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Republic of Uzbekistan: Guidebooks for Water Users' Associations in Uzbekistan

Prepared by ADAS Consulting Ltd.

A project of the Asian Development Bank, in cooperation with the Swiss Agency for Cooperation and Development, International Water Management Institute, Scientific Information Center of the Interstate Commission for Water Coordination, Japan International Cooperation Agency, and the US Agency for International Development

For Ministry of Agriculture and Water Resources (MAWR)

Asian Development Bank

OVERVIEW

In recent years, with the restructuring of agricultural land in Uzbekistan, the number of its independently run and smaller-sized farm units has been increasing. The demand for irrigation water has been increasing as well, but the development of irrigation facilities has not kept pace with the growing requirements of the small-farm users. This is because the Uzbekistan Government does not have enough funds to rehabilitate the country's irrigation and drainage infrastructure, much less to maintain the secondary and tertiary canals. The condition of the irrigation systems has therefore worsened. The utilization of water has become more and more inefficient and its distribution more and more inequitable. Moreover, as there are hardly any funds for their operations and maintenance, the on-farm irrigation and drainage infrastructure has also been deteriorating, thus making agricultural land less and less productive and farming much less profitable.

Under these circumstances, there is a growing need for farmers and other water users in Uzbekistan to take a much more active role in managing the irrigation system at the on-farm level and in ensuring the efficient use and allocation of the scarce irrigation water. They should be encouraged to become more self-reliant and to share the irrigation burden as a means for helping themselves. For this reason, the Government of Uzbekistan has taken the initiative of promoting the formation and development of water users' associations (WUAs) in the country.

Being nongovernment and noncommercial organizations, WUAs are established on a voluntary basis by users of water in particular localities. Their potential members are leasehold farmers, collective farms or *shirkats*, *dehqan* or peasant farmers, and owners of home garden plots. By organizing themselves into a WUA, they can put together the resources to run their respective on-farm irrigation and drainage systems efficiently.

Learning Guidebooks. Being a new concept in Uzbekistan, forming a WUA in the country is not an easy task. Prospective WUA organizers and members are hampered not only by their limited technical and financial resources but also by their lack of knowledge of how to organize and develop a WUA. Most of the early WUAs in Uzbekistan have therefore been formed with hardly any formal guidance, developing themselves essentially through a learning-by-doing process.

The ADB decided to come up with these six-volume WUA guidebooks in answer to this pressing need. They are meant to serve as guidebooks to prospective and existing WUAs in Uzbekistan. They address in a factual and straightforward manner the major issues and concerns that newly developed WUAs are grappling with in the changing agriculture landscape of Uzbekistan. They discuss in easily understandable terms the step-by-step technical, organizational, managerial, and financial functions and tasks that one needs to know to form, develop, and sustain a WUA.

Organization and Coverage. The six-volume guidebooks about the WUA experiences in Uzbekistan present a comprehensive picture of the WUA formation and development process in this transition economy.

Volume 1 discusses the basic principles in organizing a WUA. It focuses on the need to make the organizational structure of a WUA fit the actual conditions and prevailing social environment of the locality that it will serve. It emphasizes that no single standard organizational design will be appropriate for all irrigation and drainage systems, communities, and agricultural production systems. Thus, the organizational designs presented in these reports are mainly for illustrative purposes, and are meant to be used flexibly to fit the specific needs of the water users who are organizing themselves.

Volume 2 examines the legal basis and key legal features of WUAs in Uzbekistan, and provides a step-by-step guide on how water users in a particular locality can legally organize themselves into a WUA. In recognition of the fact that the legal and regulatory framework for WUAs in Uzbekistan is still in the formative stage, this volume also makes specific recommendations for enhancing the current WUA law.

Volume 3 discusses the requirements for ensuring a sound financial foundation for the WUA. It emphasizes that like all other nonprofit organizations, a WUA has to manage its financial affairs properly to ensure its efficient operation and continuing viability. Taken up in detail in this volume for the continuing guidance of WUAs are financial management and its purposes, principles, and activities; the creation of a WUA budget and calculation of a WUA's irrigation service fee; accounting procedures and practices; and auditing.

Volume 4 discusses in detail the various activities and procedures for the management, operation, and maintenance of a WUA. Each of these aspects is described step-by-step, including the equipment required at start up and on an ongoing basis, the technical staff need to run a WUA and their qualifications, samples of important documents and forms needed by a WUA, basic operating and maintenance functions, and key performance indicators for measuring the quality of work and services delivered by a WUA.

Volume 5 is a comprehensive technical guidebook designed to ensure the efficient management of irrigation water at the farm level. It discusses the various types of cropping and their corresponding irrigation requirements, the scheduling of irrigation water delivery, techniques and field applications for testing and verifying water flow and discharges, and drainage and soil management practices for avoiding farmland salinity.

The sixth and final volume is a field handbook for WUAs in Uzbekistan. Designed as a companion feature of the 5 WUA guidebooks, it discusses the various procedures and techniques needed to ensure effective water use management. It provides basic operation and maintenance guidance to WUAs in Uzbekistan so they can keep the state of repair of the irrigation and drainage infrastructure as near as possible to its "as-built" condition. It is intended specifically for the continuing reference of a WUA's line staff, but since it focuses on proven and time-tested methods for the in-farm management of irrigation and drainage systems, it should also prove very useful to farmers in the WUA's service area.

Contributors. These guidebooks were prepared as a cooperative effort by a team of consultants from ADB's Agricultural Development Advisory Service, namely (in alphabetical order) Iskandar Abdullaev, Ikramali Ahmedov, Norboy Ghoyipnazarov, Cliff Henkel, Tahir Majidov, Otabek Rashidov, Mike Thurman, Mehmood Ul Hassan, and Murat Yakubov. In preparing these volumes, they worked in close cooperation with the project staff of the Integrated Water Resources Management (IWRM) in the Ferghana Valley, using much of their field data and insights on water use management as inputs for these five guidebooks and field handbook. To determine the current state of development and the problems of WUAs in Uzbekistan, they and the IWMI team conducted extensive fieldwork in the Ferghana Valley and in various other farming areas in the country. They also used as reference various documents and papers on irrigation and drainage management as well as on WUA formation from a wide range of sources in Uzbekistan.

ADB would like to express its thanks to the authors of this six-volume guidebook for their invaluable and untiring efforts, to the countless people who have provided their support and cooperation to this undertaking, and last but certainly not the least, to the SDC, IWMI, and US Agency for International Development (USAID) for generously sharing their resources to make these manuals possible. The Regional and Sustainable Development Department, Energy, Transport and Water Division's (RSID) Water Team of ADB is gratefully acknowledged for providing insightful comments to the various drafts of these guidebooks. Lastly, financial support for the reproduction of these guidebooks was made possible through the ADB Regional Technical Assistance 6095: *Integrating Environmental Concerns in Government Policies, Plans, and Programs Concerns*.

August 2006

Preface

The Government of Uzbekistan is promoting the development of water users' associations (WUAs) in the country. WUAs play an important role in the allocation and management of the water resources of the country. They serve as responsive vehicles for ensuring the efficient, sustainable, and equitable use of irrigation water. By actively promoting sustainable water use management practices at the farm level, the WUAs in Uzbekistan are also helping reverse the serious degradation of the country's agriculture land while significantly improving farm productivity and profitability.

To further hasten the formation and growth of WUAs in Uzbekistan, the Asian Development Bank (ADB) has produced these six guidebooks about the WUA development process and experience in the country. The ADB engaged the services of a nine-man team of water resource management consultants for the undertaking. The team worked on the project under an advisory support program, the Technical Assistance for Uzbekistan (TA 3706-UZB: Institutional Support for Sustainable Agricultural Development), which was undertaken in association with the ADB Uzbekistan Ak Altin Agricultural Development Project (Loan No. 1833-UZB)).

The six guidebooks are the first of their kind in Central Asia. They focus on the formation process, legislative status, operations, organizational life, financial needs, and technical requirements of WUAs in Uzbekistan. They are designed to serve as comprehensive tool kits for addressing the many issues and problems that newly developed WUAs have to grapple with before they can make themselves sustainable..

These guidebooks are addressed to a wide range of target audiences, particularly irrigation managers, WUA farmer-members, agriculture and water resources ministry officials, representatives of district and province *hakimiyats*, nongovernment development practitioners, and members of the international community who are primarily involvedt in the establishment of WUAs in Uzbekistan. While they were written in the context of Uzbekistan's agriculture circumstances, with the Ak Altin agricultural area as a particular case in point, their insights and prescriptions should also prove useful to the Governments of other Central Asian transition economies and to their own WUAs.

The production of these guidebooks benefited from the support and cooperation of ADB's many partners in the international community. In particular, the six volumes drew heavily from the experiences of the Integrated Water Resources Management (IWRM) in Uzbekistan's Ferghana Valley. This IWRM project in Ferghana, where one of the very first WUAs in Uzbekistan has been successfully developed, is funded by the Swiss Agency for Cooperation and Development (SDC) and is jointly managed by the International Water Management Institute (IWMI) and the Scientific Information Center of the Interstate Commission for Water Coordination (SIC-ICWC). Also, the preparation of these manuals was fully supported by the US Agency for International Development (USAID). Finally, financial support for the reproduction of these guidebooks was made possible through the Regional Technical Assistance 6095: Integrating Environmental Concerns in Government Policies, Plans, and Programs Concerns.

We hope that these six-volume guidebooks would prove useful to Uzbekistan and other countries in Central Asia in promoting the formation of WUAs as partners in agricultural development.

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WATER USERS' ASSOCIATIONS IN UZBEKISTAN

GUIDEBOOK 1:
OVERVIEW, FORMATION, AND DEVELOPMENT

August 2006

CURRENCY EQUIVALENTS
(as of August 2006)

Currency Unit - som (SOM)

SOM	=	$0.000815
$1.00	=	SOM1,226.74

ABBREVIATIONS

MAWR	Ministry of Agriculture and Water Resources of Uzbekistan
NGO	nongovernment organization
O&M	operations and maintenance
RBAC	Rural Business Advisory Center
WUA	water users' association
WUG	water user group

GLOSSARY

aksakals	elderly people
avran	rotational distribution
bosh ariqlar	main canals
dehqan	peasant
fermer xojaliklari	farming enterprise
fermerlar uyushmalari	association of farmers
fuqaro yighini	assembly of citizens in a rural municipality
hakimiyat	local administration at district and province levels
hashar	community-organized activities rendered for free
imam	religious leader of mosque
kengash	assembly
kolkhoz	collective farm (during Soviet period)
kolkhozy	variant of *kolkhoz*
magistrallar	main irrigation canal and main drain-collectors
mirabs	watermasters
nawbat	turn
pudrat	family-based production units
pudratlar	variant of *pudrat*
rais	chairman
shirkat	present-day collective farm whose assets are co-owned by the farmers
shirkatlar	plural of *shirkat*
shox ariq	secondary canal
sovkhoz	state farming enterprise (during Soviet period)
sovkhozy	variant of *sovkhoz*
tamorqalar	household or garden plot
ustuvorligi	priority
uq ariqlar	tertiary irrigation canals

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INTRODUCTION

This guidebook aims to help facilitate the formation and development of water user associations (WUAs) in Uzbekistan. It is specifically designed as a resource material for the major participants in that process, particularly members of WUAs, agriculture and water resources ministry officials, representatives of district and province *hakimiyats* (local administrations), and the staff of donor organizations primarily involved in establishing WUAs in Uzbekistan.

Although prepared with the specific needs of Ak Altin in mind, the material presented in this guidebook was designed such that it can also be applicable to other areas in Uzbekistan, whether or not they are being assisted by a similar government-supported or international donor-supported project.

This guidebook conforms to all the relevant laws, codes, and degrees of the Uzbekistan Government. To the maximum possible extent, it also conforms to the guidelines contained in the manual produced by Uzbekistan's Ministry of Agriculture and Water Resources (MAWR) for the creation of WUAs. That earlier manual was based on Attachment No. 7 to Decree No. 8 (5 January 2002) entitled "On Measures Concerning the Restructuring of Agricultural Enterprises." It stipulated the creation of WUAs on the territory of liquidated *shirkatlar* or production cooperatives.

Along with the four other guidebooks in the series, this WUA formation and development guidebook recommends a number of important changes and corrections to the manual prepared by the MAWR. It is hoped that for consistency and unity in approach, the MAWR would ultimately adopt this series of guidebooks as its own.

I. OVERVIEW

A. What is a Water Users' Association?

A water users' association, or WUA, is a nongovernment, nonprofit organization[1] initiated and managed by a group of farmers and other water users along one or more hydrological subsystems or watercourses. Its potential members are water users such as individual members of leaseholding farms and *shirkats* (collective farms), owners of private and *dehqan* (peasant) farms, and owners of home garden plots. By organizing themselves, they can put together the financial, material, technical, and human resources needed to manage, operate, and maintain an efficient irrigation and drainage system in their locality.

B. What are the Major Benefits of Having a WUA?

The major benefits of having a WUA are as follows:

- Creation and enforcement of a unified set of water use rules within the area it serves;
- Protection of the interest of WUA members and of other legitimate water users;
- A stronger negotiation capability for farmers;
- A more responsive, better understood, and well-respected water management system for farmers and other water users;
- A more equitable distribution of water among farmers regardless of their location, type and size of farm, and status (whether a WUA member or not);
- A much more reliable water supply for particular crops and other needs;
- More systematic and efficient use of water that will minimize waste and prevent erosion, salinization, waterlogging, groundwater depletion, and over-watering of irrigated lands;
- Prevention of illegal withdrawals of water;
- Faster and more efficient resolution of disputes between WUA members and nonmembers over (1) the distribution and use of water, (2) the management of irrigation and drainage infrastructure, and (3) the operation and maintenance of equipment;
- Better maintenance of irrigation canals, drainage and other infrastructure, operating and maintenance equipment, and other properties owned by the WUA;
- Better protection of the environment;
- Improvement of onfarm water use; and
- Creation of opportunities for other mutually beneficial activities for WUA members.

C. What are the Major Tasks of a WUA?

To provide these benefits to its members, a WUA carries out the following tasks in an organized way:

- Protects the interest of its members by facilitating a fair and democratic decision-making process, and ensures the full participation of members in WUA activities;

[1] Uzbekistan law refers to nongovernment organizations (NGOs) such as WUAs as "non-governmental, non-commercial organizations." Henceforth in this manual, NGOs will be referred to as "nongovernment, nonprofit organizations."

- Withdraws irrigation water from main canal systems on the basis of contracts or agreements, and abstracts water from rivers, lakes, or groundwater sources in accordance with permits and contracts;
- Distributes irrigation water in an equitable and timely manner based on contracts or agreements between the WUA and water users, whether WUA members or not;
- Resolves disputes between members by facilitating information-sharing, consultation, and mutual agreement;
- Makes short-term and long-term estimates and plans for the maintenance and development of the WUA’s irrigation and drainage systems;
- Maintains the WUA’s irrigation and drainage systems on the basis of long-term needs;
- Rehabilitates or improves the WUA’s irrigation and drainage systems, and performs construction works as needed;
- Procures, replaces, and repairs operations equipment, maintenance equipment, and other WUA property;
- Prepares an annual budget and work plan for the WUA’s operations and other activities;
- Collects membership fees and the operations and maintenance charges needed to sustain the WUA’s activities;
- Manages the WUA’s finances;
- Trains WUA members (1) in the proper governance, management, and operation of the association, and (2) in advanced and sustainable irrigation and drainage practices;
- Implements water conservation measures such as rotational distribution (*avran* or *nawbat*);
- Implements environmental protection measures;
- Monitors and evaluates the WUA’s performance and development;
- Makes reports about the association’s operations and financial position as required by regulatory authorities and other concerned bodies; and
- Provides additional services or ancillary functions that may be required once the WUA becomes fully self-sustaining.

D. How Can a WUA be Formed, Developed, and Sustained?

Successful WUAs typically pass through the following three stages in the course of their development: (1) formation, (2) transition and empowerment, and (3) sustainability.

Formation. This stage covers the preliminary tasks required to create a WUA and to enable it to begin its activities. During this stage, the water users decide to establish a WUA following the steps that are discussed in detail in this guidebook. The new WUA then registers itself, opens a bank account, and signs a management transfer agreement with the local state irrigation authority. Water users pay an initial membership fee to the association.

Transition and Empowerment. This stage covers the development and strengthening of the WUA’s capability to accomplish its operations and maintenance tasks. During this stage, the members of the new WUA become more and more knowledgeable about their rights and duties, and they learn to exercise them democratically. The staff of the WUA Management Team has been hired and is being paid regularly. A long-term training program for WUA staff and association members has been initiated. The WUA is able to prepare a long-term operations and maintenance plan. It is able to gradually increase the irrigation service fee to cover expenses and to pay for charges by outside agencies. The percentage of association members who are dutifully paying the irrigation service fee is growing. In practice, most WUAs remain in this phase for several years before becoming self-sustaining.

Sustainability. This is the stage when the WUA has become viable both organizationally and financially: All of its internal governing and management bodies have been constituted and have become fully accountable to the WUA membership. The members of the WUA management staff have become fully competent in handling their responsibilities. All WUA members are now regularly paying the irrigation service fee. The WUA is able to undertake regular preventive maintenance for its facilities and equipment.

Once a WUA becomes self-sustaining, it is ready to join other WUAs in a federation. The formation of a federation of sustainable WUAs within a specific region is highly desirable for two major reasons: (1) it allows them to combine resources and achieve economies of scale, (2) it makes them capable of operating and managing common distributaries and possibly even main canals and other joint infrastructures. Such a federation may even become capable of performing additional or ancillary functions for the benefit of the WUAs, such as input supply, agro-processing, and agricultural advisory services.

E. Why are WUAs Needed in Uzbekistan?

WUAs are urgently needed in Uzbekistan because leasehold farming has become its most predominant agricultural production system. By getting adequate irrigation water and by practicing good irrigation water management, the country's farmers can achieve higher farm productivity and earn bigger incomes from their crops.

Uzbekistan has over 4 million hectares (ha) of irrigated land. This accounts for over 98% of the country's crop production and 92% of its use of water. During the last decade, however, Uzbekistan's irrigation and drainage systems have been performing far below expectations. This is particularly the case with the irrigation and drainage systems within the boundaries of both existing and former *shirkats* or production cooperatives.

Causes of Poor Irrigation Performance. The irrigation and drainage systems in Uzbekistan are performing poorly for the following reasons:

- Their management is too centralized. As such, their operation and maintenance plans are extremely standardized. They are unsuited to actual conditions in many locales. They cannot respond fast enough or well enough to the problems of farmers and other water users at the local level.
- They could no longer be operated and maintained properly by the shirkat*s* and by the other production cooperatives. This is because these shirkat*s* and production cooperatives are performing badly themselves. As a result, the irrigation and drainage systems have deteriorated in many places. The water supply has become unreliable. Also, the onfarm systems no longer get the proper attention.
- The distribution of irrigation water to users has become severely unequal. This problem is mainly due to two reasons: (1) water from the irrigation canals is being poorly distributed, and (2) illegal water withdrawals have been increasing. As a result, the water supply in many downstream areas has become unreliable. Disputes among water users over the distribution of irrigation water have also been increasing.

Remedial Action Taken by the Government. In 1999–2000, the Ministry of Agriculture and Water Resources (MAWR) of Uzbekistan took concrete steps to remedy this situation. It began discussions with the World Bank and other donor agencies on the possibility of introducing WUAs in Uzbekistan. After that, it created WUAs on an experimental basis in such areas as Karakalpakistan and Khorezm and the Syr Darya provinces.

Because more and more shirkat*s* were being liquidated, the need to create WUAs in Uzbekistan became even more urgent. For this reason, the Uzbekistan national Government decided to establish WUAs at an even faster rate. In early 2002, it decreed that WUAs should be established on the territory of liquidated shirkat*s*. This decree was contained in Attachment No. 7 to Decree No. 8 (5 January 2002), entitled “On Measures Concerning the Restructuring of Agricultural Enterprises.”

Status of WUA Formation in Uzbekistan. At present, according to data from the MAWR, 562 WUAs have already been formed in Uzbekistan. These WUAs serve over 56,000 farms, of which 52,000 are leasehold farms (*fermer xojaliklari*). The total area served by these WUAs is 1.72 million ha. This is almost half of the entire area served by the irrigation and drainage systems in Uzbekistan.

Of the existing WUAs in Uzbekistan, 223 were formed in late 2003 and in 2004. In the next 2 years or so, over 700 more WUAs are expected to be formed. This is as projected by Decree No. 476 of 10 October 2003 entitled “On Measures for the Implementation of the Conception of the Development of Leasehold Farms in the Years 2004–2006.”

All of these WUAs in Uzbekistan, both old and new, need to be immediately trained on how to develop and run themselves. It is for this reason that this guidebook on the formation and development of WUAs has been prepared.

II. ORGANIZATIONAL STRUCTURE OF A WUA

A. Principles of Organizing a WUA

There is no standard method for organizing a WUA. This is because every WUA has to be organized on the basis of the actual conditions in the locality that it will serve. It has to fit the prevailing social environment. It has to work with the existing irrigation and drainage system and agricultural production systems in the locality.

Major Organizing Principles. Wherever a WUA is organized, however, the following eight major principles should be observed:

- The WUA must be formed and developed with the fullest possible participation and involvement of its prospective members. It should mobilize their support and make full use of their deep familiarity with the existing irrigation and drainage system in the locality.
- The WUA must build upon the pre-existing institutions of collective action in Uzbekistan such as the *hashar*, which are organized activities traditionally rendered by members of the community for free. This will help ensure the successful operation and maintenance of the irrigation and drainage system.
- The WUA must be based on a specific hydrological unit or water system. If necessary, the WUA's organizers must make an effort to reconfigure this unit based on the prevailing farm structure in the locality.
- The WUA must be large enough to permit economies of scale, yet small enough to keep its management costs low.
- The WUA's organizational structure should be as simple as possible. This particularly applies to Uzbekistan, where forming WUAs is still a very recent development. Also, there must be a separation of powers and a balance of powers within the WUA. Its members should not be allowed to hold multiple positions in the WUA's various governing or management units.
- The WUA must get the continuing support of outside organizations such as the bulk water supplier and the *hakimiyat* (local administration). It should always aim to cultivate beneficial relationships with them.
- The WUA must make itself flexible enough so it can serve not only the present but also the future needs of its members.

Essential Functions of a WUA. A WUA has two essential functions: governance and management. Its organization must provide for internal bodies that will separately perform these two functions.

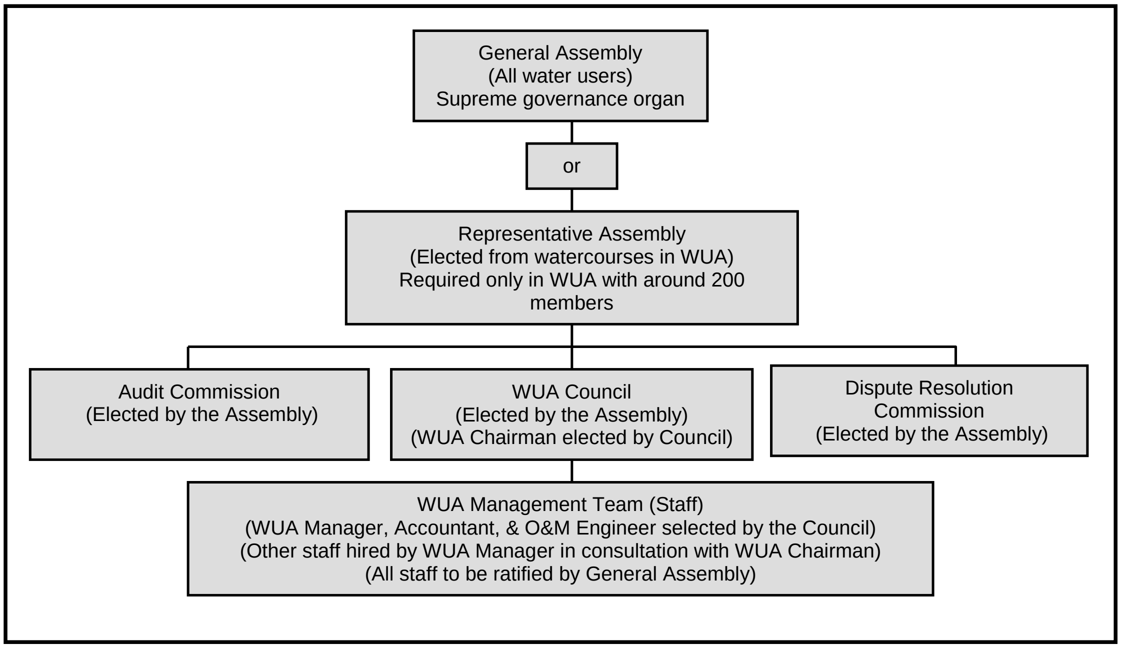
The governing and management bodies of a typical WUA are presented in Figure 1.

B. The WUA's Governance Functions

The governance functions of a WUA are as follows:

- Setting irrigation and drainage service objectives based on the needs of the WUA's members;
- Formulating policies to meet the WUA's service objectives;
- Appointing staff for the WUA Management Team that will oversee the WUA's operations and activities;
- Monitoring, evaluating, and supervising the performance of the WUA Management Team;

Figure 1. Structure of a Typical WUA



- Resolving disputes among WUA members; and
- Auditing of the association's finances and assets.

The internal bodies of the WUA responsible for these governance functions are the General Assembly or the Representative Assembly, the WUA Council, the Dispute Resolution Commission, and the Audit Commission.

The members of WUA governing bodies must be members of the WUA themselves. Members elected or appointed to positions in WUA governing and management bodies should not hold more than one position at the same time. This is to avoid conflicts of interest among them.

C. The WUA's Management Functions

The management functions of a WUA are as follows:

- Day-to-day handling of irrigation and drainage-related tasks;
- Identifying and planning seasonal, annual, medium, and long-term maintenance-related tasks;
- Preparing cost estimates and budgets;
- Calculating water charges for various members and nonmembers as well as issuing billings for and collecting water charges;
- Collecting, processing, and analyzing data required for periodic reports to governing bodies and regulatory authorities; and
- Performing other water-related and land-related tasks required by the governing bodies.

The internal body of the WUA responsible for its management functions is the WUA Management Team. It implements the mandates established by the WUA's governing bodies.

D. The WUA's Governing and Management Bodies

1. The General Assembly

The WUA's supreme governing body is the General Assembly. It consists of all members of the WUA. It provides general strategic guidance to the WUA Council and to the WUA Management Team.

Powers of the General Assembly. The General Assembly has the following powers:

- Defining the main directions of the WUA's activities;
- Establishing and making necessary changes to the organizational structure of the WUA's internal governing and management bodies, as well as determining their mandates, rights and responsibilities, terms of office, and decision-making procedures;
- Nominating, electing, and, whenever necessary, dismissing members of internal governing bodies;
- Ratifying staff appointments made by the WUA Council and its chairman and those made by the WUA Management Team itself;
- Approving annual and long-term policies and plans of the WUA for operations, maintenance, and other activities;
- Setting the annual membership fees and charges to members and nonmembers as well as setting the method of payment;
- Approving the WUA's annual report and financial statements;
- Approving the WUA's annual budget;
- Approving work plans and irrigation schedules;
- Establishing and amending internal bylaws and orders;
- Approving management transfer agreements;
- Establishing sanctions such as water cut-offs and the level of fines in case of non-payments, and establishing sanctions for breaches of charter provisions and other internal rules;
- Deciding on the acquisition of funds or credit from banks and other sources; and
- Deciding on reorganizations and the appointment of a liquidation commission if necessary, and approving interim and final liquidation balances.

Meetings of the General Assembly. The General Assembly has to meet at least twice a year. Quarterly meetings of the General Assembly are recommended during the first 2 years or so of the WUA.

Decisions by Majority Vote. Each member of the General Assembly is entitled to one vote. All decisions of the General Assembly are made through majority vote. A majority vote means a majority of all the members. This means that if the WUA charter provides that at least 65% of the total membership should constitute a General Assembly, at least 80% of those present must vote in favor of the proposal. The same rule applies to voting by the Representative Assembly.

2. The Representative Assembly and the Water User Groups

In many WUAs of moderate size, all of the members can gather for a General Assembly meeting without encountering major problems. However, this may not be possible in the case of WUAs with 200 members or more. The assembly may become too difficult to manage, or a suitable meeting place for it may not be found.[2]

Creating Hydrological Zones. To make the size of the assembly more manageable, the WUA may divide its WUA members into separate hydrological or watercourse zones. Each zone has to correspond to a hydrological unit within the WUA's territory, which is usually a tertiary canal. Such a unit typically consists of 5–20 members occupying an area of between 300 to 1,000 ha. In each of these hydrological zones, the members elect their own representative to the Representative Assembly.

Forming Water User Groups (WUGs). A WUG can either be formal or informal. It functions best informally in zones where water users can cooperate and work closely in operations and maintenance, such as the hashar. If such an informal cooperation is not possible, the WUA members may consider creating a formal WUG instead. They can draw up a simple charter for this WUG and appoint a council to manage its internal affairs. They can even elect one or more members to the Representative Assembly.

Powers of the Representative Assembly. The powers of the Representative Assembly are the same as those of the General Assembly. This is except for those extraordinary circumstances when the WUA needs to convene a General Assembly. For this reason, this guidebook will use the term General Assembly to refer to both the General Assembly and the Representative Assembly.

3. The WUA Council

The WUA Council, or *Kengash* (assembly), is mandated to manage, supervise, and monitor the day-to-day financial and technical activities of the WUA. It typically has a minimum of five members, all chosen by election. The council members then elect a chairman from among themselves. The chairman of the WUA Council becomes the highest official in the WUA.

Responsibilities of the WUA Council. The responsibilities of the WUA Council are as follows:

- It manages the WUA's activities and performs the General Assembly's mandates during periods in-between General Assembly meetings;
- It elects a WUA Chairman from among the members of the WUA Council;
- It appoints the manager, accountant, and operations and maintenance engineer for the WUA Management Team;
- It ensures that the WUA Management Team performs in accordance with the charter and duly represents the interests of all members, and reviews the activities of the WUA Management Team on a monthly basis;
- It monitors the financial operations of the WUA and makes financial reports on a monthly or quarterly basis;
- It reviews and revises budget and work plans as proposed by the WUA Management Team;
- It prepares the WUA's annual balance report, budget, irrigation service fee, and work plan, then presents them to the General Assembly for approval;

[2] The threshold of 200 members is only a general recommendation. It should not be perceived as an established limit. WUAs must identify an appropriate organizational design that will (1) ensure adequate representation of their hydrological zones, and (2) fit the specific conditions of the locale served by the WUA.

- It reviews the reports of the Audit Commission;
- It participates in the WUA's monitoring, evaluation, and feedback activities;
- It calls and manages General Assembly meetings and prepares the agenda for them; and
- It implements other matters assigned to it by the General Assembly.

Authority of the WUA Council. The chairman of the WUA Council (1) has the authority to sign documents on behalf of the WUA, (2) is responsible for representing the WUA in its dealings with outside entities and organizations, and (3) represents the WUA in court proceedings that may involve it.

4. The Audit Commission

A WUA should have its own Audit Commission. The members of this commission have to be elected by the General Assembly or Representative Assembly. The Audit Commission conducts an annual review of all financial records and books of the WUA. It makes a periodic inventory of its various assets. Based on this review, the Audit Commission then prepares a report of its conclusions and recommendations and presents them to the General Assembly. The General Assembly reviews this report and takes appropriate action on any problems or irregularities cited in the report. During audits, the WUA accountant has to fully assist the Audit Commission by presenting to it all pertinent records and accounts for examination.

5. The Dispute Resolution Commission

When a WUA's water distribution and maintenance services are inequitable and often result in significant conflict, it may become necessary to establish a Dispute Resolution Commission. This commission primarily serves as an intermediary in disputes over (1) the distribution of water irrigation, (2) the outflow of drainage water, and (3) the maintenance of the irrigation and drainage infrastructure. It uses public hearings and mutual consensus as the primary means for resolving such disputes. However, if a consensus cannot be reached between the contending parties during such public hearings, the commission has to make a ruling on the dispute. This ruling becomes binding on all the parties concerned unless a court of law overrules it.

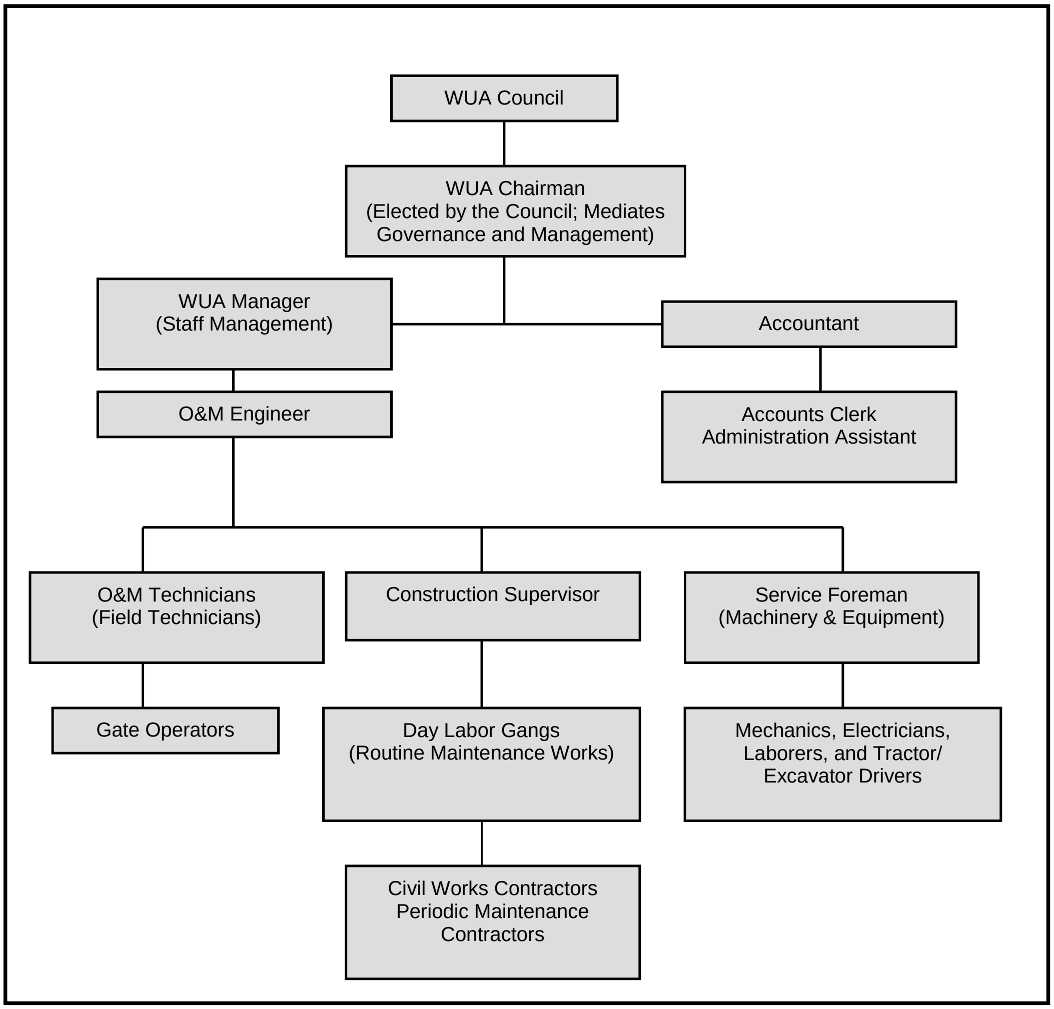
To effectively perform its functions, the Dispute Resolution Commission has to work in close coordination with the MAWR's District Water Control Commission, the WUA Council, and the WUA Management Team.

6. The WUA Management Team

The WUA Management Team runs the day-to-day operations of the association. It typically consists of the WUA manager, the WUA accountant, and the WUA operations and maintenance engineer. They are all appointed by the WUA Council, subject to the General Assembly's approval. The rest of the staff of the Management Team are appointed by the WUA manager. This staff may include operations and maintenance technicians, gate operators, an amelioration expert, a head mechanic, drivers, and a security guard. The members of the Management Team are the only positions in the WUA that receive a salary. Their salary rates are subject to the General Assembly's approval.

Typical Structure of the WUA Management Team. The typical structure of a fully developed WUA Management Team is shown in Figure 2.

Figure 2. Structure of a Fully Developed WUA Management Team



Tasks of the WUA Management Team. The tasks of the WUA Management Team are as follows:

- Hiring and supervision of the WUA staff;
- Preparing draft budgets and work plans for the WUA Council's approval;
- Maintaining a register of members and reviewing and updating it annually;
- Operating and maintaining the WUA's irrigation and drainage systems;
- Preparing proposed plans for water delivery, maintenance, and financing as well as preparing draft contracts for the WUA Council's approval;
- Concluding contracts on behalf of the WUA and ensuring their fulfilment;
- Managing the finances and assets of the WUA;
- Providing information to the WUA's internal bodies and members; and
- Undertaking monitoring, evaluation, and feedback activities.

7. Organizational Design Options

There is no standard organizational design for a WUA that will be appropriate for all irrigation and drainage systems, communities, and agricultural production systems. The design should be based on the specific needs of the water users that are organizing themselves. In particular, a WUA has a choice between forming a General Assembly or a Representative Assembly. It may or may not create a Dispute Resolution Commission. Depending on the magnitude of its operating and maintenance tasks, it can also be flexible in determining the composition and size of the staff of the WUA Management Team.

III. FORMATION OF A WUA

The formation of a WUA should not be done hurriedly. Its organizers need to consider very carefully the specific conditions of the irrigation and drainage system and of the communities the WUA intends to serve. Only after this evaluation is done should formation activities be started.

Formation Activities. The major WUA formation activities are as follows:

- Establishing an Initiative Group;
- Establishing rapport with prospective members and building a knowledge base;
- Establishing a formation committee;
- Making consultations on organizational issues;
- Preparing the necessary documents for forming a WUA;
- Holding formation meetings;
- Registering the WUA;
- Forming WUGs and, if part of its chosen organizational design, electing a Representative Assembly;
- Selecting personnel for the WUA Management Team;
- Negotiating and ratifying management transfer agreements;
- Building status and acquiring recognition as a primary water user;
- Collecting membership fees and transferring shirkat equipment; and
- Negotiating and signing contracts with the MAWR.

Preparatory Steps. Sufficient preparation is needed before a WUA can be formed. The Initiative Group must first undertake the following preparatory steps:

- Build rapport with local water users;
- Generate support for the WUA;
- Make water users aware of what is required to successfully create a WUA; and
- Familiarize themselves with the local agricultural production systems and their various operating and maintenance requirements.

Once these four steps are successfully completed, the Initiative Group can proceed to the next three steps:

- Establish a Formation Committee;
- Discuss the various organizational options with potential members; and
- Begin the activities required to formally establish the WUA.

A. The Initiative Group

The first step in forming a WUA is identifying and gathering a group of people who are interested in the idea and who stand to directly benefit from it. They are the ones who will eventually form the Initiative Group.

An Initiative Group has to be informal in character. Its potential members should preferably be persons who can rightfully become members of the WUA. This means that they are water users in actual possession of the right to utilize agricultural land in the locality.

Need for Advice and Support Groups. In many areas of Uzbekistan, however, potential WUA members would likely not have enough knowledge or resources to initiate the formation of a WUA. They need advice and support from outside agencies like the District

MAWR Department,[3] the Shirkat Liquidation Commission, the hakimiyat, the rural municipality, the Rural Business Advisory Center (RBAC), and the implementation unit of a donor project. If support units for WUAs are brought closer to the water users themselves, the formation of WUAs would be greatly encouraged and enhanced. It is therefore recommended that the Ministry of Agriculture and Water Resources establish such support units at the district, province, and central levels.

Criteria for Initiative Group Members. Potential members of an initiative group should be chosen based on the following criteria:

- Honesty and personal integrity;
- Reputation as a member of the local community;
- Clear understanding of the value of collective action in pursuing the common good;
- Thorough understanding of the local conditions in irrigated agriculture;
- Thorough understanding of the needs and wants of the water users within the designated waterway boundaries of the proposed WUA;
- Ability to communicate effectively with local farmers and institutional water users (industrial, religious, educational, and others) as well as with the local authorities; and
- Willingness to devote a significant portion of his or her spare time to the WUA formation process.

Tasks of the Initiative Group. The Initiative Group has to work with the farmers and outside agencies to accomplish the following tasks:

- Generate support and possible material assistance for the WUA from within the hakimiyat and from other local authorities;
- Build rapport with farmers and other known water users, create internal demand for WUA formation, and make potential members aware of the purpose and potential benefits of the proposed WUA;
- Collect baseline data;
- Do problem analysis and service identification;
- Determine the service area of the WUA and, with the participation of the farmers and other water users as well as outside agencies, identify an appropriate organizational design for the WUA; and
- Establish a Formation Committee.

Timing of the Initiative Group's Work. The best period for the work of the Initiative Group is in the late fall and winter, after the cotton harvest in Uzbekistan. The duties of the Initiative Group usually require a minimum of a month's work.

B. Building Rapport and Knowledge

1. Obtaining the Support of Local Authorities

The formation of a WUA will only be possible with the support and cooperation of the local authorities. Thus, during the formation stage, the Initiative Group must closely and regularly interact with the hakimiyat and the District MAWR Department.

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[3] The unit within the District MAWR body might be the existing Department for Water Use (in accordance with Attachment No. 5 to Decree No. 290 of 2003, "Concerning Improving the Organization of Water Management"). This unit might be a WUA Support Unit instead as proposed later in this manual.

This interaction is very important particularly in the case of WUAs that are being created on the territory of liquidated shirkats. This is because it is very likely that the local authorities, especially the District MAWR Department and the Shirkat Liquidation Commission, are already involved in the WUA formation process as mandated by the Uzbekistan Government in Decree No. 8 of 5 January 2002.

In such instances, the Initiative Group has to ensure the following:

- That the WUA formation process actively involves the farmers and other water users;
- That the process does not become a highly centralized effort that is dominated by outside agencies; and
- That the process does not exclude potential WUA members from active participation and decision-making.

Otherwise, the prospective members will not get actively involved in the WUA's formation. The chances for successful governance and management of the new WUA would be greatly reduced as a result.

2. Hydrological Units and Their Appropriate Size

In consultation with local authorities, the Initiative Group has to clearly establish the area, boundaries, and size of the hydrological unit to be served by the proposed WUA. This must be done before formally collecting baseline data within this area and before consulting with water users within the proposed hydrological unit.

Below is a background discussion that should serve as a rough guide on how to establish these units and determine their appropriate sizes.

Hydrological Basis for Management. In 2003, the Government of Uzbekistan decided to adopt the hydrological basis instead of the administrative basis for the country's irrigation and drainage management. As provided for by Decree No. 290, irrigation and drainage management is now being undertaken at the level of main canals, the *magistrallar* (main irrigation cananl and main drain-collectors) and the *bosh ariqlar* (main canal collectors). This is a principle that logically should also be applied to the WUAs, since they typically would also be receiving water from the main canals.

Throughout the world, the most successful WUAs are those that serve the territory supplied by a distributary canal, or the canal that distributes water directly to farms or supplies water directly to other water users. In Uzbekistan, a distributary canal is also known as a "secondary canal" or *shox ariq*. It supplies several watercourses, which in turn supply water to the farmlands directly or through their branches. These watercourses are also known as "tertiary canals" or *uq ariqlar*.

Identifying Conflicts of Interest. In forming a new WUA, problems might arise when plots of land that belong to different secondary canal systems are incorporated into the same WUA. It is possible that water users on the separate distributary canal systems may not be able to recognize each other's needs and problems. This could result in possible conflicts of interest. The Initiative Group therefore must identify such conflicts of interest ahead of time. It also must find solutions that are mutually acceptable to the water users involved.

Mapping the Hydrological Unit. To create a new WUA that conforms to a hydrological unit, the local farm boundaries within that WUA have to conform to the boundaries of the hydrological unit itself. By definition, a hydrological unit is one that covers the areas that will be served by the new WUA. It is therefore very important for the Initiative Group to find or create a map that (1) clearly indicates the configuration of the irrigation and drainage system, and (2) clearly indicates its relationship with existing farm boundaries. This mapping is particularly important because in Uzbekistan, the predominant farm structures are the production cooperative (shirkat), the leasehold farm, and the dehqan farm, not all of which may have clearly defined physical boundaries. Appendix 1 describes these types of farms in detail.

The Shirkat Liquidation Commission, the hakimiyat, the Irrigation System Administration, or the District MAWR Department—perhaps even all of them—would very likely have such a map. All of them must therefore be consulted on this matter. However, if the boundaries of a former or present shirkat do not constitute a hydrological unit, the Initiative Group should work for the establishment of a unified hydrological unit acceptable to all the administrative bodies concerned (see Appendix 2). The Initiative Group should negotiate this with the Shirkat Liquidation Commission, the hakimiyat, or the District MAWR Department.

Aiming for Economies of Scale. When determining a WUA's proposed service area, the Initiative Group should consider not only the hydrological unit and the farm structures of the territory. It should also consider the size of the territory and the number of potential members within it. The most important consideration, of course, is to have a WUA that can realize economies of scale. Typically, a WUA that can meet this criterion will have an area of between 1,500 ha and 10,000 ha. When determining the hydrological unit, however, local factors specific to the WUA's service area should also be carefully considered. These factors include (1) the WUA's management capability and the number of its members, (2) the number of water offtakes, (3) the complexity of the irrigation and drainage system, and (4) the cropping patterns in the area.

Conditions for Creating a WUA. Creating a single WUA along a hydrological unit would usually be enough under the following conditions: (1) if it covers relatively few farms from about 30 to100, (2) if it covers a substantial territory from about 3,000 ha to 7,500 ha, and (3) if there is adequate management capability to run the WUA efficiently. However, when a WUA of this size must serve a much larger number of members, say 200 or more, it may be better to consider another set of alternatives: (1) create separate WUAs based on the characteristics of the hydrological unit or of the farm structure, or of both; or (2) create within the WUA separate WUGs or a Representative Assembly, or both of them.[4] As a general rule, a balance has to be made between economies of scale and the number of members that can be adequately served by a WUA without incurring excessive paperwork and transaction costs. Appendix 2 describes the typical relationships of farms to hydrological boundaries in Uzbekistan.

3. Familiarization Meetings

After determining the hydrological unit that it will serve, the Initiative Group has to build the trust and confidence of the farmers and other water users in that unit. It can start with introductory meetings on the objectives, functions, and organizational structure of the proposed WUA. The formation process of the proposed WUA and the responsibilities of WUA members, particularly the payment of the irrigation service fee, must be emphasized in those meetings.

[4] Again, it must be emphasized that the numbers proposed here are not rigidly established limits. The Initiative Group and the Formation Committee must decide on the number in accordance with the principles presented later in this section.

4. Information and Awareness Campaign

An information and awareness campaign about the proposed WUA has to be undertaken alongside the familiarization meetings. This campaign should clearly explain what WUAs are and what they aim to do. It should strongly emphasize the potential benefits that members can derive from organizing one.

Choice of Information Media. Depending on the resources and outside support available for it, the information campaign can take the form of brochures, newspaper articles, media interviews, and short TV and radio presentations. Since farmers in Uzbekistan are not avid readers, the information is best presented in simple and easily understood forms. Efforts should also be undertaken to convince the local elders (*aksakals*), *imams* (religious leaders), and other respected persons in the locale to help inform the population about the benefits of the WUA. Particular emphasis should be given to the WUA's role in helping conserve the natural resources in the area.

Conducting Field Trips. Another very useful way to build interest in WUAs is to invite potential members to join field trips to successful neighboring WUAs. Very often, farmers and other water users learn more about WUAs and begin to better appreciate them by actually seeing them in action rather than by just hearing and reading about them. The mutual consultations and demonstrations during such field trips often can make potential members more enthusiastic about having a WUA of their own.

5. Collection of Baseline Data

Once it has gained the local community's confidence, the Initiative Group can begin collecting baseline data. This has to be undertaken with the cooperation and participation of farmers and other water users, the hakimiyat, and the District MAWR Department. The objective is to collect enough data that can provide clear indicators about the environment in which the WUA will operate.

Participation in Data Collection. Making all water users participate in data collection is also an excellent way of building their trust. This is because data collection can actively involve them in the WUA formation process from the very outset. Their participation can be in the form of focus-group interviews and walk-through surveys of the irrigation and drainage system. If the WUA is being formed and developed as part of a donor agency project, the project staff should make it a point to also actively participate in these data-collection activities.

Required Baseline Data. The following information about irrigated agriculture should be collected as baseline data:

- A list of water users, sorted into males and females, indicating the size of the farmland they are holding either on long-term or short-term lease. This information has to be collected for each of the tertiary canals in the proposed hydrological area, and has to be aggregated at the secondary canal level;
- Type of water use, whether for irrigation, municipal, industrial, charitable, religious, or educational purposes and the like. This information also has to be collected for all tertiary canals and aggregated at the secondary canal level;
- Cropping patterns, intensities, and yields per hectare. This information has to be collected for all tertiary canals;
- Availability of non-water inputs;
- Farmgate prices and access to markets; and

- Ameliorative or corrective conditions in all tertiary canals, such as those being undertaken against waterlogging and salinization.

Tapping Traditional Forms of Collective Action. Once the baseline data are gathered, the Initiative Group can begin familiarizing itself with the pre-existing forms of collective action in the locality. In most areas of Uzbekistan, in particular, farmers engage in the hashar. This is a centuries-old tradition of pooling labor and other resources so the farmers can clean and repair the irrigation and drainage system in time for the spring planting season. As much as possible, the hashar and other such traditional collective institutions should be incorporated into the design of the WUA. Since these are undertakings in which farmers are already actively participating and cooperating, the WUA should make it a point to build upon these institutions.

Determining Water Users' Relationships. The Initiative Group also needs to determine the nature and status of the relationships of the water users with the local authorities, particularly the hakimiyat, the District MAWR Department, the shirkat administration, and the informal administration of private farm conglomerates, if there are any in the locality. In many instances, however, the water users may be reluctant to discuss these matters. For this reason, the Initiative Group has to make an extra effort to build their trust and make them willing to share the needed information.

Sharing Baseline Data. The baseline data and the findings derived from them have to be shared with the potential members of the WUA. This is to give them a much better understanding of the context in which they use irrigation water. In addition, they will also be given the opportunity to review the baseline data for possible errors and clarifications. The information-sharing process will therefore not only validate the data but also help build trust between the Initiative Group and the prospective WUA members.

Other Uses of Baseline Data. The Initiative Group should also keep in mind that after the WUA is formed, the baseline data would serve as a continuing yardstick for evaluating the WUA's performance. It would also be useful to donor agencies and other proponents of WUA projects.

6. Problem Analysis and Service Identification

The next task of the Initiative Group after establishing baseline data is to identify problem areas and possible remedies for them. This process is very crucial to finding out precisely what services the WUA will have to deliver. To generate inputs for this process, the Initiative Group must hold consultation meetings with the farmers in the proposed service area. The Initiative Group should also meet with other water users within the boundaries of the proposed WUA to find out their specific water supply problems.

Exercise in Problem Analysis. A typical problem analysis applicable to industrial water use is determining the impact on the agricultural environment of wastewater from industrial users. For this particular exercise, it is useful to split the meetings of farmers and other water users into groups of 6–10 neighbors. Each group is then asked to do a problem analysis of industrial wastewater and determine "who should do what" about the problem. A discussion then follows in which the water users exchange ideas about the ideal participatory irrigation and drainage service.

Typical Questions in Problem Analysis. Some typical questions that might be asked are the following:

- What are the essential tasks?
- Who should perform these tasks and to whom should they be accountable?

- Who should pay for what?
- How should the activities of the WUA be evaluated?

The problem-analysis meetings should end with the participants defining the specific objectives of the necessary WUA services that have been identified.

C. The Formation Committee

The Formation Committee has to perform tasks associated with the final stages of the WUA formation process. This committee should consist of no more than ten people, and each of them must be a prospective member of the WUA.

Member Representation. The committee membership should be representative of all the groups that will comprise the proposed WUA, particularly the following:

- Members of private and dehqan farms as well as workers within the shirkat that will be served by the proposed WUA;
- Holders of plots of land, whether large or small, that belong to the private farmer and shirkat categories;
- Water users from different parts of the proposed service area, in particular the upstream and downstream sections of the irrigation and drainage system;
- Male and female heads of farms and work units (*pudratlar*) of the shirkat; and
- Representatives of other types of water users within the proposed WUA service area.

Aiming for True Representation. The Initiative Group should make sure that the membership of the Formation Committee is truly representative of all potential members of the WUA. Otherwise, some of the members might fear that one particular group, particularly farmers from the rural elite in the upstream sections of the irrigation and drainage system, would dominate the organization in the pursuit of its own interests. Another important thing to consider is the choice of Formation Committee members. To ensure their effectiveness as organizers, they should also possess most of the qualities required of members of the Initiative Group, as discussed earlier in this guidebook.

Need for Autonomy. A proposed WUA will have a better chance of succeeding if its Formation Committee is run by potential WUA members autonomously and without undue external interference. The committee should therefore elect its own chairman and establish its own internal rules of procedure and decision-making. Once the Formation Committee is established, members of the Initiative Group who are not potential members of the WUA—such as the MAWR, the Shirkat Liquidation Commission, the hakimiyat, and donor project staff—should no longer actively involve themselves in committee affairs. Instead, they should limit their participation to advising and providing logistical support to the committee.

Primary Tasks of the Formation Committee. The primary tasks of the Formation Committee are as follows:

- To prepare a register of potential members of the WUA and a map of the proposed service area, indicating the irrigation and drainage system and farm boundaries;
- To consult with all potential WUA members on organizational issues;
- To make extensive consultations with all potential WUA members as well as to develop a draft charter and formation agreement;
- To prepare a draft budget and work plan for the WUA's first year of operation; and

- To conduct WUA formation meetings.

Timing of WUA Formation Work. The formation work for a WUA will require at least a month. In most areas of Uzbekistan, it typically can start soon after the cotton harvest in November. Thus, if the Initiative Committee begins work in December and is able to finish its task within that month, the Formation Committee would likely be able to accomplish its own tasks by January or February the following year.

D. Consultations Concerning Organizational Issues

1. Registration of Members and Service Area Mapping

Prior to making consultations on organizational issues, the Formation Committee has to prepare a list of all potential members of the WUA. It also has to procure a map of the proposed service area and of the agricultural lands to be served. The committee may have already obtained such a list and map during its previous meetings with water users or as a result of the baseline data-gathering process. However, it is very important at this stage to double-check them for accuracy and authenticity. This is because an accurate map is a major requirement when registering a WUA.

2. Consultation with All Potential Members

Before deciding on the organizational structure of the proposed WUA, the Formation Committee has to call a series of public meetings and consult with all potential WUA members. The committee members have to make sure that they have adequate knowledge of the organizational issues to be discussed during the meetings and consultations. To guide them, they should study the typical options available for the organizational design of a WUA as discussed in this guidebook.

Notifying Potential Members. Notices and invitations to the consultation meetings can be in the form of handwritten messages and posters. They can be displayed in such public gathering places as the rural municipality or *fuqaro yighini*.

Encouraging Active Participation. During the consultation meetings, all potential members should be enjoined and encouraged to participate actively in the discussions. This is because the more they are involved in discussing the organization and rules of the proposed WUA, the greater will be their sense of proprietorship over it. Their respect for its rules and procedures will also become stronger.

Ensuring a Binding Consensus. The Formation Committee must make a special effort to draw into the discussion water users who are typically disadvantaged in getting irrigation and drainage services, particularly water users farther downstream as well as female heads of farms. It might be necessary to hold several consultation meetings before a consensus on the organizational issues is reached. To ensure a strong and truly binding consensus, the Formation Committee should conduct such meetings with utmost patience and care at all times.

Important Questions to be Raised. The questions below have to be posed during the public meetings:

- Should the WUA form a Representative Assembly or WUGs, or should it form both? If the WUA chooses the former, how many members should there be in the Representative Assembly? What zones of the irrigation and drainage system should these members represent? How should their representatives be elected? Should WUGs be organized informally or formally?

- Is a Dispute Resolution Commission required? If so, what should be its role? How many members should it have?
- What should be the tenure of the Council, the Audit Commission, and the staff of the WUA Management Team? How should their members and staff be elected or selected?
- How can pre-existing informal collective institutions such as the hashar be made part of the WUA rules and procedures?
- How can the WUA best protect the interest of disadvantaged members, particularly water users farther downstream as well as female heads of farms?
- Are there other relevant issues that the meeting participants deem important enough to be discussed?

The responses to these questions should be openly and freely discussed. All opinions and suggestions of water users should be recorded and considered in detail.

E. Preparation of Documents for the Formation Meeting

1. Draft Formation Agreement and Draft Charter

All WUAs in Uzbekistan have to conform to the provisions of the law on nongovernment, noncommercial organizations.

Provisions of WUA Charter. In compliance with this law, the charter of a WUA must state the following:

- Name, objectives, and purposes of the WUA;
- Legal form of the WUA as a nongovernment, noncommercial organization;
- Territory, indicated in plans and maps, within which the WUA will carry out its activities;
- Internal structure and governing and management bodies of the WUA, along with their specific authorities, the procedures for forming and governing them, their decision-making procedures, and their terms of office;
- Location of the permanently operating governing body;
- Terms and procedures for acquiring and terminating membership;
- Rights and duties of members;
- Sources of monetary funds used for forming the WUA as well as its other properties;
- Provisions for setting the WUA’s fees and penalties;
- Rights of the WUA and its members;
- Property management structure in the WUA’s subdivisions;
- Procedure for reorganizing and liquidating a WUA;
- Procedure for introducing changes and amendments into the WUA charter; and
- Other specific provisions related to the WUA’s activities.

Guidebook 2 provides a model WUA charter and makes a detailed discussion of the legal requirements for forming a WUA.

Preparing the Formation Agreement and Draft Charter. After prior consultations with the water users, a draft formation agreement and a draft charter for the proposed WUA should be prepared. The drafts have to be distributed to the prospective members for their review and consent. The revised draft they have agreed upon should then be submitted to the District MAWR Department for formal evaluation. By following this process, potential members will become more familiar with these documents. It will put them in a much better position to ask questions or make suggestions about them when the Formation Meeting is convened.

It is desirable that individual potential WUA members be provided with copies of the draft formation agreement and draft charter. If this is not possible, copies of these documents can be posted for public inspection in such locations as the rural municipality (*fuqaro yighini*), schools and colleges, the hakimiyat, and the District MAWR Department.

Provisions of the Formation Agreement. The formation agreement should state the following:

- Place and time of formation;
- Area to be served by the WUA;
- Rights and obligations of the WUA and of its members;
- Order of joint activities for establishing the WUA;
- Terms for transferring a member's property to the WUA;
- Terms for member participation in the WUA's activities, governance, and management;
- Terms for termination of membership; and
- Other terms as agreed upon by the potential WUA members.

Compliance with the Law. It is very important to ensure that both the draft charter and draft formation agreement are in conformity with the law on nongovernment and noncommercial organizations. For this purpose, the Formation Committee should consult with the district or province department of the Ministry of Justice on the legal aspects of these documents. This has to be done before the documents are presented during the Formation Meeting.

2. Draft Work Plan and Budget

A draft budget and a draft work plan for the first year of the WUA's activities have to be prepared by the Formation Committee. The draft work plan will outline the activities of the WUA during its first year. It will also serve as the basis for the annual budget, which will show the expected expenses and income of the WUA during the period.

It is advisable for the Formation Committee to familiarize itself with the operating costs and maintenance needs of the WUA's irrigation and drainage system. For this purpose, it has to consult with the Irrigation System Administration, the District MAWR Department, and former irrigation specialists of the shirkat. It also has to make sure that the results of the problem and service needs analysis that it had conducted are incorporated into the draft work plan.

The Formation Committee has to pay special attention to the draft budget because it is the WUA's primary financial management tool. It will provide the justification not only for the initial membership fee but also for the irrigation service fee to be collected from the WUA members.

F. The WUA Formation Meeting

WUA formation meetings require intensive preparation because all prospective members of the WUA will be attending it. The meetings usually take several hours at any one time. Thus, the Formation Committee has to carefully choose a suitable time and meeting place for these meetings. It has to give notice well in advance to all prospective WUA members.

Notifying Prospective Members. The invitation notice should state the following:

- The agenda of the meeting, which typically includes ratification of the draft charter, signing of the formation agreement, and the election of the WUA Council and all other internal governing bodies envisioned in the approved charter.
- The approval of the draft budget and work plan. The notice has to enjoin potential WUA members to nominate candidates for positions in the WUA's internal governing bodies.

Enabling Role of Government. The MAWR manual prepared under Decree No. 8 of the Uzbekistan Government provides that it has to be the District MAWR Department that should call WUA formation meetings. However, this provision runs counter to the goal of encouraging prospective members of a WUA to develop a much stronger proprietary interest in the association. For this reason, it is more advisable to make the Formation Committee responsible for calling a WUA formation meeting. This will avoid creating the wrong impression among prospective WUA members that WUAs are essentially government undertakings, and that the WUAs do not actually belong to them.

It is advisable that Government authorities simply perform an enabling and supportive role in WUA formation, particularly when requested by the Formation Committee.

The Formation Committee chairman supervises the conduct of formation meetings. The minutes of these formation meetings are duly recorded by a secretary assigned expressly for the purpose. This is because the minutes of formation committee meetings are required when registering a WUA.

1. Approval of the Draft Charter

First on the agenda of the formation meeting is the approval of the draft charter. For the draft charter to be approved and to come into force, a simple majority of at least 51% of all the potential members is needed. By the time the formation meeting is held, there should already be an adequate consensus among the prospective members for calling a vote in favor of the prospective WUA. The voting can be done either by show of hands or by secret ballot. The secretary of the formation meeting has to make an accurate record of those who attended the meeting and of those who voted in favor of the draft charter.

If the draft charter is not accepted during the formation meeting, those attending the meeting have two options. The first is to create a new Formation Committee and re-write the draft charter entirely. The second is to give the Formation Committee the mandate to make specific changes in the draft charter and, if necessary, to seek the advice of outside authorities on how to make the draft charter acceptable. Either way, however, there will be a need to prepare for and hold another formation meeting.

Situations like this are not likely to happen if the Initiative Group and the Formation Committee have already obtained the consensus of the prospective WUA members well ahead of the formation meeting. This is why prior in-depth consultations with them are very important.

2. Signing of the Formation Agreement

The next item in the formation meeting agenda is getting the prospective WUA members to sign the Formation Agreement. They have to affix their seal to the document and duly sign it before their membership in the WUA becomes official. After the Formation Agreement is signed, the new WUA should register itself with the appropriate government regulatory bodies and sign the mandatory Management Transfer Agreement with them. Only then is the WUA officially created.

3. Formation of the Internal Governing and Management Bodies

Once the formation agreement is signed, the formation meeting can proceed to elect the members of the WUA Council and of the other internal governing bodies, except those of the Representative Assembly (if one is specified in the WUA's charter). Candidates for positions in these bodies are nominated by the membership. An absolute majority of all members is needed to decide the outcome of these elections. All subsequent decisions of the General Assembly also need the same absolute majority of all members. Voting is either through a show of hands or by secret ballot.

Appointing WUA Officers and Personnel. During its first meeting, the WUA Council elects its chairman based on nominations from among the council members. The WUA Council then appoints the WUA manager, the WUA operations and maintenance engineer, and the WUA accountant. The MAWR manual specifies that the WUA manager be appointed as recommended by the District MAWR Department. However, it is not advisable for this appointment to be made by an entity outside the WUA. This is because appointees by outside authorities might find it difficult to get the full support and cooperation of the WUA members and their representatives. It is much more preferable for such appointments to be made by the WUA Council itself, being the duly elected representatives of the WUA members.

Terms of Office of WUA Personnel. The MAWR manual suggests that the General Assembly reelect the WUA manager every 2 years and the members of the internal governing bodies every year. Instead of this arrangement, however, it is more advisable to hold a new election every 3 years for the WUA Council and WUA Commission positions. In the case of the WUA manager, it is also more advisable for the WUA Council to ratify the appointment to the position every 3 years. This is to avoid high rates of turnover and the consequent need for frequent training.

Staff Appointments to the WUA Management Team. The WUA manager has to appoint the remainder of the WUA Management Team's staff, all of whom will be working under his or her supervision. This staff typically will consist of the ditch riders/*mirabs* (watermasters), an amelioration specialist, a pump specialist, a mechanic, a secretary, a guard, and such other positions that the WUA manager and the WUA Council may deem necessary. The WUA Manager himself or herself will serve as the operations and maintenance engineer on behalf of the WUA Council. He or she will also have the authority to negotiate and conclude service contracts with the WUA members.

Ratification of Staff Appointments. Once the WUA Council approves the staff list of the WUA Management Team, it is submitted for ratification by the General Assembly during its first meeting. The list may be approved, revised, or rejected by absolute majority vote of the General Assembly.

The WUA Management Team reports to the WUA Council monthly and to the General Assembly semiannually.

4. Approval of the Draft Work Plan and Budget

The third and final item on the formation meeting agenda is the approval of the draft budget and work plan. It is very important to fully explain the draft budget and work plan to the prospective WUA members. This is because as pointed out earlier in this guidebook, these two documents will form the basis for (1) the rates that will be set for the initial and subsequent membership fees, and (2) the irrigation service fee that will be collected by the WUA. Approval of the draft budget and work plan through consensus is preferred, although approval by absolute majority vote is also acceptable.

G. Registration

After the WUA formation meeting is conducted successfully, the WUA has to register with the Ministry of Justice so it can become a juridical entity. The WUA will acquire legal standing as a nongovernment, nonprofit organization only after it is duly registered. Registration has to be done within two months after the formation meeting. This is because registering beyond this period is sufficient legal ground for the Ministry of Justice to reject the registration application. Prior to registration, the WUA has to create its own official seal, as this and any other symbol of the WUA also need to be registered with the Ministry of Justice.

Registration Procedures. Current procedures for forming WUAs in Uzbekistan also require registration with the hakimiyat. This has to be done even if the hakimiyat does not have the authority to make the WUA a juridical entity or a legal NGO. Registration of the WUA with the District Tax Inspectorate is also necessary.

Registration Requirements. The application for registration with the Ministry of Justice has to include the following documents:

- An application signed by members of a managing body of the nongovernment, noncommercial organization, which in this case is the WUA. The application should stipulate each member’s last name, first name, and middle name along with the member’s year and place of birth as well as the member’s place of residence;
- Two copies of the WUA charter;
- The minutes of the WUA formation meeting. The minutes should contain all the needed information about the creation of the WUA, the members, the approval of its charter, and the formation of its governing bodies and other organs; and
- A receipt from a bank confirming that the registration fee has been paid.

Registration Processing and Approval. Once the Ministry of Justice receives a WUA’s application for registration, it has to act on the application within 2 months upon receiving the application. Within 3 days after deciding on the application, the Ministry has to either issue a certificate of state registration to the WUA or deny the application. The notice denying registration has to state the justifications for the refusal.

When its application for registration is approved, the new WUA is officially entered in the Unified State Register of juridical entities in Uzbekistan.

H. Election of the Representative Assembly

Once duly registered, WUAs with over 200 members have to decide whether or not to create WUGs and create a Representative Assembly. If a Representative Assembly is envisioned for a particular WUA, its charter has to do the following:

- Specify the hydrological units within the WUA’s service area that need representation,
- Specify the number of representatives from each of those service areas, and
- Provide for the open and democratic election of these representatives.

As previously discussed, informal or formal WUGs of from 5–20 members can have a representative to the Representative Assembly. The size of the WUG will depend on the farm structure and the nature of the hydrological units within the WUA. As much as possible, however, WUGs should be organized informally to minimize the expense and paperwork in maintaining them.

Forming a WUG. To form a WUG, the WUA Council has to initiate and supervise a series of informal meetings among the various hydrological units within the WUA's service area. As many hydrological units as possible should participate in these meetings. If the attendance in these meetings falls below 50–60% of the total number of hydrological units, they should be rescheduled. Also, the WUG members should be duly informed about the roles and the desired attributes of members of the Representative Assembly.

Guidelines for Organizing WUGs. For informal WUGs, election of the representatives is by absolute majority vote. The voting can be done either through secret ballot or by show of hands.

For formal WUGs, the organizing and election guidelines are as follows:

- The WUG members have to agree on and sign a WUG formation agreement and a WUG charter. The WUG formation agreement and charter should be as proposed by the WUA Council in consultation with the WUG members.
- A WUG with more than 20 members has to elect its own Council. If the charter of its WUA allows it, a large WUG may also decide to appoint its own Management Team.
- The WUG members have to elect their representatives to the Representative Assembly. This should be by absolute majority vote either through secret ballot or by show of hands.

I. Negotiation and Ratification of the Management Transfer Agreement

Even if a WUA has already been established, it can begin to function only after it has already signed a Management Transfer Agreement with the Irrigation System Administration. This agreement stipulates the WUA's property rights and its operating and maintenance responsibilities.

Specifications of Agreement. A Management Transfer Agreement specifies the following:

- Property rights to the area as well as to the irrigation and drainage system being transferred to the WUA;
- Transfer to the WUA of the irrigation and drainage infrastructure along with any existing operating and maintenance equipment;
- Terms of transfer for the irrigation system;
- Rights and obligations of the MAWR;
- Rights and obligations of the WUA; and
- Terms of termination of the Management Transfer Agreement.

Requirements Prior to Asset Transfer. According to Article 49 of the Law on Water and Water Use in Uzbekistan, onfarm irrigation and drainage systems become the property of the farm or of the entity that acquires responsibility over the farm, which in this case is the WUA. All of these assets have to be properly inventoried and checked by the WUA Council prior to the transfer. An accurate inventory of these assets has to be undertaken to ensure that the transfer is done properly and that future inventories will have a sound basis. Only after the inventory is completed should the WUA Council negotiate a Management Transfer

Agreement with the MAWR. The negotiated agreement is then submitted to the General Assembly for ratification during its first meeting.

J. Acquisition of Primary Water User Status

To be able to draw up water delivery agreements with its members, the WUA must become a "primary water user" as defined by the law on water and water use in Uzbekistan. In the case of liquidated shirkats, the right as a primary water user is automatically transferred from the production cooperative to the WUA on a temporary basis. Afterwards, the primary water user status has to be acquired by special permission from the State Nature Protection Committee. This committee will then issue a voucher that legally confirms this status. These procedures for acquiring primary user status also apply to WUAs that are not created on the basis of liquidated shirkats.

K. Collection of Membership Fee and Transfer of Shirkat Equipment

A new WUA cannot begin to function until it has obtained the initial monetary and material resources to support its start-up operations. For this purpose, the WUA should levy an initial membership fee equivalent to US$5–7 per member and an annual fee of US$3–5 per year per member for each succeeding year. This will be aside from the irrigation service fee that will be collected separately. The need for these fees has to be properly explained to the WUA members way ahead of the WUA Formation Meeting.

Funds Usage. Funds generated by the initial membership fee will be used primarily for the salaries of WUA personnel. Part of the funds will cover the operating and maintenance costs of the WUA during the first few months of its existence. Eventually, these costs will be covered by funds generated by the collection of the irrigation service fee. In the succeeding years, the membership fees collected by the WUA will go to a reserve fund for WUA development and for contingencies such as floods, droughts, and accidents.

Current Asset Valuation System. The present arrangement for WUA formation and development in Uzbekistan does not provide for membership fees. Instead of collecting an initial membership fee, the Shirkat Liquidation Commission calculates the shares of the WUA members in the irrigation and drainage-related equipment of the former shirkat (such as excavators, bulldozers, and tractors) as well as buildings. These assets are then transferred to the WUA. Their value is credited to the WUA member in lieu of the initial membership fee.

This present arrangement is extremely ineffective in practice. Most of the equipment is not actually transferred to the WUA. Instead, it ends up in the black market where it is illegally sold. As a result, many new WUAs in Uzbekistan do not have funds or equipment during the critical first few months of their operations.

Need for Transparent Asset Transfer Mechanism. The above problem can be solved if the MAWR could establish and require an initial membership fee and provide a transparent mechanism for transferring assets from liquidated shirkats to the WUA. This way, a fair valuation could be given to the equipment of the members of the liquidated shirkat that are to be transferred to the new WUA.

L. Negotiation and Signing of Contracts with the MAWR

Once a WUA is registered and signs a Management Transfer Agreement, it has to negotiate an initial agreement with the Irrigation System Administration for the bulk water supply to be provided by the latter. The WUA Council chairman has the authority to negotiate this agreement in consultation with the WUA manager and the membership. The agreement has to clearly define the responsibilities of both parties as well as those of any outside authorities involved.

Specifying Resource Contributions in Detail. Procedures and schedules for operations and maintenance have to be specified in detail, including provisions for such contingencies as accidents, droughts, and floods. The agreement has to clearly indicate the resource contributions of both parties to the accomplishment of operating and management tasks. Also, the agreement has to indicate that in future, when WUAs in Uzbekistan begin paying for the bulk water supply from the MAWR, the irrigation service fee will have to more accurately reflect the actual cost of the water resources supplied to the water users.

Need for a Truly Negotiated Agreement. At present, the MAWR draws up agreements with WUAs twice a year. The first is for the period from 1 October to 31 March, and the second for the period from 1 April to 30 September. However, the agreement being used is standardized and not subject to negotiation. It specifies in detail the penalties to a WUA for non-fulfillment of conditions specified by the agreement, yet is vague regarding sanctions against the MAWR for nonfulfillment of its own duties and responsibilities. Clearly, the current form of the agreement between a WUA and the Irrigation System Administration needs to be replaced by a truly negotiated agreement. This is one way to encourage the formation and promote the growth of WUAs in Uzbekistan.

IV. DEVELOPMENT OF A WUA

A. Institutions to Support Capability-Building

A new WUA has to build the capability to effectively and efficiently administer its affairs and perform its operating and maintenance management functions. Institutions such as donor-funded projects often provide valuable support to the WUA in building this capability. However, donor-funded projects are usually implemented for at most 5 years. After that, the support they provide the WUA as part of specific projects eventually stops. Thus, when the donor-funded project that supports them is concluded, many WUAs become dysfunctional or stop operating altogether.

Need for Permanent Support Institutions. The support of donor-funded projects is only temporary. It is not enough to ensure a WUA's long-term development. There is therefore a pressing need to create permanent support institutions that can provide continuing advice and training to WUAs, either as part of a donor project or as a program implemented by the Government. In Uzbekistan, in particular, the Asian Development Bank and World Bank have created the Rural Business Advisory Centers (RBACs). The RBACs advise and train WUAs and farmers in districts where agricultural development projects are being undertaken. The advisory and training services of such RBACs focus on WUA formation and development in general, and on onfarm water management, agro-technical techniques, alternative machinery tractor parks, and business plan creation in particular. The ultimate goal of a RBAC is to become self-financing or to get continuing support from the Government, or both.

Need for MAWR Support Units. Another option for enhancing the capability building of WUAs is the creation of WUA support units within the MAWR itself. In the past, there used to be a Department for Onfarm Water Use in the MAWR that dealt primarily with technical matters within *kolkhozy* (collective farm) and *sovkhozy* (state farming enterprise). Because of changes in farm structure, however, the MAWR dissolved this department in 2000. In its place, the MAWR mandated its Province Departments "to provide methodical and practical aid in the organization and development of associations and other conglomerations of water users, as well as the organization of onfarm water delivery reporting." This was provided for by Attachment No. 5 of the Decree on Improving the Organization of Water Management as adopted in July of 2003.

In line with this Government directive, it is recommended that the MAWR create a WUA Support Department with branches in each province and district in Uzbekistan. To perform their support functions effectively, each of these local units has to be staffed with a WUA development specialist, an engineer, and a water management specialist.

Responsibilities of Support Units. The RBACs and WUA support units can be given a set of responsibilities vastly different from those of the former Department for Onfarm Water Use. The responsibilities suggested for them are as follows:

- To provide support, advice, and baseline data to initiative groups seeking to form WUAs;
- To provide advice and recommendations on draft charters and draft budgets, whenever requested by a formation committee;
- To help WUAs prepare water use and maintenance plans;
- To advise WUAs on financial management and daily administrative matters, whenever requested by them;

- To provide support to WUAs when they call General Assembly meetings, whenever particular WUAs ask for such assistance;
- To identify training needs and conduct subsequent training on operations and maintenance, financial management, legal matters, and onfarm water management;
- To assist WUAs in the creation of designs for rehabilitating irrigation and drainage systems, and to render help in quality control and quantity surveys before and during construction of infrastructure; and
- To periodically monitor and evaluate WUA water deliveries.

Need for Immediate Action. The Uzbekistan Government needs to decide whether RBACs or WUA support units, or both, are the most appropriate entities for building the capability of WUAs. Since the liquidation of shirkats and the formation of WUAs in Uzbekistan have been accelerating, this decision should be made and acted upon immediately.

B. Building Capability Through Training

The best way to build the capability of a WUA is to effectively train its managers and staff in its most important functions: operations and maintenance, financial management, legal management, and onfarm water management.

To ensure the success of this training, the following important preliminary steps need to be taken:

- Identifying the target group to be trained;
- Assessing the training needs of this target group; and
- Choosing the most appropriate and most effective training methods to address those needs.

1. Trainers

Trainers of WUAs have to be specialists in their respective fields. However, many irrigation and drainage specialists and other prospective WUA trainers may not necessarily be familiar with local situations in Uzbekistan. For this reason, they themselves need to be trained before being allowed to do their respective training jobs. This training of trainers should be done in the same manner that WUA governing and management bodies as well as WUA members are trained.

Sourcing Trainers. A major consideration in the selection of trainers is deciding whether it is better to have the training conducted by an on-site agency (such as a WUA support unit or RBAC) or by an outside agency. If there is an on-site agency capable of providing the training, it is the logical choice. This is because by using it, that particular on-site agency can further develop its training capability so it can better support the WUAs in the locality on a continuing basis. An outside agency may be considered to do the training only if no such on-site training agency is available.

Qualities Required of Trainers. Trainers are chosen for qualities that will enable them to train people effectively in a non-academic setting. These qualities include:

- Competence: The trainer is familiar with the subject being taught and has the requisite teaching skills.
- Friendliness and tactfulness: The trainer knows how to get along with people and has a sincere interest in training them.

- Alertness and resourcefulness: The trainer is able to detect the slightest signs of lack of interest, misunderstanding, or confusion among the participants. He or she can adapt quickly to the learning situation, and can change teaching methods quickly when difficulties arise.
- Consideration: The trainer is sensitive to the feelings of the trainees. He or she has the ability to encourage less assertive trainees to actively participate and not be dominated by the more assertive ones.
- Enthusiasm: The trainer has a lively disposition and is eager to share knowledge with those being trained.
- Promptness: The trainer arrives at the training venue well ahead of time. He or she gets everything ready and done on schedule, and can start and end the training session right on schedule.
- Patience: The trainer is not easily irritated when things are not going well. He or she is keenly aware that a trainee's inability to grasp ideas is often the trainer's fault rather than that of the trainee's.
- Preparedness: The trainer can prepare appropriate lesson and activity plans. He or she makes sure that all the necessary training tools, equipment, and materials are ready for each training session.
- Flexibility: The trainer has the ability to tailor lessons and activities according to the different needs and styles of learning of individual trainees.
- Appreciativeness: The trainer shows an active interest in the progress of each trainee. He or she knows the motivational value of commenting favorably whenever a trainee demonstrates significant progress in learning.

2. The Target Group

Clear identification of the target group is a very important aspect of training preparation. This is because knowing who will be trained becomes the primary basis for the formal training needs assessment, the body of knowledge or information to be presented, and the selection of the appropriate training methodologies.

3. Assessment of Training Needs

A needs assessment of the group or individuals targeted for training has to be undertaken to clearly identify gaps in their knowledge and skills. The most common subjects and areas that need to be addressed in training WUA people are the following:

- WUA formation and development;
- Administration and financial management;
- Engineering, operating and maintenance procedures, and planning and budgeting;
- Onfarm water management;
- WUA law, charters, and registration procedures;
- Conflict resolution and management;
- Monitoring and evaluation of WUA performance; and
- Needs or problems unique to the WUA's locale.

The needs assessment usually requires the conduct of surveys or focus-group interviews with the various target groups. It determines the most convenient time for training the participants and the most appropriate and feasible duration of the training sessions.

4. Modules and Methods

Training modules can usually be developed based on guidebooks that are already available. The trainers themselves should be allowed to choose the most appropriate training methods for their specific action training strategy. These methods should be based on their own assessment of the learning capabilities and needs of the training participants.

Focus on Action Training. For WUA training modules, the action training strategy is much more suitable than the academic training strategy. This is because academic training usually takes up theory and general knowledge that the WUA trainees may already know or may no longer find relevant. On the other hand, action training focuses on specific problems and the practical skills that the WUA trainees need to effectively deal with them. Action training can therefore bring about faster acquisition or improvement of practical skills that immediately leads to better job performance.

Choice of Training Methods. The majority of WUA trainees are members and staff of the WUA's governing and management bodies. The fact that they are all adults should therefore be a major consideration in selecting the training methods for them. In particular, it has been determined that generally, adult learners can actually retain only the following percentages of what is taught to them:

- 10% of what they read;
- 20% of what they hear;
- 30% of what they see;
- 50% of what they see and hear; and
- 90% of what is done.

Preferred Training Approaches. The usual attention span of training participants is only about 20 minutes. For this reason, it is advisable to use several training approaches and to keep the following points about them in mind:

- Lectures: They should be short—at most 20 minutes—and largely practical in content. They should be amply supported with discussions and visual aids such as maps, overhead transparencies, posters, films, models, and actual samples like stream gauges, flumes, and other portable devices.
- Discussions: To encourage more active participation among the trainees, discussions have to be interspersed with short lectures. Typical discussion formats are (1) "brainstorming," or asking all participants to generate ideas for solving a problem; (2) "buzz groups" and "syndicates," in which the trainees break up into separate discussion groups to solve the same problem; (3) question-and-answer sessions with the panel of lecturers; (4) open forums for readings that have been provided ahead of time; and (5) unstructured discussions.
- Field trips: They give trainees the opportunity to see for themselves how a particular set of activities—such as water measurement on a demonstration plot—is done elsewhere, particularly by WUAs in a neighboring district. However, field trips have to be properly focused and adequately planned. They should never be used as excursions for pleasure.
- Role-playing and simulations: They help participants gain a better perspective about specific problems and allow them to experiment with possible solutions. However, participants need to be cautioned to view role-playing and simulations not as games but rather as real-world learning experiences.
- Case studies and applied readings: They can provide the background for in-depth discussions on important issues. They can also serve as additional reference materials that can be useful even after the training program. Handouts dealing

with key technical or problem issues are recommended, but they must be short and not overly complex.

5. Training Schedules and Training Duration

Training has to be undertaken according to a clearly defined schedule. The schedule should fit into a time frame most convenient for the target group. For Uzbekistan WUAs, this ideal period is after the cotton harvest that ends in mid-November, or before the start of the spring growing and irrigation season. The training duration should also be set for the convenience of the trainees.

Training is a long-term process. There should be follow-up training for specific subjects that are not adequately covered or learned in the initial training. Annual refresher training may be needed as well. Depending on the rate of personnel turnover, a cycle of initial trainings may also be needed for each new staff of the WUA Management Team. New members of the WUA Council and WUA Commission may also need such training.

C. Rehabilitation of Irrigation and Drainage Systems

During the 1990s, there was a significant deterioration of the onfarm irrigation and drainage systems that had been transferred to WUAs from shirkats and from other production cooperatives. This was because the shirkats could not regularly maintain them. The maintenance of onfarm drainage systems, in particular, fell far below the required levels. Over the last 5 years, cleaning of interfarm collectors reached only 70-80% of the requirement. Cleaning of onfarm open drains and subsurface drains reached only 50-60% and 4–20% of their respective requirements.

Poor Irrigation Efficiency. For example, as a result of this serious neglect of the irrigation and drainage systems, the overall conveyance efficiency in the Syr Darya River basin fell from 58–78% in 1990 to 46–74% in 2000. On the other hand, the corresponding figures for the Amu Darya River basin are 62–74% for 1990 and 48–74% for 2000. Moreover, the vertical drainage wells can now handle only 15–20% of their design capacity. This is as compared with 70–75% at the time of their installation. The subsurface drainage systems, on the other hand, are at present working at only 40–63% of their design capacity.

Need to Rehabilitate Irrigation Systems. WUAs in Uzbekistan may eventually become capable of repaying a significant share of the loans needed to rehabilitate the system. However, they simply do not have the funds to adequately overcome such a significant maintenance backlog. For this reason, a major objective of many donor-funded WUA projects is to help in the rehabilitation of these irrigation and drainage systems. However, the donors can only allocate so much in limited funds to WUA projects, so the Uzbekistan Government has to provide most of the funds needed to rehabilitate the system. It is therefore critical that both the donors and the Government make an effort to raise funds for rehabilitation projects in a manner that can develop WUAs into self-sustaining institutions.

Setting Development Criteria for WUAs. To achieve this objective, project donors should base their rehabilitation funding on prudent and sound institutional development criteria. In particular, no funding should be given to a WUA at all unless it reaches an established level of institutional development. This is because WUAs that fail to reach this level of development would most likely be unable to generate the funds needed to maintain the rehabilitated system. The system will then rapidly deteriorate and the funds used for its rehabilitation will just be wasted.

The World Bank's Development Criteria for WUAs. The World Bank has developed a specific set of criteria, known as "milestones," for measuring how developed a particular

WUA should already be before it can apply for and get funding for infrastructure rehabilitation.

These criteria are as follows:

- The WUA has already been formally established and can provide proof of legal registration and bank account opening.
- The staff of the WUA Management Team has already been hired and is being paid and trained according to a set program.
- Both the WUA Council and the WUA Management Team already have an approved operations and maintenance plan, which should include a development plan for the irrigation service fee. The irrigation service fee should be increased progressively to cover all project costs for operating and maintaining the WUA irrigation infrastructure as well as any payments to outside organizations (such as to the MAWR for bulk water deliveries in the future).
- All of the WUA members have already paid the irrigation service fee. If this milestone is reached within 1 year, funds generated by the irrigation service fee would be sufficient to cover at least 30% of the required operating and maintenance costs of the WUA.
- Alternative rehabilitation plans for the onfarm irrigation system, including all associated costs, have already been developed. The alternatives must be technically, environmentally, and economically sound (with a financial internal rate of return of at least 12%). Also, these alternatives should have been worked out during both official and unofficial meetings where WUA members were actually involved.
- The WUA members have already chosen one of the alternative rehabilitation variants for the irrigation infrastructure.
- The WUA members have already voted to proceed with the rehabilitation of the irrigation and drainage system under the repayment terms agreed upon for funding it. The WUA Council has, in turn, already formally requested the project donors or the Government to proceed with their method for funding the rehabilitation.

D. Organizational Development

A WUA has to be a dynamic organization. As its needs, capabilities, and opportunities in operations and maintenance evolve, it should be able to change and develop its organizational structure accordingly. This section describes some possible scenarios and suggested procedures to speed up the organizational development process for WUAs.

1. Internal Organizational Changes

The internal organizational restructuring of a WUA can take several forms. Listed below are some of the situations in which WUAs might require such a restructuring:

- If the WUA Management Team and WUA Council cannot adequately manage and resolve conflicts within the WUA, it should create a Dispute Resolution Commission if it still does not have one.
- If a WUA expands its service area such that the number of members goes beyond 200, the WUA should consider forming a Representative Assembly or WUGs, or both.
- If informal WUGs within a WUA are not able to function properly, it might be desirable to reconstitute them into formal WUGs, each with its own charter and council. On the other hand, if the cost of managing formal WUGs is too high and

the WUG's council and charter are deemed unnecessary, it might be advisable to reconstitute them into informal WUGs. This option may be considered if the informal cooperation within the watercourses is already strong.

- When there are major changes in the responsibilities of a particular WUA, increasing or reducing the size and types of staff of the WUA Management Team might become necessary.

The WUA Council should manage the organizational restructuring process in consultation with the WUA membership and with the staff of the WUA Management Team. An absolute majority vote of the General Assembly is needed for any organizational change to be implemented.

2. Re-Registration of Existing WUAs

The charter of a WUA has to be re-registered whenever the association makes major organizational changes. This has to be done to provide a formal basis for the WUA's organization and activities as they have evolved since the WUA was formed. In the event that a new WUA law is passed in Uzbekistan, in particular, many WUAs will need to be re-registered. This is because their charters will have to be amended to make them fully compliant with the new law.

Amending the WUA Charter. Charter amendments have to be done in an open and participatory manner as much as possible. The WUA Council is responsible for supervising this process. It should conduct several informal meetings with the WUA members to get their opinions and arrive at a consensus on the proposed charter changes. Once these changes are accepted, they have to be incorporated into the new charter.

Updating the WUA's Membership Register and Territorial Boundaries. The new charter should also update the register of the WUA members, which has to be done annually in any case. It should also indicate any changes in the boundaries of the territory served by the WUA. Before finalizing the amended charter, it would be desirable for the WUA Council to get the advice and recommendations of an outside authority like the District MAWR Department or the Ministry of Justice.

Ratifying the WUA Charter Amendments. The new WUA charter has to be ratified in an extraordinary meeting of the General Assembly. This meeting has to be convened and supervised by the WUA Council following the same procedures as those for a WUA formation meeting. Once ratified, the new charter has to be registered with the Ministry of Justice in the same manner as the original charter.

3. The Federation of WUAs

In many parts of the world, a federation is eventually formed by the various WUAs that obtain water from the same secondary or main canals. Such a federation has the same organizational structure as that of the WUA itself. It has a corresponding representative assembly, council, audit commission, dispute resolution commission, and management team. In Uzbekistan, in particular, WUA federations are intended to eventually take over the role of the existing irrigation system administrations and to work directly with the main canal administrations.

Preparedness to Federate. However, WUAs are advised to form a federation only when all of the WUAs within the larger hydrological unit have already become fully sustainable. There are two good measures of the preparedness of a group of WUAs to federate: (1) their collection rate for the irrigation service fee, and (2) their success in delivering water to downstream areas. Ideally, WUAs that intend to federate must have already been collecting an aggregate of at least 80% of the irrigation service fee for 3 consecutive years prior to federating. They also must have already achieved a 100% fulfillment of water delivery contracts to downstream areas for 3 years prior to federating.

Gestation Period Before Federating. A period of around 5–15 years is usually needed before a group of WUAs can establish a federation. In Uzbekistan, in particular, it is recommended that WUAs do not federate as yet. This is because the WUA formation and development process in the country is still in its very early stages. If WUAs federate before all of them have become sustainable, the federation would likely be unable to conduct operations and maintenance successfully. There would be serious inequities between upstream and downstream WUAs. As a result, the federation would likely be subject to excessive interference from outside authorities.

E. Ancillary Functions

Once a WUA becomes fully viable, it may consider performing a number of ancillary activities. These ancillary activities may include agro-processing, input supply, marketing, advisory services, or some other activity that fills the particular needs of the members and that the WUA itself can effectively provide. Since these functions are typically performed by WUA federations, individual WUAs need not necessarily pursue them if they would only interfere with their regular functions or distract them from performing those functions.

If a WUA federation itself decides to perform ancillary activities, it has to make changes in its organizational structure for that purpose. These changes may include creating a department or staff positions to specifically handle those ancillary activities. Even if a WUA federation has become fully sustainable, however, it should not pursue ancillary activities if those activities would only serve to jeopardize the taxation status of its member WUAs as nongovernment, nonprofit organizations.

F. Monitoring, Evaluation, and Feedback

A WUA has to institute a monitoring, evaluation, and feedback system that (1) can effectively track and analyze its performance both annually and over the long term, (2) enable it to inform its members regularly about this performance, and (3) keep itself abreast of developments in the external environment.

This system would have the following major objectives:

- To regularly provide information to the WUA membership as well as to its governing and management bodies about (1) the overall performance of the WUA's irrigation and drainage system and (2) its major management, operating, and maintenance activities. A WUA's openness and transparency in providing such information will enhance its credibility among its members.
- To obtain regular feedback from members about the WUA's performance and about the quality of the service that the WUA is providing them. This will (1) help improve communication with them, (2) strengthen their sense of proprietorship over the association, and (3) increase their willingness to pay the service and membership fees.
- To enable the WUA to objectively assess its performance and level of development as well as to identify specific weaknesses and areas of improvement.
- To enable the WUA to set realistic objectives, performance goals, and development targets.

1. Roles and Responsibilities

The WUA Management Team is responsible for monitoring key performance indicators at regular intervals. Precisely what indicators are to be used have to be determined by the WUA Management Team itself. They have to be discussed and agreed on with the WUA Council, then submitted to the General Assembly or Representative Assembly for approval.

Given its built-in technical and management capabilities, the WUA itself should carry out the monitoring process. Since the monitoring function needs to be done on a continuing basis, funds should be provided for it in the WUA's annual budget. The findings of the monitoring process should be evaluated quarterly or semiannually and presented to the WUA Council.

Sharing Performance-Monitoring Results. The results of the WUA's performance monitoring have to be shared with the members of the WUA. At the annual meeting of the WUA General Assembly or Representative Assembly, in particular, the WUA chairman has to present a report on the performance of the irrigation and drainage system as well as on the performance of the WUA Management Team. The Audit Commission has to separately present an annual report on the financial management of the WUA. On the basis of these reports, the General Assembly or Representative Assembly will then give feedback to the WUA Council and the WUA Management Team along with the appropriate recommendations or remedial actions.

Establishing Monitoring System Linkages. Ideally, the WUA's monitoring, evaluation, and feedback system should be linked with the Government's own monitoring, evaluation, and feedback system for WUAs. When this happens, however, the Government's system should not be used to control WUA activities. Instead, the Government's role may be limited to evaluating the overall development status of WUAs and to making policy recommendations regarding them.

2. Performance Indicators

The WUA Council and the WUA Management Team have to establish a set of key performance indicators for the various components of the irrigation and drainage system. These indicators may include (1) the irrigation management component, (2) the maintenance component, (3) the financial component, (4) the agricultural component, and (5) the environmental component. Recorded results for each of the indicators should be compared to the original design targets or in relation to those targets, which may be revised from time to time.

3. Evaluation and Establishment of Objectives

The formal WUA performance monitoring process gives the WUA Council, the WUA Management Team, and the general membership a clear understanding of the overall performance of the WUA. As a very important next step, however, these performance-monitoring findings have to be thoroughly evaluated to enable the WUA to do the following crucial tasks:

- Identify specific performance weaknesses;
- Explain those weaknesses to the WUA Council and to the WUA members;
- Set realistic objectives for the next operating period;
- Take the appropriate corrective measures for the identified weaknesses; and
- Set long-term development goals and objectives for the WUA.

The annual and long-term objectives set by the WUA form part of the Annual Operation Plan (or Annual Report) that it will prepare for submission to the General Assembly or

Representative Assembly. On the other hand, the findings, assessment, and the recommended corrective measures are presented quarterly or semiannually to the WUA Council for discussion. They are later presented to the annual General Assembly or Representative Assembly meeting.

V. CONCLUSION

The development of WUAs in Uzbekistan is a continuous, long-term process. For most WUAs to become sustainable, they need to be intensively trained in their management as well as operating and maintenance functions. They need to be given adequate and sustained support by the country's irrigation agency and other Government institutions. In Uzbekistan, in particular, WUAs can be greatly helped by the Government as well as by institutional donors in rehabilitating the country's deteriorated irrigation and drainage systems.

Their assistance, however, should be conditional on the WUA's actual capability to perform its mandated functions. For this reason, existing WUAs in Uzbekistan will likely first need to be reorganized to qualify for such assistance. They need to improve their management and operating capabilities so they can effectively meet the major changes in their service objectives.

It will be highly desirable for WUAs within the same hydrological unit to eventually form a federation. However, this should be done only once all of them have become self-sustaining. A federation of WUAs, in turn, should first aim to make itself truly viable. After that, it can consider performing such ancillary functions as agro-processing, input supply, marketing, and advisory services for its member WUAs.

Every WUA should have a continuous monitoring, evaluation, and feedback program. Such a program will enable it to track its own development, guide it in its performance improvement efforts, and serve as a basis for its annual and long-term goals and objectives.

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Appendix 1. FARM STRUCTURES IN UZBEKISTAN

The predominant farm structures in Uzbekistan are the production cooperative (*shirkat*), the private farm, and the peasant farm *(dehqan)*.

The production cooperative typically contains 1,000–5,000 hectares (ha) of irrigated land. The shirkat is most often supplied with water from one or more distributary canals. In areas with a high population density, however, a distributary canal supplies several shirkats located along its course.

The management of a production cooperative consists of a director (*rais*) and an administrative staff that resembles that of the *kolkhoz* (collective farm) or *sovkhoz* (state farming enterprise) that it has replaced. This administrative staff consists of an agronomist, irrigator, head mechanic, economist, and accountant. Production cooperatives contain several *pudrats*, which are family-based production units that have replaced the former “brigades” of the kolkhoz or sovkhoz.

There are at present around 1,800 shirkats in Uzbekistan. They occupy over 2 million hectares (ha) of arable land. During the period from 1999 to 2003, a total of 337 shirkats were liquidated (177 in 2003 alone). On the territory of the former shirkats, 252 WUAs were created. These WUAs serve almost 30,000 members—21,200 of them private farms—and 642,700 ha of irrigated land. The restructuring of shirkats is expected to accelerate in the next several years. During the period from 2004 to 2006, about 1,020 shirkats are scheduled for liquidation and replacement by private farms.

Private farms, which are long-term leaseholdings, cover an area between 10 and 150 ha, depending on which region of Uzbekistan they are located. They are typically located within the territory of an existing or recently restructured production cooperative. Most heads of private farms are former pudrat leaders. However, in the case of private farms created before 1998/1999, the heads are mostly former kolkhoz and sovkhoz directors, brigade leaders, or members of the rural elite, or both.

Eventually, private farms will become the predominant system of agricultural production in Uzbekistan. Between end-2000 and October of 2003, their number grew from 43,759 to 85,511. The area occupied by them expanded from 889,600 ha to 2,238,000 ha. Of this area, 1,399,000 ha is irrigated.

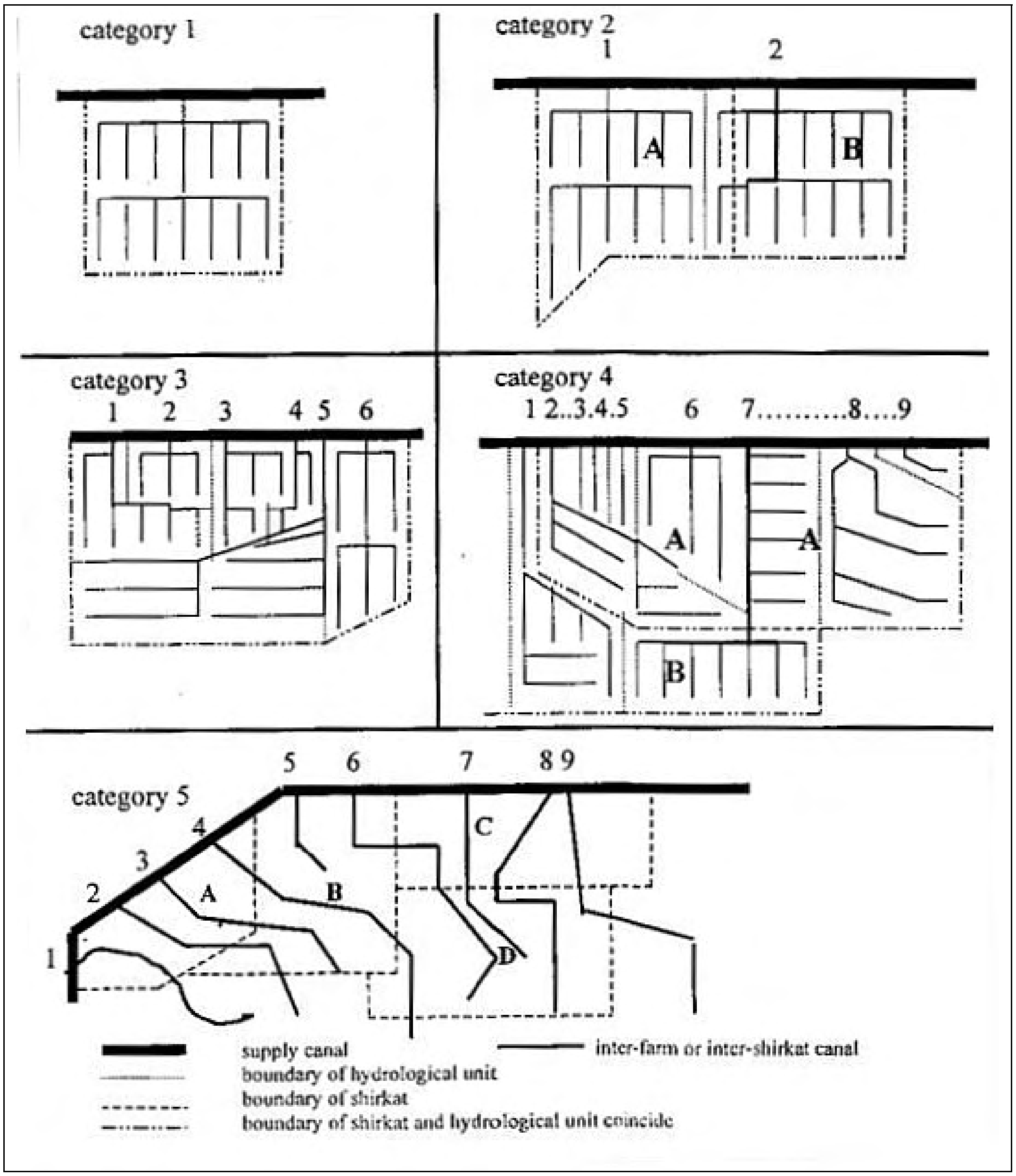
Dehqan farms are garden plots (*tamorqalar*) that occupy an area of between one-tenth and half a hectare (the standard dimension in Uzbekistan is one-fourth hectare). Unlike production cooperatives and private farms, dehqan farms are exempt from production quotas. All members of production cooperatives and heads of private farms also have one or more garden plots that are also not subject to production quotas. There are at present around 3.5 million dehqan farms in Uzbekistan. They occupy over 500,000 ha of arable land.

Appendix 2. FARM STRUCTURES AND HYDROLOGICAL UNITS

The liquidation of present-day collective farms *(shirkats)* is accelerating in Uzbekistan. This development eliminates the need for negotiating with them once a water users' association (WUA) is formed on the shirkat*'s* territory. In most instances, WUAs will not be formed in areas still served by shirkat*s*. If a liquidated shirkat does not conform to the specified hydrological boundaries, however, there would still be a need to negotiate with the hakimiyat.

The relationships of farms to hydrological boundaries listed in the figure below are typical in various regions of Uzbekistan.

Schematic Overview of Hydrological Boundaries, as Compared to WUA Boundaries and Farm Boundaries



Source: World Bank, 2003, *Manual on Formation and Empowerment of WUA.*

In the Golodnaya Steppe (Mirzachol) and Karshi Steppe (Kashkadarya Province), the boundaries of the former shirkat often form a hydrological unit with the distributary canal. Irrigation blocks are rectangular in shape and often consist of canalettes. In this instance, the formation of the WUA does not involve negotiation with the *hakimiyat* (local administration at district or province level).

In some areas, distributary canals supply more than one or more former production cooperatives. In this instance, negotiation with the hakimiyat will be needed to ensure that the WUA covers a unified hydrological boundary emanating from a distributary canal.

In many areas of Karakalpakistan and Khorezm Province, production cooperatives and private farm associations receive water from as many as 15 distributary canals. In this instance, the topography of the area is irregular, and land leveling was not considered in the original design of the irrigation and drainage system. Pumps supply most of the water for these farms. In this case, the hydrological unit of the WIA consists of various sub-units. For this reason, no extra negotiation will be needed before WUA formation can proceed. If the service area of a particular distributary canal contains more than one production cooperative, however, extra negotiation would likely be required.

In areas in Uzbekistan that have been irrigated for several centuries, a single distributary canal will supply several production cooperatives or their successors, the *fermerlar uyushmalari*. This is the case with the Ferghana Valley, Bukhara Province, and some parts of Khorezm Province and Samarqand Province. In particular, the Uzbekistan portion of the Ferghana Valley contains several systems of this type that are densely populated. There are as many as 400 persons per square kilometer on the average in such systems. In this instance, substantial preparatory work will be necessary. The WUA can cover several production cooperatives or successor organizations. Otherwise, the sub-hydrological units of the former cooperatives will need to be consolidated. In the latter case, before WUA formation can proceed, significant negotiations with the hakimiyat will be required.

In some areas, such as various locales in Tashkent Province, there are pockets of land belonging to production cooperatives that are geographically separate from the main territory of a particular production cooperative. If a WUA incorporates these units, the cost of management will be significantly higher. Communication and maintaining internal cohesion between them may also be problematic. The options in this case include (1) consolidating the pockets of former production cooperatives into one unit; (2) merging the territories of two former production cooperatives into a single WUA in the event that the combined territory is too small to form an economically sustainable unit; or (3) incorporating separate pieces of land into an existing WUA that is based on the territory of a former production cooperative adjacent to those pieces of land. In any of these cases, significant negotiation with the relevant bodies will be required before WUA formation can begin.

Asian Development Bank

WATER USERS' ASSOCIATIONS IN UZBEKISTAN

GUIDEBOOK 2:
LEGAL ISSUES AND RECOMMENDATIONS

August 2006

CURRENCY EQUIVALENTS
(as of August 2006)

Currency Unit - som (SOM)

SOM	=	$0.000815
$1.00	=	SOM1,226.74

ABBREVIATIONS

MAWR	Ministry of Agriculture and Water Resources of Uzbekistan
NGO	nongovernment organization
Uzsuvnazorat	Uzbekistan Water Control Commission
WUG	water user group

GLOSSARY

cadastre	official register of the quantity, value, and ownership of real estate used in apportioning taxes
dehqan	peasant
fermer xojaliklari	farming enterprise
fermerlar uyushmalari	association of farmers
fuqaro yighini	assembly of citizens
hakim	local administrator
hakimiyat	local administration at district and province levels
hashar	community-organized activities rendered for free
ijro organi	executive organ, particularly in reference to the Management Team of a WUA in Uzbekistan
imam	religious leader of mosque
kengash	assembly
kuzatuv kengashi	steering committee
kolkhoz	collective farm (during Soviet period)
lishentsy	deprived people
magistrallar	main canal and main drainage collectors
mahalla	neighborhood
meliorativnoe tovarishchestvo	ameliorative or reclamation association
mirab	watermaster
rais	chairman
shirkat	present collective farm whose assets are co-owned by the farmers
shirkatlar	plural of *shirkat*
sovkhoz	state farming enterprise (during Soviet period)
tamorqalar	household plot
ustuvorligi	priority
uyushma boshqaruvi	management of an association
zapovednik	nature park

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INTRODUCTION

This guidebook discusses the legal aspects of water user associations (WUAs) in Uzbekistan and aims to familiarize them with their rights and responsibilities under the law. It is specifically designed for the guidance of the major participants in the formation and development of WUAs, particularly members of water user associations, agriculture and water resources ministry officials, representatives of district and province *hakimiyats* (local administrations), and the staff of donor organizations primarily involved in establishing WUAs in Uzbekistan.

Although prepared with the specific needs of Ak Altin in mind, the material presented in this guidebook was designed such that it can also be applicable to all other areas in Uzbekistan, whether or not they are being assisted by a similar government-supported or international donor-supported project.

I. THE CURRENT WUA LEGAL FRAMEWORK

A water users' association (WUA) needs a clear understanding of the law for three fundamental reasons. First, knowledge of the law is very important in the creation of a WUA's charter and internal regulations. Second, awareness and proper application of the law by WUA officers and staff will promote good governance and management in a WUA. Third, knowledge of the law is crucial in the event that it becomes necessary for a WUA to take recourse to the courts.

A. The Legal Basis of WUAs

1. Form of Organization

WUAs are nongovernment, noncommercial organizations. They are created voluntarily by a group of water users to collectively manage, operate, maintain, and develop an irrigation and drainage system. Revenues from the commercial activities of a WUA are utilized solely to support its activities or to form part of a reserve fund. None of these revenues accrue to the WUA members as profit.

2. Objectives and Tasks

WUAs are being promoted and created in Uzbekistan "to bring order to mutual water management relations." This is as provided for by Article 2.1 of Decree No. 8, entitled "On Measures Concerning the Restructuring of Agricultural Enterprises." This decree was issued by the Uzbekistan Government on 5 January 2002.

Statement of Objectives. A more definitive general statement of a WUA's objectives can be found in Article 5 of the model WUA formation agreement provided by the Ministry of Agriculture and Natural Resources (MAWR) of Uzbekistan. The article states that:

> The basic purpose of the association consists of the protection of the rights of its founders, as well as other water users who utilize the water management infrastructure, the delivery of water to them on the basis of established limits, the ordering to water management relations, and the implementation of other activities not forbidden by the law.

Principal Tasks. The WUA's principal tasks for attaining its objectives are as follows:

- Registering water users and water delivery turnouts;
- Creating water use plans within the limit established by MAWR;
- Concluding and enforcing contracts with secondary water users;
- Supplying and distributing of water and determining water flows within the WUA;
- Reporting to the MAWR on its water deliveries;
- Concluding maintenance contracts;
- Organizing maintenance work;
- Constructing measuring devices;
- Leaching salt from soils;
- Introducing water-saving technologies;
- Establishing short-term and long-term estimates and plans for the maintenance and development of the irrigation and drainage system;
- Making the periodic reports required of WUAs by the relevant agencies; and

- Undertaking other measures for the benefit of its members.[1]

These tasks are not contained in a single comprehensive legal document. They come from various sources, particularly from Decree No. 8, from the model WUA formation agreement, and from the model WUA charter provided by the MAWR.

3. Rights and Responsibilities of the Organization

Current Legal Basis. Existing laws in Uzbekistan state the rights and responsibilities of WUAs only in general. Decree No. 8, in particular, has no specific sections regarding them. However, it mentions or implies the following rights of WUAs in various articles:

The right to make itself a legal entity *(Article 2.5)*;

The right to make a symbol for itself *(Article 2.5)*;

The right to open a bank account *(Article 2.5)*;

The right to be a "primary water user," or the right to conclude water delivery contracts with "secondary water users." *(Article 3.7)*;

The right to conclude water delivery contracts with WUA members *(Article 3.4)*;

The right to collect fees in cash and in kind from members, and the right to obtain funds from other sources not forbidden by law *(Article 2.4)*;

The right to receive the infrastructure of the liquidated shirkat or production cooperative *(Article 2.7)*; and

To right to take over the operations and maintenance equipment of the liquidated shirkat *(Article 2.9)*.

Rights Granted by the WUA's Bylaws. Much more comprehensive are the rights granted to WUAs in the internal bylaws prescribed by Article 15 of the model WUA formation agreement and by Article 10 of the model WUA charter. These rights are as follows:

The right to change water use plans in times of unforeseen water scarcity;

The right to temporarily cut off water supply to members who are delinquent in the payment of service fees, and the right to abrogate the membership of those who are delinquent for 2 or 3 years;

The right to conclude contracts for machinery services;

To right to appoint water user representatives for water delivery and the right to the "day-and-night" supervision and guarding of water supplies;

To right to obtain permission for "special water use" as defined in the Law on Water and Water Use; and

To right to engage in other activities not forbidden by the laws of Uzbekistan.

[1] These measures are provided for by Article 1.2 of Decree No. 8, Article 7 of the MAWR Model Formation Agreement, and Articles 7–9 of the MAWR Model Charter.

Additional Rights Granted to WUAs. WUAs are also granted the following rights in the 2002 redaction of the model WUA charter:

The right to establish an irrigation system department and other enterprises;

The right to obtain, purchase, sell, and temporarily grant the use of movable and immovable property, with the exception of irrigation and drainage infrastructure;

The right to sell products and services;

The right to obtain credit from banks and other creditors; and

The right to engage in accounting and statistical reporting.

These rights of the WUA are summarized in Table 1.

4. The Responsibilities of the WUA Organization

The following responsibilities of WUAs are either specified or implied in Articles 1.2, 3.1 and 3.5 of Decree No. 8:

To observe the primacy and priority (*ustuvorligi*) of water usage;

To adhere to established water use limits;

To only distribute water that comes from established sources;
To ensure that water is used effectively; and

To maintain the irrigation and drainage infrastructure in adequate condition.

Additional Responsibilities Given to WUAs. The model WUA formation agreement and model WUA charter give the WUA the following additional responsibilities:

The use of property and funds in accordance with the WUA's statutory purpose;

The proportional delivery of water in accordance with water use plans;

The payment of the requisite dues to the state;

The maintenance and repair of operating and maintenance equipment; and

The submission of a semi-annual report to the WUA's General Assembly.

These rights of the WUA are summarized in Table 2.

B. Registration of WUAs

According to Article 44 of the Civil Code, all juridical entities in Uzbekistan should first be listed in the Unified State Register of Juridical Entities before they can begin to function. This requirement also applies to WUAs as nongovernment, nonprofit organizations. Their juridical listing will follow once they are officially registered with the Ministry of Justice.

Table 1: Rights of the WUA Organization

Rights Provided for or Implied by Decree No. 8 of the Uzbekistan Government	Rights Granted by the WUA Formation Agreement and Model WUA Charter	Rights Provided for by the 2002 Redaction of the Model WUA Charter
1. The right to make itself a legal entity. 2. The right to make a symbol for itself. 3. The right to open a bank account. 4. The right to be a "primary water user," which means the right to conclude water delivery contracts with "secondary water users." 5. The right to conclude water delivery contracts with WUA members. 6. The right to collect fees in cash and in kind from members, and the right to obtain funds from other sources not forbidden by law. 7. The right to receive the infrastructure of the liquidated shirkat. 8. The right to take over the operations and maintenance equipment of the liquidated shirkat.	1. The right to change water use plans in times of unforeseen water scarcity. 2. The right to temporarily cut off water supply to members who are delinquent in the payment of service fees, and the right to abrogate the membership of those who are delinquent for 2 or 3 years. 3. The right to conclude contracts for machinery services; 4. The right to appoint water user representatives for water delivery and the right to the "day-and-night" supervision and guarding of water supplies; 5. The right to obtain permission for "special water use" as defined in the Law on Water and Water Use; and 6. The right to engage in other activities not forbidden by the laws of Uzbekistan.	1. The right to establish an irrigation system department and other enterprises. 2. The right to obtain, purchase, sell, and temporarily grant the use of moveable and immovable property, with the exception of irrigation and drainage infrastructure. 3. The right to sell products and services. 4. The right to obtain credit from banks and other creditors. 5. The right to engage in accounting and statistical reporting.

Table 2: Responsibilities of the WUA Organization

Responsibilities Provided for or Implied by Decree no. 8 of the Uzbekistan Government	Responsibilities Provided for by the WUA Formation Agreement and Model WUA Charter
1. To observe the primacy and priority (*ustuvorligi*) of water usage; 2. To adhere to established water use limits; 3. To only distribute water coming from established sources; 4. To ensure that water is used effectively; and 5. To maintain infrastructure in adequate condition.	1. The use of property and funds in accordance with the WUA's statutory purpose; 2. The proportional delivery of water in accordance with water use plans; 3. The payment of the requisite dues to the state; 4. The maintenance and repair of operating and maintenance equipment; and 5. The submission of a semi-annual report to the WUA's General Assembly.

A WUA should register within 2 months after its formation meeting. Registering beyond this 2-month period is a legal ground for the rejection of the registration application.

Prior to registration with the Ministry of Justice, a WUA should create its own official seal, as this and any other symbols of the WUA must also be registered along with its charter.

Registration Requirements. The application for registration with the Ministry of Justice should include the following documents:

> An application signed by members of a managing body of the organization. It should stipulate the last name, first name, and middle name as well as the year, place of birth, and place of residence of each of them;
>
> Two copies of the WUA charter;
>
> The minutes of the WUA's formation meeting. They should contain information concerning the creation of the WUA, the membership, the approval of the charter, and the formation of the WUA's governing bodies and other organs; and
> A receipt from a bank as proof that the registration fee has been paid.

Registration Processing. The department in the Ministry of Justice that receives applications for WUA registration is required to either approve or disapprove them within 2 months upon receipt of the registration application. Within 3 days after making this decision, the Ministry of Justice has to issue the WUA either a certificate of state registration or a notice of refusal to register it. A notice of refusal must state the justification for the refusal. It should specifically list the laws or regulations violated or not complied with. As provided for in Article 44 of the Civil Code, however, refusal of state registration may be appealed in a court of law.

C. Forming, Developing, and Operating WUAs

1. Legal Basis of Forming WUAs

The right of all farmers to create WUAs is legally provided for in the Constitution of Uzbekistan as well as in several enactments concerning the various types of farms in the country.[2] The pertinent constitutional provisions are as follows:

> *Article 28 of the Law on Individual Farms, Article 22 of the Law on Dehqan Farms, and Article 28 of the Law on Agricultural Cooperatives.* The provisions permit members of these farms to "establish *on a voluntary basis* [italics added], including on share basis, to associate and join cooperatives, unions, associations, and other joint organizations...for water management...and other types of services."
>
> *Article 15 of the Law on Nongovernment, Noncommercial Organizations*. It provides for the voluntary creation of these organizations. They are to be "established by decision of its members (founders) in compliance with the legislation."[3]

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[2] Articles 32–35 of the Constitution grant citizens the right to "participate in the management of the affairs of society and government," the right to associate in public meetings, the right to join together in public associations, and the right to address the government and representative bodies with declarations, proposals, and complaints.

[3] Article 42 of the Civil Code specifies that juridical entities are founded by the owners of their property "or a duly appointed plenipotentiary." The latter provision is superseded by the Law on Non-Governmental, Non-Commercial Organizations.

In the particular case of WUAs, their initiators or founders have to call a formation meeting in which a WUA formation agreement is signed, a WUA charter is adopted, and the WUA's governing and management bodies are formed. *(Guidebook 1 describes the WUA formation process in detail.)*

2. The WUA's Charter and Internal Regulations

Every WUA is required by law to have a charter that will serve as its primary internal governing document. This charter specifies the rights and duties of WUA members and those of the WUA's governing and management bodies.

Some aspects of the WUA charter are fixed by law, but the law also permits some degree of variation in the final form of a WUA and of its charter. A WUA can use the model WUA charters or their component provisions as a basis for preparing its own charter. As long as all of its provisions comply with the law, a WUA's charter need not necessarily use the exact wordings of the model WUA charter.

3. Governance and Management

A WUA can be governed and managed much more effectively when its administrators, managers, staff, and general membership are fully cognizant of their respective legal rights, responsibilities, and obligations. Their knowledge and consistent application of the law will give the WUA the following benefits:

- A much more predictable and reliable exercise of their rights and responsibilities as well as performance of their roles;
- Stronger accountability of the WUA's governing and management bodies to the WUA membership;
- Better enforcement of the law;
- Equity and fairness in decision-making and resource allocation; and
- Enhanced legitimacy of the WUA among its members and among its external publics.

To make the law known and understood by all of its stakeholders, a WUA has to obtain and maintain copies of all laws, decrees, and bylaws that concern its primary activities. It should make a continuing effort to keep them up to date.

4. Recourse to the Judicial System

As with all other business and corporate entities, a WUA should consider the judicial system only as a last resort for resolving legal problems. In a great many instances, simply stating one's rights clearly and expressing the determination to defend them are sufficient to avoid resorting to judicial litigation. However, there are instances when it becomes unavoidable for a WUA and its members to resolve disputes or seek redress through the judicial system. When this happens, it is to their advantage knowing precisely what their legal rights are and how the state guarantees and seeks to protect those rights.

The Right to Judicial Protection. In Uzbekistan, the Law on Courts states that citizens and noncitizens alike are entitled to "judicial protection from any illegal decisions of the state and other authorities...as well as any attempts against life and health, honor and dignity, personal freedom, and property rights, other rights, and freedoms" (Article 9).[4]

Article 1 of the Law on Courts stipulates that "Administration of justice shall be executed by the courts only." No other entity in Uzbekistan is permitted by law to enter judgment against a citizen.

Article 6 specifies that "Judicial acts shall be binding on all state bodies, public organizations, enterprises, officials, citizens, and (are) subject to enforcement in the territory of the Republic of Uzbekistan."

Article 65 grants to judges the right to demand enforcement of their decisions. It provides that "Failure to observe the requirements and orders of judges shall entail legal liability."

The Right to Legal Assistance. The right to legal assistance is guaranteed at every stage of the investigative and judicial proceedings. However, WUAs intending to go to court should heed the words of the President of Uzbekistan, who noted in a speech to the Oliy Majlis on 29 August 2001 that:

> the judiciary system itself is still feeling the legacy of the Soviet past. To put it more exactly, the adopted laws and norms of legal proceedings more and more meet international universally accepted democratic norms, but unfortunately, little is changing in the mentality and way of thinking of the judges, officials of the procurator's office, and investigating bodies themselves; in a word, of those who must implement the newly adopted laws. This must be admitted, and our main task is to get rid of this legacy of the past as soon as possible.

WUAs and their members can help to fulfill this task by responsibly exercising their rights in the judicial system and by demanding that the law be strictly enforced.

5. The Judicial System in Uzbekistan

Most court cases in Uzbekistan pertaining to WUAs will be judged in Courts of General Jurisdiction. These courts are divided into the criminal and civil sections. They have three levels: the district courts, the province courts, and the Supreme Court.

The District Courts. Each of the 210 districts in Uzbekistan has a criminal court. There are 76 lower-level civil courts in the country. Most of them, particularly the so-called inter-district courts, cover more than one district. In these lower-level courts, criminal cases are heard by only one professional judge. More serious cases are heard by two lay assessors selected by the *mahalla* (neighborhood) committee. Civil cases are heard by only one professional judge.

The Province Courts. The province courts hear only the more important civil cases. Many of these cases are appeals. Cases in province courts are adjudicated by one professional judge and two lay assessors.

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[4] Furthermore, the Law on Appeals of Citizens states, "Complaints against acts or decisions of governmental bodies, public organizations, enterprises, agencies, or officials shall be submitted to the higher body or to the court" (Article 8). The Law on Appealing to the Courts Against Acts and Decisions Violating Civil Rights and Liberties (Article 1) provides that "Every citizen shall have the right to appeal to the court if he/she believes that his/her rights and liberties have been violated by illegal acts (or decisions) of governmental bodies, entities, agencies, organizations, self-governing bodies, or officials." The procedure for appeals is specified in detail in this law.

The Economic Courts. Commercial disputes that only involve corporate enterprises are adjudicated by the Economic Courts. There is an Economic Court in each province of Uzbekistan, while the Higher Economic Court is located in Tashkent.

Judicial Proceedings. Most judicial proceedings that pertain to WUAs, such as disputes over contracts and water distribution, are settled in civil courts. However, cases involving criminal actions such as extortion and bribery are resolved in the criminal courts. Some matters pertaining to WUAs, such as liabilities and appeals concerning contract disputes, are dealt with by the Economic Courts. The Constitutional Court, which reviews laws and decrees to ensure compliance with the Constitution of Uzbekistan, will rarely be resorted to by WUAs.

II. LEGAL INADEQUACIES OF WUAS IN UZBEKISTAN

The legal and regulatory framework for WUAs in Uzbekistan is still in the formative stage. There is as yet no comprehensive law enacted specifically to cover WUAs. The bylaws of the country's model charter for WUAs still need to be modified to make it truly responsive to the needs of the farmers and other water users.

Current Laws Governing WUAs. As of this writing, prospective WUAs in Uzbekistan are being guided only by the following laws, decrees, and other enactments relevant to the formation and development of WUAs:

The Constitution of Uzbekistan (8 December 1992). It provides the basis for the country's entire legal and regulatory framework.

The Civil Code of Uzbekistan (1 March 1997). It provides the basis for the prevailing civil law system in Uzbekistan.

The Law on Individual Farms (30 April 1998), the Law on Dehqan Farms (30 April 1998), and the Law on Agricultural Cooperatives (30 April 1998). Together, they define the status of various types of farms in Uzbekistan;

Attachment No. 7 to Decree No. 8 (5 January 2002) entitled "On Measures Concerning the Restructuring of Agricultural Enterprises." It stipulates the creation of WUAs on the territory of liquidated production cooperatives (*shirkatlar*).

The Law on Water and Water Use (6 May 1993). This is an updated version of the water laws passed in 1972 and 1941. It establishes the legal basis for water rights. It has several articles pertaining to (1) the operations and maintenance of irrigation and drainage systems, and (2) the resolution of disputes concerning water.

Decree No. 385 (3 August 1993) entitled "On Limited Water Use in Uzbekistan." It has important rules concerning water distribution during periods of scarcity.

The Administrative Accountability Code (25 April 1997). It has several articles that specify penalties for violations of the law concerning water use.

Decree No. 290 (29 July 2003) entitled "On the Improvement of the Organization of the Ministry of Agriculture and Water Resources." It establishes a basic principle for the structure and functioning of the MAWR. In addition, Attachment No. 5 to this decree mandates the MAWR to support WUAs.

The Land Code of Uzbekistan (30 April 1998). It has several articles devoted to the legal status of irrigated land.

The Tax Code of Uzbekistan (24 April 1997). It provides a legal definition of tax obligations.

The Law on Accounting (30 July 1996), the National Accounting Standards (1998 and 1999), and the Law on Auditing (9 December 1992). All three have several articles directly relevant to the financial management of WUAs.

The Law on Property (31 October 1990). It legally defines the basis for state and shirkat property that are transferred to or utilized by WUAs, or both.

Model WUA Bylaws and Agreements. Aside from these legal enactments, model bylaws, agreements, and contracts for WUAs have also been provided by the MAWR. These include (1) a model formation agreement for WUAs, (2) a model charter for WUAs, (3) a model contract for WUAs developed by the MAWR in 2003,[5] and (4) a redaction of the model WUA charter provided by the MAWR in 2002.[6]

A draft WUA Law has been proposed to the Uzbekistan Government. *(The Appendix shows the full text of the proposed WUA Law.)* The government, for its part, is now working on specific provisions covering WUAs for inclusion in the Law on Water and Water Use.

Understanding the Laws Pertaining to WUAs. To succeed in their formation and development efforts, water users and the WUA's governing and management bodies have to understand at least the most significant components of the laws and enactments pertaining to WUAs. In particular, they should carefully study the description and analysis provided in this guidebook about the laws and regulations applicable to WUAs in the following aspects: (1) legal status; (2) formation and development; (3) financial management; (4) operations and maintenance; (5) dispute resolution; and (6) water, land, and property rights.

A. Form of Organization

Current Legal Basis: It is still unclear what precise form will be taken by WUAs in the legal and regulatory framework of Uzbekistan. The model WUA formation agreement and model charter provided by the MAWR both state that WUAs are nongovernment, noncommercial organizations. However, this is not specifically provided for by Decree No. 8, the legal enactment that directly concerns WUAs and with which a WUA's bylaws are required to conform. Article 2.5 of Attachment No. 7 to this decree merely stipulates that WUAs are juridical entities whose legal status is specified in detail by Articles 39–57 of the Civil Code.

Analysis: A WUA can be classified as a "noncommercial organization" in accordance with Article 40 of the Civil Code. However, it does not precisely conform to the types of nongovernment, noncommercial organizations specified in either the Civil Code or the law on nongovernmental, noncommercial organizations (NGOs). These two laws specify that an NGO can be a supply cooperative, a social organization, or a social fund, but a WUA does not fall under any one of them. A WUA is not a supply cooperative because it has functions other than supplying water. It is not a social organization because it does not specifically provide for "spiritual or non-material needs." It is not a social fund, because a social fund is an entity that "does not have members," while a WUA has members.

Thus, based on a loose interpretation of the law, a WUA might be classified as an "institution." Article 13 of the law on nongovernment, noncommercial organizations defines an "institution" as "an organization created by physical and juridical entities for the fulfillment of socio-cultural or other functions of a noncommercial nature." Still, this definition is not completely in accord with how "institution" is defined by Article 76 of the Civil Code. It defines an "institution" as an organization with only one property owner. A WUA, however, has many owners because all of its members are owners of the property.

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[5] These are contained in the MAWR manual for implementing Decree No. 8: O'zbekiston Respublikasi Qishloq va suv xojailigi vazirligi, 2003, *O'zbekiston Respublikasi Vazirlar Mahkamasining 2002 yil 5 Yanvardagi 8-sonli qarorida belgilangan tartibda qayta tashkil etilayotgan qishloq xojaligi korxonalari hududlarida Suvdan foydalanuvchilaruyushmalarini tuzish bo'yicha qo'llanma*.

[6] O'zbekiston Respublikasi Qishloq va suv xojailigi vazirligi, 2002, *O'zbekiston Respublikasi Vazirlar Mahkamasining 2002 yil 5 Yanvardagi 8-sonli qarorga asoslangan qayta tashkil etilayotgan qishloq xojaligi korxonalari hududlarida tashkil etiladigan Suvdan foydalanuvchi uyushmaci Namunavi ustavi*.

Recommendation: To resolve these legal problems, WUAs should be given a special status in the Civil Code as a unique type of nongovernment, nonprofit organization on the basis of the Constitution.[7] Such a status would entitle WUAs to the same tax exemptions granted to nongovernment, noncommercial organizations.

B. Legal Aspects of the WUA Organization

1. The Formation of WUAs

Current Legal Basis: The right of farmers to create WUAs on a voluntary and autonomous basis is provided for by the Constitution of Uzbekistan as well as by several other enactments. However, this principle of voluntary, autonomous formation of WUAs is directly contradicted by Decree No. 8. Articles 2.2 and 2.3 of the decree states that the WUA should be established “in agreement with” and “according to the recommendations of” the District MAWR Department. A similar contradictory clause is also to be found in the WUA formation agreement and model WUA charter provided by the MAWR. Both documents state that the formation agreement and model charter should be adopted “in accordance with the recommendations of MAWR” as well in accordance with the legal enactments of Uzbekistan. Another complication is that the MAWR guidebook for implementing Decree No. 8 stipulates that the WUA formation meeting be called “upon the initiative of the District MAWR Department.”

Analysis: This approach to forming WUAs is neither advisable nor conducive to their formation in Uzbekistan. It must be recognized that government authorities cannot just order a WUA to be created “out of thin air.” In the first place, farmers in Uzbekistan have a very little idea of what a WUA is. Institutions similar to the WUA have not existed in Uzbekistan since the removal in the 1920s of the "water master" (*mirab*) management system under the khanates as well as of the Reclamation Association (*meliorativnoe tovarishchestvo*). It is much better for the Government to simply play a facilitation and supporting role in the formation of WUAs. It should allow the farmers themselves to take the initiative in forming and developing them.

Recommendation: The law to be promulgated specifically for WUAs could provide the basis and legal framework for this facilitation and supporting role of the Government. It should limit the direct participation of government authorities to advising and assisting in the formation of WUA initiative groups. It should also limit membership of WUA formation committees to potential members of the WUA. In addition, the law should provide that since a WUA formation meeting is a purely internal matter among potential WUA members, government authorities should neither participate nor directly involve themselves in it.

2. Criterion for WUA Membership

Current Legal Basis: The criterion for membership in a WUA is defined in Article 1.2 of Decree No. 8 as “newly created leasehold farms (*fermer xojaliklari*)” and other juridical and physical entities. However, the phrasing of Article 2.2 inadvertently excludes dehqan farms (small garden plot farms) from membership: “…the District MAWR Department is to protect the interests of nonmembers, the list of which includes dehqan farms, schools, healthcare institutions, communal farms, and other similar entities.”

Recommendation: Preferably, the law to be enacted on WUAs instead should specify “the right to land use” as the criterion for membership. This is the prevailing practice in most

[7] Article 56 of the Constitution defines "public associations," under which WUAs can be classified, as "other citizen's associations registered in accordance with the established legal procedure." Article 58 obligates the Government to ensure the "adherence to the rights and legal interests of public associations." It also prevents the Government and public associations from interfering in each other's affairs.

countries of the world in which WUAs have been successful. It must be pointed out here that the 2002 redaction of the MAWR Model Charter, by stipulating that members be owners or lessees of immovable property, already comes close to this criterion.

3. Guiding Principle for Creating WUAs

Current Legal Basis: Probably because many shirkats do not conform to hydrological units, the principle of creating WUAs within an indivisible hydrological unit is not specified in Decree No. 8. However, if the WUA is not created on the basis of a hydrological unit, there is significant potential for inattention to certain parts of the system. Hopes might be raised that some other organization will shoulder this responsibility. Disputes and litigation concerning operations and maintenance will likely ensue.

Recommendation: The law to be enacted on WUAs has to specify that in general, a WUA should be created within an indivisible hydrological unit. A possible exception to this rule are those instances in which the hydrological unit crosses international boundaries or includes part of a protected federal land, such as a nature preserve (*zapovednik*).

4. Terms of Organization and Membership

Current Legal Basis: The WUA model formation agreement provided by the MAWR deals primarily with the various joint activities needed to establish a WUA organization. It does not specify the terms of property transfer to the WUA. Instead, it simply provides that the WUA's initial property is to be based on its members' property shares in the liquidated shirkat. Terms of termination of membership are lacking. Also, the terms of member participation in the activities and management of the organization are only a general list of rights and responsibilities. They do not specify *how* WUA members are to participate in decision-making processes.

Recommendations: The WUA needs to be more specific about the terms of its organization and membership. The following provisions are recommended for that purpose:

- The name, objectives, and purposes of the nongovernment, noncommercial organization;
- The organization's legal form;
- The territory within the limits of which the organization will carry out its activities;
- The organization's internal structure and governing bodies;
- The authority and the procedure for forming governing bodies and their terms of office;
- The location of the permanently operating governing body;
- The terms and procedures for acquiring and terminating membership;
- The rights and duties of members;
- The sources of funds and other property used in forming the organization;
- The rights of the organization;
- The property management structure for its subdivisions;
- The procedure for reorganizing and liquidating the organization; and
- The procedure for introducing changes and amendments in the charter.

A critical item in the list above—the terms and procedures for acquiring and terminating membership—is absent in the model WUA charter provided by the MAWR. This is despite the fact that this particular item was already provided for in the 2002 redaction of this model charter.

Also, the charters of many WUAs in other parts of the world include provisions or sections regarding the operations and maintenance of the irrigation and drainage system, the imposition of charges for water delivery, and the creation of WUA federations.[8] These aspects should be considered for inclusion in the model charter for WUAs in Uzbekistan.

5. Registration of WUAs

Current Legal Basis: As provided for by Article 44 of the Civil Code, a WUA has to register with the Ministry of Justice to become a juridical entity. However, the MAWR Manual for implementing Decree No. 8 also requires WUAs to register with the local hakimiyat and "other organs." Thus, what often happens in practice is that WUAs take the line of least resistance. They would apply for registration only with the hakimiyat, and forget to register with the Ministry of Justice altogether. When this happens, the WUA does not become a legally registered juridical entity at all.

Recommendation: To avoid confusion, a WUA should be required to register only with the Ministry of Justice. It should no longer register with the local hakimiyat and "other organs."

6. The WUA's Organizational Structure

Current Legal Basis: The organizational structure of WUAs is not yet specified comprehensively in existing laws of Uzbekistan. In particular, Article 2.6 of Decree No. 8 only implies this organizational structure. This is when it provides for a WUA General Assembly and for the number of WUA staff that the General Assembly has to ratify on an annual basis.

Provisions of Model WUA Charter: The model WUA charter prepared by the MAWR is much more specific about the WUA's internal structure and governing bodies. It provides for them in the following manner:

> The General Assembly is the supreme governing organ of the WUA and all WUA members have the right to participate in its decision-making. It has to meet at least twice a year. Every WUA member is entitled to one vote in its proceedings.
>
> The General Assembly has to elect the following: (1) a WUA Supervisory Council (the *uyushma boshqaruvi* or *kuzatuv kengashi*, or WUA Council for short) composed of five persons; (2) an Audit Commission composed of three persons; and (3) a WUA Management Team (referred to in the model WUA charter as the "Executive Organ").
>
> The chair (*rais*) of the WUA Council is concurrently the WUA chair and is responsible for fulfilling the WUA Council's mandate. The WUA Council has to meet at least once a month and has to report to the General Assembly twice a year. The members and chair of the WUA Council have to be elected or reelected by the General Assembly on an annual basis.
>
> The Audit Commission has to be elected by the General Assembly on an annual basis.
>
> The WUA Management Team (the *ijro organi* or executive organ) is to be composed of "highly qualified individuals." Its chief, to be referred to as the "WUA manager," has to be appointed on contract by the WUA Council chair. The WUA manager is responsible for implementing the tasks assigned by the WUA. He or she will report to both the General Assembly and the WUA Council.

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[8] Salman M.A. Salman, 1997, *The Legal Framework for Water Users' Associations: A Comparative Study*, *World Bank Technical Paper No. 360*.

Recommendations: The WUA law and model WUA charter should also specify the following provisions:

> The WUA Council appoints the WUA manager and the WUA accountant as well as defines their terms of reference and tenure.
>
> The WUA manager, in turn, appoints the remainder of the staff of the WUA Management Team as specified by the General Assembly.
>
> All of these appointments have to be ratified in the subsequent General Assembly meeting.
>
> Members of WUA's internal bodies will not be allowed to hold dual positions.
> Only the members of the WUA's Management Team will have salaried positions.

The law should also give flexibility to the WUA to adapt to local conditions and needs. For instance, in areas where a WUA has to contend with so many disputes, it should be given the option to form a Dispute Resolution Commission. In areas where the WUA membership is so large that it is difficult to gather them for General Assembly meetings, a WUA should be given the option to create representative assemblies. There could be one such assembly for each of the internal hydrological sub-units that are being governed by individual Water User Groups (WUGs).

Inappropriate Stipulation for the WUA Council. The MAWR stipulates that the WUA Council chair should be elected by the WUA General Assembly from among candidates "agreed upon with the District MAWR Department."

Analysis: Such a stipulation constitutes direct government interference in the internal affairs of the WUA, and is forbidden by the Constitution of Uzbekistan and by other laws. It grants the MAWR effective and unwarranted control over the WUA's activities.

Because of this stipulation, the MAWR and the district hakimiyat in practice often appoint the chair of the liquidated shirkat as the WUA Council chair. They also often appoint the former irrigator of the liquidated shirkat as the WUA manager. As a result, the WUA manager appointed in this manner often gets wrongly referred to as the WUA chair (*rais*) himself or herself. Often, he or she is mistakenly perceived by WUA members as their leader, which is not the case at all.

Recommendation: To avoid this confusing state of affairs, the Government needs to amend the above inappropriate stipulation in the MAWR manual.

7. Powers and Prerogatives of WUA's Internal Bodies

Current Legal Basis: Existing laws in Uzbekistan do not fully elucidate the powers, prerogatives, and procedures required of the WUA's internal bodies, particularly the General Assembly. Decree No. 8 simply provides that the General Assembly has the right (1) to ratify water use plans in accordance with the cropping plan, hydro-module, and limit established by the MAWR *(Article 3.3)*, and (2) to decide on the matter of water supply to additional secondary water users *(Article 3.7)*.

Rights and Responsibilities of General Assembly. The WUA model charter provided by the MAWR specifies the following powers and prerogatives for the WUA's General Assembly:

> Electing the WUA Council and its Chair, creating the Audit Commission, and ratifying their tasks as well as approving the WUA formation agreement;
>
> Creating staff positions for the WUA Management Team and ratifying the appointment of its chief;
>
> Determining the basic directions of the WUA Management Team's work and ratifying its proposed size and its projected expenses and short-term and long-term plans.
>
> Granting authority to the WUA manager to negotiate and sign contracts with water users, to hire staff for the WUA Management Team, and to undertake financial transactions and other activities;
>
> Ratifying proposed measures and planned activities regarding the water supply, the utilization of water management infrastructure, and other undertakings not forbidden by the law;
>
> Amending the WUA formation agreement and the WUA charter as it sees fit;
>
> Ratifying the current fees (fixed costs) and development fees (variable costs) being collected by the WUA as well as the method of their payment by members.
>
> Removing WUA members for nonpayment of fees for a period in excess of 2 or 3 years;
>
> Accepting members into the organization and removing them for cause;
>
> Determining the manner that the WUA will be audited, and appointing the WUA auditor as well as determining his or her compensation;
>
> Deciding on the acquisition of funds and credit from banks and other sources;
>
> Deciding on the termination of the WUA and its re-establishment if warranted; and
>
> Other powers and prerogatives not forbidden in the laws of Uzbekistan.

Recommendations: To make WUAs even more effective in performing its functions, the General Assembly should also be given the following powers and prerogatives:

> Defining the main directions of the WUA's activities;
>
> Dismissing for cause the WUA Council or the WUA Council chair as well as any member of the WUA's other internal bodies;
>
> Approving the WUA's annual work plan;
>
> Approving the WUA's annual budget;
>
> Approving the WUA's annual report and accounts;

Approving the reorganization of the WUA;

Creating internal rules and orders; and

Establishing the level of sanctions and fines to WUA members.

Decision-Making Procedures of the General Assembly. Specific decision-making procedures for the General Assembly are largely absent in the current model WUA charter provided by the MAWR. In the 2002 redaction of this model charter, however, the bylaws contained the following provisions:

A General Assembly meeting may be called on the initiative of at least three-quarters of the WUA's members or of the WUA Council. The Audit Commission, by the same percentage of its members, may also call for such a meeting in extraordinary circumstances in which violations of the law have been discovered. The members of the WUA have to be informed of the convening of the General Assembly 7 days in advance. The notice should be in written form and should include the date, time, place, and agenda.

A simple majority is required to establish a quorum.

Voting is by show of hands or secret ballot. Decisions can be made by at least one third of the participants.

Decisions are reached by simple majority vote. When there is a deadlock, a vote is taken again. If the deadlock remains even after this second voting, the WUA Council chair decides the matter.

The minutes of the General Assembly have to be recorded and later ratified in the subsequent General Assembly.

Members may, at their own expense, obtain copies of all of the decrees and decisions made by the General Assembly.

Elected members of the WUA Council and Audit Commission who wish to relinquish their posts have to formally inform the General Assembly. They can vacate their posts only after their replacements have been elected.

The WUA Council is responsible for managing the General Assembly. It has to prepare in advance all proposals to be presented to General Assembly. The minutes of the General Assembly should be duly taken by a secretary.

Recommendations: While most of the above provisions are adequate for decision-making by the General Assembly, their particulars need the following refinements to make them more workable and effective:

The 7-day advance notice required for convening the General Assembly is too short. It should be extended to 30 days to give WUA members ample time to prepare their own proposals. In the case of extraordinary sessions, a minimum of 2 weeks for the advance notice would be more appropriate.

The simple majority required of the General Assembly to establish a quorum and the majority vote prescribed for its decision-making are not enough to make its decisions truly representative. If followed, these stipulations will empower only slightly over a quarter of the WUA members to make decisions for the entire WUA. Under such circumstances, decisions of the General Assembly will not truly reflect the collective thinking of its membership. Instead of these stipulations, the model WUA charter should require an *absolute* majority vote for General Assembly decisions. This means the vote of the majority of *all* members of the WUA. This absolute majority vote should be required no matter what proportion of members—two thirds, for example—is required by the General Assembly to establish a quorum.

There should be a mechanism for equitably allocating voting rights to farms of various types. For instance, if *dehqan* farms are to be allowed to join the WUA, which is desirable, then one vote each should be given to every individual farm and to every group of dehqan farms in a certain municipality.

The WUA's bylaws should require the WUA Council to keep minutes of General Assembly meetings and proceedings and to maintain a record of them in its permanent archives. A similar archiving procedure should be required of the meeting protocols of the WUA Council, the Audit Commission, and the Dispute Resolution Commission.

There should be a provision for similar voting procedures in the Representative Assembly if a particular WUA decides to have one. This is to ensure fair and equitable representation.

Rights and Responsibilities of the WUA Council. The WUA model charter provided by the MAWR grants the following rights and responsibilities to the WUA Council:

Ensuring that the decisions of the WUA General Assembly as well as the provisions of the WUA formation agreement and charter are duly followed by the members and other water users;

Ensuring that the WUA obtains water in accordance with its limit and that its manner of water distribution is equitable;

Adopting extraordinary decisions subject to ratification by the General Assembly;

Calling meetings of the General Assembly, preparing the necessary documentation for them such as minutes and protocols, and ensuring that General Assembly decisions are duly followed;

Hearing the monthly and quarterly reports of the WUA manager and making the decisions regarding the various aspects of these reports;

Approving temporary cut-offs of the water supply to those with overdue current and development fees;

Examining proposals and complaints from water users and from the WUA Management Team and adopting the appropriate measures to address them;

Supervising the WUA's financial activities and adopting measures to eliminate any deficiencies in them;

Analyzing the conclusions and proposals of the Audit Commission; and

Protecting the rights of the water users and of the WUA Management Team.

Tasks of the WUA Council Chair. The 2002 redaction of the model WUA charter lists the following tasks of the WUA Council chair that should be included in the model WUA charter: (1) the signing of reports and other documents, and (2) representing the WUA in court, in organizations, and in other undertakings. However, none of the enactments or bylaws for WUAs specifies procedures for decision-making in the WUA Council.

Recommendations: The following decision-making procedures for the WUA council should be adopted in the model WUA charter: (1) requiring four out of five members of the WUA Council to constitute a quorum; (2) decision-making by majority vote, with the WUA Council chair deciding in the event of a tie; and (3) removing a WUA Council member for repeated non-attendance and electing his or her replacement in the subsequent General Assembly. The WUA Council should also be allowed to develop other internal rules as it deems fit.

The following additional tasks should also be given to the WUA Council chair: (1) the general governance of WUA activities in accordance with the mandates of the General Assembly; (2) the preparation of annual reports, balance sheets, work plans, and budgets for approval by the General Assembly; and (3) the approval of reports prepared by the WUA manager.

Qualifications of the WUA Council Chair. The 2002 redaction of the model WUA charter specifies the following qualifications for the WUA Council chair: (1) that only citizens of Uzbekistan over 25 years of age may occupy the position; (2) that the position be denied to persons whose political rights have been abrogated (*lishentsy*), who have been sentenced or are under interrogation, who are indebted to the WUA, or who have been previously removed from posts in the WUA.

Recommendation: The WUA is not a political organization, so it is not rightful for the above political requirements to be applied to its officials and members. More appropriate qualifications should be prescribed for members of the WUA Council.

Rights and Responsibilities of the Audit Commission. The model WUA charter provided by the MAWR grants the following rights and responsibilities to the WUA Audit Commission:

> Making a quarterly examination of the WUA’s financial activities and submitting its audit report to the WUA Council chair together with the necessary corrective measures, if any;
>
> On request by the WUA Council chair, conducting analysis and making conclusions concerning various tasks of the WUA and its Management Team; and
> Reporting to the General Assembly.

The 2002 redaction of the model WUA charter also allows the Audit Commission (1) to conduct audits *any time it sees fit* (underscoring provided), and (2) to convene extraordinary sessions of the General Assembly if serious violations of the law are discovered in the course of the audit.

Recommendations: In practice, a full quarterly audit of any business entity is unnecessary. A once-a-year audit would be sufficient in most instances. Also, to avoid unnecessary disruption of a WUA's operations and activities, it is important that audits be initiated only upon the request of either the General Assembly or the WUA Council.

It is too burdensome to allow the WUA Audit Commission to conduct audits any time it sees fit and to convene extraordinary sessions of the General Assembly. After all, there are sufficient provisions in the 2002 redaction of the model WUA charter to ensure the integrity of the auditing process. These provisions are as follows:

That the Audit Commission make its decisions by majority vote;

That if a member of the Audit Commission protests the conclusions and decisions of the commission, he or she can issue a minority opinion independent of the other members of the Commission; and

That when a member of the Audit Commission fails to participate in two consecutive audits, he or she can be removed and replaced by the General Assembly.

Rights and Responsibilities of the WUA Management Team. As specified in the model WUA charter provided by the MAWR, the WUA Management Team has the following rights and responsibilities:

Managing the daily tasks of the WUA;

Implementing the directives of the General Assembly and of the WUA Council;

Registering the WUA in accordance with the WUA formation agreement and charter, procuring the requisite seals and stamps, and opening a bank account;

Preparing expense estimates for the water supply and for operations and maintenance, and facilitating the ratification of those estimates;

Concluding contracts on behalf of the WUA and ensuring their fulfillment;

Approving certificates for the property of members and other property held by the WUA;

Utilizing and protecting the property and funds of the WUA; and

Providing information and reporting to the WUA Council and other relevant bodies regarding its activities.

Recommendations: There is a need to make refinements and additions to these rights and responsibilities. In particular, the registration of a WUA, the procurement of the requisite seals and stamps, and the opening of a bank account for the WUA should be placed under the purview of the WUA Council chair, not the WUA manager. Also, to make the WUA Management Team more effective in operating the WUA, it should also be given the following responsibilities and prerogatives:

Preparing the draft budget, draft work plan, and other documents for presentation to the WUA Council;

Maintaining and regularly updating a register of WUA members and undertaking an annual review of it;

Proposing to the WUA Council the rates of fees to be collected from members and water users;

Providing information to the internal bodies and members of the WUA; and

Accepting property contributions from members and nonmembers in accordance with the terms of contract and with the WUA's bylaws.

Representative Assembly and Dispute Resolution Commission. The law to be enacted on WUAs as well as the WUA bylaws should permit the creation of the Representative Assembly and Dispute Resolution Commission and provide for the following:

> The Representative Assembly will have the same powers as those of the General Assembly. The model WUA charter will specify the number of representatives for each of the WUA's internal hydrological sub-units. It should also delineate their terms of office as well as the procedures for electing them.
>
> The Dispute Resolution Commission will be tasked to (1) resolve disputes among water users regarding the WUA's operations and maintenance and other related matters, and (2) resolve disputes between the WUA and the water users within its service area.

8. Rights and Responsibilities of WUA Members

Current Legal Basis: The rights and responsibilities of WUA members are not yet fully delineated by the law and by the bylaws of the model WUA. In some cases, the pertinent provisions are either inadequate or inappropriate for the purpose.

Analysis: Articles 2.2, 2.6, 3.3, and 4.2 of Decree No. 8, in particular, do not specifically give WUA members the right to participate in the General Assembly's decision-making with respect to the formation of the WUA's Management Team and the ratification of its staffing plans, water use plans, and expense estimates. The right is only implied.

Also, the model WUA charter only provides for water usage rights to members and "nonmember water users" located within the WUA's service area, and nothing else. Specifically, it gives them (1) the right to demand that water is delivered according to the level specified in their contract with the WUA, and (2) the guarantee that the other terms of the contract as well as "other rights as determined in legal documents" will be met. The model WUA formation agreement provided by the MAWR, in turn, only grants WUA members the right to participate in the governance of the WUA and to request information concerning its activities.

Additional Rights of WUA members. The 2002 redaction of the model WUA charter gives WUA members the following seven other rights:

> To elect and be elected to the governing and management organs of the WUA;
>
> To independently decide how irrigation and amelioration services are to be rendered within the boundaries of one's own farm;
>
> To enjoy all the benefits granted to WUA members;
>
> To make proposals to the WUA;
>
> To exercise control over the volume and quality of work of the WUA's paid services;
>
> To obtain monetary compensation if the WUA is unable to fulfill its contract; and
>
> To authorize a WUA member to allow another member to use any portion of its water allocation so long as the pre-arranged terms of payment for that allocation are met.

However, these rights were not included in the most recent version of that model WUA charter as provided by the MAWR.

Recommendations: The above rights of WUA members should be formally incorporated in the WUA law as well as in the WUA charter bylaws. In addition, the following rights should also be specified:

To vote at general meetings;

To nominate candidates for various positions;

To check accounting books and records; and

To have their disputes resolved by the bodies specified in the WUA Charter.

Responsibilities of WUA Members and Nonmembers. At present, the responsibilities of WUA members and nonmembers are found piecemeal in various enactments. Decree No. 8 makes WUA members responsible for the conclusion of service contracts with the WUA (Article 3.2) and for the payment of service fees (Article 3.6). In addition, the model WUA formation agreement and model WUA charter provided by the MAWR give the following responsibilities to members and nonmembers:

Avoiding damage to irrigation and drainage infrastructure, as well as paying compensation for any damages inflicted upon the WUA;

Constructing water measuring devices at their own individual expense; and

Supplying temporary staff for operations and maintenance at the request of the WUA.

A previous variant of the model WUA charter provided for the following responsibilities of WUA members and nonmembers:

Effectively using of water in accordance with the designated purpose;

Adherence to the terms of the Charter;

Observing the established water use limits;

Adequately maintaining the irrigation and drainage infrastructure located within the territory of one’s own farm; and

Constructing water delivery and diversion structures within the territory of the WUA according to the WUA’s specifications.

However, the most recent redaction of the model WUA charter no longer carries these five responsibilities.

Recommendations: The law to be enacted on WUAs should consolidate all of the responsibilities listed above. It should also provide for the following:

Make water users responsible for providing the WUA with information concerning land and water use within the boundaries of their respective farms;

Make it mandatory for water users to give the WUA right of way for its operations, maintenance, and construction tasks; and

Institute sanctions against members who violate the WUA's terms and other internal rules.

However, it is necessary to exclude the provision requiring water users to construct water-measuring devices at their own expense. This is because the fees paid to the WUA by the water user should be utilized for that purpose, if deemed necessary by the WUA.

9. The Management Transfer Agreement

Current Legal Basis: Even if a WUA has already been established, it cannot begin to function until it has reached a formal agreement with the District MAWR Department or Irrigation System Administration concerning the transfer of property rights as well as the operations and maintenance responsibilities for the irrigation and drainage system. According to Article 49 of the Law on Water and Water Use in Uzbekistan, onfarm irrigation and drainage systems become the property of the farm or of the entity that acquires responsibility over the farm, which in this case is the WUA.

Recommendation: The conditions and terms for the transfer should be formally embodied in a Management Transfer Agreement.

10. Acquisition and Termination of Membership

Current Legal Basis: The present versions of the WUA model formation agreement and model WUA charter provided by the MAWR do not have any provisions regarding the acquisition and termination of WUA membership. However, the 2002 redaction of the model WUA charter made specific provisions for them. Those provisions prescribe the following procedures:

The prospective member submits to the WUA chair (*rais*) a written membership application along with documents confirming the existence of the candidate's immovable property.

The WUA Council accepts or rejects the membership application. A rejection can be appealed to the WUA General Assembly. A rejection by the General Assembly can, in turn, be appealed through the court system.

Recommendation: This above arrangement for acquiring WUA membership can in practice be very cumbersome and troublesome. It is better for the General Assembly to be vested with the exclusive, non-appealable right to either ratify or deny the WUA Council's decision to reject a membership application.

Circumstances for Terminating WUA Membership. The 2002 redaction of the model WUA charter prescribes the following circumstances for the termination of membership in a WUA:

The member's own desire to leave the WUA;

Nonpayment of WUA fees for 6 months;

Repeated violations of the WUA charter as well as of contracts or water laws;

Infliction of material damage on other members;

Bankruptcy of the WUA member; and

Modification of immovable property that serves the WUA.

Recommendation: The above circumstances for terminating WUA membership are adequate. However, it would be desirable to also specify that membership may be terminated when the status of the member's landholding is changed such that the membership criteria are no longer met.

Refund of the WUA Membership Fee. The model WUA charter has a clause that provides that the initial WUA membership fee be refunded if the member being terminated has no outstanding obligations with the WUA.

Recommendation: This clause is unnecessary. The initial membership fee is a mandatory requirement for joining a WUA. It has nothing to do with being terminated from the WUA for cause.

11. Reorganization of a WUA

WUAs are not meant to be static organizations. Their organizational structure has to be modified in accordance with changing circumstances. This reorganization option is at the discretion of the WUA's General Assembly.

Procedural Requirements After Reorganization: Whenever a WUA is reorganized or if there are major changes in the structure of its governing bodies, its charter should be correspondingly modified to reflect those structural changes. *(Guidebook 1 presents various options for reorganizing WUAs.)* Every time a WUA reorganizes, it has to re-register in accordance with the same procedures for initial registration.

12. Suspension, Liquidation, and Reformation of WUAs

Current Legal Basis: Article 52 of the Civil Code of Uzbekistan allows the Ministry of Justice or courts to suspend the activities of nongovernment, nonprofit organizations like the WUA for (1) repeated violations of the law, after an initial warning and the establishment of a timeframe to correct the violations, or (2) for inactivity for 6 months or more.[9] Suspension entails the removal of most of the rights of the WUA that do not involve the correction of violations and the payment of expenses for economic activities. If violations are corrected to the satisfaction of the Ministry of Justice, the organization may be allowed to resume its activities.

Recommendation: The above arrangements are satisfactory except for the suspension of the rights of a WUA to continue to operate. If a WUA ceases to function, its operations and maintenance will come to a halt. There would be a consequent stoppage of water supply to the farms. For this reason, a WUA should be allowed to continue to provide these services even during its suspension.

Liquidation Proceedings for a WUA. Articles 55–57 of the Civil Code provide that in the event that a WUA goes into liquidation proceedings, its members should appoint a liquidation commission with the concurrence of the Ministry of Justice. This liquidation commission thereafter acquires the right of management to the liquidated WUA. Upon

[9] Article 62 of the Constitution states that "the disbandment, forbiddance or restriction of the affairs of public associations can take place only on the basis of a court decision."

liquidation, the WUA is removed from the Unified State Register of Juridical Entities. The liquidation commission then (1) proceeds to pay any debts of the liquidated WUA, (2) collects any debts owed to the organization, and (3) calculates a liquidation balance for the organization's property, which may be auctioned off if necessary to pay off the WUA's debts.

Analysis: According to the current model WUA charter, a WUA can face liquidation proceedings for any of these two reasons: (1) by court order due to a failure to address violations of the law or due to bankruptcy, or (2) by a decision of its own General Assembly. On the other hand, the 2002 redaction of the model WUA charter stipulates that the General Assembly needs a two thirds majority vote to liquidate a WUA, but only requires three fourths of all WUA members in attendance to meet the quorum requirement.

Recommendation: By requiring a quorum of only three fourths of its membership, a WUA can be liquidated by only 49.5% of its members. This does not constitute an absolute majority. It is better for the quorum requirement for liquidating WUAs to be made precisely the same as that for the initial formation of the WUA: at least 85% of all the members in attendance.

C. Financial Management

Current Legal Basis: The model WUA charter stipulates that a WUA should manage its finances in a systematic and prudent manner "as determined by the law." The existing enactments on financial management in Uzbekistan are the Law on Accounting, the National Standards for Accounting, and the Law on Auditing. Along with all of these laws, the model WUA charter specifies the financial year of the WUA as the period from 1 January to 31 December.

Recommendation: Aside from managing its finances in a systematic and prudent manner, a WUA should also aim to achieve "an independent financial balance." It can set aside and maintain a reserve fund for the improvement and development of its activities, for social security, and for other purposes not forbidden by law. The law to be enacted on WUAs should also stipulate that this reserve fund and other special-purpose funds be kept separate from the WUA's operating funds.

1. Budget-Related Provisions for WUAs

Current Legal Basis: Decree No. 8 and the model WUA charter make no reference to the WUA budget itself. Rather, they only prescribe the role of the various internal bodies of the WUA in forming and ratifying expense estimates. On the other hand, the 2002 redaction of the model WUA charter made the following specific budget-related provisions:

That the WUA independently create and manage its own budget.

That the WUA's annual work plan and budget have to be ratified no later than November of the year preceding the budget. Reporting concerning the budget has to be made within the first quarter of the budgetary year.

That if the law does not already specify the value of various expenses, the General Assembly determines those amounts.

That the allocation of various portions of the budget "has to be done in accordance with the ratification of the General Assembly."

> That the income portion of the budget is to be brought into order by the WUA Council in accordance with actual revenues. It has to be submitted to the General Assembly for ratification.
>
> That the salary portion of the budget has to be created on the basis of the requirements of the minimum wage and social security. It also has to reflect the government-mandated 35–40% tax on salaries.

These provisions, however, are no longer carried by the present version of the model WUA charter.

Recommendation: The above budget-related provisions should be restored in the model WUA charter.

2. Formal Basis for WUA Budget

Current Legal Basis: The WUA budget is based on both short-term and long-term expense estimates. It also provides an allocation for such unforeseen contingencies as accidents and natural disasters. Article 4.2 of Decree No. 8 specifies that these expense estimates must account for "the norms in practice" and the "index of values."

Recommendation: The above provision is inappropriate for sound financial management. For a WUA budget to be realistic, it has to be based on actual expenses, not on state-specified expenses. Otherwise, the WUA might come up with an unrealistic rate for the irrigation service fee, which necessarily has to be computed based on the budget.

3. Determining the Irrigation Service Fee

Current Legal Basis: Decree No. 8 does not specify how the rate of the irrigation service fee will be determined. It only specifies the right of the WUA to collect service fees in cash and in kind (Article 2.4), and only provides that service fees be collected based on the size of the landholding, the volume of water delivery, and the WUA's annual expenses.

Recommendation: The law to be enacted on WUAs need to be more precise in providing a basis for the irrigation service fee. In Uzbekistan, where the irrigation service fee is divided into current (fixed) and development (variable) costs, its rate must be based on the WUA budget. This way, the irrigation fee can be universally understood and recognized by the water users served by the WUA. Otherwise, they will be reluctant to pay the fee, a situation that could lead to the failure of the WUA.

4. Payment of the Irrigation Service Fee

Current Legal Basis: The model WUA charter and the model WUA contract contain several provisions regarding the payment of the irrigation service fee. They also provide sanctions against the WUA for nonfulfillment of the water delivery contract, and sanctions against water users for delinquency in the payment of the irrigation service fee.

The specific provisions and the recommended courses of action are as follows:

> *Fees are to be paid after the contract is fulfilled.*
>
> **Recommendation:** This directly contradicts the article that precedes it, which states that half of the irrigation service fee is to be paid by 10 April. The two provisions are unrealistic. They should be replaced in the model WUA charter by provisions that are timed with the transfer of funds to farmers for their cotton and wheat crops.

The irrigation service fee is to be paid to either the WUA's bank account or to the cashier of the WUA.

Recommendation: To prevent graft and irregularities in the payment of this fee, the WUA law and the model WUA charter should stipulate that *all* payments be made directly to the WUA Accountant, who must provide an official receipt to both the water user and the WUA. In addition, there has to be a fine for late payments. A fine in the amount of 0.1% of the amount of the irrigation service fee should be imposed for each day of delinquency in payment. If payment is 20 days late, water supply will be cut off. Water supply will be resumed only after the payment of the delinquent amount.

Temporary cut-off of water supply is permitted in the event of capture of water above the established limit, arbitrary capture of water resources, damage to or illegal alteration of water delivery and diversion structures, non-payment of the Irrigation Service Fee, or other violations.

Recommendation: This provision should be included in both the law to be enacted on WUAs as well as in the model WUA charter.

If water is captured above limit, the cut-off is in the excess amount. A two-party manifestation is to be written concerning the violation. If the water user does not provide representation, a one-party manifestation is written with two other water users as witnesses.

The determination of above-limit and below-limit water withdrawals is to be based on actual water measurements.

If a member of the WUA Management Team is at fault for inadequate water supply, a requisite manifestation is written and the staff member sanctioned in accordance with the Administrative Accountability Code.

If the WUA causes harm to the land of a water user, the staff member of the Management Team pays for the liability. A manifestation written with the participation of the WUA Council, the District MAWR Department, and the Uzbekistan Water Control Commission (*Uzsuvnazorat*) is required in this case.

The WUA is not responsible for accidents, natural disasters, or scarcity at the water source.

If the water user captures water from an unregistered source, the cut-off from this source is to be immediate and complete.

If the water user damages the infrastructure of the WUA, a manifestation is written and the water user must pay for the cost of the damage.

Analysis: The Administrative Accountability Code and the "Temporary Order of Limited Water Use" contradict the specification of cut-offs in the manner noted above. Articles 74–76 of the former enactment permit only the levy of monetary penalties in amounts up to three times of the minimum wage.

Recommendation: The above provisions on the payment of the irrigation service fee, with the amendments suggested above, should be incorporated into the law to be enacted on WUAs as well as into the model WUA bylaws. The law and the bylaws should also specifically grant WUAs the legal authority to cut off water supplies to delinquent water users.

5. Incentives to Join the WUA

Current Legal Basis: Decree No. 8 and the model WUA charter provided by the MAWR simply specify that a WUA should draw up contracts with water users for its water deliveries. There are two such contracts: the first for the "vegetative period" from 1 April to 31 September, and the second for the "non-vegetative period" from 1 October to 31 March. Water deliveries are to be established at 10-day intervals. The amount of the irrigation service fee is specified in these contracts. It is not made clear, however, whether or not higher irrigation service fees can be set for nonmembers.

Recommendation: This absence of a rate differential weakens the incentive to water users to join the WUA. To strengthen that incentive, the law should make it clear that WUAs will collect higher service fees from nonmembers.

6. Contract Provisions on WUA Infrastructure

Current Legal Basis: The model WUA contract has a clause that requires a WUA to make a manifestation that the irrigation and drainage infrastructure is in adequate operating condition and that it has been equipped with measuring devices.

Analysis: This clause is causing great consternation to the managers of many WUAs in Ak Altin and other districts of Uzbekistan. This is because they are well aware that their respective irrigation and drainage systems do not actually meet this requirement. Also, the existence of this provision raises the possibility of liabilities for nonfulfillment of the contract. This is what would happen in the event that the system collapses and causes damage to the land of a water user.

Recommendation: This clause in the model WUA contract needs to be amended. In practice, it simply cannot be fulfilled by either party. It will only lead to litigation with unclear and often arbitrary outcomes.

7. Taxation on WUAs

Current Legal Basis: According to the Tax Code, WUAs in Uzbekistan are subject to the following taxes:

- The Social Security Tax on salaries (at a rate of 35–40%), to be paid to the Social Security and Pension Funds.
- The ecological tax (1% of expenses), to be paid by legal entities such as WUAs that are engaged in the “manufacturing of goods, performance of works, and rendering of services.”
- Revenues derived from interest, dividends, royalties, and rent payments, which are classified as “entrepreneurial income” and are subject to the 20% income tax.

Tax Benefits to WUAs. The model WUA charter, on the other hand, specifies that WUAs are to benefit from the following privileges granted in legal enactments:

- Section 31, Article 6 of the Tax Code, which exempts nongovernment, noncommercial organizations from the tax on profits (calculated at a base rate of 20%), except for income received for “entrepreneurial activities.” As defined in the Law Concerning Guarantees of Entrepreneurial Activities, an “entrepreneurial activity" is an "initiative activity...aimed at the procurement of income at [one's] own risk and responsibility."

- Section 16 of the Tax Code, which provides that gratuitous contributions, shares, and other designated financial allocations to charter funds (capital) aggregated to pursue common goals are not deemed to be income of the legal entity. Based on the provision, WUAs are not subject to taxation.
- Section 71 of the Tax Code, which exempts nongovernment, noncommercial organizations from paying the 20% value-added tax for the following: (1) registration fees, (2) services associated with record-keeping in the national language (Uzbek); and (3) equipment, materials, and works imported by legal entities at the expense of loans and grants provided by international and foreign governmental, financial, and economic organizations under the auspices of contracts concluded by the Republic of Uzbekistan.
- Sections 92 and 102 of the Tax Code, which exempt nongovernment, noncommercial organizations from the property tax and land tax, respectively. If the tax inspectorate determines that an NGO is engaged in excessive entrepreneurial activity, however, it typically calculates these taxes according to the percentage of revenues that consist of "entrepreneurial income."

Recommendation: The practice in many countries is for tax inspectorates to attempt to collect taxes from WUAs in excess of what is specified by law. This can be avoided if WUAs are given the same tax status as a nongovernment, noncommercial organization.

8. Accounting Procedures for WUAs

Current Legal Basis: The manner in which WUAs should do its accounting is determined by the Law of Accounting in Uzbekistan. Based on Article 7 of this law, the chair of the WUA Council ("head of the enterprise") has the following rights: (1) to organize the accounting service of the WUA; (2) to delegate accounting to an outside firm; and (3) to independently conduct accounting.

Analysis: Under Article 7 of the Law on Accounting, the WUA Council chair is obligated (1) to facilitate the development of an internal accounting and reporting system; (2) to exercise control over financial operations; and (3) to ensure complete and authentic accounting, the safekeeping of registration documents, the preparation of financial reports for external users, the preparation of the tax reports and other financial documents, and the timeliness of accounts.

The WUA Council chair or another person determined by him or her (preferably the WUA Accountant) will have the authority to sign accounting reports and other financial documents. As provided for by Article 10 and the National Standard of Accounting No. 1, accounting should be done according to the double-entry method. Article 23, on the other hand, provides that accounting documents should be kept on file for at least 3 years.

Recommendation: Giving the WUA Council chair the right "to independently conduct accounting" appears to contradict one of the basic principles of Article 6 as well as the National Standard of Accounting No. 1—that of neutrality of accounting. It should therefore be the Audit Commission, not the WUA Council chair, which should be given the role of checking the WUA's books. Allowing the WUA Council chair to independently conduct accounting may just undermine the Audit Commission's work.

Instead of the 3-year cutoff required by the National Standard of Accounting No. 1, WUAs should permanently keep documents on record. This is because those documents are needed on a continuing basis in estimating the WUA's annual budget.

9. Financial Reporting of WUAs

Current Legal Basis: Article 19 of the Law of Accounting provides that a WUA should submit a quarterly financial report to the tax and state statistical agencies, while Article 20 provides that a WUA should submit an annual financial report to banks. These financial reports include the balance sheet, the financial results, the movement of permanent assets, the money flows, and the status of the ownership capital. Notes, accounts, and explanations can be appended to these reports.

Recommendations: Many WUA members and members of the Audit Commission will most likely find this system of accounting and financial reporting too complicated. A provision should therefore be made in law to make the accounting system for WUAs simpler and more understandable to their members. This is very important because WUA members need to be continually assured that their assets in the WUA are being managed in an honest and fair manner.

10. Auditing of the WUA's Financial Activities

Current Legal Basis: The Law on Auditing specifies well-established auditing standards and procedures that are directly applicable to WUAs:

> Article 8 grants auditors the rights to conduct audit reporting, to independently determine the form and method of the audit, to access financial records and other documents, and to obtain the necessary explanations from the subjects of the audit.
>
> Article 9 obligates auditors to provide a "sound" audit, to inform the leader of the audited organization about violations of the law, to observe confidentiality, to conduct a complete audit, to call a general meeting of the audit subject if necessary, and to refuse to continue the audit if they cannot be objective or unbiased in their opinions.
>
> Article 10 provides that the subject of the audit should pay for any expenses incurred during the audit.
>
> Article 16 provides that the auditor should report to the subject of the audit and to its banks no later than 5 months after the conclusion of the financial year; that is, before June of each year.
>
> Article 15 requires that the audit report should include an audit conclusion, the final balance, a declaration of revenues, and other accounting information that the auditor deems necessary.

Analysis: It is unknown if the Audit Commission has to be licensed and entered into the Register of Professional Auditors, as specified in Article 2. Also, according to Article 17, auditors cannot be relatives of the WUA Council chair, relatives of officers of other organs, partners, creditors, or relatives of a founder or of property owners of the subject of the audit. Under these circumstances, all WUA Audit Commissions will automatically be disqualified because their members are not professional auditors and they are also property owners of the subject of the audit.

Recommendation: Either this provision is superseded in the law to be enacted on WUAs, or the Law on Auditing has to be amended to accommodate WUAs.

D. Operations and Maintenance

Current Legal Basis: Section III of Decree No. 8 specifies several provisions for the operations and maintenance procedures of the WUA that largely resemble the operating and maintenance procedures of a shirkat. These procedures are also the same ones specified in the Law On Water and Water Use and in the Temporary Rules on Limited Water Use.

Analysis: This section of Decree No. 8 has one vague provision that is also incorporated in water delivery contracts. It is the requirement that the onfarm irrigation and drainage systems be maintained in "technically proper condition." No specification is provided as to how a WUA might accomplish this. Thus, the matter of possible liabilities for damage to farms due to the WUA's nonfulfillment of this provision could lead to potentially complicated litigation.

Recommendation: The law to be enacted on WUAs should clearly state what "technically proper condition " means and provide the specifications for attaining it.

E. The Management Transfer Agreement

Current Legal Basis: Under existing laws in Uzbekistan, a registered WUA can begin to function only after it has already signed a Management Transfer Agreement with the Irrigation System Administration. This agreement is required to stipulate the WUA's property rights and its operating and maintenance responsibilities.

Analysis: In the absence of well-defined rights and responsibilities for both the WUA and the MAWR, conflicts often arise over the operations and maintenance of portions of infrastructure that intersect or pass through the territory of another water user or entity. This, for example, is the case with the Q'oshtarmoq WUA of the Ak Altin District. This WUA covers over 7,000 ha of land as well as structures that formally belong to the service territory of the Boyovut-Arnasay Irrigation System Administration. The manager of this particular WUA, who has at his disposal only two tractors to maintain the infrastructure serving this land area, had requested clarification of this matter several times but to no avail.

Recommendations: To avoid such misunderstandings, the Management Transfer Agreement should embody the mutual rights and responsibilities of both the WUA and MAWR with regard to the operations and maintenance of specific portions of the irrigation and drainage infrastructure. It should list in detail the property, ancillary equipment, operations, and management rights and responsibilities to be transferred to the WUA. It should also clearly delineate the process of management transfer (whether on an interim joint management or immediate transfer basis, for example), the sanctions for non-compliance, and the conditions for its termination (such as expiration, renewal, or non-compliance).

The law to be enacted on WUAs should also provide general guidelines for the procedures to be followed when negotiating the Management Transfer Agreement. It should require that a thorough inventory of the irrigation and drainage system be made before the agreement is negotiated. It should also require that a realistic statement be specified about the condition of the irrigation and drainage system at the time of the formal handover.

F. Dispute Resolution

Current Legal Basis: Existing laws in Uzbekistan do not provide adequate stipulations to ensure the speedy resolution of disputes within WUAs over water distribution, maintenance, and other irrigation and drainage matters. Articles 85–88 of the Law on Water and Water Use, in particular, simply empower rural municipalities to resolve disputes within their jurisdiction. They similarly empower district hakimiyats to resolve disputes among farms and other enterprises.

Analysis: Considering that one of the main tasks of WUAs is to resolve internal conflicts without outside interference, the model WUA charter makes the WUA Council primarily responsible for internal dispute resolution. It also specifies that a WUA should take recourse to the court system only if necessary.

Recommendation: The model WUA charter also needs a provision formally giving WUAs the option to create an independent Dispute Resolution Commission as part of their organizational structure. Such a provision should specify procedures for dispute resolution that prescribes information sharing and consensus building as the first resort. It should make compulsory dispute resolution only as a last resort.

G. Water, Land, and Property Rights

1. Transfer of Water Rights

Current Legal Basis: The Law on Property (Article 19) and the Law on Water and Water Use (Article 3) clearly specify that water within the country's territory belongs to the state of Uzbekistan, which holds exclusive right to it. However, there is no provision in either of these laws that can be used as a basis for the transfer of the water rights of liquidated production cooperatives to WUAs. For that purpose, Decree No. 8 simply grants WUAs the right to "primary water use," or the right to conclude contracts for water delivery to members, and the right to "special water use," or water use that alters the hydrological regime.

Analysis: The transfer of water rights is also specified in the current model WUA bylaws. Because the WUA is a "primary water user," the model WUA charter grants to the WUA the shirkat*'s* permit for "special water use" until the WUA obtains its own permit. Two permits have to be obtained by the WUA. The first is a primary use permit for abstraction from surface water sources. It is issued by the State Nature Protection Committee, which decides in accordance with the MAWR's recommendations. The other permit is for abstraction from sub-surface water sources. It is issued by the State Committee for Geology and Mineral Resources. These procedures for permit issuances are as provided for by Articles 22, 24, and 27 of the Law on Water and Water Use.

The specific water use plans of a WUA form the basis for its right to allocations of irrigation water. These water use plans are, in turn, based on the proposed plans submitted to the WUA by onfarm and interfarm primary water users. Based on Article 48 of the Law on Water and Water Use, they are subject to revision by the MAWR's operations and maintenance bodies. They are also subject to ratification by the district hakimiyat*s*. Water allocation limits are then established by the MAWR in its role as "a plenipotentiary organ" of the state empowered by laws that govern the various types of farms in Uzbekistan. Article 30 of the Law on Water and Water Use specifies that the water limits set by the MAWR are obligatory for all water users. In practice, water rights in Uzbekistan are tightly linked with production quotas for cotton and wheat, which regularly receive priority in allocation.

The above procedural arrangements place control of water allocations entirely in the hands of government bodies. It leaves no room for WUAs to negotiate contracts for the bulk water deliveries that will form the basis for their water allocations. Also, it provides official bodies with a powerful mechanism for unduly controlling WUAs.

Recommendations: These arrangements for allocating water need to be corrected by an appropriate amendment to Article 30. To be fair and more realistic, the provision should specify that while the MAWR can correct water allocations in accordance with water availability in the larger systems, the water allocation contracts themselves should be negotiated on a fair and equal basis between the MAWR and the WUA as a primary water user. The provision should make no reference whatsoever to the hakimiyat, since it does not have the legal standing to interfere in this matter.

While production quotas for cotton and wheat regularly receive priority in allocation, it is possible for the production quotas for these crops to decline significantly. There is therefore a need to establish a more stable and practical basis for allocating water rights to individual water users.

2. Criteria for Abrogating Water Rights

Current Legal Basis: As provided for by Article 36 of the Law on Water and Water Use, the criteria for the abrogation or cancellation of irrigation water rights are as follows:

Refusal to exercise the right;

Expiration of the right;

Liquidation of the enterprise, institution, organization, or farm;

Transfer of infrastructure to another water user;

A need to remove the infrastructure from special water use;

Violation of the rules of water use;

Utilization of infrastructure not in accordance with its specified purpose;

Failure to pay fees associated with water use; and

Other criteria specified in the law.

Analysis and Recommendations: These criteria for the abrogation of water rights are vague. They leave significant room for arbitrary interpretation and manipulation. They need to be clarified fully, particularly with respect to what constitutes a violation of water use rules and how the “specified purpose” of infrastructure is to be determined. For clarity, the water use violations listed in detail in Articles 114 and 115 of the Law on Water and Water Use should form part of Article 36.

It is not specified who has the authority to determine how these criteria are to be interpreted. According to these criteria, even official bodies that issue permits for special water use can annul those rights. Also, as provided for by Article 37 of the Law on Water and Water Use, even primary water users, pending agreement with the MAWR, can also cancel the rights to secondary water use. There is a need to consolidate and reconcile these provisions.

Article 38 of the Law on Water and Water Use provides that persons who inflict damage through “water management measures (hydro-technical work, etc.), irrigation use and exhaustion of ground water, as well as the abrogation or alteration of the conditions of water use” are liable for damages“ in accordance with the arrangement specified by the Cabinet of Ministers.” Article 117, in turn, provides that violations of water use are a sufficient cause for a water user to incur liabilities. However, there is no specification as to who will resolve and how the liability issues will be resolved with respect to WUAs. A specific provision in the law is needed to fill this major procedural gap.

3. Guarantees for Land Rights

Current Legal Basis: According to Article 16 of the Land Code and Article 19 of the Law on Property, land is the property of the state, which does not confer ownership but only grants rights for its use. In Uzbekistan, grants for the right to use land are given through long-term leases, and only garden plots (*tamorkalar*) are inheritable.

Analysis: Since membership in a WUA is contingent on land use, there is a need to strengthen the legal guarantees for land tenure. Contrary to this, however, Article 36 of the Land Code permits the termination of land use rights in several vaguely defined circumstances that can be subject to loose interpretation and easy manipulation. These circumstances include (1) “irrational use resulting, in the case of agricultural land, in yields below the standard during one to three years,” and (2) land use that results in a drop in soil fertility.

If the above provisions are strictly interpreted, a great deal of irrigated land in Uzbekistan will not meet the standard yield and will be subject to expropriation. This is because soil salinization has become more widespread in Uzbekistan farms. Soil fertility has declined in many areas as a result of inadequate crop rotation. This, in turn, is partly due to a reduction of alfalfa planting and a dramatic increase in wheat planting, as specified in production quotas.

Recommendations: Implementing the above provisions of the Land Code can lead to the arbitrary removal of land use rights. These particular provisions should be taken out altogether from the Land Code.

4. Suspension of Land Use Rights

Current Legal Basis: At present, suspension of land use rights is at the discretion of district *hakims* (local administrators) and of the Land Commission. In practice, it is common for hakims to demand money from farmers in exchange for the continued right to use the land.

Analysis: Despite the unstable legal and regulatory environment in Uzbekistan, leaseholding has engendered a strong sense of proprietorship among farmers. For instance, a survey conducted in 2000/01 for the World Bank in Uzbekistan showed that farmers believed that they would be able to use the land beyond the duration of their formal tenure (as stated in their leases).[10] However, this is simply because farmers have been operating for decades under conditions in which informal connections and influence peddling are the norm. This has given them the flexibility to extend their land tenures beyond the periods allowed by law.

[10] Mike Thurman and Mark Lundell. 2001. *Agriculture in Uzbekistan: Private, Dehqan, and Shirkat Farms in the Pilot Districts of the Rural Enterprise Support Project*. The executive summary is available online at: http://lnweb18.worldbank.org/ECA/ECSSD.nsf/ECADocByUnid/CDC28DCE1F60B4C985256B96006D0A96?Opendocument.

Recommendation: There is a need to more closely regulate the suspension of the right of land use and of possession of garden plots. Legal guarantees should be made to prevent the very widespread practice of extorting from farmers to ensure continued land use.

The Land code should also be modified to give stronger legal guarantees to the right of land use as well as to improve land administration—of the *cadastre* (official register of real estate for tax purposes), in particular. Otherwise, WUA membership, if it is to be based on the right of land use, may become unstable.

5. Transfer of Property Rights

Current Legal Basis: The existing laws in Uzbekistan permit WUAs to own several types of property. In particular, Article 49 of the Law on Water and Water Use provides that onfarm irrigation and drainage systems are the property of the farm or of the bodies that acquire responsibility over the farms. Decree No. 8, in turn, provides that the irrigation and drainage infrastructure of liquidated production cooperatives is "to be given to the WUA." It also provides that the infrastructure property rights should be included in the Management Transfer Agreement. However, Article 49 of the Law on Water and Water Use stipulates that off-farm irrigation and drainage systems are the property of the state and shall remain unavailable for privatization.

Recommendation: Article 49 should be amended to provide the legal basis for WUA federations to take over the operations and maintenance of these off-farm irrigation and drainage systems. Since WUA federations are envisioned to be created over the long term, the matter of ownership of secondary irrigation and drainage infrastructure in Uzbekistan need to be changed by law.

6. Transfer of Operations and Maintenance Equipment

Current Legal Basis: In addition to infrastructure, WUAs are to receive the operations and maintenance equipment of the liquidated shirkat. This transfer in lieu of paying the WUA's initial membership fee is provided for in the MAWR Manual for implementing Decree No. 8. It is also contained in the decrees of hakimiyats concerning the establishment of WUAs.

Analysis: The transfer process above is largely ineffective in practice. First, many shirkat*s* do not own adequate equipment, or if they do, the equipment has exceeded its service life by several years and can therefore be hardly considered an asset. Second, the process of transfer is nontransparent. As a result, most of the equipment does not actually go to the WUA.

Recommendations: It is much more desirable for WUA members to pay an initial membership fee of, say, 5,000–7,000 som, and thereafter an annual membership fee of 3,000–5,000 som. The law should also stipulate a transparent process of equipment transfer, one that is based on the property shares of shirkat members *(Guidebook 3 discusses this property transfer method in detail.)* Otherwise, the majority of WUAs in Uzbekistan will begin their activities either without funds or without the equipment that belongs to their members. (This was the case in most of the WUAs in Ak Altin District.) Such a situation will greatly reduce their chances for success from the very outset.

7. Utilization of WUA Property

Current Legal Basis: The discretion of WUAs over the utilization of property is not adequately guaranteed in the law. At present, under Decree No. 8, "all property" of the WUA, including equipment that is passed on to it from the shirkat, cannot be sold, rented, exchanged, or pledged as collateral.

Recommendation: This impractical prohibition of Decree No. 8 needs to be amended. The law to be enacted on WUAs as well as the model WUA charter should make an exception in the case of the WUA's equipment, furniture, and other movable property. Otherwise, a WUA could end up with so much outmoded or dilapidated equipment and items that it cannot dispose of.

8. Right to Obtain Property

Current Legal Basis: As provided for by the model WUA charter, WUAs can obtain assets in the form of (1) membership and service fees, (2) the property shares of WUA members in a liquidated shirkat, (3) stocks, (4) credit from banks and other sources, (5) aid from the government and international donor organizations, and (6) funds derived from other activities not forbidden by law. The start-up capital of the WUA must be listed in detail in the WUA's charter. The list has to specify (1) the amount and percentage of the WUA's capital that belongs to each member, and (2) the percentage of the start-up capital representing the value of the irrigation and drainage infrastructure. Additions to the startup capital from new members may be made in agreement with the WUA's founding members.

Recommendation: The WUA charter and the law to be enacted on WUAs should stipulate that the WUA's income must not be distributed among its members. It should also stipulate that any extra funds remaining at the end of the year must go into a WUA reserve fund. This fund will be exclusively used for emergencies and other contingencies, for the acquisition of new operating and maintenance equipment, and for the long-term development of the WUA's irrigation and drainage system.

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Appendix. PROPOSED WUA LAW

LAW OF UZBEKISTAN
"ON WATER USERS ASSOCIATIONS"
…. Of …. 2005

Draft – 8 December 2004

The present Law determines the procedures of the formation of Water users' associations, their activities, their legal basis of their rights and obligations, and it regulates relations with other juridical and physical entities.

CHAPTER 1. GENERAL PROVISIONS

Article 1. Legislation Concerning Water Users' Associations

The legislation of Uzbekistan concerning Water Users' Associations consists of this Law, the Constitution of the Republic of Uzbekistan, the Civil Code, the Law on Non-Governmental, Non-Commercial Organizations, the Law on Water and Water Use, the Land Code, the Tax Code, and other legislative enactments, as well as the international legal treaties and protocols ratified by the Republic of Uzbekistan.

This law shall supersede the Law on Non-Governmental, Non-Commercial Organizations and Attachment No. 7 to Decree No. 8 (5 January 2002) "On Measures Concerning the Restructuring of Agricultural Enterprises," in instances where the provisions of these legal enactments do not conform to the present law.

Article 2. Definitions

The following definitions refer to the terms used in the present Law:

Water Users' Association (WUA) – is a nongovernment, noncommercial organization, established on a voluntary basis by physical and juridical entities in accordance with this law in order to protect the interests of water users, to regulate water use relations between members, nonmembers, and outsiders, and to render services to them.

Water Users - are leasehold farmers, dehqan farmers, and other natural or legal persons, who are involved in irrigation, drainage, and other rural water use and are conducting related activities based on limited water allocations from the available water resources.

General Assembly – is the supreme governing body of the WUA, which consists of all WUA members and establishes mandates and makes decisions concerning the WUAs policies, management, and operations, upon an open, fair, and democratic basis.

Representative Assembly – an assembly of WUA members who are appointed from each Representation Area to provide the same functions as the General Assembly, in accordance with the mandates and procedures established by the General Assembly.

Representative Zone – a part of the WUA Service Area, occupied by water users with the legal right to land use, who are WUA members and elect one or more representatives to WUA Representative Assembly.

Water Users' Group (hereinafter referred to as WUG) – is a group of water users within a certain Representation Area of the WUA.

WUA Water Resource Infrastructure – is infrastructure in the possession of a water users within the WUA, such as irrigation and drainage networks, hydro-technical structures, pump stations and associated facilities, irrigation and drainage wells together with associated electrical transmission lines and additional transformer stations, and other infrastructure required for operations and maintenance within the WUA's Service Area.

Water Use Allocation – is a limited volume of water fixed by the appropriate state water management body for every water user so that the latter will have adequate water to meet his needs by using the water in an efficient manner.

Water Use Plan – is a schedule of water distribution developed by the WUA to meet the needs of the water users, based on the size of the cultivated agricultural land, the types and water requirements of the crops, and the location of the water user.

Service Fee – is a fee imposed by the WUA on its members to cover the expenses associated with the provision of operations and maintenance and other services provided by the WUA for the benefit of its members.

Operations and Maintenance Equipment and Property – are excavators, bulldozers, scrapers, closed drain cleaning equipment, means of transport, cranes or lifting equipment, buildings located within these territories, and other properties utilized by the WUA in order to fulfil the mandates established by its members.

Water Supplier – is the entity that operates the canals outside the WUA service area and supplies water to the WUA in bulk.

WUA Service Area – is the defined geographical area served by the irrigation and drainage systems of a WUA.

Hydrological Unit – is a specific land area, which can receive water for irrigation from one single source, headwork, or outlet.

Regulatory Authority – is the entity, which ensures that WUAs function in accordance with this and other legal enactments of the Republic of Uzbekistan, and is identified in Article 25.

WUA Charter – by-law of the WUA providing the objectives, rights and obligations of members and governing and management bodies, and details of governance and management, in accordance with the relevant legislative enactments.

WUA Formation Agreement – by-law of the WUA providing the agreement of founding WUA members to establish the WUA, the ratification of the WUA Charter by the founding members, and the objectives, rights and obligations of members and governing and management bodies.

Management Transfer Agreement – agreement between the WUA and the Water Management Administration providing the area and irrigation system to be transferred (property rights), terms of the transfer of the irrigation system, rights and obligations of the Water Management Administration, and rights and obligations of the WUA, and terms of termination of the Management Transfer Agreement.

Article 3. Objectives

The objectives of a WUA, established in accordance with this law as a non-governmental, non-commercial organization, are:

- Creation and enforcement of a unified set of water use rules within the WUA Service Area;
- Protection of the interests of WUA members;
- Increased farmer negotiation capacity;
- Management of water that is understood and respected by all water users and is more responsive to their needs;
- Equitable water distribution among farmers regardless of their location, type of farm, size of the farm, or status as a WUA member or nonmember;
- Increased reliability of the water supply, in accordance with crop and other needs;
- More efficient use of water in order to minimize waste, and prevent erosion, salinization, waterlogging, groundwater depletion, and the over-watering of irrigated lands;
- Prevention of illegal withdrawals of water;
- More rapid and successful resolution of disputes arising among WUA members, as well as nonmembers, concerning the distribution and use of water and other issues in the management of the WUA Water Resource Infrastructure and Operations and Maintenance Equipment and Property;
- Better maintenance of the WUA Water Resource Infrastructure and Operations and Maintenance Equipment and Property;
- Protection of the environment;
- Improvement of onfarm water use; and
- The implementation of other ancillary activities for the benefit of WUA members.

Article 4. Activities

In the pursuit of its objective a WUA may undertake the following activities:

- Facilitation of a fair and democratic decision-making process, as well as the full participation of all members;
- Withdrawal of irrigation water from main canal systems on the basis of contracts or agreements with the bulk Water Supplier, as well as the abstraction of water from rivers, lakes, or groundwater sources in accordance with permits and contracts;
- The distribution of water in an equitable and timely manner on a contractual basis to persons, WUA members or not, who require water for irrigation, leaching of soils, or for other purposes within the WUA service area;
- The resolution of disputes upon the basis of information-sharing and mutual agreement, whenever this is possible;
- Formation of short- and long-term estimates and plans for maintenance and development of the irrigation and drainage system;
- Maintenance of the WUA Water Resource Infrastructure in accordance with long-term needs;
- The rehabilitation and improvement of the irrigation and drainage system within the WUA Service Area and the undertaking of construction works, as necessary;
- The procurement, replacement, operation and maintenance of Operations and Maintenance Equipment and Property;
- Creation of an annual budget and work plan for the WUA's activities;
- Collection of fees for membership, operations and maintenance to sustain the WUA's activities;
- Management of the WUA's finances;
- The training of WUA members in the governance, management, and operation of the WUA and in sustainable irrigation and drainage practices;

- Introducing new irrigation and drainage methods and technologies;
- Implementation of environmental protection measures;
- Monitoring and evaluation of the WUA's performance and development;
- Reporting concerning the WUAs financial and other activities to the Regulatory Authorities and other bodies specified in the present law and the legal enactments of the Republic of Uzbekistan;
- Other activities for the benefit of WUA members that are not forbidden by the legal enactments of the Republic of Uzbekistan.

Article 5. Rights of the WUA

The WUA shall possess the rights:

- To be a juridical entity, which shall entail the rights to have symbols and stamps, open a bank account, and participate in the judicial process;
- To represent and defend the rights and lawful interests of its members and participants;
- To be free from interference into its internal affairs on the part of state authorities and administrative agencies, in accordance with the Constitution of Uzbekistan;
- To present initiatives and to introduce proposals to the state authorities and administrative agencies;
- To participate in developing the decisions of state authorities and administrative agencies by the order established in the legal enactment of the Republic of Uzbekistan;
- To distribute information about its activities;
- To establish ownership structures in order to carry out the statutory purposes of the WUA;
- To organize meetings and conferences related to its activities;
- To establish affiliations and to open representational offices in compliance with the legal enactments of the Republic of Uzbekistan;
- To negotiate and conclude a Management Transfer Agreement, upon equal terms with the bulk Water Supplier;
- To create a federation with other WUAs, upon the basis of an indivisible Hydrological Unit;
- To obtain permits for special water use;
- To be a primary water user with the right to conclude water delivery and other contracts with secondary water users, both WUA members and nonmembers;
- To collect fees in cash and in kind from members, in accordance with the Foundation Agreement and Charter, and to obtain funds from other sources not forbidden in the legal enactments of the Republic of Uzbekistan;
- To make amendments to the water use allocations, based upon available water resources, on the amount of annual rainfall, and on water supply shortfalls, after coordinating with the water users;
- To allocate water to water users by turns in case of shortage;
- To reduce the amount of delivered water if a water user through his fault exceeds his water use allocation;
- To halt the delivery of water and other services to water users who have not paid their fees in a timely manner, and to abrogate the membership of those who are delinquent for two or three years;
- To sanction members for violation of the WUA Formation Agreement, Charter, and mandates of and decisions made by the General Assembly or Representative Assembly;
- To resolve disputes among members that pertain to operations and maintenance and other services of the WUA;
- To recruit outside contractors for maintenance and other services;

- To have right of way to all the lands within the Service Area, upon which are located the WUA Water Resource Infrastructure and Operations and Maintenance Equipment of Property; and
- To exercise other rights, which are not in conflict with the provisions of other legal enactments of the Republic of Uzbekistan.

Article 6. Obligations of the WUA

The WUA is obligated:

- To abide by the legal enactments of the Republic of Uzbekistan;
- To ensure access to information concerning the usage of its property and monetary assets;
- To ensure access of all its activities to the authority that is charged with its regulation;
- To submit annual reports about its activities to tax and statistical agencies
- To assure the full participation of all WUA members in the governance of the WUA through fair, open, and democratic decision making processes;
- To register water users and water delivery turnouts;
- To create water use plans within the established limit;
- To deliver water in a fair, equitable, and timely manner to water users in accordance with their water use schedule and allocations;
- To report to the bulk Water Supplier concerning water deliveries to water users, on a ten-day basis, for the purposes of monitoring;
- To enter into agreements with the bulk Water Supplier for the supply of water to the WUA and to adhere to the established water use limits;
- To ensure that water is used effectively;
- To maintain the WUA Water Resource Infrastructure and Operation and Maintenance Property in adequate condition, to the best of its abilities; and
- To utilize property and funds in accordance with the WUA's statutory purpose.

CHAPTER 2. FORMATION AND MEMBERSHIP

Article 7. Formation

The purpose of the establishment procedure is to define relations between the WUA and its members and other entities and persons, and to enable its members to undertake various activities, which are not in conflict with the law.

The establishment of a WUA shall take place on a voluntary basis. Citizens possess the right to become a member or remain a nonmember.

Juridical or physical entities who possess the right to utilize agricultural lands, and desire to establish a WUA shall form an Initiative Group which may propose the Service Area of the proposed WUA and organise the creation of a Formation Committee, which shall consist of no more than ten (10) potential members of the WUA.

The Initiative Group may contain persons other than potential WUA members who will provide outside support to the Initiative Group. These persons are forbidden to interfere into the activities of the Formation Committee.

The Formation Committee shall elect a Chairman and it shall elaborate rules and procedures for itself.

The Formation Committee shall prepare the foundation documents, consisting of a draft Charter for the WUA, a draft Formation Agreement, a plan of the Service Area of the WUA defining the size and location of any Representative Zones, a complete list of potential members of the WUA, and a draft budget and draft work plan.

In defining the Service Area of a proposed WUA the Formation Committee shall prepare a map indicating the agricultural lands, farm boundaries, and the WUA Water Resource Infrastructure. The Service Area must be a Hydrological Unit, which may be comprised of several smaller Hydrological Units. Each Hydrological Unit must be fully included into the Service Area of the WUA in order to conform to the principle of indivisibility of each Hydrological Unit.

The Formation Committee may send a copy of the draft WUA Charter to any outside body for advice and recommendations prior to the Formation Meeting.

The Formation Committee shall call a Formation Meeting, to which the Formation Committee shall invite all potential members of the WUA for consideration of the proposed Charter.

The Chairman of the Formation Committee shall chair the Formation Meeting.

The Formation Meeting shall approve or reject the Foundation Agreement, draft Charter, draft budget, and draft work plan. These founding documents shall be considered to be approved if at least fifty-one (51) percent of all of the potential members of the WUA vote to approve it.

In the Formation Meeting, the potential WUA members shall elect a WUA Council consisting of five (5) persons and an Audit Commission consisting of three (3) persons.

The Formation Meeting may also elect a Dispute Resolution Commission consisting of three (3) persons and other internal bodies, if the potential members deem these bodies to be necessary.

The Formation Committee may also decide, upon the basis of absolute majority vote, to create a Representative Assembly that will fulfil the functions of the General Assembly, in accordance with its mandates.

In the approval or rejection of founding documents and the election of internal bodies, voting procedures shall be as follows: one vote is granted to each potential member, in the case of leasehold farms; one vote is granted to a representative of each rural municipality, who must be a potential member, in the case of dehqan farms.

The Formation Meeting shall set the date of the first General Assembly.

Article 8. State Registration of the WUA

Registration of the WUA as a nongovernmental, noncommercial organization and juridical entity shall be made exclusively with the Ministry of Justice or its branch office at the local level in the oblast, in accordance with the relevant provisions of the Law on Non-Governmental, Non-Commercial Organizations.

In addition to the causes provided in the Law on Non-Governmental, Non-Commercial Organizations as sufficient cause for refusal of registration, the Ministry of Justice shall refuse registration of the WUA in the event that the bylaws of the WUA do not conform with the provisions of this law.

Any WUA established before entry into force of the present law shall re-register in accordance with the provisions of this law.

After the WUA has been registered, it shall be considered as an established non-governmental, non-commercial organization and juridical entity, which provides the WUA with the rights to open accounts with banks and to create an official seal.

Article 9. Management Transfer Agreement

The WUA shall begin its activities only after state registration and the conclusion of the Management Transfer Agreement.

The WUA Council shall negotiate the Management Transfer Agreement with the bulk Water Supplier.

The General Assembly shall vote to ratify or reject the Management Transfer Agreement in its first meeting. In the event that the General Assembly rejects the Management Transfer Agreement, it shall be re-negotiated and ratified or rejected in the next meeting of the General Assembly.

Article 10. WUA Bylaws

The bylaws of a WUA are the Foundation Agreement and the Charter. All founders shall sign the WUA foundation agreement. The Chairman of the Formation Meeting signs the Charter of the WUA, following its approval by the Formation Meeting.

The Formation Agreement shall include:

- The place and time of formation of the WUA;
- The area served by the WUA;
- The rights and obligations of the WUA;
- The order of joint activities aimed to establish the WUA;
- The terms of transfer of member property to the WUA;
- The terms of member participation in the activities, governance, and management of the WUA; The terms of termination of membership; and
- Other terms as agreed by the foundering members.

The Charter shall include:

- The name, objectives, and purposes of the WUA;
- The legal form of the WUA (non-governmental, non-commercial organization);
- The territory within the limits of which the WUA carries out its activities by reference to plans and maps;
- The WUA's internal structure and governing and management bodies, the authority and the procedure of forming governing and management bodies, their decision-making procedures, and the terms of their offices;
- The location of the permanently operating governing body;
- The terms and procedures for acquiring and terminating membership;
- The rights and duties of members;
- The sources of forming monetary funds and other property;
- The provisions for the setting the fees and penalties in the WUA;
- The rights of the WUA;
- The structure of property management for its subdivisions;
- The procedure of reorganization and liquidation of the WUA;
- The procedure for introducing changes and amendments into the Charter; and
- Other provisions related to the WUA's activities that do not contradict the legal enactments of the Republic of Uzbekistan.

Article 11. Acquisition and Termination of Membership

Any physical or juridical entity that possesses the right to utilize a plot of agricultural land within the WUA's Service Area for a term of more than three (3) years can be a member of the WUA. The right to utilize a plot of agricultural land shall be proven by a leasehold contract or other appropriate documentation that does not contradict the legal enactments of the Republic of Uzbekistan.

The acquisition or termination of membership shall be decided by a vote conducted in a meeting of the General Assembly. The WUA Staff shall forthwith amend the register of members.

Founding and new members shall contribute to the WUA their initial share property contribution of the WUA Water Resource Infrastructure and Operations and Maintenance Equipment and Property. In the case of members of a liquidated production cooperative, this share shall be the property share. In the event that the WUA is created on the basis of pre-existing leasehold and dehqan farms, either within or outside of the boundaries of a production cooperative, whether liquidated or not, this share shall be determined in proportion to the amount of land utilized by each member, as well as the land plot's fertility coefficient and location with relation to the WUA Water Resource Infrastructure.

WUA membership shall be terminated in the event of a desire on the part of the member to cease to be a member, of the member's loss of the right to utilize agricultural land, of the members' delinquency over a period of two to three years to pay fees specified agreements with the WUA, and of repeated violation by the member of the provisions of the Charter and other rules of the WUA.

If a member decides to cease to be a member of the WUA, the initial share property contributed by the water user to the WUA shall not be returned to the water user, but in case of liquidation of a WUA due to bankruptcy the initial share property, which was contributed in order to become a member of a new WUA, shall be returned to the former members.

If a WUA member ceases to be a member of the WUA on his or her own initiative or by a decision of the WUA, that water user shall be paid in cash or in kind for his or her share in the Operations and Maintenance Equipment and Property, which were purchased with fees paid by the member.

Article 12. Rights of WUA Members

Each WUA member possesses the following rights:

- To participate in the decision-making processes of the WUA;
- To vote in the General Assembly;
- To propose agenda items for discussion at the General Assembly;
- To nominate candidates for, to elect, and to stand for election to the WUA governing bodies;
- To request and obtain information concerning the WUA's activities;
- To check the accounting books and other records of the WUA;
- To benefit from the services provided by the WUA;
- To enjoy a fair and equitable share of the irrigation water that the WUA distributes;
- To demand from the WUA timely compliance with the stipulations of water supply and other agreements;
- To independently decide how irrigation and amelioration services are to be rendered within the boundaries of one's own farm or plot;
- To appeal for dispute resolution to the bodies specified in the WUA Charter; and

- To exercise other rights, as specified in the legal enactments of the Republic of Uzbekistan.

Article 13. Obligations of WUA Members

Each WUA member is obligated:

- To observe the provisions of the Charter and of any internal rules made by the General Assembly;
- To promptly pay any charges and fees in accordance with the Charter, decisions of the General Assembly, and agreements with the WUA;
- To promptly enter into agreements, provided that these are negotiated and concluded on a fair and equitable basis, concerning water delivery and other services;
- To comply with the schedules and agreements concerning water delivery and other services, and to obtain irrigation water and other services in accordance with those schedules and agreements;
- To not cause damage to the WUA Water Resource Infrastructure and Operations and Maintenance Equipment and Property, which is used or owned by the WUA;
- To pay for the repair or replacement costs of any to the WUA Water Resource Infrastructure and Operations and Maintenance Equipment and Property, which is damaged as a result of any wilful or negligent act, or omission;
- To provide information to the WUA concerning land and water use within the boundaries of one's own farm or plot; and
- To provide access and right of way to the WUA for the utilization of the WUA Water Resources Infrastructure and Operations and Maintenance Equipment and Property.

Article 14. Nonmembers

A WUA may supply irrigation water to the owners or users of land plots within its Service area who are not WUA members.

Charges to users who are not WUA members shall be defined by the General Assembly of the WUA.

The rights and responsibilities of nonmembers shall be protected, as specified in the Law on Water and Water Use and other legal enactments of the Republic of Uzbekistan.

CHAPTER 3. GOVERNING AND MANAGEMENT BODIES AND THEIR POWERS

Article 15. Governing and Management Bodies of the WUA

Governing bodies shall provide representation of the members.

Management bodies shall implement the mandates established by governing bodies in order to ensure adequate, efficient, reliable, and equitable provision of irrigation, drainage, and other services to all members.

The General Assembly shall be the supreme governing body of the WUA.

The WUA Council shall be the chief governing body during the periods between meetings of the General Assembly.

The WUA Staff shall be the management body of the WUA.

The Audit Commission and, in the event that provision is made for such in the Charter, the Dispute Resolution Commission shall be governing bodies.

The competencies of the internal bodies of the WUA are specified in this law, as well as the WUA's Charter.

Members of the WUA's Council, Audit Commission, Dispute Resolution Commission, Staff, as well as other bodies listed in the Charter, are forbidden to hold more than one position at the same time. Provided that they are members of the WUA, members of governing and management bodies have the right to participate and vote in General Assembly meetings.

Only the WUA Staff may receive a salary. All other members of internal bodies shall perform their functions without monetary or other compensation. No salaried employee of the WUA has the right to stand for election to the WUA Council, to the Audit Commission or to the Dispute Resolution Commission.

Article 16. The General Assembly

The exclusive competencies of the General Assembly are:

- To define and approve the main directions of the WUA's activity;
- To amend the Charter and Formation Agreement;
- To approve or reject the Management Transfer Agreement;
- To approve or reject the entrance of new members and termination of membership;
- To establish and alter the organizational structure of internal governing and management bodies of the WUA and determine their mandates, rights and responsibilities, terms of office, and procedures for decision-making, in accordance with the provisions of this law;
- To nominate, elect, ratify appointments, and dismiss members of internal governing and management bodies of the WUA, in accordance with the provisions of this law;
- To approve or reject annual and long-term policies and plans of the WUA in operations and maintenance and other activities not forbidden by the legal enactments of the Republic of Uzbekistan;
- To delegate specific competencies to the WUA Council for immediate implementation and to disapprove and reject the actions taken in accordance with these competencies by the WUA Council;
- To set the annual fees for water delivery and other services payable by members and nonmembers, and to determine the procedures for their payments;
- To establish sanctions and fines of members for violations of the terms of the Charter and water delivery and other agreements, as well as the method of their implementation, in accordance with the provisions of this law;
- To approve or reject the annual budget, annual work plan, the irrigation schedule, and annual report and accounts of the WUA;
- To empower the Manager of the WUA Staff to enter into agreements with secondary water users on behalf of the WUA
- To make decisions concerning the acquisition of funds and credit from banks and other sources not forbidden by the legal enactments of the Republic of Uzbekistan;
- To hear the reports of the Audit Commission and to determine measures to correct any irregularities in the financial management of the WUA;
- To appoint an outside auditor and approve the contract with this auditor; and
- To make decisions concerning the liquidation or re-establishment of the WUA, the appointment of a liquidation commission, and approval or rejection of the interim and final liquidation balances.

The WUA Council shall call a meeting of the General Assembly of the WUA when necessary, but not less than twice in a year. An extraordinary meeting of members is conducted upon a decision of the WUA Council of the WUA, upon the request of the Audit commission, and upon the request of one fifth (1/5) of the members of the WUA.

The WUA Council shall, no less than 30 days before the General Assembly, notify every member by all available means of the date, time, and agenda. Members of the WUA have the right to make proposals within the competence of the General Assembly for inclusion in the agenda no later than 10 days before the General Assembly. The body which calls for a meeting of the General Assembly shall make available to the members of the WUA an opportunity to familiarize themselves with all materials prepared according to the agenda of the meeting and to propose amendments to the agenda during twenty (20) days before the General Assembly.

The quorum for a General Assembly is sixty (60) per cent of the members of the WUA.

Each member who is the head of a leasehold farm shall possess one vote in the General Assembly. Members who are the holders of dehqan farms within a rural municipality shall jointly possess one vote per municipality.

Decisions on amendments of the Charter and on reorganization, liquidation, and re-establishment of the WUA are ratified by majority of two thirds (2/3) of the total number of votes of WUA members. Decisions of the General Assembly concerning other affairs are ratified by an absolute majority of all WUA members.

Voting in the General Assembly shall be made by show of hands or, in the event that it is requested by one third of the members participating, secret ballot.

The decisions taken by the WUA Council in accordance with special competencies granted by the General Assembly are subject to automatic review by the General Assembly at its next meeting.

In the event that the General Assembly removes a member of the WUA Council or a member of a Commission from office it must elect a replacement at the same meeting.

Meetings of the General Assembly shall be chaired by the Chairman of the WUA Council or in his absence by a deputy from the WUA Council appointed by the Chairman.

The Chairman and Secretary of the WUA Council must sign the protocols of the General Assembly and have them stamped and kept in the permanent archives of the WUA. All WUA members shall possess the right to have access to and to obtain copies of these documents, at their own expense. The same procedure applies to protocols, minutes, and documents of other internal bodies of the WUA.

Article 17. The Representative Assembly

A WUA with a large number of members, such that it is impractical for all members to attend and participate in meetings of the General Assembly, may provide in its Charter for the establishment of a Representative Assembly in accordance with the provisions of this article. A Representative Assembly shall exercise all of the powers of the General Assembly as set out in the present law, with the exception of amendment of the Charter and reorganization, liquidation, and re-establishment of the WUA, which shall be exclusive competence of the General Assembly.

In order to establish a Representative Assembly, the Charter shall provide for the WUA Service area to be subdivided into Representative Zones that conform to Hydrological Units within the Service Area. The WUA members who own or use land plots within each Representative Zone shall elect one or more Zonal Representatives to represent them at the meetings of the Representative Assembly. The Representative Zones of the WUA shall be clearly indicated on the plan of the WUA Service area.

The Charter shall specify the terms and conditions of office of each Zonal Representative, the number of Zonal Representatives in respect of each Representative Zone, and the procedures for their election, and shall specify the number of votes each Zonal Representative is to exercise at meetings of the Representative Assembly.

The principles for decision-making by the General Assembly described in the preceding article shall be applied to decision-making by the Representative Assembly.

WUA members who are not Zonal Representatives shall have the right to attend meetings of the Representative Assembly but shall not have the right to vote.

WUA members in representative zones may form Water User Groups for the purpose of discussing their zonal water issues and electing representatives; they may formulate their own rules, provided that they do not contradict the provisions of the present law and the Charter.

Article 18. The WUA Council

The WUA Council shall consist of not less than 5 persons, all of whom must be members of the WUA. The number of members of the WUA Council shall be specified in the Charter.

The members of the WUA Council are elected by the General Assembly and serve for a term of no more than 3 years, after which they must stand for reelection.

The Charter defines the powers of the Chairman, who also serves as Chairman of the WUA. The Chairman of the WUA Council shall be in charge of the timely implementation of all the tasks entrusted to the WUA Council. The Chairman of the WUA Council shall report to the General Assembly about the WUA Council activities in all meetings of the General Assembly.

The WUA Council shall meet at least once a month. If necessary the WUA Chairman may call extraordinary meetings of the General Assembly.

Decisions of the WUA Council shall be made by an absolute majority vote, with one vote granted to each member. The Charter may provide that the Chairman is to have a deciding vote in the event of a tie. A quorum for a WUA Council meeting is a majority of the Council members. The WUA Council shall formulate its own rules of procedure and shall keep minutes of its meetings.

The competences of the WUA Council are:

- Governing the WUA's activities, in accordance with the mandates established by the General Assembly and the Charter, during periods between General Assembly meetings;
- Enforcing compliance with the rules, made by the Foundation Agreement and by the WUA Charter, and General Assembly;
- Approving temporary cut-offs of water supply to members and nonmembers who are delinquent in the payment of water delivery and other service fees;

- Making decisions on issues within the framework of the General Assembly competences in urgent cases, subject to the automatic review and approval or rejection of such decisions at the next meeting of the General Assembly;
- Calling and managing General Assembly meetings and preparing related materials for those meetings;
- Appointing the WUA Manager, Operations and Maintenance Engineer, and Accountant, subject to ratification in the next General Assembly meeting.
- Preparing the annual balance report, budget, service fee amounts, and work plan at least at least 20 days before the year-end meeting of the General Assembly, and presenting them to the General Assembly for approval or rejection.
- Supplying any information requested by members of the WUA.
- Approving or rejecting reports of the WUA Manager;
- Receiving and considering written requests, complaints, and suggestions of WUA members, other water users and members of the WUA Staff, and taking the necessary measures, subject to automatic review and approval and rejection at the next meeting of the General Assembly;
- Implementing other tasks as mandated by the General Assembly or by the present law.

The Chairman of the WUA Council chairs meetings of the General Assembly of the WUA and meetings of the WUA Council, and represents the WUA in all aspects of its relations with external bodies, in accordance with the mandates of the General Assembly.

Article 19. The WUA Staff

The WUA Staff shall consist of a Manager, Operations and Maintenance Engineer, and Accountant appointed by the WUA Council and subject to confirmation by the General Assembly, as well as other staff appointed by the WUA Manager. The terms of reference of the Director and the Accountant are defined by the WUA Council and incorporated in labor agreements signed by the WUA Chairman.

The Manager is in charge of the execution of the tasks entrusted to the WUA. The Manager shall report to the WUA Council concerning the execution of the WUA's activities.

The obligations of the WUA Staff shall include:

- Preparing the draft budget, work-plan of operation and maintenance of irrigation systems and other required documents for presentation to the WUA Council of the WUA;
- Keeping a register of members and nonmembers, which should be reviewed and updated every year, and which shall contain a description of the size and location of each member's and nonmember's land plot within the WUA service area, a record of the quantities of water received by the WUA, a record of the requests for irrigation water from WUA members and nonmembers and the number of irrigations they receive;
- Preparing contracts for approval by the WUA Council in accordance with the approved budget and work plan for operation and maintenance of the irrigation and drainage systems.
- Receiving water from the water supplier organizations and distributing it equitably to water users in accordance with the water allocations;
- Providing operation and technical maintenance of irrigation and drainage systems.
- Proposing to the WUA Council the levels of the service and other fees, and estimating other tariffs for WUA members and other water users for water delivery or the use of Operations and Maintenance Equipment and Property;

- Receiving the payment of service and other fees from members and nonmembers of the WUA in accordance with the terms of the WUA Charter and mandates of the General Assembly;
- Providing for the accounting and other daily financial management functions of the WUA;
- Opening and managing bank accounts of the WUA;
- Reporting and providing data in accordance with procedures established to the internal bodies of the WUA, WUA members, and other relevant organizations concerning the activity of the WUA;
- Securing appropriate use of the WUA funds and property; and
- Managing the daily activities of the WUA.

The WUA Staff has the following rights:

- Drafting agreements on behalf of the WUA and supervising their execution;
- Developing staff proposals for the WUA Staff and issuing instructions and orders, which are necessary for the proper performance of all staff of the WUA Staff;
- Executing cut-offs of water and other sanctions of members and nonmembers who are delinquent in the payment of service and other fees or who have violated others terms of water delivery and other agreements, in accordance with the mandates provided by the WUA Council;
- Managing the bank accounts of the WUA in accordance with provision approved by the WUA Council; and
- Executing other daily activities defined by the WUA Council or by the present law.

Article 20. The Audit Commission

The Audit Commission provides supervision over the financial and economic activities of the WUA.

The Audit Commission shall have no less than three members, who are elected by the General Assembly from among the members of the WUA by direct ballot for a 3-year term.

The Charter and General Assembly define the work of the Audit Commission.

An audit of the financial and economic activities of the WUA shall be conducted no less than one time per year on initiative of the Audit Commission. A more frequent audit shall be conducted on the basis of a decision of the General Assembly or at the request of no less than one fourth (1/4) of the members of the WUA Council.

The WUA Council and the WUA Staff shall provide documents on financial and economic activities of the WUA at the request of the Audit commission.

The Audit Commission is responsible to the General Assembly.

Reelection of the Audit Commission can be conducted before expiry of its term on request of one forth of the members of the WUA, and also at the request of the WUA Council.

The Audit Commission upon its own initiative or on the demand of one-fifth of the members of the WUA has the right to engage independent auditors to audit the financial operation of the WUA.

On request of the WUA Chairman, the Audit Commission shall analyze any problems that may have occurred during the work of the WUA Staff and it shall formulate recommendations for their resolution.

Article 21. The Dispute Resolution Commission

A WUA may have a Dispute Resolution Commission that shall consist of three persons elected by the General Assembly for a 4-year term. The members of the Dispute Resolution Commission shall elect one of their members to be the Chairman.

The Dispute Resolution Commission shall attempt to settle disputes concerning water use, distribution, and maintenance between members of the WUA or between the WUA and its members.

A WUA member who alleges that another member has violated the WUA Charter, rules, or watering plan may lodge a written complaint with the Chairman of the Commission.

After accepting the complaint the Chairman shall schedule a hearing of the Commission within 10 days.

Both parties to the dispute shall attend the hearing which shall be held in public and which shall be chaired by the Chairman of the Commission. Another member of the WUA may represent an interested party when he is unable to attend.

The Commission shall hear evidence from both parties to the dispute, which may include documentary evidence, and it may undertake inspections. The Commission shall hold its deliberations in private and shall announce its verdict within 10 days of the hearing or of completion of its investigation.

If the Commission considers that the complaint is false it shall dismiss the complaint. If the Commission is satisfied that the complaint is true it may take a decision to impose sanctions in accordance with the Charter to the unsuccessful party.

A decision of the Commission to impose sanctions may be appealed to the courts.

If the Commission cannot settle disputes by negotiations and discussions, those disputes shall be settled by the court in accordance with the rules in force.

CHAPTER 4. FINANCES AND PROPERTIES

Article 22. Sources of Property

Sources of income of the WUA may include:

- Initial property shares of the WUA Founders;
- Fees and charges payable to WUA by its members;
- Income received from nonmembers for the supply of irrigation water on a contractual basis;
- Interest on bank accounts;
- Donations, other legal assets, and grants from the state and other sources
- Securities and associated incomes;
- Gifts obtained from banks and other organizations;
- Gratuitous funds and properties allocated by international donor and state agencies;
- Credit obtained from banks and other sources;
- Income received from entrepreneurial activities, but only if this income is utilized in accordance with the statutory purpose of the WUA; and
- Other sources which are not in contradiction with laws of the Republic of Uzbekistan.

A WUA is the owner of any property legally transferred to it, including irrigation and drainage systems within its Service Area, as specified in the Management Transfer Agreement.

Article 23. Fees and the Reserve Fund

The Charter of the WUA or the General Assembly shall define the various types of fees and charges that are payable to the WUA by the water users in the Service Area, as well as the method of their collection.

The level of internal fees and charges is set by the General Assembly on the basis of recommendations by the WUA Council.

The amount of the water supply service charges should cover the expenses payable to the external Water supplier for operation and maintenance of the main canal outside the WUA service area, and the internal expenses incurred by the WUA for operation and maintenance of the irrigation and drainage systems within the WUA service area.

The WUA shall establish a Reserve Fund to cover the cost of future replacement of the infrastructure, to undertake major repairs to the irrigation and drainage systems within the WUA Service area, and to cover the cost of emergency situations

The Reserve Fund shall be maintained separately from the operating funds of the WUA.

The Charter of the WUA shall provide that following the preparation of the annual accounts; any surplus funds accruing to the WUA at the end of each financial year shall not distributed among the members of the WUA, but shall be paid into the Reserve Fund. Other contributions to the WUA may also be deposited in the Reserve Fund.

Article 24. WUA Financial Management

A WUA shall maintain financial, statistical records, and books in accordance with the National Standards of Accounting of Uzbekistan and other relevant legal enactments of the Republic of Uzbekistan.

A WUA shall have an independent balance. A WUA shall carry out its activities on the basis of the fees payable by members and other water users, and of other income that is not in conflict with the laws in force.

The WUA financial year starts on 1 January and ends on 31 December. For its own internal purposes, the WUA may develop reports on a different time basis.

The WUA shall independently create and manage its own budget.

The WUA shall determine the value of expenses to be included into the budget independent of state-specified norms and indexes of values.

The WUA shall possess the right to tax exemptions provided for nongovernment, noncommercial organizations in the Tax Code of Uzbekistan and benefit from other incentives stipulated in provisions of the legal enactments of the Republic of Uzbekistan.

The WUA shall conduct annual reporting to the tax and statistical agencies, in accordance with the Law on Non-Governmental, Non-Commercial Organizations.

The WUA shall maintain all financial records in its permanent archive and shall provide to all members access to these records upon request.

CHAPTER 5. REGULATION AND SUPPORT OF THE WUA

Article 25. State Regulation

An independent Regulatory Authority with no external relationship with WUAs other than regulation shall exercise state regulation of the activities of the WUA. This body shall be the Ministry of Justice, which is responsible for the regulation of nongovernment, noncommercial organizations in the Republic of Uzbekistan.

The Regulatory Authority has the right:

- To approve or reject registration of the WUA, in accordance with the provisions of the Law on Non-Government, Non-Commercial Organizations;
- To monitor the activities of the WUA in order to ensure that its activities are carried out in accordance with the legal enactments of the Republic of Uzbekistan;
- To demand accurate and timely submission of annual reports and other documentation in accordance with the instructions issued by the Regulatory Authority;
- To conduct audits or invite independent auditors to conduct an audit upon receipt of a written application from one third of the WUA members;
- To suspend the some or all of the activities of WUAs which have repeatedly violated the legal enactments of the Republic of Uzbekistan; and
- To obtain data concerning water deliveries and other activities from the Ministry of Agriculture and Water Resources and other state agencies in order to conduct monitoring activities.

The Regulatory Authority is obligated:

- To provide advice and recommendations concerning Draft Charters proposed by WUA Formation Committees, if such advice is solicited;
- To provide advice to the WUA with respect to legal issues;
- To avoid interference into the activities of the WUA while monitoring its activities;
- To provide an initial warning to WUAs concerning violations of the law, to establish a reasonable timeframe for correction of the violations, and to prove repeated violations of the law before suspending some or all of the activities of the WUA;
- To permit the resumption of some or all of the activities of the WUA which have been suspended in the event that violations of the law have been corrected; and
- To ensure that Ministry staff charged with regulation are competent in legal affairs, the management of irrigation and drainage systems, and the governance and management of WUAs.

Article 26. State Support

The Ministry of Agriculture and Water Resources shall be responsible for providing methodical and practical aid in the organization and development of WUAs, as well as the organization of onfarm water delivery reporting, in accordance with the Decree on Improving the Organization of Water Management.

Support of WUA shall consist of:

- Providing support, advice, and baseline data to Initiative Groups that seek to form WUAs;
- Helping WUA Formation Committees prepare the Draft Budget;
- Helping WUAs prepare Water Use and Maintenance Plans;
- Advising WUAs concerning financial management;

- Identifying training needs and conducting subsequent training concerning operations and maintenance, financial management, legal matters, and onfarm water management; and
- Assisting WUAs in the creation of designs for the rehabilitation of irrigation and drainage system, as well as rendering aid in quality control and quantity surveys before and during construction.

The support of WUAs shall be either solicited by the WUA or proposed by the Ministry and agreed upon by the WUA.

CHAPTER 6. FINAL PROVISIONS

Article 27. WUA Federations

WUAs are permitted to form federations within an indivisible Hydrological Unit only after all WUAs have collected 80% of all fees payable by water users for a period of 3 years prior to the formation of the federation.

All WUAs within the Hydrological Unit shall agree to the formation of the federation.

The objectives and activities, terms of formation and membership, and mandates and procedures for the governance and management of WUA federations shall be specified by a separate law, or by an amendment of the present law.

Article 28. Reorganization and Liquidation

Reorganization of a WUA is accomplished by a decision of the General Assembly or Courts in accordance with the rules established.

Property and financial assets remaining after satisfaction of all liabilities during liquidation of the WUA, except for assets that were received free of charge from the state, are subject to distribution among the members of the WUA by a decision of the liquidation commission or organ, which was created to execute the liquidation in accordance with conditions foreseen by the Charter of the WUA.

Reorganization of a WUA is accomplished by the amendment and re-registration of the Charter of the WUA in accordance with the relevant provisions of this law

Article 29. International Agreements

If provisions of the present Law are in conflict with the provisions of International Agreements of the Republic of Uzbekistan then the provisions of the International Agreements shall prevail.

Article 30. Entry into Force

The present law shall enter into force on the day of its official publication.

The Government of Uzbekistan shall:

- Prepare proposals to bring existing legislation in harmony with the present law; and
- Bring decrees and regulations issued by bodies of the Government of Uzbekistan, ministries, state committees and departments in harmony with present law.

Asian Development Bank

WATER USERS' ASSOCIATIONS IN UZBEKISTAN

GUIDEBOOK 3:
FINANCIAL MANAGEMENT

August 2006

CURRENCY EQUIVALENTS
(as of August 2006)

Currency Unit - som (SOM)

SOM = $0.000815
$1.00 = SOM1,226.74

ABBREVIATIONS

KPD	coefficient for conveyance efficiency
MAWR	Ministry of Agriculture and Water Resources of Uzbekistan
NGO	nongovernment organization
WUA	water users' association

GLOSSARY OF FOREIGN TERMS

ball bonitet	soil fertility coefficients
dehqan	peasant
fuqaro yighini	assembly of citizens
hakim	local administrator
hakimiyat	local administration at district and province levels
hashar	community-organized activities in Uzbekistan traditionally rendered for free
kolkhoz	collective farm (during Soviet period)
mahalla	neighborhood
mirab	watermaster
rais	chairman
shirkat	present collective farm whose assets are co-owned by the farmers
shirkatlar	plural of *shirkat*
taqsim	traditional Uzbek principle on which the detailed criteria for allocating labor for the *hashar* (see *hashar*) is based

GLOSSARY OF FINANCIAL TERMS

Accounting is the recording, classifying, and summarizing of financial transactions in a manner that can be easily interpreted and analyzed.

Assets of WUA consist of cash, farm products, and labor received as payment, together with the irrigation and drainage infrastructure, buildings, vehicles, equipment, furniture, and office supplies, etc.

Asset/Inventory Book is a register containing the details of all property, irrigation and drainage facilities, buildings, and equipment owned by a WUA. The asset/inventory book should include a description of the asset, serial number, date of purchase, cost, location, and any other pertinent information. As new items are purchased, they should be added to the inventory list.

Audit report (financial) is a comprehensive report of an audit committee/commission regarding their investigation to ensure that income, expenses, and assets have been properly recorded, that moneys were paid appropriately, that the irrigation service fee has been collected and recorded, and that malfeasance has not occurred. The audit greatly helps in determining the financial condition of the WUA, identifies problem areas that could threaten the WUA's economic viability and continued existence, and helps establish and maintain the confidence of the WUA's members.

Bank Book is a register or notebook maintained by the WUA Accountant for use in recording cash deposits, bank transfers, and cash withdrawals from the bank. It is closed on the last day of each month and is opened again on the first day of the following month.

Budget of the WUA is a detailed estimate of the expected expenses and income of the WUA, and is created on an annual basis. In a balanced budget, the sum of all the incomes and the sum of all the expected expenses are equal.

Cash Book is a register or notebook maintained by the WUA Accountant for use in recording cash receipts and payments made by the WUA Accountant. It is closed on the last day of each month and is opened again on the first day of the following month.

Deferred maintenance is the postponement of maintenance to some future time.

Depreciation is the decline in the value of an asset as it ages and gradually wears down.

Expenses of WUA include salaries of staff, office supplies, materials for maintenance, repairs, social security fund payments, cost of purchase of equipment, and interest and loan payments. This will also include payment for water to the supplier, if the water use has to be paid.

Financial management is the receipt, maintenance, expenditure, and accounting of the assets of a person, business, government, association, or group.

Income of the WUA includes the irrigation service fee, the membership fee, fines and penalties, fees for other services, interest from bank accounts, and loans.

Irrigation Service Fee is the cost of WUA operations to be levied on both WUA members and nonmembers receiving services from the WUA. It is calculated based on the expected expenditures of the WUA during a particular season or financial year. *It is not a payment for water.* Instead, it is used to pay for the cost of the operations and maintenance of the irrigation and drainage system. Charges for actual water deliveries have to be paid separately. The WUA can decide on the rates and manner of payment for the irrigation service fee, subject to approval by its General Assembly.

Membership Fee is a fee levied at a uniform rate on all prospective members of a WUA. Only those who pay this fee can become a WUA member, and nonmembers have to pay higher water charges than those paid by members.

O&M Plan of WUA is the estimated financial cost of running a WUA's business successfully in a manner that meets its irrigation and drainage service objectives. It includes maintenance and repair of the irrigation and drainage infrastructure, equipment, building, and machinery as well as the cost of staffing, travel, utilities, rents, taxes, and other current payments that the WUA has to make during the year.

Preventive maintenance is the cleaning, repair, and replacement of structures within the irrigation and drainage system in accordance with long-term needs, such as regularly cleaning irrigation collectors once every three years rather than just for the immediate needs of the upcoming year.

Reserve Fund is a special fund maintained by WUA in a separate bank account or in cash to cover the cost of repairs and the improvement and upgrading of the irrigation and drainage system, as well as to provide for unexpected expenses in the event of emergency situations such as floods, breakages in the system, and budgetary shortfalls. This fund cannot be used for any other purpose.

Taxes are the payments levied by the state on business transactions of individuals, business firms, companies, and non-governmental/non-profit organizations.

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INTRODUCTION

This guidebook aims to lay the groundwork for the financial management function in the formation, development, and operation of water user associations (WUAs) in Uzbekistan. It is particularly designed for use by the major participants in that process, particularly members of water user associations, agriculture and water resources ministry officials, representatives of district and province *hakimiyats* (local administrations), and the staff of donor organizations primarily involved in establishing WUAs in Uzbekistan.

Although prepared with the specific needs of Ak Altin in mind, the material presented in this guidebook can also be applicable to all other areas in Uzbekistan, whether or not they are being assisted by a similar government-supported or international donor-supported project.

Covered in this guidebook are the following topics: financial management and its purposes, principles, and activities; the creation of a WUA budget and calculation of a WUA's irrigation service fee; accounting procedures and practices; and auditing. These topics will be discussed more extensively in the individual training modules that will be subsequently prepared for the training and continuing reference of WUA accountants, WUA managers, WUA Councils, WUA Audit Commissions, and WUA members in general.

I. THE FINANCIAL MANAGEMENT FUNCTION

Like all other nonprofit organizations, a water users' association (WUA) has to manage its financial affairs properly to ensure its efficient operation and continuing viability. A WUA must be able to account for all its funds and assets at all times. It also must ensure that the irrigation service fee—the lifeblood of WUAs all over the world—is set at appropriate levels and is collected promptly on a continuing basis.

Financial management can be defined as the receipt, maintenance, expenditure, and accounting of the assets of a person, business, government, association, or group. Its most fundamental aspect is transparent and accurate accounting. Accounting is, in turn, defined as the recording, classifying, and summarizing of financial transactions in a manner that can be easily interpreted and analyzed.

A. Purposes, Principles, and Activities

1. Principal Purposes

The principal purposes of the WUA's financial management function are as follows:

- To effectively manage the cash and assets of the WUA and to monitor how its funds are being mobilized and used.
- To ensure the WUA's economic viability, keeping in mind that a WUA's maintenance function is more a financial rather than a technical concern.
- To provide a clear and accurate picture of the WUA's financial condition as a primary tool for managing the association.
- To gain and strengthen the trust and confidence of WUA members in how the association is conducting its business.

2. Basic Principles

A WUA has to observe the following basic principles[1] of financial management to be able to operate effectively:

- Financial management must be transparent and accurate. All documents must be complete and available for the inspection of all WUA members. Disclosure is critical.
- Financial management must respect the rule of law. All financial transactions of the WUA must be undertaken in accordance with the law.
- A common set of accounting principles, methods, and standards for pricing, budgeting, and reporting must be used by WUAs in a given area.
- The system of financial management must be simple enough to be easily understood by the WUA manager, the WUA accountant, the WUA staff, the WUA Council, the WUA Audit Commission, and the WUA members. This is particularly important in areas served by WUAs where financial institutions are weak.

[1] The basic principles of financial management are as follows: (1) It should be able to show how funds are being mobilized and used; (2) It should present financial statements clearly and accurately so they can serve as an effective monitoring tool for the budget and the statement of accounts; and (3) It should serve as a primary instrument for managing the organization. To succeed, financial management has to have the following characteristics: transparency, respect for the rule of law, comprehensive and systemic organization, equity, accountability, and cost effectiveness. In the particular case of WUAs, the specific financial management procedures should be based on the service objectives set by the WUA members directly or through their elected representatives.

- The receiving and spending of money, labor, and products and services must be conducted in an orderly and effective manner.
- All transactions must be recorded systematically and witnessed as much as possible.
- The calculation of the irrigation service fee must be simple enough to be easily understood by all WUA members and the WUA staff. The irrigation service fee must be tightly linked to the WUA budget. Its calculation and collection must be based on the nature of the WUA's infrastructure. When there are no water measurement devices, for instance, an irrigation service fee based on volume of water delivered would be unsuitable.
- The WUA should receive service fees and other payments directly from the water users rather than through intermediaries. All such payments, except for labor, should be made at the WUA office.
- Accepting service fees and other payments in kind must be avoided unless a cash transaction is absolutely impossible. This is because storage and disposal of farm products by a WUA unduly complicates financial management. For this reason, the manual prepared for WUAs by the Ministry of Agriculture and Water Resources (MAWR) does not have any provision for in-kind income or expenses. However, an exception to this rule must be made in the case of in-kind labor (*hashar*), which is practiced by all WUAs in Uzbekistan.
- The financial management system should conform to national legal requirements, particularly the National Standard of Accounting.

3. Basic Activities

The basic activities of financial management in a WUA are as follows:

- Recording and filing of contracts as well as of water service and delivery records;
- Collection of the irrigation service fee;
- Collection of penalties;
- Collection of membership and other fees;
- Recording of all income, including labor provided by WUA members and contributions by third parties such as the MAWR;
- Making payments;
- Recording of all expenditures;
- Preparation of the annual budget;
- Accounting of cash and all types of assets;
- Managing the WUA's long-term reserve fund;
- Preparation of financial statements;
- Auditing of financial activities;
- Preparation of reports; and
- Recording the minutes of WUA meetings.

B. A WUA's Records and Books

The assets of a WUA consist of the cash and farm products in its possession. They include labor received as payment, the irrigation and drainage infrastructure, buildings, vehicles, equipment, furniture, and office supplies. The WUA has to manage and account for all of these assets in an appropriate manner. As required by the MAWR and the Ministry of Finance, it has to maintain records of all its financial activities.

Below are the books and records required to accomplish the WUA's accounting task:

- **Chart of Accounts:** This lists all of the WUA's books and records and indicates where they are located.
- **Flow Charts:** They show the prescribed stages for the processing of income and expenses.
- **Register of WUA members and nonmembers:** This lists the names of the landowners and water users served by the WUA. It indicates the size and location of their landholdings.
- **Contracts with farmers and with the local Irrigation System Administration:** These are as required by law.
- **Water service and delivery records:** These are as required by irrigation agencies and the WUA members. The records should indicate (1) the quantity received from sources, (2) the requests for water, (3) the quantity and number of times water was delivered, and (4) the date and time of delivery. They should be duly signed by the water user and the *mirab* (watermaster) upon delivery of the water.
- **Minutes and protocols of General Assembly and WUA Council meetings:** These should be made available for review by WUA members.
- **Cash Book:** This is used for recording all of the WUA's income and expenses, including cash receipts and payments and the cash value of payments made in kind.
- **Payment Book:** This records all payments made to the WUA in cash or in kind, such as the cash value of labor rendered to the WUA.
- **In-Kind Labor Book:** This records and accumulates the cash value of labor rendered by a farmer (hourly or daily) until it is enough to defray the irrigation service fee due from him or her.
- **In-Kind Products Book:** This records payments made to the WUA in the form of products (and of payments in-kind, where it is practiced).
- **In-Kind Machinery Services Book:** This records payments made to the WUA in the form of machinery services.
- **Expense Summary Book:** This records all expenses incurred or paid by the WUA and by its personnel.
- **Inventory Book:** This accounts for all assets owned by the WUA, such as property, buildings, irrigation and drainage infrastructure, and equipment. It lists the serial number, date of purchase, cost, and location of each of those assets.
- **Files for receipts, invoices, and expense vouchers:** They consist of the duplicate copies of these documents for recording and safekeeping by the WUA accountant.
- **Bank Book:** This is opened and closed on a monthly basis, and should always conform to the WUA's monthly bank statement.
- **Balance Sheet:** This is used to balance accounts on a monthly basis. It tracks the financial position of the WUA and corrects errors, if there are any.
- **Income and Expense Statement:** This is to be prepared and completed on a monthly or quarterly basis.
- **Annual Income Summary and Expense Summary:** This is used in the preparation of accounting data and the proposed annual budget. It serves as the basis for comparing them with those of previous years.
- **Business Plan and Budget:** This estimates the future income and expenses of the WUA. It serves as the basis for determining the rate of the irrigation service fee.
- **Auditor's Report:** This review of the WUA's financial performance is periodically undertaken by the WUA Audit Commission as provided for by law.

These records and files should capture all transactions and contracts of the WUA. They should be readily available for inspection by all WUA staff and WUA members.

C. The WUA Finance Staff and Their Qualifications

The WUA Accountant. The WUA accountant is the most important position in the financial management of a WUA. It is responsible for the accounting and maintenance of all cash and other assets of the WUA. The person appointed to this position must possess adequate experience and must be honest and trustworthy. He or she should be recommended by the WUA Council chair or the WUA manager, or both, subject to approval by the WUA Council. The appointment must be ratified by the WUA's General Assembly every 2 years. This is to ensure that an incapable or dishonest accountant does not get entrenched in the WUA Management Team, and that a capable accountant is retained.

The WUA accountant reports directly to the WUA manager and is under his administrative supervision, but the position must be given proper autonomy to ensure neutrality in financial management. The WUA manager should not interfere in the WUA accountant's work, and neither should the WUA Council chair. Strict oversight is required to prevent such interference. However, it is the responsibility of the WUA Council chair to monitor the WUA's financial operations on a monthly or quarterly basis.

The WUA Audit Commission. The WUA has an Audit Commission to ensure that the WUA Council chair, the WUA manager, and the WUA Council do not interfere in the WUA's financial operations. It is very important to ensure that the Audit Commission is not subjected to undue influence from them. For this reason, the WUA's bylaws provide that Audit Commission members should not be relatives of the WUA Council chair, the WUA Manager, or a WUA Council member.

The members of the Audit Commission must thoroughly familiarize themselves with the WUA's financial management and accounting procedures. This is important because they need this knowledge to successfully conduct their annual review of all the financial operations, procedures, and accounts of the WUA.

The Audit Commission presents its financial report to the General Assembly. The General Assembly, in turn, is responsible for examining the WUA's Balance Sheet, Income and Expenditure Statement, and Financial Audit Report. It makes the necessary corrective action whenever irregularities are discovered in the WUA's financial operations.

II. THE WUA BUDGET AND FEES

A WUA has to prepare its annual budget before the start of the financial year, which is specified by the MAWR as the period from 1 January to 31 December. This period is in accordance with the standard set by the National Standard of Accounting No. 1 (14 August 1998).

The annual budget consists of detailed estimates of the projected expenses and income of the WUA for the particular financial year. The budgeting process involves adjusting expected expenses against expected income until a balanced budget is produced. Until the budget for a particular year is actually executed, it is generally not possible to find out if that budget is realistic or not. However, as a WUA becomes more experienced in preparing annual budgets, its annual budgets typically become more realistic and predictable.

The annual budget is primarily designed to provide the funds needed to successfully implement the WUA's Annual Operations Plan and the Annual Maintenance Plan. One of its most important purposes is to provide a realistic basis for determining the irrigation service fee.

A. Responsibilities for Forming the WUA Budget

The initial budget of a new WUA is prepared by its Formation Committee. To make its estimates for this initial budget as realistic as possible, the committee should get the inputs and assistance of the MAWR and of the irrigators of former *shirkats* (present-day collective farms). These two groups can provide valuable information and advice on the actual costs associated with various aspects of a WUA's operations. However, a budget prepared in this manner would most likely be fairly simple and not very detailed.

Preparing Subsequent WUA Budgets. Subsequent WUA budgets are the responsibility of the WUA Management Team and the WUA Council. They must be prepared in the following manner:

- The repair, maintenance, rehabilitation, and improvement needs of the existing irrigation and drainage system in the WUA's service area are first identified. This is done through walk-through surveys of the system by the WUA's operations and maintenance (O&M) technicians and gate operators. Based on these surveys, improvement priorities are established in line with the WUA's service objective. Those priorities are then translated into costs that can be inputted into the WUA budget.
- Based on the findings above, a proposed Annual Operations Plan and Annual Maintenance Plan are prepared. The cost estimates for these plans are worked out by the operations and maintenance (O&M) engineer or by the WUA's technicians (mirabs) under the WUA manager's guidance.
- The WUA accountant thoroughly reviews the financial results of the previous years to provide the WUA manager with a realistic basis for preparing the proposed WUA budget. For this purpose, the WUA accountant assembles and reviews past balance sheets and income-and-expense summaries to determine the following: (1) the reasons for the major changes in the budget from year to year, (2) the ability of the WUA to cope with the financial impact of major adverse developments in the past, (3) the cost effectiveness of previous budgets, (4) the soundness of previous revenue projections, and (5) the appropriateness of the fees and charges being collected for the WUA's services.
- The WUA accountant provides cost estimates for the WUA's administrative and management activities.

- Given the various inputs generated by the action steps above, the WUA manager takes the lead in preparing a budget for the WUA that can support the proposed Annual Operations Plan and Annual Maintenance Plan. The WUA manager makes the final decisions on the various aspects of the proposed budget.
- The WUA Council, through its chair, reviews the proposed WUA budget and the Annual Operations Plan and Annual Maintenance Plan, provides its own inputs, then submits them to the WUA General Assembly for approval.

Approvals by the General Assembly. The General Assembly makes the final decision on the WUA's budget as well as on other related financial matters. Before doing so, however, it undertakes the following:

- It reviews and approves the WUA's Balance Sheet and Income and Expense Summary before considering the budget.
- It reviews and discusses the conclusions and recommendations of the Audit Commission's report as well as the actions taken regarding them.
- It reviews and approves the WUA's proposed annual budget and its accompanying Annual Operations Plan and Annual Maintenance Plan. It also sets the salaries of the WUA manager and other WUA staff.
- It establishes the rate for the irrigation service fee at a level that can cover the cost of the WUA's operations and maintenance. It then establishes another rate of the irrigation service fee for nonmembers, the membership and other fees, as well as the rates for fines and penalties.
- It establishes and approves the conditions and guidelines for the right of WUA members and nonmembers to the continued supply of irrigation water.

B. Calculation of the WUA Budget

The WUA budget follows the standard accounting format. Budget items that are anticipated as income are listed as income on the left side of the budget, while proposed expenses are listed on the right side. A sample budget is shown in Table 1.

1. Expense and Income Items

The WUA Budget. Typically, the WUA budget will contain the following expense and income items:

- **Expenses:** salaries and social security fund payments, office supplies, materials for maintenance, repairs, purchase of equipment, interest, and loan payments. At some point in the future, the MAWR will start charging for the actual volume of water supplied. By that time, the WUA's payments to the MAWR for bulk water will form part of this expense list.
- **Income:** the irrigation service fee, fines and penalties, fees for other services, interest from bank accounts, loans, and grants from donor organizations.

The WUA budget classifies expenses into either *current expenses* or *development expenses*. The MAWR defines "current expenses" as payments required to maintain staff and office; they are also known as "non-production expenses." "Development expenses" are those required to maintain, repair, and develop infrastructure and equipment.

Budget formation for WUAs should always begin with expenses. They should be listed first in the Annual Operations Plan and Annual Maintenance Plan.

Table 1. Sample Budget Table

ANNUAL BUDGET FOR (BUDGET YEAR)
(NAME OF THE WUA)

Date Approved: ________
Service Area: _____ Ha
Number of Members: ________

INCOME			EXPENSE		
Item No.	**Description**	**Amount**	**Item No.**	**Description**	**Amount**
	Operating Income			**Current Expenses**	
1	Irrigation Service Fee		1	Staff Director, salary	
	Members			12 months @ ?? soms	
	Nonmembers		2	Accountant, salary	
2	Membership Fees			12 months @ ?? soms	
3	Other Service Fees		3	Mirabs/gidrotekhniks, salary	
	Non-Operating Income			12 months @ ?? soms x no.	
4	Fines/Penalties		4	Maintenance workers, salary	
5	Interest Income			6 months @ ?? soms x no.	
6	Miscellaneous Income		5	Social Security Tax	
7	Grants (proposed)		6	Salary Bonus	
8			7	Office Rent	
9	Balance (if in excess of Reserve Fund)		8	Office Supplies	
			9	Electricity	
			10	Telephone	
			11	Fuel, Oil, and Grease	
			12	Ecological Tax	
			13	Road Tax	
				Development Expenses	
			12	Equipment Purchase	
			13	Equipment Repair/Maintenance	
			14	Transport Repair/Maintenance	
			15	Maintenance Materials	
			16	Channel Cleaning	
			17	Miscellaneous Expenses	
			18	Loan Repayment/Interest	
			19	Contingencies	
			20	Reserve Fund	
	INCOME TOTAL			**EXPENSE TOTAL**	

2. Specific Budget Considerations for WUAs

Provisions for Preventive Maintenance. The MAWR manual for WUAs emphasizes that development expenses should provide for *preventive maintenance* instead of *deferred maintenance*. Preventive maintenance is the cleaning, repair, and replacement of structures within the irrigation and drainage system in accordance with long-term needs. Deferred maintenance is the postponement of maintenance to some future time when the need for it becomes absolutely necessary. This is usually the time when the equipment breaks down.

One form of preventive maintenance is cleaning the irrigation system's collectors regularly every 3 years instead of cleaning it only as needed during a particular budget year. Another form of preventive maintenance is providing for the cost of depreciation of the various operations and maintenance equipment. This way, by the time the equipment has aged to the end of its useful life and needs to be replaced, enough funds shall have been set aside to purchase its replacement.

Budgeting for Preventive Maintenance. The advantage of budgeting for preventive maintenance instead of deferred maintenance is that the former prevents two major problems from occurring. First, when maintenance is deferred, what should only be minor problems in the irrigation and drainage system become major expensive problems in the future. Second, major periodic maintenance needs that are deferred might result in significant shortfalls in the WUA budget during the years when those needs finally have to be met. They might force the WUA to increase its irrigation service fee very sharply just to cover the costs of those extraordinary maintenance expenses.

Setting the Irrigation Service Fee. During the budgeting process, there is usually some tension between the WUA's O&M engineer and the water users. This is because the former has to raise the money actually needed for operations and maintenance. The water users, on the other hand, normally want to keep the fees they have to pay for operations and maintenance as low as possible. Both sides, however, should accept the fact that maintenance is commonly a financial rather than a technical concern. The WUA simply has to provide the funds for it. For this purpose, it has to carefully and accurately establish *the actual cost* of operating and maintaining the irrigation and drainage system. It should not just unilaterally set a rate for the irrigation service fee that it believes the farmers "can afford."

Providing for the System's Future Needs. Once the projected expenses of the WUA for a particular budget year are determined, the rate for the irrigation service fee can then be calculated. When its irrigation and drainage system has to be rehabilitated, however, the WUA should input into the irrigation service fee an *estimate of future needs* during the first several years after rehabilitation. This estimate should be based on the optimum operations and maintenance work that should be done, rather than on the bare minimum required for the year. If this is not done, the operations and maintenance costs would increase each year after rehabilitation. The irrigation service fee would then need to be increased each time to meet those costs.

Monitoring the Budget Implementation. The WUA accountant monitors the implementation of the budget and work plans as part of the financial performance monitoring function. He or she should make a report on the cost monitoring of the budget at the end of each irrigation season.

Unrealistic Legal Provision on Expenses. Article 4.2 of Decree No. 8 specifies that the WUA's expense estimate must follow "the norms in practice" and the "index of values." This legal provision needs to be amended to make WUA budgets more realistic. Expenses should be based not on state-specified levels but on actual prevailing costs. Otherwise, the irrigation service fee on which the budget is based would either be too low to support the WUA's operations, or too high to be affordable and acceptable to the water users.

C. Taxes on WUAs

Tax Exemptions of WUAs. In many countries, tax inspectorates attempt to collect taxes from WUAs in excess of what is specified by law. To spare WUAs from such intrusions, the charters of WUAs in Uzbekistan—including the model WUA charter provided by the MAWR—grant them the status of nongovernment, nonprofit organizations (NGOs).[2]

[2] The laws of Uzbekistan refer to juridical entities such as WUAs as "non-governmental, non-commercial" organizations, or NGOs for short. Henceforth in this guidebook, the term "NGOs" will be used to refer to such organizations.

This status gives them with the following tax exemptions:

- *Exemption from profit taxes (which are calculated at a base rate of 20%), except for income derived from “entrepreneurial activities.”* This is as provided for under Section 31, Article 6 of the Tax Code, which specifically permits NGOs to engage in entrepreneurial activities “within the limits corresponding to their statutory purpose.” However, “entrepreneurial activities” are vaguely defined in the Law Concerning Guarantees of Entrepreneurial Activities as “initiative activity...aimed at the procurement of income at [one’s] own risk and responsibility.” A WUA should therefore ensure that it does not excessively engage in commercial pursuits, particularly if it accepts in-kind income and such other types of payment.
- *Exemption from taxes of gratuitous contributions, shares, and other designated financial allocations to charter funds (capital) that are aggregated to pursue common goals.* Section 16 of the Tax Code does not deem these fund inflows as income of the legal entity (NGO), so they are not subject to taxation.
- *Exemptions from the value-added tax* (the current rate is 20%) of the following: (1) registration fees; (2) services associated with record-keeping in the national language (Uzbek); and (3) equipment, materials, and works imported by legal entities at the expense of loans and grants provided by international and foreign governmental financial and economic organizations under contracts concluded by the Republic of Uzbekistan. This is as provided for by Section 71 of the Tax Code.
- *Exemption from both the property tax and the land tax, as provided for by Sections 92 and 102 of the Tax Code, respectively.* However, if the tax inspectorate determines that an NGO is engaged in excessive entrepreneurial activity, it typically calculates these taxes according to the percentage of revenues that is deemed to be in the form of entrepreneurial income.

Taxes WUAs Must Pay. The only taxes that WUAs in Uzbekistan are subject to are the following:

- The Social Security Tax on salaries (at a rate of about 40%), which is paid to the Social Security and Pension Funds.
- The ecological tax (1% of expenses), which is paid by legal entities engaged in the “manufacturing of goods, performance of works, and rendering of services,” including WUAs.
- Revenues derived from interest, dividends, royalties, and rent payments, which are classified as “entrepreneurial income” and are thus subject to the 20% income tax.

D. WUA Reserve Fund

A WUA has to set aside a reserve fund to (1) cover the cost of repairs, (2) provide funds for the development of its irrigation and drainage system, and (3) cover the cost of contingencies and emergency situations such as floods, breakages in the system, and budgetary shortfalls. This reserve fund has to be established and maintained as a separate cash fund. If a reliable bank is available in the area where the WUA is based, the reserve fund may be placed in a bank account. In the event that the reserve fund is maintained as a cash fund, no withdrawals should be made from it except for the purposes it is specifically allocated for.

Deposits to the WUA’s reserve fund have to be authorized by the WUA’s General Assembly. As a matter of good procedure, a WUA should establish the rate for the irrigation service fee at a level high enough to permit the formation of a positive balance in its year-end cash position. It is recommended that any positive balance at the end of the financial year be deposited into the reserve fund.

E. The Irrigation Service Fee

1. Purpose of the Irrigation Service Fee

The purpose of the irrigation service fee is to cover the cost of the operations and maintenance of the irrigation and drainage system ("development expenses") as well as the salaries and administration costs of the WUA ("current expenses"). The members of a WUA are obligated to pay this fee to the association as provided for by Article 3.6 of Attachment No. 7 to Decree No. 8 of the Cabinet of Ministers (5 January 2002). In the future, when the MAWR starts charging for the cost of bulk water deliveries to WUAs (the target year for implementing this is 2006), the irrigation service fee will have to be computed taking this additional cost into account. There may also be a need for the irrigation service fee to include an allowance for building up the WUA's reserve fund.

It is very important for all WUA members to understand that the irrigation service fee is not a payment for water supplied to them. Rather, it is their share of the cost of the operations and maintenance of the WUA's irrigation and drainage system. They should also understand that the irrigation service fee is not fixed and is subject to change from year to year. As mentioned earlier, the MAWR will soon be charging water users for the actual cost of its bulk water deliveries. The irrigation service fee may in future be also made to carry another charge to reflect the scarcity of water as a natural resource. At present, these additional charges are not yet being collected because most water users in Uzbekistan cannot afford them.

2. Calculation of the Irrigation Service Fee

Applying a Payment Compliance Factor. The irrigation service fee is calculated on the basis of the projected expenses listed in the WUA's annual budget. This manner of determining the irrigation service fee is specified by Article 4.2 of Attachment No. 7 to Decree No. 8 of the Cabinet of Ministers. When calculating this fee, however, a WUA cannot simply assume that all of its members will be able to pay it. This rarely happens during the first years of a WUA's existence. For this reason, the rate for the irrigation service fee should not only be based on the annual expenses as budgeted. This rate should also factor in the expected percentage of members that will actually be able to pay the fee. During the first years of a WUA, this percentage could reach a maximum of 75% but could fall way below 60% in some cases.

Need for Acceptable Collection Efficiency. There is another very important consideration why a WUA should make the rate of the irrigation service fee as realistic as possible. This is because unless a WUA has already reached a certain level of efficiency in collecting this fee, it will not qualify for grants or loans for rehabilitating its irrigation and drainage system.

Options for Establishing the Fee Rate. The irrigation service fee should be calculated in a manner simple enough for all WUA members to easily understand. Members would be much more willing to pay this fee if they knew precisely how the rate was arrived at.

During the first years of a WUA's existence, the irrigation service fee is typically calculated on a per-hectare basis. The volumetric basis is rarely used because the existing water measurement structures are often inadequate for doing it. These calculation options for determining the irrigation service fee are not very accurate in any case. There is at least a 15–20% inaccuracy when the per-hectare calculation is used, depending on the crop variations in the irrigated farms. When the rates are determined by volumetric calculation, the inaccuracies are even greater. These inaccuracies are expected to become even more significant when the irrigation service fee begins to reflect the MAWR's charges for actual bulk deliveries to WUAs.

Recommended Fee Calculation Method. The MAWR recommends a more accurate method for calculating the irrigation service fee. All WUAs in Uzbekistan are enjoined to shift to this method as soon as it becomes realistically possible for them to do so.

The method combines both per-hectare and volumetric calculations. It breaks down the fee into two components: *the development fee* and *the current fee*. The development fee is computed as the total operations and maintenance expense of the irrigation and drainage system divided by the total number of hectares irrigated. This fee is equally collected from all water users as their standard contribution to the system's maintenance, regardless of the actual amount of water supplied to them. It is meant to ensure the continuing availability of funds to maintain the system.

The current fee is computed as the salaries and administrative expenses of the WUA divided by the water use limit or the amount of water ordered by the particular water user. In computing this fee, a coefficient for conveyance efficiency (KPD) is used in place of actual water measurement at the offtake.

Further Refinements to the Irrigation Service Fee. The calculation of the development fee and the current fee needs further refinements to make them more accurate, equitable, and realistic. Specifically, these fees should also take the following considerations into account:

- The development fee should also factor in a coefficient for water use as a function of the various crops planted to the farms. This coefficient can be used instead of the soil fertility coefficient or perhaps in addition to it. This is because soil fertility coefficients (*ball bonitet*) only account for the variable amounts of water utilized by different types of land. They are difficult to measure and are often based on outdated and inaccurate data. In contrast, a crop coefficient is easy to measure. It could more accurately account for the vastly different water requirements of crops such as cotton and wheat (as well as for the income the farmers derive from them).
- The current fee is based on cubic meters of water delivered. At present, however, it is impossible to measure water volumes at the offtake for individual farms in Uzbekistan. It may require many years more before WUAs can measure its water deliveries in this manner. For this reason, the MAWR has introduced a coefficient for conveyance efficiency (KPD). Typically, however, the figures available for conveyance efficiency are inaccurate, particularly for farms within the boundaries of liquidated shirkats. This will force the WUA to absorb the cost of water losses on the irrigation system within the boundaries of the liquidated shirkat. To avoid this situation, the "current fee" should be based on the amount of water ordered (the "limit") rather on the amount of water actually delivered to the farms.
- In all probability, the WUA had already taken a particular conveyance efficiency into consideration when calculating its water use plan for a particular water user ("water ordered" divided by the "limit"). There is therefore no need to include the conveyance efficiency (KPD) in the formula for calculating the current fee.

Table 2 shows the current and recommended methods of calculating the development fee component and the current fee component of the irrigation service fee.

Table 2. Calculation of Development Fee and Current Irrigation Service Fee

PRESENT METHOD FOR COMPUTING THE DEVELOPMENT FEE:

$$\text{Development Fee} = \frac{\text{Total Operations and Maintenance Expenses}}{\text{Hectares Irrigated} \times \text{Soil Fertility Coefficient}}$$

PRESENT METHOD FOR COMPUTING THE CURRENT FEE:

$$\text{Current Fee} = \frac{\text{Salaries and Administrative Costs}}{\text{Water Limit (cubic meters)} \times \text{Conveyance Efficiency}}$$

RECOMMENDED METHOD FOR COMPUTING THE DEVELOPMENT FEE:

$$\text{Development Fee} = \frac{\text{Total Operations and Maintenance Expenses}}{\text{Hectares Irrigated} \times \text{Crop Area Coefficient}}$$

RECOMMENDED METHOD FOR COMPUTING THE CURRENT FEE:

$$\text{Current Fee} = \frac{\text{Salaries and Administrative Costs}}{\text{Water Limit (cubic meters)}}$$

Inadvisable Collection Arrangement. The MAWR recommends that WUAs collect the development fee and current fee separately. This arrangement is not advisable. It would only complicate the collection of fees at a time when many WUAs are already finding it difficult just to collect the single irrigation service fee. It would be much better for WUAs to combine the two fees and collect a unified irrigation service fee from each water user.

Higher Water Fees for Nonmembers. Not all of the water users a WUA will be serving are WUA members. To encourage them to become WUA members, nonmembers should be charged a significantly higher irrigation service fee than that collected from members. A rate 20–50% higher than that for WUA members is recommended.

Water Supply to Dehqan Farms. Many WUAs in Uzbekistan do not admit *dehqan* (peasant) farms and holders of garden plots as members, but they are required to supply them with water nevertheless. Also, the MAWR manual for WUAs provides that dehqan farms and holders of garden plots should not be charged an irrigation service fee. This is on condition that they will clean canals and will not illegally withdraw water.

This is not a fair and equitable arrangement. WUAs provide the same service to dehqan farms and garden plots that they provide to paying water users. They incur the same costs for the service. It is therefore recommended that dehqan farms and holders of garden plots be also required to pay the irrigation service fee. If they do not join the WUA as members, their rate for that fee should be set at the same level as that for other nonmembers.

Payment in Kind for WUA's Services. In areas where WUA members are not financially strong, the WUA may have to accept payment in kind for its services during the first years of its existence. (In the long term, however, WUAs should discourage this practice.) Under such circumstances, the WUA should have a well-established system for determining the value of in-kind payments. Otherwise, it would be extremely difficult to find out if a WUA member who uses this mode of payment has already accumulated enough values to pay for the irrigation service fee.

As a general rule, payments in kind should be significantly greater in value than the corresponding cash payment. This is because of the costs associated with payments in kind, such as storage, weight loss through moisture loss, the need to dry the products, transport, marketing, and taxes upon sale. The resulting increase in the irrigation service fee due to these adjustments could be as high as 20–30%. In no case, however, should a WUA accept vegetable crops and other perishables as in-kind payment.

Using Labor in Kind During Hashar. In practice, most WUAs in Uzbekistan utilize labor in-kind during the hashar. The value of labor used as payment in kind in such situations should be set according to the prevailing rates of payment for labor on a per hour or per day basis. Before acknowledging the payment, the WUA manager or the O&M engineer should first evaluate the effectiveness of the work done. Whenever called for, a penalty for unsatisfactory performance of labor duties must be imposed.

It must also be made clear that hashar work performed at the behest of the hakim for road repairs, clearing of weeds, and similar tasks does not constitute acceptable in-kind labor for paying the irrigation service fee. The WUA Manager and O&M Engineer should only accept in-kind labor for work designated by them that directly benefits the WUA or actually improves the irrigation and drainage system.

Labor Allocation Based on Taqsim. In many areas of Uzbekistan, the allocation of labor for the hashar is done using detailed criteria based on the traditional principle known as the *taqsim*. The lists created for the taqsim usually include such information as the area and location of the land, the crops that need to be irrigated, and the volume of water received. To reduce paperwork, the WUA's Management Body should formally incorporate such lists into its accounting system and maintenance program. This way, the hashar will benefit the WUA rather than work against it. When detailed hashar lists are not already in existence, the WUA must create them so it can formally accept hashar labor as payment for the irrigation service fee.

Exclusions in Determining the Irrigation Service Fee. When determining the rate for the irrigation service fee, it is important not to consider in the computations expense items that will be specifically covered by other income of the WUA, such as funds from grants and loans.

3. Approval of the Irrigation Service Fee

Once the General Assembly approves the WUA's budget, the WUA Council has to make its recommendations regarding the irrigation service fee, the fines and penalties for its nonpayment, and the policies and procedures for implementing them. It is very important for all of the members of the General Assembly to understand the basis for the rate of the irrigation service fee. Otherwise, they will not be in a position to know whether the proposed rate for the irrigation service fee is realistic or not. They may find it so unreasonably high that they may be unwilling to pay it.

The General Assembly should also establish the dates when the payment for the irrigation service fee will be due. These dates are very important because they will determine precisely when the funds needed for the WUA's operations for a particular budget year will become available.

F. WUA Contracts, Membership Records, and Water Delivery Records

Contracts for Two Farming Seasons. In Uzbekistan, WUAs provide services to all water users in their respective service areas on the basis of contracts for the country's two farming seasons: the vegetative season from 1 April to 30 September, and the non-vegetative season from 1 October to 30 March. Article 2.9 of Attachment No. 7 to Decree No. 8 of the Cabinet of Ministers (5 January 2002) specifies that these contracts with the water users be drawn up "in accordance with the Formation Agreement and Charter of the WUA."

Specifications of the Water Service Contract. The water service contract specifies the following:

- The name of the farm to be served and the land area to be irrigated;
- The source of the water to be delivered;
- The duties and obligations of both parties in operations and maintenance;
- The penalties to each of the parties for non-fulfillment of the contract;
- The amount of pre-payment required for water delivery;
- The rights and responsibilities of each party during unexpected contingencies such as natural disasters;
- The records and procedures required to fulfill the contract;
- The schedule of delivery and the water volumes to be provided to the water user, calculated at 10-day intervals; and
- The address, official stamp, and signature of both parties.

Water Delivery Contracts by Group. It is not feasible for WUAs in Uzbekistan to draw up contracts with each individual dehqan farm and holder of a garden plot. This is because these types of landholdings are so numerous in many areas and they are typically very small, ranging from 0.10 ha to 0.50 ha apiece. Thus, in this particular case, it is recommended that WUAs draw up contracts with dehqan farms and garden plot holders by group, specifically with those whose landholdings lie along the same watercourse. In some instances, such groups will constitute a whole village, neighborhood (*mahalla*), or jurisdiction of the rural municipality (*fuqaro yighini*).

Records of Water Users. The WUA should maintain the following records about the water users with which it has service contracts:

- A register of members, updated on an annual basis, indicating the water user's name, the size of and location of the landholdings, and the name of the owner or lessee from the state;
- A register of nonmembers containing the same information as that for members;
- Records of fees owed and paid by members and nonmembers;
- A map of the service area of the WUA;
- Water service and delivery records that indicate the following: (1) sown area, (2) quantities of water received by the WUA, (3) requests for water from farmers, (4) limits and actual amounts of water delivered to members and nonmembers, and (5) irrigation volumes received by the water users. As required by the MAWR, records of this nature should be attached to the service contract between the WUA and the water user.

Contract with the Local Irrigation Authority. In Uzbekistan, WUAs should also draw up a contract with the local Irrigation System Administration. At present, this contract does not require WUAs to pay for bulk water deliveries to its service area. However, WUAs should expect to make such payments in the future and should already plan for this eventuality.

G. Collection of the Irrigation Service Fee

Need for Realistic Payment Dates. A WUA's collection system should be such that water users will pay at least a significant portion of the irrigation service fee before water is delivered to them. For this to happen, however, the payment dates have to be realistic. They should coincide with the periods when the farmers have the cash or in-kind products to make the payment. However, this is not the case with the payment schedule prescribed by Article 36 of the model WUA charter provided by the MAWR. It specifies that 50% of the irrigation service fee has to be paid by 10 April. In practice, this will be difficult to achieve during the first years of the WUA's existence.

To be realistic, this percentage should be lowered to 30% of the total to be due in April. Another 30% should be made due in July or August after the farmers receive payment for the winter wheat. The remaining 40% should be made due in December and January after the farmers receive payment for their cotton harvest.

Direct Payment Scheme. It is very important that WUAs collect the irrigation service fees themselves rather than rely on bank transfers or allow *mirabs* and other staff to do the collection. As provided for by Article 40 of the model WUA charter provided by the MAWR, WUA members should pay service fees "in cash to the WUA bank account or to the WUA cashier." For better control, however, it should be the WUA accountant and not any other member of the WUA staff who should receive payment for the irrigation service fee. It is the experience of many WUAs that when *mirabs* are allowed to collect fees in the field, the occurrence of embezzlement of funds becomes very significant.

As a matter of good procedure, therefore, payments for the irrigation service fee should be made directly to the WUA office. This applies to both cash and in-kind product payments. The corresponding receipts for them should be duly issued to the water users. However, when labor is rendered to the WUA in payment of the irrigation service fee, the payment should be credited in the field. The corresponding receipt should also be duly issued for it.

H. Penalties for Nonpayment of WUA Fees

All water users being served by the WUA should be advised about the consequences of failure to pay the irrigation service fee and other dues. The General Assembly determines the type and amount of penalties for delayed payment or nonpayment. However, Article 39 of the model WUA charter prescribes a 0.1% surcharge on the Irrigation Service Fee as penalty for each day that payment is delayed. Articles 26 and 39 of the model WUA charter further provide that in the event of nonpayment of the irrigation service fee for a total of 20 days, the WUA can cut off the water supply to the user temporarily. Article 36 of the "Law Concerning Water Use" also provides for this penalty.

When delayed payments or nonpayments by a WUA member reach very serious levels, the WUA Council may consider paying the member a social visit or subjecting him or her to public shunning. Removal of the member from the WUA should be considered when nonpayment of the irrigation service fee extends to 2 or more years.

I. WUA Membership Fees

A newly formed WUA should levy an initial membership fee of US$5–7 per member, then $3–5 per year per member for each succeeding year. This initial membership fee will provide for the salaries of the WUA staff and part of the WUA's operations and maintenance costs during the first few months of its existence. Afterwards, it will be the irrigation service fee that will cover these costs. The membership fees collected in the succeeding years then go to a reserve fund for the WUA's long-term development as well as for such contingencies as floods, droughts, and accidents.

III. ACCOUNTING PROCEDURES AND PRACTICES

Accounting is the analysis, recording, and summarizing of financial transactions. It involves maintaining a systematic and transparent record of all incomes and expenditures as well as of all financial contributions.[3] All juridical entities in Uzbekistan, including WUAs, are required to do their accounting in accordance with the Law on Accounting. Based on Article 7 of this law, the WUA Council chair as "head of the enterprise" has the right to organize the accounting service of the WUA, the right to delegate accounting to an outside firm, and the right to independently conduct accounting.

Contradictory Accounting Provision. The first two of these rights are perfectly in keeping with the law. However, the third—the right of the WUA council chair to independently conduct accounting—appears to contradict one of the main principles of Article 6 and the National Standard of Accounting No. 1. This is that the neutrality of accounting must be maintained. How this particular contradiction may be resolved will be taken up later in these discussions.

Accounting Obligations of WUA Council Chair. Article 7 of the Law on Accounting obligates the WUA Council chair to undertake the following: (1) facilitate the development of an internal accounting and reporting system, (2) control financial operations, (3) conduct complete and authentic accounting, (4) perform safekeeping of registration documents, (5) prepare financial reports to external users, (6) prepare tax reports and other financial documents, and (7) ensure timely recording and reporting of accounts. The WUA Council chair or his duly designated representative (preferably the latter in the person of the WUA accountant) is authorized to sign accounting and other financial documents.

Prescriptions for Accounting Method. Article 10 of the Law on Accounting prescribes that the double-entry accounting method be used, while Article 23 requires that all documents be kept on file for at least 3 years. In the case of WUAs, however, all financial documents should be kept permanently on file so they can serve as a continuing reference in the preparation of the WUA's annual budget.

Simplified Accounting Method for WUAs. The accounting method proposed in this guidebook for use by WUAs does not strictly follow the standard double-entry method used by the accounting profession. It is a simplified form that considers the fact that many WUA accountants, managers, councils, and Audit Commission members do not have highly developed accounting skills. This simplified form should suffice until WUAs shall have already developed the level of financial management skills needed to do standard double-entry accounting. Whichever accounting method is chosen by a WUA, however, the General Assembly has to ratify it.

To make the entire accounting process more understandable, Figures 1, 2, and 3 on pages 22-24 show the flow charts for the processing of income and expenses using, cash, in-kind farm products, and in-kind labor.

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[3] Proper accounting is a statement of account that is precise and reliable. It provides a complete record of all expenditures and incomes, and must include any other changes in amounts in the accounting records, without exception, and at their real value. The books must be kept according to the core principle that income and expenditures must be entered separately. Moreover, accounting must be verifiable; that is, each operation must be supported by a voucher, which must in turn correspond to a financial transaction. Goods and services invoiced must have been actually delivered and the price must be competitive according to prevailing conditions. Finally, accounting must be transparent; that is, each entry must be legible, comprehensive and plain, and dated and signed by the person responsible.

A. Procurement and Procurement Procedures

1. Bank Accounts

Having a bank account will make it possible for a WUA to properly account for all the cash it receives or disburses. Once a WUA is duly registered as a legal entity, therefore, it should open an account for this purpose in a bank of its choice.

Inadequate Banking Services. In Uzbekistan, however, the following two factors limit the usefulness of banks in the financial management of WUAs:

- Both the WUAs and the farmers find it a problem to obtain cash from banks. This situation greatly complicates and slows down the payment of the irrigation service fee and penalties by farmers. It also complicates and slows down the disbursement of salaries to WUA personnel. Another problem is that many banks in Uzbekistan simply do not transfer money due to WUAs under the country's tranche system of accounting inputs for crop production.
- Banks are not readily available in many localities to handle the WUA's daily financial transactions.

Until banks in Uzbekistan become readily available and are able to properly serve its financial needs, a WUA has to maintain a cash account and a secure storage facility (such as a safe) in its office to protect its financial assets.

2. Bank Book Procedures

A WUA with ready access to a bank should record all of its bank transactions in a Bank Book. This Bank Book should be managed in the same way as the Cash Book (the master accounting record of all of the WUA's cash and in-kind income as well as expenses), except that the "receipt/invoice numbers" column has to be changed to become simply an "invoice numbers" column. Cash withdrawals from the bank should be entered as expenditures in the Bank Book and as income in the Cash Book. On the other hand, deposits into the bank account are entered as expenditures in the Cash Book and as income in the Bank Book.

The Bank Book, not the actual bank account, should be closed and opened on a monthly basis in the following manner:

1. When closing the Bank Book, the income and expenditure columns should be summed up. The difference between the sums is the bank balance.
2. The balance should then be entered into the expenditure column to balance the account. The total income should be equal to the sum of the total expenditures and the balance of the bank account.
3. The ending bank balance should be carried forward to the following page of the Cash Book as the first entry.
4. The WUA accountant should visit the bank each month to determine the WUA's bank balance. The bank balance shown in the Bank Book should match the balance indicated in the monthly statement provided by the bank to the WUA. Any discrepancies between these two amounts—such as those due to mathematical error, bank charges, or interest—must be properly explained. The bank's charges or any interest accruing to the account must be entered into the books as expenditures and income, respectively.

3. In-Kind Income

It is highly preferable for WUAs to receive cash, rather than products or other in-kind payments, as income. This is because of the significant costs involved in the storage and marketing of in-kind products accepted as payments. For example, if all of the irrigation service fees due to a WUA that serves around 3,000 ha are to be received in-kind in the form of wheat at present farmgate prices, that WUA would need a facility that can store and sell at least 300 tons of wheat.

Given the actual conditions of farmers in Uzbekistan at present, however, it will be largely unavoidable for WUAs to accept in-kind income and make in-kind payments. For this reason, Attachment No. 7 of Resolution No. 8 of the Cabinet of Ministers (5 January 2002) allows WUAs to receive the irrigation service fee in cash or in-kind "in accordance with the Formation Agreement and Charter" *(Article 2.4)*.

Considerations for In-Kind Transactions. When a WUA engages in in-kind transactions, it should clearly keep in mind the following considerations:

- A suitable and secure storage facility should be set up for products received as payment from farmers.
- Perishable products such as vegetables should not be accepted as in-kind payment.
- Payments in-kind must be about 20–30% higher in value than the equivalent payment in cash. This is to offset weight losses during the drying of the products as well as to cover the cost of marketing them.
- Payments in kind will make WUA budgets vulnerable to changes in the market prices for agricultural products.
- The WUA should ensure that in-kind products paid to it are recognized by state purchasing boards as having contributed to the farm's fulfillment of the production quota.

B. Receiving and Recording Income

All payments for fees, whether in cash or in the form of in-kind farm products, should be paid directly to the WUA office. The WUA accountant should receive and record all such payments. When an in-kind payment is accepted by the WUA, the farm products should be delivered to the WUA's storage facility rather than to the WUA office. The WUA accountant should supervise the handling and storage of the in-kind products and should establish the procedures to account for these payments and assets.

Receipts for all payments, such as those for the irrigation service fee and for penalties, should be issued to the water user. The duplicate copy of each receipt should be retained by the Accountant to track and record all income in the manner described below. Appendix 1 shows samples of these documents and records.

Accounting of Cash *(Appendix 1.1)***.** The accounting of income that the WUA receives as cash should proceed as follows:

1. Receive cash from the water user.
2. Prepare the receipt in duplicate.
3. Give the original receipt to the water user.
4. Deposit the cash into the WUA's safe or bank account.

5. Use the duplicate receipt as the basis for processing the payment, as follows: enter the payment separately into the Cash Book and into the Payment Book, then file the duplicate receipt with its corresponding WUA service contract.

Accounting of In-Kind Products *(Appendix 1.2)***.** The accounting of income that the WUA receives as in-kind products should proceed as follows:

1. Receive the in-kind farm product from the water user and calculate its appropriate cash value.
2. Prepare the receipt in duplicate.
3. Give the original receipt to the water user.
4. Place the farm product into storage.
5. Use the duplicate receipt as the basis for processing the payment, as follows: enter the payment separately into the In-Kind Products Book and into the Payment Book, then file the duplicate receipt with its corresponding WUA service contract.

Accounting of In-Kind Labor *(Appendix 1.3)***.** The accounting of income that the WUA receives as in-kind labor should proceed as follows:

1. Receive the in-kind labor from the water user and calculate its appropriate cash value.
2. Prepare the receipt in duplicate.
3. Give the original receipt to the water user.
4. Use the duplicate receipt as the basis for processing the payment, as follows: enter the payment separately into the In-Kind Labor Book and into the Payment Book, then file the duplicate receipt with its corresponding WUA service contract.

Accounting of In-Kind Machinery Services *(Appendix 1.4)***.** The accounting of income that the WUA receives as in-kind machinery services should proceed as follows:

1. Receive the in-kind machinery services from the water user and calculate its appropriate cash value.
2. Prepare the receipt in duplicate.
3. Give the original receipt to the water user.
4. Use the duplicate receipt as the basis for processing the payment, as follows: enter the payment separately into the In-Kind Machinery Services Book and into the Payment Book, then file the duplicate receipt with its corresponding WUA service contract.

C. Paying and Recording Expenses

All expenditures of a WUA should be appropriate, sensible, and economical. This means that they should be justifiable costs at competitive prices under the prevailing circumstances.

Acceptable Modes for Paying Expenses. Depending on the WUA's payment policy as determined by the General Assembly, both cash and in-kind farm products may be used to pay for the WUA's expenses. This mode of payment may prescribe the following: (1) issuance of an invoice before payment can be made, (2) preselecting who should be paid with cash and who should be paid with in-kind farm products, and (3) determining whether or not the in-kind farm products have to be sold to generate the cash needed to make payments.

The WUA accountant should record all payments for expenses, whether paid for with cash or with in-kind products. In-kind farm products used to pay for the WUA's expenses should be accounted for in terms of their cash value based on the WUA's guidelines for computing it. The product is then taken from storage and given to the person receiving payment, after which the transaction is duly recorded and processed.

Preparation of Expense Vouchers. The WUA accountant is responsible for the issuance of the necessary expense vouchers, the spending of cash and farm products, and the recording of the payment of expenses. He or she is also responsible for supervising the handling, storage, and release of payments in the form of in-kind products, as well as for establishing internal procedures to account for all of the WUA's in-kind assets.

Before the payment of any expense, the WUA accountant should first prepare an expense voucher for it in duplicate. The original copy of the expense voucher goes to the one being paid (the payee) and the duplicate has to be retained for use in tracking and processing all of WUA's expense payments. Using the duplicate expense voucher as the basis, the WUA accountant should record all expenses as described in detail below.

Accounting for Expense Payments in Cash *(Appendix 1.5)***.** The accounting of expenses that the WUA pays for in cash should proceed as follows:

1. Receive the invoice or request for payment from the payee (the one who has to be paid).
2. Prepare a cash expense voucher in duplicate.
3. Give the original copy of the cash expense voucher to the payee.
4. Get the necessary cash from the WUA's safe or bank account and pay the payee.
5. Using the duplicate cash expense voucher as the basis, process the payment of the expense in this manner: enter the expense payment (as a negative amount) into the Cash Book and enter it separately (as a positive amount) into the Expense Summary Book, then file the duplicate cash expense voucher in its corresponding expense file.

Accounting for Expense Payments in In-Kind Products *(Appendix 1.6)***.** The accounting of expenses that the WUA pays for in the form of in-kind products should proceed as follows:

1. Receive the invoice or request for payment from the payee.
2. Prepare an in-kind expense voucher in duplicate, based on the calculated cash value of the in-kind products to be used as payment.
3. Give the original in-kind expense voucher to the payee.
4. Remove the farm product from storage and have it received by the payee as payment.
5. Using the duplicate in-kind expense voucher as the basis, process the payment of the expense in this manner: enter the expense payment (as a negative amount) into the In-Kind Book (for products, labor, or machinery services) and enter it separately (as a positive amount) into the Expense Summary Book, then file the duplicate in-kind expense voucher in the corresponding expense file.

Selling of In-Kind Products to Generate Cash. If the WUA sells in-kind farm products for the purpose of generating cash to pay for expenses, all such sales should be entered as an expense in the In-kind Book and entered as income in the Cash Book *(Appendix 1.7)*. Thus, the farm product is removed from inventory and replaced with cash—a transaction that does not change the total assets of a WUA. It simply converts an asset in the form of farm product inventory into its cash equivalent.

D. Balancing Accounts and Internal Reporting

The WUA accountant has to balance the accounts of the WUA on a monthly basis. This is a very important procedure for (1) discovering if any accounting errors had been made during the month and (2) determining the financial position of the WUA. Each time that an account or form is not in balance or when its figures do not add up, the source of the error must be found. It should be corrected before the books can be closed for the month.

Procedures for Closing and Balancing Accounts. Towards the end of each month, the WUA accountant must total all of the WUA's books preparatory to closing the accounts. The accounts should be balanced by adding the ending balance to the expense side (right side) of the balance sheet. This ending balance should be equal to the sum of the ending balances of the Cash Book and the In-Kind Book. Relevant sample documents for closing and balancing accounts are given in Appendix 2.

Once all of the accounts for the month are closed and balanced, the WUA accountant has to prepare the monthly financial statement. This statement should contain the WUA's beginning balances, income, expenses, ending balances, and inventory of cash and farm products for the month just ended. It should be presented to the WUA manager and to the WUA Council to give them a clear idea of the WUA's current financial status.

Preparing Annual Income and Expense Summaries. When the financial statement is finalized, the WUA accountant should enter its monthly income and expense data into the WUA's Annual Income Summary and Annual Expense Summary. These summaries are designed to help the WUA accountant in the preparation of the annual accounting data and the proposed budget for the following year. The WUA accountant should also prepare an Annual In-Kind Net (Income & Expense) Summary and Inventory Summary to account for the farm products and assets of the WUA, respectively. The WUA accountant has to present these summaries to the WUA manager for review and approval. The WUA manager, in turn, has to submit the summaries to the WUA Council for review and approval.

Annual Financial Statements. At the end of every year, the WUA accountant has to prepare a Balance Sheet and Income and Expense Statement for the WUA for that particular year. These financial statements should be submitted to the WUA manager, the WUA Council, and the General Assembly to apprise them of the WUA's financial status. They will also serve as reference in the preparation and approval of the annual budget for the succeeding year.

E. External Reporting

The WUA has to prepare a quarterly financial report as required by the country's tax and state statistical agencies, and an annual financial report as required by the WUA's banks. Both reports require the WUA's balance sheet, financial results, and movements of permanent assets, money flows, and ownership capital. Notes, accounts, and explanations can be appended to these reports.

It must be noted, however, that Articles 8 and 33 of the Law on Non-Governmental, Non-Commercial Organizations only requires annual reporting to the tax and statistical authorities. Which of the laws takes precedence in this matter has not yet been resolved.

F. Inventory

An annual inventory of a WUA's assets has to be prepared for the information of WUA members as joint owners of its properties. For this purpose, the WUA accountant has to prepare an Asset Summary based on a detailed inventory of all property, irrigation and drainage facilities,[4] buildings, and equipment owned by a WUA. The inventory should include a description of each asset, its serial number, date of purchase, cost, location, depreciated value, and other pertinent information. When new items are purchased by the WUA, they should be added to the inventory list.

[4] According to Article 49 of the Law on Water and Water Use, onfarm irrigation and drainage systems are the property of the farm or bodies that acquire the responsibilities of the farms (such as WUAs).

G. Flow Charts

Figure 1. Cash Income and Expense

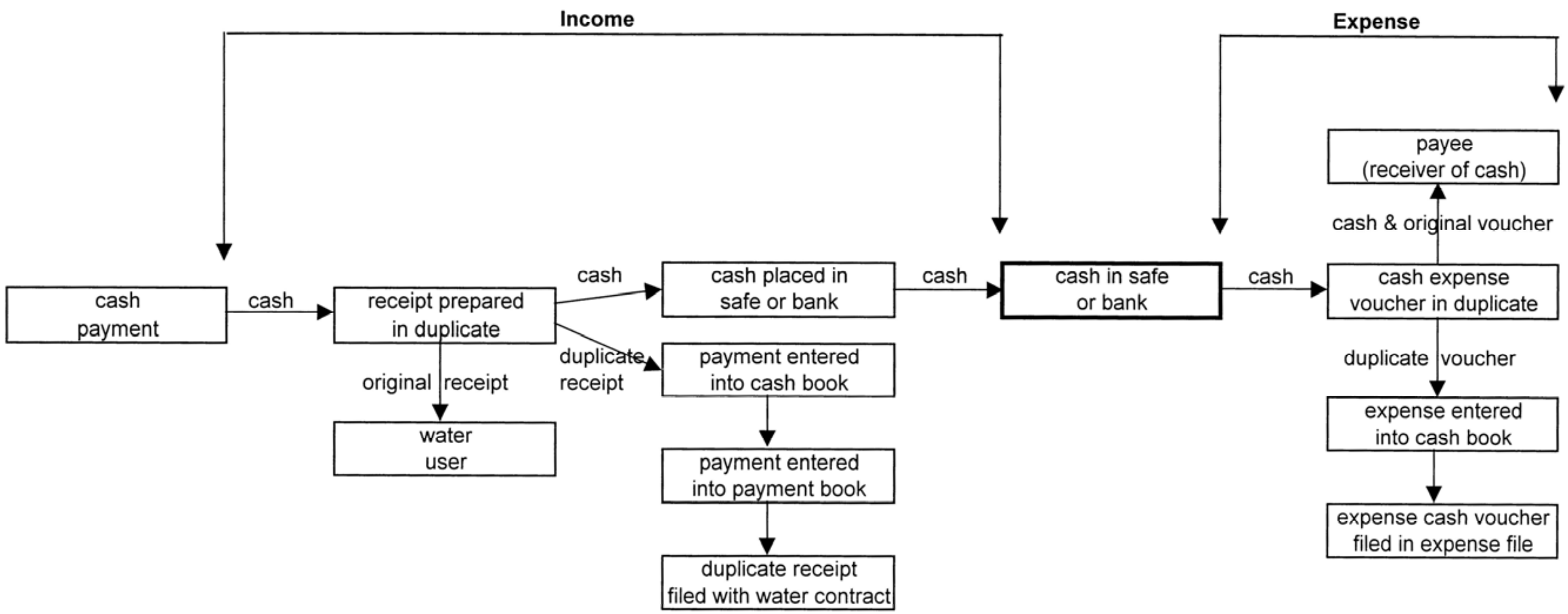


Figure 2. In-Kind Products Income and Expense

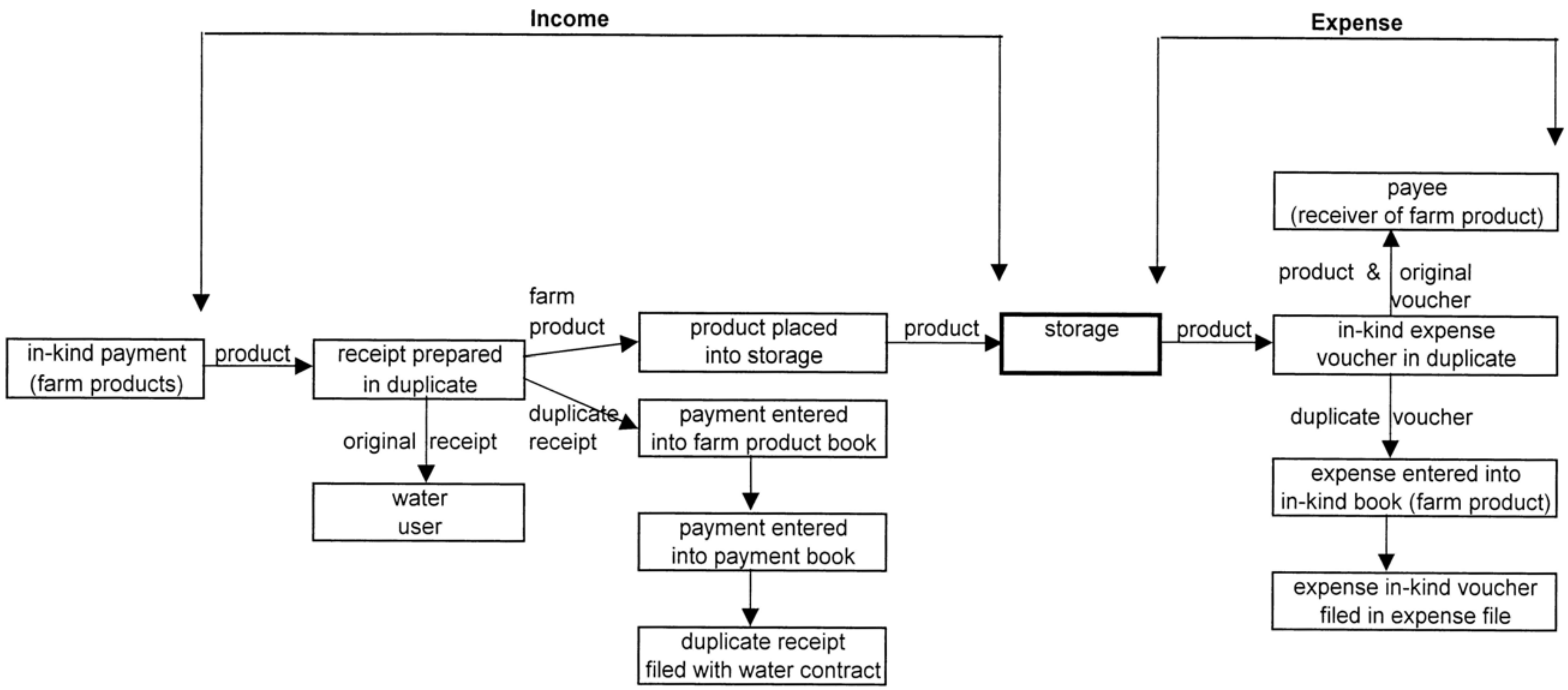
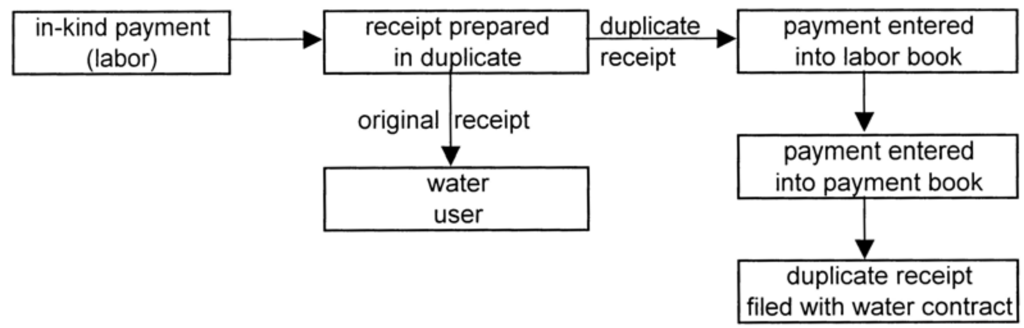


Figure 3. In-Kind Labor Income



IV. FINANCIAL AUDITS

A. Purposes

The WUA charter requires an annual audit of the WUA to ensure that its finances are being managed properly and prudently and with the best interests of the WUA members in mind. This financial audit primarily determines (1) whether the WUA's income, expenses, and assets have been properly recorded; (2) whether moneys were paid appropriately; (3) whether the irrigation service fees have been received and duly recorded; and (4) whether there has been any incidence of malfeasance of the WUA's funds. The audit also helps to determine the financial condition of the WUA and the measures that need to be undertaken to ensure its economic viability and continued existence.

B. The Audit Commission and its Roles

Primary Objective of Audit. The WUA's Audit Commission is responsible for auditing the WUA's finances. The primary objective of the audit is to verify (1) whether proper accounting procedures have been observed by the WUA, and (2) whether funds have been used in accordance with the WUA's aims and objectives. The audit can be internal, which is one conducted by the Audit Commission itself; or external, which is one conducted by an outside firm under the close supervision of the Audit Commission. Either way, the Audit Commission should make sure that the audit is conducted in a competent and independent manner.

Need for Independent Audit. The audit should be conducted independent of the functional monitoring activities of the WUA's Management Team. It should be the Audit Commission doing the audit rather than the Management Team, which should have no direct hand in conducting it. To ensure the independent character of this audit, Article 8 of the Law on Auditing grants auditors the following authority: (1) to conduct audit reporting, (2) to independently determine the form and method of the audit, (3) to access financial records and other documents, and (4) to obtain the necessary explanations from the subjects of the audit.

In addition, Article 9 obligates auditors (1) to provide a "sound" audit, (2) to inform the leader of the audited organization about violations of the law that have been uncovered, (3) to observe confidentiality, (4) to conduct a complete audit, (5) to call a general meeting of the audit subject if necessary, and (6) to refuse to continue the audit if they cannot be objective or unbiased in their opinions.

Membership in the Audit Commission. The charters of most WUAs specify that the Audit Commission should consist of three members elected by the General Assembly for a 3-year term. In contrast, Article 25 of the model WUA charter provided by the MAWR specifies their election on an annual basis, which is much too often. The model WUA charter also specifies that members of the Audit Commission should be WUA members themselves. However, they should neither be members of the WUA Council nor relatives of a WUA Council member, the WUA manager, or the WUA accountant.

Specific Aspects to be Audited. The Audit Commission has to determine the following specific aspects of the WUA's financial activities:

- Whether assets, income, and expenses were properly incurred, recorded, and processed by the WUA accountant.
- Whether procurements were justifiable and in accordance with the WUA's objectives and goals.

- Whether moneys, goods, and labor were spent in accordance with the budget guidelines.
- Whether the WUA Management Body and the WUA Council members illegally benefited in the course of the WUA's financial activities.
- Whether WUA policies, procedures, and rules were fairly applied to all water users served by the WUA.
- Whether the level of nonpayments of the irrigation service fee will significantly affect the operation and maintenance of the WUA's irrigation and drainage system.
- Whether the amounts provided in the budget can assure the effective operation and maintenance of the WUA's irrigation and drainage system.

Disclosure of Records for the Audit. For the Audit Commission to make the above determinations, it has to conduct an annual review of all the financial records and books of the WUA. It also has to make an annual review of the inventory of the WUA's assets. During the audit, the WUA accountant is obligated by law to disclose all of the WUA's records and accounts for examination.

Audit Conclusions and Recommendations. On the basis of its financial review of the WUA, the Audit Commission has to prepare a report of its conclusions and recommendations for presentation to the WUA's General Assembly. In turn, the General Assembly has to review the Audit Commission's report and take appropriate action to correct problems or irregularities that have been uncovered by the audit.

As required by Article 16 of the Law on Auditing, the Audit Commission should report to the subject of the audit and to the banks no later than 5 months after the conclusion of the financial year, which is June of the succeeding year. It must also be kept in mind that the Audit Commission's annual report will be a very important input to (1) the WUA's annual evaluation of the results of its own monitoring activities, and (2) the establishment of its objectives for the following year.

The Audit Commission can exercise the prerogative of hiring independent external auditors to review the financial condition of a WUA. When this is done, the independent external auditors have to present their conclusions and recommendations directly to the General Assembly.

C. Procedures

During the audit, it is highly advisable for the members of the Audit Commission to divide the number of financial records among themselves, such that a member is assigned only a particular set of financial records to audit. For WUAs that serve only a few water users, all of its financial records should be reviewed and examined. For WUAs that serve a large number of water users, however, the Audit Commission members can agree on a set number of water user accounts to be reviewed. They can then select a representative sample of their records for auditing.

The Audit Commission members will need a formal guide for reviewing the financial records and for recording their individual observations and judgments. The Audit Checklist and Questions Form and Audit Reporting Form below are recommended for that purpose.

1. Checklist

During the audit, each member of the Audit Commission should fill out the Audit Checklist and Questions Form with their observations regarding the following aspects:

- The level of cooperation extended by the WUA manager and the WUA accountant in the course of the audit;
- Any inappropriate correlation between the WUA's funds disbursements and expenses and the income of the WUA staff and WUA Council members or their spending that benefits their friends and relatives.
- The level of interference of outside authorities in the financial management of the WUA;
- The prices paid for purchases;
- Whether expenses exceeded the budget;
- Whether proper approval was obtained for expenses; and
- Whether the documentation of financial transactions was thorough enough.

2. Audit Questions and Areas of Review

The Audit Commission should focus on specific areas of the WUA's financial management in performing the audit. Before that, however, the Audit Commission members should study the WUA's budget in detail until they become intimately familiar with it. This review will give them a firmer basis for understanding how the WUA's finances have been managed during the budget year under review. It will also help them arrive at an informed judgment on whether the WUA's irrigation service fee regime is adequate to sustain the WUA's operations in the long term.

Once it has finished this review of the WUA's budget, the Audit Commission can proceed with its audit of the following aspects of the WUA's financial records:

- Vouchers (available records);
- Accounts (correct posting);
- Inventory audits (cash on hand, cash in bank, balances, verification of assets); and
- Special tests (balance sheet, expenditures/earnings versus budget, interest received).

Questions on Specific Financial Aspects. The Audit Commission members should pose some basic questions about specific areas of the WUA's financial management. As they gain more auditing experience and get more familiar with the auditing process, they may also consider other areas of concern or use other methods of reviewing the records.

Below is a sample of set of questions that are typically posed by the Audit Commission:

Income:

- Were the files of water service contracts complete?
- Was a corresponding receipt issued for all income?
- Was the irrigation service fee calculated correctly in the water service contract?
- Were all income properly recorded in the Payment Book and in the other income books?
- Were the proper farm product loss factor and price applied to in-kind payments?
- Was the correct labor rate applied and was labor time properly accounted for?
- Were all previous debts in the Payment Book carried forward to the current year?

The Commission should also track both in cash and in-kind payments for the irrigation service fee in the accounting records.

Expenses:

- Were receipts duly issued for all expenses?
- Were the WUA employees paid correctly?
- Were all expenses listed in the Monthly Expense Summary?
- Were the expenses correctly categorized?

Summary Accounting Statements:

- Were the accounts balanced on a monthly basis?
- Were the entries in the Monthly Balancing of Accounts form correct?
- Did the entries in the Monthly Income and Expense Statement match the totals in the other books?
- Were beginning balances in the Monthly Income and Expense Statement the same as the ending balances from the previous month?
- Were the entries from the Monthly Income and Expense Statements correct?
- Are the totals in the Annual Income Summary and Annual Expense Summary correct?
- Were the proper data entered in the Annual In-Kind Net and Inventory Statement?
- Are totals in the Annual In-Kind Net and Inventory Statement correct?

Current Assets in the Balance Sheet:

- Was the correct data entered from the December Monthly Income/Expense Statement?
- Does the cash entry match what is actually in the safe (or in the bank)?
- Does the in-kind farm products entry match the actual amount in storage?
- Does the Balance Sheet truly represent the assets, liabilities, and equity of the WUA?
- Are the entries in the Income and Expense Statement correct?
- Were newly acquired items added to assets in the Fixed Assets and Asset List?
- Were the sold /lost/destroyed items removed from assets in the Fixed Assets and Asset List?
- Does it appear that the assets are being used appropriately?

3. Audit Report

Once the Audit Commission members have finished filling out their auditing forms, they have to meet formally and share their findings with one another. Based on a consolidated summary of their individual findings, they will then prepare an Audit Report for presentation to the WUA’s General Assembly.

If there is disagreement among the Audit Commission members regarding their findings and recommendations and they cannot resolve the disagreement among themselves, they will have to put the matter to a vote. The majority opinion rules. However, if an Audit Commission member disagrees with the findings or recommendations in the Audit Report, that member may prepare a Minority Audit Report. This Minority Audit Report should state the areas of disagreement and the reasons for the disagreement.

The Audit Report has to be signed by the Audit Commission members who agree with it, and the Minority Audit Report, in turn, has to be signed by those who agree with it. Finally, both reports have to be submitted to the General Assembly for review and consideration.

In addition to its Audit Report, the Audit Commission also has to provide the WUA's final balance, a declaration of the WUA's revenues, and other required accounting information. This is in accordance with Article 15 of the Law on Auditing.

WUA ANNUAL FINANCIAL AUDIT CHECKLIST AND QUESTIONS

Instructions:

Each member of the Audit Commission has to fill out a copy of this form during the audit. Upon completion of the review of the WUA financial records, the members of the Commission should jointly prepare a summary report with their conclusions and recommendations for submission to the General Assembly (or Representative Assembly). The summary report has to be signed by the Commission members acknowledging their approval of its content, conclusions and recommendations. If any member of the Commission does not agree with the other members regarding particular conclusions or recommendations in the report, that member may prepare a separate report stating the areas of disagreement. This dissenting report has to be signed and submitted to the General Assembly for its consideration.

In the case of small WUAs with only a few water users, all of their financial records should be reviewed and examined. For big WUAs with a large number of water users, the Commission should determine a set number of water user accounts to be reviewed and randomly select a representative sample of documents from each for auditing purposes.

Audit for Year: ________
Audited by: ______________________

General Audit Questions:

Was the Staff Director cooperative during the audit? Yes ____ No ____
Was the Accountant cooperative during the audit? Yes ____ No ____
What was the general impression as to the financial records?

Does there appear to be an inappropriate correlation between the income of (or spending that benefits) friends and relatives and the funds disbursements and expenses attributable to the:

Staff Director? Yes ____ No ____ If yes, explain:

Accountant? Yes ____ No ____ If yes, explain:

Council members? Yes ____ No ____ If yes, explain:

Did outside authorities interfere in the financial management of the WUA?

Yes ____ No ____ If yes, explain:

Do the prices for purchases appear to be appropriate?

Yes ____ No ____ If no, explain:

Did expenses exceed budget? Yes ____ No ____
If yes, was proper approval obtained prior to the expense? Yes ____ No ____
Explain:

Was everything documented? Yes ____ No ____ If no, explain:

Prepared by: ______________________________ **Date:** ____________

AUDIT REPORTING SHEET

Audit for Year: __________

Audited by: ________________________

Date: _______________

Income:

Number of water users' files reviewed: ________

File numbers of those reviewed: _______ _______ _______ _______ _______ ___ _______
_______ _______ _______ _______ _______ _______ _______ _____

Problems identified:

File Number	Problem
________	________________________________
________	________________________________
________	________________________________
________	________________________________
________	________________________________
________	________________________________
________	________________________________
________	________________________________

Other problems identified:

____
____
____
____
____
____
____

Expenses:

Problems identified:

____
____
____
____
____
____
____
____
____

Summary Statements:

Monthly Account Balancing:

Are they balanced every month? Yes ____ No ____

If no, explain: ____
____

Problems identified: ________________________________
____
____

Monthly Income and Expense Statement:

Did the entries match other totals from other books? Yes ____ No ____

If no, explain: ____

____

Were the starting balances correct? Yes ____ No ____

If no, explain: ____

____

Annual Income Summary and Annual Expense Summary Statements:

Were the entries from the Monthly Summary Statements correct?

Yes ____ No ____ If no, explain: ____________________________________

____

Were the calculations correct? Yes ____ No ____

If no, were corrections made? Yes ____ No ____

Annual In-Kind Net and Inventory Statement:

Were proper data entered? Yes ____ No ____ If no, explain: ___________

____

Are the totals correct? Yes ____ No ____

If no, were corrections made? Yes ____ No ____

Balance Sheet:

Current Assets - Problems identified: ___________________________________

____

____

Assets, Liabilities, and Equity:

Do the amounts truly represent the financial status of the WUA?

Yes ____ No ____ If no, explain: ____

____

____

Income and Expense Statement:

Are the entries correct? Yes ____ No ____

If no, were they corrected? Yes ____ No ____

Fixed Assets & Asset List:

Problems identified: ____

____

____

Budget Review and Considerations

After reviewing the budget and the financial records and from discussions with the WUA Manager and the WUA Engineer, it is my judgment that:

The Budget and the Irrigation Service Fee are at levels adequate to cover the cost of operating and maintaining the irrigation system in the long term:

Yes ______ No ____ If no, explain: ____________________________________

____

At the close of the year (December 31), ______ % of the Irrigation Service Fee was paid for Year _______, with ______ % unpaid.

The unpaid Irrigation Service Fee is not likely to affect the continued operation and maintenance of the irrigation and drainage systems:

Yes ____ No ____ If no, explain: ____________________________________

____

The management of the WUA is fulfilling its responsibility to maintain the irrigation and drainage systems for sustainable long-term service:

Yes ____ No ____ If no, explain: ______________________________________

____

Recommendations:

____

The above observations, opinions, and judgments are based on my review of the financial records of the WUA and my discussions with the WUA staff.

Prepared by: ________________________________ **Date:** ________________

Additional information (if needed):

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Appendix 1.0 SAMPLE DOCUMENTS AND RECORDS

1.1 Receipt for Cash

RECEIPT FOR CASH

Number: __________

Received from: ____

Amount of: ____

Payment for: ____

____

____

Date: _______________ Received by: ___________________________
(Signature)

1.2 Receipt for In-Kind Farm Product

RECEIPT FOR IN-KIND FARM PRODUCT

Number: ___________

Received from: ____

Amount: gross___________ kg net___________ kg
( ) wheat ( ) maize ( ) barley ( ) ___________

Value:___________ net kg x ________ som /kg = ___________ som

Payment for: ____

____

____

Date: _____________ Received by: ___________________________
(Signature)

1.3 Receipt for In-Kind Labor

RECEIPT FOR IN-KIND LABOR

Number __________

Received from: ____

Amount: _______ # of days x _______ som/day = __________ som

Payment for: ____

____

____

Date: _____________ Verified by: ___________________________
(Signature)

1.4 Receipt for In-Kind Machinery Services

RECEIPT FOR IN-KIND MACHINERY SERVICES

Number __________

Received from: ____

Amount: _______ amount of service x _______ som/service = __________ som

Payment for: ____

____

____

Date: _____________ Verified by: ___________________________
(Signature)

1.5 Cash Expense Voucher

CASH EXPENSE VOUCHER

Number: __________

Paid to: ____

Amount of: ____

Payment for: ____

____

Date: ________________ Paid by: ___________________________________
(Signature)

Date: ________________ Received by: ______________________________
(Signature)

1.6 In-Kind Expense Voucher

IN-KIND EXPENSE VOUCHER

Number: ___________

Paid to: ____

Amount: _________ kg ( ) wheat ( ) maize ( ) ______________

Value: ___________ kg x ________ som /kg = ___________ som

Payment for: ____

____

Date: _____________ Paid by: __________________________________
(Signature)

Date: ________________ Received by: ______________________________
(Signature)

1.7 Cash Book

Year: _________

WUA ____________________________________ **Period:** _________________________

Item Number	Date	Description	Receipt Number	Income Debit	Expenses (Credit)	Balance
Balance Forward		------	------	------	------	0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
Total Income and Expenses				0	-	------
Balance Ending		(Balance Forward + Total Income - Total Expenses)				-

Appendix 2.0 SAMPLE DOCUMENTS FOR DEVELOPING FINANCIAL STATEMENTS

2.1a Payment Book

WUA_________________________ **Year:**

Water User's Number	Water User's Name	Previous Debt	Current ISF	Other Fees	Total Owed	Notes	Date Paid	Receipt Number	Type of Payment			Amount (kg)	Amount Paid (som)	Balance Due
									cash	crop	labor			
Totals for this sheet														

2.1b In-Kind Products Book

Year: _________

WUA _____________________________ **Period:** ____________________

Item Number	Date	Description	Receipt Number	Wheat (kg)	Wheat (som)	Maize (kg)	Maize (som)	(kg)	(som)	Income (som)
Balance Forward and Inventory				-	-	-	-	-	-	------
Total Income and Expenses (som)				------	------	------	------	------	------	
Balance Ending and Inventory (kg & som)				-	-	-	-	-	-	------

2.1c In-Kind Labor Book

Year: _________

WUA _______________________________ **Period:** __________________

Water User #	Date	Water Users Name	Description of Work	Previous Debt (som)	Current Debt (som)	Total Amount Owed (som)	Receipt Numbers	No. of Hours or Days Worked	Value of Labor (som)	Balance Due (som)
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
Total Income from Labor									0	------

2.1d In-Kind Machinery Services Book

Year: _________

WUA ______________________________ **Period:** _________________

Water User #	Date	Water Users Name	Description of Work	Previous Debt (som)	Current Debt (som)	Total Amount Owed (som)	Receipt Numbers	Amount of Service	Value of Service (som)	Balance Due (som)
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
						0				0
Total Income from Labor									0	------

2.1e Monthly Expense Summary

WUA ______________________________ ___________________ __________
(month) (year)

Expense Category	Cash	In-Kind Farm Products								Total Cash & In-Kind (som)
		Wheat (kg)	Wheat (som)	Maize (kg)	Maize (som)	(kg)	(som)	Total (kg)	Total (som)	
Salary Expense:										
Salary Expenses Totals										
Other Expenses:										
Bonuses										
Social Fund										
Office Expenses										
Repair & Maintenance										
Other Expenses Totals										
Total Expenses										

2.1f Monthly Income/Expense Statement

WUA ______________________________ **Period:** __________________

	Cash	In-Kind Value	Total	In-Kind Farm Products (kg)		
	(som)	(som)	(som)	Wheat	Maize	Other
Beginning Balances:						
Cash		---				
In-Kind Products	---					
Beginning Totals	**0**	**0**	**0**			
Income:						
Cash		---				
In-Kind Farm Products	---					
In-Kind Labor	---					
Other: ___________						
Other: ___________						
Total Income	0	0	**0**			
Expenses:						
Salaries						
Social fund						
Rayon Irr. Dept.						
Total Expenses	0	0	**0**			
		--------------	--------------			
Total In-Kind (Product & Labor)		0				
Less In-Kind Labor		-				
	--------------	--------------		--------------	--------------	--------------
Ending Balance (cash & product):	**0**	**-**	**0**	**0**	**0**	**0**
	=======	=======		=======	=======	=======
Unpaid Fees, Penalties, etc.:						

Total Cash, In-Kind, & Unpaid:			**0**			
			========			

2.2 Monthly Balancing of Accounts (Sample)

WUA____________________ **Month: January** **Year: 2001**

Description	Amount	Where From	Description	Amount	Where From
Beginning Balance:	107500	Monthly Inc/Exp Statement (previous month's Ending Balance)		0	
Income:			Expenses:		
Cash	0	Cash Book	Cash	4400	Cash Book
In-Kind farm Products	0	In-Kind Book	In-Kind Farm Products	0	In-Kind Book
In-Kind Labor	0	In-Kind Labor Book			
	--------------			--------------	
Totals	107500			4400	
In-Kind Labor	0			0	In-Kind Labor Book
Ending Balance:	0			103100	<---must match monthly inc/exp st. (This month's Ending Balance)
	--------------			--------------	
Balancing Accounts:	107500			107500	
	========			========	

2.3 Annual Income Summary

WUA ______________________ **Year:** ___________

Month	Irrigation Service Fee				Other Fees	Fines & Penalties	Other Income	Loans	Grants	Total Income
	Cash	Farm products	Labor	Total ISF						
January				0						0
February				0						0
March				0						0
April				0						0
May				0						0
June				0						0
July				0						0
August				0						0
September				0						0
October				0						0
November				0						0
December				0						0
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
								Check--->		0

2.4 Annual Expense Summary

WUA ______________________________ ______________
(Year)

Months	Expense Categories									Totals
	Salaries	Bonus	Social Fund	Office Expense	Repair & Maintenance	Vehicle Operation				
January										0
February										0
March										0
April										0
May										0
June										0
July										0
August										0
September										0
October										0
November										0
December										0
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
									Check--->	0

2.5 Annual In-Kind Net (Income and Expense) and Inventory

WUA ________________________________ ____________

(Year)

Months	Net Income and Expenses by Month (from monthly In-Kind Book)								Totals
	Wheat (kg)	Wheat (som)	Maize (kg)	Maize (som)	Barley (kg)	Barley (som)	(kg)	(som)	(som)
Balance Forwarded									0
January									0
February									0
March									0
April									0
May									0
June									0
July									0
August									0
September									0
October									0
November									0
December									0
Balance Ending	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
								Check--->	0

2.6 Balance Sheet

Balance Sheet as of:

____

WUA _________________________

ASSETS			
Current Assets			
Cash		0	
Farm Products Inventory		0	
Accounts Receivable (unpaid ISF)		0	
Accounts Receivable (unpaid fines/penalties)		0	
Accounts Receivable (unpaid other fees)		0	
Less Uncollectible Accounts Receivable		0	
	Total current assets	0	
Fixed Assets			
Plant, Property, and Equipment (PP&E)			
Furniture and fixtures		0	
Office equipment		0	
Maintenance Equipment		0	
Land		0	
Buildings		0	
	Total fixed assets	0	
Total Assets			**0**
			=========
LIABILITIES AND EQUITY			
Liabilities			
Current Liabilities			
Accounts payable		0	
Taxes payable		0	
Short-term debt		0	
	Total current liabilities	0	
Noncurrent Liabilities			
Long-term debt		0	
	Total liabilities	0	
Equity			
Water Users' Equity (Net Income)		0	
Total Liabilities and Equity			**0**
			=========

2.7 Annual Income and Expense Statement

WUA ____________________________

INCOME AND EXPENSE STATEMENT
for the Year Ended March 31, 20____

Operating Revenue:		
Irrigation Service Fee	0	
Other fees	0	
Fines and penalties	0	
Other income	0	
Loans	0	
Grants	0	
Totals operating revenue		0
Net Operating Revenue		0
Operating Expenses:		
Salaries	0	
Bonuses	0	
Social Fund	0	
Personal taxes	0	
Office expense	0	
Repair & maintenance	0	
Vehicle operation	0	
Miscellaneous expense	0	
Total operating expense		0
Operating Income		0
Other Expenses:		
Interest expense		0
Net Income		-
		========

2.8 Assets

WUA ______________________________ **As of:** ________________

(Date)

Account Number	Description			Cost	Totals
01	Land and Rights-Of-Ways				
	Office property and storage yard	_____	ha	0	
	Canals and little canals	_____	km	0	
	Drains	_____	km	0	
					0
02	Pipelines	_____	km	0	
					0
03	Pumps	_____	#	0	
					0
04	Gates and water meters				
	Gates	_____	#	0	
	Water meters	_____	#	0	
					0
05	Autos and trucks				
	Autos	_____	#	0	
	Trucks	_____	#	0	
					0
06	Canal operating equipment				
	list			0	
				0	
				0	
					0
07	Office furniture and fixtures			0	
					0
08	Radio equipment			0	
					0
09	Maintenance equipment				
	list			0	
				0	
				0	
					0
10	Buildings and grounds				
	Buildings			0	
	Grounds (trees, sprinkler system, etc.)			0	
					0
11	Fuel storage tanks	_____	#	0	
					0
	Total Assets				**0**
					=========

Asian Development Bank

WATER USERS' ASSOCIATIONS IN UZBEKISTAN

GUIDEBOOK 4:
MANAGEMENT, OPERATIONS, AND MAINTENANCE

August 2006

ABBREVIATIONS

NGO	nongovernment organization
O&M	operations and maintenance
WUA	water users' association

GLOSSARY

ariq	field ditches
bosh ariqlar	main canals
dehqan	peasant
fuqaro yighini	assembly of citizens in a rural municipality
hakimiyat	local administration at district and province levels
hashar	community-organized activities rendered for free
ketmans	spades
kolkhoz	collective farm (during Soviet period)
mirab	watermaster
oblast	province
plan vodopol' zovaniia	water use plan (also called *suvdan foydalanish rejasi*)
rayon	district
shirkat	present-day collective farm whose assets are co-owned by the farmers
shirkatlar	plural of *shirkat*
sovkhoz	state farming enterprise (during Soviet period)
suvdan foydalanish rejasi	water use plan (also called *plan vodopol'zovaniia*)
uq ariq	infield ditch
uq ariqlar	tertiary irrigation canals

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INTRODUCTION

This guidebook is primarily intended to help the managers and staff of water user associations (WUAs) in Uzbekistan perform their management, operations, and maintenance tasks more effectively. It is also designed as a continuing reference for the major participants in the WUA formation and development process, particularly members of WUAs, agriculture and water resources ministry officials, representatives of district and province *hakimiyats* (local administrations), and the staff of donor organizations primarily involved in establishing WUAs in Uzbekistan.

This particular guidebook has freely used some excellent existing works on the methods and technology for operating and maintaining irrigation and drainage systems. For them, the authors owe a great debt of gratitude to Onno Schaap and Charles Jones. Onno Schaap is a consultant of Mott MacDonald, Temelsu JV and Zher-Ana, the group that manages the Kazakhstan Water Resources Management and Land Improvement Project, while Charles Jones is a consultant of Mott MacDonald–Temelsu JV, the group that manages the Uzbekistan Ak Altin Agricultural Development Project.

Although prepared with the specific needs of Ak Altin in mind, the material presented in this guidebook can also be applicable to all other areas in Uzbekistan, whether or not they are being assisted by a similar government-supported or international donor-supported project.

I. THE TECHNICAL FUNCTION OF WATER USERS' ASSOCIATIONS

A. Technical Objectives of a Water Users' Association

A water users' association, or WUA, is initiated and managed by a group of farmers and other water users to manage, operate, and maintain an efficient irrigation and drainage system in their locality. It has three principal technical objectives:

> To operate the irrigation system in such a way that all water users, irrespective of their location in the system, will receive a fair and equitable water allocation that takes seasonal and supply variations into account;
>
> To maintain the irrigation and drainage properly and keep the state of repair of its infrastructure as near as possible to its "as-built" condition; and
>
> To ensure good and responsible water resources management as well as a 100% level of collection of payment of all charges to water users, including membership fees and service fees.

B. Achieving the WUA's Technical Objectives

Six main functional areas determine a WUA's capability to achieve the above technical objectives. These are (1) management and administration, (2) operations, (3) maintenance, (4) financial management, (5) governance, and (6) performance evaluation. Each of these functional areas entails several activities that need to be effectively programmed and managed throughout the year. Table 1 shows these six functional areas with their corresponding activities.

The management and administration of WUAs will be discussed first in this guidebook, after which the focus will solely be on the WUA's maintenance, operations, and performance monitoring functions. The WUA's governance and financial management are taken up separately in Guidebooks 1 and 3.

C. The Need for WUA-Specific Operations and Maintenance Manuals

The operations and maintenance (O&M) procedures presented in this guidebook are standard procedures that are used internationally. With appropriate modification to suit the irrigation and drainage system of each locality, they should be applicable to all irrigated areas in Uzbekistan. However, such general O&M procedures may not apply under certain exceptional conditions in a WUA's service area.

In practice, when a WUA acquires responsibility for the operation of an irrigation and drainage system, it prepares a much more comprehensive O&M manual for it using the "as built" drawings of the system. This customized manual shows the infrastructure as actually constructed, the completed detail design data, and the specific changes made in the procedures for managing, operating, and maintaining the system. It contains three main sections: a handbook of operation procedures, a handbook of maintenance procedures, and a handbook of performance monitoring procedures.

The WUA's Management Team prepares this customized O&M manual in draft form, then implements it on a test basis for up to three irrigation seasons. Based on the WUA's experience during this test run, the O&M manual is then modified as necessary.

Table 1. WUA Functions and Activities

Function	Activity	Date
Maintenance	• Routine inspection of infrastructure • Major inspection • Preparation of annual maintenance plan • Preparation of annual budget • Routine maintenance of infrastructure • Periodic maintenance of infrastructure (WUA and/or tender, contract) • Emergency maintenance • Procurement and maintenance of machinery and equipment • Procurement of spare parts and materials	Apr–Oct Oct Oct–Nov Nov–Jan Ongoing Nov–Dec & Jan– Apr As required Ongoing Ongoing
Operations	• Preparation of Operation Plan ("Water Use Plan") • Water distribution: leaching • Water distribution: irrigation • Operation of drainage system	Feb–Mar Jan–Mar Apr–Oct Jan–Oct
Financial Management	• Preparation of annual WUA budget • Determination of irrigation service fee, based on the budget • Routine budgeting and accounting • Collection of irrigation service fees for O&M • Collection of membership fees • Collection of infrastructure payments (upgrades/rehabilitation) • Collection of repayments for rehabilitation • Sanctions for defaulters • Auditing of WUA finances • Running the office (administration)	Nov–Dec Feb–Mar Ongoing Feb–Mar Annually Semiannually As required As required Annually/Ongoing Ongoing
Governance	• WUA General / Representative Assembly meetings • Regular WUA Council meetings • Interaction with other agencies • Communication: WUA Council and members • Communication: WUA Manager and staff • Communication: WUA Chair and WUA Manager • Communication: WUA Chair and WUA Council • Consultations with Dispute Resolution Commission • Mediation by WUA Dispute Resolution Commission • Enforcement by WUA Dispute Resolution Commission and WUA Council	Semiannually Monthly Ongoing Daily / Weekly Daily / Weekly Daily / Weekly Daily / Weekly Daily / Weekly As required As required As required
Performance Monitoring and Evaluation	• Data collection • Proposing performance indicators • Performance measurement of maintenance works	Ongoing Ongoing Ongoing
Adapted from Mott MacDonald, *et al*, November 1999**,** *Draft O&M Manual – Makhtali WUA*.		

II. ORGANIZATION, EQUIPMENT, AND MANAGEMENT REQUIREMENTS

The successful performance of O&M activities for an irrigation and drainage system needs adequate organization and staffing, the requisite equipment and tools, and systematic administrative and financial management procedures. Certain minimum levels for these requirements must be met for a WUA to become functional. Later, when the WUA becomes more financially capable, it can expand its organization and equip itself to perform its O&M activities optimally.

A. Organization of O&M Staff

To efficiently carry out the O&M management function, a WUA has to be staffed with an adequate number of O&M technicians and gate operators. The size of the O&M staff primarily depends on (1) the funds available for it, (2) the number of water users to be served, (3) the total length of irrigation canals and drains in the system, and (4) the total number of offtake gates. Laws, decrees, and other government enactments on WUAs may also predetermine the minimum size of this staff complement as well as the structure of the WUA's management organization.

For a newly formed WUA, the minimum staff requirement during its first or second year of development is as shown below:

Table 2. A WUA's Minimum Staff Requirements

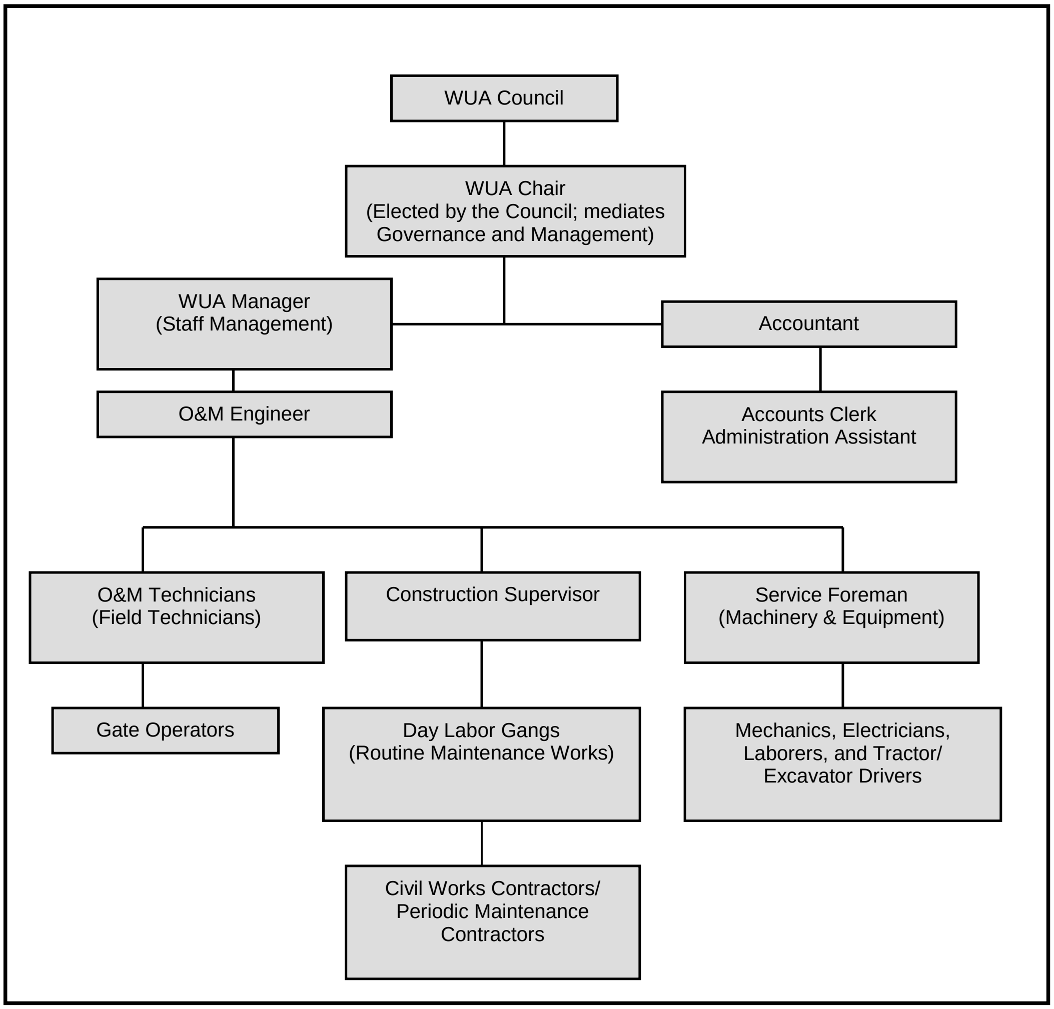
WUA Chair	Elected by the WUA Council from among the council members themselves (this is an unpaid position)
WUA Manager	Appointed by the WUA Council and is responsible for overall staff management
Accountant	Appointed by the WUA Council
O&M Engineer (Senior Hydro-Technician)	Appointed by the WUA Council
O&M Technicians (*Mirabs*) and Ditch Riders (Field Hydro-Technicians)	Appointed by the WUA Manager
Gate Operators	Appointed by the WUA Manager

The hiring of staff for a WUA is the responsibility of either the WUA Chair or WUA Manager. All of these appointments are subject to approval by the WUA Council. To ensure transparency, all appointments to the WUA staff positions are later submitted to the WUA Assembly for ratification.

The full complement of a WUA's staff is not expected to be in place in the early stages of the WUA's operation and development. That usually happens only after 3–5 years. By then, the WUA will be in a much better position to hire more staff. It can also reorganize to meet both its current requirements and its long-term needs.

A WUA can form its organization and management staff along the lines of the standard structure presented in this guidebook. This organizational structure may be modified and the staffing increased or decreased depending on the WUA's actual needs. The organizational chart for the WUA Management shown in Figure 1 is recommended for WUAs with a service

Figure 1. Organization Chart of the WUA Management Team



area of around 3,000 hectares (ha) or more. Appendix 1 provides representative qualifications required for each WUA staff.

When advertising for these staff positions, the WUA Council should specify the minimum qualifications and experience required for them. Appendix 1 describes in detail the qualifications and responsibilities for the typical WUA staff positions.

B. Facilities, Vehicles, Machinery, and Equipment

A WUA needs the proper facilities, vehicles, machinery, and equipment to effectively perform its O&M tasks. This section describes those requirements in detail and recommends how they should be installed or deployed for maximum efficiency.

1. WUA Facilities

A WUA should have an office, a machinery workshop, a storage warehouse, and a secure area for parking its vehicles, machinery, and equipment. Ideally, all of these facilities should be located in the same compound.

Refurbishing an Office for a WUA. Many WUA offices in Uzbekistan are located either in the administration building of the former *kolkhoz* (collective farm during Soviet period) or *shirkat* (present-day collective farm) or in the premises of the village administration (*fuqaro yighini*). These offices often need to be refurbished and furnished with the necessary furniture, office equipment, and supplies.

The typical set of office equipment needed by a WUA consists of the following:

- Filing cabinets;
- Office table and chairs for the WUA chair, WUA manager, WUA accountant, and WUA O&M engineer;
- White boards and message boards, as needed;
- Cupboard for storing office supplies;
- Photocopy machine; and
- A safe.

Communication equipment, particularly a base receiver and walkie-talkies, is mandatory. The base set of this equipment should be located in the premises of the WUA where the O&M engineer holds office.

It will be desirable for a WUA to have a desktop computer with applicable software as well as a printer.

Machine Shop, Tools, and Equipment. In the course of performing its O&M functions, a WUA is responsible for purchasing, operating, and servicing various types of vehicles, machinery, and equipment. In time their number can grow very large, so the WUA needs a suitable area for a machine shop that can house them. This machine shop should be regularly upgraded and stocked with the appropriate tools.

The typical tools and equipment needed by such a machine shop are as follows:

- Hydraulic hoist or mechanical hoist, and a repair service pit;
- Complete set of tools for repairing and servicing vehicles;
- Equipment for welding, burning, and cutting steel;
- Electrical testing equipment;
- Equipment for replacing and repairing pneumatic tires;
- Electric generator set;
- Diesel-powered generators for workshop use and field use;
- Small motors (diesel-powered or gasoline-powered); and
- Storage tanks for oil, grease, and cleaning solutions.

Warehouse for Materials and Small Equipment. The size of a WUA's storage warehouse depends on whether the WUA undertakes activities other than its O&M function. In particular, if a WUA accepts service fee payments in-kind (produce) that will have to be sold later, then it would need a produce warehouse separate from its warehouse for O&M equipment and materials.

The typical O&M materials that a WUA has to provide storage for are as follows:

- Bags of cement for routine maintenance needs;
- Steel rods or steel reinforcing mesh (kept either in a secure yard outside the warehouse or inside the warehouse);
- Paints for repainting irrigation offtake/outlet gates, hydro-posts, exposed steel, and signs;

- Oil and grease for vehicles, machinery, equipment, and irrigation regulatory gates;
- Gate rubbers, rubbers for canalette seals;
- Sealants and lubricants;
- Small O&M equipment such as concrete mixers, small soil or earthwork compactors/tampers, spades (*ketmans*), hoes, buckets, wheelbarrows, sandbags, scythes, motorized grass cutters, and brush-cutters;
- Motorcycles (which need cover from rain and snow, if not yet provided for in the secure parking area or machinery yard).

Secure Yard for Vehicles, Machinery, and Equipment. A WUA needs a secure yard where WUA staff vehicles can park and where O&M equipment can be stationed. When not in use, machinery has to be parked and secured at a central location near the WUA office.

The machinery yard should be fenced and preferably provided with security fencing, a gate, and a secure lock. This yard should have an area for the storage of diesel fuel and gasoline, equipped with a fuel pump (preferably electric-operated or generator-operated). As protection against fire, the fuel storage area should be located far enough from machinery.

A covered parking area should also be provided for the WUA's motor vehicles (such as cars, pickups, and motorbikes).

2. Initial O&M Machinery and Equipment Suitable for WUAs

A WUA should have ready and continual access to machinery and equipment for maintaining its irrigation and drainage infrastructure. They may be acquired through outright purchase or credit.

General guidelines for machinery and equipment typically needed by WUAs are listed on Table 3. To this list should be added the tools and equipment required for the machinery workshop and the WUA's communications equipment, as specified earlier.

Table 3. Initial O&M Machinery and Equipment Suitable for WUAs

Machinery / Equipment	Initial	Future
Pick-up wagon (for WUA Manager and/or O&M Engineer)	1	2
Motorcycles (for O&M Field Technicians)	3	6–8+
Topographic survey equipment	1 set	2 sets
Hydraulic excavator (with small standard boom)	1	1
Backhoe with rear bucket and front blade (either as a complete unit or as equipment that can be attached to a tractor of suitable size)	1	2
Subsurface piped drain cleaning/flushing equipment (with closed drain and with a suitable tractor)	1	1
Standard tractor-towed land-leveling equipment (tractor-and-bucket type)	1	2
Tractor and trailer	1	2
Crane or lifting equipment for tractor attachment (for use in systems with canalettes)	1	2
Grader (for road maintenance or field leveling)	1	1
Small concrete mixer (gasoline- or diesel-powered)	1	2
Small soil/earth compactor or tamper	1	2
Water pumps (for maintenance of canals and drains)	2	3 or 4
Motorized brush-cutters	As required	
Spades (*ketmans*), buckets, wheelbarrows, sandbags, scythes, grass cutters	As required	

Selection of O&M equipment should be practical, financially viable, and in line with WUA's O&M priorities. It should carefully take the following into account: (1) the WUA's actual needs, (2) the availability of contractors, (3) the viability of contracts and tenders, and (4) the sustainability of the equipment's financial and technical aspects. The WUA has to make sure that it does not assume unnecessary and unwarranted financial liabilities in the event that machinery and equipment are damaged, lost, or liquidated.[1]

3. Access to Heavy O&M Equipment

Normally, a WUA already has its own heavy equipment (such as an excavator and bulldozer) to routinely maintain and de-silt its irrigation and drainage system. However, there are some occasions when the WUA needs much heavier O&M equipment than these, such as large draglines, large boom hydraulic excavators, bulldozers, drain-pipe layers, and laser land-leveling equipment. The capacity of these equipment is much too high for use by only one WUA. It would therefore be advisable to have them acquired for the joint use of several WUAs in adjoining localities.

Heavy Equipment for Joint Use with Other WUAs. Listed below are heavy equipment that can be utilized jointly by several WUAs that serve a combined area of around 20,000 ha of irrigated land:

- Draglines (one for three WUAs)
- Long-boom excavator (one for three WUAs)
- Laser land-leveling equipment
- Self-propelled, self-loading scraper
- Large bulldozers
- Drainage trencher and/or pipe-laying machine
- Large earth-compactors or tampers

The Equipment Ownership Option. A WUA should opt for ownership of machinery and equipment only when it is both technically feasible and cost-effective. Before deciding to purchase equipment, the WUA should first quantify and analyze the amount of maintenance work that it needs to carry out in the long term. It should then determine whether it would be more financially feasible to own this equipment or to just contract services out when they are required. The experience of WUAs in most countries is that contracting for services that require heavy equipment would be far more cost-effective than owning them.

Contracting Out Certain Maintenance Tasks. In general, a WUA should make itself sufficiently equipped to manage and implement all of its routine and periodic maintenance tasks. However, its large periodic maintenance tasks are better contracted out by tender. The usual possible outside contractors that a WUA might call upon to make such tenders are the Irrigation System Administration, the Canal Administration, the Hydrogeological Meliorative Expedition, and private civil works contractors in the locality.

Three important questions that need to be asked when inviting such tenders are as follows:

- Are there sufficient numbers of available contractors for 10 periodic maintenance programs, particularly the cleaning of collector drains, the cleaning of closed-pipe

[1] In the case of equipment provided by a donor project, the WUA has to meet not only it own conditions for receiving equipment but also the specific conditions imposed by its purchaser (the donor in this particular instance). For example, a WUA should be able to provide documentation that it is already able to collect at least 40% of the service fees due from its water users, and that the funds from these collections are adequate to cover the cost of the operation and maintenance of both the irrigation and drainage system as well as that of the equipment being purchased.

drains, the cleaning and repair of irrigation canals, and the repair of roads?
- Is there a sufficient number of heavy equipment such as large draglines that can be contracted out?
- Does the Basin Administration's O&M department have sufficient machinery to effectively cover WUA tenders in addition to its own regular off-farm O&M responsibilities?

Base for Donated Heavy Equipment. Heavy equipment purchased under the auspices of a donor project should be stationed in a heavy-equipment base set up for the exclusive use of WUAs. Such equipment should never be stationed in the premises of another institution, such as in a common machine-tractor park or in a depot of the Irrigation System Administration. Doing this inevitably results in the unauthorized use of the equipment for such purposes as the O&M of main canals and drains, field machinery services, and the pet projects of the hakimiyat.

Ideally, a WUA heavy-equipment base should serve an irrigated cropland area of 20,000 ha or more. As the central equipment station owned and managed by several WUAs, this heavy equipment base will have its own simple charter and a board of directors. The members of this board will consist of (1) the representative of each of the WUA Councils that formed the heavy equipment base, and (2) a representative of each of the institutions that provide technical guidance to the staff of the heavy-equipment base, such as the Irrigation System Administration, the machine-tractor park, and the Rural Business Advisory Center.

Procedures for Setting Up a Heavy-Equipment Base. When setting up a heavy-equipment base, appropriate procedures need to be worked out in advance to determine the following:

- The specific needs of the WUAs for heavy equipment;
- The contribution of each WUA to the maintenance and transport of equipment; and
- The investment to be contributed by each WUA in the purchase of new equipment.

In addition, the taxation status of the WUA heavy-equipment base should be determined beforehand. The heavy-equipment base may or may not have the status of an NGO, so it may or may not be entitled to the tax exemptions granted to NGOs. *(Guidebook 3 describes the specific tax exemptions granted to NGOs like WUAs.)*

When all the WUAs within a large hydrological unit have become sustainable and it becomes feasible for them to federate, the WUA federation to be formed by them can assume responsibility for the WUA heavy-equipment base and for other ancillary activities. These ancillary activities may include providing farmers with agronomic and irrigation advice and supplying them with fertilizers and pesticides.

C. O&M Administration of the Irrigation and Drainage System

The O&M of a WUA's irrigation and drainage system is the direct responsibility of the O&M engineer, under the overall guidance and supervision of the WUA manager. There should therefore be a good working relationship between the O&M engineer and the WUA manager. Also, the O&M engineer has to work in close coordination with the WUA accountant so he or she can get the necessary budget and funds for implementing the WUA's O&M activities.

1. O&M Documentation

Thorough and accurate documentation is required for successful O&M administration. For this purpose, the WUA needs to systematically retain and file all technical reports, maps, record forms, books, contracts, and other documents pertaining to the O&M of the WUA's irrigation and drainage system. This database should include the baseline data obtained during the formation of the WUA. *(Guidebook 1 describes the baseline data needed for forming WUAs.)* Apart from their use in the effective conduct of O&M work, these documents are critically important to the WUA's financial management.

An inventory of the documents required for O&M documentation is provided below.

General Purpose Documents:

- Location maps of the WUA and/or project in relation to other irrigation areas, *rayons*, and *oblasts*;
- Maps and drawings of the irrigation and drainage system, including all of its structures, particularly measurement flumes (hydro-posts), tertiary offtakes, closed-pipe drainage areas, and roads and crossings;[2]
- Design criteria and a description of the operational design of the irrigation and drainage systems and structures, particularly of the flows, irrigation demand (in liters/second/hectare), and operational head (meter) for canals and structures;
- A register of water users, inclusive of all WUA members and nonmembers as well as other agricultural and non-agricultural users, indicating name, specific use of water, hectarage, cadastral map of farm boundaries, and ownership number or title;
- The WUA's charter and bylaws along with the foundation agreement, management transfer agreement, and registration certificate with the corresponding registration number;
- All water-related legislation in Uzbekistan;
- The annual operations plans, annual maintenance plans, and annual budgets of the WUA for previous years; and
- A copy of the WUA's own O&M procedures manual, which should contain the following: a handbook of operation procedures, a handbook of maintenance procedures, and a handbook of performance monitoring procedures.

Water User Contracts and Staff Contracts:

- Water delivery contract between the Irrigation System Administration and the WUA;
- Documentation of the MAWR's acceptance of the WUA's annual water use plan;
- Water delivery contracts between the water users and WUA; and
- Permanent staff contracts and temporary staff contracts.

Documents Specific to the WUA's Annual Planning and Reporting:

- The WUA Annual Report;
- The WUA's Annual Operations Plan indicating the cropping plan for the irrigation season, the Water Distribution Plan, the Operations Plan (scheduling of delivery, demand, and reporting), and Maintenance Plan (inspections, routine and periodic works, implementation); and

[2] The complete set of drawings and maps should be copies of the "as-built" plans following the completion of the construction of the irrigation and drainage system or of its rehabilitation. The drawings should be inclusive of all longitudinal and cross-sectional plans for canals, drains, structures, and roads.

- The WUA's Annual Budget.

Annual O&M Administration Records:

- Water use records: volume of water supplied by the Basin Administration and verification that the WUA records conform to the Basin Administration records;
- Water delivery records: volume of water delivered to each user (or group of users, if individual farm deliveries cannot be measured);
- A record of the cropping plan for each season;
- A record of the maintenance work implemented per season (including routine and periodic maintenance works and a list of the deferred maintenance works);
- A report on the performance monitoring done by the WUA on its irrigation and drainage system; and
- A report on the WUA's cost monitoring of its annual budget (this should be prepared and evaluated before the next season's budget preparation).

Copies of all of these documents should be made available to the WUA manager, the WUA accountant, the O&M engineer, and the O&M technicians (for the sections of the irrigation system for which they are responsible). This data should be filed and updated regularly at intervals not exceeding 12 months. Based on them, the O&M procedures manual should be continually updated as well.

2. Verification of the WUA Boundary and Irrigation Supply

A WUA can be constituted and managed by water users along one or more hydrological units. For this reason, a WUA has to verify that all irrigated lands in its service area are supplied by canals from a hydrological unit or units within its boundaries. This verification of boundaries—including farm boundaries, WUA boundaries, and hydrological boundaries—is normally done at the very outset by the WUA's Initiative Group and Formation Committee. (Guidebook 1 describes in detail the tasks of a WUA's Initiative Group and of its Formation Committee.)

Every time that a WUA undertakes a design upgrade, rehabilitation, or new construction in the system, the WUA Council should direct the WUA manager and the O&M engineer to perform the following tasks:

- Confirm the locations of all of the WUA's supply regulatory offtakes (hydro-posts);
- Confirm that these regulatory offtake gates are supplying water only to irrigated areas within the WUA's service area;
- Confirm that the WUA boundaries actually coincide with the hydrological boundaries of the canals delivering water from the WUA's supply regulatory offtake gates;
- Confirm that all supply canals and secondary canals are delivering water to irrigated farms within the boundaries of the WUA, and that the supply canals do not extend into and deliver irrigation water to another WUA.

Guidebook 1 provides a schematic overview of variations in WUA boundaries, in production cooperative or shirkat boundaries, and in hydrological boundaries.

3. Description and Inventory of the Irrigation and Drainage System

A clear and accurate description of the irrigation and drainage system is necessary in the preparation of water distribution and maintenance plans. The description should provide (1) the specifics of the WUA system's layout, (2) the dimensions and capacity of canals and drains, and (3) the dimensions and capacity of division boxes and gates. The corresponding maps, drawings, and inventory of the irrigation and drainage infrastructure should be provided with the description.

The inventory of the irrigation and drainage infrastructure should list all canals, drains, roads, and structures in the WUA's territory. The list should be inclusive of all secondary, tertiary and field canals, drains, division boxes, culverts, roads and road crossings, and other structures. The particulars of all existing works should be detailed in the inventory, citing the code number of the different items, their length and dimensions, their hydraulic capacity, and the construction material used (whether earth, concrete, steel, etc.). The inventory should clearly indicate (1) which hydraulic works are the WUA's responsibility, (2) which of them should be updated whenever changes are made in the irrigation and drainage systems, and (3) which of them should be stored as part of the WUA's permanent database.

Appendix 2 provides a sample inventory form for an irrigation and drainage system.

4. Maps and Drawings of Hydrological Units

Maps are very important and useful in the preparation of the WUA's water distribution, cropping, and maintenance plans. Moreover, they are very important to the WUA Management Team in identifying and locating problems and shortcomings in the irrigation and drainage system. They also facilitate the needed maintenance and repair work.

Maps of the existing irrigation and drainage systems in Uzbekistan may be obtained from the MAWR, the Irrigation System Administration, or the O&M department of the Basin Administration. The staff of these government entities regularly update these maps based on data furnished by the WUAs.

The following maps and drawings should be procured by a WUA:

- The area to be irrigated and its location within the area served by the MAWR's Irrigation System Administration and Basin Administration.
- The layout, drawn to scale, of the irrigation scheme of the area managed by the local Irrigation System Administration. These drawings should show all WUA boundaries, all main canals and drains, all roads and crossings, and the location of secondary canals. A copy of this drawing, preferably drawn to a larger scale, should be displayed on the wall of the WUA Management Team's office.
- The layout, drawn to scale, of the irrigation scheme of the area managed by the WUA. The drawing should depict (1) all irrigation canals and structures, including all main, secondary and tertiary canals; (2) all open-collector drains, (3) all roads and crossings, and (4) all areas of subsurface (closed pipe) drains with the length and spacing of the closed drains indicated. A copy of this drawing, preferably drawn to a larger scale, should be displayed on the wall of the WUA Management Team's office.
- A schematic diagram of the irrigation area served by the WUA.

5. Cadastral Map, List of Water Users, and List of WUA Members

Identifying the WUA's Service Area. The WUA should procure a cadastral map that shows the boundaries of farms of both WUA members and nonmembers. This cadastral map will enable the WUA to clearly identify the irrigated areas and cropped areas it has to serve. It will also allow the WUA to accurately locate the irrigated lands in relation to the irrigation supply canal and offtake. For the cadastral map to be useful, however, the WUA should also have on hand a complete list of the water users and WUA members it is serving as well as a register of the irrigated areas.

Listing All Water Users. The WUA needs the complete list of water users and WUA members for the following purposes:

- To distinguish between WUA members and nonmembers, particularly if the WUA is charging nonmembers a higher irrigation service fee than what it charges members;
- To identify all of the other water users that the WUA is serving aside from leasehold farms; and
- To determine the comparative sizes of the irrigated, nonirrigated, and cropped areas the WUA is serving.

Identifying Irrigated and Cropped Areas. The WUA needs the register of irrigated plots to determine the following with precision: (1) the hectares of irrigated land in its service area, (2) the percentages of cropped areas and irrigated areas in any given year, and (3) the comparative aggregate sizes of land held by WUA members and those held by nonmembers. Moreover, the WUA should duly note and record which parts of the irrigated areas, farms, or plots are being used for purposes other than farming. This is to ensure the accurate calculation of the membership and service fees to be levied on individual members and nonmembers.

Irrigated area and cropped areas can either be included in the list of water users and WUA members, or else listed in a separate register for irrigated areas. Appendix 3 presents a sample form for the recording of all water users and related information, and a sample register of an irrigated area.

The list or register should include the following information: (1) name of the farmer (irrigator), (2) the plot number or cadastral number specific to the farm area, (3) the farm or plot area, (4) the percentage of area for irrigation, (5) the area devoted to particular crops, and (6) the soil type and slope. This data should be specific down to the level of tertiary or quaternary canals.

D. Basic Financial and Administrative Procedures

The financial and administrative aspects of the O&M function of WUAs consist of the planning, reporting, and creating of budgets and the levying of service fees. Guidebook 3 gives a detailed description of these financial procedures.

1. Annual Reports

The WUA Management Team has to make periodic reports to the WUA Council regarding the WUA's financial and administrative performance and results. The WUA Council, in turn, has to make its own periodic reports on these matters to the WUA's General Assembly or Representative Assembly. Typically, the WUA Council chair asks for a monthly report, and the WUA manager prepares and presents the report with the assistance of the O&M engineer and the WUA accountant.

The four most important reports that have to be prepared and presented by the WUA's Management Team are the following: the Annual Report, the Annual Budget, the Annual Maintenance Plan, and the Annual Operations Plan. These reports may be presented separately or in combination. Their format and manner of presentation are at the discretion of the WUA Council, subject to the particular legal and financial requirements of the state as well as the accepted system of audit. In practice, when presented to the WUA Council and the General Assembly, the Annual Report generally already includes all the other three reports.

Contents of the WUA Annual Report. Typically, the WUA Annual Report contains the following:

- General overview and summary of the past year's performance and results;
- Cropped areas: planned and actual;
- Irrigation deliveries: planned and actual;
- Irrigation efficiencies, water availability, water usage by farmers, water wastage;
- Maintenance works: planned and actual (routine, periodic, and emergency); achievement of works (within or exceeding budget);
- Actual maintenance status of system;
- Operation of system: planned and actual;
- Staff and staff performance: planned and actual;
- Financial review (balance sheet, planned and actual expenditures, planned and actual revenues, income-and-expense statement);
- The annual budget for the next year;
- The irrigation service fee;
- Plans and recommendations for the next year: water supply, operation objectives, maintenance objectives, staff requirements, training needs, materials and supplies, and fund requirements;
- Evaluation of performance monitoring activities; and
- Recommendations for improvement.

Contents of the Annual Maintenance Plan. The Annual Maintenance Plan, which is usually included in the Annual Operations Plan and the Operations Report, collates all of the WUA's maintenance report forms as well as the contents of the WUA's maintenance register. The contents of these forms will be discussed later in these discussions.

Contents of the Operations Report. The Operations Report reviews the following:

- **Organization and management:** Introduction, the WUA's functions and objectives, staff requirements, staff responsibilities, training needs for staff and members, facilities and equipment, communications, the O&M annual budget, and the irrigation service fee;
- **Operations:** Methods and objectives, cropping plan, water use plan, O&M plan, and operation records (eventual updates);
- **Maintenance:** Overview and objectives, inspections, priorities, activities, the maintenance implementation plan, and maintenance records (eventual updates); and
- **Performance monitoring:** Proposed indicators, proposed performance objectives, monitoring plan, and records of monitoring activities (eventual updates).

2. Budgeting for Operations and Maintenance

The annual budget of the WUA for O&M has to be carefully planned. It should provide for all expenses from the smallest to the largest cost item so that shortages of funds, materials, and equipment can be avoided. Table 4 presents a recommended structure for the O&M portion of the Annual Budget. *(Guidebook 3 provides a sample structure of a WUA's Annual Budget.)*

There are some expense items that are often overlooked when the WUA's annual budget is prepared. The WUA should make it a point to provide for them to avoid needless inconvenience and complications later on. The items include consumables, office

Table 4. Typical O&M Line Items in the WUA's Annual Budget

Category	Line item	Specific items
Staff Costs	Wages	Wages, pensions, social security, etc.
	Other costs	Allowances, housing, travel, training, etc.
Recurrent Expenses	Operational expenses	Office operations, consumables, production of documents and reports
	Repairs and maintenance	Pump station, irrigation and drainage system, vertical drainage pumps, equipment, buildings, by scheme staff, labor, contractors
	Other labor costs	Wages, casual labor
	Vehicle usage	Fuel, taxes, insurance, repairs and maintenance
	Electricity bills	Pump station, vertical drainage pumps, office, workshop etc.
	Performance monitoring	Payment for expertise and/or service agencies
	Taxes	Government taxes payable by WUA
Capital Costs	Office equipment Communications equipment Workshop equipment Vehicles Building improvements	Estimates should be made each year for the WUA's facilities, office and workshop refurbishment, vehicle upgrades, O&M machinery and equipment, and upgrade and rehabilitation plans for the irrigation and drainage system.
Reserve Fund	Provision for major construction works	Repair of canals, flumes, vertical drainage pumps, drains, and other structures
	Emergency works	Major unforeseen developments and emergencies
	Replacement of equipment and vehicles	Future replacement based on normal working life

refurbishment, capital cost items, capital cost replacements, and the Reserve Fund. *(Guidebook 3 describes the Reserve Fund in detail.)*

Major Consumables. The most important consumables that should be provided for are the following:

- Office supplies: paper, ink cartridges for printers, pens and paper;
- Maintenance supplies: paint, grease, oil, sand, gravel, and cement; and
- Supplies for the maintenance workshop and equipment: oil, grease, and spare parts.

Major Refurbishments. The major office refurbishment items that should be provided for are the following: computer upgrades, software, electricity, rental (if appropriate), tables and chairs, filing cabinets, white boards, calculators, and a drawing file with cabinet.

Capital Cost Items. There are some capital cost items that are generally not included in a WUA's basic annual budget. This is because their acquisition is contingent on the WUA's financial and technical sustainability. Among these capital cost items are the additional office equipment, communication equipment, workshop equipment, O&M machinery and equipment, and vehicles (such as motorcycles and pick-ups) that the WUA will have to acquire to meet the growing needs of its service area. Moreover, even with an ideal maintenance program, the WUA has to provide for the eventual upgrade, improvement, and rehabilitation of its irrigation and drainage infrastructure at some future time. It is recommended that the WUA budget for these expected future costs on a yearly basis over a period of 10, 15, or 20 years. The effects of inflation should be taken into account.

Since machinery and equipment have a limited operational life, the cost of replacement of these capital items should be budgeted over the course of their useful life. These costs should form part of the annual budget and irrigation service fee calculations.

Extraordinary Expense Items. Some of the WUA's extraordinary expense items can be covered by the WUA's Reserve Fund, which typically makes an allowance for emergency maintenance. The Reserve Fund provides for emergency maintenance, whether in the form of civil works or major repairs of machinery and equipment, to ensure the immediate restoration of the WUA's services when system breakdowns and fortuitous events occur.

3. Irrigation Service Fee

Both from the financial and O&M point of view, a WUA has to prepare a realistic annual budget and ensure that the irrigation service fee is sufficient to cover the costs of implementing the WUA's two major functions: (1) the operation and administration of the WUA itself and of its irrigation and drainage system, and (2) the performance of the WUA's routine, periodic, and emergency maintenance works programs. For this reason, the rate of the irrigation service fee should never be determined on a "what the farmers and water users can afford" basis. Instead, that rate should be based on "what the farmers and water users must realistically pay."

Guidebook 3 makes a detailed presentation on how the irrigation service fee should be calculated. It evaluates the current MAWR method for calculating it, recommends amendments to this method, and emphasizes the need to make the calculation and application of the irrigation service fee as simple and straightforward as possible.

Cost Components of the Irrigation Service Fee. A WUA should levy only a single irrigation service fee to make collection easier. When it is computed, however, its various cost components should be disaggregated as follows:

- Administration, salaries, vehicle operation, and routine maintenance costs: These are nonvariable costs that should be budgeted annually, regardless of whether irrigation is delivered or not. All WUA members are required to pay these costs.
- Periodic maintenance, emergency maintenance, machinery and equipment repairs and maintenance: These costs are incurred by the WUA when water users request irrigation to be delivered on a seasonal basis based on their cropping plan. These particular water users should shoulder these costs.

III. MAINTENANCE PROCEDURES

A. Overview

1. Principal Objective

The principal objective of the WUA's maintenance function is to ensure that the irrigation and drainage system operates as designed, both now and in the future, so that optimal water distribution is achieved at all times and in a fair and equitable manner. The WUA should have a planned program of works that keeps or returns the irrigation and drainage infrastructure to its "as-built" condition or as near to it as possible. It should inspect the infrastructure regularly and implement a systematic maintenance work program. This is to prevent the deterioration of canals, flumes, drains, structures, inspection and access roads, and ancillary facilities such as offices, housing, vehicles, and other equipment.

Table 5 shows the wide range of a WUA's typical infrastructure maintenance activities.

2. The Consequences of Poor Maintenance

Regular and planned maintenance is the most visible activity of the WUA. It ensures the long-term sustainability of the irrigation and drainage infrastructure. When it is not done properly, problems can arise that can hinder the delivery of the WUA's services to the water users.

Some of the most common consequences of poor maintenance are as follows:

- Mechanical failure and inoperability of gates and valves;
- Leakage from canals or flumes;
- Silting up of canals and flumes;
- Deterioration of flumes and concrete joints;
- Erosion and silting up of field ditches;
- Washouts and bogging of roads that make access to parts of the system difficult; and
- Silting up of collector drains as well as blockages and failure of closed-pipe drains.

Once a malfunction or defect is discovered in the system, repairs should be carried out as soon as possible. This prevents small problems from developing into big problems and reduces the overall cost of maintenance.

When maintenance is not performed properly, the following consequences usually arise:

- Delivery of water becomes problematic and this makes WUA members unwilling to pay the irrigation service fee and other WUA fees.
- The irrigation and drainage system deteriorates at an accelerated pace, requiring major investments that the WUA is unprepared to make. The financial burden of so many repair expenses cropping up simultaneously can sometimes become so heavy that the WUA collapses altogether.
- A very badly maintained irrigation and drainage system may become inoperable. It may need major rehabilitation work that will be possible only with significant government or donor assistance. In the meantime, farm incomes typically decline and poverty becomes widespread in the area served by the WUA.

Table 5. Typical Maintenance Activities for WUA Infrastructure

Canal Structure	Item	Typical Routine Maintenance Items	Typical Periodic Maintenance Items
Secondary Canals and Structures	Secondary Canals	Clearing out weeds and vegetation Minor repairs to canal lining Minor repairs to concrete Dewatering at end of season	Clear out silt Resection canal Repair lining joints Repair broken concrete
	Staff Gauges Measuring Structures	Clearing away trash Painting of metalwork Cleaning staff gauges Minor repairs	Replace staff gauge Repair damaged parts Replace whole structure
	Secondary Head Regulator	Clearing away of trash Greasing of gates Painting of metalwork - gates Minor repairs to gates Minor repairs to concrete	Replace gate Do major repairs to concrete/ structure
	Other Structures	Clearing away of trash Removing silt Painting metalwork - gates Minor repairs to concrete Pumping out water at end of season	Do major repairs to concrete/structure
Tertiary Canals and Structures	Canals	Clear out weeds and vegetation Minor repairs to lining Minor repairs to concrete Dewatering at end of season	Clear out silt Resection canal Repair lining joints Repair broken concrete
	Flumes (if appropriate)	Minor repairs to joints Minor repairs to concrete Draining water away from pedestals Removing vegetation from along flume line Dewatering at end of season	Clear out silt Replace leaking joints Realign sunken sections Repair broken concrete Spray flumes to reduce moss or algae growth
	Staff Gauges Measuring Structures	Clearing away of trash Painting of metalwork Cleaning of staff gauges Minor repairs	Replace staff gauge Repair damaged parts Replace whole structure
	Tertiary Head Regulators and Farm Canal Inlets (quaternary unit)	Clearing away of trash Greasing of gates Minor repairs to gates Minor repairs to concrete	Replace gate Do major repairs to concrete/structure
	Other Structures	Clearing away of trash Greasing of gates Minor repairs to gates Minor repairs to concrete	Replace gate Do major repairs to concrete/structure
Onfarm Canals and field ditches (ariqlar)	Canals & Ditches	Clearing of weeds De-silting	Re-section channel
Roads	Road surfacing	Filling of holes in road surface	Re-grade to remove depressions and corrugations Fill up holes with good fill material Repair tarmac
	Structures	Repairing of cracks in concrete Clearing of blockages from culverts	Do major repairs to damaged structures
Vertical Drainage Wells (if appropriate)	Motors	Painting	Do periodic overhaul
	Pumps	Painting	Do periodic overhaul
	Pipework	Painting Repair of minor leaks	Repair leaking joints
	Electrical equipment	Minor repairs, adjustments	Do periodic overhaul Replace broken equipment
	Well	Minor repairs to concrete	Clear and cleanout the well
Drainage System	Collector Drains	Clearing out of weeds Minor repairs to banks, drain inlets from field collectors or drains, concrete lining	Clear out silt Repair damaged lining and drain inlets and do major repair to banks and eroded sections
	Closed Drains	Repairing outlets to collectors	Flush and clean the system on a programmed basis – no longer than every 2 years
	Structures	Minor repairs	Do major repairs to damaged structures

Many WUAs in Uzbekistan wrongly consider the delivery of water as their only objective, so they pay very little attention to maintaining the irrigation and drainage system. It is extremely difficult for a WUA to become sustainable with this kind of thinking. On the contrary, the WUA Management Team, particularly the WUA manager and the O&M engineers, should all fully understand the need to give high priority to the maintenance of the system. They should give special emphasis to the continuing and periodic checking of the system, the identification and reporting of its defects and deficiencies, the planning and budgeting of the needed repair and maintenance works, and the actual implementation of these works. Regular and planned maintenance is the secret to the long-term sustainability of the irrigation and drainage system's infrastructure, and is the most visible and important activity of the WUA.

3. Routine Maintenance

Routine maintenance covers small-scale repair and restoration works that need to be done continuously throughout the year, whether on a daily, weekly, fortnightly, and monthly basis. To be successfully implemented, routine maintenance has to be properly calendared and performed consistently using standard forms, methods, and procedures. The O&M engineer is responsible for planning, implementing, and overseeing the WUA's routine maintenance activities.

Some typical routine maintenance activities are as follows:

- For irrigation and drainage infrastructure: greasing of valves, painting of metalwork; de-silting of field ditches (*ariq*) and repair of ditch banks; cleaning of drains; repair of access roads and minor earthworks; de-silting of flumes and small irrigation canals, gated turnout structures, flume measuring structures, and hydro-post locations; and grass cutting and vegetation removal; and
- For vehicles and O&M machinery and equipment: servicing, cleaning, and replacement of worn parts.

Supervision of routine maintenance activities is done either by the WUA construction supervisor, if the WUA has appointed one, or by the O&M technicians or in coordination with them. Scheduled tasks are undertaken directly by the gate operators, work gangs and maintenance teams, and laborers. Infield works are undertaken by the WUA members themselves.

4. Periodic Maintenance

Periodic maintenance consists of repairs that are too large to be undertaken at any one time during the seasonal delivery of water. For this reason, these repairs must be planned for those times when the irrigation system is shut down. Some of the maintenance tasks should be done yearly as part of good O&M management procedure. Others can be conducted semiannually depending on cropping patterns and crop-irrigation requirements.

Typical Maintenance Tasks. The typical periodic maintenance tasks are as follows:

- Overhauling of machinery and equipment;
- Repair, cleaning, and de-silting of medium and large irrigation canals;
- Programmed replacement and insertion of old and worn-out joint seals or sealants of concrete canals and flumes;
- Programmed replacement of gates and valves, including their seals or slides;
- Programmed reforming of quaternary canals, onfarm canals, and infield ditch profiles (to be done by WUA members under the supervision of the O&M technicians);

- Cleaning and de-silting of sedimentation ponds, large turnout structures, and measuring structures; and
- Repair, cleaning, and de-silting of open collector drains and closed-pipe drain systems that cannot be done during the irrigation season.

De-silting of Collector Drains. In a good and well-managed periodic maintenance plan, the de-silting of large collector drains and the flushing of the closed piped drains are carried out as a year-round activity. The cleaning of large collectors generally requires large equipment. However, such collectors usually have access roads that allow the use of machinery without impeding or interfering with the seasonal irrigation or farming activities. The cleaning work can therefore be planned as a year-round maintenance activity.

Flushing of Closed-Pipe Drains. The flushing of closed-pipe drain systems, which involves the cleaning of inspection pits, can also be planned as a year-round maintenance activity. Although drain-flushing machines cannot work on a field planted to crops, they can do so on fallow fields or on fields right after the crop is harvested. Drain-flushing can therefore be programmed for the period immediately after the May-July harvests of wheat and cereals. If farmers can advise the WUA about their cropping plans and indicate which parts of their land will lie fallow, closed drain pipe flushing can also be undertaken even during the irrigation season itself.

A WUA has to prioritize much of its major periodic or highly specialized maintenance requirements. They will generally be undertaken by tender or contract. Among such requirements are the repair and overhaul of irrigation and O&M machinery and equipment as well as large-scale irrigation and drainage civil works.

5. Emergency Maintenance

Emergency maintenance consists of the urgent or temporary repairs that must be done to restore water delivery after a sudden failure of the system, such as a structure washout, an earth canal breakout, or a flume collapse. Such emergency situations require the WUA's immediate action so as to minimize the inconvenience to the farmers and avoid damaging their crops. The WUA should have a well-planned emergency response system for such situations and should provide funds for it in its annual budget.

B. Forms and Documentation for Maintenance Work

The planning and execution of all WUA maintenance work need to be properly documented. The typical maintenance record forms used by WUAs for this purpose are as follows:

Maintenance Identification Form: This is part of the field book used by the O&M technician.

Maintenance Register: This is used for recording and prioritizing all periodical and emergency maintenance work required as identified during field inspections.

Maintenance Implementation Report: This documents completed periodical and emergency maintenance work.

Maintenance Materials and Tools Form: This is used for ordering maintenance materials and spare parts.

Appendix 4 shows some samples of these maintenance record forms.

References for Maintenance Planning. A WUA has to have on hand the following major references for its maintenance planning and execution:

> **Annual Maintenance Plan:** This shows the cost estimates for all of the WUA's planned periodical maintenance work as well as emergency maintenance work for the particular budget year. The estimates often form part of the WUA's Annual Operations Plan.
>
> **Handbook of Maintenance Procedures:** This lists the WUA's routine maintenance activities such as greasing, painting, grass cutting, tree/brush cutting, and trash cleaning. The list forms part of the WUA's O&M manual.
>
> **Machinery and Equipment Maintenance and Servicing Manuals:** These are for the particular use of the WUA's service foreman, mechanics, and electricians. A copy of each of them has to be made available at the WUA's machinery workshop. The originals should be on file in the WUA manager's office).
>
> **Standard contracts with contractors** (if needed).

C. Maintenance Inspections and Annual Maintenance Plan

There are three levels of maintenance inspections provided for in the WUA's Annual Maintenance Plan: regular maintenance inspections, monthly maintenance inspections, and annual maintenance inspections.

Step 1: Regular Maintenance Inspections

The WUA's O&M technicians and gate operators are responsible for conducting regular maintenance inspections of the physical condition of the WUA's irrigation and drainage infrastructure. They should do this in the course of their daily supervisory and liaison tasks for the WUA's irrigation delivery as well as during their meetings with farmers. In the course of their daily activities, the WUA's construction supervisor and the service foreman (for O&M machinery and equipment) should likewise regularly take note of the maintenance needs in their respective areas of responsibility. They should report these needs to the O&M technicians.

Any repairs that are needed should be recorded in their field notebooks. Repair information from the daily inspections should be entered into a Maintenance Register. This register is divided into sections for each O&M area, namely the irrigation network section, the drainage network section (open collectors, closed pipes and structures), and access roads section. These sections are in turn divided into subsections, one for each distribution canal or flume and drain.

The O&M engineer has to establish priorities for each item entered in the Maintenance Register. These priorities should be decided after he or she has studied the register and has conducted monthly site visits of the system and of the reported locations that require maintenance work. The O&M engineer then classifies the repair either as (1) a routine task, which should then be fitted into the maintenance plan as time or labor availability permits; or as (2) a periodic task, which can be deferred until the next yearly system shutdown is undertaken. In the case of emergency repairs, the O&M engineer should attend to the tasks at once or assign them for immediate execution.

The O&M technician is responsible for entering repair data into the Maintenance Register and for reporting his or her daily findings to the O&M engineer. The O&M engineer, in turn, is responsible for regularly checking the Maintenance Register and for establishing the WUA's maintenance priorities.

Step 2: Monthly Maintenance Inspections
The O&M engineer has to conduct monthly maintenance inspections based on the Maintenance Register and has to summarize his or her findings in a Monthly Inspection Report Form. He or she then updates the Maintenance Register and establishes priorities for the required maintenance.

Step 3: Annual Maintenance Inspections
At the end of each irrigation season, the O&M engineer along with the WUA manager should conduct a formal field inspection to verify all data that have been recorded in the Maintenance Register Form and the Monthly Inspection Form. Based on this annual inspection, the O&M Engineer has to reassess his or her maintenance priorities and make the necessary adjustments. The confirmed Maintenance Register entries are then used as the basis for planning and executing the WUA's annual periodic maintenance activities.

Step 4: Requirements for Periodic Maintenance (Topographic Survey and Design)
To determine the volume of maintenance work to be done and arrive at accurate cost estimates for the work, it may be necessary to conduct field topographic surveys and to prepare a formal design for the proposed works. The O&M engineer is responsible for the planning of these preparatory tasks.

Step 5: Prioritization of Periodic Maintenance
Based on the volume and cost estimates for each required periodic maintenance task, the O&M engineer has to again reassess the maintenance priorities and decide on how best to implement each of the required periodic maintenance work. Table 6 shows a generalized list of the WUA's maintenance priorities.

Step 6: Preparation of the Annual Maintenance Plan
The O&M engineer uses the outcomes of Steps 1–5 above as the primary basis for the WUA's Annual Maintenance Plan. The accuracy and reliability of this plan is therefore dependent on how well the Maintenance Register had been updated and on the thoroughness of the monthly and annual maintenance inspections.

To keep the cost of maintenance at reasonable levels as well as within budget limits, it may become necessary to defer less important works to the following year based on the priorities established by the WUA. The best approach, however, is to focus on preventive maintenance as well as make a prudent allowance in each year's budget for emergency maintenance works.

D. Implementation of Routine Maintenance

Generally, routine maintenance is implemented on a daily basis directly by the WUA maintenance team (work group and laborers) under the supervision of the O&M technician. On-site locality supervision, on the other hand, is handled by the WUA's service foreman. The O&M engineer is responsible for their overall direction.

The WUA members themselves will carry out the routine and periodic maintenance activities at the quaternary unit (farm/field) level, which includes the quaternary canal, onfarm canal, infield ditches (*uq ariqs*), and furrows. Also, when requested, WUA members are expected to assist in the scheme management at the main system level. This service is considered as in-kind labor and is credited by the WUA as payment for the members' irrigation service fee.

Table 6. Maintenance Priorities for Irrigation and Drainage Infrastructure

Priority	Structure	Comments and Consequences
1	Head Regulator or Pump Station (if appropriate)	Difficulties with the operation of the head regulator from the Main Canal could have serious consequences for the operation of the canals managed by the WUA, such as an oversupply or shortage of water, wastage, waterlogged soils, overtopping, and a decrease in crop yield. Failure of any of the pumps or valves could have serious consequences for the operation of the canals managed by the WUA and for crop yields.
2	Tertiary Regulator Structures	Difficulties with operation of the regulator structures would result in poor distribution of water between canals, inequitable distribution to the tertiary units, and farmer dissatisfaction.
3	Secondary Canals	Excessive leakage from the canals would reduce the amount of water available to the farmers, leading to reductions in crop yields. The cost of water would also become higher. Weeds or silt in the canals would result in difficulties in distributing water.
4	Tertiary Canals	Excessive leakage from the canals (or flumes) would cause not only a reduction in water available to the farmers and higher water cost, but could also result in a high water table in adjacent fields. Weeds or silt in the canals (or flumes) would result in difficulties in distributing water.
5	Quaternary Regulator Structures Farm/field Canal Inlets	Difficulties with the operation of these structures could result in farmers locally experiencing water shortages.
6	Onfarm Canals and Field Ditches	Poor bank structure, compaction, weeds or silt in the farm canals would result in difficulties of distributing water at the farmer level. Leakage would result in shortages, flooding, loss of land, and reduced crop yield
7	Measuring Structures, Staff Gauges, etc.	Measuring structures and staff gauges in poor condition would result in difficulties in distributing water equitably among farmers and in measuring water for fee collection.
8	Drainage System (Collectors and Closed Systems)	Silting up of the drain system could in the long-term result in a rise in groundwater levels and increases in salinity, leading to reduced crop yields.
9	Vertical Drainage Wells (if appropriate)	Poor operation of wells could result in a high water table, resulting in reduced crop yields, increases in soil salinity, longer cultivation time, delays in planting, and adverse consequences on the drainage system

The WUA's routine maintenance tasks are yearly and seasonal O&M requirements that need to be done no matter what the circumstances are. To ensure that they are not overlooked, however, they have to be planned in the manner described below:

Step 1: Instructions to the WUA Staff and WUA Maintenance Team
The O&M engineer discusses and agrees with the O&M technician and the WUA service foreman on a list of maintenance requirements and tasks that need to be undertaken. The O&M technician and the service foreman, in turn, give instructions to the WUA maintenance team on what should be done on a day-to-day basis.

Step 2: Supervision by the O&M Technician and Service Foreman
In the course of their regular fieldwork, the O&M technician and the WUA service foreman ensure that routine maintenance tasks are carried out properly.

Step 3: Arranging Supply of Consumable Materials
Prior to the irrigation season, the O&M engineer has to make the necessary requisitions for supplies in coordination with the WUA service foreman. These supplies will include such consumables as grease, oil, fuel, sand, gravel, cement, tool replacement, spades, shovels, and grass cutters. All of these consumables should be listed in the Usage of Maintenance Materials and Tools Form. This form has to be approved by the WUA manager and forwarded to the WUA accountant, who will then make the necessary purchase orders.

Step 4: Arranging Supplementary Labor and Material Purchases
The O&M engineer, in coordination with the O&M technician, determines and makes cost estimates of additional labor and other resources (machinery, equipment, tools, and other

consumables) that may be needed to complete routine maintenance work. They should get the WUA manager's approval for those cost estimates, and ensure that the necessary hiring or purchases are made on time.

E. Implementation of Periodic Maintenance

Programming Periodic Maintenance. Periodic maintenance repairs are programmed well in advance. In general, the program of works has to be previously agreed upon between the WUA Management Team, the WUA Council, and the General Assembly or Representative Assembly. In the case of simple periodic maintenance works, however, the WUA maintenance team is in a better position to plan, organize, and execute them. This applies to the de-silting of canals and drains, road repairs, and minor repairs to gates, canals, and other basic structures. In some cases, the WUA maintenance team may need to hire additional laborers on a temporary basis to undertake these simple periodic maintenance works.

Implementing Periodic Maintenance Works. The planning and implementation of periodic maintenance works are the responsibility of the O&M engineer together with the O&M technicians. The O&M technicians and gate operators, for their part, are expected to identify other periodic maintenance requirements of the system in the course of their regular maintenance inspections and surveys. Whenever such a requirement is identified, they should be recorded in the Maintenance Register and reported to the O&M engineer. Whenever necessary, the O&M engineer will arrange for an investigation, a survey, and a maintenance design and cost estimate. Arrangements for implementing the maintenance work are then entered in the Periodic Maintenance Plan. The actual execution of the maintenance work may be done by the WUA maintenance team itself or by tender to outside contractors.

Components of Periodic Maintenance. Major periodic maintenance has two components, namely (1) major civil works (repair and replacement) on the irrigation and drainage infrastructure, and (2) major overhaul and repairs of O&M machinery and equipment. In general, most of a WUA's major periodic maintenance works are undertaken by outside contractors. However, if a WUA has enough mechanics and electricians as well as a competent service foreman in its employ, it could very well carry out by itself the major overhaul and repair of O&M machinery and equipment.

For very large-scale structural repairs and maintenance, a WUA needs to contract the work by tender. This applies to such major civil works as the cleaning and re-shaping of open-collector drains, major repairs to or replacement of canal banks and structures, and the flushing of closed-piped drains. The WUA has to strictly follow the standard procedures for contracting work by tender to ensure transparency and control over the transaction.

Step 1: Preparation of Bidding Documents and a Standard Contract
The WUA manager and the O&M engineer are responsible for preparing the bidding documents for the tendering of contracts for both periodic maintenance works and emergency maintenance works.

The standard contract package for such tenders typically provides for the following conditions:

- The quality control and performance testing criteria;
- A guarantee period of one year;
- A two-step certification process (one at the date of completion of construction work, and the other 1 year after the date of completion of construction work);

- A penalty for delayed completion at the rate of 0.005% of the contract price per day exceeding the agreed date of completion; and
- Clauses for the settlement of disputes.

The bidding documents should contain conditions of the contract and the specifications as well as the bill of quantities, drawings, and list of works. Additionally, standard tender procedures should be developed for the submission and evaluation of bids. A copy of these procedures should be given to the bidders.

One procedural requirement for the tendering process is that invitations to bid and the bidding documents be sent only to those contractors who have prequalified through a standard selection process.

Step 2: Prequalification of Contractors
The prequalification or preselection of contractors can greatly help a WUA choose the best possible contractor for a particular maintenance work. It will enable the WUA to choose the lowest bid from a number of contractors who have satisfied the following selection criteria: (1) years of experience, (2) reputation for quality work, (3) financial stability, and (4) access to machinery. It can also help speed up the WUA's decision-making process.

The major preselection criteria for contractors are as follows:

- Previous work experience of the contractor as shown by work certificates;
- The number of the contractor's personnel and equipment;
- The location of the contractor, particularly of its workshop, machinery, and personnel; and
- The financial condition and tax situation of the contractor.

A WUA's list of preselected contractors should be kept up-to-date by having it revised annually and by admitting new contractors. There should be at least 5–10 contractors in this list. Formal invitations to bid should be sent to all listed contractors who wish to bid for the contract. Ideally, the number of contractors submitting bids should be between four and six.

Step 3: Awarding of Contract
Prequalified or preselected contractors will be invited to bid for particular maintenance works or projects. The WUA will evaluate their respective bids, choose the winning bid, and award the contract to the winning bidder.

The contract is awarded according to the rules specified in the bidding or tender documents. After the validity of the bids is verified, the lowest compliant bid is normally accepted for the following reasons:

- **Transparency:** The lowest bid is the simplest criterion for evaluating bids. There is no need for discussions because it is clear to everyone why the contract is being awarded to the contractor who made that bid;
- **Minimizing of risk:** The prequalification process for contractors greatly minimizes the possibility of getting unrealistically low bids and the low-quality work that might result from them; and
- **Cost-efficiency:** WUA members have the right to a cost-efficient use of their money.

Step 4: Supervision of the Contract Works
If the WUA has a full-time construction supervisor in its employ, then the responsibility for the day-to-day supervision of civil works contracts will be his. On the other hand, if the contract is for the overhaul and repair of O&M machinery and equipment, then the WUA's service foreman will be given the responsibility for supervising it.

For the civil works component of a contract, the O&M engineer may appoint a site/field supervisor to provide on-site supervision and direction. The need for this appointment will depend on (1) the volume of works to be undertaken within the WUA's boundaries, and (2) the scope of works to be undertaken at each site. The site supervisor will be directly reporting to the WUA's construction supervisor.

If the WUA has no full-time construction supervisor, the O&M engineer has to appoint one of the O&M technicians to oversee the implementation of civil works contracts. In any case, the O&M engineer should inspect all major works frequently.

Step 5: Performance Testing, Quality Control, and Certification
Upon completion of the construction of the tendered works and at the request of the contractor, the WUA's O&M engineer undertakes a performance test of the completed work. If the completed work meets the required performance standards, the O&M engineer should give the contractor a certificate of completion. The certificate should be dated on the same date that the construction was completed.

A WUA must ensure that the contractor abides by (1) the quality control clauses of the contract, (2) the penalty clauses for construction delays, (3) the guarantee periods with their corresponding warranties, and (4) the final certification requirement at the end of the warranty period.

F. Implementation of Emergency Maintenance

By definition, emergency works are unforeseen, so the scope of the works that will be required can vary widely. For this reason, a flexible approach to accomplishing the needed repairs has to be pursued. The WUA's overriding concern in such situations is to maintain water deliveries or to restore water deliveries as soon as possible. This minimizes their adverse effects on the agricultural output in the WUA's service area.

Step 1: Identification of Emergency Works
The O&M technician, the gate operators, and the service foreman are responsible for immediately reporting the need for emergency works to the WUA's O&M engineer.

Step 2: Implementation of Emergency Works
A WUA needs to develop a well-planned routine emergency response system that can be implemented quickly and efficiently. Such a system also ensures the quick sourcing of equipment, materials, and labor needed to deal with emergencies.

The emergency response process should be as follows:

- Wherever possible, emergency or temporary repairs should be immediately started by the WUA staff, using whatever resources are already available and with the help of the WUA members in the affected area.
- Basic emergency equipment and materials should always be on hand at the WUA's scheme office, and they should be replaced or replenished immediately after use.

- When technically extensive or complex works are needed to effect permanent repairs, every effort should be exerted to implement temporary repairs for the short term. The repairs should use emergency contract resources or WUA members, who should be paid for performing such emergency services. The remaining works should then be given high priority in the annual maintenance plan for the following year.
- In the case of emergency machinery and equipment breakdowns that require urgent repairs, it would be desirable to have the works contracted out. The contract preferably should be given to the same machinery or equipment organization that the WUA had already contracted for its annual machinery overhaul and repair works.
- In the case of emergency maintenance for large civil works that cannot be handled by the WUA’s routine emergency response system, the WUA should immediately negotiate an emergency maintenance contract with a particular contractor. This will avoid unnecessary delays and inconvenience to water users and farmers. It will also ensure that the WUA is not forced to pay excessively in procuring equipment, contractors, and labor to undertake the emergency works.

In contracts for emergency work, the WUA should negotiate typical unit prices with the contractor. The latter should be obligated to begin the work without delay.

IV. OPERATION PROCEDURES

A. Overview

The principal objective of operating an irrigation system is that all water users, regardless of their location in an irrigation system, should receive a fair and equitable water allocation according to a water distribution plan that takes seasonal and supply variations into consideration. Operating the irrigation and drainage system based on a well-conceived Annual Operation Plan (or Water Use Plan) will enable a WUA to achieve this objective and contribute to its long-term sustainability. In contrast, poor operation of a WUA's irrigation and drainage system results in illegal consumption of water, inequitable distribution, waterlogging, excessive water use, incorrectly timed deliveries, increased water losses, and reduced water use efficiencies.

B. Responsibilities for Operations

The operations of a WUA cannot be effectively implemented without clearly assigned roles and responsibilities to those concerned. It is therefore very important that these roles and responsibilities are properly identified, understood, and performed:

1. The WUA, based on its charter and contracts with water users, is responsible for operating the secondary canals in its service area, the offtake gates that deliver water down to the tertiary canals, the tertiary canals themselves, and the quaternary offtake gates that deliver water to the farmer-constructed quaternary canals and field ditches.
2. The water users in the WUA's service area are responsible for operating the quaternary canals and any offtake structures constructed by the water users for delivering water to the field ditches.
3. The Irrigation System Administration, based on its water delivery agreements with the WUA, is responsible for operating the primary canals and the offtake structures or regulatory gates to the secondary canals.
4. The rayon MAWR department is responsible for establishing water withdrawal limits for the various irrigation system administrations in the locality.

These roles and responsibilities are presented in Figure 2.

C. Annual and Daily Planning

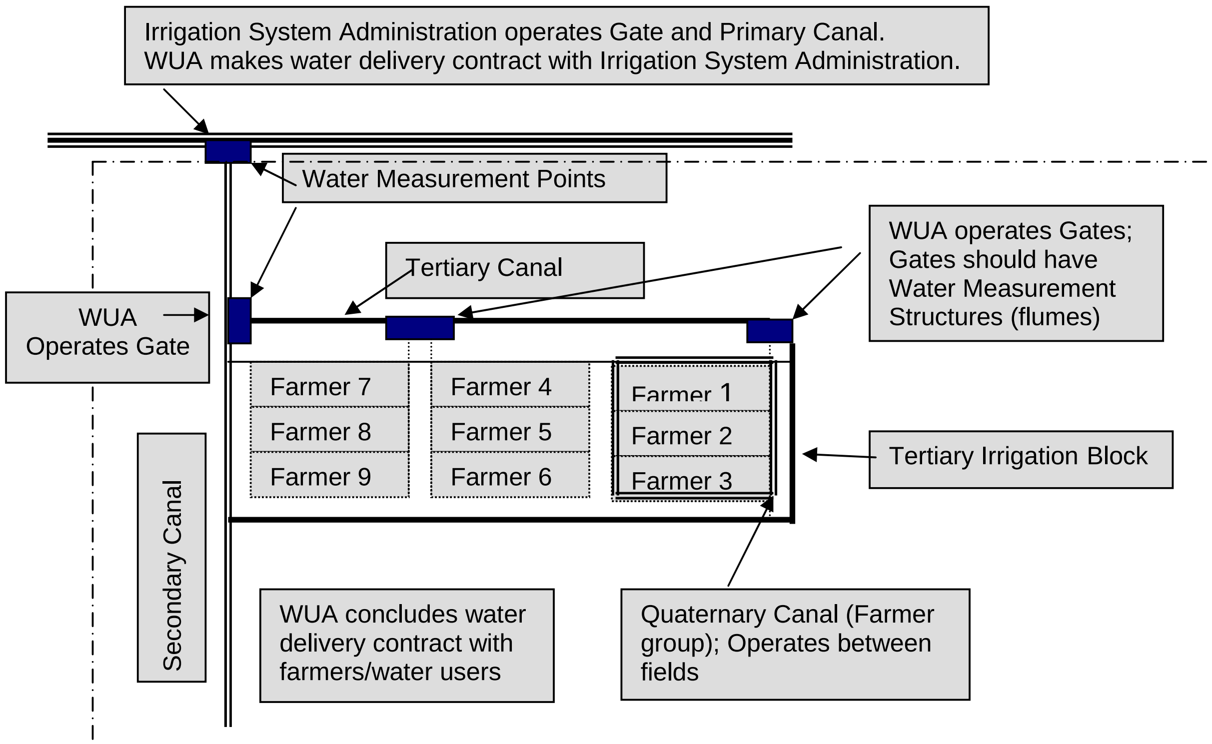
There are two types of irrigation operation planning, both of which are important to efficient O&M. They are as follows:

Annual (seasonal) planning: This is the planning of the annual water requirement based on the annual cropping plan submitted by the farmers before the beginning of the vegetative season (April); and

Day-to-day planning: This is the planning of the water needs of farmers on a 2-day, as-needed basis.

In day-to-day planning, the O&M technician or technicians meet with the farmers (or their irrigation representatives) in their respective areas of responsibility, which typically cover one or more tertiary units. The farmer's irrigation requirements are established during such meetings. The O&M technicians then calculate the total irrigation water requirement per quaternary unit and tertiary unit. For the day-to-day water allocations, the O&M technicians prepare either a 2-day or 3-day operations plan, after which they meet with the O&M

Figure 2. Roles and Responsibilities in Operations



engineer, who checks and approves the plan. The O&M engineer or O&M technician, or both, then gives specific instructions to the WUA's gate operator on the discharge to be provided at the quaternary unit and tertiary unit outlets.

The O&M technicians are responsible for controlling the release of irrigation water at the outlets. The WUA's gate operator or operators do the actual releases at the head of and along the tertiary distribution canals. At the field level, the individual farmers or their representatives are responsible for the actual distribution of the water to the farms or fields.

Daily planning gives an allowance for small variations from standards and norms, particularly for those instances when farmers make sudden changes in their demand for irrigation water.

D. Creation and Execution of the Annual Operations Plan

A WUA undertakes its annual irrigation operation planning between December and March. It should be noted here that in Uzbekistan, the local equivalent of an Annual Operations Plan is the Water Use Plan, the *suvdan foydalanish rejasi* or *plan vodopol'zovaniia*.

The following are the steps to be taken in creating an Annual Operations Plan for a WUA:

Step 1: Farmers submit their proposed annual cropping plans no later than 31 January, using the Annual Cropping Plan Form shown in Appendix 5.1. These plans indicate (1) the crops to be planted, (2) the number of hectares per crop, (3) the starting or planting dates of the various crops, and (4) the amount of water required, particularly the "wetting-up" requirements for cotton.

Based on this information from each farmer, the O&M technician prepares the cropping schedules for the quaternary and tertiary blocks as well as the cropping plan. A cropping plan is needed for (1) the preparation of the Annual Operations Plan, (2) the preparation of the standard contract between the Irrigation System Administration and the WUA, (3) the initial estimates for the season's water charges for the whole WUA command area and for the individual farmer, and (4) the preparation of the WUA's water budgeting system.

Step 2: The O&M engineer calculates the water required for each crop and for each irrigation as the basis for determining the irrigation requirement of each quaternary unit,[3] of each tertiary unit,[4] of each secondary canal, and of the WUA's entire service area. The leaching requirements, conveyance efficiency, and the needs of nonagricultural water users are taken into account in these calculations.

To ensure the accuracy of these calculations, the WUA should obtain from the Irrigation System Administration an updated set of hydro-modules, or the monthly water delivery norms for specific agricultural crops. These hydro-modules are updated every 4–5 years.

Once or twice a year, the O&M engineer and the Irrigation System Administration should undertake balance metering to determine the irrigation conveyance efficiency of the canals within the WUA's service area.

Step 3: The O&M engineer compares the calculated irrigation requirements with the allowable limit for extracting water from the water source. If the calculated volume exceeds the limit, the WUA Council will review and revise the proposed cropping plan. This is to ensure that the seasonal and annual irrigation water requirements are within the expected water availabilities.

In turn, the Irrigation System Administration of the MAWR is informed about the volume of water and the water availability for the current year. From the known water delivery limits, it can determine the allowable extraction limit, which will then constitute the bulk water supply to the WUA.

Step 4: The O&M engineer finalizes the Annual Operation Plans. To be shown in this plan are (1) the aggregate areas of the various crops to be grown; (2) the irrigation period; (3) the irrigation requirements per farmer, per quaternary unit, and per tertiary unit for each irrigation period or schedule (10-day cycle); and (4) the total irrigation requirement for the WUA command area per irrigation period, per season (vegetative and nonvegetative) and annually. A sample of the Annual Operation Plan Form is shown in Appendix 5.2.

In Uzbekistan, the Annual Operations Plan should have two subplans: one for the vegetative season from April to October, and another for the nonvegetative season from November to March (this is the season for winter wheat and for the leaching of soil salts, which are estimated at 3,000m^3/hectare). The operations plan for the nonvegetative period should take the following into account: (1) the requirements of the leaching process, (2) the disruption of water supply to the farms that it will cause, and (3) the possible delays that might be encountered in the WUA's periodic maintenance works program.

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[3] A quaternary unit is the area serviced by the earth farm canals and field ditches constructed by farmers from the offtake gate on the tertiary canal (between 4 and 6 offtakes per 1kilometer (km), approximately).

[4] A tertiary unit is the area serviced by each tertiary canal from an offtake gate on the secondary canal, with a tertiary offtake being located every 1.25 km, approximately, along the secondary canal.

Considering the above factors, the WUA has to decide on the following:

In determining the rate of the irrigation service fee that will be levied on all water users, should it include the costs of O&M disruption during the nonvegetative season?

When the government eventually begins to collect charges for its bulk water supply to WUAs, should the WUA include the costs of the leaching operations in computing the rate of the irrigation service fee?

Step 5: Each farmer signs a contract with the WUA for water delivery for the total volume of water needed (or for the volume that can be made available).

Step 6: The WUA signs a water delivery contract with the Irrigation System Administration for the total volume of water that the WUA needs (or for the volume that can be made available).

Step 7: Each farmer submits a request for water to the WUA's O&M technician as needed. Appendix 5.3 provides a sample form for requesting water supply.

Step 8: The O&M technician verifies if the farmer has not exceeded his allowance, then works out the daily discharges for a 2-day operation plan (starting the day following the requests). The verification is done for all quaternary units and tertiary units. Appendix 5.5 shows a sample form for measuring the daily water discharge.

Step 9: The O&M engineer checks and confirms the daily discharges and the 2-day operation plan that were calculated by the O&M technician.

Step 10: The O&M technician instructs the WUA gate operator on how much discharge is to be provided at the quaternary or farmgated outlet, and gives a list of the farmers who will receive water.

Step 11: The WUA gate operator, under the supervision of the O&M technician, controls the gates according to the 2-day daily discharge plan provided by the O&M technician. Ideally, a request should be given within 2 days after it is made.

Step 12: The WUA gate operator measures the water discharge, farmers or water users sign for the receipt of the volume of water; and a copy of the receipt is forwarded to the WUA accountant. Appendix 5.6 shows a sample receipt for water supplied.

Step 13: The water users or their representatives (per quaternary unit) distribute the water to the farms or fields through their respective earth canals. No farmer should be allowed to take water without authorization.

E. Calculating a Water Use Plan

Several methods can be used for formulating a Water Use Plan for the distribution of irrigation water. Each differs significantly in approach and complexity, but this guidebook recommends a relatively simple methodology for WUAs.

1. Hydro-Module Zoning

To develop an effective water use plan for irrigation purposes, a WUA has to undertake hydro-module zoning of the irrigated lands in its service area. This means grouping irrigated

Table 7. Recommended Hydro-Module Region Scales

HYDRO-MODULE REGION NO.	SOIL CHARACTERISTICS
Automorphic soil types (SSW 3m and higher)	
1	Low strong (0.2–0.5 m) loamy and clayey on sandy-shingle sediment and strong sandy
2	Middle strong (0.5–1.0 m) middle and hardly loamy and clayey on sandy-shingle sediment and strong clayey-sandy and slight loamy
3	Strong (1m and above) middle and hardly loamy and clayey
Transition soil types (SSW 2–3 m)	
4	Sandy and clayey-sandy, as well as slightly and middle loamy and clayey
5	Slightly and middle loamy, uniform and hardly loamy, falling down
6	Hardly loamy and clayey, uniform and different on mechanical composition, with layer
Hydromorphic soil types (SSW 1–2 m)	
7	Sandy and clayey-sandy and slightly and middle loamy and clayey
8	Slightly and middle loamy, uniform and hardly loamy, falling down
9	Hardly loamy and clayey, uniform and different on mechanical composition, with layer

lands according to hydro-module regions having similar natural conditions that determine crop irrigation regimes. In this manner, the water supply capability of canals can be accurately calculated as a basis for the WUA's Water Use Plan and Annual Operations Plan.

Taxonomic Modules. Four taxonomic modules are classified in hydro-module zoning, as follows:

- **Soil-climatic region:** The part of a region with common geomorphological, climatic, hydrogeological, soil, and plant factors.
- **Soil-climatic zone:** The part of a soil-climatic region with common meteorological factors and a similar soil base.
- **Soil-meliorative region:** The part of the soil-climatic zone with similar hydrogeologo-meliorative factors and a close genetic relationship in soil base processes.
- **Hydro-module region:** The part of the soil-meliorative region characterized by similar soil power indicators, mechanical factors, creation of ground in aeration layer, air-water capabilities, and subsoil waters, all of which determine the irrigation volume and regime for agricultural crops.

Differentiation of soil-climatic region is determined by complex natural factors that affect the value of crop evapotranspiration. The basic method employed in Uzbekistan, introduced by Mr. S.N. Rizhkov in 1948, is the identification of water balance deficit evaporation minus precipitation during the vegetation period for cotton.

Table 7 presents recommended scales for hydro-module regions.

Need to Regularly Update Hydro-Modules. Hydro-modules should be regularly reassessed, updated, and recalculated by WUAs in cooperation with the appropriate government agencies. This is particularly needed for systems whose hydraulic parameters have changed significantly either due to neglect or subsequent rehabilitation. When a drainage network is rehabilitated, the water tables will be lowered, salinity will decrease, and soil conditions will be enhanced. The soil structure and soil physical parameters will improve. As a result, more efficient water application and a reduced incidence of waterlogged soils can be expected from the rehabilitated irrigation infrastructure.

When updating hydro-modules, the following questions have to be addressed:

- What is the hydro-module liters/sec/ha for cotton and wheat within the project area?
- What hydro-module was selected for calculating the design of the rehabilitated system?
- What is the accuracy of the hydro-module that was used as the design criteria?

2. Irrigation Conveyance Efficiencies

A WUA has to accurately determine the irrigation efficiency of its system to ensure that the true and correct discharge and cumulative volume of irrigation water is delivered to the intake structure of its Right Branch Canal/PR Secondary Canal. Incorrect determination of irrigation efficiencies can result in supply shortages. They can, in turn, lead to inequitable water distribution and, ultimately, to reduction in crop yields in the WUA’s service area.

Conveyance Efficiency Estimates. The calculation of the volume of water that has to be withdrawn at the head of the system critically depends on an accurate assessment of irrigation conveyance efficiencies and the overall irrigation efficiencies of the irrigation system itself. In Uzbekistan, estimates of irrigation conveyance efficiencies are quite high: 0.85–0.90 for a reinforced steel concrete chute, 0.70 for an earthen canal, and 0.50–0.85 for infield delivery. However, the efficiency of infield delivery falls below these levels. The efficiency ratings for onfarm and infield irrigation distribution systems go only as high as 0.65–0.70.

Ensuring Efficient Irrigation. Farmers have to properly construct their quaternary unit canals, onfarm delivery canals, and infield water distribution systems to ensure efficient irrigation. Unless farmers grade, shape, and compact them correctly, apply land leveling and subsoiling, and make use of piped siphons, their farms will suffer high water losses, waterlogging, and inequitable water distribution.

The WUA should therefore make it standard practice to do the following:

- Assist farmers so they can meet the expected civil works standards for their quaternary unit, onfarm and infield canals, and ditches, particularly in terms of their onfarm conveyance efficiency and infield conveyance and application efficiencies;
- Encourage farmers to use delivery and application methods that save water, such as providing head canals and ditches with piped polyethylene or PVC siphons (30mm, 40mm, and 50mm) to deliver irrigation water to the fields; and
- Review all standards, norms and irrigation duties in its service area and revise them as necessary to fit local conditions and improve water use efficiency. This should be undertaken with the assistance of outside engineers and agronomists following the completion of the civil works construction as well as during the regular operation of the system.

3. Calculating a Water Use Plan for a Tertiary Unit

The following example illustrates how to make a water distribution plan for a tertiary unit. The same methodology can be used in making a Water Use Plan for a WUA that distributes water to several tertiary units.

In Figure 3, the sample tertiary unit has a size of 600 m x 1,250 m, or 75 ha. There are five quaternary units (A, B, C, D, E) in this particular tertiary unit, each comprising 15 ha. Soybeans and maize are the predominant crops, and it is assumed that each block of 15 ha has the same cropping pattern of 3/5 soybeans and 2/5 maize.

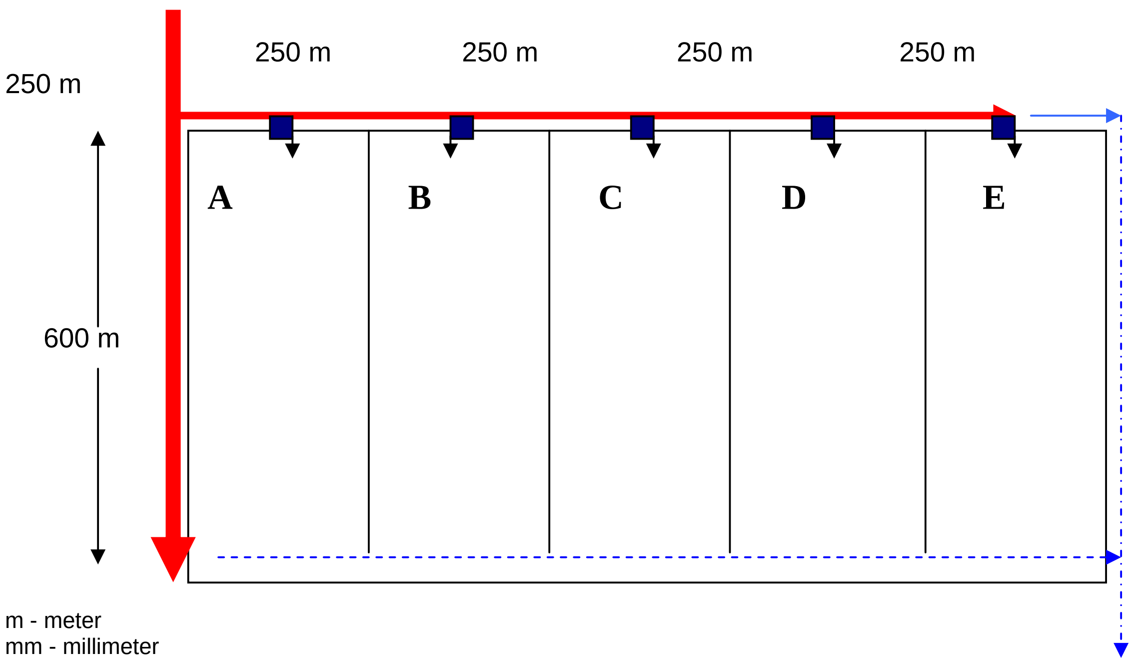
According to the hydro-module, the water requirements of the crop during a certain period (based on 24-hour irrigation) are as follows:

3/5 of the area:	soybeans:	0.4 liters/second/hectare (l/s/ha)
2/5 of the area:	maize: 0.7 l/s/ha	

The average hydro-module for this secondary canal is computed as follows:

$$\frac{(3 \times 0.4) + (2 \times 0.7)}{5} = 0.52 \text{ l/s/ha}$$

Figure 3. Sample Tertiary Unit



m - meter
mm - millimeter

Conversion from l/s/ha to mm:

1	l/s/ha
86400	l/ha/day
8.64	l/m^2
8.64	mm

Conversion from mm into m^3/ha: 1 mm = 0.001 m x 10,000 m^2 = 10 cubic meters/hectare (m^3/ha)

This means that the crop water requirements are:

- 0.4 l/s/ha corresponds with 0.4 x 8.64 mm = 3.5 mm/day
- 0.7 l/s/ha corresponds with 0.7 x 8.64 mm = 6.0 mm/day
-

The weighted average water requirement is = 0.52 x 8.64 = 4.5 mm/day

Based on 24h irrigation per day, the total water flow required for the tertiary canal is 0.52 x 75 = 39 liters/second (l/s).

Given losses of 25%, the gross requirement would equal the total net requirement multiplied by the loss factor in the tertiary unit. In this particular instance:

39 x 1.25= 49 l/s ~ 50 l/s

The irrigation interval, based on rooting depth and available water in the soil, is assumed to be 15 days, so every 15 days each field will need to receive water.

How will the water be distributed within the tertiary unit? This problem can be approached in two steps: making an allocation to the quaternary units, and making an allocation to the strips.

Step 1: Allocation to the Quaternary Units
Assume that the secondary canal is always filled with water and that the rotation is along the tertiary canals. Every 15 days a tertiary canal will receive water. Assume that the irrigation time for each tertiary canal is 5 days.

The water required for the tertiary canal will be 50 l/s x 15 days = 750 l/s.

This will be given in 5 days, so the tertiary canal capacity is 750/ 5 = 150 l/s.

There are 5 outlets (A, B, C, D, E), so every outlet receives 150/5 = 30 l/s. This water will be available for 5 days.

Step 2: Allocation to the Individual Fields
Assume that each block of 15 ha is divided into areas of 50 x 75 m = 3,750 square meter ($m^{2)}$. So in each block there are 40 fields.

On average, each field needs to receive 4.5 mm/day x 15 days = 67.5 mm. In volume terms this means 0.0675 m x 10,000 m^2 = 675 cubic meters/hectare (m^3/ha).

Each field is only 0.3750 ha, therefore the volume to be delivered at each field is 253 m^3.

The maximum flow each farmer can handle is about 15 l/s; therefore, the irrigation time becomes 253 / 0.015 = 16,866 seconds

Each hour has 60 x 60 = 3,600 seconds, and therefore the irrigation time for each field becomes 16,866/ 3,600 = 4.7 hours.

There are two fields irrigating at the same time, because the inlet flow to the block is 30 l/s.

It means that the total irrigation time for each block is (40/2) x 4.7 hours = 94 hours = 4 days.

The same methodology of this example applies to the calculation of the water distribution plan for all the tertiary canals.

Using the mechanism explained before, some examples of variations can now be made:

Irrigation only 12 hours per day:

Need for increased canal capacity, or
Need for night storage reservoirs

Rotation not every 15 days, but every 20 days: Need to increase the canal capacity

Change cropping pattern:

Rice: 24 hours of irrigation and no rotation among tertiary canals
Cotton irrigation

A simple calculation sample for cotton provides another example of working out a water use plan. For the purpose of calculating the example, the following is assumed:

- The provision of 510 l/s to a typical tertiary unit;
- This tertiary unit has a command area of 600 ha, of which 250 ha (or 42%) is planted to cotton;
- There are 15 farmers, each with 15–25 hectares of cotton; and
- Each farmer aims to provide an irrigation of 120mm (1200 m^3/ha).

Dividing the flow, say between three farmers, gives each 170 liters/sec. Thus:

- A farmer with 15 ha receives water for 29 hours [$t = (\omega * m)/(3.6 * Q)$, where: $\omega = 15$ ha; m = 1200 m^3/ha – irrigation rate; and Q = 170 l/s – flow rate],
- A farmer with 25 ha receives water for 49 hours. If all 15 farmers have 15 ha, then for each farmer to receive his water allocation, an irrigation schedule of 7 days is required. If all farmers have 25 ha, then for each farmer to receive his water allocation, an irrigation schedule of 11 days is required.

F. Water Measurement

When the water available from a particular source is limited and thus must be used very carefully, it is useful and at times necessary to measure both the discharge at various points in the system and the flow at farmer's intakes. Undertaking this measurement is important to WUAs for several reasons. First, it enables the WUA to supply only the proper amounts of water, thus minimizing water use and O&M costs. Second, since both the farmers and the WUAs have to pay for water delivery, all parties have the right to know how much water is actually being delivered. Moreover, water measurement, water accounting procedures, and other such record-keeping measures will result in greater transparency and accountability as well as a more equitable water distribution. Flow measurements may also be useful for settling any disputes about the distribution of the water. Finally, they can provide important information about the functioning of the irrigation system.

Canal discharges can either be measured without using structures or with the use of discharge-measurement structures. Such devices will be discussed in this section, starting with weirs and followed by flumes.

1. Discharge

Irrigation canals transport water from the water source to the farmers' fields. The more fields that are served by a canal, the more water needs to be transported. The rate at which water is transported by a canal is known as its "discharge," and the maximum discharge that any canal can transport is known as the "canal capacity." These terms are described in detail below.

a What is a Discharge?

A discharge is the volume of water that is transported each second. The volumes are expressed in liters (l) or in cubic meters (m^3) ($1\ m^3 = 1{,}000$ l). The letter *Q* is commonly used as the symbol for the discharge.

Figure 4. Discharge in a Canal

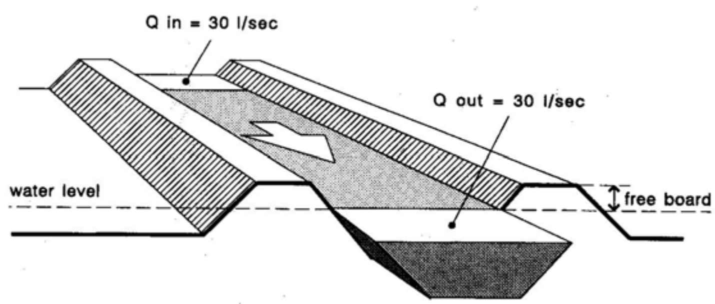


Figure 4 shows a short section of an irrigation canal that transports 30 liters of water every second (l/s). At the upper end of the section a volume of 30 liters (l) enters each second. In the same second, a volume of 30 l leaves the section at the lower end. If, for example, a container with a volume of 30 l is placed at the end of this canal section, it will be filled every second. In symbols, this discharge is expressed as Q = 30 l/s.

b Discharge and Demand

The demands for irrigation water in a scheme are not constant during the irrigation season. This is because they are largely affected by the amount of rainfall and by the water requirement of crops growing in the scheme. At the beginning of the season, large amounts of water may be needed for land preparation or for leaching, followed by a period of low water demand during the initial growth of the crop. As the crop develops and reaches full growth, water requirements will increase. The demand finally decreases when the crop matures and becomes ready for harvesting.

There are several ways of meeting the changing water demands of the farms:

- The discharges in the canals can be adapted to the actual demands by manipulating the control structures or gate settings;
- The duration of water delivery to the farms can be reduced or increased while discharges remain constant;
- The period between water deliveries—-the interval—can be made longer or shorter, while the discharge and the duration of water delivery remain constant; or
- A combination of these three ways.

c Discharge Control

Whichever of the options above is chosen to meet the actual water demands in an irrigation scheme, the water supply to the scheme and its distribution through the canals and over the fields have to be regulated and controlled. Also, so that the required amounts of water can be supplied to the crops and so that waste through oversupply can be avoided, it is important to know the volume of discharges in the canals. A procedure to estimate the discharge in a canal is presented in the discussions that follow.

As shown in Figure 5, it can be said that in the same canal section, the water level is low for small discharges and high for large discharges.

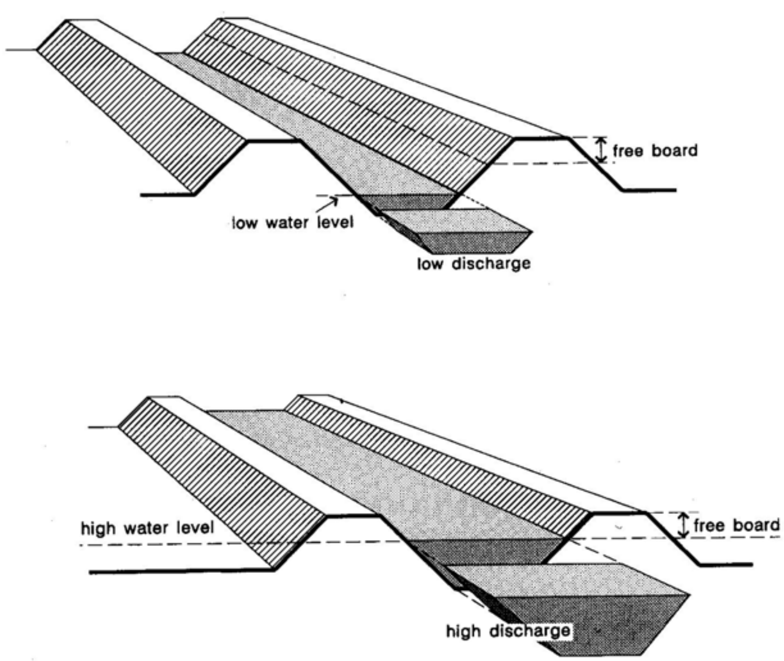
As the discharge in a canal increases and the water level rises, there is a danger that the canal embankment will be overtopped. Thus, to avoid spillage of water and also to prevent the embankments from being damaged by overtopping water, a certain safety margin, called the minimum required free board, is provided between the top of the canal banks and the maximum water level.

When the water level reaches the maximum water level, the discharge in the canal is the maximum allowable discharge, which is called the canal capacity. The symbol Q_m or Q_{max} is commonly used to represent canal capacity.

2. Estimating the Discharge

The discharge in a canal can be measured with or without a discharge measurement structure. A method that does not require a structure, known as the "floating method," is described below. It is a quick and cheap way to estimate discharge in a canal, but it is not very accurate. Errors of at least 10% can be expected when this method is used.

Figure 5. Water Level and Discharge



The “floating method” involves estimating the average flow velocity (V), and measuring the area of the cross-section, which is called the “wetted cross-section” (A). The discharge (Q) can be calculated by the following formula:

$$Q = V \times A$$

wherein

Q = discharge in m^3/s;
V = average flow velocity in m/s; and
A = area in m^2 of the wetted cross-section.

To know the discharge in l/s instead of m^3/s, the formula to use is:

$$Q = I000 \times V \times A$$

wherein

Q = discharge in l/s;
1,000 = a factor to convert m^3 to 1(1 m^3 = 1,000 l);
V = average flow velocity in m/s; and
A = area in m^2 of the wetted cross-section.

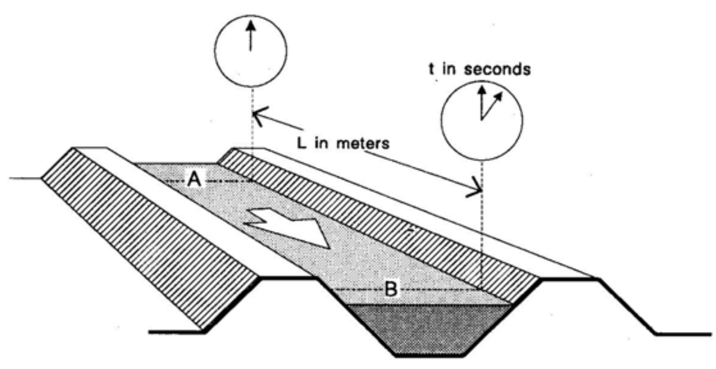
The next section describes a method to estimate the average flow velocity and provides a method for determining the area of the wetted cross-section.

a Average Flow Velocity

To estimate the average flow velocity, the flow velocity of the water at the surface—the surface velocity V_s—is first determined.

The surface velocity is determined by measuring the time it takes for a floating object—such as a stick, a bottle, or an apple—to travel through a previously measured distance of, for example, 10–20 meters along the canal. The floating object should be placed in the center of a canal and the time measurement should be repeated several times to avoid mistakes. This process is depicted in Figure 6 below.

Figure 6. Measuring the Surface Velocity



The stretch of canal used for measurement should be straight and uniform to avoid changes in the velocity and in the area of the cross-section. Any such variation reduces the accuracy of the velocity estimation.

To compute the surface velocity V_S, the selected length (L) is divided by the travel time t:

$$V_s = L / t$$

wherein

V_s = surface velocity in meters per second (m/s);
L = the distance in meters between points A and B; and
t = the travel time in seconds between point A and B.

The surface velocity must be reduced when obtaining the average velocity because surface water flows faster than subsurface water. For most irrigation canals, this reduction factor is about 0.75. The average velocity is therefore determined as:

$$V = 0.75 \times V_s$$

wherein

V = average flow velocity in m/s;
0.75 = the reduction factor constant; and
V_s = surface velocity in m/s as determined in the previous calculation.

b Area of the Wetted Cross-Section

To transport the canal discharge, various shapes and sizes of canal can be used, but the most commonly used shape is a trapezoidal cross-section. It can be used for every type of canal, whether the channel surface is covered with waterproof material (a lined canal) or not (an unlined or earthen canal). However, rectangular and circular shapes are also used for lined canals. This guidebook covers only trapezoidal and rectangular shapes, as illustrated in Figures 7 and 8.

Figure 7. Rectangular Canal

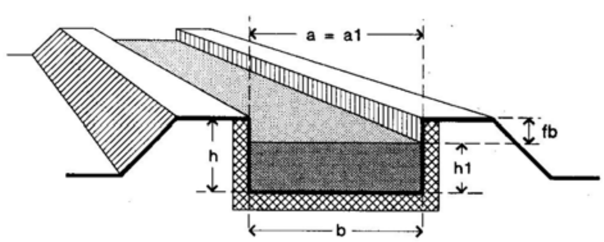
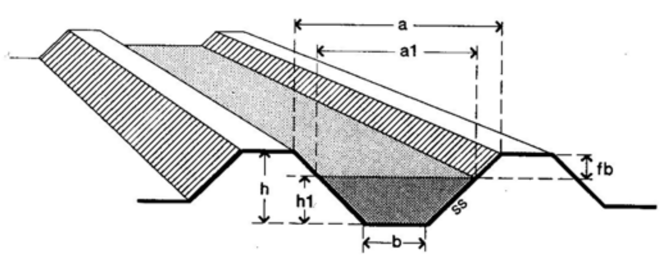


Figure 8. Trapezoidal Canal



In both Figures 7 and 8, the following symbols are used:

a = top width; and for rectangular canals a = a_1 = b;
a_1 = water surface width;
b = canal bed width;
h = height of the embankment above the canal bed level;
h_1 = depth of water;
fb = the free board; and
ss = the side slope (not applicable for rectangular canals)

The free board (fb) is needed to avoid overtopping of canal embankments and to prevent spillage of water and possible destruction of the banks by water erosion. It serves as a buffer for accommodating fluctuations in water levels in canals. This buffer is defined as the difference between the water level and the level of the crest of the embankment. The height of the minimum required free board depends on the water depth and on the material used for constructing the embankments. Embankments constructed using sandy material should have more free board than those that use clay.

When embankments are also used as pathways, the free board should be increased to help protect them from destruction. As a rule of thumb, the following minimum required free board levels for small and medium canals should be observed:

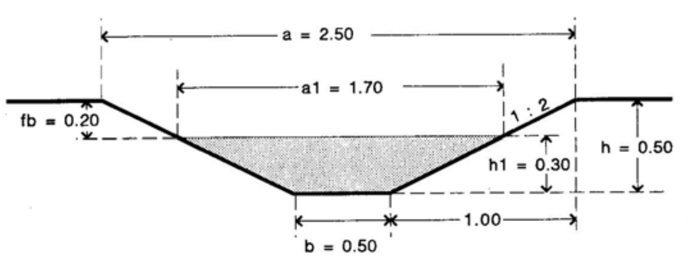
fb = 0.20 m for water depths of 0.40 m or less. The minimum height for an embankment should be the maximum water depth + 0.20 m, or h = h_1 + 0.20 m;

fb = 0.5 x water depth for water depths of 0.40 m or more. The minimum height of an embankment should be 1.5 x water depth, or h = 1.5 x h_1.

The water surface width a_1 depends on the side slope (ss). The quantity of a_1 becomes closer to bed width (b) as the ss becomes larger. The side slope depends on the material used for constructing the canal, and canals constructed with heavy clay can have steeper side slopes than those built with sandier material. Lined canals constructed from bricks or concrete can even have vertical side slopes.

The side slope is expressed as a ratio (for example, 1 in 2, 1 to 2, or 1:2). This means that the embankment rises one unit for each 2 units that it goes sideways; that is, 10 cm up for every 20 cm out, or 50 cm vertical rise for each 100 cm horizontal displacement. This is illustrated in Figure 9 below.

Figure 9. Side Slope



The side slope (ss) can be calculated in the following way:

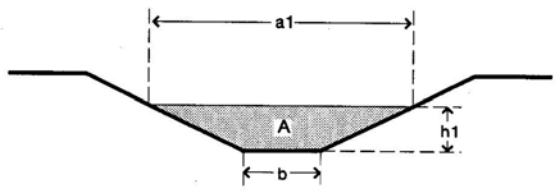
$$ss = \frac{\text{Height of embankment}}{\text{Width of embankment}}$$

$$ss = \frac{0.5}{1.0} > ss = 1:2$$

c Calculating the Area of the Wetted Cross-Section

For measuring the flow with the floating method, the area of the wetted cross-section (A) should be determined for a selected straight and uniform portion of the canal. If the canal is trapezoidal, this area is calculated from measurements of the bed width (b), the width of the surface water (a_1), and the water depth (h_1). How this area is computed is shown in Figure 10.

Figure 10. Area of Trapezoidal Wetted Cross-Section



The following formula should be used:

$$\mathbf{A = \frac{(b+a_1)}{2} \times h_1}$$

wherein

A = area of wetted cross section (m^2)
b = bed width in meters (m)
a_1 = surface water width in meters (m)
h_1 = water depth in meters (m)

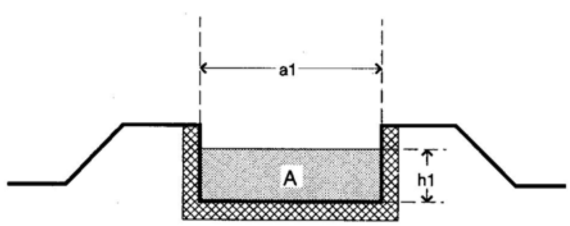
For rectangular canals the equation is as follows:

$$\mathbf{A = a_1 \times h_1}$$

wherein

A = area of wetted cross section
a_1 = surface water width in meters (m)
h_1 = water depth in meters (m)

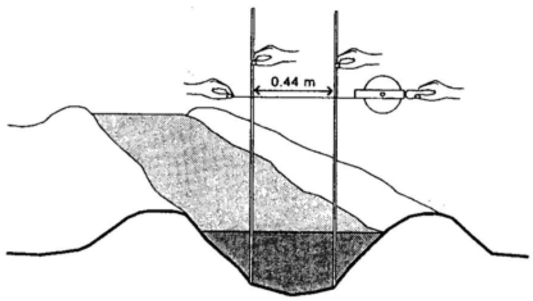
Figure 11. Area of Rectangular Wetted Cross-Section



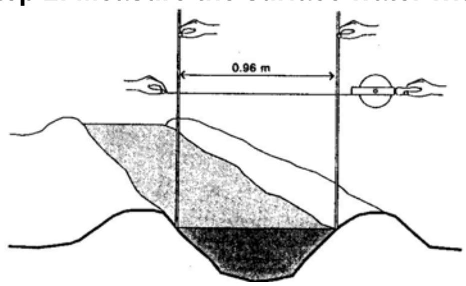
Cross-sections of unlined irrigation canals seldom have a regular shape. The bed width and the water depth may vary, even over short distances along the canal. The same applies for lined canals. However, the changes in bed width and water depth in lined canals are less than those in unlined canals. Because of these irregularities that are typical of unlined canals, the area of the cross-section should be measured several times to obtain the average area.

The procedures are as follows:

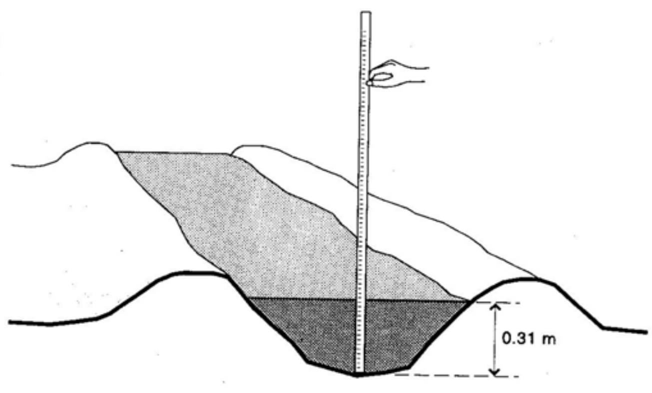
Step 1: Measure the bed width.



Step 2: Measure the surface water width.



Step 3: Measure the water depth.



d Flow Estimation Procedure

The following procedure is used for measuring the discharge using a floating object through an irregular shape of cross-section.

Equipment:

Measuring tape at least 5 meters long;
4 stakes;
Stopwatch or watch capable of measuring time in seconds;
Floating object such as a bottle or an apple.

Procedure:

Step 1: Select a straight section of the canal at least 10 meters long. The shape of the canal along this section should be as uniform as possible.

Step 2: Place two stakes, one on each side, at the upstream end of the selected portion of the canal. They should be perpendicular to the centerline of the canal (point A).

Step 3: Measure 10 meters or more along the canal.

Step 4: Place two stakes at the downstream end of the selected section of the canal, also perpendicular to the centerline of the canal (point B).

Step 5: Place the floating object on the centerline of the canal at least 5 m upstream of point A, and start the stopwatch when the object reaches point A.

Step 6: Stop the stopwatch when the floating object reaches point B, and record the time in seconds.

Step 7: Repeat steps 5 and 6 at least four times to determine the average time necessary for the object to travel from point A to point B. The object should not touch the canal embankment during the trial, but if it does, the operation must be repeated and the time for the bad trial must not be included when calculating the average time.

Step 8: Measure the following in the selected canal section:

The canal bed width, b
The surface water width, a_1
The water depth, h_1

The cross-section within the selected portion of the canal will usually not be regular, and so b, a_1 and h_1 need to be measured in several places to obtain an average value.

If working with a canal with a rectangular cross-section, the surface water width a_1 will equal the bed width b.

Step 9: Calculate the surface velocity (V_s), and then the average flow velocity (V), using the equations given before: $V_s = L / t$, where *t* is the travel time in seconds, based on the average of four clear runs of the floating object, and V = 0.75 x l/s.

Step 10: Calculate the wetted area of the cross-section A, using the formula

$$\mathbf{A = \frac{(b+a_1)}{2} \times h_1}$$

(b, a_1 and h_1 are average values)

Step 11: Calculate the discharge Q, in the canal, using the formula

$$\mathbf{V \times A\ m^3/s}$$

or

$$\mathbf{Q = 1{,}000 \times V \times A\ l/s}$$

Example:
The following example demonstrates how to calculate the discharge in a trapezoidal canal.

A straight and uniform portion of a trapezoidal canal was selected. Within this portion a length of 20 m was marked with pegs (as in Steps 1–4 above).

An apple was used to determine the surface velocity (Steps 5–6). This was repeated 4 times with the following results:

t_1 = 50 seconds;
t_2 = 52 s;
t_3 = 53 s;
t_4 = 53 s.

The wetted area of the cross-section was measured 4 times (Step 8):

b =	0.44;	0.42;	0.40 and 0.45 m
a_1 =	0.96;	1.02;	1.03 and 0.94 m
h_1 =	0.31;	0.28;	0.29 and 0.30 m

Question: What is the discharge Q?

Solution:

Step 1: Calculate the average travel time:
$t_{(average)}$ = (50 + 52 + 53 + 53) / 4 = 208 / 4 = 52 seconds.

Step 2: Calculate the average values of b, a_1, and h_1:

$b_{1(average)}$ = (0.44 + 0.42 + 0.40 + 0.45) /4 = 1.71 / 4 = 0.43 m.
$a_{1(average)}$ = (0.96 + 1.02 + 1.03 + 0.94) /4 = 3.95 / 4 = 0.99 m.
$h_{1(average)}$ = (0.31 + 0.28 + 0.29 + 0.30) /4 = 1.18 / 4 = 0.30 m.

Step 3: Calculate the surface velocity, V_s, and the average flow velocity, V. Surface velocity is given by: $V_s = L / t$
L = 20 meter (marked); t = 52 seconds (Step 1)
Therefore V_s = 20 / 52 = 0.38 m/s.

Average flow velocity is given by: V= 0.75 x Vs
Therefore V= 0.75 x 0.38 = 0.29 m/s.

Step 4: Calculate the wetted area (A) of the cross-section, from Step 2:
The area is given by: $A = ((b + a_1) /2) \times h_1$
b = 0.43 m; a_1 = 0.99 m; and h_1 = 0.30 m.
A = ((0.43 + 0.99)/2) x 0.30 = (1.42/2) x 0.30 = 0.71 x 0.30 = 0.213 m^2

Step 5: Calculate the discharge:
Discharge is given by: Q = V x A:
V= 0.29 m/s (from Step 3); A = 0.213 m^2 (from Step 4)
Therefore Q = 0.29 x 0.213 = 0.062 m^3/s
or
Q = 1 000 x V x A = 1 000 x 0.29 x 0.213 = 62 l/s.

Answer: The discharge in the canal is 62 liters per second.

3. The Current Meter

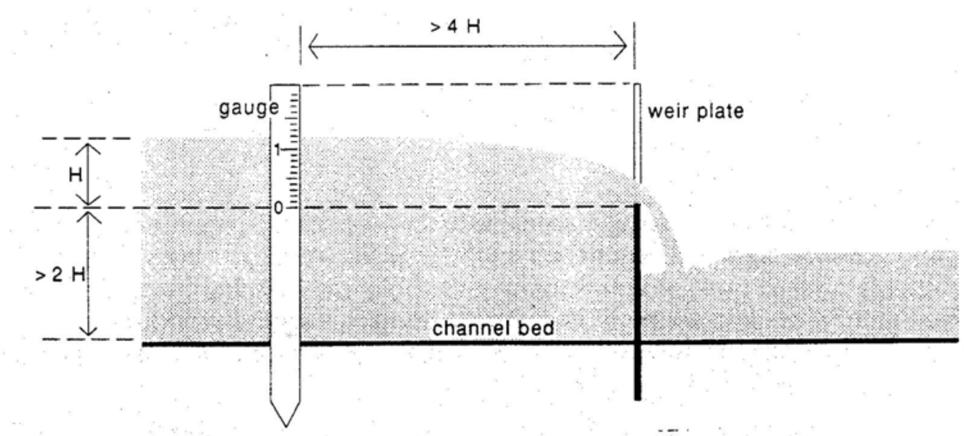
More accurate methods for measuring the mean velocity of water are based on the use of a current meter. Such a meter usually consists of a set of cups that rotate about a vertical axis when placed in flowing water. The rate of rotation of the cups can be indicated and recorded electrically. To obtain the velocity distribution and to average it appropriately, this measurement must be made systematically over the cross-section of the stream.

4. Weirs

Weirs are sharp-crested overflow structures that are built across open canals. They are easy to construct and can measure the discharge accurately when correctly installed. Weirs are used extensively in Central Asia.

The water level upstream of the structure is measured using a measuring gauge, as shown in the figure below, where the difference—"the head"—between the water level and the crest of the weir is marked "H." The discharge corresponding to that water level is then read from a table that is specific for the size and type of weir being used, or the gauge post can show the discharge directly.

Figure 12. Operation of a Weir



a Types of Weirs

Examples of three well-known weir types are illustrated in the next page: the rectangular weir, the Cipoletti trapezoidal weir, and the 90° V-notch weir. As shown in Figure 13, the rectangular weir has a rectangular opening. The Cipoletti trapezoidal weir, shown in Figure 14, is in fact an improved rectangular weir, with a slightly higher capacity for the same crest length; its opening is trapezoidal, with the sides inclining at a slope of 4 (vertical) to 1 (horizontal). The 90° V -notch weir, shown in Figure 15, has a triangular opening, a type well suited to measure small flows with high accuracy.

Figure 13. Rectangular Weir

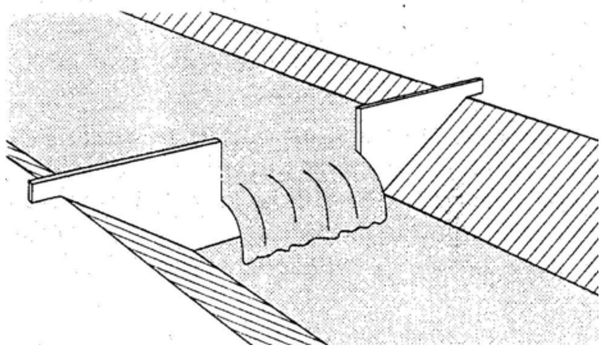


Figure 14. Cipoletti Weir

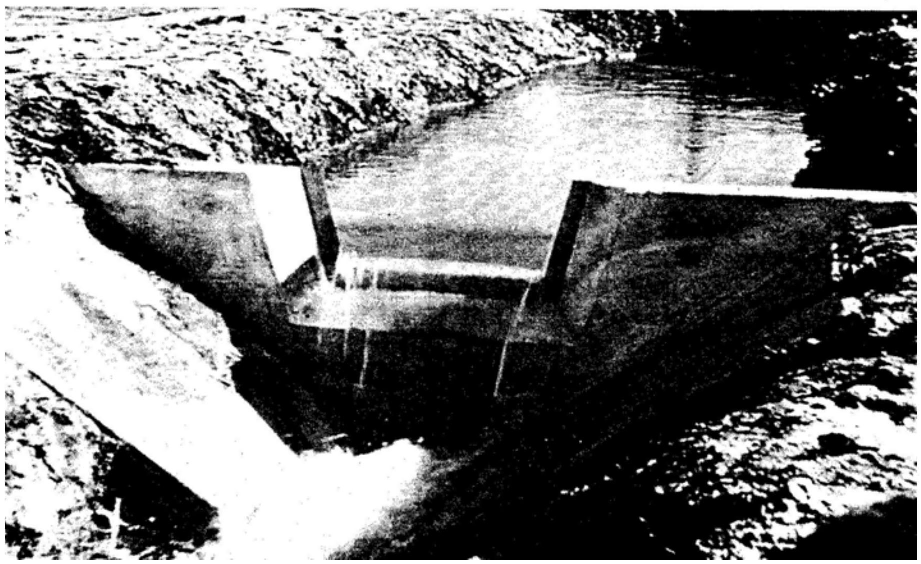


Figure 15. V-notch Weir

b Measurement Procedures Using Weirs

To obtain a true measure of the flow over weirs, certain dimensions must be observed because they are critical to correct operation. These dimensions, as indicated earlier in Figure 12, are as follows:

The level of the weir crest relative to the channel bottom;
The horizontal distance between the measuring gauge and the weir;

The level of the gauge relative to the level of the crest of the weir.
The procedure for getting the correct setup for the structure is given below in the form of a practical example. The measurement structure in this example is assumed to be the overflow type, namely a rectangular weir with crest length of 1.0 m.

Step 1: Estimate the likely maximum discharge in the canal to be measured. This defines the corresponding maximum head of water over the weir crest for the structure concerned.

The maximum discharge to be measured is estimated at 200 l/s

Using Table 8, it is clear that for a discharge of 200 l/s, the head H is a little less than 0.25 m.

Step 2: Check the level of the weir crest.

The level of the crest above the canal bed should be at least two times the maximum head, (2H, shown in the figure above). In this case the weir should have a crest level that is at least 2 x 0.25 = 0.50 m higher than the canal bed.

Step 3: Check the distance between the gauge and the weir.

The distance between the gauge and the weir should be at least 4 times the maximum head, 4H (shown in the figure above). In this case, the gauge should be located at least 4 x 0.25 = 1.00 m upstream of the weir.

Step 4: Check the elevation of the zero (0) mark on the gauge.

The 0 mark on the gauge, which indicates a discharge of 0 l/s (no flow), should have the same elevation as the weir crest. This can be checked using a carpenter's level or by the water level when there is no flow over the weir.

The discharge measurement procedure described here is standard for the three types of overflow weirs shown in the figures before, except that there is a different table for each type. Table 8 is used for a rectangular weir, Table 9 for a Cipoletti trapezoidal weir, and Table 10 for a 90° V-notch weir.

Assume that the structure is a rectangular weir with a crest length of 1.25 m.

Step 1: Read the water level on the gauge. The reading is 0.12 m, so H = 0.12 m.

Step 2: In Table 8, find the row corresponding to 0.12 m, and move across that row till it meets the column for the weir crest being used, 1.25 m. The value at the point where the column and row cross is 94, which is the discharge in liters per second: Q = 94 l/s.

To carry out discharge measurements for Cipoletti trapezoidal weirs and for 90° V-notch weirs, the same procedures are used for establishing the proper dimensions for the setup of the structure. However, different tables are used to obtain the value of the discharge, as previously noted above.

If the measured head H is not found in a table, the rows with the H values immediately above and below are followed, and the two discharge values found in the table are averaged to obtain the actual discharge.

For example, suppose a trapezoidal weir is being used to measure the discharge in a canal. The crest has a length, L, of 1.00 m and the head reading H is 0.17 m.

H = 0.17 m is not found in Table 9, so the nearest H values above and below are used. These are 0.16 and 0.18 m. H = 0.16 m gives, when L = 1.00 m, a discharge, Q, 119 l/s, and H = 0.18 m gives a discharge of 142 l/s.

These two discharges are averaged to obtain an approximate value for the canal discharge, namely Q = (119 + 142) /2 = 131 l/s.

If the length of the weir crest does not correspond to any one of the lengths given in the tables, then a handbook should be consulted or an engineer should be contacted to make a specific table for the weir concerned.

Table 8. Discharge-Head Relationship for a Rectangular Weir

Head (H) Meters	Discharge (Q) Liters/Second					
	Length of Crest (L) Meters					
	0.25	**0.5**	**0.75**	**1.00**	**1.25**	**1.50**
0.01	0	1	1	2	2	3
0.015	1	2	3	3	4	5
0.02	1	3	4	5	6	8
0.03	2	5	7	10	12	14
0.04	4	7	11	15	18	22
0.05	5	10	15	20	26	31
0.06	6	13	20	27	33	40
0.08	10	20	31	41	51	62
0.10	13	28	42	57	72	86
0.12	17	36	56	75	94	113
0.14		45	70	94	118	142
0.16		55	85	114	143	173
0.18		65	100	135	171	206
0.20		76	117	158	199	
0.25		104	161	219		
0.30			209			

Table 9. Discharge-Head Relationship for a Cipoletti Trapezoidal Weir

Head (H) Meters	Discharge (Q) Liters/Second — Length of Crest (L) Meters					
	0.25	0.5	0.75	1.00	1.25	1.50
0.01	0	1	1	2	2	3
0.015	1	2	3	3	4	5
0.02	1	3	4	5	6	8
0.03	2	5	7	10	12	14
0.04	4	7	11	15	19	22
0.05	5	10	16	21	26	31
0.06	7	14	21	27	34	41
0.08	11	21	32	42	53	63
0.10	15	29	44	59	74	88
0.12	19	39	58	77	97	116
0.14		49	73	97	122	146
0.16		60	89	119	149	179
0.18		71	107	142	178	213
0.20		83	125	166	208	
0.25		116	174	233		
0.30			229			

Table 10. Discharge-Head Relationship for a 90º V-Notch Weir

H	Q
0.01	0.0
0.02	0.1
0.03	0.2
0.04	0.4
0.05	0.8
0.06	1.2
0.07	1.8

H	Q
0.08	2.5
0.09	3.3
0.10	4.3
0.11	5.5
0.12	6.8
0.13	8.3
0.14	10

H	Q
0.15	12
0.16	14
0.17	16
0.18	19
0.19	22
0.20	24

5. Flumes

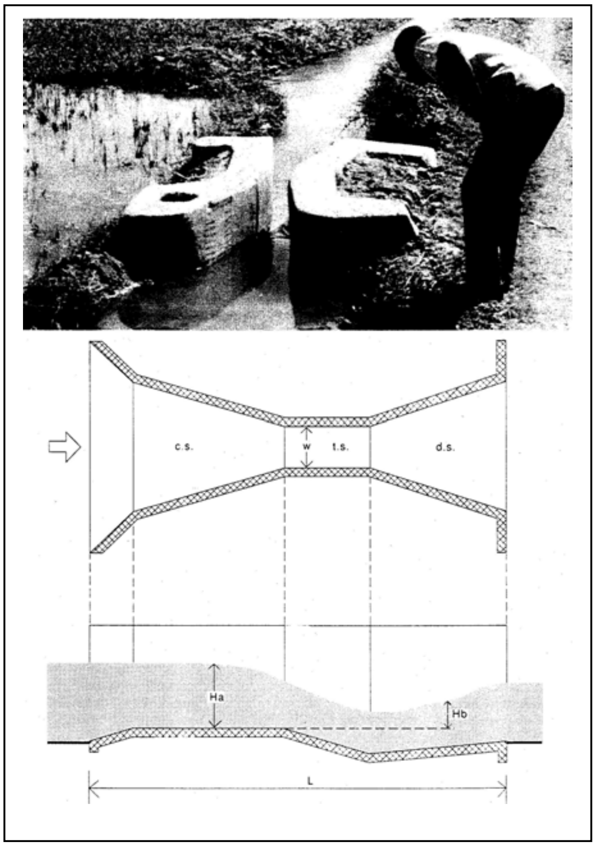
Another well-known type of structure for discharge measurement is the flume. Flumes consist of a narrowed canal section with a particular, well-defined shape. The advantage of flumes over weirs is the small drop in water level (head loss); for this reason, flumes can be used in relatively shallow canals with flat grades. For the same discharge under similar conditions, the drop in water level is only one quarter of the drop needed to be able to use a weir. Because of this, smaller flumes can easily be used as transportable measuring devices. However, a disadvantage of flumes is that they are relatively expensive and, unlike weirs, they cannot easily be combined with other structures.

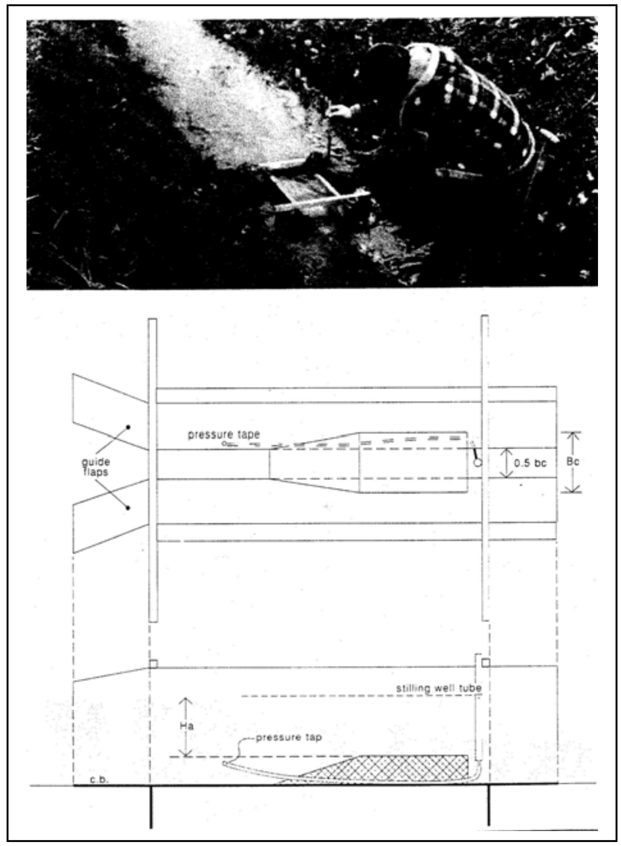
As in measurements with weirs, the water level upstream of the flume is a measure of the discharge through the flume. When the head has been measured, the discharge can be obtained by reading the value on a diagram, which is specific for the flume being used.

a Types of Flumes

Two of the most common types of measuring flumes are the Parshall flume and the RBC flume, which are illustrated on the next page.

Figure 16. The Parshall and RBC Flume





The abbreviations used in the plan and longitudinal section views of the two common flume types are as follows:

c.b. = canal bed;
H_a = upstream water level, relative to the bottom of the structure;
$H_{b\,=}$ downstream water level, relative to the bottom of the structure;
L = length of flume;
c.s. = converging section;
t. (s.) = throat (section);
d.s. = diverging section;
W = throat width; and
Bc = throat bottom width.

A Parshall flume consists of three principal sections:

A converging section at the upstream end;
A constricted section or throat in the middle; and
A diverging section downstream.

The floor of the throat slopes downward and the diverging section slopes upwards. These are as shown in Figure 16 together with the plan and longitudinal section views.

Parshall flumes have standard dimensions, which must be followed closely in order to obtain accurate measurements.

The RBC flume has a short trapezoidal section with a contraction inserted in the flume bottom. When constructing an RBC flume, it is not absolutely necessary to follow the standard measures exactly, since a flume-specific head-discharge table can be established for each RBC flume. This is not possible in the case of the Parshall flume.

b Measurement Procedures for Flumes

When using a flume to measure discharge in a canal, it is assumed that the flume has been made using standard dimensions, and that flume-specific tables are available. In the case of an RBC flume, the assumption is made that a table has been established especially for the flume being used. Tables for the two types of flumes presented above are found at the end of this section. These tables are applicable for the so-called ”free flow” condition, which means that the upstream water level is not affected by the downstream water level.

The method for measuring discharge using a flume is illustrated below:

Question: What is the discharge in a canal if a Parshall flume with throat width W= 0.46 m is used to measure the flow, and the reading taken under free flow conditions is 0.23 m?

Given that the upstream water level head H_a = 0.23 m, use Table 11 below for a Parshall flume with a throat width of 0.46 m, then read from the table the discharge when Ha = 0.23 m. The discharge will be Q = 110 l/s.

Table 11. Discharge-Head Relationship for a Parshall Flume (with Throat Width of W = 0.46 m)

H	Q	H	Q	H	Q	H	Q
0.03	5.8	0.11	35	0.19	82	0.27	141
0.04	7.4	0.12	41	0.20	89	0.28	149
0.05	11	0.13	46	0.21	96	0.29	157
0.06	18	0.14	51	0.22	103	0.30	166
0.07	22	0.15	57	0.23	110	0.31	174
0.08	26	0.16	63	0.24	118	0.32	183
0.09	31	0.17	69	0.25	125	0.33	192
0.10	35	0.18	76	0.26	133	0.34	201
						0.35	210

Table 12. Discharge-Head Relationship for a RBC Flume (with Throat Width of Bc = 0.20 m)

H	Q	H	Q	H	Q	H	Q
0.03	1.8	0.08	9.3	0.13	22	0.18	40
0.04	2.9	0.09	11	0.14	25	0.19	45
0.05	4.2	0.10	14	0.15	29	0.20	49
0.06	5.7	0.11	16	0.16	32		
0.07	7.4	0.12	19	0.17	36		

V. PERFORMANCE MONITORING

A. The Purpose of Performance Monitoring

The O&M of irrigation and drainage systems is the primary function of a WUA. It is therefore very important that this function be monitored closely and systematically at all times. The WUA's O&M engineer is responsible for the day-to-day monitoring of this performance and has to make periodic and detailed reports on its various aspects to the WUA manager. The O&M performance monitoring report, together with the WUA manager's own report on the performance of the WUA's Management Team and staff, later forms the core and primary basis of the WUA's Annual Report. This report is later presented by the WUA Council chair to the WUA's General Assembly or Representative Assembly.

The major reasons for instituting a formal performance monitoring system for a WUA's O&M are as follows:

- The WUA members, as the owners and primary clients of the WUA, have the right to know precisely how the WUA is doing in the pursuit of its objectives and tasks. The WUA has to be transparent about this performance because it is crucial to the strengthening of the farmers' willingness to pay the irrigation service fee.
- The WUA members need a clear idea of the organizational capability of the WUA, the competence of its personnel, and the quantity and quality of their work.
- For the WUA itself, performance monitoring is a good means for measuring its organizational effectiveness, for reassessing its objectives, and for instituting changes and measures to improve its performance.

B. Performance Monitoring: General Description

1. Performance Indicators

A set of key performance indicators is used for evaluating how effective the WUA and its irrigation and drainage system are in meeting their set goals and objectives. These performance indicators consist of (1) the irrigation management component, (2) the maintenance component, (3) the financial component, (4) the agricultural component, and (5) the environmental component. When doing performance monitoring, the WUA has to compare the recorded results for each indicator to the original design targets or in relation to targets that had been revised in the course of the budget year.

Generally, performance monitoring has to be carried out at regular intervals, and the results and trends as well as their causes have to be evaluated each year or more frequently as required by the WUA Management Team or the WUA Council itself. As such, performance monitoring serves as a very important management tool for a WUA.

It would be ideal for a WUA's performance monitoring system to be linked with the government's own monitoring and evaluation system for water-related activities. However, when the two systems are linked, the arrangement should be used not as a form of state control over WUAs. It should only be a means for supporting the current operations of WUAs and enhancing their future development.

2. Performance Objectives

The performance monitoring evaluation serves as the WUA's primary basis for continuing self-improvement as well for preparing its Annual Operations Plan for the next budget year.

For this reason, it is very important for the performance monitoring results to accomplish the following:

- Identify weaknesses in the WUA's performance;
- Explain these weaknesses to the WUA Council and to the WUA members and farmers;
- Form a solid basis for setting realistic goals for the next season; and
- Guide the WUA in developing appropriate measures for avoiding the same mistakes in its future performance.

The precise performance monitoring indicators to be used and the objectives they are meant to identify have to be developed by the WUA Management Team, discussed with and accepted by the WUA Council, and approved by the WUA's General Assembly or Representative Assembly. The next section discusses a number of proposed performance indicators for each of the components to be monitored. The subsequent section explains the identified performance objectives for each of the indicators.

C. Performance Indicators

1. Irrigation Management Indicators

Irrigation Delivery Ratio. This ratio, which is calculated at each of the staff gauges at the head of the distribution canals or flumes, compares the actual flows with the planned flows. It indicates whether the water distribution system is performing as designed, and whether any parts of the system are suffering from water shortages. Determination of this ratio should be done on a monthly and seasonal basis. Ideally, this ratio should be close to 1.00.

Calculation of the irrigation delivery ratio proceeds as follows:

- The WUA's gate operators read the flow-meters and staff gauges every morning and evening and record the readings on a distribution monitoring form;
- At the start of each season, the flow-meters and staff gauges are checked to ensure they are reading the correct discharge;
- A rain gauge is installed near the WUA offices to make daily rainfall readings; and
- The irrigation delivery ratio is calculated for each tertiary canal by dividing the volume given (including rainfall) by the volume planned.

Water Use Efficiency. Water use efficiency is a measure of the quantity of operation losses and misappropriation of water. It can be determined by comparing the actual delivery to the farmers as a percentage of the extraction from the main canal. Ideally, this should be close to 100%, but losses due to seepage, percolation, evaporation, and managerial oversight or neglect are inevitable. The actual figure will thus be lower. It will reflect the water losses that are not accounted for, including illegal water deliveries.

Calculation of this indicator by the O&M engineer proceeds as follows:

- Water delivered is calculated on the basis of receipts for water delivery per tertiary canal;
- Total extraction is calculated on the basis of measurements taken at the head gate; and
- Water delivery is calculated as a percentage of water extraction.

Timeliness of Delivery. Because the date when a farmer requests for water is systematically recorded by the WUA, it can be easily compared to the date when the farmer actually receives the water, which is likewise systematically recorded. The time between request and delivery should be as close as possible to that set by the WUA in its Annual Operation Plans (that is, 2 days at most). Thus, an indication of the quality of the WUA's service can be obtained by calculating the deviation from the objective for each water delivery:

- A One (1): This score is given if water is delivered 1 day before the objective;
- A Zero (0): This score is given if the water is delivered according to the objective;
- A Minus One (-1): This score is given if water is delivered 1 day after the objective; and
- A Minus Two (-2): This score is given if water is delivered 2 days after the objective.

At the end of the season, an overall figure is calculated and included in the Annual Operations Plan. The calculation of this indicator by the O&M engineer proceeds as follows:

- The reports on demands for water delivery are examined and compared with the water delivery reports; and
- The overall figure for the season is calculated.

Cumulative Water Use. The total actual and planned water use should be compared on a 10-day basis throughout the season. This is done using the Annual Water Plan and the actual measured discharges into the PR Secondary Canal. This indicator shows whether the total volume used is within the allowable extraction limit from the Main Canal (Right Branch Canal). If necessary, as the season progresses, discharge rates may have to be slightly reduced to ensure that the extraction limits are not exceeded.

Calculation of the cumulative water use indicator proceeds as follows:

- Measure the intake from the main canal (Right Branch Canal to PR) into the area of the WUA, both in the morning and in the evening (coordinate with the bulk water supplier in doing this);
- Calculate the cumulative intake per 10-day period; and
- Put the data into a graphical record and presentation that shows in red the maximum allowable extraction from main canal, the planned extraction, and the actual cumulated extraction.

2. Maintenance Indicators

Structure Condition Ratio. At the end of the season, which is usually also the time of the annual maintenance inspection, the condition of each part of the irrigation and drainage system (canals and flumes, drains and structures) is assessed in any of three ways: (1) in good condition, (2) having minor defects, or (3) having major defects. The structure condition ratio is the number of parts of the system in good condition divided by the total number of parts of the system. Ideally, the ratio should be close to 1.00 each time. A similar subjective indicator could be used for the condition of the quaternary canals and structures, the onfarm canals, and the infield ditches and structures.

Calculation of the structure condition ratio by the O&M engineer proceeds as follows:

- Data are collected on the basis of the annual maintenance inspection;
- A rating is made for each part of the infrastructure based on how they are sectioned in the Maintenance Register. For each section, a rating is given and recorded (10 = highest, 1 = lowest); and

- The overall rating is calculated as the sum of the ratings given divided by the maximum possible sum.

3. Financial Indicators

Collection of Water Fees and Charges (Membership Fee and Irrigation Service Fee). The ratio of the water charges collected and those planned needs to be monitored. A high level of water charge collection is essential for a WUA's financial viability and sustainability. The WUA should be able to present the collection figures at the annual meeting of the General Assembly or Representative Assembly.

Calculation of this collection indicator by the WUA accountant proceeds as follows:

- A report on the amount paid is prepared as a percentage of the amount due. This is done based on the water delivery receipts signed by the farmers; and
- A report on the amount paid is prepared as compared to the total extraction from the main canal. This is a measure of the amount of water that is unaccounted for.

Collection of Rehabilitation (Cost Recovery) Charges. The collection of the Rehabilitation Repayment Charge (Cost Recovery) needs to be closely monitored. Monitoring is needed at the individual farmer level, at the tertiary unit level, and at the overall WUA area level. The WUA should be able to present the percentage of cost recovery payments to the annual meeting of the General Assembly or Representative Assembly. The names of the defaulters should be published.

Calculation of this indicator proceeds as follows:

- The WUA accountant prepares a report on the actual Rehabilitation Repayment Charge (Cost Recovery) as a percentage of the amount due;
- The total amount due is calculated by multiplying the number of hectares by the repayment levy;
- The total amount paid is calculated on the basis of the receipts; and
- The WUA accountant calculates the percentage by dividing the two and multiplying it by 100.

Payment in Cash Ratio. Farmers in Uzbekistan pay the WUA a considerable portion of the irrigation service fee in kind. However, as the farmers become better off financially due to the WUA's services, such in-kind payments should eventually be replaced by cash payments. In the meantime, the payment in cash ratio serves as an important indicator of the WUA's own state of development.

Calculation of the payment in cash ratio proceeds as follows:

- The WUA accountant prepares a report on actual payments in kind and on payments received in cash;
- The totals by method of payment is calculated on the basis of the receipts; and
- The WUA accountant calculates the percentage by dividing the payment in cash by the total payment received, then multiplying it by 100.

Other Financial Indicators. Other financial performance indicators of the WUA include the following: (1) the amount of interest paid because of low bank balance, (2) the amount of penalties paid due to late payment of taxes, (3) surcharges for late payments of the WUA's telephone and electricity bills, and (4) other such penalties. These indicators should be as close to 0 as possible.

These financial indicators should be presented separately to the General Assembly or Representative Assembly.

4. Agriculture Indicators

A WUA should exercise caution in analyzing agricultural indicators because of the multitude of factors that influence cropped areas, cropped intensity, and yields per hectare. These factors include input supply, the weather, the skill of the farmers, farmgate prices, production quotas, and the like.

Cropped Areas and Intensity, by Crop. For each crop, the area planted to it as well as the cropped intensity (%) of the whole irrigated area should be recorded. Changes in crops grown from year to year should be monitored. Calculation of this indicator proceeds on the basis of the cropping plan submitted by the farmers. This plan should be verified by the WUA at the end of the season.

Crop Yields. For each crop, the yield can be calculated based on a method of experimentally cutting the crop (test harvesting) in sample areas. This can show whether productivity is changing for each crop, and it can be used to assess the comparative crop productivities of the various parts of the irrigation area.

The O&M technician should calculate this indicator in the following manner:

- Indicate a $1m^2$-circular area in a representative part of a field, then harvest the crop within that circular area and weigh it;
- Multiply the weight by 10 to obtain the yield in tons per ha;
- Do this for several fields in several quaternary areas, then sum the results up to the various tertiary command areas; and
- Record all data in the Crop Yield Assessment Form.

Forms specific to performance monitoring are provided in Appendix 6.

5. Irrigation System and Environmental Monitoring Indicators

Soil Salinity. The soil salinity in a WUA's service area needs to be monitored on an annual basis. If necessary, leaching will have to be carried out, and the overall effectiveness of this leaching process has to be verified by field experimentation. If crop yields have been low in certain areas, testing for and verifying soil salinity at those locations is recommended.

Calculation of soil salinity proceeds as follows:

- The WUA's O&M technician, in cooperation with the Rural Business Advisory Council (RBAC), collects soil samples from suspected problem areas down to the applicable crop rooting depths;
- The soil samples are laboratory-tested for levels of salinity, physical structure, and chemical structure;
- The results of the soil test are assessed, recorded, and filed for future reference;
- The WUA advises the farmers on how remedial agricultural and irrigation practices are planned and implemented; and
- The O&M engineer reports the increased or decreased percentage of saline soil areas to the WUA Council and to the General Assembly or Representative Assembly during its annual meeting.

Groundwater Table Depths. As with the soil salinity, water table depths should be monitored on a quarterly basis in areas with subsurface or closed-pipe field drainage. The depths should give a good indication of the effectiveness of the drainage system.

Calculation of this indicator proceeds as follows:

- The O&M technician installs piezometer tubes (using 50mm PVC pipe) to a depth of 4 meters below the natural ground surface, with a gravel surround over the last meter of pipe that is slotted; or
- The O&M technician notes the location of pre-established tube-wells (bores) installed by the local Hydro-geological Amelioration Expedition Department; and
- The O&M technician measures, records, and files the data for compilation and analysis; and at the same time
- The O&M technician takes water samples for laboratory analysis of chemical content, nutrient content, and pesticide content. (Note: This is separate from the fortnightly taking of water samples for the assessment of salinity as well as of nutrient and pesticide content);
- If groundwater tables are unseasonably high, the WUA advises the farmers, then plans and implements remedial agricultural practices and irrigation practices to lower the groundwater table; and
- Investigation of the drainage system (collectors and closed-piped) is done to see if maintenance, repairs, or additional drains are needed. For this purpose, the Maintenance Registers are consulted to ascertain the extent of the recorded maintenance activities; and
- The O&M engineer reports the status of the depth of the water table to the WUA Council on a quarterly basis and to the General Assembly or Representative Assembly on an annual basis.

Water Salinity. The salinity of the irrigation water, groundwater, and drainage water should be monitored on a quarterly basis. The results of this monitoring should be correlated with the soil salinity results. They will also give an indication of the effectiveness of the field drain and natural drainage system.

Calculation of this indicator proceeds as follows:

- The O&M technician takes surface water samples from the irrigation canals, from the collector drains, and from the main irrigation supply canal to determine their water salinity (subsurface water samples are also taken to determine their nutrient and pesticide content);
- The O&M technician(s) arranges laboratory analyses of the same groundwater samples he had previously collected, this time for chemical content, nutrient, and pesticide determination;
- The WUA advises the farmers, then plans and implements remedial agricultural and irrigation practices to ensure that water applications are efficient and that excess water or runoff is avoided; and
- The O&M engineer reports the salinity levels of the irrigation, drainage and groundwater to the WUA Council on a quarterly basis and to the General Assembly or Representative Assembly on an annual basis.

Nutrients and Pesticides in Surface and Groundwater. The levels of nutrients and pesticides in both the surface water (irrigation and drainage water) and groundwater should be monitored on a bimonthly basis. This will give an indication of whether there is a cumulative effect resulting from the use of fertilizers and pesticides, and whether their application rates need to be modified.

Calculation of this indicator proceeds as follows:

- The O&M technician arranges for a laboratory analysis for nutrient and pesticide content of the same water samples he had collected for the salinity tests from the irrigation canals, collector drains, and the main irrigation supply canal and from the groundwater;
- The WUA advises the farmers on the results of the nutrient and pesticide content tests, and, if necessary, plans and implements remedial agricultural and irrigation measures for reducing fertilizer and content in the irrigation water;
- The WUA investigates the amount of irrigation runoff or excess applications that are draining to the underground; and
- The O&M engineer reports the results of the nutrient and pesticide content analysis to the WUA Council on a bimonthly basis and to the General Assembly or Representative Assembly on an annual basis.

D. Performance Objectives

1. Objectives for Irrigation

Irrigation Delivery Ratio. The irrigation delivery ratio is a measure of the quality of the WUA's operation. Consistently lower than 1.00 ratios need to be explained to the General Assembly or Representative Assembly and the necessary solutions have to be found. This is because inequitable or inadequate water deliveries are bound to dampen the willingness of the farmers to pay the irrigation service fee.

Possible reasons for irrigation delivery ratios consistently lower than 1.00 are as follows:

- Water theft by farmers upstream of the turnout structure;
- Illegal water deliveries to farmers who have not paid;
- The turnout structure and gate maintenance have been unduly deferred, or necessary replacements have not been undertaken; and
- Major irrigation canal repairs or maintenance work needed upstream are pending because the funds or machinery are not yet available, resulting in canal leakage.

Possible remedial measures for these are as follows:

- Implement sanctions against farmers responsible for water theft; and
- Improve the WUA's emergency maintenance response capabilities.

Water Use Efficiency. The water use efficiency is another good measure of the quality of the WUA's operation. It is also a reliable indicator of losses and misappropriation of water. It is determined by comparing the total cumulated actual delivery to farmers as a percentage of the total cumulated extraction from the main canal. It should also be calculated at the tertiary canal level. In such cases, it is determined by calculating the total cumulated delivery to a tertiary canal as a percentage of total cumulated extraction from the main canal.

Ideally, water use efficiencies should be close to 100%. Since losses are inevitable, however, the actual figures for a WUA will be considerably lower. They will reflect the water losses that are not accounted nor paid for.

Possible reasons for low water use efficiencies are as follows:

- Water losses due to theft, leakage, wastage, and oversupply;

- Deferment of canal maintenance and repairs; and
- Less than optimum maintenance measures being undertaken by the WUA.

Possible remedial measures are as follows:

- The WUA manager and O&M engineer should implement and apply sanctions on those responsible for water theft; and
- The O&M engineer should assess, rectify, and address poor maintenance activities and update the WUA's maintenance priorities.

Timeliness of Water Delivery. A WUA should deliver irrigation water to users promptly. The time lapse between the promised delivery time and the time of actual delivery should be as close as possible to 0. Every deviation from this objective should be duly accounted for and explained. For instance, emergency maintenance on the system may have made it impossible to make the delivery as scheduled. Repeated and systemic deviations from work schedules should be analyzed and corrected.

Possible reasons for a WUA's untimely water deliveries are as follows:

- Delays in the delivery of the bulk water supply to the WUA due to factors that are not under its control, such as emergency maintenance, water shortage, and inequitable distribution of bulk water between adjoining rayons;
- Maintenance activities within the secondary and tertiary canals;
- Breakages or malfunction in the turnout structure gate;
- Failure of the WUA gate operator to comply with the O&M engineer's instructions; and
- Failure of the water user to request for or demand his or her allocation or to report cropping plans, irrigation requests, or changes of plans to the O&M technicians.

Possible remedial measures for these situations are as follows:

- The WUA manager should improve liaison with the bulk water supplier so the WUA will know any major changes in its bulk water delivery plans well ahead of time;
- The O&M engineer should aim to rectify maintenance problems more quickly and efficiently;
- The WUA should exert more effort to improve the farmer/water user interface, such as by encouraging early reporting and prompt discussion of problems; and
- The WUA should determine and rectify any staff problems affecting the WUA's delivery, particularly between the WUA's gate operators and the O&M technician.

Cumulative Water Use. The cumulative water use of a WUA needs close monitoring so it will not exceed the allowable extraction level. The WUA should therefore inform farmers well in advance that water needs will have to be rationed so as not to exceed the prescribed extraction level. With experience, a WUA should be able to tell farmers way ahead if and when shortages, if any, will occur. The individual farmer can then take appropriate measures to minimize the adverse effects of such water shortages on his farming activities.

Possible reasons for a poor rating on cumulative water use are as follows:

- Outside influences beyond the WUA's control, particularly shortages in the bulk water supply; and
- Unforeseen major maintenance work due to natural disasters and fortuitous events.

2. Objectives for Maintenance

Structure Condition Ratio. The structure condition ratio is a clear—although subjective—measure of the WUA's quality of work. It can also be taken as a measure of the WUA's financial viability and sustainability, particularly with respect to its capacity to undertake maintenance, repair, and replacement works. This ratio can be monitored and presented for each tertiary canal. The WUA can then evaluate if any one tertiary unit is worse off than another.

A less than 100% score—which means a ratio less than 1.0—could in some instances be due to deferred maintenance. However, a structure condition ratio that consistently falls below 1.0 need to be explained to the WUA Council and to the General Assembly or Representative Assembly. Ideally, a WUA should target a consistent ratio of 1.0.

Possible reasons for a structure condition ratio below 1.0 are as follows:

- Budget constraints that require some periodic maintenance to be deferred;
- Excessive emergency maintenance requirements; and
- Deficient or less than optimum quality of maintenance works.

Possible remedial measures for these are as follows:

- The O&M engineer and the O&M technician should reassess the deferred maintenance list and establish new priorities;
- They should properly evaluate what caused the need for emergency maintenance; and
- The O&M engineer should properly assess the quality of work delivered by the WUA maintenance team (work gangs) and the civil works contractors.

3. Financial Objectives

The most important indicators for the attainment of a WUA's financial objectives are the following: (1) collection of water charges, (2) payment in cash ratio, (3) collection of rehabilitation repayment charges (cost recovery), and (4) such other financial indicators as the amount of interest paid because of low bank balance, the amount of penalties paid due to late payment of taxes, and surcharges for late payment of telephone and electricity bills. All of these indicators should be monitored on an individual, tertiary, and overall scheme level.

The WUA should target a consistent score of 100% for the first three financial indicators, then a score of zero for the "other financial indicators." The O&M engineer and the WUA's accountant should take immediate action whenever the figures for the first three financial indicators fall below 100%. The names of the payment defaulters should be made known at the General Assembly or Representative Assembly. The WUA's accountant should likewise take immediate action when the "other financial indicators" go consistently above zero.

Possible reasons for a score of less than 100% in the first three financial indicators as follows:

- Crop failure, reduced yields, and pest and disease incidence, all of which require verification and concurrence between the farmer, the WUA, and the agricultural department advisor;

- Water users' dissatisfaction with water delivery and maintenance activity in their respective quaternary and tertiary units;
- Inability of a certain percentage of farmers to crop during the current year; and
- Abnormal or excessive rainfall, which results in reduced yields, minimal water usage and requests, and a minimal irrigation service fee payment by the water user.

Possible remedial measures for these problems are as follows:

- The WUA staff should visit the farmers and water users who default in their payments to get them to agree to make partial payments or work out a mutually acceptable payment schedule;
- The O&M engineer should clarify and rectify the water distribution problem as well as check the maintenance activity and records for possible mistakes or overlooked items; and
- The WUA's accountant should reassess expenses with respect to telephone and electricity usage.

4. Objectives for Agriculture

Cropped Areas and Crop Intensities. Although a WUA is not primarily responsible for increasing the cropped area and the crop intensities in its service area, achieving these two objectives is nevertheless considered a criterion for evaluating the quality of its management and O&M. The WUA should therefore identify the reasons for the reduced cropped areas and low crop intensities and determine to what extent poor O&M had contributed to them. Afterwards, the WUA should take appropriate measures to increase them.

High values for cropped areas and crop intensities will directly improve the WUA's financial situation. Indeed, when cropped areas and crop intensities are consistently high, farmers will be in a much better position to pay the irrigation service fee and other dues. The WUA would then be able to pay the salaries of its staff even in the hypothetical case that no farmer in its service area grows a crop during a particular growing season.

Possible reasons for reduced cropped areas and low crop intensities, insofar as the WUA is responsible for them, are as follows:

- Illegal water deliveries to farmers who have not paid the irrigation service fee;
- Failure of some areas to grow crops due to salinization or high groundwater level, or both;
- Deferred maintenance or poor periodic maintenance activity by the WUA, or the WUA's failure to provide routine maintenance to the area; and

Possible remedial measures for these problems are as follows:

- Instructing the WUA's gate operators to reinforce control on water deliveries;
- Investigating the drainage network, adding additional open collectors or closed-pipe (SDH) drainage installations, and reminding the farmers concerned about the leaching requirement; and
- Undertaking maintenance works that give priority to tertiary units where cropped areas and intensities are the lowest.

Crop Yields. A WUA is not primarily responsible for crop yields as there are simply too many criteria and variables beyond its control that affect them. As noted earlier, however, crop yields are one of the criteria for measuring the quality of a WUA's management. The WUA should therefore ask itself to what extent poor O&M is a reason for a low crop yield. Afterwards, the WUA should take appropriate measures to increase those yields. It should always keep in mind that higher crop yields, along with higher cropped areas and crop intensities, will mean that a farmer will be better able to pay the irrigation service fee.

Possible reasons for low crop yields, insofar as the WUA is involved, are as follows:

- Illegal water deliveries to farmers who have not paid the irrigation service fee;
- Failure of some areas to grow crops due to salinization or high groundwater level, or both;
- Deferred maintenance or poor periodic maintenance activity by the WUA, or the WUA's failure to provide routine maintenance to the area;
- Improper timing of irrigation discharges; and
- Improper volumes of irrigation discharges.

Possible remedial measures for these problems are as follows:

- Instructing the WUA's gate operators to reinforce control over water deliveries;
- Investigating the drainage network, adding additional open collectors or closed-piped (SDH) drainage installations, and reminding the farmers concerned about the leaching requirement;
- Assessing and strengthening the O&M capability of WUA members and farmers within the quaternary units that are identified with poor crop yields; and
- Assisting WUA members and farmers in undertaking or establishing priorities for routine and periodic maintenance works in quaternary units where greatly reduced cropped areas and crop intensities have been identified.

5. Objectives of Irrigation System and Environmental Monitoring

The major performance indicators here are soil salinity, groundwater table depths, water salinity, and nutrient and pesticide content in surface water and groundwater. These indicators should be monitored on the individual, tertiary, and overall scheme level. The assessment of the performance monitoring sampling should show a lowering of all the "value" indicators, which is the ultimate objective.

Possible reasons for high readings of chemicals and salts in surface and groundwater are as follows:

- The farmers' lack of knowledge about the correct methods of applying fertilizers and pesticides, and the disposal of fertilizer and pesticide containers close to watercourses and collector drains;
- Excessive irrigation applications during or after periods of fertilizer, pesticide and herbicide sprays or spreading; and excess wastage of water during irrigation applications; and high losses from canals due to seepage; and
- Adverse effects of malfunctioning drainage systems on the water table.

Possible remedial measures for these problems are as follows:

- Consultation with and training of farmers on the correct procedures for fertilizer and chemical applications and for the disposal of excess chemicals and their containers;
- Consultation with and training of farmers in good irrigation management practices;

- Inspection by the O&M engineer of the operational capacity of the drainage systems (collectors and closed piped);
- Assessment and evaluation of the need for additional drainage; and
- Checking of the maintenance register of works to ensure timely execution of critical maintenance activities.

E. Performance Monitoring and Assessment Forms and Records

The forms listed below may help WUAs in conducting performance monitoring:

- Maintenance Registers and Monthly Inspection Report Forms *(Appendix 4.2)*: These should be kept on file in the WUA office;
- Maintenance Implementation Report *(Appendix 4.3)*: This should be kept on file in the WUA office;
- Use of Maintenance Materials and Tools Form *(Appendix 4.4)*;
- Annual WUA/Farmer Cropping Plan *(Appendix 5.1)*;
- WUA Annual Operations Plan *(Appendixes 5.2, 5.3)*: This is for use in calculating the seasonal water requirements on an overall basis throughout the season;
- Request for Water Supply Form *(Appendix 5.4)*;
- WUA Daily Water Measurement and Daily Planning Distribution Form *(Appendix 5.5)*: These are for use in recording the discharges at each flow-meter and staff gauges each morning and evening;
- Water User Receipt of Water Supply *(Appendix 5.6)*;
- Crop Yield Assessment Form *(Appendix 6.1)*;
- Record of WUA Charges and Irrigation Service Fee Collections *(Appendix 7.1)*: This is the amended payment book form described in Guidebook 3. It should be kept on file in the WUA office; and
- Rehabilitation Repayment (Cost Recovery) Form *(Appendix 7.2)*: This is used to record payments of the farmers, whether WUA members or not, for their proportional share of the cost of rehabilitation of the irrigation and drainage infrastructure.

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Appendix 1.0 STAFF QUALIFICATIONS

1.01 Management Staff

The WUA Council chair is an unpaid position in the WUA's governing bodies (the WUA Council and General Assembly), rather than in the WUA's Management Team (staff). He or she is a member of the WUA Council, and is elected to the position by its members. Organizationally, however, the position of WUA chair is included in the list of the WUA Management staff because it is responsible for the supervision of the WUA Management Team (WUA Manager and Staff), and as such is the liaison between the WUA Management Team and the WUA Council.

1.02 WUA Chair

Qualifications	Responsibilities
▪ Farmer ▪ High school education ▪ Irrigation or agricultural management experience	▪ Overall management of the WUA scheme ▪ Supervision of the WUA Management Team (staff) ▪ Regular meetings with WUA Manager (daily, weekly, or as agreed) ▪ Liaison between WUA Management Team and WUA Council ▪ Liaison with all interrelated agencies, such as the Basin Administration, MAWR, local government, rayon and oblast authorities

1.03 WUA Manager

Qualifications	Responsibilities
▪ Senior Hydro-Technician or ▪ Former Brigade Leader of Shirkat Irrigation Brigade ▪ Experienced in irrigation and/or agricultural management and administration ▪ Knowledge of the government's water management policies, laws and regulations	▪ Day-to-day management of the staff of WUA Management Team ▪ Overall scheme management with respect to O&M ▪ Preparation and implementation of annual work plans In cooperation with O&M Engineer ▪ Planning and implementation of water distribution/scheme operation in cooperation with O&M Engineer ▪ Planning and implementation of scheme maintenance works programs in cooperation with O&M Engineer ▪ Directing budget and financial control in cooperation with the WUA's Accountant ▪ Reports on WUA activities to WUA Chair daily or weekly or as agreed ▪ Setting and approving irrigation service fee rates for presentation to WUA Council and General/Representative Assembly ▪ Collating data on the overall performance monitoring of irrigation and drainage, of O&M, and of WUA and staff

1.04 Accountant

Qualifications	Responsibilities
▪ Bachelors Degree or Diploma in Accounting or Business Administration ▪ Experience in accounting/business practice for an agricultural enterprise or irrigation management enterprise	▪ Financial management accounting practices recognized by the Government of Uzbekistan ▪ Keeping of transparent records of all WUA financial transactions ▪ Collection and recording of water charges–cash or in-kind (crop & labor) ▪ Payment of all accounts as per invoice and on time ▪ Preparation of regular financial statements for WUA Council and WUA General/Representative Assembly ▪ Purchasing and supervising stores such as spare parts, materials, office disposables, etc. ▪ Maintenance of accurate bank records and statements ▪ Reporting financial management issues to WUA Chair/WUA Manager ▪ Assisting WUA Manager in the preparation of the annual budget ▪ Making records available for inspection by WUA members and Audit Commission when requested.

1.05 O&M Engineer (Senior Hydro-Technician)

The combination of an O&M Engineer as WUA Manager and the appointment of a separate position of O&M Engineer (Senior Hydro-Technician) is the best situation for a WUA Management Team. However, if the WUA Manager is an administrator and not an engineer, then consideration may have to be given to the appointment of two O&M positions, namely an O&M Engineer and a Deputy O&M Engineer. The associated O&M activities are numerous and demanding of time.

Qualifications	Responsibilities
▪ Irrigation (O&M) Engineer (Senior Hydro-Technician) ▪ Experience as an Irrigator/ Engineer on a *Shirkat* or with MAWR as an engineer ▪ Knowledge on maintenance and quality control ▪ Experience on light and heavy-duty equipment and machinery ▪ A knowledge of construction materials ▪ Experience on O&M planning and budgeting	▪ Day-to-day planning and management of O&M ▪ Water planning and distribution and overall system operation based on O&M Technicians' reports ▪ Operation of the drainage system ▪ Performing maintenance inspections, planning, and implementation ▪ Planning and implementing scheme maintenance in cooperation with O&M Technicians and WUA Manager ▪ Consultation with WUA Manager on the drafting of the annual work plan ▪ Coordination and supervision of O&M Technicians, Construction Supervisor, routine maintenance work force, laborers; and maintenance contractors for periodic maintenance ▪ Calibration and checking of all measuring structures at all regulated gated outlets and structures in relation to design flows and calibration charts ▪ Day-to-day performance monitoring

1.06 O&M Technicians (Field Hydro-Technicians)

The number of O&M Technicians to be employed depends on several aspects of WUA management: the number of farmers or water users, the total number of kilometers of irrigation canals and the number of structures, and the total number of kilometers of drains, both surface and subsurface. A decision must be made on the basis of how many farmer/water users that an O&M Technician can meet with daily, and the number of kilometers of canals/drains that he or she can inspect daily or weekly. Experience will be a good guide in the decision process, but a rule of thumb is to employ more rather than less in the initial years, either as part-time of full-time employees. In the non-irrigation season, O&M Technicians can be employed to assist in maintenance works.

Qualifications	Responsibilities
▪ Technical College diploma or high school education ▪ Experience in irrigation practices, O&M procedures, regulator gate operation, flow measurement, recording, maintenance assessment ▪ A knowledge of machinery, equipment, and construction materials ▪ Knowledge of soil-water-crop relations ▪ A willingness to be trained	▪ Farmer liaison for details of cropping patterns, planting dates and daily/scheduled water requirements ▪ Water distribution at field level (control and supervision) and scheme operation and distribution at secondary canal and tertiary canal level ▪ Regular inspections of canals and drains for reporting of routine and periodic maintenance needs ▪ Accurate record-keeping of maintenance requirements, per canal, per structure and per entry into Maintenance Register ▪ Supervision of and liaison with gate operators ▪ Regular reporting to O&M Engineer ▪ Assistance in the preparation of the scheme maintenance work plans ▪ Supervision of routine maintenance work schedules and gangs in cooperation with the Construction Supervisor

1.07 Gate Operators

Selection of the appropriate number of Gate Operators depends on several factors:

- The number of gates;
- The distance between gates; that is, the number of gates per kilometer;
- The honesty of the water users with respect to WUA allocations and regulatory gate settings, and the need to guard gates against vandalism and water theft; and
- The number of gates that an operator can handle daily taking into account the following activities: irrigation scheduling; opening and closing gates; guarding; measuring and recording flows; and routine maintenance of the gate structure, the measurement structure, and the irrigation canals for a minimum distance of 10 meters upstream and downstream from the gate and/or measuring structure.

Experience will be a good guide in deciding how many Gate Operators are required, but a rule of thumb is to employ more rather than less in the initial years, either as part-time of full-time employees. During the non-irrigation season, they can be employed to assist in maintenance works. As in the case of O&M Technicians, Gate Operators can be used as laborers or supervisors of maintenance works during the non-irrigation season. Gate Operators can be employed either full-time or part-time.

Qualifications	Responsibilities
▪ High school education ▪ Technical experience/	▪ Responsible for day-to-day gate operation ▪ Responsible for routine maintenance of gate structures,

qualification as a mechanic, electrician, or other ▪ Experience of irrigation system operation ▪ Experience on flow measurement and related devices ▪ Basic knowledge of maintenance requirements and techniques ▪ Willingness to be trained	gates, gate rubbers, gate drive mechanisms, measuring structures, flumes, and hydro-posts ▪ Cleaning of the gate structure and flow measuring structure for trash, sediment, blockages, and weed growth ▪ Cleaning of the irrigation canal for a minimum distance of 10 meters upstream and downstream of the gate structure and flow measuring structure ▪ Recording of delivery flows to the water users twice daily –in the morning and afternoon ▪ Assisting O&M Engineer in regular calibration checks of all measuring structures and regulated gate outlets

1.08 Construction Supervisor

Qualifications	Responsibilities
▪ Bachelor's degree in Engineering, or ▪ Technical diploma in Engineering, or ▪ Vast experience as a Construction Foreman on irrigation construction sites ▪ Experience in construction supervision of irrigation or civil works contracts– relative to quality reporting, time management, and sign-off on work completed –i.e., construction management ▪ Knowledge of light and heavy machinery and equipment	▪ Supervision of day labor/work gangs responsible for repair and construction under routine maintenance work plans ▪ Supervision of contractors/tenders for repair and construction under periodic maintenance work plans ▪ Reporting progress to O&M Engineer and WUA Manager ▪ Supervision and control of materials store for maintenance ▪ Supervision of vehicles, machinery, and equipment used during the implementation of maintenance work plans ▪ Reporting maintenance needs and requirements noticed during the repair and construction of routine or periodic maintenance plans, particularly those missed by O&M Technicians / O&M Engineers in their irrigation and drainage system walk-throughs ▪ Assist the O&M Engineer in the preparation of cost analysis of works and tenders with respect to machinery, equipment, material, and labor costs

1.09 Service Foreman (Maintenance Work Gangs / Machinery & Equipment)

Qualifications	Responsibilities
▪ Technical Engineering diploma, or ▪ Technical diploma-mechanic for machinery/equipment repair and maintenance ▪ Experience in supervision of workers and work gangs on a day-to-day basis ▪ Working knowledge of the operation and use of heavy and light equipment and machinery ▪ Working knowledge of the type and use of construction materials ▪ Basic knowledge of maintenance procedures	▪ Organizing and supervising the day-to-day maintenance work gangs, laborers, and program for the irrigation and drainage system ▪ Consulting with the O&M Technicians on the above activities as to needs, priorities, and planning ▪ Assisting the Construction Supervisor in the supervision of contracts and the day-to-day planning of periodic maintenance contracts ▪ Assisting the O&M Engineer in maintenance planning and implementation ▪ Supervising stores, machinery, vehicles, and equipment ▪ Preparing plans for machinery servicing requirements of all vehicles, machinery, and equipment ▪ Responsible for oil, fuel, and spare parts stores for all vehicles, equipment, and machinery, ordering them under the direction of the Accountant and WUA Manager ▪ Responsible for control and supervision of the machinery workshop and all of its tools and equipment.

1.10 Agronomist

The position of Agronomist is not included in the WUA Management Organization Chart above, as it is considered only as a possible staff position for inclusion within the WUA Management Team of a WUA Federation. However, some WUAs may have a need for an agronomist for consulting services on a part-time contractual basis. It should be noted here that the Rural Business Advisory Center (RBAC) is meant to offer agronomic advice and other services to WUAs and farmers in Ak Altin Rayon as well as to the five rayons within the World Bank Rural Enterprise Support Project. However, the RBACs exist only with these pilot rayons, and it is unknown whether or not the government will choose to adopt this as a model to be replicated throughout Uzbekistan.

Qualifications	Responsibilities
▪ Agricultural Science or Rural Technology degree from a recognized university ▪ Experience in an agricultural/agronomic extension capacity or as an agronomic consultant	▪ Agricultural advice to WUA members ▪ Presenting and encouraging crop diversification and crop rotation programs ▪ Conducting small-scale agricultural demonstrations ▪ Advising farmers on infield water management (furrow length and flow) ▪ Advising farmers on irrigation scheduling (how often and how much and when to irrigate) ▪ Advising farmers on agricultural inputs, marketing, and machinery

1.10 Amelioration Expert (for Saline and Waterlogged Areas)

The position of Amelioration Expert has merit in areas with saline soils and waterlogged soils. However, a qualified O&M Engineer should be capable of achieving irrigation water conveyance and application efficiency as well as achieving adequate management of drainage to control salinization and waterlogging. Thus, sound O&M practices and good irrigation infield practices by farmers reduce the need for an amelioration expert. As in the case of the agronomist position, however, the position of amelioration expert is considered a possible staff position for inclusion within the WUA Management Team of a WUA Federation. Some WUAs in particularly salinized and waterlogged areas (such as Karakalpakistan) may have a need for an amelioration expert for consulting services on a part-time contractual basis. It must be kept in mind, however, that WUAs can also consult with the RBAC in Ak Altin District on methods of combating salinization and waterlogging (The role of RBACs in Uzbekistan is as explained in the discussion of the agronomist position above.)

Qualifications	Responsibilities
▪ Bachelor of Science in Agriculture or Bachelor of Irrigation Engineering ▪ Experience as a consultant or practical researcher on issues of salinity, waterlogged soils, drainage, and irrigation	▪ Advising farmers on methods of control of salinity ▪ Advising farmers on methods of best practice with respect to the control of salinity and waterlogged areas ▪ Advising the WUA on methods of best practice for agricultural applications to combat salinity and high water table, such as land leveling, subsurface drainage, deep ripping (subsoiling) ▪ Conducting small-scale agricultural trials on the WUA area to improve saline soil areas, etc. ▪ Monitoring water table salinity levels and the salinity of irrigation water

SUPPORT STAFF

1.11 Accounts Clerk

This position should be filled on a part-time or full-time basis, depending on the specific needs of the WUA.

Qualifications	Responsibilities
▪ High school education ▪ Accounting diploma or Business degree	▪ Assisting the Accountant in the recording of all WUA financial activities and transactions ▪ Recording collections of the irrigation service fee and all other fees and charges ▪ Assisting in routine accounting procedures and record-keeping ▪ Assisting the WUA Manager and Accountant as directed

1.12 Administration Assistant

This position should be filled on a part-time or full-time basis, depending on the specific needs of the WUA.

Qualifications	Responsibilities
▪ High school education ▪ Business Administration/office management experience	▪ Performing routine office administration duties ▪ Typing correspondence and reports, filing all correspondence, and maintaining office records ▪ Assisting the WUA Manager and Accountant as directed

1.13 Mechanics and Electricians

Each WUA should have one full-time mechanic in its staff to handle emergency breakdowns of vehicles, machinery, and equipment. However, electricians and other mechanics (if needed) should be employed on a contract, on-call basis. If the mechanics on call are experienced, professional, and reliable, then there may be no need to employ a permanent mechanic. It is enough that a mechanic is available at the time of an emergency breakdown.

Qualifications	Responsibilities
▪ High School education ▪ Technical Trade diploma as mechanic/electrician ▪ Experience in the trade ▪ Professional and reliable work practice	▪ Performing mechanical and electrical (if included in WUA O&M inventory) equipment inspections to determine repair, maintenance, or replacements ▪ Carrying out routine mechanical and electrical equipment, repairs, and maintenance schedules ▪ Ensuring that all vehicles, machinery, and equipment are serviced as per service warranty agreements and operational guidelines

1.14 Laborers/Work Gangs for Routine Maintenance

Each WUA needs a permanent manual work force to implement the day-to-day maintenance activities of routine maintenance. This work can also be contracted to civil works contractors who have been awarded tenders for large-scale periodic maintenance works. Therefore, the group of laborers can encompass both a full-time workforce, complemented whenever necessary by a part-time manual labor force.

It should be emphasized that the *hashar* will cover only part of the labor needs of the WUAs. Furthermore, a work gang, after it gains experience, can provide more specialized and effective services.

Qualifications	Responsibilities
▪ A minimum of primary school education ▪ Experience as a farm laborer or as a laborer in civil construction works	▪ Employed as part of a manual labor work gang to carry out routine irrigation and drainage system maintenance, such as repairs, painting, oiling, greasing, grass cutting, trash, and weed removal from canals and drains, road repair, minor concrete repair, earth canal repair

1.15 Drivers

According to best management practice, employed drivers should be multiskilled. Drivers should have multiple licenses (car, truck, tractor, excavator, dragline, motorcycle, etc). In addition, a driver who is also a qualified mechanic is an advantage, for he can be employed as a multi-technician; i.e., as a mechanic and driver.

Qualifications	Responsibilities
▪ Multi-skilled with multiple licenses for road vehicles, tractors, excavators, graders, drag-lines ▪ If a mechanic, a bonus	▪ Employed to drive WUA vehicles, machinery, and equipment as directed ▪ Ensuring that all vehicles, machinery, and equipment are available for regular servicing as per operational guidelines and warranty agreements ▪ Ensuring the regular checking of fuel and oil needs

Appendix 2.0: SAMPLE INVENTORY FORM

INVENTORY IRRIGATION AND DRAINAGE INFRASTRUCTURE

Description of Item – Canal, Drain or Structure	Number or Name of Irrigation or Drainage Item	Length of Canal or Drain kilometers	Capacity of Canal or Drain – (D) = design & (P) = peak (m^3/sec)	Length of Canal Concrete / Earth Ratio (kilometers)	Distance of Irrigation Structure from Offtake Gate (kilometers)	Distance of Drainage Structure from Drain Outlet (kilometers)	Irrigated Service Area of Irrigation Canal or Collector Drain (hectares)	Date of last Maintenance Inspection	Date of Construction or Rehabilitation or Major Maintenance (C or R or M)	Responsible Organization
Main Supply System										
Main Supply Canal	RBC		46 (D) 51.5 (P)							Boyovut Arnasay Irrigation System Administration
Main Offtake Gate to PR5 – Second Canal	RBC-PR5 (OG)									Boyovut Arnasay Irrigation System Administration
Regulatory Gate Structure on RBC for PR5	RBC-PR5 (RG)									
Pumped Supply – if applicable										
SECONDARY CANAL SYSTEM										
Secondary Canal	PR5	11.6								WUA Ung Tarmok
Tertiary Offtake Structure – Gate No 1	PR5-1G									
Tertiary Regulatory Gate – No 1	PR5-1R									
Road Crossing										
Culvert										
Siphon										

INVENTORY IRRIGATION AND DRAINAGE INFRASTRUCTURE										
Description of Item – Canal, Drain or Structure	**Number or Name of Irrigation or Drainage Item**	**Length of Canal or Drain kilometers**	**Capacity of Canal or Drain – (D) = design & (P) = peak (m^3/sec)**	**Length of Canal Concrete / Earth Ratio (kilometers)**	**Distance of Irrigation Structure from Offtake Gate (kilometers)**	**Distance of Drainage Structure from Drain Outlet (kilometers)**	**Irrigated Service Area of Irrigation Canal or Collector Drain (hectares)**	**Date of last Maintenance Inspection**	**Date of Construction or Rehabilitation or Major Maintenance (C or R or M)**	**Responsible Organization**
Measuring Structure	PR5-TM1									
TERTIARY CANAL SYSTEM										
Tertiary Canal	PR5-1	0.75								WUA Ung Tarmok
Quaternary/Field Offtake Gate No 1	PR5-1-1G				0.25					
Quaternary/Field Offtake Gate No 2	PR5-1-2G				0.5					
Quaternary/Field Regulatory Gate	PR5-1-1R									
Measuring Structure	PR5-1-1M									
Road Crossing										
Siphon										
Culvert										
OPEN COLLECTOR DRAINAGE NETWORK										
Collector	18-K-9	12.7								
Collector	19-K-1	12.6								
Collector	19-K-2	12.9								
CLOSED PIPE DRAINAGE NETWORK										
Field – Network	Farm xxx									

INVENTORY IRRIGATION AND DRAINAGE INFRASTRUCTURE										
Description of Item – Canal, Drain or Structure	**Number or Name of Irrigation or Drainage Item**	**Length of Canal or Drain kilometers**	**Capacity of Canal or Drain – (D) = design & (P) = peak (m^3/sec)**	**Length of Canal Concrete / Earth Ratio (kilometers)**	**Distance of Irrigation Structure from Offtake Gate (kilometers)**	**Distance of Drainage Structure from Drain Outlet (kilometers)**	**Irrigated Service Area of Irrigation Canal or Collector Drain (hectares)**	**Date of last Maintenance Inspection**	**Date of Construction or Rehabilitation or Major Maintenance (C or R or M)**	**Responsible Organization**
ROAD NETWORK										
Road No 1 - Collector	19-K-1 (AR)									
Road No 2 - Collector	18-K-9 (AR)									

Appendix 3.0: REGISTERS

3.1 List of Water Users and WUA Members

LIST OF WATER USERS AND WATER USERS' ASSOCIATION MEMBERS											
Name of Water User Farmer	**Tertiary Unit Quaternary Unit Number**	**WUA Member (Y / N)**	**Water Use ***	**Farm / Plot Cadastral Number or Other**	**Farm Area (ha)**	**Irrigated Area of Farm / Plot Crops**					
						Cotton	**Wheat**	**Lucerne Alfalfa**	**Maize**	**Melons**	**Other**
Tertiary Canal / Unit	*PR5-11*										
Quaternary Unit	*5-11-QU-1*										
Oybek Hamidov		*Y*	*A*	*CS 58*	*27*	*15*	*12*				
Safar Urokbayev		*Y*	*A*	*CS 59*	*35*	*20*	*10*			*5*	
Husan Abdullaev		*N*	*DF*	*CS 60*	*2*						*2*
Quaternary Unit	5-11-QU-2										
Ghaybulla Holbekov		*Y*	*A*	*CS 62*	*50*	*30*	*15*		*3*	*2*	

WUA Member: Y = Yes and N = No.
Water Use (*): Agricultural = (A); Dehqan Farmer = (DF); Garden Plot = (GP); Industrial = (I); School = (S); Church/Mosque = (C)

3.2 Register of Irrigated Area

REGISTER OF IRRIGATED AREA							
WUA: *(Ung Tarmok)*____________________ **Irrigation Block Number:** *(Q4 / PR5-11)*						**Village:** *(Ung Tarmok)*____________________ **Quaternary Block Number:** *(PR5-11 / QB 4)*_ **Tertiary Block Number:** *(PR5-11)*___________	
Name of Farmer / Irrigator	**Irrigation Plot / Field No.**	**Plot Area (ha)**	**Crops**	**Cropped Area (ha)**	**% of Total Irrigated Plot**	**Soil Type & Slope**	**Remarks**
Abdunazar Egilikov	*Field 1*	*25*	*Cotton*	*15*	*60*	*Loamy clay – 0.001%*	
			Wheat	*10*	*40*	*Loamy clay – 0.001%*	
			Maize				
			Lucerne / Alfalfa				
			Vegetable				
			Melon				
	Sub Total	*25*		*25*	*100*		
Otabek Rashidov	*Field 1*	*35*	*Cotton*	*20*	*57.15*	*Sandy Loam 0.002%*	
Please note that the name registered on the above line could be the same farmer with a different irrigated field/plot OR it could be the name of another farmer			*Wheat*	*9*	*25.70*	*Sandy Loam 0.002%*	
			Maize				
			Lucerne / Alfalfa				
			Vegetable				
			Melon	*2*	*5.71*		
	Sub Total	*35*		*31*	*88.57*		

Appendix 4.0 SAMPLE MAINTENANCE FORMS

4.1 Maintenance Identification Form

MAINTENANCE IDENTIFICATION FORM

Prepared: ________________________

Daily / Monthly / Yearly inspection: ____________________________________

Date: __________________________

Date: ____

LOCATION		Description of Problem (including full detail and sketch)	Cost estimate of works (Som)	Priority
Canal/Drain	Chainage and structure			
1	2	3	4	5

4.2 Maintenance Register

MAINTENANCE REGISTER

Prepared: ________________________ **Daily / Monthly / Yearly inspection:** ______________________________

Date: __________________________ **Date:** ____

LOCATION		Description of Problem (including full detail and sketch)	Cost estimate of works (Som)	Priority	Carried out or not
Canal/Drain	Chainage and structure				
1	2	3	4	5	6
		Date of identification:			☐ Y ☐ N
		Date of identification:			☐ Y ☐ N
		Date of identification:			☐ Y ☐ N
		Date of identification:			☐ Y ☐ N

4.3 Maintenance Implementation Report

MAINTENANCE IMPLEMENTATION REPORT

Prepared: ________________________ **Approved:** ____

Date: ___________________________ **Date:** ____

LOCATION		Description of completed repair works (including reference to document of fulfillment assessment)	By whom fulfilled	Date of completion	Cost (Som)
Canal/Drain	Chainage and structure				
1	2	3	4	5	6

4.4 Use of Maintenance Materials and Tools

USE OF MAINTENANCE MATERIALS and TOOLS FORM

Prepared: ________________________ **Approved:** _____________________ **Month:** ______________ **Year:**__________________

Date: ____________________________ **Date:** __________________________

Material	Unit	Stocks at the beginning of month	Use	Check (if 3>4)	Quantity for purchase	Stocks at end of month
1	2	3	4	5	6	7
Cement	Sack					
Stone	M3					
Empty sacks for sand	Pieces					
Steel of 8 mm	M					
Steel of 12 mm	M					
Paint	Kg					
Grease	Kg					
Vaseline	Kg					
Lubricant SAE 40	Kg					
Lubricant SAE 90	Kg					
Paintbrushes	Pieces					

Appendix 5.0 SAMPLE OPERATIONS FORMS

5.1 Annual WUA Cropping Plan

№	Crops	Area (ha)	March			April			May			June			July			August			September			October			November			December			January			February			Total Area
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1	Cereals, ear and one year grasses																																						*0*
2	Sugar beet																																						*0*
3	Vegetables																																						*0*
4	Melon / Potatoes																																						*0*
5	Maize																																						*0*
6	Perennial grasses																																						*0*
7	Cotton																																						*0*
8	Water spreading																																						*0*
9	Total physical area (ha)	0																																					*0*

Checked by

5.2 Annual Operations Plan: April 1 to September 30

№	Crops	Area (ha)	Irr. Norm (m3/ha)	Units	April			May			June			July			August			September		Total Area
					1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	
1	Cereals, ear and one year grasses			ra / ha																		
				т.м3/t.m3																		
2	Sugar beet			ra / ha																		
				т.м3/t.m3																		
3	Vegetables			ra / ha																		
				т.м3/t.m3																		
4	Melon / Potatoes			ra / ha																		
				т.м3/t.m3																		
5	Maize			ra / ha																		
				т.м3/t.m3																		
6	Perennial grasses			ra / ha																		
				т.м3/t.m3																		
7				ra / ha																		
				т.м3/t.m3																		
8	Cotton			ra / ha																		
				т.м3/t.m3																		
10	Water spreading			ra / ha																		
				т.м3/t.m3																		
11	**Total physical area by all Nrs.**	**0**	**0**	ra / ha																		
				т.м3/t.m3																		
12	**Also for farming needs**	0	0	ra / ha																		
				т.м3/t.m3																		

13	**Total water use**	**0**	т.м3/t.m3	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
14	**Efficiency of farm network**	**0.80**	т.м3/t.m3	0.80	0.80	0.80	0.80	0.80		0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
15	**Gross water use**	**0**	т.м3/t.m3	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
16	Constant project flow (m3/s)			0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Total area watered			0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Flow in l/s/ha watered area			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Flow in l/s/ha project area			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
16	**In the head of offtake**		м3/га m3/ha																			
17	**Water limit**		м3/га m3/ha																			

5.3 Annual Operations Plan: October 1 to March 30

№	Crops	Area (ha)	Irr. Norm (m3/ha)	Units	October			November			December			January			February			March			Total Area
					1	2	3	1	2	3		1	2	3	1	2	3	1	2	3	1	2	
1	Cereals, ear and one year grasses			ra / ha																			
				т.м3/t.m3																			
2	Sugar beet			ra / ha																			
				т.м3/t.m3																			
3	Vegetables			ra / ha																			
				т.м3/t.m3																			
4	Melon / Potatoes			ra / ha																			
				т.м3/t.m3																			
5	Maize			ra / ha																			
				т.м3/t.m3																			
6	Perennial grasses			ra / ha																			
				т.м3/t.m3																			
				ra / ha																			
7				т.м3/t.m3																			
8	Cotton			ra / ha																			
				т.м3/t.m3																			
10	Water spreading			ra / ha																			
				т.м3/t.m3																			
11	**Total physical area by all Nrs.**	**0**	**0**	ra / ha																			
				т.м3/t.m3																			
12	Also for farming needs	0	0	ra / ha																			
				т.м3/t.m3																			

13	**Total water use**		**0**	т.м3/t.m3	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
14	**Efficiency of farm network**		**0.80**	т.м3/t.m3	0.80	0.80	0.80	0.80	0.80		0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
15	**Gross water use**		**0**	т.м3/t.m3	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
16	Constant project flow (m3/s)				0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Total area watered				0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Flow in l/s/ha watered area				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
	Flow in l/s/ha project area				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
16	**In the head of offtake**			м3/га																			
				m3/ha																			
17	**Water limit**			м3/га																			
				m3/ha																			

5.4 Water User Request for Water Supply

WATER USERS ASSOCIATION
REQUEST FOR WATER SUPPLY

No: _____________________________

Farmer's name: ____

Field location:____

Preferable date supply: ____

Overcharging volume of water: ____

Water charge: ____

Payment: _______________________________- (Som)

In signing this request, I recognize and I accept the conditions of water supply; in particular, I know that I shall not receive water if:
- I have not paid for it
- I have not yet paid the duty on reconstruction of infrastructure
- I have exceeded the limit

Signature: __________________________ **Date:** ________________________

Only for Official Use

Total water supply:	m^3	**Number of contract of water supply:**	**Data/№**
		Current water supply:	m^3
Reconstruction duty:			**Data/№**
Total supply:	m^3	**Purchase duty:**	**Data/№**
Limit:	m^3	**Water charge:**	**Data/№**

Approved:___________________ **Date:** ______________________

5.5 Daily Water Measurement

Measurement – depending on the type of measurement structure

(i) **Flume** – water levels related to the calibrated design curve

(ii) **Hydro-post** – measuring pole / rod related to a calibrated curve from flow meter measurements and determination.

(The sample form is shown on the next page.)

DAILY WATER DISCHARGE AND LEVELS

Post №_____________ on canal________________________ system _______________

___________________ Rayon Oblast: ______________________

Month ___________

Note of bench mark ______________zero of gauge _____________gauge datum________

Numbers	№ gauge	Time of observation	**Water level** (cm)			Water discharge m3	Numbers	№ gauge	Time of observation	**Water level** (см)			Water discharge m3
			Report	Above gauge datum	Daily average					Report	Above gauge datum	Daily average	
1		8					18		8				
		20							20				
2		8					19		8				
		20							20				
3		8					20		8				
		20							20				
4		8					Average sum		8				
		20							20				
5		8					21		8				
		20							20				
6		8					22		8				
		20							20				
7		8					23		8				
		20							20				
8		8					24		8				
		20							20				
9		8					25		8				
		20							20				
10		8					26		8				
		20							20				
	Average sum						27		8				
									20				
11		8					28		8				
		20							20				
12		8					29		8				
		20							20				
13		8					30		8				
		20							20				
14		8					31						
		20											
15		8					Average sum						
		20											
16		8					Sum per month						
		20											
17		8					average						
		20											

Greatest ________ Least__________ Hydrometer____________

Check__________ Hydro observer__________________

5.6 Water User Receipt of Water Supply

WATER USERS ASSOCIATION
RECEIPT OF WATER SUPPLY

Monthly: ________________________ **Day:** _____________________________

Distribution:______________________ **Subdistribution:**______________________

Request for duty of water No (%) _______________________________

User: _________________________________

Day	Date	Time	Action	Discharge m3/sec	Hours	Duty of water m^3
1	2	3	4	5	6	7
TOTAL:						

Signature: ______________________________ **Date:** __________________

WATER USERS ASSOCIATION
RECEIPT OF WATER SUPPLY

Monthly: ________________________ **Day:** _____________________________

Distribution:______________________ **Subdistribution:**______________________

Request for duty of water No (%) _______________________________

User: _________________________________

Day	Data	Time	Action	Discharge m3/sec	Hours	Duty of water m^3
1	2	3	4	5	6	7
TOTAL:						

Signature: ____________________________ **Date:** ________________________

5.7 Daily Water Measurements and Planning

MEASUREMENT

daily discharge-acceptance for periods

since / с"_____"_________________________200________ to/по "_____"________________200___

у(г)

WATER SUPPLIER WUA:_____________________________________

WATER CONSUMER:______________________________________

Water offtake:____

Type of meter:____

Data of observation	Time of observation	Account by meter	Discharge l/s	Average discharge for period l/s	Duration discharge, per hour	Daily volume of water discharge, th m3	Contract water need (m3)	To be given next day (m3)	Authorised representatives signature	
									Water supplier	Water consumer

TOTAL for month:_________________________ th.m^3

MEASUREMENT was checked:

Meter (hydrotechnik) of WATER SUPPLIER: ____________________

Hydrotechnik of WATER CONSUMER:__ ____

5.8 Precipitation Records

DAILY RAINFALL (PRECIPITATION) RECORDS

____

Location: ______________________ **Year:** ______________________

Data	January	February	March	April	May	June
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL						

Collected: _________________________________ **(Name, surname)**

(Signature): ____

DAILY RAINFALL (PRECIPITATION) RECORDS

____

Location: ____________________ **Year:** ____________________

Data	July	August	September	October	November	December
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL						

Collected: ______________________________ **(Name, surname)**

(Signature): ____________________________________

5.9 Evaporation Records

DAILY EVAPORATION (PAN EVAPORIMETER) RECORDS

Location: ____________________ **Year:** _____________________

Data	January	February	March	April	May	June
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL						

Collected: ________________________________ **(Name, surname)**

(Signature): ______________________________________

DAILY EVAPORATION (PAN EVAPORIMETER) RECORDS

____

Location: ______________________ **Year:** ___________________________

Data	July	August	September	October	November	December
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL						

Collected: __________________________________ **(Name, surname)**

(Signature): ____

Appendix 6.0 SAMPLE PERFORMANCE MONITORING FORMS

6.1 Crop Yield Assessment Form

Crop yield assessment form Форма оценки урожая с/х кульур

Farmer name/ Ф.И.О. фермера:_______________________________________

Date/Дата:__________________

n.º	Crop/с/х культура	Observation 1 наблюдение 1	Observation 2 наблюдение 2	Observation 3 наблюдение 3	Average среднее	Yield estimate подсчет урожая
		(kg)/кг	(kg)/кг	(kg)/кг	(kg)/кг	(t/ha)/т/га
1	Potatoes/картофель	2	3	2	2.3	23.33
2						
3						
4						
5						
6						
7						

Appendix 7.0 RECORD OF WUA CHARGES & IRRIGATION SERVICE FEE COLLECTIONS

7.1 Water Users (Members & Nonmembers) Payment Book

WUA___________________________ **Year:**

Water Users Number	Water Users Name	Previous Debt	Current ISF	Other Fees	Total Owed	Notes	Date Paid	Receipt Number	Type of Payment			Amount (kg)	Amount Paid (som)	Balance Due
									cash	crop	labor			
Totals for this sheet														

Record of Rehabilitation Cost Recovery

7.2 Water Users (Members & Nonmembers) Cost Recovery Repayment

WUA Name: ________________________________ **Year:** ___________________

Water Users Number	Water Users Name	Previous Debt	Current Cost Recovery Payment	Total Owed	Notes	Date Paid	Receipt Number	Cash Payment Paid in (Som)	Balance to be Paid (Som)	Balance of Payment Due Date

Asian Development Bank

WATER USERS' ASSOCIATIONS IN UZBEKISTAN

GUIDEBOOK 5: IRRIGATION MANAGEMENT FOR LEASEHOLD FARMS

August 2006

ABBREVIATIONS

O&M	operations and maintenance
TACIS	Technical Aid to the Commonwealth of Independent States
USAID	United States Assistance for International Development
WUA	water users' association

GLOSSARY

oblast	province
rayon	district
yahob	the leaching of fields in Uzbekistan during late fall and winter

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INTRODUCTION

This guidebook is primarily intended for the use of water users' associations (WUAs) in Uzbekistan in training and assisting leasehold farmers on how to manage irrigation water more effectively. It is also designed as a continuing reference for the major participants in the WUA formation and development process, particularly members of WUAs, agriculture and water resources ministry officials, representatives of district and province *hakimiyats* (local administration), and the staff of donor organizations primarily involved in establishing WUAs in Uzbekistan.

This particular guidebook has freely used some excellent existing works on the methods and technology for operating and maintaining irrigation and drainage systems. For them, the authors owe a great debt of gratitude to Onno Schaap and Charles Jones. Onno Schaap is a consultant of Mott MacDonald, Temelsu JV and Zher-Ana, the group that manages the Kazakhstan Water Resources Management and Land Improvement Project, while Charles Jones is a consultant of Mott MacDonald–Temelsu JV, the group that manages the Uzbekistan Ak Altin Agricultural Development Project.

Although prepared with the specific needs of Ak Altin in mind, the material presented in this guidebook can also be applicable to all other areas in Uzbekistan, whether or not they are being assisted by a similar government-supported or international donor-supported project.

I. OVERVIEW ON WATER USAGE

A. Benefits of Better Water Management to Leasehold Farms

Leasehold farming is becoming the predominant agricultural production system in Uzbekistan. For this reason, the Government is undertaking a long-term program to increase the productivity of leasehold farms through better irrigation and drainage. A major objective of this program is to encourage and support the formation and development of water users' associations (WUAs) by leasehold farmers and other water users. This is to ensure not only an adequate, reliable, and equitable water supply to the farms but also better water management at the farm level.

Ensuring More Productive Water Use. Through the WUAs, the program aims to make leasehold farmers and their workers more knowledgeable about the basic irrigation and drainage management procedures for particular types of farms and crops. Thus, although its charter makes a WUA responsible for water management only up to the boundaries of leasehold farms, the WUA must also ensure that the irrigation water it provides is used productively and not wasted at the user end of the system. The WUA has to do this by sharing with farmers and other water users effective and proven ways of achieving higher onfarm water productivity and farming efficiencies.

Benefits of Better Water Usage to WUAs. The effective use of irrigation water at the farm level will bring two very important benefits to the WUA itself:

- Overall water productivity and farm productivity in the areas served by the WUA will improve. This will serve as a good measure of the WUA's effectiveness and importance to agricultural production in its service area.
- Farmers will use less water but achieve better crop yields. The WUA's overall demand for water will therefore decline, thus reducing the WUA's management and operations and maintenance (O&M) costs.

B. Using Simple Proven Methods for Onfarm Irrigation Tasks

In the typical agricultural production areas served by WUAs, the basic onfarm irrigation tasks are the same: determining crop water and irrigation requirements, irrigation scheduling, field application of water, drainage, and control of salinity. A wide range of methods is available to accomplish these tasks. However, leasehold farmers in Uzbekistan generally do not have the resources to acquire and operate costly equipment. This guidebook therefore presents only simple and proven concepts, methods, and procedures that the farmers themselves can immediately put to use.

Farm production in Uzbekistan involves a great number of crops requiring various types of irrigation. However, this guidebook will primarily focus on the furrow irrigation of cotton, which is the country's most important irrigated crop. Farmers who cultivate other crops and require other types of irrigation will nevertheless find most of the discussions in this guidebook relevant to their own specific irrigation needs.

The methods and procedures presented in this guidebook were derived from international experience and took into account knowledge from prevailing local practices. They can therefore be easily adapted and applied to suit the particular needs and conditions of each farm and WUA in Uzbekistan.

II. CROP WATER AND IRRIGATION REQUIREMENTS

Farmers in Uzbekistan usually find out what the irrigation water requirements of their crops are from the WUA's O&M engineer. This is because the O&M engineer calculates them based on the annual cropping plan and hydro-module that the farmers have submitted to the WUA. The accuracy of the O&M engineer's calculations therefore greatly depends on the accuracy of the annual cropping plan and hydro-module themselves. For this reason, it is very important for the farmers to know how to develop their annual cropping plans and hydro-modules accurately.

As a guide for doing this task, the following section will take up the basic concepts, methods, and procedures for determining the correct amount of irrigation water during the various stages of crop development.

A. Evapotranspiration (ET)

The determination of crop water and irrigation requirements begins with a clear understanding of the concept of evapotranspiration.

Evapotranspiration consists of the evaporation of water from the soil and the transpiration of water from plants. The pattern and rate of evaporation from soil surfaces depend on the external climate as well as on the internal movement of soil moisture and heat.

Soon after irrigation, while the soil surface is still wet, the main factor that influences the evaporation rate is the climate (air temperature, humidity, solar radiation, wind). As the soil surface area dries (generally within a few days), the evaporation rate diminishes significantly. When the crop grows to cover the greater part of the soil surface, however, transpiration from plant canopies becomes more predominant than direct evaporation of soil moisture. At this stage, the following factors become the chief determinants of evapotranspiration: (1) the biological peculiarities of crops and varieties, (2) the age of the plant, (3) the duration of the vegetation period, (4) the fertility of the soil, and (5) the agricultural techniques used.

In much of Uzbekistan, evapotranspiration is high in the dry and hot air that prevails during the growing season.

B. Reference Crop Evapotranspiration (ET_o)

Evapotranspiration depends on both the climate (radiation, atmospheric humidity and temperature, wind, etc.) and the internal conditions of the field. The influence of the climate upon evapotranspiration is expressed as the "reference crop evapotranspiration" (ET_o), which is measured in millimeters per day.[1] The reference crop used for this purpose is grass, which has well-studied aerodynamic and surface characteristics and is accepted worldwide as a reference surface crop. Evapotranspiration rates of various crops are related to the evapotranspiration rate from the reference surface (ET_o) by means of crop factors.

Figure 1 depicts the concept of reference crop evapotranspiration.

[1] If the field is maintained permanently wet, the rate of evapotranspiration should depend only on the meteorological regime. This rate is known as "reference evapotranspiration (ET_o)." In practice, reference evapotranspiration is more restrictively defined as "the amount of water transpired in unit time by a short green crop, completely shading the ground, of uniform height and never short of water."

Figure 1. Reference Crop Evapotranspiration

Although easy to grasp as a concept, reference crop evapotranspiration is difficult to measure in practice. A wide variety of methods is available, but all of them have shortcomings and many are highly complex or expensive, or both. However, two methods that farmers can readily use are the pan evaporation method, which is accurate enough for 10-day calculations of ET_o, and the Blaney-Criddle method, which is suitable for calculations of a month or a season.

The procedures for employing these methods are presented in Appendix 1.

C. Crop Evapotranspiration (ET_c)

The daily rate of actual evapotranspiration from a crop will seldom equal the reference crop evapotranspiration. Canopy characteristics, stand density, stage of growth and degree of surface cover, and especially the moisture regime (whether wet or relatively dry) all affect evapotranspiration. In the case of a typical annual crop, the seasonal total evapotranspiration will generally not equal the total ET_o even if the moisture regime is a wet one. Early in the season, particularly during the germination and seedling-establishment phase, the rate of transpiration is generally very small. As the bare soil surface dries up between irrigations, the direct evaporation rate also becomes lower than ET_o. Later, as the crop approaches full cover, the transpiration rate increases until, at full cover, that rate approximates (and may even exceed) the rate of ET_o. Finally, as the crop matures and dries, its actual evapotranspiration again falls below ET_o. Therefore, the particular kind of crop must be indicated when calculating evapotranspiration.

Crop evapotranspiration (ET_c) is defined as the reference crop evapotranspiration multiplied by the crop factors, as shown in Figure 2. Because it accounts for crop factors, crop evapotranspiration is taken as the equivalent of the crop water requirement.

Appendix 2 contains crop water requirements calculated for various provinces of Uzbekistan.

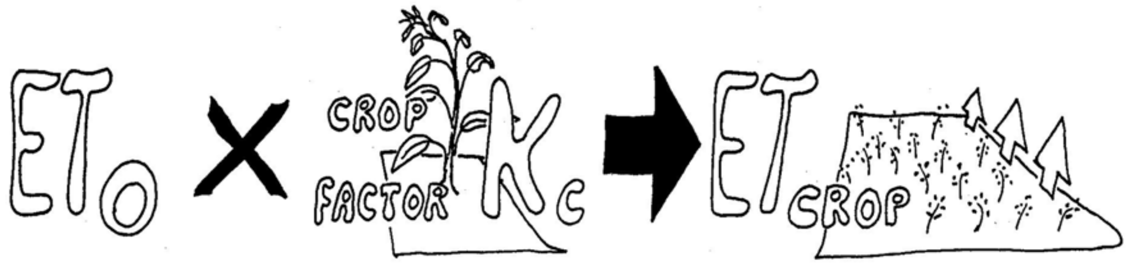
The formula for crop evapotranspiration is:

$$\mathbf{ET_c = K_c \times ET_o}$$

wherein

ET_c = Crop evapotranspiration in millimeters per day (mm/day)
K_c = Crop factor (-)
ET_o = Reference crop evapotranspiration (mm/day)

Figure 2. Crop Evapotranspiration



The crop factor (K_c) depends on the type of crop, the stage of crop development, and the climate. In general, the crop factor is higher in hot, windy, and dry climates than in cool, calm, and humid climates. Crop factor values vary even among the same crops because of (1) differences in reflectivity, (2) crop height and roughness, (3) degree of ground cover, and (4) canopy resistance to transpiration. To determine an appropriate crop factor value, farmers should consider the different stages of growth, particularly as they affect wind and turbulence within and above the plant canopy. In the case of annual crops, the crop factor typically increases from a low value at seedling emergence to a maximum value when the crop reaches full ground cover. It continues at that value during the stage of full activity, and then declines as the crop matures and ends its growth cycle.

Appendix 3 provides procedures for calculating the crop factor.

D. Irrigation Water Requirement

After crop evapotranspiration is calculated, it becomes possible to determine the irrigation water requirement.

Crops receive water from effective rainfall and irrigation. Effective rainfall is the portion of rainfall that can be used by the crop. Part of the rainwater percolates below the root zone of the plants, and part of the rainwater flows away over the soil surface as run-off. The plants cannot use this deep-percolation and run-off water, which means that this share of the rainwater is not effective. However, the remaining part, which is known as “effective rainfall,” is stored in the root zone and can be used by the plants.

Part of the crop’s water requirement is met by effective rainfall, while irrigation must provide the remaining moisture deficit. Therefore, the irrigation water need is defined as the crop water requirement (crop evapotranspiration ET_c) minus the effective rainfall. This is the part of the crop water need that rainfall cannot supply.

Appendix 4 describes how the irrigation water requirement can be calculated using data on the reference evapotranspiration, crop factor, and effective rainfall.

III. IRRIGATION SCHEDULING

Farmers can manage the soil water profile through proper irrigation scheduling. This involves determining the exact quantity and timing of irrigation application throughout the season. By avoiding over-irrigation and by establishing the proper number of irrigations for the season, savings in water can be realized, stress on the plants can be reduced, and crop yields can be boosted.

Efficient irrigation management at the farm level obviously would not be possible if water is not available to the farmers on demand and if it is provided on an arbitrary, rigid schedule that ignores varying crop needs. For example, if water is delivered to the farmers in a *shirkat* (collective farm) for only a limited number of hours on specified dates during the growing season, the farmers would have no choice but to "take it or leave it." This means that most of them will withdraw water even beyond their reasonable needs as an insurance against possible future disruptions of delivery.

It is for this reason that total water withdrawals by farms in some areas of Uzbekistan are as high as 10,000 to 14,000 cubic meters per hectare (m^3/ha). Due to the arid climate and relatively saline soil conditions of Uzbekistan, this tendency of farmers is often self-defeating. It leads to drainage and soil salinity problems, which in turn reduce crop yields and damage the soil structure.

One of the benefits of a functional WUA is that it can be much more responsive than a shirkat to the irrigation needs of farmers. The farmers can request for water as needed so long as it is within the limits of the WUA's Water Use Plan. All the farmers have to do is to coordinate closely with the WUA regarding their irrigation water needs.

A. Soil Water Balance

To properly manage irrigation scheduling, there should be a clear understanding of the variable state of water in the soil and of its cyclic movements into, within, and out of the root zone. As shown in Figure 3, the soil is composed of solid, water, and air phases. These components need to be in balance. For instance, if there is too much water but not enough air, the plant will suffer. Irrigation aims to replenish the water taken out by the plants from the unsaturated zone of the soil. Underneath the unsaturated zone is the saturated zone, where groundwater is present.

Water Cycle in the Field. Water and air are always moving into and out of the soil. The cycle of water in the field begins with the entry of water into the soil (a process known as "infiltration"), continues with its redistribution and downward drainage within the soil, and culminates with its uptake by plants and its return to the atmosphere through the twin processes of transpiration and evaporation.

The soil water balance is an account of all quantities of water added to, subtracted from, and stored within the root zone during a given period of time. Figure 4 illustrates the components of the soil water balance. The difference between the total amount of water added and the total of that withdrawn must equal the change in storage. When gains exceed losses, water storage increases. Conversely, when losses exceed gains, water storage decreases.

Figure 3. Soil, Water, and Air Phases

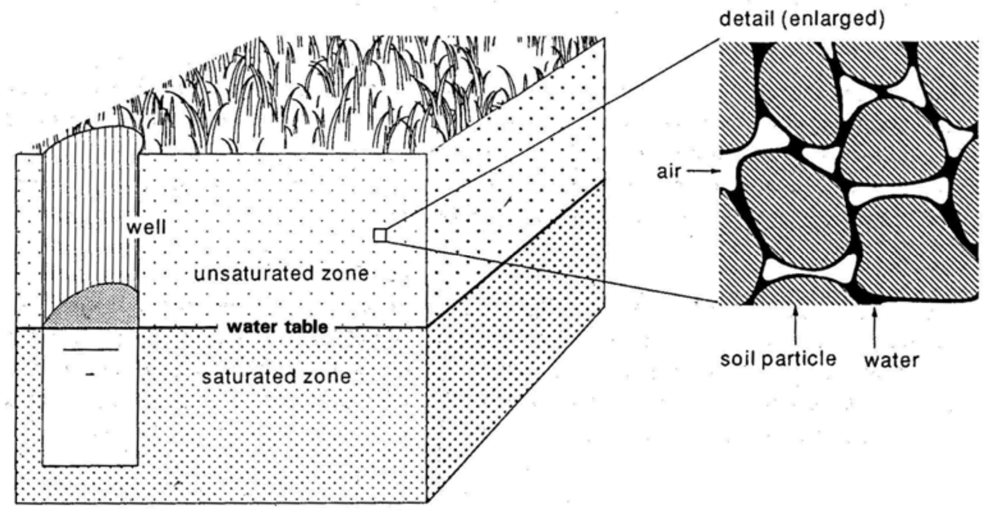
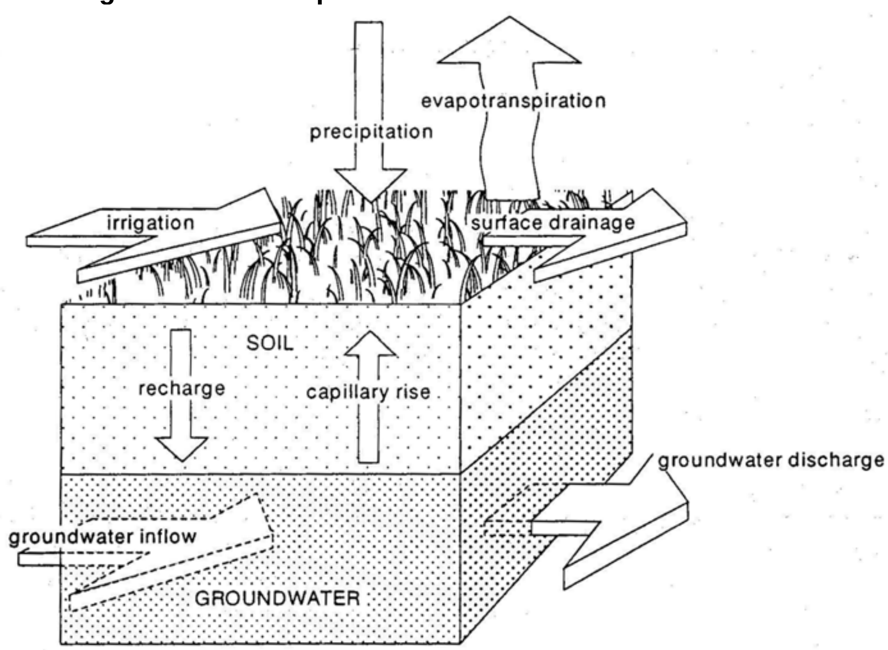


Figure 4. Components of the Soil Water Balance



By keeping track of the amount of water entering and going out of the root zone, a farmer can calculate the amount of water in the root zone at any moment.

Components of Soil Water Balance. The soil water balance has the following components:

- **Precipitation (P):** determined by using a rain gauge;
- **Irrigation (R):** determined depending on the irrigation method used;
- **Capillary rise (Cp):** determined by measuring the distance between the groundwater table and root zone;

- **Drainage (D):** determined by measuring the excess irrigation water over the soil water retention capacity; and
- **Reference crop evapotranspiration (ET_o):** calculated as described in Appendix 1.

The soil water balance is calculated as follows:

$$\mathbf{V_{(t)} = V_{(t-1)} + P + R + Cp - D - ET_o \text{ (in millimeters)}}$$

wherein

$V_{(t)}$ = soil water today
$V_{(t-1)}$ = soil water yesterday
P = precipitation
R = irrigation
C_p = capillary rise
D = drainage
ET_o = reference evapotranspiration

All quantities included in the field water balance are expressed in millimeters (equivalent to cubic meters per 1,000 square meters of land).

Irrigation scheduling can be done on the basis of simple observations of the crop and soil appearance. In more complex farming operations, it could involve operating a computer model that predicts crop use from real-time data about weather conditions.

B. Monitoring the Soil

1. Field Capacity

The most common method of determining when and how much to irrigate is to observe the moisture reserve of the crop's root zone as it gradually diminishes following each delivery of irrigation water. It has to be ascertained when this moisture reserve has been depleted to the minimum allowable level. This is the refill point or the "time to refill" level. If irrigation is not applied before the soil water level drops below an accurate refill point, a yield reduction or vegetative reduction will occur depending on the stage of the crop.

When the refill point is reached, the irrigator should apply the volume of water calculated to replenish the soil reservoir of the root zone to its "full" level. This is the so-called “full point” or “field capacity.” At this level, the soil profile is full of water and no drainage is evident.

Establishing the Crop's Rooting Depth. An important precondition to effective management of root-zone soil moisture is establishing the rooting depth of each crop as it varies during the growing season. Typically, the seedling of an annual crop will develop such that its roots extend both vertically and laterally. This will continue until their lateral ends touch an area already occupied and tapped by the roots of neighboring plants. After that, roots mostly extend themselves downward. As it deepens, the root system proliferates within the moist layers until it can grow no further. Among the environmental factors involved in this growth process are moisture, salinity, acidity or alkalinity, aeration, and mechanical impedance.

Volume of the Soil Moisture Reservoir. The volume of soil covered by the rooting zone of a plant is the first determinant of the size of the soil moisture reservoir potentially available to it. Farmers can establish this volume by considering the area and density of the crop stand and by measuring the depth of root penetration. This can be done by sampling the soil with an auger and examining the extracted samples for the presence of live roots. For the major crops grown in several fields, the depth of root penetration should be determined several times during the growing season. This should be done as necessary so the range of variation can be assessed and more confidence in the data can be established. Provided that planting dates and environmental conditions remain more or less the same from season to season, this data can be used over the long term.

Establishing the Root Zone's Water Deficit. After the rooting volume is known, the potential and actual water contents of the root zone can be determined. This is to establish the root zone's water deficit at any time. The potential ("full reservoir") water content of the root zone is generally taken as equal to the "field capacity."[2] Field capacity is often taken to represent the upper limit of the soil's capacity to store water.

The following example illustrates how to calculate the deficit in field capacity:

Step 1: Assume that the root zone is 1.2 meters (m) or 1,200 millimeters (mm) deep, and that its field capacity in volumetric terms is 22%.

Step 2: The equivalent depth of water contained in the root zone is 1,200 x 22% = 264 mm. For a hectare of land (10,000 square meters or m^2), the volume of the root zone is l0,000 x 1.2 = 12,000 cubic meters (m^3), and the total water content is 12,000 x 228 = 2,640 m^3. Suppose that within 10 days following the last irrigation, the volumetric wetness has decreased from 22% to 13%.

Step 3: The deficit to field capacity is therefore 9% (22% - 13% = 9%) of 1.2 m, namely 0.108 m or 108 mm. So the amount of water to apply is: 0.108 m x 10,000 m^2 = 1,080 m^3 per hectare.

Note that this calculation accounts for the amount of irrigation needed to make up for the overall loss of water from the root zone. However, it ignores the issue of assessing how much of that loss may have been due to direct evaporation from the soil, to transpiration from the crop, and to internal drainage below the root zone. Despite this limitation of the field capacity concept, it is a useful indicator of the limit of soil moisture that can be stored for subsequent crop use in a given depth of soil.

The Need for Properly Timed Irrigations. Ideally, the soil water should be near maximum capacity at planting time but depleted by 50% or more at harvest. Successive, properly timed irrigations should maintain water within the root zone during vegetative growth at a level that produces no plant water stress.

In some places, water may be available most of the time but it may become unavailable part of the time, often unpredictably. In such cases, a safety factor or buffer of several days is needed to protect the crops. This can be done by lowering the "refill" criterion. This means increasing the range of allowable depletion during periods of restricted water supply.

2. Measuring Moisture Content

There are several methods of measuring soil moisture content. Most of them are difficult or expensive, or both. The simplest is the by "appearance and feel" method. This is a valid procedure no matter how sophisticated the irrigation scheduling system might be. In addition to indicating how much moisture is in the soil, this method also reveals where that moisture is located in the profile. Determining the depth of water penetration from irrigation or rainfall

[2] Field capacity is defined in practice as the water content of the specified volume of soil measurable 2 days after a thorough irrigation.

is useful in planning and making management decisions. In particular, it can detect problem areas where compacted soil layers are restricting water penetration.

Procedures for Extracting Soil Samples. A soil probe, soil auger, or spade can be used to extract a soil sample. Farmers should evaluate the soil moisture at 20–30 centimeter (cm) intervals from the surface to the bottom of the active root zone. The active root zone for most irrigated crops is approximately one meter deep. For cotton, the soil sample should be taken at 20 cm in depth during the prebudding phase. During budding, flowering, and reproduction, the depth of the sample should be 35–40 cm. When using a soil probe to extract the samples, the following procedures will make the job easier:

- Scrape a clean, level area on the soil surface before inserting the probe.
- Insert the probe to the desired depth and turn the probe once clockwise before pulling it back to the surface.
- After inspecting the soil, remove all of the soil from the tube, including the tip. Soil left in the tip may tend to compact the next sample.
- Clean the probe after each use to prevent rust and hard caked soil.
- Replace or sharpen the tip as needed.

Evaluating Soil Moisture Levels. To get a better idea of the appearance and feel of the soil at particular levels of moisture content, start early in the spring 1 or 2 days after a heavy rain. The soil moisture level at this point should be near field capacity. This means the soil is holding almost 100% of the water that it can naturally retain. In the same way, probe the soil at the end of the growing season when the profile is likely to be dry. Knowing the appearance and feel of the soil in wet conditions (planting) and dry conditions (harvesting) will help in making determinations during the midseason. The number and location of sampling sites depend on both the uniformity of the soils in the field and the irrigation procedures. After checking the starting and stopping areas of the irrigation and drainage system, also check problem areas in the field. Sample a minimum of four sites in different parts of the field.

Table 1 on the next page provides a rough guide for judging available soil moisture on the basis of the appearance and feel of the soil.

Oven Drying of Soil Samples. Although the appearance-and-feel method is easiest, it is also the least accurate. A more precise estimate of the soil sample can be obtained by drying it in an oven and by comparing the weights before and after drying. This is a laborious and time-consuming method. Also, it yields values of wetness by weight rather than by volume. The results therefore must be multiplied by the soil's bulk density (the mass of dry soil per unit bulk volume).

More Precise Soil Moisture Measurements. Much more precise measurements of soil moisture content can be obtained by using any of the various types of field meters. The best of these is a neutron moisture meter, which senses volumetric wetness with minimum disturbance. However, this instrument costs about US$3,000–4,000. Tensiometers, on the other hand, measure the soil moisture though tension. After a field is irrigated, as soil moisture is depleted by evaporation and root extraction, the tensiometers register any increase in tension. If properly interpreted, such readings provide a forecast of when the plants might begin to suffer stress.

Tensiometers have two major drawbacks, however. They must be supervised constantly and serviced periodically. Also, acquiring an adequate number of them is fairly expensive.

Table 1. Guide for Judging Available Soil Moisture for Crops

Available Soil Water Remaining	**FEEL OR APPEARANCE OF SOIL AND WATER DEFICIT**			
	Loamy Sand, Coarse Texture	**Sandy Loam, Moderately Coarse Texture**	**Loam & Silt Loam, Medium Texture**	**Clay Loam or Silty Clay Loam. Fine & Very Fine Texture**
0% - 25%	Dry, loose, single grained, flows through fingers.	Dry, loose, flows through fingers.	Powdery dry, sometimes slightly crusted but easily broken down into a powdery condition.	Hard baked, cracked, sometimes has loose crumbs on surface.
25% - 50%	Appears to be dry, will not form a ball with pressure.	Appears to be dry, will not form a ball.	Somewhat crumbly but holds together from pressure.	Somewhat pliable.
50% -75%	Appears to be dry, will not form a ball with pressure.	Tends to ball under pressure, but seldom holds together.	Forms a ball, somewhat plastic, will sometimes slick slightly with pressure.	Forms a ball, ribbons out between thumb and forefinger.
75% - 100% (Field Capacity)	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms a weak ball, breaks easily, will not slick.	Forms a ball, is very pliable, slicks readily, and is relatively high in clay.	Easily ribbons out between fingers, has slick feeling.
100% (Field Capacity)	Upon squeezing, no free water appears on soil, but wet outline of ball is left on hand			
Note: A ball is formed by squeezing a handful of soil very firmly.				

C. Monitoring the Crop

Experienced agronomists or farmers who know their crop can detect early signs of thirst by the plant's physical appearance, especially during the period of peak transpirational demand (generally at midday). This method has a disadvantage, however. By the time the symptoms become evident, irrigation water might have already been inadequate or absent long enough to significantly reduce the crop yield. It is therefore very important for the farmer to obtain physical indications as early as possible. One way to do this is to select for crop monitoring that part of the field where the plants will most likely first show signs of stress (a sandy spot, for example).

General Indications of Water Stress in Crops. Some general indications of water stress in crops are as follows:

- Curling or wilting;
- Darkening;
- The curling or flaccidity (lack of firmness) of young leaves, which are more sensitive than mature ones;
- Considerable slowing of plant growth; and
- Changes in leaf orientation due to water scarcity.

These are physiological defense mechanisms that become particularly evident on hot, windy afternoons. At such times, the crop cannot transpire fast enough even if the water is readily available in the soil. If the crop does not recover from these symptoms overnight, it is a sign that the crop is suffering from water stress. This can result in a reduction in crop yield.

Water Stress Symptoms in the Cotton Plant. The cotton plant, in particular, exhibits many plant water stress symptoms and responses to stress that can be used to help schedule the needed irrigation.

Cotton plants undergo a change in leaf color from bright to darker green, or to almost blue when severely water-stressed. It is very important to look at the health of the youngest leaves that are still growing. Irrigation is needed when the leaves of about 20% of the cotton in the field turn dark green. After irrigation, the cotton leaves will turn light green. However, because leaves often change color, this method can produce misleading results when done during and after flowering of the cotton.

Differentiating Midday Wilt from Water Stress. Plant wilting is an obvious water shortage symptom, but care should be taken not to confuse a "midday wilt" with water stress. Midday wilt is an internal transport problem that occurs when cotton plant roots can no longer absorb enough water to meet the plant's transpiration demand. Midday wilting occurs on very hot days, particularly when the air is dry. If the wilted plant recovers as the day cools down in the evening, this is a sign of midday wilt rather than a soil water shortage. Checking the soil moisture will help clarify any confusion regarding this situation.

Unique Characteristic of the Cotton Plant. As a tropical plant, cotton does not shut down its stomata (small openings in the leaf) in the heat of the day to conserve water. This characteristic, which makes cotton different from many other plants, allows gas exchange through the cotton leaf to continue. Cotton can therefore keep growing at temperatures higher than what many other crops can tolerate. Only when severe stress occurs will the stomata of the cotton leaf respond and close. This usually occurs after leaf growth has already stopped.

Crop Temperature as Indicator of Water Stress. Crops use water to keep cool, so the leaves of water-stressed crops are warmer to the touch. Around noontime, the temperature of crops that are not water-stressed will be about 4^{o} Celsius cooler than the surrounding air temperature. Water-stressed crops will be less than 1^{o} cooler than the air temperature.

Rule of Thumb for Scheduling Cotton Irrigation. The number of nodes (branches) above the most recent white flower on the first fruiting position is another plant observation used by cotton growers to schedule irrigations. Early in the season, irrigation may be applied around nine nodes above the white flower. Midseason, seven nodes above the white flower is the rule of thumb used as a target irrigation point for crops. Later in the season, as crops stop growing, around five nodes above the white flower will be the target. Crops with more nodes above the white flower generally have more vigor. This characteristic can help indicate which crops should be watered when water becomes scarce.

D. Irrigation Scheduling for Cotton

Cotton growers should decide whether to preirrigate or water up the crop after planting. In certain situations, it can be beneficial to combine the two options by preirrigating to moisten the plant and giving the crop a quick watering to ensure good plant stands. Since every farm is different, however, the following questions need to be considered before making a decision:

- What method traditionally gives the best plant stands and early vigor?
- Do I have enough water available?
- Is my cotton traditionally subjected to a lot of pressure from seedling disease?
- What is the likely rainfall pattern before and after planting?
- Am I likely to get enough rain before planting to plant into moisture?
- Is it likely to rain straight after the field is watered up?
- Is my soil likely to dry out quickly before planting?
- How does my soil soak up, and how badly does it erode?

The likely advantages and disadvantages of the different options are presented in Table 6.

Table 6. Advantages and Disadvantages of Options for the First Irrigation

PREIRRIGATION (PRIOR TO PLANTING)	WATERING-UP (AFTER PLANTING)	PREIRRIGATION AND LATE WATERING
Likely advantages: No time pressure to apply the water In a heavy clay, water losses can be less than keeping it in an onfarm storage Soil temperature is less likely to drop after planting—potentially less disease pressure	**Likely advantages:** Potential to take advantage from preplanting rain events Easier to plant, especially when beds are not 100% even Faster planting operation and less machinery needed	**Likely advantages:** Helps in fixing up plant stand problems Can give the crop the necessary ”boost” to get going after a slow start
Likely disadvantages: Soil drying out too quickly Dry rows in uneven fields Soil stays too wet when followed by rain Unable to capture rainfall before planting	**Likely disadvantages:** Higher disease pressure Herbicide damage more likely Sides of beds might erode when flushing for a long time Waterlogging if rain occurs after flushing	**Likely disadvantages:** Likely to use more water Similar disadvantages to watering up

Timing and Quantity of First In-Crop Irrigation. The timing and quantity of the first in-crop irrigation is the most difficult irrigation scheduling decision for cotton. It requires careful balancing between not stressing the crop and ensuring that the water stored in the soil profile is fully explored by the cotton roots. It is difficult to get a crop growing again if water stress has stopped growth. On most heavy clay soils, cotton should not need irrigating earlier than halfway between squaring and flowering (60–70 days from sowing). On lighter texture or compacted soils, crops will need irrigating earlier.

After regular irrigation has started, extending the interval between irrigations without monitoring soil water levels can result in significant yield reductions. Water can be saved, but yield losses will occur. The other consideration is that, by stretching the irrigation interval, greater amounts of water will need to be applied at the next irrigation. Stretching irrigation intervals too much can also indirectly cause waterlogging. It prolongs the time water has to be applied to fill the large soil moisture deficit. If water stress occurs, it is better late or early in the season, but not in the middle during peak flowering and early boll fill stages. In hot dry summers it is better to be early than late. Careful monitoring of soil moisture and daily water use will enable the farmer to determine the correct timing of the irrigation.

Ensuring Completion of Boll Maturity. The objective of the final irrigation is to ensure that boll maturity is completed without water stress. At the time of last irrigation, all bolls have been set, vegetative growth is limited, and the majority of carbohydrates are used to satisfy boll demands. After a boll is 10–14 days old, the abscission layer that causes boll shed cannot form. It is for this reason that boll numbers are not significantly reduced by late water stress. However, fiber development can be affected. Crops that come under stress prior to defoliation can suffer some yield reduction and fiber quality reduction. The longer the stress occurs, the higher will be the level of reduction. End-of-season water requirements can be estimated from the date of the last effective flower (four nodes above the white flower).

IV. FIELD APPLICATION

The predominant field irrigation method in Uzbekistan is furrow irrigation. It is therefore important for farmers to be familiar with the basic concepts and tools for doing furrow irrigation more efficiently.

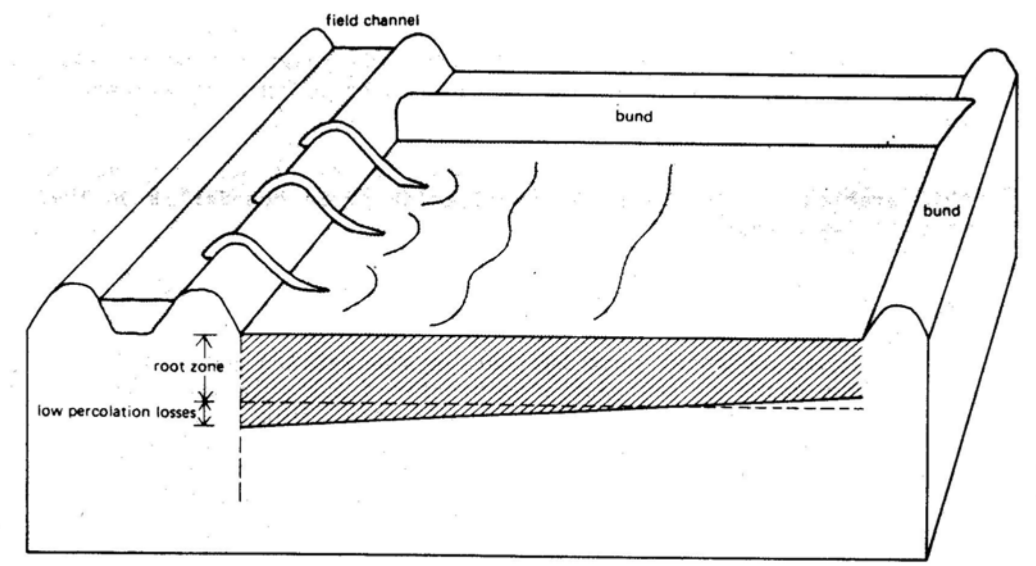
A. Wetting Patterns

For good crop growth, it is important that the right amount of water is supplied to the root zone and that the root zone is wetted uniformly. If crops receive too little water, they will suffer from water stress, and yields may be reduced. If they receive too much water, however, the water will be lost through deep percolation. Especially on clay soils, permanent pools may form and drown the plants.

1. Ideal Wetting Pattern

To obtain a uniformly wetted root zone, the surface of the field needs to be uniformly leveled, and the water has to be applied quickly. Figure 5 shows an ideal wetting pattern: the field was supplied with the right quantity of water at the right stream size (flow). The part of the field near the irrigation ditch will always have more water because it will be in contact with the water during a longer time period. Therefore, percolation losses will occur near the canal, and the other side of the field will have less water.

Figure 5. Ideal Wetting Pattern



2. Poor Wetting Patterns

Poor wetting patterns can be caused by several factors. They include the following:

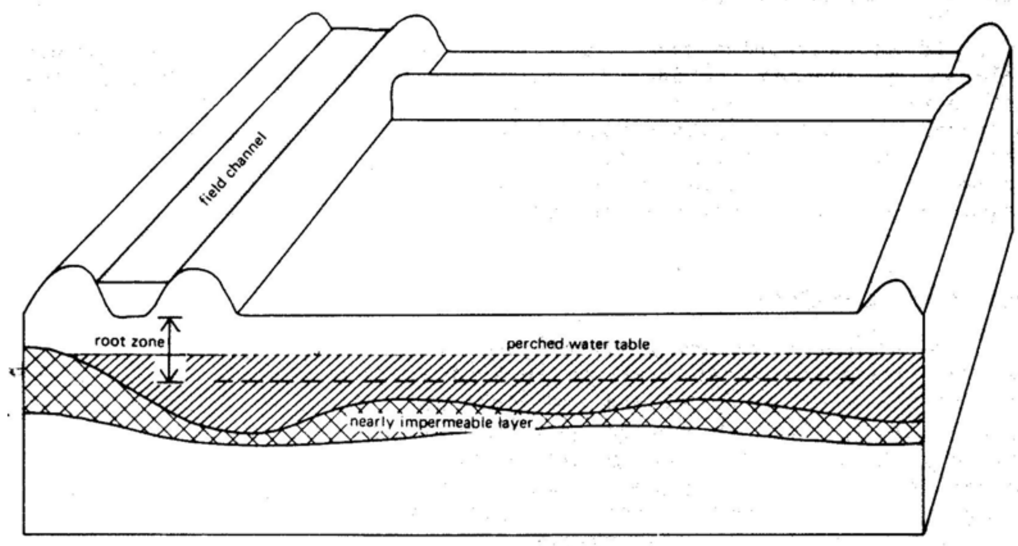
- Unfavorable natural conditions: compacted soil layer, different soil types in the field.
- Poor field layout: shape, land leveling.
- Poor management: incorrect stream size, application of too much or too little water.

Unfavorable Natural Conditions. A compacted soil layer can sometimes occur 30–50 cm below the soil surface, and infiltration through this layer may be very slow. Thus, water tends to accumulate above this layer, resulting in a “perched” water table as shown in Figure 6.

This may result in waterlogging. The compacted layer can be removed by using deep plows or rippers to break the subsoil.

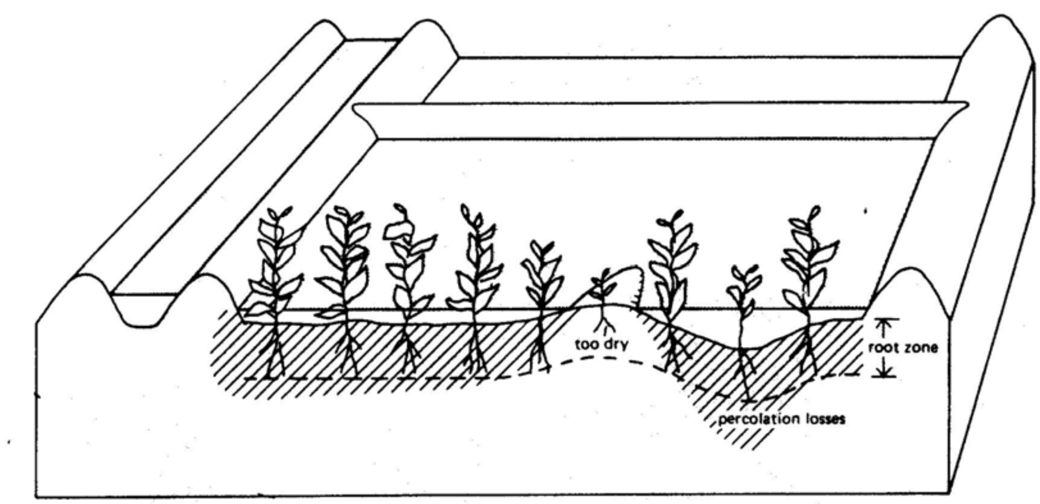
Different soil types within a field can cause very uneven water distribution. This problem can be solved by realigning the furrows so that each set of furrows will contain the same soil.

Figure 6. Impermeable Soil Layer and "Perched" Water Table



Poor Field Layout. Figure 7 shows what happens to the wetting pattern if the soil surface is not level. Some parts of the root zone receive too little water. In the lower parts, water may pond or may be lost through deep percolation. Plants suffer in the drier parts because they receive too little water, causing them to wilt. Plants may also suffer in the wet parts. Plant nutrients may be carried away from the root zone to the subsoil and, especially on clay soils, the plants may drown. These faults can be corrected by regular land leveling.

Figure 7. Wetting Pattern of a Poorly Leveled Field



Poor Management. Figure 8 shows the results of using such a small stream size that the furrows are irrigated too slowly. The part of the furrow that receives irrigation water first (near the field canal) receives too much water. Percolation losses occur, nutrients are washed away, and the plants may drown. However, the other end of the furrow remains too dry. The plants there do not receive enough water, thus causing them to wilt. The solution to this problem is to increase the stream size so that the furrow will be flooded more quickly and to subdivide the field into shorter subfields (shorter furrows that need a smaller stream size).

Figure 8. Wetting Pattern Resulting from Insufficient Flow Rate

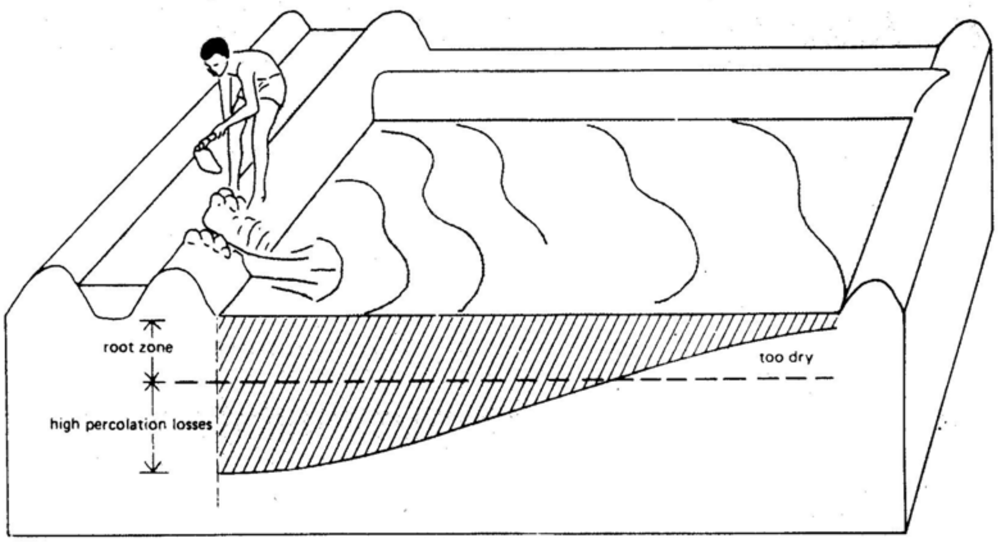
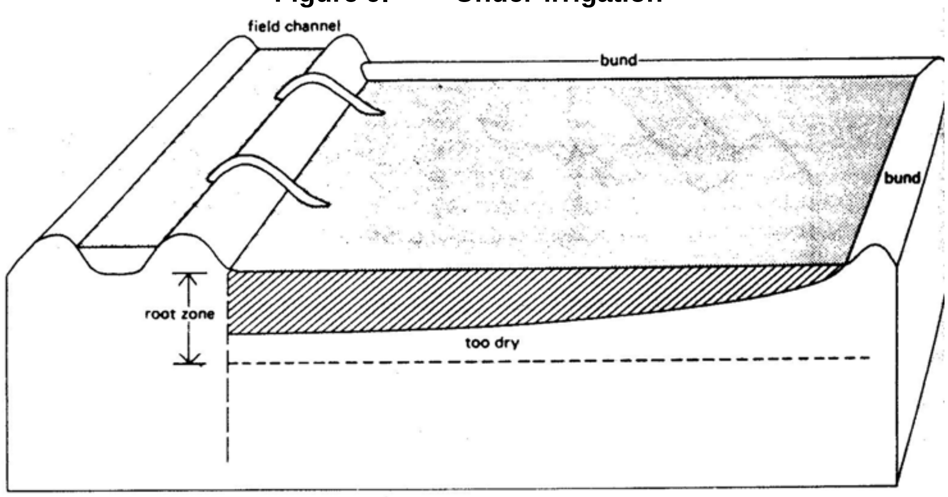


Figure 9 depicts what happens if insufficient water is applied to irrigate the root zone. This is called under-irrigation and is caused by underestimating the time needed to fill the root zone.

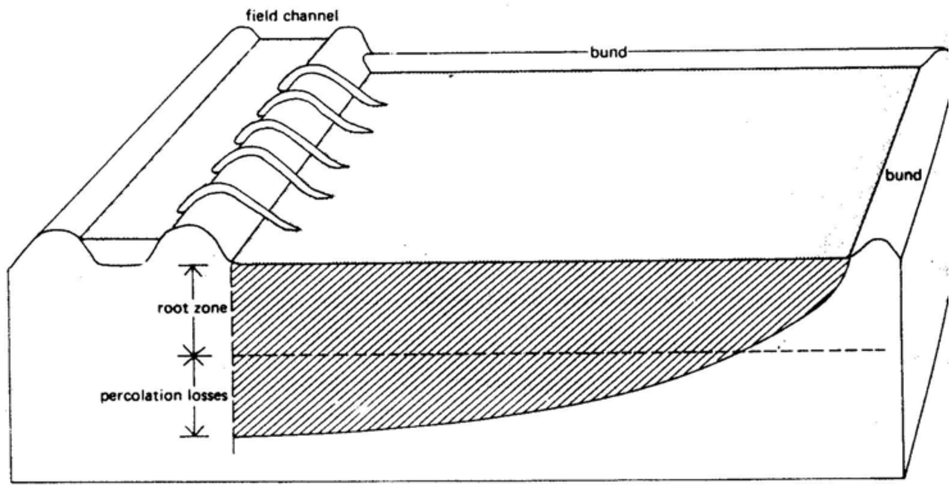
Figure 9. Under-irrigation



There are no percolation losses during under-irrigation. Although water may be used efficiently by this approach, frequent irrigation will be necessary to meet the crop water needs. However, continual under-irrigation will eventually restrict root development and the crop may suffer when there are delays in irrigating particularly when water is in short supply or the supply system breaks down.

Figure 10 describes over-irrigation that occurs when too much water is applied to the field. The percolation losses are high, the plant nutrients are washed away, and, on clay soils, the plants may drown. The obvious solution is to apply less water, which means reducing the irrigation time.

Figure 10. Over-irrigation



B. Factors Influencing Efficiency

Several factors influence the efficiency of furrow irrigation. They are as follows:

- **Slope:** Uniform slopes are preferred for furrow irrigation. Although furrows can be longer when the land slope is steeper, the maximum recommended furrow slope is 0.5% to avoid erosion. Furrows can also be level and are thus very similar to long, narrow basins. However, a minimum grade of 0.05% is recommended so that effective drainage can occur following irrigation or after excessive rainfall. If the slope is steeper than 0.5%, then furrows can be set at an angle to the main slope or even along the contour lines to keep furrow slopes within the recommended limits. Furrows can be set this way when the main land slope does not exceed 3%. Beyond this, there is a major risk of soil erosion when there is a breach in the furrow system. On steep land, terraces can also be constructed and furrows cultivated along the terraces. On steeper slopes, the flow rate into the furrows must be reduced to avoid erosion.
- **Soil Type:** The wetting patterns are different in sandy and clay soils. In sandy soils, water infiltrates quickly to deeper layers and there is little horizontal (lateral) movement of water. Furrows should be short (less than 110 m), so that water can reach the downstream end without excessive percolation losses. In clay soils, the water infiltrates slowly to deeper layers, and there is a substantial lateral movement of water in the soil as well as a capillary rise. Therefore, in order to obtain an overlapping wetting pattern, the spacing between furrows in clay soils can be larger than in sandy soils. As with all surface irrigation methods, very coarse sands are not recommended because percolation losses can be high.
- **Furrow length:** Furrows must be in harmony with the shape, length, and spacing of the furrows. Generally, the shape, length, and spacing are determined by natural circumstances, such as the slope, soil type, and available stream size.

However, other factors may influence the design of a furrow system, such as the irrigation depth, farming practice, and the field length. Table 7 provides some practical values of maximum furrow lengths.

Table 7. Practical Values of Maximum Furrow Lengths (m) Depending on Slope, Soil Type, Stream Size and Net Irrigation Depth

Furrow Slope (%)	Maximum Stream Size (l/s) Per Furrow	Clay		Loam		Sand	
		Net Irrigation Depth (mm)					
		50	75	50	75	50	75
0.0	3.0	100	150	60	90	30	45
0.1	3.0	120	170	90	125	45	60
0.2	2.5	130	180	110	150	60	95
0.3	2.0	150	200	130	170	75	110
0.5	1.2	150	200	130	170	75	110

m = meter
mm = millimeter
l/s = liter per second

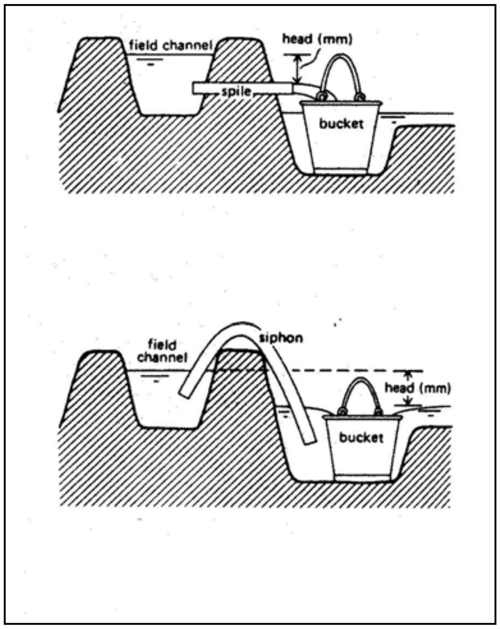
- **Stream size:** Normally, stream sizes up to 0.5 liters per second (l/s) will provide adequate irrigation when the furrows are not too long. When larger stream sizes are available and possible to apply, water will move rapidly down the furrows. Thus, in general, longer furrows can be used. The maximum stream size that will not cause erosion will depend on the furrow slope, shape, dimensions, and soil type. It is advisable not to use stream sizes larger than 3.0 l/sec.
- **Furrow shape:** On sandy soils, narrow but deep V-shaped furrows are desirable to reduce the soil area through which water percolates. In clay soils, a wide, shallow furrow will cover a larger wetted area, thus increasing the rate of infiltration.
- **Spacing:** In mechanized farming, a compromise is required between spacing requirements of the machinery, ideal spacing for crops, and the provision of adequate lateral wetting off the soil. In coarse sand, this spacing should be 30 cm; in fine sand, 60 cm; and in clay soils, 75–150 cm.
- **Irrigation depth:** Applying larger irrigation depths usually means that furrows can be made longer. This is because there is more time available for water to flow down the furrow and infiltrate the soil.
- **Cultivation practice:** When farming is mechanized, furrows should be made as long as possible to facilitate the work. Short furrows require a lot of attention, since the flow must be changed frequently from one furrow to the next. However, short furrows can usually be irrigated more efficiently than long ones. This is because it is much easier to keep the deep percolation losses low in short furrows.
- **Field length:** It may be more practical to make the furrow length equal to the length of the field instead of making it equal to the ideal length. This is because the latter would result in a small piece of land left over. Likewise, the length of the field may be much less than the maximum furrow length. This is not usually a problem as the furrow lengths can be made to fit the field boundaries.

C. Measurement of Furrow Discharge

The easiest way to measure the furrow inflow is to use a siphon or spile. The following are required to make this measurement:

- Siphon
- Bucket with known volume (10 l)
- A watch
- Two people

Figure 11. Measurement of Furrow Discharge



Setup:
A hole is made in the soil just behind the bund (embankment) of the field ditch. A bucket is placed on the hole.

If the siphon or spile is freely discharging, then the pipe can discharge into the bucket. However, if the siphon discharge is drowned, then the bucket must be held firmly with the bucket lip at the same level as the normal water level in the field.

Water is discharged into the hole alongside the bucket, where the water level rises and overflows into the bucket. This procedure is important for accurately measuring the discharge under the normal operating head. If the siphon is allowed to discharge directly into the bucket, the head would be changing as the bucket fills and this would affect the siphon discharge.

Procedure:
The siphon is first filled with water to take out all the air. This is called "priming." One end is kept under water and the other end is covered with the hand to prevent air from re-entering. The siphon is placed over the embankment with one end in the field ditch, and with the other end in the hole beside the bucket.

As the water level rises, water flows into the bucket. The time it takes to fill the bucket is then recorded.

For free siphon flow, the water can be discharged directly from the siphon into the bucket.

The siphon discharge in liters per second is then calculated in the following way.

$$\textbf{Siphon discharge (l/s)} = \frac{\textbf{Volume of bucket (l)}}{\textbf{Time to fill the bucket (s)}}$$

Example: A siphon fills a 10-liter bucket. The time to fill the bucket is 24 seconds. Therefore, the discharge is 10/24 = 0.42 l/s

Some typical discharges for siphons and spiles (l/s) are presented in Table 8 below.

Table 8. Typical Discharges for Siphons and Spiles

	Head (cm)			
Diameter (mm)	**5**	**10**	**15**	**20**
20	0.19	0.26	0.32	0.73
30	0.42	0.59	0.73	0.84
40	0.75	1.06	1.29	1.49
50	1.17	1.65	2.02	2.33

mm = millimeter
cm = centimeter

D. Measurement of Infiltration Rate

The infiltration rate is the velocity at which the water enters into the soil. It is expressed by the depth in millimeters (mm) of the water that enters the soil in 1 hour. An infiltration rate of 20 millimeters per hour (mm/h) means that in 1 hour, a layer of 20 mm infiltrates into the soil.

Infiltration refers to the vertical entry of water into the soil. It is not to be confused with hydraulic conductivity, which indicates the ability of the soil to transmit water in all directions.

In dry soil, water infiltrates rapidly. This is called the “initial infiltration rate.” As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady state. This is called the “basic infiltration rate.”

The infiltration rate depends on soil texture (the size of the soil particles) and soil structure (the arrangement of the soil particles). It is a useful way of categorizing soils from an irrigation point of view.

Some typical values for basic infiltration rates for various soil types are presented in Table 9.

Table 9. Basic Infiltration Rates by Soil Type

Soil Type	Basic Infiltration Rate (mm/h)
Sand	> 30
Sandy loam	20 – 30
Loam	10 – 20
Clay loam	5 – 10
Clay	1 – 5

mm/hr = millimeters per hour

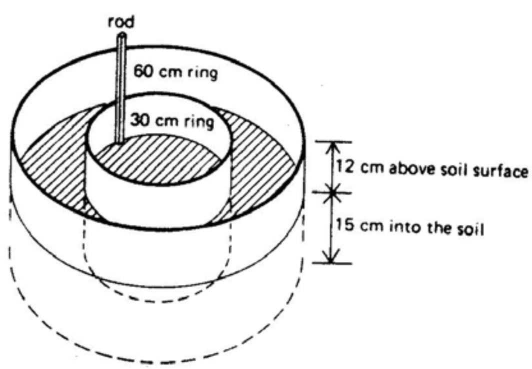
Typical values in Central Asia are around 20–25 mm/h. This is very good for surface irrigation.

The most common method to measure the infiltration rate is by a field test using a ring infiltrometer, which is shown in Figure 12.

Equipment required:

- Shovel
- Hammer
- Watch
- 3 buckets, 10-liter capacity
- Plastic sheet
- Water nearby
- Piece of timber
- Ring infiltrometer
  (one 30-cm ring and one 60-cm ring)
- Measuring rod of 30 cm
- Data sheet

Figure 12. Ring Infiltrometer



cm = centimeter

Method:

Step 1: Hammer the 30 cm diameter ring at least 15 cm into the soil. Use the piece of timber to protect the ring from damage during hammering. Keep the side of the ring vertical and drive the measuring rod into the soil. Approximately 12 cm should be left above the ground.

Step 2: Hammer the 60 cm ring into the soil or construct an earth bund (embankment) around the 30 cm ring to the same height as the ring.

Place the measurement rod in the inner ring.

Place a plastic sheet in the inner ring.

Step 3: Pour water in the outside circle up to a depth of 7–10 cm.

Step 4: Pour water in the inner ring up to the same level as the outside ring.

Step 5: Take away the plastic sheet from the inner ring. Record starting time and initial water height in the inner ring (read this from the measuring rod).

Step 6: Continue to take readings, in the beginning every 1–2 minutes. When the difference between the readings becomes less, increase the interval to every 5 minutes. The interval between readings can be increased up to 20–30 minutes.

The water level in the rings needs to be maintained more or less at the same level. Therefore, the rings (inner and outer) have to be refilled on a regular basis. The best way is to do that right after a measurement. The new heights will need to be recorded as new reference values.

Continue the measurement until the infiltration rate becomes constant. This means that the infiltrated amount of water over time has remained the same.

To be properly carried out, an infiltration measurement might take up to 8–12 hours. It may not be practical to do this at this time, but it might become necessary in the future.

At least two infiltration measurements have to be made on each site.

Step 7: Calculate the infiltration rate and the cumulative infiltration for each moment of time that data were recorded.

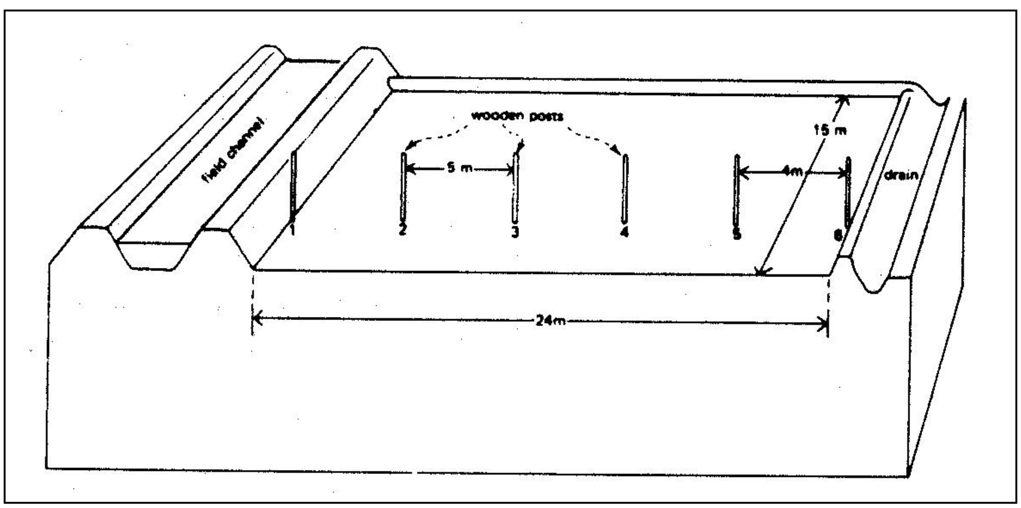
Graph the infiltration rate and cumulative infiltration rate on millimeter (mm) paper.

E. Evaluation of Irrigation Performance

To evaluate the most adequate inlet discharge into a furrow, it is in practice always best to carry out some field trials using different stream sizes. These trials can be carried out easily during the irrigation season. The objective of the trials is to determine the optimum furrow length and stream size in a specific condition.

It is assumed that the application depth of the crop, or the "net irrigation gift," is known. This is compared with what happens during the actual irrigation practice. The field application efficiency obtained in this manner is a good measure for evaluating irrigation performance.

Figure 13. Method of Evaluating Field Irrigation Performance



Equipment required:

- Buckets (3)
- Shovel (3)
- Siphon (three different sizes)
- Measuring tape (30–50 m)
- Wooden posts
- A watch with second pointer
- Data sheet
- Soil auger
- mm paper

Method:

Step 1: Identify a typical furrow that can be considered representative of the field in terms of size, shape, soil type, and crop. Measure the length and record the data on the data sheet. Also measure the furrow shape and the distance between the furrows.

Step 2: Place wooden posts at 5–10 m intervals (depending on the field length) as shown in Figure 13. Record the positions of the posts on the data sheets

Step 3: Calibrate the inlet flow into the furrow, as described in Point 11 (measurement of furrow discharge).

Step 4: Start the irrigation. Record the time it takes for the waterfront to reach each wooden post. This is called the “advance time.” It is recommended to use at least three different furrow flows, one the same as the farmer always uses, the second smaller, and the third a bigger discharge.

Step 5: Record the time the water reaches the end of the field. Continue to irrigate so that the water flows off the field in the same way the farmer does this. If a flume or small weir is available, the furrow runoff can also be measured. Then a volume balance can be made of the furrow’s inflow and outflow.

Step 6: Cut off the inflow into the furrow. Record the time that the flow is cut off. Now record the time that all water is infiltrated at each post. This is called the “recession time.”

Step 7: Calculate the contact time in minutes. This is the difference between the advance time and recession time.

Step 8: Calculate at each of the wooden posts the amount of water applied, using the infiltration curve. All data are recorded on the sheets provided. Draw a graph as in the example.

If the results of all the furrow experiments are drawn in the same graph, the differences will become very clear.

Step 9: Determine the “field application efficiency.”

The field application efficiency is the fraction of the applied water that is used by the crop. Provided there are no runoff losses, the field application efficiency (%) is the required irrigation depth in millimeters (mm), divided by the average applied irrigation depth (mm), then multiplied by 100%, or:

$$\textbf{Field application efficiency (\%)} = \frac{\textbf{Required irrigation depth (mm)}}{\textbf{Average applied irrigation depth}} \times 100\%$$

Before leaving the field, auger a hole at every post to determine up to which depth the water has infiltrated into the soil. Ideally, this should be done 24 hours after finishing the test. This can then be compared with the results obtained earlier by calculating the infiltrated water depth.

F. Construction of Furrows

The recommended steps for the construction of furrows are described below.

Straight Furrows:

Step1: A straight line is set out in the field along the proposed line of furrows. This can be done by setting up ranging poles or marking a line on the ground with chalk powder.

Step 2: The ridger is moved along the line. The resulting furrow should be straight.

Step 3: About every 5 m, a new straight line should be set out.

Contour Furrows on Sloping or Undulating Land:

Step 1: A guide furrow must first be set out along the upper edge of the field close to the farm channel. A leveling device should be used to locate the contour line. Further guide furrows are set out every 5 m on undulating ground, and 10 m on uniform sloping land.

Step 2: Working from each guide furrow, furrows are made up to halfway along the next guide furrow.

G. Land Leveling

Land leveling, or the preparation of the field surface for the conveyance and distribution of irrigation water, is very important to efficient surface irrigation. It ensures that water depth is relatively uniform over the field surface and within the soil profile. The uniformity of water application in a field significantly affects the efficiency of an irrigation system.

Water distribution in a field is obviously affected by many factors, such as (1) the method of irrigation, (2) soil topography, (3) soil infiltration characteristics, and (4) the hydraulic characteristics of the irrigation system. However, land leveling is one of the best methods for increasing the uniformity of water distribution. It improves irrigation efficiency, prevents soil waterlogging, allows for longer furrows with better-planned onfarm and infield canal layouts, and allows for improved methods of application (such as the use of piped siphons).

In surface irrigation systems, leveling is required nearly every season and therefore adds a significant cost to a producer's operation. In most cases, however, the benefit of leveling outweighs the associated costs of doing it.

Precision Equipment for Land Leveling. New leveling equipment is continually being introduced, thus providing even better capabilities to achieve precise land-leveling operations. One of the most significant advances is laser control in land-leveling equipment, a highly precise but expensive technology. In Uzbekistan, a choice between laser and nonlaser leveling has to be made. The difference in cost between them is significant, so a

WUA needs to do a cost-benefit analysis. In particular, the cost of laser leveling during a demonstration by the US Agency for International Development (USAID) in the Kushkulak WUA, the Mirzaabad Rayon, and the Syrdarya Oblast was US$210 per hectare, inclusive of initial topographic survey costs. Nonlaser leveling is not as effective as laser leveling, but it is far cheaper and should be adequate for a WUA's needs if undertaken by competent and experienced operators.

Adverse Effects of Land Leveling. The major problem with land leveling is the consequent removal of fertile topsoil and its adverse impact on crop growth and productivity. If significant soil removal is required, it may take several years before the soil can recover normal fertility. For this reason, land leveling is not advisable on slopes greater than 3%. Whenever land leveling becomes unavoidable, however, the productivity of cut areas can be reclaimed by adding organic amendments such as manure or compost.

Another concern is the soil compaction caused by leveling machinery. Soil compaction will decrease the infiltration rate of the soil. To avoid unnecessary compaction, land should be leveled when soils are relatively dry. Subsoiling and chiseling should be practiced after construction.

H. Subsoiling or Deep-ripping to Eliminate Hard Pan

In many fields in Uzbekistan, there is a presence of soil plow pans (hard pans) that form impermeable layers at depths of 40–60 cm. They are caused by poor machinery selection, poor implement selection, cultivation of wet soils, and poor irrigation practices.

Plow pans reduce soil permeability and drainage, contribute to waterlogged soils, and delay the absorption by the crops of agricultural inputs such as fertilizer. To eliminate plow pans, deep plowing (subsoiling) or deep ripping of the field needs to be undertaken.

Recommended are two perpendicular deep-plowing applications at a depth of 65 cm. This should be followed every 5–7 years by applications at depths of 40–50 cm in one direction. On some soil types, this should be done preferably every 3 years.

In a well-planned method of application, subsoiling or deep ripping at depths of 35–65 cm results in the elimination of plow pans. It improves permeability, helps prevent soil waterlogging, and improves crop yields.

V. DRAINAGE

Due to the inefficient operation and inadequate maintenance of the country's irrigation and drainage systems, drainage problems in Uzbekistan's farms have worsened during the last 15 years. As a result, there have been significant reductions in crop yields, farmers' incomes, and machinery operation productivity.

Farm productivity is greatly dependent on the proper operation and maintenance of the drainage collectors and subsurface drains that lie within the boundaries of a farmer's leaseholding. At present, however, the farmers in Uzbekistan do not have the capacity to do this task themselves. The WUAs therefore have to do it to ensure proper irrigation and drainage of the farms.

To effectively manage the drainage system both inside and outside farm boundaries, a WUA needs the full cooperation of the farmers in its service area. In particular, the farmers should make a continuing effort to identify the specific drainage problems in their fields and to report them to the WUA for appropriate action.

A. Effects of Poor Drainage

Poor drainage can cause significant or severe damage to crops. The damage can occur in the following ways:

- Prolonged soil saturation eventually leads to oxygen deprivation. Rooting depth is restricted. Plants may suffer not only from lack of oxygen (and excess of carbon dioxide) in the soil but also from lack of nutrients. The negative impact of poor drainage is higher in warm climates such as that in Uzbekistan. This is because higher temperatures decrease the solubility of oxygen in water. They also heighten the respiration rate of both plant roots and soil microorganisms.
- The surface zone of a saturated soil does not warm up readily at springtime. As a result, germination and early seedling growth are retarded in the waterlogged soil.
- If the water table drops periodically, plants with very shallow roots growing in waterlogged soil may suffer from occasional lack of water. This happens especially when plant transpiration is high.
- The presence of a high water table can result in salinization of the soil, particularly in arid regions such as those prevalent in much of Uzbekistan. Water evaporation inevitably causes precipitation of salts at or near the soil surface.
- Moist conditions near the surface make the soil susceptible to compaction by animal and machinery traffic.

In addition, waterlogged soils reduce the productivity of machinery operation. They make it impossible to perform many important farming operations such as tillage, planting, spraying, and harvesting.

B. Field Monitoring of Drainage

Surface drainage problems can be recognized in the prolonged ponding of water on the soil surface after flooding, rainfall, or irrigation. Surface ponding often occurs in depressions, valley bottoms, and behind obstructions in natural drainage flows.

Subsurface drainage problems can appear in the same way as surface drainage problems, such as prolonged ponding of water. However, in areas with subsurface drainage problems, waterlogging can occur even without surface ponding. Waterlogging problems of this type normally occur in flat lands. Deep percolation is sometimes impeded by impermeable or poorly permeable layers at a certain depth below the soil surface. On this layer, a so-called perched water table might develop and last long enough to impede crop growth.

While cultivating their land, farmers should watch for waterlogging problems that might occur due to wet soil conditions and a shallow water table. They should also observe the water level in open wells and pits. Symptoms of waterlogging in the crop are (1) poor germination, (2) inhibited root development, (3) stunted crop growth, (4) sensitivity to fungal diseases, and (6) decay of roots and crop failure in extreme cases. Salinity problems, which will be discussed in the next section, may also appear.

C. Selection of Drainage Improvement Measures

The best solution for drainage problems is not always the implementation of an artificial drainage system. Depending on the causes of the drainage problem, the solution may lie in (1) improving irrigation management and practices, (2) upgrading the canal system, (3) land leveling, (4) changes in land use or farm practices, or (5) removing blockages in the natural drainage system.

Farmers should consider whether or not poor drainage significantly lowers the returns from the farm's crop production. They should also determine what return can be expected from investing in artificial drainage or other options. They should keep in mind that only when drainage is not a major constraint could a significant increase in farm returns be expected.

If an artificial drainage system is required, alone or in combination with one of the options already mentioned, farmers should consult with the WUA O&M engineer concerning the type of drainage measures required. Unless the area under consideration is located in the vicinity of a natural drainage outlet, artificial drainage from a leasehold farm will require access to a main collector or other drainage infrastructure. This access needs to be planned and implemented by the WUA.

VI. SALINITY CONTROL

A. Water Salinity

All irrigation water contains dissolved mineral salts, but the concentration and composition of the dissolved salts vary depending on the source of the irrigation water. As the level of salt increases in an irrigation source, the quality of that water for plant growth decreases. In many areas, good quality water (with low salt and low sodium) is not available for irrigation. For this reason, even waters containing high levels of salt have to be used.

In general, irrigation water containing 0.5–2 grams per liter (g/l) of salts poses a slight-to-moderate risk of salinization to land and crops. It can be used so long as the appropriate water management procedures are undertaken. However, the application of water containing concentrations above 2 g/l (mostly drainage water) poses a much higher risk of salinization.

For instance, average salinity levels are 0.45–0.60 g/l in the upper reaches of the Amu Darya and Syr Darya. The Amu Darya becomes more intensely salinized between its middle and lower reaches (from .60 g/l in Termiz to over 1 g/l near the Aral Sea). Salinity levels remain fairly constant in the middle and lower reaches of the Syr Darya River (1.1 g/l at the outlet of the Ferghana Valley to 1.4 g/l).

By the time irrigation water makes its way to the root zone, its salinity has grown much higher. In Uzbekistan, cropland with groundwater mineralization of up to 3 g/l comprises around three quarters of the irrigated area (the remainder contains 3–5 g/l or over 5 g/l).[3]

B. Soil Salinity

Soil salinity is a condition in which the soluble salt content of the soil reaches a level harmful to crops. It is caused by either the mobilization of salts already present in the soil or by the application of saline water. The former problem is more prevalent in areas of Uzbekistan that lie on the upstream and midstream reaches of the Amu Darya and Syr Darya Rivers. In parts of the downstream sections of Amu Darya, both problems are prevalent. Over half of the irrigated cropland in Uzbekistan is salinized, of which over 20% is moderately or severely salinized. The percentage of severely salinized land in Uzbekistan has risen by more than one third since 1990.

C. Effects of Salinity on Crops

Salinity inhibits the growth of plants because the osmotic pressure of the soil-water solution in the root zone inhibits the ability of plants to absorb water. This osmotic effect is prevalent in Uzbekistan, but salts can also enter plants through the roots and leaves and hamper growth through ion toxicity. The yield response to salinization varies according to several site-specific factors, including (1) the salt-tolerance of the crop, (2) the stage in the life cycle that the salts are applied (plants are especially sensitive during germination), (3) the moisture content and texture of the soil, and (4) the characteristics of the salts.

Salt Content of Uzbekistan Soils. Most of the salts in the soils of Uzbekistan are calcium sulfates (gypsum) and magnesium sulfates. Chlorides are predominant in the Amu Darya delta. Salts in the Ferghana Valley are primarily sulfates, although there is great variation in the proportion of sulfates and chlorides among the valley's southern alluvial fans. In the Zerafshan Valley, toxic salts contain carbonate-magnesium and sulfate-magnesium compounds. Chlorides and sulfates are predominant in the Bukhara depression. Much land

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[3] IFAS Uzbekistan National Working Group 2001. *National Report 1, National Water Demands and Options for Demand Management, vol. 2* (draft), p. 49.

developed in the 1980s in Jizzakh, Golodnaya, and Karshi Steppes has an inordinately high content of gypsum (calcium sulfate).[4]

When measured on a weight or equivalent basis, chlorides inhibit the growth of crops more than calcium sulfate does. However, the specific toxic effect of salts does not influence plant growth as much as the osmotic pressure of the soil-water solution in the root zone (measured by electrical conductivity, EC_e, expressed in dS/m).[5] When osmotic pressure, rather than weight, is measured, the difference in the yield response of crops to chlorides and sulfates diminishes substantially.

Yield Response to Salinization. Experts in Central Asia have studied the yield response to salinization of a variety of crops, with cotton as the focus of most research. In southern areas of the Aral Sea basin, they are at present measuring concentrations of sodium and chlorides, owing to the prevalence of these salts there. Elsewhere, the concentration of gypsum is high, and the "sum of toxic salts" is being used because it better reflects the osmotic potential of the soil-water solution.[6] The estimates by the Central Asia Scientific-Research Institute for Irrigation of the loss in cotton yields are as follows: 20–30% on slightly salinized land, 40–60% on moderately salinized land, and up to 80% and beyond on severely salinized land. Severely salinized land often cannot be cultivated, and Uzbekistan loses around 20,000 ha of irrigated land per year for this reason.

D. How to Recognize Salinity/Sodicity

Salinity problems only become visible in the field after they have reached an advanced stage. The concentration of salts in the soil must be quite high for salinity symptoms to become apparent. Salinity/sodicity symptoms appear in plants in the same way as moisture stress from dry conditions. Plants may be stunted, leaves may cup, and overall plant health and color are affected. The symptoms progress to the brown and brittle leaf tips, to the leaf margins, to the overall leaf and, finally, to the entire plant.

Early Signs of Salinity Damage. Usually, the plant stages that are most sensitive to salinity and sodicity are the germination or the early growth stages. Early signs of salinity damage are (1) failed germination, (2) irregular and stunted crop growth, (3) darker leaves than the normal color, and (4) smaller leaves and stems with shorter spaces between leaf nodes. When the problem gets more serious, leaves turn yellow and are affected by "burning" (firing, browning) and the death of leaf edges.

Signs of High Salt Concentrations in Soils. High salinity concentrations can be recognized in the soil by a white soil crust, a powder-like layer covering the soil surface, and an oily appearance of the soil surface. Salinity often appears in patches within the field. High sodium concentrations are often accompanied by black soil patches on the soil surface, hard soil crust, dense/massive soil structure, and poor water infiltration. Bare patches often appear in fields due to the death of crops during germination. This is due to their lower tolerance for salt during this phase, to uneven watering, and to local concentrations of salt in groundwater and substrata. Poor leveling of fields is perhaps the greatest contributor to the salinized "patches." This is because slopes make fields hard to leach. Slopes also make the fields prone to aeration and to the consequent rising of salts to the soil's root zone.

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[4] B. Grechikhin and M. Kochubei. 1988. *Zemel'nyi fond Uzbekistana i perspekitvy ego ispol'zovaniia*, pp. 42-44; Water and Environmental Management Project (WEMP), App.B.3.

[5] DeciSeimens per meter (dS/m). When the salinity of the soil-water solution (saturation extract) reaches a range of 4.5–9 dS/m, it is considered to be slightly saline, moderately saline at 9–18 dS/m, and severely saline at over 18 dS/m. These ranges are roughly equivalent to 3–6 g/l, 6–12 g/l, and over 12 g/l of total dissolved solids, respectively. DeciSeimens (dS/m) is alternatively expressed as millimhos per centimetre (mmho/cm).

[6] WEMP, App.B.3, App.B.3-4.

In general, farmers should be aware of the limitations in field detection of salinity. For their part, WUAs should monitor soil salinity on an annual basis and advise farmers concerning remedial management practices.

E. Controlling Salinity in Irrigated Soils

There are several management practices available for controlling salinity. These practices include the following:

- Selection of crop varieties tolerant to salt;
- Modification of land preparation practices; and
- Improvement of irrigation and drainage management.

When selecting a set of management practices to optimize production, the crop type, climate, irrigation water quality, and soil properties should be carefully considered.

1. Crop Management

Crops vary considerably in their tolerance to salinity. They should therefore be selected such that they can produce satisfactorily under the particular conditions of salinity expected to occur in the root zone. Among the crops grown in Uzbekistan, the most salt-tolerant are barley and sugar beets. Moderately tolerant crops are alfalfa, rice, cotton, wheat, corn, potatoes, carrots, onion, cucumbers, pomegranates, figs, melons, and grapes. The least salt-tolerant crops are stone fruits, almonds, peas, and beans. Plant density should be increased to compensate for the smaller plant size that results due to saline conditions.

It is especially important to consider the crop's salt tolerance during seedling development. This is often the most sensitive growth stage. Optimum yields are impossible without satisfactory establishment of crop stand. When a crust is likely to develop on the soil, the sowing rate should be increased to facilitate seedling emergence and stand establishment.

2. Land Preparation

Where irrigation is by the flood or furrow method, careful land leveling is desirable to achieve more uniform water application and, consequently, better salinity control.

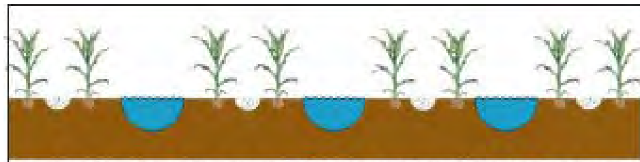
Deep ripping of soils can eliminate plow pans that impede drainage.

Seedbed shape and seed location can be managed to move salts away from germinating seeds and plant roots. With this method, irrigation uniformity is essential. Without uniform distribution of water, salts will build up in areas with germinating seeds and seedling plants, damaging them.

Double-row bed systems are illustrated in Figure 14. This method requires uniform wetting toward the middle of the bed. This leaves the sides and shoulders of the bed relatively free from injurious levels of salinity. Without uniform applications of water (in which one furrow receives more or less than another), salts accumulate closer to one side of the bed. Periodic leaching of salts down from the soil surface and below the root zone may still be required to ensure that the beds are not eventually salted out.

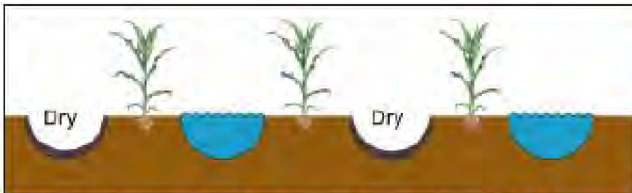
The alternate furrow irrigation shown in Figure 15 may be desirable for single-row bed systems. It is accomplished by irrigating every other furrow and leaving alternating furrows dry. Salts are pushed across the bed from the irrigated side of the furrow to the dry side. Care is needed to ensure that enough water is applied to wet all the way across the bed to prevent build up in the planted area. This method of salinity management, however, can still result in plant injury. This will happen if large amounts of natural rainfall fill the normally dry

Figure 14. Salt Management in Double Row Bed Systems

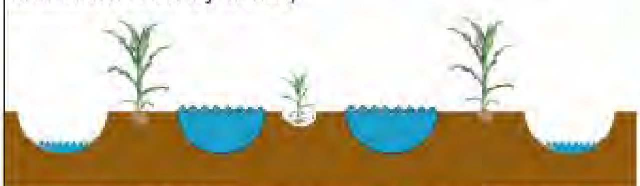

Good uniformity: salts accumulate in the center of the bed and away from plants.


Poor uniformity: salts accumulate toward edge of bed near one row.

Figure 15. Salt Management in Single Row Bed Systems



Uniform, healthy plants with alternate furrow irrigation (salt accumulates in the dry furrows).


Irregular growth due to variable accumulation of salt (plants may overcome this situation if roots can grow out of the saline area).

furrows and push salts back across the bed toward the plants. Plant injury can also occur if the normally dry furrows are accidentally irrigated.

Practices that maintain high organic matter levels in the soil, such as green manuring and incorporation of crop residues, will help in the maintenance of good tilth and prevent surface crusting. It is important to avoid tillage at high water content.

3. Irrigation and Drainage Management

Improvements in salinity control of irrigated lands generally come from improvements in irrigation management. The key to effective irrigation—and hence to salinity control—is to provide the proper amount of water at the proper time. Careful control of timing and of the amount of water applied requires the following:

- Water delivery to the field on demand: This requires close coordination between the farmer and the WUA. Many delivery systems encourage over-irrigation because the water is supplied for fixed periods, or in fixed amounts, irrespective of seasonal variations in onfarm needs.

- Accurate measurement of water flow (rates and volumes): Without effective flow controlling and measuring devices, seepage losses are difficult to identify. Oversupply to fields is likely to occur.
- Adequate delivery and drainage system: Seepage losses should be reduced by lining the canals with impermeable materials or by compacting the soil to achieve low permeability. Also, the drainage system should be kept clean and on grade.
- Accurate measurement of the water and salt content of the soil.
- Adoption of reliable methods to predict or measure the rate of water use by the crop, and of ways to detect or predict the onset of plant stress.

Risks from Excessive Irrigation. Over-irrigation contributes to the water table and to salinity problems. It also increases the amount of water that the drainage system must accommodate. A proper relation between irrigation management and drainage must therefore be maintained to prevent irrigated lands from becoming salinized. The amount of water applied should be sufficient to supply the crop and satisfy the leaching requirement, but not too much as to overload the drainage system. It is important to recognize that inefficient irrigation is a major cause of salinity and of shallow water tables in many irrigation projects of the world, and that the need for drainage can usually be reduced through improvements in irrigation management. Ways to improve irrigation efficiency should be sought first before the drainage capacity is increased.

The frequency of irrigation affects the response of crops to saline waters. Salts reduce the availability of water for plant use in almost direct proportion to their total concentration in the soil solution. For this reason, irrigation frequency should be increased irrespective of irrigation method. This will keep the moisture content of saline soils as high as practicable without creating aeration or disease problems. This is especially true during seedling establishment and the early stages of vegetative growth.

F. Leaching Requirement

Water must be applied at least occasionally to leach out the salt that has accumulated during previous irrigations. The additional amount of the water should be over that required to replenish losses by plant transpiration and evaporation. The importance of leaching becomes apparent from this fact: a 1-meter depth of irrigation (the amount normally applied in a single season) of even reasonable-quality water contains enough salt to salinize an initially salt-free soil at the level of about 5,000 kg/ha. However, any attempt to leach without providing for adequate drainage is not merely doomed to fail but will only exacerbate the problem.

Determining the Volume of Leaching Water. The key to proper leaching is to determine the optimal quantity of additional water that must be applied. The application of too much water can be as harmful as the application of too little. Exaggerated leaching not only wastes water but also tends to remove essential nutrients and to impede aeration by waterlogging the soil. The optimal "leaching requirement" is the fraction of the irrigation water that must be leached out of the bottom of the root zone to prevent average soil salinity from rising above some permissible limit.

Scheduling the Leaching of Fields. Most leaching can be achieved during pre-irrigations between crops or during early season irrigations. This is when soil permeability is generally at its maximum and crop use is at its minimum.

The leaching requirement depends on the salt content of the irrigation water and on the maximum salt concentration permissible in the soil solution, which in turn depends on the salt tolerance of the crop. Leaching as a means for controlling salinity works best in permeable, coarse-textured soils. If they have good structure, medium- and fine-textured soils ordinarily present no major problem from the standpoint of salinity control. Prevention of salt accumulation is most difficult in fine-textured, slowly permeable soil.

Appendix 5 shows how to calculate the leaching requirement.

Some Questionable Leaching Practices. For most surface irrigation systems in Uzbekistan, over-irrigation already accounts for the leaching requirement (or is in excess of it). In addition, as much as 35% of total water use in some areas (around 2,000–3,000 m^3/ha) is devoted to leaching fields during late fall and winter (locally known as *yahob*). The benefit of this practice is questionable. The seeding of cotton requires a “wetting-up” irrigation in late March and early April for a programmed seeding date of mid- to late-April. Will not this irrigation leach soils to an acceptable depth? If so, why apply water for leaching at volumes of up to 3,000 m^3/ha?

Moreover, irrigation scheduling is programmed for 10-day intervals. If a proper leaching requirement is calculated, will not these regular irrigations leach any salts brought to the surface from the water table by soil capillary action? No matter what the answer, the current timing of irrigation scheduling is already a problem. A study of irrigation applications by TACIS (Technical Aid to the Commonwealth of Independent States) in 2000 and 2001 recorded time intervals between irrigations of up to 4, 6, 8, and 10 weeks. These increased intervals have been required generally due to the following factors:

- Bulk supply delivery was influenced by the requirements of a downstream district.
- Deterioration of the irrigation infrastructure caused inter-farm and onfarm delivery problems.
- Irrigation was postponed due to significant delay in the application of agricultural inputs. This was particularly due to the farmers’ poor access to field cultivation machinery.

The Need for Controlled Irrigation Scheduling. Winter leaching is known to denude the residual fertility of the soil and also to destroy the structure of the soil. Properly planned and controlled irrigation scheduling in accordance with the leaching requirement will control capillary salt rise to the surface from the water table. The “wetting-up” for seeding would then be sufficient for leaching the salts. The costs and benefits of various options need to be reassessed by field research under the following conditions: (1) rehabilitated drainage, (2) planned irrigation scheduling, (3) applied land leveling, and (4) deep plowing.

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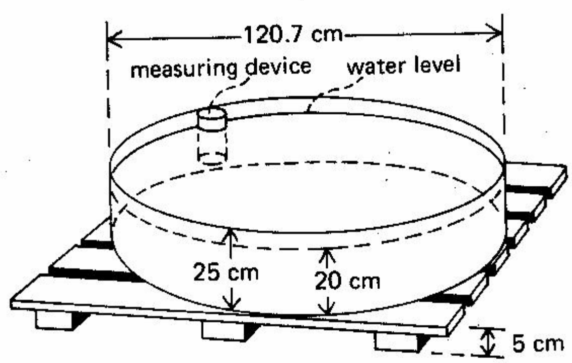
Appendix 1. MEASUREMENT OF REFERENCE CROP EVAPOTRANSPIRATION

Pan Evaporation Method

Various evaporation-measuring devices (called evaporimeters) are available for estimating reference crop evapotranspiration. The most frequently employed measuring devices are evaporation pans. They indicate the effect of radiation, wind, temperature, and humidity on evaporation from an open water surface.

The most widely adopted type of evaporation pan (the “Class A” pan) is a circular container, 121 centimeters (cm) in diameter and 25.5 cm deep. It is placed on a slatted wooden frame resting over the ground. The pan is filled with water to a height between 5 and 15 cm below the rim (see Figure 2 below).

Class A Evaporation Pan



Pans are relatively inexpensive and are easy to install, maintain, and monitor. They must be used carefully. Pan evaporation depends greatly on the exact placement of the pan. Pans surrounded by a tall crop may evaporate 20–30% less than pans placed in a fallow area, especially if the climate is dry and windy. To avoid water loss to drinking animals (especially birds), pans are often covered by screens. This reduces the evaporation rate generally by about 10–20%, thus requiring the use of a correction factor. The screens also interfere somewhat with the measurements and with the servicing of the pan.

It should be emphasized that although a vegetated field responds to the same climatic variables as does a pan, it does not necessarily respond in the same way. Reflection of solar radiation from water in the shallow pan might be different. The daytime storage of heat within the pan can cause considerable evaporation at night (10–40% of the 24-hour total). In contrast, nighttime transpiration from crops is generally below 5% of the 24-hour total. The color of the pan, heat transfer through the sides, the turbidity of the water, and possible shading from screens or nearby plants all affect the measurement. Notwithstanding the difference between pan-evaporation and the evapotranspiration of cropped surfaces, the use of pans to predict ET_o for periods of 10 days or longer is warranted.

Procedures for using an evaporation pan are as follows:

- The pan is installed in the field.

- The pan is filled with water and the level is measured.
- The water is allowed to evaporate during a certain period of time (usually 24 hours).
- After 24 hours the water level is measured (normally at 7:00).
- The difference between the two measurements is the pan evaporation: E_{pan} (mm/day).
- E_{pan} is multiplied by a pan coefficient (K_{pan}) to obtain the ET_o.

The following formula is to calculate the ET_o:

$$\mathbf{ET_o = E_{pan} \times K_{pan}}$$

wherein

ET_o = reference evapotranspiration [mm/day]
K_p = pan coefficient [-]
E_{pan} = pan evaporation [mm/day]

The pan coefficient (K_{pan}) depends on the type of pan used, the pan environment (if the pan is placed in fallow or cropped area), and the climate (humidity and wind speed). The pan coefficient is high if the pan is placed in a fallow area, if the humidity is high, or if the wind speed is low. The pan coefficient is low if the pan is placed in a cropped area, where humidity is low and wind speed is high. For the Class A evaporation pans placed in the open, the pan coefficient generally varies from 0.85 for conditions of high humidity and light winds (below 175 km per day) to about 0.5 for low humidity and very strong winds (above 700 km per day). The average is about 0.7.

Blaney-Criddle Method

For measuring reference crop evapotranspiration, many practitioners prefer simplified empirical methods. These methods provide good estimates for a season or a month, but they can be grossly inaccurate for shorter periods. When not enough data are available to use more precise methods, it is possible to use the Blaney-Criddle method. This method employs the following formula:

$$\mathbf{ET_o = p\,(0.46\,T_{average} + 8)}$$

wherein

$T_{average}$ = Average daily temperature
p = Average daily percentage of annual daytime hours

Below are the steps for calculating reference crop evapotranspiration using the Blaney-Criddle method.

Step 1: Determine the average daily temperature ($T_{average}$).

$$\mathbf{\frac{T_{average}\ (T_{max} + T_{min})}{2}}$$

wherein

$$T_{max} = \frac{\text{Sum of all maximum temperature values during the month}}{\text{Number of days}}$$

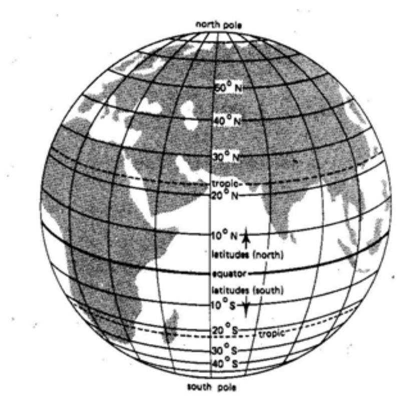
$T_{min} =$ $\dfrac{\text{Sum of all minimum temperature values during the month}}{\text{Number of days}}$

Step 2: Determine the average daily percentage of annual daytime hours (p).

The table below is used to determine the value of p. This value can be obtained based on the approximate latitude of the area (the number of degrees north or south of the equator).

Average Daily Percentage of Annual Daytime Hours

Latitude	**North**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
	South	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**
60°		.15	.20	.26	.32	.38	.41	.40	.34	.28	.22	.17	.13
55		.17	.21	.26	.32	.36	.39	.38	.33	.28	.23	.18	.16
50		.19	.23	.27	.31	.34	.36	.35	.32	.28	.24	.20	.18
45		.20	.23	.27	.30	.34	.35	.34	.32	.28	.24	.21	.20
40		.22	.24	.27	.30	.32	.34	.33	.31	.28	.25	.22	.21
35		.23	.25	.27	.29	.31	.32	.32	.30	.28	.25	.23	.22
30		.24	.25	.27	.29	.31	.32	.31	.30	.28	.26	.24	.23
25		.24	.26	.27	.29	.30	.31	.31	.29	.28	.26	.25	.24
20		.25	.26	.27	.28	.29	.30	.30	.29	.28	.26	.25	.25
15		.26	.26	.27	.28	.29	.29	.29	.28	.28	.27	.26	.25
10		.26	.27	.27	.28	.28	.29	.29	.28	.28	.27	.26	.26
5		.27	.27	.27	.28	.28	.28	.28	.28	.28	.27	.27	.27
0		.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27



Step 3: Calculate ET_o, using the formula.

An example is provided below:

Step 1: Assume $T_{average}$

$\mathbf{T_{max}}$ 25 ºC

$\mathbf{T_{min}}$ 15 ºC

$\mathbf{T_{average}}$ (25 + 15)/2 = 20 ºC

Step 2: Assume
Latitude: 43º North
Month of July
P = 0.345

Step 3: Calculate

$$\mathbf{ET_o = p\ (0.46\ T_{average} + 8)}$$

$ET_o = 0.345 * (0.46 * 20 + 8) = 5.9$ mm/day

Appendix 2. CROP WATER REQUIREMENTS IN UZBEKISTAN

Since the 1970s, research institutes and government agencies in Uzbekistan have developed several methodologies for calculating crop water requirements and have compared them with those utilized elsewhere in the world (such as the standard methods of the Food and Agriculture Organization of the United Nations). Table 1 presents water requirements for selected crops for various regions. Note the variation among the requirements for various crops and provinces.

Crops	Andijan	Ferghana	Namangan-Naryn	Namangan-Syr-Darya	Syr-Darya	Dzhizzak	Samarkand	Navoi	Bukhara	Surkhandarya	Karshi	Kashkadarya	Tashkent-Syr Darya	Tashkent-Chirchik	Khorezm	Southern Karakalpakstan	Northern Karakalpakstan
Winter Wheat	2123	2528	2574	2574	2356	2486	2218	2390	2596	2948	3229	2722	2430	2286	2426	2419	2382
Rice	17623	16259	18513	14169	19866	19596	17833	14768	20325	21441	22050	14973	19155	17592	20250	20250	19562
Grain Maize	4236	5757	5319	6150	5253	5202	3729	5549	6154	5795	6087	4766	4985	3645	5925	5925	5853
Cotton	4625	6183	5785	6600	5679	5658	4153	5970	6620	6601	6789	4635	5412	4065	5300	5143	5685
Alfalfa	6445	7879	7750	8175	7085	7520	6469	7518	8199	8224	8413	6423	7033	6212	7604	7596	7096

Source: NWG Uzbekistan, pp. 39-40.

Appendix 3. CALCULATION OF THE CROP FACTOR

Step 1: Determine the total growing period for each crop.

The total growing period (in days) is the period from sowing or transplanting to the last day of the harvest. It depends mainly upon the type of crop and the variety, the climate, and the planting date. Because the growing period varies according to local conditions (such as local crop varieties), it is always best to obtain these data locally. Farmers should utilize the data in Table 3.1 only if no data are available locally. There is a large variation of values not only between crops but also within one crop type. In general, the growing period for a certain crop is longer when the climate is cool and shorter when the climate is warm.

Table 3.1 Indicative Values of the Total Growing Period

Crop	Total Growing Period (Days)	Crop	Total Growing Period (Days)
Alfalfa	100-365	Millet	105-140
Banana	300-365	Onion green	70-95
Barley/Oats/Wheat	120-150	Onion dry	150-210
Bean green	75-90	Peanut/Groundnut	130-140
Bean dry	95-110	Pea	90-100
Cabbage	120-140	Pepper	120-210
Carrot	100-150	Potato	105-145
Citrus	240-365	Radish	35-45
Cotton	180-195	Rice	90-150
Cucumber	105-130	Sorghum	120-130
Eggplant	130-140	Soybean	135-150
Flax	150-220	Spinach	60-100
Grain/small	150-165	Squash	95-120
Lentil	150-170	Sugar beet	160-230
Lettuce	75-140	Sugarcane	270-365
Maize sweet	80-110	Sunflower	125-130
Maize grain	125-180	Tobacco	130-160
Melon	120-160	Tomato	135-180

Step 2: Determine the growth stages.

Once the total growing period is known, the duration (in days) of the various growth stages has to be determined. The total growing period is divided into four growth stages:

1. **The initial stage:** It lasts from sowing or transplanting until the crop covers about 10% of the ground.
2. **The crop development stage:** It starts at the end of the initial stage and lasts until the full ground cover has been reached (ground cover 70-80%); it does not necessarily mean that the crop is at its maximum height.
3. **The midseason stage:** It begins at the end of the crop development stage and lasts until maturity; it includes flowering and grain-setting.
4. **The late season stage:** It starts at the end of the mid season stage and lasts until the last day of the harvest; it includes ripening.

Table 3.2 below presents the duration of the various growth stages for some of the major field crops. For each crop, the "minimum" and "maximum" duration of the total growing period (from Table 3.1) has been taken and subdivided in the various growth stages. It should again be emphasized that it is important to obtain (preferably locally) an accurate estimate of the total growing period. The duration of the four growth stages can be estimated with the help of Table 3.2.

Table 3.2 Approximate Duration of Growth Stages for Various Field Crops

Field Crop	Total	Initial Stage	Crop Development Stage	Mid-Season Stage	Late-Season Stage
Barley/Oats/Wheat	120	15	25	50	30
	150	15	30	65	40
Bean/green	75	15	25	25	10
	90	20	30	30	10
Bean/dry	95	15	25	35	20
	110	20	30	40	20
Cabbage	120	20	25	60	15
	140	25	30	65	20
Carrot	100	20	30	30	20
	150	25	35	70	20
Cotton/Flax	180	30	50	55	45
	195	30	50	65	50
Cucumber	105	20	30	40	15
	130	25	35	50	20
Eggplant	130	30	40	40	20
	140	30	40	45	25
Grain/small	150	20	30	60	40
	165	25	35	65	40
Lentil	150	20	30	60	40
	170	25	35	70	40
Lettuce	75	20	30	15	10
	140	35	50	45	10
Maize, sweet	80	20	25	25	10
	110	20	30	50	10
Maize, grain	125	20	35	40	30
	180	30	50	60	40
Melon	120	25	35	40	20
	160	30	45	65	20
Millet	105	15	25	40	25
	140	20	30	55	35
Onion/green	70	25	30	10	5
	95	25	40	20	10
Onion/dry	150	15	25	70	40
	210	20	35	110	45
Peanut/Groundnut	130	25	35	45	25
	140	30	40	45	25
Pea	90	15	25	35	15
	100	20	30	35	15
Pepper	120	25	35	40	20
	210	30	40	110	30
Potato	105	25	30	30	20
	145	30	35	50	30
Radish	35	5	10	15	5
	40	10	10	15	5
Sorghum	120	20	30	40	30
	130	20	35	45	30
Soybean	135	20	30	60	25
	150	20	30	70	30
Spinach	60	20	20	15	5
	100	20	30	40	10
Squash	95	20	30	30	15
	120	25	35	35	25
Sugar beet	160	25	35	60	40
	230	45	65	80	40

Sunflower	125	20	35	45	25
	130	25	35	45	25
Tomato	135	30	40	40	25
	180	35	45	70	30

Step 3: Determine crop factors.

Per crop, four crop factors have to be determined: one crop factor for each of the four growth stages. Table 3.3 below indicates per crop the K_c values for each of the four growth stages. The table above shows average K_c values for the various crops and growth stages. In fact, the K_c is also dependent on the climate and, in particular, on the relative humidity and the windspeed. The values indicated above should be reduced by 0.05 if the relative humidity is high (RH > 80%) and if the windspeed is low (u < 2 m/sec); e.g., K_c = 1.15 becomes K_c = 1.10. The values should be increased by 0.05 if the relative humidity is low (RH < 50%) and the windspeed is high (u > 5 m/sec); e.g., K_c = 1.05 becomes K_c = 1.10.

Table 3.3 Crop Factor Values for Various Crops and Growth Stages

Crop	Initial Stage	Crop Development Stage	Mid-Season Stage	Late-Season Stage
Barley/Oats/Wheat	0.35	0.75	1.15	0.45
Bean, green	0.35	0.70	1.10	0.90
Bean, dry	0.35	0.70	1.10	0.30
Cabbage/Carrot	0.45	0.75	1.05	0.90
Cotton/Flax	0.45	0.75	1.15	0.75
Cucumber/Squash	0.45	0.70	0.90	0.75
Eggplant/Tomato	0.45	0.75	1.15	0.80
Grain/small	0.35	0.75	1.10	0.65
Lentil/Pulses	0.45	0.75	1.10	0.50
Lettuce/Spinach	0.45	0.60	1.00	0.90
Maize, sweet	0.40	0.80	1.15	1.00
Maize, grain	0.40	0.80	1.15	0.70
Melon	0.45	0.75	1.00	0.75
Millet	0.35	0.70	1.10	0.65
Onion, green	0.50	0.70	1.00	1.00
Onion, dry	0.50	0.75	1.05	0.85
Peanut/Groundnut	0.45	0.75	1.05	0.70
Pea, fresh	0.45	0.80	1.15	1.05
Pepper, fresh	0.35	0.70	1.05	0.90
Potato	0.45	0.75	1.15	0.85
Radish	0.45	0.60	0.90	0.90
Sorghum	0.35	0.75	1.10	0.65
Soybean	0.35	0.75	1.10	0.60
Sugar beet	0.45	0.80	1.15	0.80
Sunflower	0.35	0.75	1.15	0.55
Tobacco	0.35	0.75	1.10	0.90

The example on the next page illustrates the calculation of crop factors for maize and cotton.

Location : Example...   Date : 1/8/86

Humidity : crop 1: high/medium/low   Wind speed : crop 1: high/medium/low

crop 2: high/medium/low   crop 2: high/medium/low

Crop 1 : Maize (grain)   Planting Date : 1 July

Duration of total growing period : 130 days
(from local information or Table 6)

Estimated duration of growth stages (Table 7) :		Dates
Initial stage	: 20 days	1 July - 20 July
Crop dev. stage	: 35 days	21 July - 25 August
Mid-season stage	: 45 days	26 August - 10 October
Late season stage	: 30 days	11 October - 10 November

Crop factors, Kc (Table 8) :	
Initial stage	: 0.40*
Crop dev. stage	: 0.80*
Mid-season stage	: 1.15*
Late season stage	: 0.70*

Crop 2 : Cotton   Planting Date : 1 JUNE

Duration of total growing period : 165 days
(from local information or Table 6)

Estimated duration of growth stages (Table 7) :		Dates
Initial stage	: 25 days	1 June - 25 June
Crop dev. stage	: 45 days	26 June - 10 August
Mid-season stage	: 50 days	11 August - 30 September
Late season stage	: 45 days	1 October - 15 November

Crop factors, Kc (Table 8) :	
Initial stage	: 0.45
Crop dev. stage	: 0.75
Mid-season stage	: 1.15
Late season stage	: 0.75

* In case of low RH & high windspeed the Kc values would resp. be: 0.45, 0.85, 1.20 & 0.75. In case of high RH & low windspeed the Kc values would resp. be: 0.35, 0.75, 1.10 & 0.65.

Appendix 5. CALCULATION OF THE IRRIGATION REQUIREMENT

The example below demonstrates how the irrigation water requirement can be calculated using data concerning the reference evapotranspiration, crop factor, and rainfall.

Step 1: Estimate the growing stages, their duration, and the crop factor.

		nº of days	**Start**	**Finish**	**K_c**
Tomato		**135**			
	Initial	30	01-Apr	01-May	0.45
	Development	40	02-May	10-Jun	0.75
	Mid	40	11-Jun	20-Jul	1.15
	Late	25	21-Jul	15-Aug	0.80
	Harvest		15-Aug		

Step 2: Enter the reference evapotranspiration (ET_o).

Months	**Apr**	**May**	**Jun**	**Jul**	**Aug**
ET_o (mm/day)	3.5	5.2	8.8	9.7	9.3
Growth stages	***Init***	***Dev***	***Mid***		***Late***

Step 3: Estimate the monthly values of the crop factor (K_c).

Months	**Apr**	**May**	**Jun**	**Jul**	**Aug**
ET_o (mm/day)	3.5	5.2	8.8	9.7	9.3
Growth stages	***Init***	***Dev***	***Mid***		***Late***
Values of K_c	0.5	0.75	1.15		0.80
Monthly K_c	0.5	0.75	1.02	1.03	0.80

It can be seen from the table above that the months and growth stages do not correspond. Thus, the ET_o and the K_c values do not correspond. Yet the ET crop (= $ET_o \times K_c$) has to be determined on a monthly basis. It is thus necessary to determine the Kc on a monthly basis, which is done as provided in the example below:

Month A 30 days K_c Feb = 0.45
Month B 5 days: K_c = 0.45
Month B 25 days: K_c = 0.75

The calculation for Kc of Month B incorporates factors from different seasons into the same month:

$$Kc = \frac{5}{30} \times 0.45 + \frac{25}{30} \times 0.75 = 0.07 + 0.62 = 0.69 = \text{approx}\, 0.70$$

Step 4: Calculate, on a monthly basis, the crop water requirements ($ET_c = K_c \times ET_o$).

Months	**Apr**	**May**	**Jun**	**Jul**	**Aug**
ET_o (mm/day)	3.5	5.2	8.8	9.7	9.3
Growth stages	***Init***	***Dev***	***Mid***		***Late***
Values of K_c	0.5	0.75	1.15		0.80
Monthly K_c	0.5	0.75	1.02	1.03	0.80
ET_c (mm/day)	1.8	3.9	8.9	10.0	7.4

Step 5: Calculate the monthly crop water requirements as follows: ET_c (mm/day) x 30 days. All months in the irrigation calendar are assumed to have 30 days.

Months	Apr	May	Jun	Jul	Aug
ET_o (mm/day)	3.5	5.2	8.8	9.7	9.3
Growth stages	***Init***	***Dev***	***Mid***		***Late***
Values of K_c	0.5	0.75	1.15		0.80
Monthly K_c	0.5	0.75	1.02	1.03	0.80
ET_c (mm/day)	1.8	3.9	8.9	10.0	7.4
ET_c (mm/month)	53	117	268	301	149

Step 6: Calculate the monthly irrigation water requirements by subtracting effective rainfall from the crop water requirement (ET_c).

Months	Apr	May	Jun	Jul	Aug
ET_o (mm/day)	3.5	5.2	8.8	9.7	9.3
Growth stages	***Init***	***Dev***	***Mid***		***Late***
Values of K_c	0.5	0.75	1.15		0.80
Monthly K_c	0.5	0.75	1.02	1.03	0.80
ET_c (mm/day)	1.8	3.9	8.9	10.0	7.4
ET_c (mm/month)	53	117	268	301	149
Precipitation (mm/month)	52	39	21	8	4
Effective precipitation (mm/month)	39	29	16	0	0
Irrigation need (mm/month)	14	88	252	301	149
Irrigation need (mm/day)	0.5	2.9	8.4	10.0	5.0

Appendix 6. CALCULATION OF THE LEACHING REQUIREMENT

Assume: (1) steady-state conditions of through-flow (thus disregarding short-term changes in soil moisture content, flux, and salinity), (2) no appreciable dissolution or precipitation of salts in the soil and (3) no removal of salts by the crop or by the capillary rise of salt-bearing water from below. We then use the equation:

$$Vd/Vi=Ci/Cd$$

Since the volume of water drained, Vd, is the difference between the volumes of irrigation and of evapotranspiration (V'i-Vet), we have

$$(Vi-Vet)/Vi=Ci/Cd$$

Hence

$$Vi=[Cd/(Cd-Ci))Vet$$

The water volumes are usually expressed per unit area of land as equivalent depths of water, D (10 cubic meters per hectare being 1 mm in terms of depth). Accordingly, we obtain the formulation: Di=[Cd/(Cd-Ci)]Det

wherein:

Di is the depth of irrigation, and
Det is the equivalent depth of "consumptive use" by the crop evapotranspiration.

The leaching requirement concept implies that by varying the fraction of applied water that is percolated through the root zone, it is possible to control the salinity of the drainage water and to maintain the desirable level of salt concentration in the main part of the root zone at some intermediate level between Ci and Cd. A distinct disadvantage of the leaching requirement concept is its disregard of short-term fluctuations in the salt concentration of the soil's upper zone that take place during individual irrigation cycles, as affected by the frequency as well as quantity of irrigation. In particular, the spatial and temporal variation of root-zone salinity is affected by the degree to which soil moisture is depleted between irrigations. The less frequent the irrigation regime, the greater the build up of salt concentration between successive irrigations, and the greater the fluctuations in the osmotic pressure of the soil solution during the irrigation season.

In determining the optimal leaching fraction, a possible constraint must be taken into account, namely the limited hydraulic conductivity of the subsoil at the lower boundary of the root zone. If the soil is relatively impermeable, then it might restrict the attainable leaching fraction. Unless this limitation is recognized and defined, a blind attempt to follow the leaching requirement concept may lead to waterlogging the soil and thus to aggravating, rather than alleviating, the salinity problem.

Asian Development Bank

WATER USERS' ASSOCIATIONS IN UZBEKISTAN

FIELD HANDBOOK

August 2006

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INTRODUCTION

All water users' associations (WUAs) in the world have a common primary objective: to operate an irrigation system that can give all of its water users a fair and equitable water allocation that takes into account seasonal and supply variations. For this to happen, however, every WUA must keep the state of repair of its irrigation and drainage infrastructure as near as possible to its "as-built" condition.

This field handbook is designed to provide basic operations and maintenance guidance that can help WUAs in Uzbekistan achieve both of these objectives. It is specifically intended as a convenient reference for the WUA's line staff, particularly the O&M engineers and *mirabs* (watermasters). To guide them in their daily work, the handbook covers the standard methods and procedures for the various levels of maintenance inspection and repair for an irrigation and drainage system.

Also discussed in this handbook are farm irrigation scheduling, field application, drainage, and salinity—topics that should prove useful not only to the WUA's line staff but also to the farmers in the WUA's service area. These topics are included in recognition of the crucial importance of better in-farm management in (1) reducing the demand and competition for water, (2) improving farm incomes, and (3) reducing the operations and maintenance expenses of the WUA itself.

This handbook is a companion feature of the series of 5 guidebooks prepared for WUAs in Uzbekistan by the Asian Development Bank's (ADB's) Agricultural Development Advisory Service. The technical procedures and techniques it takes up are discussed in more detail in the WUA guidebooks. Users of this handbook are therefore encouraged to refer to the guidebooks themselves for a deeper understanding of those procedures and techniques.

I. MAINTENANCE PROCEDURES

A. Overview of the Maintenance Function

The principal objective of maintenance is to ensure that the irrigation and drainage system operates as designed and that optimal water distribution is achieved at all times. Through a planned program of works, the irrigation and drainage infrastructure should therefore be properly maintained and kept as near as possible to its "as-built" condition. Such a program primarily covers regular inspection of the infrastructure and regular maintenance work to prevent the deterioration of canals, flumes, drains, structures, and inspection and access roads. It also covers the upkeep of such ancillary facilities as offices, housing, vehicles, and other equipment.

Table 1 presents the typical range of a water users' association's (WUA's) infrastructure maintenance activities. *(Guidebook 4 discusses a WUA's operations and maintenance procedures in detail.)*

B. Maintenance Inspections and Annual Maintenance Plan

Three levels of maintenance inspections are provided for in the WUA's Annual Maintenance Plan: regular maintenance inspections, monthly maintenance inspections, and annual maintenance inspections.

Step 1: Regular Maintenance Inspections

The WUA's operations and maintenance (O&M) technicians and gate operators are responsible for conducting regular maintenance inspections of the physical condition of the WUA's irrigation and drainage infrastructure. These inspections are done in the course of their daily supervisory and liaison tasks for the WUA's irrigation delivery as well as during their meetings with farmers.

As part of their daily activities, the WUA construction supervisor and the WUA service foreman (for O&M machinery and equipment) should similarly take note of the maintenance needs in their respective areas. They should report these needs to the O&M technicians.

Any needed repairs should be recorded in the prescribed WUA Field Notebooks, and repair information from the daily inspections should be entered into a Maintenance Register. This register is divided into sections for each of the three O&M areas, namely (1) the irrigation network section; (2) the drainage network section that covers open collectors, closed pipes, and other structures; and (3) the access roads section. These sections are in turn divided into subsections, one for each distribution canal or flume and drain.

The O&M engineer has to establish priorities for each item entered in the Maintenance Register. He or she should do this after studying the register and after conducting monthly site visits of the system and of the locations reported as needing maintenance work. The required repairs should be classified as either a routine task, which should be fitted into the maintenance plan as time or labor availability permits; or as a periodic task, which can be deferred until the next yearly system shutdown. In the case of emergency repairs, the O&M engineer should attend to the tasks at once or assign them for immediate execution.

The O&M technician is responsible for entering repair data into the Maintenance Register and for reporting his or her daily findings to the O&M engineer. The O&M engineer, in turn, is responsible for regularly checking the Maintenance Register and for establishing the WUA's maintenance priorities.

Table 1. Typical WUA Infrastructure Maintenance Activities

Canal Structure	Item	Typical Routine Maintenance Items	Typical Periodic Maintenance Items
Secondary Canals and Structures	Secondary Canals	Clear out weeds and vegetation Minor repairs to lining Minor repairs to concrete Dewater at end of season	Clear out silt Resection canal Repair lining joints Repair broken concrete
	Staff Gauges, Measuring Structures	Clear away trash Paint metalwork Clean staff gauges Minor repairs	Replace staff gauge Repairs to damaged parts Replace whole structure
	Secondary Head Regulator	Clear away trash Grease gates Paint metalwork - gates Minor repairs to gates Minor repairs to concrete	Replace gate Major repairs to concrete and structure
	Other Structures	Clear away trash Remove silt Paint metalwork - gates Minor repairs to concrete Pump out water at end of season	Major repairs to concrete/structure
Tertiary Canals and Structures	Canals	Clear out weeds and vegetation Minor repairs to lining Minor repairs to concrete Dewater at end of season	Clear out silt Resection canal Repair lining joints Repair broken concrete
	Flumes (if appropriate)	Minor repairs to joints Minor repairs to concrete Drain water away from pedestals Remove vegetation from along flume line Dewater at end of season	Clear out silt Replace leaking joints Realign sunken sections Repair broken concrete Spray flumes to reduce moss or algae growth
	Staff Gauges Measuring Structures	Clear away trash Paint metalwork Clean staff gauges Minor repairs	Replace staff gauge Repairs to damaged parts Replace whole structure
	Tertiary Head Regulators and Farm Canal Inlets (quaternary unit)	Clear away trash Grease gates Minor repairs to gates Minor repairs to concrete	Replace gate Major repairs to concrete/structure
	Other Structures	Clear away trash Grease gates Minor repairs to gates Minor repairs to concrete	Replace gate Major repairs to concrete/structure
Onfarm Canals and Field Ditches	Canals and Ditches	Clear weeds De-silting	Re-section channel
Roads	Road surfacing	Fill holes in road surface	Re-grade to remove depressions and corrugations Fill up holes with good fill material Repair tarmac
	Structures	Repair cracks in concrete Clear blockages from culverts	Major repairs to damaged structures
Vertical Drainage Wells (if appropriate)	Motors	Painting	Periodic overhaul
	Pumps	Painting	Periodic overhaul
	Pipework	Painting Repair minor leaks	Repair leaking joints
	Electrical equipment	Minor repairs, adjustment	Periodic overhaul Replace broken equipment
	Well	Minor repairs to concrete	Clear and cleanout the well
Drainage System	Collector Drains	Clear out weeds Minor repairs to banks, drain inlets from field collectors or drains, concrete lining	Clear out silt Repair damaged lining and drain inlets and major repair to banks and erosion
	Closed Drains	Repair outlets to collectors	Flush and clean the system on a programmed basis – not less frequent than every 2 years
	Structures	Minor repairs	Major repairs to damaged structures

Step 2: Monthly Maintenance Inspections

The O&M engineer has to conduct monthly maintenance inspections based on the Maintenance Register, summarize the findings in a Monthly Inspection Report Form, then update the Maintenance Register and establish priorities for the required maintenance.

Step 3: Annual Maintenance Inspections

At the end of each irrigation season, the O&M engineer—along with the WUA manager—has to conduct a formal field inspection to verify all data that have been recorded in the Maintenance Register Form and in the Monthly Inspection Form. Based on this annual inspection, the O&M Engineer should reassess his or her maintenance priorities and make the necessary adjustments. The confirmed Maintenance Register entries become the basis for planning and executing the WUA's annual periodic maintenance activities.

Step 4: Periodic Maintenance Requirements (Topographic Survey and Design)

To determine the volume of maintenance work to be done and to arrive at accurate cost estimates for the work, it may be necessary to conduct field topographic surveys and to prepare a formal design for the proposed works. The O&M engineer is responsible for the planning of these preparatory tasks.

Step 5: Prioritization of Periodic Maintenance

Based on the volume and cost estimates for each required periodic maintenance task, the O&M engineer has to reassess the maintenance priorities and decide on how best to implement each of the required periodic maintenance works. Table 1 shows a generalized list of the WUA's maintenance priorities.

Step 6: Preparation of the Annual Maintenance Plan

The O&M engineer uses the outcomes of Steps 1–5 above as the primary basis for the WUA's Annual Maintenance Plan. The accuracy and reliability of this plan is therefore dependent on how well the Maintenance Register has been updated and on the thoroughness of the monthly and annual maintenance inspections.

To keep the cost of maintenance within reasonable levels and within budget limits, it may be necessary to defer less important works to the following year based on the priorities established by the WUA. The best approach, however, is to focus on preventive maintenance and to make a prudent allowance in each year's budget for emergency maintenance works.

C. Implementation of Routine Maintenance

Generally, routine maintenance is implemented on a daily basis directly by the WUA maintenance team (work group and laborers) under the supervision of the O&M technician. On-site locality supervision is handled by the WUA's service foreman. The O&M engineer provides overall direction to these routine maintenance activities.

The WUA members themselves will carry out the routine and periodic maintenance activities at the quaternary unit (farm/field) level, which covers the quaternary canal, on-farm canal, in-field ditches (*uq ariqs*), and furrows. When requested, WUA members are expected to assist in the scheme management at the main system level. This service is considered as in-kind labor and will be credited by the WUA as payment for the members' irrigation service fee.

The WUA's routine maintenance tasks, shown in Table 2, are yearly and seasonal O&M requirements that need to be done no matter what the circumstances are. To ensure that they are not overlooked, they have to be planned in the manner described below:

Table 2. Maintenance Priorities for Irrigation and Drainage Infrastructure

PRIORITY	STRUCTURE	COMMENTS AND CONSEQUENCES
1	Head Regulator or Pump Station (if appropriate)	Difficulties with the operation of the head regulator from the Main Canal could have serious consequences on the operation of the canals managed by the WUA, such as an oversupply or shortage of water, wastage, waterlogged soils, overtopping, and a decrease in crop yield. Failure of any of the pumps or valves could have serious consequences on the operation of the canals managed by the WUA and on the crop yields.
2	Tertiary Regulator Structures	Difficulties with operation of the regulator structures would result in poor distribution of water between canals, inequitable distribution to the tertiary units, and farmer dissatisfaction.
3	Secondary Canals	Excessive leakage from the canals would reduce the amount of water available to the farmers, leading to reductions in crop yields. The cost of water would also be higher. Weeds or silt in the canals would result in difficulties of distributing water.
4	Tertiary Canals	Excessive leakage from the canals (or flumes) would not only cause a reduction in water available to the farmers and higher water cost, but could also result in a high water table in adjacent fields. Weeds or silt in the canals (or flumes) would result in difficulties of distributing water.
5	Quaternary Regulator Structures Farm/Field Canal Inlets	Difficulties with operation of these structures could result in farmers locally experiencing water shortages.
6	On-farm Canals and Field Ditches	Poor bank structure, compaction, and weeds or silt in the farm canals would result in difficulties of distributing water at farmer level. Leakage would result in shortages, flooding, and loss of land and crop yield
7	Measuring Structures, Staff Gauges, etc.	Measuring structures and staff gauges in poor condition would result in difficulties of distributing water equitably between farmers, and in measuring water for fee collection.
8	Drainage System (Collectors and Closed Systems)	Silting up of the drain system could in the longer term result in rises in groundwater levels and increases in salinity, leading to reduced crop yields.
9	Vertical Drainage Wells (if appropriate)	Poor operation of wells could result in a high water table with reduced crop yields, soil salinity increases and cultivation time increases, and delays in planting.

Step 1: Instructions to the WUA staff and WUA Maintenance Team

The O&M engineer will discuss and agree with the O&M technician and the WUA service foreman on a list of maintenance requirements and tasks that need to be undertaken. The O&M technician and the WUA service foreman will, in turn, give instructions to the WUA maintenance team on what should be done on a day-to-day basis.

Step 2: Supervision by the O&M Technician and Service Foreman

In the course of their regular fieldwork, the O&M technician and the WUA service foreman have to ensure that routine maintenance tasks are carried out properly.

Step 3: Arranging Supply of Consumable Materials

Prior to the irrigation season, the O&M engineer has to make the necessary requisitions for supplies in coordination with the WUA service foreman. These supplies should include such consumables as grease, oil, fuel, sand, gravel, cement, tool replacement, spades, shovels, and grass cutters. All of them should be listed in the Usage of Maintenance Materials and Tools Form. This form has to be approved by the WUA manager and forwarded to the WUA accountant, who will then make the necessary purchase orders.

Step 4: Arranging Supplementary Labor and Material Purchases

The O&M engineer, in coordination with the O&M technician, has to determine and make cost estimates of additional labor and other resources (machinery, equipment, tools, and other consumables) that may be needed to complete routine maintenance work. They should get the WUA manager's approval for those cost estimates and ensure that the necessary hiring or purchases are made on time.

II. OPERATING PROCEDURES

This section provides a few simple procedures and tools for a WUA's operations. *(Guidebook 4 discusses the WUA's various operating procedures in more detail.)*

A. Responsibilities for Operation

The operations of a WUA can be implemented effectively if all those concerned clearly know their respective roles and responsibilities. These roles and responsibilities are as follows:

- The WUA, based on its charter and contracts with water users, will operate the secondary canals in its service area, the offtake gates that deliver water down to the tertiary canals, the tertiary canals themselves, and the quaternary offtake gates that deliver water to the farmer-constructed quaternary canals and field ditches.

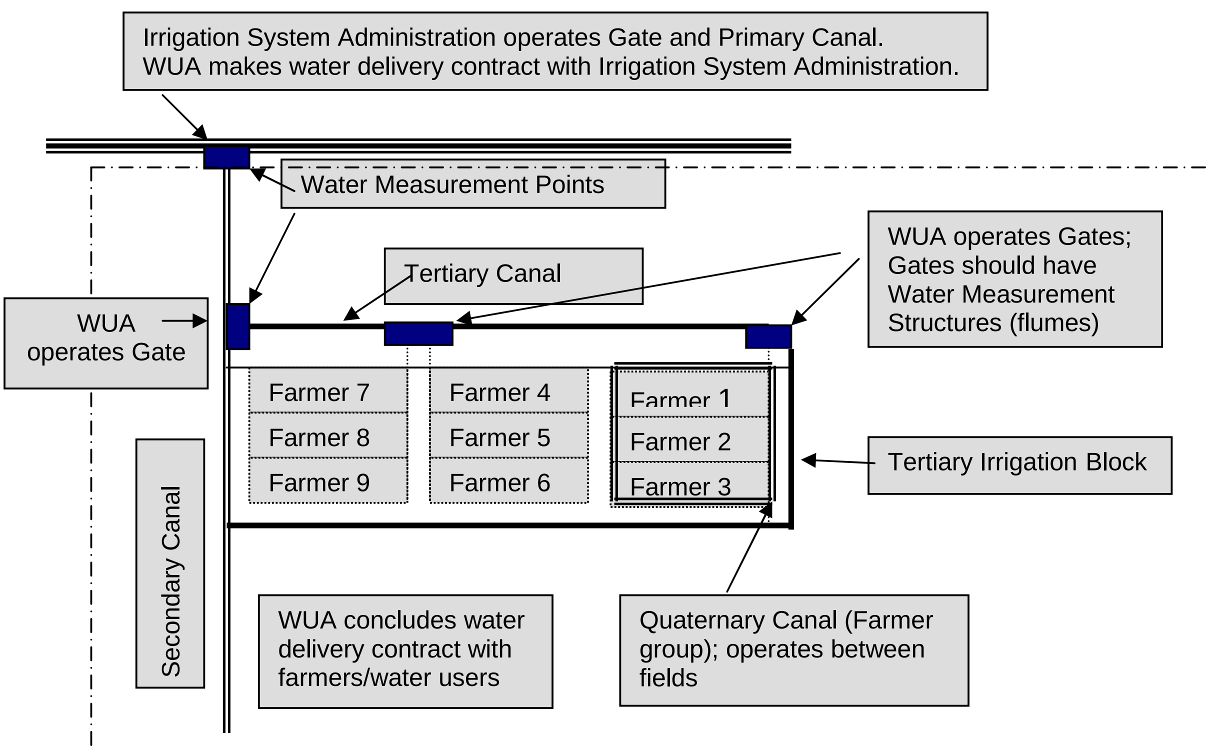
- The water users in the WUA's service area will operate the quaternary canals and any offtake structures they have constructed for delivering water to the field ditches.

- The Irrigation System Administration, based on its water delivery agreements with the WUA, will operate the primary canals and the offtake structures or regulatory gates to the secondary canals.

- The Rayon MAWR Department will establish the water withdrawal limits for the various irrigation system administrations in the locale.

These roles and responsibilities are presented in Figure 1.

Figure 1. Roles and Responsibilities in Operations



Within the WUA, the operation function is the responsibility of the WUA manager. The O&M engineer, which provides overall technical guidance, manages a line staff of O&M technicians (*mirabs*) and other line staff, such as ditch riders, as required.

B. Creation and Execution of the Annual Operation Plan

A WUA undertakes its annual irrigation operation planning between December and March. It should be noted here that in Uzbekistan, the local equivalent of an Annual Operation Plan is the Water Use Plan, the *suvdan foydalanish rejasi* or *plan vodopol'zovaniia*.

The following are the steps in creating an Annual Operation Plan for a WUA:

Step 1: Farmers will submit their proposed annual cropping plans no later than 31 January using the Annual Cropping Plan Form, a copy of which is provided by WUA Guidebook 4. These plans will indicate (1) the crops to be planted, (2) the number of hectares per crop, (3) the starting or planting dates of the various crops, and (4) the amount of water required, particularly the "wetting-up" requirements for cotton.

The information will be compiled into cropping schedules for the quaternary and tertiary blocks, then developed into the cropping plan for the WUA. A cropping plan is needed for (1) preparing the Annual Operation Plan, (2) preparing the standard contract between the Irrigation System Administration and the WUA, (3) making initial estimates for the season's water charges for the whole WUA command area and for the individual farmer, and (4) preparing the WUA's water budgeting system.

Step 2: The O&M engineer will calculate the water required for each crop and for each irrigation as the basis for determining the irrigation requirement of each quaternary unit[1], each tertiary unit[2], each secondary canal, and the WUA's entire service area. The leaching requirements, conveyance efficiency, and the needs of nonagricultural water users will be taken into account in these calculations.

To ensure the accuracy of the calculations, the WUA should obtain from the Irrigation System Administration an updated set of hydromodules, or the monthly water delivery norms for specific agricultural crops. These hydromodules are updated every 4–5 years.

Once or twice a year, the O&M engineer and the Irrigation System Administration should undertake balance metering to determine the irrigation conveyance efficiency of the canals within the WUA's service area.

Step 3: The O&M engineer will compare the calculated irrigation requirements with the allowable limit for extracting water from the water source. If the calculated volume exceeds the limit, the WUA Council will review and revise the proposed cropping plan. This is to ensure that the seasonal and annual irrigation water requirements are within the expected water availabilities.

Step 4: The O&M engineer will finalize the Annual Operation Plan. To be shown in this plan are (1) the aggregate areas of the various crops to be grown; (2) the irrigation period; (3) the irrigation requirements per farmer, per quaternary unit, and per tertiary unit for each irrigation period or schedule (10-day cycle); and (4) the total irrigation requirement for the WUA

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[1] A quaternary unit is the area serviced by the earth farm canals and field ditches constructed by farmers from the offtake gate on the tertiary canal,measuring between 4 and 6 offtakes per 1kilometer (km), approximately.
[2] A tertiary unit is the area serviced by each tertiary canal from an offtake gate on the secondary canal, with a tertiary offtake being located every 1.25 km, approximately, along the secondary canal.

command area per irrigation period, per season (vegetative and nonvegetative), and annually.

In Uzbekistan, the Annual Operation Plan should have two subplans: one for the vegetative season from April to October, and another for the nonvegetative season from November to March. The latter is the season for winter wheat and the time for the leaching of soil salts from the fields. Leaching is a major activity in many Uzbekistan farms because of the significant salinity of their soils.

The operation plan for the nonvegetative period should take the following into account: (1) the requirements of the leaching process, (2) the disruption of water supply to the farms that it will cause, and (3) the possible delays that might be encountered in the WUA's periodic maintenance works program. It must be kept in mind that even during this nonvegetative period, the WUA has to continue operating the irrigation and drainage system.

The WUA therefore has to decide on the following:

- Should it include the costs of operation and O&M disruption during the non-vegetative season in determining the rate of the irrigation service fee to be collected from all water users?
- When the Uzbekistan Government eventually begins to collect charges for its bulk water supply to WUAs, should the WUA include the costs of the leaching operations in computing the rate of the irrigation service fee?

Step 5: Each farmer will sign a contract with the WUA for water delivery for the total volume of water needed, or for the volume that can be made available.

Step 6: The WUA will sign a water delivery contract with the Irrigation System Administration for the total volume of water that the WUA needs, or for the volume that can be made available.

Step 7: Each farmer will submit a request for water to the WUA's O&M technician as needed.

Step 8: The O&M technician will verify if the farmer has not exceeded his allowance, then work out the daily discharges for a 2-day operation plan (starting the day following the requests). The verification is done for all quaternary units and tertiary units.

Step 9: The O&M engineer will check and confirm the daily discharges and the 2-day operation plan as calculated by the O&M technician.

Step 10: The O&M technician will instruct the WUA gate operator on how much discharge is to be provided at the quaternary or farmgated outlet, and will give a list of the farmers who will receive water.

Step 11: The WUA gate operator, under the supervision of the O&M technician, will control the gates according to the 2-day daily discharge plan provided by the O&M technician. On a daily basis, small variations from the "standards and norms" may be allowed for areas that need more or less irrigation water than originally requested. Ideally, the WUA should grant such requests within 2 days after they are made.

Step 12: The WUA gate operator will measure the water discharge, and the farmers or water users will sign for the receipt of the volume of water. A copy of the receipt will be forwarded to the WUA accountant.

Step 13: The water users or their representatives (per quaternary unit) distribute the water to the farms or fields through their respective earth canals. No farmer should be allowed to take water without authorization.

C. Water Measurement

To get a clear picture of the efficiency of the irrigation system, the WUA has to accurately measure the discharge of water at various points in the system as well as the flow at the farmer's intakes. These measurements will enable the WUA to supply only the proper amounts of water, thus minimizing water use and O&M costs. They will also form the basis for water accounting and other record-keeping measures.

Accurate flow measurements will ensure greater transparency and accountability in the irrigation water supply as well as a more equitable water distribution. They should also prove useful for settling disputes about the distribution of the water, and could provide important information about the functioning of the various parts of the irrigation system.

1. Estimating the Discharge

Discharge is the volume of water that is transported each second. The discharge in a canal can be measured with or without a discharge measurement structure. A method that does not require a structure, known as the "floating method," is described below. It is a quick and cheap way to estimate discharge in a canal, but it is not very accurate. Errors of at least 10% can be expected when this method is used.

The "Floating Method." This method involves estimating the average flow velocity (V), and measuring the area of the cross-section, which is called the "wetted cross-section" (A). The discharge (Q) can be calculated by the following formula:

$$\mathbf{Q = V \times A}$$

wherein

Q = discharge in cubic meters per second (m^3/s);
V = average flow velocity in meters per second (m/s)*;* and
A = area in square meters (m^2) of the wetted cross-section.

To know the discharge in liters per second (l/s) instead of cubic meters per second (m^3/s), the formula to use is:

$$\mathbf{Q = I000 \times V \times A}$$

wherein

Q = discharge in liters per second (l/s);
1,000 = a factor to convert cubic meters ($m^{3)}$ to liters (l), since 1 m^3 = 1,000 l);
V = average flow velocity in m/s; and
A = area in m^2 of the wetted cross-section.

The next section describes a method to estimate the average flow velocity and provides a method for determining the area of the wetted cross-section.

Flow Estimation Procedure. The procedure that follows is used for measuring the discharge using a floating object.

Equipment:

- Measuring tape at least 5 meters (m) long;
- 4 stakes;
- Stopwatch or watch capable of measuring time in seconds; and
- Floating object such as a bottle or an apple.

Procedure:

Step 1: Select a straight section of the canal that is at least 10 m long. The shape of the canal along this section should be as uniform as possible.

Step 2: Place 2 stakes, one on each side, at the upstream end of the selected portion of the canal. They should be perpendicular to the centerline of the canal (point A).

Step 3: Measure 10 m or more along the canal.

Step 4: Place 2 stakes at the downstream end of the selected section of the canal. They should also be perpendicular to the centerline of the canal (point B).

Step 5: Place the floating object on the centerline of the canal at least 5 m upstream of point A, and start the stopwatch when the object reaches point A.

Step 6: Stop the stopwatch when the floating object reaches point B, and record the time in seconds.

Step 7: Repeat steps 5 and 6 at least 4 times to determine the average time necessary for the object to travel from point A to point B. The object should not touch the canal embankment during the trial. If it does, the operation must be repeated. The time for the bad trial must not be included when calculating the average time.

Step 8: Measure the following in the selected canal section:

- The canal bed width, b
- The surface water width, a_1
- The water depth, h_1

The cross-section within the selected portion of the canal will usually not be regular. For this reason, b, a_1, and h_1 need to be measured in several places to obtain an average value.

If working with a canal with a rectangular cross-section, the surface water width a_1 will equal the bed width b.

Step 9: Calculate the surface velocity V_s, and then the average flow velocity V, using the equations given before: $V_s = L / t$, where L is the crest length and *t* is the travel time in seconds, based on the average of four clear runs of the floating object, and V = 0.75 x l/s.

Step 10: Calculate the wetted area of the cross-section A, using the formula

$$\mathbf{A = \frac{(b+a_1)}{2} \times h_1}$$

(b, a_1 and h_1 are average values)

Step 11: Calculate the discharge Q, in the canal, using the formula

$$V \times A \ m^3/s$$
or
$$Q = 1{,}000 \times V \times A \ l/s$$

2. Measurement Procedures Using Weirs

Weirs are sharp-crested overflow structures that are built across open canals. They are easy to construct and can measure the discharge accurately when correctly installed. Weirs are used extensively in Central Asia.

Well-Known Types of Weirs. Three well-known types of weirs are the rectangular weir, the Cipoletti trapezoidal weir, and the 90° V-notch weir. As shown in Figure 2, the rectangular weir has a rectangular opening. The Cipoletti trapezoidal weir, shown in Figure 3, is in fact an improved rectangular weir, with a slightly higher capacity for the same crest length. Its opening is trapezoidal, with the sides inclining at a slope of 4 (vertical) to 1 (horizontal). The 90° V-notch weir, shown in Figure 4, has a triangular opening, a type well-suited to measure small flows with high accuracy.

Figure 2. Rectangular Weir

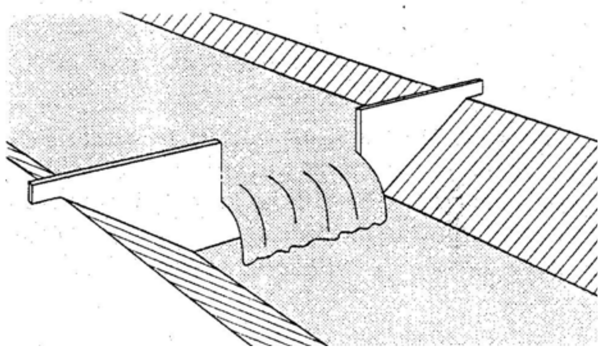


Figure 3. Cipoletti Weir

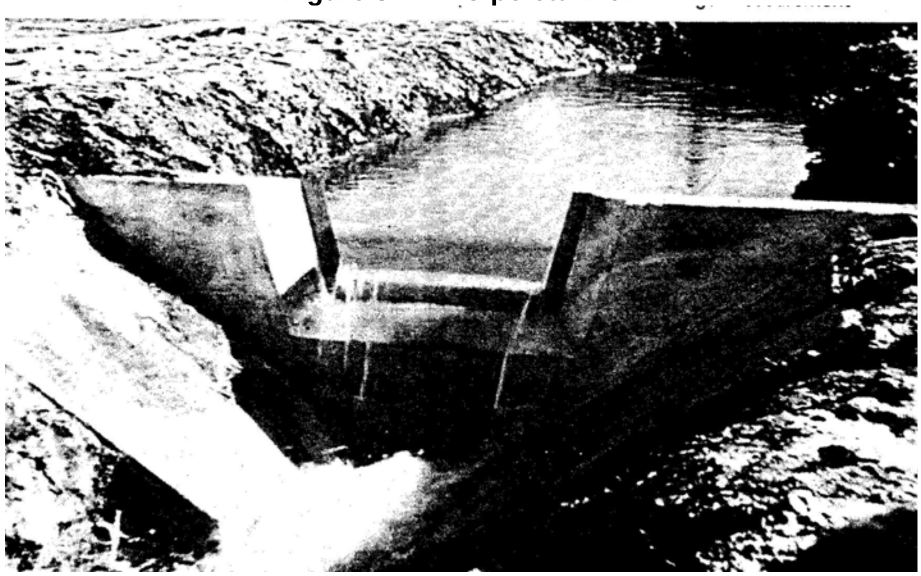
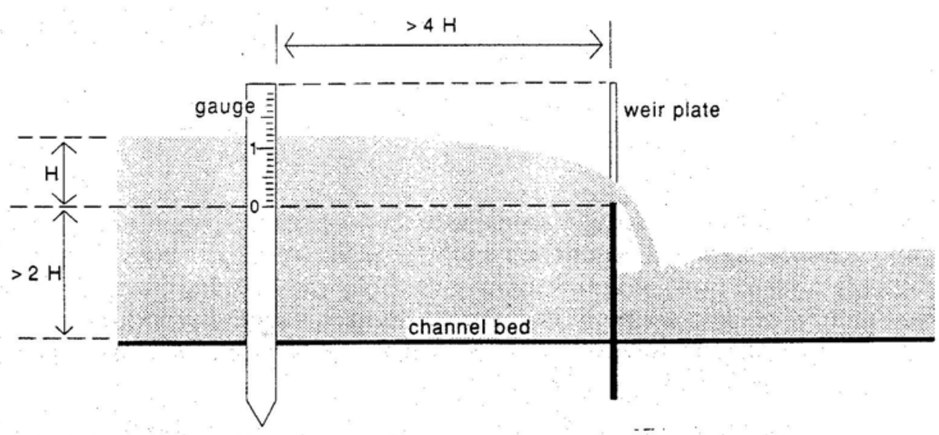


Figure 4. V-notch Weir

Measuring Upstream Water Level. The water level upstream of the structure is measured using a measuring gauge, as shown in Figure 5 below, where the difference—"the head"—between the water level and the crest of the weir is marked "H." The discharge corresponding to that water level is then read from a table that is specific for the size and type of weir being used, or the gauge post can show the discharge directly.

Figure 5. Operation of a Weir



Critical Dimensions of Weirs. To obtain a true measure of the flow over weirs, certain dimensions must be observed because they are critical to correct operation. These dimensions, as indicated in Figure 5 above, are as follows:

- The level of the weir crest relative to the channel bottom;
- The horizontal distance between the measuring gauge and the weir;
- The level of the gauge relative to the level of the crest of the weir.

Correct Setup Procedures. The procedure for getting the correct setup for the structure is best explained in the form of a practical example. The measurement structure in the following example is assumed to be the overflow type, namely a rectangular weir with crest length of 1.0 m.

Step 1: Estimate the likely maximum discharge in the canal to be measured. This defines the corresponding maximum head of water over the weir crest for the structure concerned.

The maximum discharge to be measured is estimated at 200 liters per second (l/s).

Using Table 4 on the next page, it is clear that for a discharge of 200 l/s, the head H is a little less than 0.25 m.

Step 2: Check the level of the weir crest.

The level of the crest above the canal bed should be at least 2 times the maximum head, 2H (as shown in Figure 5). In this case, the weir should have a crest level at least 2 x 0.25 = 0.50 m higher than the canal bed.

Step 3: Check the distance between the gauge and the weir.

The distance between the gauge and the weir should be at least 4 times the maximum head, 4H (shown in the figure above). In this case, the gauge should be located at least 4 x 0.25 = 1.00 m upstream of the weir.

Step 4: Check the elevation of the 0 (zero mark) on the gauge.

The 0 mark on the gauge, which indicates a discharge of 0 l/s (no flow), should have the same elevation as the weir crest. This can be checked using a carpenter's level or by the water level when there is no flow over the weir.

Discharge Measurement. The measurement procedure described here is standard for the 3 well-known types of overflow weirs, except that there is a different table for each type, as shown below. Table 3 on the next page is that for a rectangular weir, Table 4 for a Cipoletti trapezoidal weir, and Table 5 for a 90° V-notch weir.

Assume the structure is a rectangular weir with a crest length of 1.25 m.

Step 1: Read the water level on the gauge. The reading is 0.12 m, so H = 0.12 m.

Step 2: In Table 3, find the row corresponding to 0.12 m, and move across that row until it meets the column for the weir crest being used, 1.25 m. The value at the point where the column and row cross is 94. This is the discharge in liters per second: Q = 94 l/s.

The same procedures for establishing the proper dimensions for the setup of the structure and for carrying out discharge measurements apply to Cipoletti trapezoidal weirs and to 90° V-notch weirs. However, different tables are used to obtain the value of the discharge, as previously noted above.

If the measured head, H, is not found in a table, the rows with the H values immediately above and below are followed, and the 2 discharge values found in the table are averaged to obtain the actual discharge.

For example, suppose a trapezoidal weir is being used to measure the discharge in a canal. The crest has a length, L, of 1.00 m and the head reading, H, is 0.17 m.

H = 0.17 m is not found in Table 5, so the nearest H values above and below are used. These are 0.16 and 0.18 m. H = 0.16 m gives, when L = 1.00 m, a discharge Q of 119 l/s, and H = 0.18 m gives a discharge of 142 l/s.

These two discharges are averaged to obtain an approximate value for the canal discharge, namely Q = (119 + 142) /2 = 131 l/s.

If the length of the weir crest does not correspond to one of the lengths given in the tables, then handbooks should be consulted. An engineer may be contacted to make a specific table for the weir concerned.

Table 3. Discharge-Head Relationship for a Rectangular Weir

Head (H), meters	Discharge (Q), liters/second					
	Length of Crest (L), meters					
	0.25	**0.5**	**0.75**	**1.00**	**1.25**	**1.50**
0.01	0	1	1	2	2	3
0.015	1	2	3	3	4	5
0.02	1	3	4	5	6	8
0.03	2	5	7	10	12	14
0.04	4	7	11	15	18	22
0.05	5	10	15	20	26	31
0.06	6	13	20	27	33	40
0.08	10	20	31	41	51	62
0.10	13	28	42	57	72	86
0.12	17	36	56	75	94	113
0.14		45	70	94	118	142
0.16		55	85	114	143	173
0.18		65	100	135	171	206
0.20		76	117	158	199	
0.25		104	161	219		
0.30			209			

Table 4. Discharge-Head Relationship for a Cipoletti Trapezoidal Weir

Head (H), meters	Discharge (Q), liters/second					
	Length of Crest (L), meters					
	0.25	**0.5**	**0.75**	**1.00**	**1.25**	**1.50**
0.01	0	1	1	2	2	3
0.015	1	2	3	3	4	5
0.02	1	3	4	5	6	8
0.03	2	5	7	10	12	14
0.04	4	7	11	15	19	22
0.05	5	10	16	21	26	31
0.06	7	14	21	27	34	41
0.08	11	21	32	42	53	63
0.10	15	29	44	59	74	88
0.12	19	39	58	77	97	116
0.14		49	73	97	122	146
0.16		60	89	119	149	179
0.18		71	107	142	178	213
0.20		83	125	166	208	
0.25		116	174	233		
0.30			229			

Table 5. Discharge-Head Relationship for a 90º V-Notch Weir

H	Q
0.01	0.0
0.02	0.1
0.03	0.2
0.04	0.4
0.05	0.8
0.06	1.2
0.07	1.8

H	Q
0.08	2.5
0.09	3.3
0.10	4.3
0.11	5.5
0.12	6.8
0.13	8.3
0.14	10

H	Q
0.15	12
0.16	14
0.17	16
0.18	19
0.19	22
0.20	24

Table 6. Discharge-Head Relationship for a Parshall Flume (with Throat Width of W = 0.46 m)

H	Q
0.03	5.8
0.04	7.4
0.05	11
0.06	18
0.07	22
0.08	26
0.09	31
0.10	35

H	Q
0.11	35
0.12	41
0.13	46
0.14	51
0.15	57
0.16	63
0.17	69
0.18	76

H	Q
0.19	82
0.20	89
0.21	96
0.22	103
0.23	110
0.24	118
0.25	125
0.26	133

H	Q
0.27	141
0.28	149
0.29	157
0.30	166
0.31	174
0.32	183
0.33	192
0.34	201
0.35	210

Table 7. Discharge-Head Relationship for a RBC Flume (with Throat Width of Bc = 0.20 m)

H	Q
0.03	1.8
0.04	2.9
0.05	4.2
0.06	5.7
0.07	7.4

H	Q
0.08	9.3
0.09	11
0.10	14
0.11	16
0.12	19

H	Q
0.13	22
0.14	25
0.15	29
0.16	32
0.17	36

H	Q
0.18	40
0.19	45
0.20	49

3. Measurement Procedures for Flumes

When using a flume to measure discharge in a canal, it is assumed that the flume has been made using standard dimensions, and that flume-specific tables are available. In the case of an RBC flume, the assumption is made that a table has been established especially for the flume being used. Tables for the two types of flumes presented above are found at the end of this section. These tables are applicable to the so-called "free flow" condition, which means that the upstream water level is not affected by the downstream water level.

The method for measuring discharge using a flume is illustrated below:

Question: What is the discharge in a canal if a Parshall flume with throat width W= 0.46 m is used to measure the flow, and the reading taken under free flow conditions is 0.23 m?

Answer: H_a = 0.23 m

Using Table 3 for a Parshall flume with a throat width of 0.46 m, read from the table the discharge when Ha = 0.23 m. The discharge Q = 110 l/s.

III. IRRIGATION SCHEDULING FOR FARMS

After obtaining the irrigation requirement, farmers can manage the soil water profile through irrigation scheduling. This involves determining the exact quantity and timing of irrigation application throughout the season. By avoiding over-irrigation and by establishing the proper number of irrigations for the season, savings in water can be realized, stress on the plants can be reduced, and crop yields can be boosted. *(Guidebook 5 provides more details concerning irrigation scheduling and other aspects of water management for leasehold farms in Uzbekistan.)*

A. Monitoring the Soil

1. Field Capacity

The most common method of determining when and how much to irrigate is to observe the moisture reserve of the crop's root zone as it gradually diminishes after each irrigation. It has to be ascertained when this moisture reserve has been depleted to the minimum allowable level, which is also known as the "time to refill" level. When this point is reached, the irrigator should apply the volume of water calculated to replenish the soil reservoir of the root zone to its "full" level.

Establishing the Crop's Rooting Depth. An important precondition to effective management of root-zone soil moisture is establishing the rooting depth of each crop as it varies during the growing season. Typically, the seedling of an annual crop will develop such that its roots extend both vertically and laterally until their lateral ends touch an area already occupied and tapped by the roots of neighboring plants. After that, roots mostly extend themselves downward. As it deepens, the root system proliferates within the moist layers until it can grow no further. Among the environmental factors involved in this growth process are moisture, salinity, acidity or alkalinity, aeration, and mechanical impedance.

Determining the Soil Moisture Reservoir Size. The volume of soil covered by the rooting zone of a plant is the first determinant of the size of the soil moisture reservoir potentially available to it. Farmers can establish this volume by considering the area and density of the crop stand and by measuring the depth of root penetration. One way to do this is to sample the soil with an auger and examine the extracted samples for the presence of live roots.

Assessing the Range of Variation. For the major crops grown in several fields, the depth of root penetration should be determined several times during the growing season. This should be done as often as necessary so the range of variation can be assessed and more confidence in the data can be established. Provided that planting dates and environmental conditions remain more or less the same from season to season, this data can be used over the long term.

Establishing the Root Zone's Water Deficit. After the rooting volume is known, the potential and actual water contents of the root zone can be determined. This has to be done to establish the root zone's water deficit at any time. The potential ("full reservoir") water content of the root zone is generally taken as equal to the "field capacity."[3] Field capacity is often taken to represent the upper limit of the soil's capacity to store water.

The example that follows illustrates how to calculate the deficit in the field capacity.

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[3] Field capacity is defined in practice as the water content of the specified volume of soil measurable two days after a thorough irrigation.

Step 1: Assume that the root zone is 1.2 meters (1,200 mm) deep, and that its field capacity in volumetric terms is 22%.

Step 2: The equivalent depth of water contained in the root zone is 1,200 x 22% = 264 mm. For a hectare of land (10,000 square meters), the volume of the root zone is 10,000 x 1.2 = 12,000 cubic meters, and the total water content is 12,000 x 228 = 2,640 cubic meters. Suppose that within 10 days following the last irrigation, the volumetric wetness has decreased from 22% to 13%.

Step 3: The deficit to field capacity is therefore 9% (22% - 13% = 9%) of 1.2 m, namely 0.108 m or 108 mm. So the amount of water to apply is: 0.108 m x 10,000sq.m. = 1,080 cubic meters per hectare.

Factors Neglected in Water Loss Assessment. Note that while this calculation accounts for the amount of irrigation needed to make up for the overall loss of water from the root zone, it ignores the issue of assessing how much of that loss may have been due to (1) direct evaporation from the soil, (2) transpiration from the crop, and (3) internal drainage below the root zone. Despite this limitation of the field capacity concept, however, it is a useful indicator of the limit of soil moisture that can be stored for subsequent crop use in a given depth of soil.

Ideally, the soil water should be near maximum capacity at planting time but depleted by 50% or more at harvest. Successive, properly timed irrigations should maintain water within the root zone during vegetative growth at a level that produces no plant water stress.

The Need for a Safety Factor. In some places, water may be available most of the time but it may become unavailable part of the time, often unpredictably. In such cases, a safety factor or buffer of several days is needed to protect the crops. This can be done by lowering the "refill" criterion, or increasing the range of allowable depletion during periods of restricted water supply

2. Measuring Moisture Content

The simplest method for measuring soil moisture content is the "appearance and feel" method, which remains a valid procedure no matter how sophisticated the irrigation scheduling system is. A soil probe, soil auger, or spade can be used to extract a soil sample. Farmers should evaluate the soil moisture at 20–30 cm intervals from the surface to the bottom of the active root zone. The active root zone for most irrigated crops is approximately one meter deep. For cotton, the soil sample should be taken at 20 cm in depth during the pre-budding phase. During budding, flowering, and reproduction, the depth of the sample should be 35–40 cm.

Procedures for a Soil Probe. When using a soil probe to extract the samples, the following procedures will make the job easier:

- Scrape a clean, level area on the soil surface before inserting the probe.
- Insert the probe to the desired depth and turn the probe once clockwise before pulling it back to the surface.
- After inspecting the soil, remove all of the soil from the tube, including the tip. Soil left in the tip may tend to compact the next sample.
- Clean the probe after each use to prevent rust and hard caked soil.
- Replace or sharpen the tip as needed.

Assessing Moisture Content by Feel. To begin getting familiar with the appearance and feel of the soil at particular levels of moisture content, start early in the spring 1 or 2 days after a heavy rain. The soil moisture level at this point should be near field capacity, or holding almost 100 percent of the water that it can naturally retain. Likewise, probe the soil at the end of the growing season when the profile is likely to be dry. Knowing the appearance and feel of the soil in wet conditions (planting) and dry conditions (harvesting) will help in making determinations during the midseason.

Number and Location of Sampling Sites. The number and location of sampling sites depend on both the uniformity of the soils in the field and the irrigation procedures. After checking the starting and stopping areas of the irrigation and drainage system, also check problem areas in the field. Sample a minimum of four sites in different parts of the field. Table 8 provides a rough guide for judging available soil moisture on the basis of the appearance and feel of the soil.

Table 8. Guide for Judging Available Soil Moisture for Crops

Available Soil Water Remaining	Feel	Appearance
	Fine sand and loamy fine sand soils	
0% - 25%	Dry, loose, will hold together if not disturbed, loose sand grains on fingers with applied pressure.	**(Not shown)**
25% - 50%	Slightly moist, forms a very weak ball with well- defined finger marks, light coating of loose and aggregated sand grains remains on fingers.	
50% -75%	Moist, forms a weak ball with loose and aggregated sand grains on fingers, darkened color, moderate water staining on fingers, will not ribbon.	

Available Soil Water Remaining	Feel	Appearance
75% - 100%	Wet, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon.	
100% (Field Capacity)	Wet, forms a weak ball, moderate to heavy soil/water coating on fingers, wet outline of soft ball remains on hand.	**(Not shown)**
	Sandy loam and fine sandy loam	
0% - 25%	Dry, forms a very weak ball, aggregated soil grains break away easily from ball.	**(Not shown)**
25% - 50%	Slightly moist, forms a weak ball with defined finger marks, darkened color, no water staining on fingers, grains break away.	
50% -75%	Moist, forms a ball with defined finger marks, very light soil/water staining on fingers, darkened color, will not slick.	

Available Soil Water Remaining	Feel	Appearance
75% - 100%	Wet, forms a ball with wet outline left on hand, light to medium staining on fingers, makes a weak ribbon between the thumb and forefinger.	
100% (Field Capacity)	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers.	**(Not shown)**
	Sandy clay loam, loam, and silt loam	
0% - 25%	Dry, soil aggregations break away easily, no staining on fingers, clods crumble with applied pressure.	**(Not shown)**
25% - 50%	Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers, few aggregated soil grains break away.	
50% -75%	Moist, forms a ball, very light staining on fingers, darkened color, pliable, forms a weak ribbon between the thumb and forefinger.	

Available Soil Water Remaining	Feel	Appearance
75% - 100%	Wet, forms a ball with well-defined finger marks, light to heavy soil/water coating on fingers, ribbons between thumb and forefinger.	
100% (Field Capacity)	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers.	**(Not shown)**
	Clay, clay loam, and silty clay loam	
0% - 25%	Dry, soil aggregations separate easily, clods are hard to crumble with applied pressure.	**(Not shown)**
25% - 50%	Slightly moist, forms a weak ball, very few soil aggregations break away, no water stains, clods flatten with applied pressure.	
50% -75%	Moist, forms a smooth ball with defined finger marks, light soil/water staining on fingers, ribbons between thumb and forefinger.	

Available Soil Water Remaining	Feel	Appearance
75% - 100%	Wet, forms a ball, uneven medium to heavy soil/water coating on fingers, ribbons easily between thumb and forefinger.	
100% (Field Capacity)	Wet, forms a soft ball, free water appears on soil surface after squeezing or shaking, thick soil/water coating on fingers, slick and sticky.	**(Not shown)**

Source: http://www.wy.nrcs.usda.gov/technical/soilmoisture/soilmoisture.html

B. Monitoring the Crop

The most common way to monitor the crop is by the tried-and-true method of direct visual inspection. Experienced agronomists or farmers who know their crop can detect early signs of thirst by the plant's physical appearance, especially during the period of peak transpirational demand (generally at midday). The physical observation of the plans is often the only method that farmers can use to monitor the status of plants apart from checking soil moisture. To obtain indications as early as possible, the farmer should select for crop monitoring the part of the field where the plants will most likely first show signs of stress (a sandy spot, for example).

Indications of Water Stress. Some general indications of water stress in crops are as follows:

- Curling or wilting
- Darker color
- The foliage's physical appearance. Young leaves, which are more sensitive than mature ones, begin to curl or become flaccid.
- Plant growth slows down considerably.
- Leaf orientation changes due to water scarcity.

These are physiological defense mechanisms that become particularly evident on hot, windy afternoons. This is when the crop cannot transpire fast enough even if the water is readily available in the soil. If the crop does not recover from these symptoms overnight, it is a clear sign that the crop is suffering from water stress. Any changes in crop appearance due to water stress may mean a reduction in yield.

Water Stress Symptoms in the Cotton Plant. The cotton plant, in particular, exhibits many plant water stress symptoms and responses to stress that can be used to help schedule the needed irrigation. They undergo a change in leaf color from a bright to a darker green, or to almost blue when severely water-stressed. It is very important to look at the health of the youngest leaves that are still growing in size. Irrigation is needed when around 20% of the cotton in the field has dark-green leaves. After irrigation, the cotton leaves will turn light green. However, because leaves often change color, this method can produce misleading results when done during and after flowering of the cotton.

Differentiating Midday Wilt from Water Stress. Plant wilting is an obvious water shortage symptom, but care should be taken not to confuse a "midday wilt" with water stress. Midday wilt is an internal transport problem that occurs when cotton plant roots can no longer absorb enough water to meet the plant's transpiration demand. Midday wilting occurs on very hot days, particularly when the air is dry. If the wilted plant recovers as the day cools down in the evening, this is a sign of midday wilt rather than a soil water shortage. Checking the soil moisture will help clarify any confusion regarding this situation.

Unique Characteristic of the Cotton Plant. Due to its tropical origin, cotton does not shut down its stomates in the heat of the day to conserve water, unlike many other plants. This permits gas exchange through the leaves to continue and thus allows the plant to keep growing at higher temperatures than many other crops. Only when severe stress occurs will the stomata respond and close. This usually occurs after leaf growth has already stopped.

Plant Temperature as Sign of Water Stress. Crops use water to keep cool, so the leaves of water-stressed crops are warmer to the touch. Around noontime, crops that are not water-stressed will be about 4^{o} Celsius cooler than the surrounding air temperature. Water-stressed crops will be less than 1^{o} cooler than the air temperature.

Rule of Thumb for Irrigating the Cotton Plant. The number of nodes (branches) above the most recent white flower on the first fruiting position is another plant observation used by cotton growers to schedule irrigations. Early in the season, irrigation may be applied around 9 nodes above the white flower. Midseason, 7 nodes above the white flower is the rule of thumb used as a target irrigation point for crops. Later in the season, as crops stop growing, around 5 nodes above the white flower will be the target. Crops with more nodes above the white flower generally have more vigor. This characteristic can help indicate which crops should be watered when water is scarce.

C. Irrigation Scheduling for Cotton

Cotton growers should decide whether to pre-irrigate or water up the crop after planting. In certain situations, it can also be beneficial to combine the two options by pre-irrigating to moisten the plant and giving the crop a quick watering to ensure good plant stands. Every farm is different, of course, and the following questions need to be considered before making a decision:

- What method has traditionally given the best plant stands and early vigor?
- Do I have enough water available?
- Is my cotton traditionally subjected to a lot of pressure from seedling disease?
- What is the likely rainfall pattern before and after planting?
- Am I likely to get enough rain before planting to justify planting into moisture?
- Is it likely to rain straight after the field is watered up?
- Is my soil likely to dry out quickly before planting?
- How does my soil soak up, and how badly does it erode?

The likely advantages and disadvantages of these options are presented in Table 9.

Table 9. Advantages and Disadvantages of Options for the First Irrigation

PRE-IRRIGATION (PRIOR TO PLANTING)	WATERING-UP (AFTER PLANTING)	PRE-IRRIGATION AND LATE WATERING
Likely advantages: No time pressure to apply the water In a heavy clay, water losses can be less than keeping it in an on-farm storage Soil temperature is less likely to drop after planting; potentially less disease pressure	**Likely advantages:** Potential to take advantage from pre-planting rain events Easier to plant, especially when beds are not 100% even Faster planting operation and less machinery needed	**Likely advantages:** Helps in fixing up plant stand problems Can give the crop the necessary “boost” to get going after a slow start
Likely disadvantages: Soil dries out too quickly Dry rows in uneven fields Soil stays too wet when followed by rain Unable to capture rainfall before Planting	**Likely disadvantages:** Higher disease pressure Herbicide damage more likely Sides of beds might erode when flushing for a long time Waterlogging if rain occurs after flushing	**Likely disadvantages:** Likely to use more water Similar disadvantages to watering up

First In-Crop Irrigation. The timing and quantity of the first in-crop irrigation is the most difficult irrigation scheduling decision for cotton. It requires careful balancing between not stressing the crop and ensuring that the water stored in the soil profile is fully explored by the cotton roots. It is difficult to get a crop growing again if water stress has stopped growth. On most heavy clay soils, cotton should not need irrigating earlier than halfway between squaring and flowering (60-70 days from sowing). On lighter texture or compacted soils, crops will need irrigating earlier.

Setting the Proper Irrigation Intervals. After regular irrigation has started, extending the interval between irrigations without monitoring soil water levels can result in significant yield reductions. Water can be saved, but yield losses will occur. The other consideration is that, by stretching the irrigation interval, greater amounts of water will need to be applied at the next irrigation. Stretching irrigation intervals too much can also indirectly cause waterlogging. This is because it prolongs the time water has to be applied to fill the large soil moisture deficit.

If water stress occurs, it is better late or early in the season, but not in the middle during peak flowering and early boll fill stages. In hot dry summers it is better to be early than late. Careful monitoring of soil moisture and daily water use will enable the farmer to determine the correct timing of the irrigation.

Ensuring Completion of Boll Maturity. The objective of the final irrigation is to ensure that boll maturity is completed without water stress. At the time of last irrigation, all bolls have been set, vegetative growth is limited, and the majority of carbohydrates are used to satisfy boll demands. After a boll is 10–14 days old, the abscission layer that causes boll shed cannot form. It is for this reason that boll numbers are not significantly reduced by late water stress. However, fiber development can be affected. Crops that come under stress prior to defoliation can suffer some yield reduction and fiber quality reduction. The level of reduction increases the longer the stress occurs. End-of-season water requirements can be estimated from the date of the last effective flower (4 nodes above the white flower).

IV. FIELD APPLICATION

A. Factors Influencing Efficiency

Several factors influence the efficiency of furrow irrigation. These factors are as follows:

- **Slope:** Uniform slopes are preferred for furrow irrigation. Although furrows can be longer when the land slope is steeper, the maximum recommended furrow slope is 0.5% to avoid erosion. Furrows can also be level and are thus very similar to long, narrow basins. However, a minimum grade of 0.05% is recommended so that effective drainage can occur following irrigation or after excessive rainfall. If the slope is steeper than 0.5%, then furrows can be set at an angle to the main slope or even along the contour lines to keep furrow slopes within the recommended limits. Furrows can be set in this way when the main land slope does not exceed 3%. Beyond this, there is a major risk of soil erosion following a breach in the furrow system. On steep land, terraces can also be constructed and furrows cultivated along the terraces. On steeper slopes, the flow rate into the furrows must be reduced to avoid erosion.
- **Soil type:** The wetting patterns are different in sandy and clay soils. In sandy soils, water infiltrates quickly to deeper layers and there is little horizontal (lateral) movement of water. Furrows should be short (less than 110 m), so that water will reach the downstream end without excessive percolation losses. In clay soils, the water infiltrates slowly to deeper layers. There is a substantial lateral movement of water in the soil as well as a capillary rise. Therefore, to obtain an overlapping wetting pattern, the spacing between furrows in clay soils can be larger than in sandy soils. As with all surface irrigation methods, very coarse sands are not recommended because percolation losses can be high.
- **Furrow length:** Furrows must be in harmony with the shape, length, and spacing of the furrows. Generally, the shape, length, and spacing are determined by the natural circumstances: the slope, soil type, and available stream size. However, other factors may influence the design of a furrow system, such as the irrigation depth, farming practice, and the field length. Table 7 provides some practical values of maximum furrow lengths.

Table 10. Practical Values of Maximum Furrow Lengths (m) Depending on Slope, Soil Type, Stream Size and Net Irrigation Depth

Furrow Slope (%)	Maximum Stream Size (l/s) Per Furrow	Clay		Loam		Sand	
		Net Irrigation Depth (mm)					
		50	75	50	75	50	75
0.0	3.0	100	150	60	90	30	45
0.1	3.0	120	170	90	125	45	60
0.2	2.5	130	180	110	150	60	95
0.3	2.0	150	200	130	170	75	110
0.5	1.2	150	200	130	170	75	110

- **Stream size:** Normally, stream sizes up to 0.5 liters per second (l/s) will provide adequate irrigation when the furrows are not too long. When larger stream sizes are available and possible to apply, water will move rapidly down the furrows. Thus, in general, longer furrows can be used. The maximum stream size that will not cause erosion will depend on the furrow slope, shape, dimensions, and soil type. It is not advisable to use stream sizes larger than 3.0 l/s.

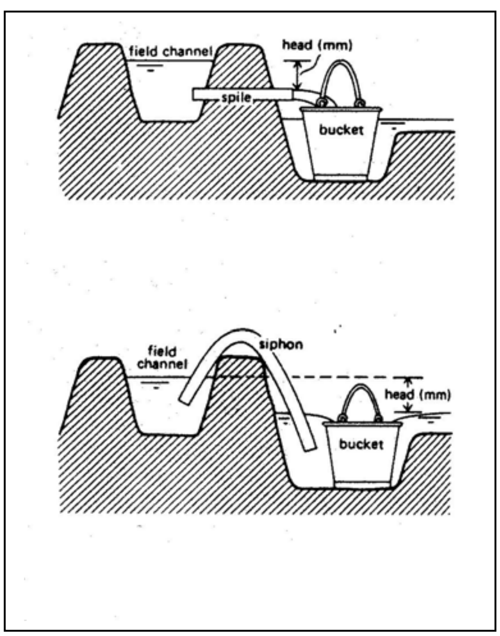
- **Furrow shape:** On sandy soils, narrow but deep V-shaped furrows are desirable to reduce the soil area through which water percolates. In clay soils, a wide, shallow furrow will cover a larger wetted area, thus increasing the rate of infiltration.
- **Spacing:** In mechanized farming, a compromise is required between spacing requirements of the machinery, ideal spacing for crops, and the provision of adequate lateral wetting off the soil. In coarse sand, the ideal spacing is 30 cm; in fine sand, 60 cm; and in clay soils, 75–150 cm.
- **Irrigation depth:** Applying larger irrigation depths usually means that furrows can be longer, as there is more time available for water to flow down the furrow and infiltrate.
- **Cultivation practice:** When farming is mechanized, furrows should be made as long as possible to facilitate the work. Short furrows require a lot of attention, because the flow must be changed frequently from one furrow to the next. However, short furrows can usually be irrigated more efficiently than long ones because it is much easier to keep the deep percolation losses low.
- **Field length:** It may be more practical to make the furrow length equal to the length of the field instead of making it equal to the ideal length, as the latter would result in a small piece of land left over. Equally, the length of the field may be much less than the maximum furrow length. This is not usually a problem as furrow lengths can be made to fit the field boundaries.

B. Measurement of Furrow Discharge

The easiest way to measure the furrow inflow is to use a siphon or spile. The following are required to make this measurement:

- Siphon
- Bucket with known volume (say, 10 liters)
- A watch
- 2 people

Figure 6. Measurement of Furrow Discharge



Setup:
Just behind the bund (embankment) of the field ditch, a hole is made in the soil, in which a bucket is then placed, as shown in Figure 6.

If the siphon or spile is freely discharging, then the pipe can discharge into the bucket. However, if the siphon discharge is drowned, then the bucket must be held firmly with the bucket lip at the same level as the normal water level in the field.

Water is discharged into the hole alongside the bucket, where the water level rises and overflows into the bucket. This procedure is important to accurately measure the discharge under the normal operating head. If the siphon is allowed to discharge directly into the bucket, the head would be changing as the bucket fills and this would affect the siphon discharge.

Procedure:
The siphon is first filled with water to take out all the air. This is called "priming." One end is kept under water and the other end is covered with the hand to prevent air from reentering. The siphon is placed over the embankment with one end in the field ditch and with the other end in the hole beside the bucket.

As the water level rises, it flows into the bucket. The time it takes to fill the bucket is then recorded.

For free siphon flow, the water can be discharged directly from the siphon into the bucket.

The siphon discharge is then calculated in the following way.

$$\textbf{Siphon discharge (l/s)} = \frac{\textbf{Volume of bucket (l)}}{\textbf{Time to fill the bucket (s)}}$$

Example: A siphon fills a 10-liter bucket. The time to fill the bucket is 24 seconds. Therefore, the discharge is 10/24 = 0.42 l/s

Some typical discharges for siphons and spiles (l/s) are presented in Table 11 below.

Table 11. Typical Discharges for Siphons and Spiles

	Head (cm)			
Diameter (mm)	**5**	**10**	**15**	**20**
20	0.19	0.26	0.32	0.73
30	0.42	0.59	0.73	0.84
40	0.75	1.06	1.29	1.49
50	1.17	1.65	2.02	2.33

C. Measurement of Infiltration Rate

The infiltration rate is the velocity at which the water enters into the soil. It is expressed by the depth (mm) of the water that enters the soil in one hour. An infiltration rate of 20 mm/h means that in one hour, a water layer of 20 mm infiltrates into the soil.

Infiltration refers to the vertical entry of water into the soil. It is not to be confused with hydraulic conductivity, which indicates the ability of the soil to transmit water in all directions.

In dry soil, water infiltrates rapidly. This is called the initial infiltration rate. As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady state. This is called the basic infiltration rate.

The infiltration rate depends on soil texture (the size of the soil particles) and soil structure (the arrangement of the soil particles). It is a useful way of categorizing soils from an irrigation point of view.

Some typical values for basic infiltration rates for various soil types are presented in Table 12.

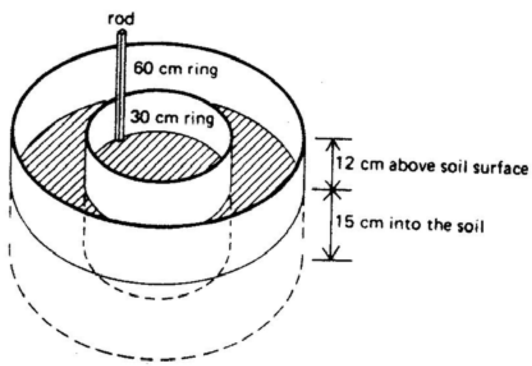
Table 12. Basic Infiltration Rates by Soil Type

Soil Type	Basic Infiltration Rate (mm/h)
Sand	> 30
Sandy loam	20 – 30
Loan	10 – 20
Clay loam	5 – 10
Clay	1 – 5

Typical values in Central Asia are around 20-25 mm/h, which is very good for surface irrigation.

The most common method to measure the infiltration rate is by a field test using a ring infiltrometer, as shown in Figure 7.

Figure 7. Ring Infiltrometer



cm = centimeter

Equipment required:

- Shovel
- Hammer
- Watch
- 3 buckets, 10-liter capacity
- Plastic sheet

- Water nearby
- Piece of timber
- Ring infiltrometer
  (one 30-cm ring and one 60-cm ring)
- Measuring rod of 30 cm
- Data sheet

Method:

Step 1: Hammer the 30 cm diameter ring at least 15 cm into the soil. Use the piece of timber to protect the ring from damage during hammering. Keep the side of the ring vertical and drive the measuring rod into the soil so that approximately 12 cm is left above the ground.

Step 2: Hammer the 60 cm ring into the soil or construct an earth bund (embankment) around the 30 cm ring to the same height as the ring.

Place the measurement rod in the inner ring.

Place a plastic sheet in the inner ring.

Step 3: Pour water in the outside circle up to 7–10 cm deep.

Step 4: Pour water in the inner ring up to the same level as the outside ring.

Step 5: Take away the plastic sheet from the inner ring. Record starting time and initial water height in the inner ring (read this from the measuring rod).

Step 6: Continue to take readings, in the beginning every 1–2 minutes; when the difference between the reading becomes less, increase the interval to every 5 minutes. The interval between readings can be increased up to 20–30 minutes.

The water level in the rings needs to be maintained more or less at the same level. Therefore, the rings (inner and outer) have to be refilled on a regular basis. The best is to do that right after a measurement. The new heights will need to be recorded as new reference values.

Continue the measurement until the infiltration rate becomes constant. This means that the infiltrated amount of water over time has remained the same.

To be carried out well, the infiltration measurement might take up to 8–12 hours. We may not have the time during a busy day to do this, but it may become necessary in some situations. At the very least, 2 infiltration measurements will need to be made on each site.

Step 7: Calculate the infiltration rate and the cumulative infiltration for each moment of time that data were recorded.

Graph the infiltration rate and cumulative infiltration rate on millimeter (mm) paper.

D. Evaluation of Irrigation Performance

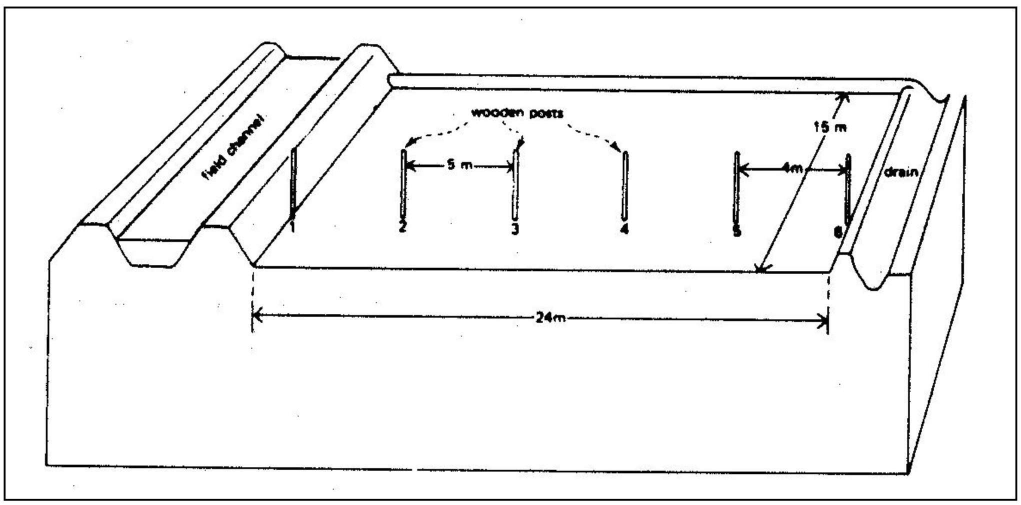
To evaluate the most adequate inlet discharge into a furrow, it is in practice always best to carry out some field trials using different stream sizes. It is therefore advisable to perform field tests to evaluate the optimum furrow length and stream size in a specific condition. These field tests can be carried out easily during the irrigation season.

It is assumed that the application depth of the crop, or the so-called “net irrigation gift,” is known. This should be compared with what happens during actual irrigation practice. The field application efficiency obtained in this manner is a good measure for evaluating irrigation performance.

Equipment required:

- Buckets (3)
- Shovel (3)
- Siphon (three different sizes)
- Measuring tape (30–50 m)
- Wooden posts
- A watch with seconds pointer
- Data sheet
- Soil auger
- mm paper

Figure 8. Method of Evaluating Field Irrigation Performance



Method:

Step 1: Identify a typical furrow that can be considered representative of the field in terms of size, shape, soil type, and crop. Measure the length and record the data on the data sheet. Also measure the furrow shape and the distance between the furrows.

Step 2: Place wooden posts at 5–10 m intervals (depending on the field length) as shown in the figure above. Record the positions of the posts on the data sheets.

Step 3: Calibrate the inlet flow into the furrow, as described in the procedure for measuring furrow discharge.

Step 4: Start the irrigation. Record the time it takes for the waterfront to reach each wooden post. This is called the “advance time.” It is recommended to use at least three different furrow flows, one the same as the farmer always uses, the second smaller, and the third a bigger discharge.

Step 5: Record the time the water reaches the end of the field. Continue to irrigate so that the water flows off the field in the same way the farmer does this. If a flume or small weir is available, the furrow runoff can also be measured. Then a volume balance can be made of the furrow's inflow and outflow.

Step 6: Cut off the inflow into the furrow. Record the time that the flow is cut off. Now record the time that all water is infiltrated at each post. This is called the "recession time."

Step 7: Calculate the contact time in minutes. This is the difference between the advance time and recession time.

Step 8: Calculate at each of the wooden posts the amount of water applied, using the infiltration curve. All data are recorded on the sheets provided. Draw a graph as in the example.

If the results of all the furrow experiments are drawn in the same graph, the differences will become very clear.

Step 9: Determine the field application efficiency.

The field application efficiency is the fraction of the applied water that is used by the crop. Provided there are no runoff losses, the field application efficiency (%) is the required irrigation depth (mm), divided by the average applied irrigation depth (mm), then multiplied by 100%.

or:

$$\textbf{Field application efficiency (\%)} = \frac{\textbf{Required irrigation depth (mm)}}{\textbf{Average applied irrigation depth}} \quad \textbf{x 100\%}$$

Before leaving the field, auger a hole at every post to determine up to which depth the water has infiltrated into the soil. Ideally, this should be done 24 hours after finishing the test. This can then be compared with the results earlier obtained by calculating the infiltrated water depth.

E. Construction of Furrows

The recommended steps for the construction of furrows are described below.

Straight Furrows:

Step1: A straight line is set out in the field along the proposed line of furrows. This can be done by setting up ranging poles or marking a line on the ground with chalk powder.

Step 2: The ridger is moved along the line. The resulting furrow should be straight.

Step 3: About every 5 m, a new straight line should be set out.

Contour Furrows on Sloping or Undulating Land:

Step 1: A guide furrow must first be set out along the upper edge of the field close to the farm channel, using a leveling device to locate the contour line. Further guide furrows are set out every 5 m on undulating ground and 10 m on uniform sloping land.

Step 2: Working from each guide furrow, furrows are made up to halfway along the next guide furrow.

V. DRAINAGE

A. Field Monitoring of Drainage

Surface drainage problems can be recognized by prolonged ponding of water on the soil surface after flooding, rainfall, or irrigation. Surface ponding often occurs in depressions, in valley bottoms, and behind obstructions in natural drainage flows.

Prolonged Ponding of Water. Subsurface drainage problems can appear in the same way as surface drainage problems: there is prolonged ponding of water. In areas with subsurface drainage problems, however, waterlogging can occur without surface ponding. Waterlogging problems of this type normally occur in flat lands. Sometimes, deep percolation is impeded by impermeable or poorly permeable layers located at a certain depth below the soil surface. On this layer, a so-called perched water table might develop long enough to impede crop growth.

Symptoms of Waterlogging. While cultivating their land, farmers should watch for waterlogging problems that might occur due to wet soil conditions and a shallow water table. They can also observe the water level in open wells and pits. Symptoms of waterlogging in the crop are poor germination, inhibited root development, stunted crop growth, sensitivity to fungal diseases, and—in extreme cases—decay of roots and crop failure. Salinity problems, which are described below, may appear.

B. Selection of Drainage Improvement Measures

The best solution for drainage problems is not always the implementation of an artificial drainage system. Depending on the causes of the drainage problem, the solution may lie in (1) improving irrigation management and practices, (2) upgrading the canal system, (3) land leveling, (4) changes in land use or farm practices, or (5) removing blockages in the natural drainage system.

Considering the Artificial Drainage Option. Farmers should consider whether or not poor drainage significantly lowers the returns from the farm's crop production, as well as what return can be expected from investing in artificial drainage or other options. Only when drainage is not a major constraint can a significant increase in farm returns be expected.

Need for Consultations with the WUA. If an artificial drainage system is required, alone or in combination with one of the options already mentioned, farmers should consult with the WUA's O&M engineer concerning the type of drainage measures required. Unless the area under consideration is located in the vicinity of a natural drainage outlet, artificial drainage from a leasehold farm will require access to a main collector or other drainage infrastructure. This access needs to be planned and implemented by the WUA.

VI. SALINITY CONTROL

A. How to Recognize Salinity/Sodicity

Salinity problems only become visible in the field after they have reached an advanced stage. The concentration of salts in the soil must be quite high for salinity symptoms to become apparent. Salinity/sodicity symptoms appear in plants in the same way as moisture stress from dry conditions. Plants may be stunted, leaves may cup, and overall plant health and color are affected. The leaf tips turn brown and brittle and the symptoms progress to the leaf margins, to the overall leaf, and, finally, to the entire plant.

Most Sensitive Plant Stages. Usually, the plant stages that are most sensitive are the germination or the early growth stages. Early signs of salinity damage are failed germination, irregular and stunted crop growth, darker leaves than the normal color, and smaller leaves and stems with shorter spaces between leaf nodes. When the problem gets more serious, leaves turn yellow and are affected by “burning” (firing, browning) and the death of leaf edges.

Signs of High Saline Content. High salinity concentrations can be recognized in the soil by a white soil crust, a powder-like layer covering the soil surface, and an oily appearance of the soil surface. Salinity often appears in patches within the field. High sodium concentrations are often accompanied by black soil patches on the soil surface, hard soil crust, dense/massive soil structure, and poor water infiltration. Bare patches often appear in fields due to the death of crops during germination. This is due to their lower tolerance for salt during this phase, to uneven watering, and to local concentrations of salt in groundwater and substrata.

Major Cause of Salinized Patches. Poor leveling of fields is perhaps the greatest contributor to the salinized “patches.” This is because slopes make fields hard to leach and make them prone to aeration and to the consequent rising of salts to the soil’s root zone.

In general, farmers should be aware of the limitations in field detection of salinity. As noted in Guidebook 4, WUAs should monitor soil salinity on an annual basis and advise farmers concerning remedial management practices.

B. Controlling Salinity in Irrigated Soils

There are several management practices available for controlling salinity. These practices include the following:

- Selection of crop varieties tolerant to salt;
- Modification of land preparation practices; and
- Improvement of irrigation and drainage management.

When selecting a set of management practices to optimize production, the crop type, climate, irrigation water quality, and soil properties should be carefully considered.

1. Crop Management

Because crops vary considerably in their tolerance to salinity, crops should be selected that produce satisfactorily for the particular conditions of salinity expected to occur in the rootzone.

Figure 9. Bare Patches in Cotton Field Due to Salinity and Poor Land Leveling, Ak Altin District, Uzbekistan

Most Salt-Tolerant Crops. Among the crops grown in Uzbekistan, the most salt-tolerant are barley and sugar beets. Moderately tolerant crops are alfalfa, rice, cotton, wheat, corn, potatoes, carrots, onion, cucumbers, pomegranates, figs, melons, and grapes.

Least Salt-Tolerant Crops. The least salt-tolerant crops are stone fruits, almonds, peas, and beans. Plant density should be increased to compensate for the smaller plant size that results due to saline conditions.

It is especially important to consider the crop's salt tolerance during seedling development. This is often the most sensitive growth stage. Optimum yields are impossible without satisfactory establishment of crop stand. When a crust is likely to develop on the soil, the sowing rate should be increased to facilitate seedling emergence and stand establishment.

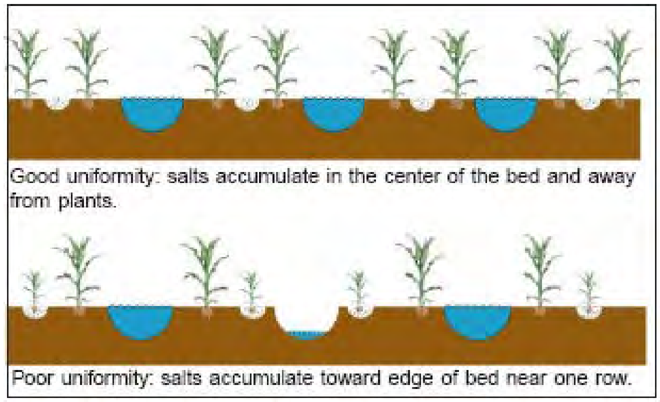
2. Land Preparation

Where irrigation is by flood or furrow methods, careful land leveling (as described earlier) is desirable to achieve more uniform water application and, consequently, better salinity control. Deep ripping of soils can eliminate plow pans that impede drainage.

Moving Salts Away from Seedbeds. Seedbed shape and seed location can be managed to move salts away from germinating seeds and plant roots. Irrigation uniformity is essential with this method. Without uniform distribution of water, salts will build up in areas with germinating seeds and seedling plants, damaging them.

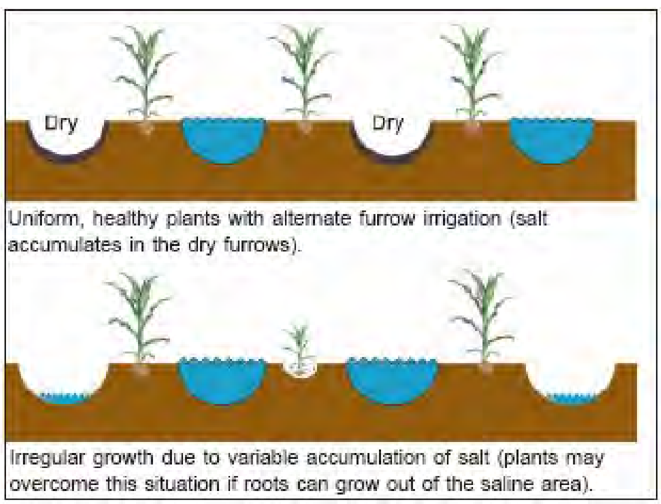
Double-Row Bed Systems. These systems are as illustrated in Figure 10. This method requires uniform wetting toward the middle of the bed. This leaves the sides and shoulders of the bed relatively free from injurious levels of salinity. Without uniform applications of water (one furrow receiving more or less water than another), salts accumulate closer to one side of the bed. Periodic leaching of salts down from the soil surface and below the root zone may still be required to ensure that the beds are not eventually salted out.

Figure 10. Salt Management in Double Row Bed Systems



The Alternate Furrow Irrigation. This system, which is shown in Figure 11, may be desirable for single-row bed systems. This is accomplished by irrigating every other furrow and leaving alternating furrows dry. Salts are pushed across the bed from the irrigated side of the furrow to the dry side. Care is needed to ensure that enough water is applied to wet all the way across the bed to prevent build up in the planted area. This method of salinity management could still result in plant injury if large amounts of natural rainfall fill the normally dry furrows and push salts back across the bed toward the plants. This will also occur if the normally dry furrows are accidentally irrigated.

Figure 11. Salt Management in Single Row Bed Systems



Practices that maintain high organic matter levels in the soil, such as green manuring and incorporation of crop residues, will help in the maintenance of good tilth and prevent surface crusting. It is important to avoid tillage at high water content.

3. Irrigation and Drainage Management

Improvements in salinity control of irrigated lands generally come from improvements in irrigation management. The key to effective irrigation—and hence to salinity control—is to provide the proper amount of water at the proper time.

Conditions for Effective Irrigation. Careful control of timing and of the amount of water applied requires the following:

- Water delivery to the field on demand: This requires close coordination between the farmer and the WUA. Many delivery systems encourage over-irrigation because the water is supplied for fixed periods, or in fixed amounts, irrespective of seasonal variations in on-farm needs.
- Accurate measurement of water flow (rates and volumes): Without effective flow controlling and measuring devices, seepage losses are difficult to identify and oversupply to fields is likely to occur.
- Adequate delivery and drainage system: Seepage losses should be reduced by lining the canals with impermeable materials or by compacting the soil to achieve low permeability. Also, the drainage system should be kept clean and on grade.
- Accurate measurement of the water and salt content of the soil.
- Adoption of reliable methods to predict or measure the crop's rate of water use and to detect or predict the onset of plant stress.

Adverse Effects of Over-Irrigation. Over-irrigation contributes to the water table and to salinity problems. It also increases the amount of water that the drainage system must accommodate. A proper relation between irrigation management and drainage must therefore be maintained to prevent irrigated lands from becoming salinized. The amount of water applied should be sufficient to supply the crop and satisfy the leaching requirement, but not too much to overload the drainage system.

Improving Irrigation Efficiency. It is important to recognize that inefficient irrigation is a major cause of salinity and of shallow water tables in many irrigation projects of the world, and that the need for drainage can usually be reduced through improvements in irrigation management. Ways to improve irrigation efficiency should be sought first before the drainage capacity is increased.

The Need for Increased Irrigation Frequency. The frequency of irrigation affects the response of crops to saline waters. Since salts reduce availability of water for plant use in an almost direct proportion to their total concentration in the soil solution, irrigation frequency (irrespective of irrigation method) should be increased. This way, the moisture content of saline soils can be kept as high as practicable without creating aeration or disease problems. This is especially true during seedling establishment and during the early stages of vegetative growth.