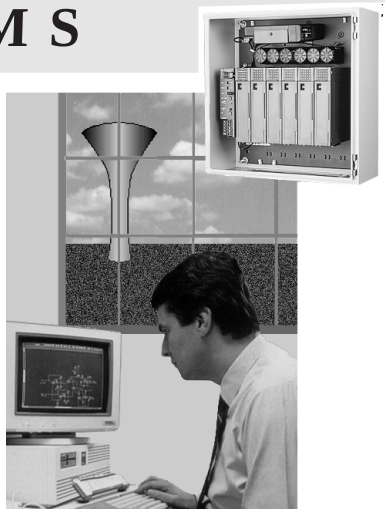
MOTOROLA

M O S C A D A P P L I C A T I O N N O T E

WATER SYSTEMS



APPLICATION OVERVIEW

Fresh Water Distribution Systems are present in all populated areas, with most water utilities using some level of automatic control, monitoring and information processing. Water distribution can become more effective and less costly by using remote monitoring and control of the supply, storage and pumping of fresh water.

The primary goal of water distribution management is to balance demand with supply. The quality of the fresh water and the quality of service to consumers are also functions of proper water system management. Until recently, this could be only be achieved by using manual control. New and emerging water standards are becoming more demanding. Faced with these conditions, most municipalities are moving to automation.

Motorola provides a wide range of Supervisory Control and Data Acquisition (SCADA) and radio telemetry products that are well suited for the monitor and control of water distribution systems.

Motorola has proven experience in the Water SCADA business. The installed customer base includes hundreds of SCADA systems and tens of thousands of RTUs. Several are complex systems, particularly those including multiple control points, wide area coverage, and difficult topographical problems.

This experience has evolved into a new and improved generation of products, higher quality field engineering and installations, and greater customer satisfaction. The product line has recently been strengthened with the new **MOSCAD - the most innovative and powerful SCADA system on the market today.**

BASIC ELEMENTS OF A WATER DISTRIBUTION SYSTEM

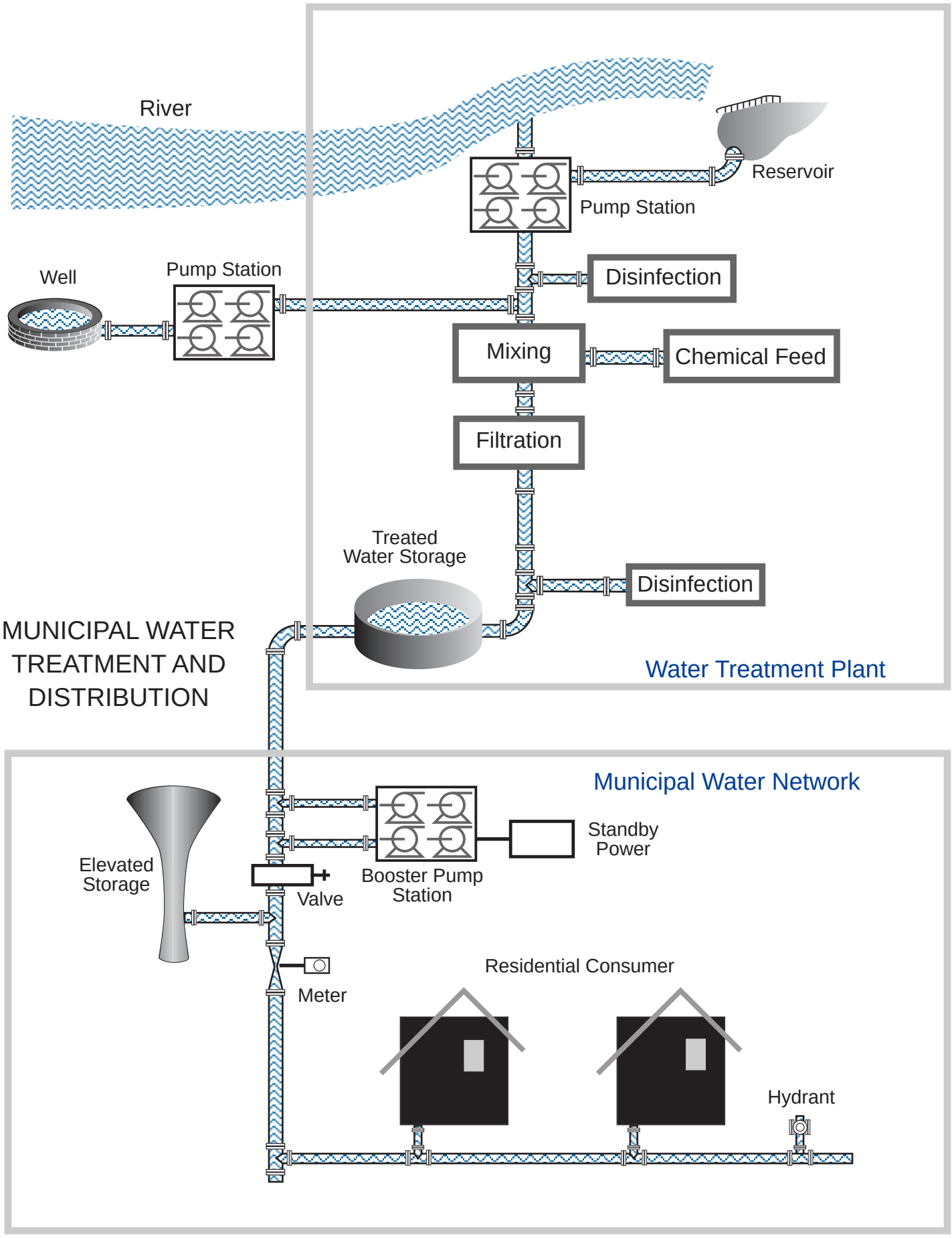
A typical fresh water distribution system, graphically illustrated in Figure 1, consists of:

- Rivers, wells and other water sources
- Water treatment plant
- Well pumps and booster pumps that distribute the water by pressure to all water system locations
- Water reservoirs, water towers, elevated storage tanks and other water storage facilities
- Water meters at main supply points
- Valves that regulate water distribution and flow
- Water pipelines that deliver water to all consumer points

These process steps and others, typically found in fresh water systems, need to be constantly monitored to ensure that fresh water is supplied efficiently to all consumers.

Many municipalities, even today, rely heavily on periodic site visits of personnel to check on the status of equipment at wells, booster pump sites and reservoirs.

With the advent of remote monitor and control systems, the frequency of these visits has been reduced. From the comfort of an office, or out at a distant location, personnel can monitor and control virtually any aspect of the operations. Information is provided in a real-time environment that identifies problems as they occur and takes corrective action when needed.


River
Reservoir
Pump Station
Well
Pump Station
Disinfection
Mixing
Chemical Feed
Filtration
Treated
Water Storage
Disinfection
MUNICIPAL WATER
TREATMENT AND
DISTRIBUTION
Water Treatment Plant
Municipal Water Network
Standby
Power
Elevated
Storage
Booster Pump
Station
Valve
Meter
Residential Consumer
Hydrant

BASIC ELEMENTS OF A MONITOR AND CONTROL SYSTEM

A typical monitor and control system for water includes the following elements:

- Remote Terminal Units (RTUs)
- Sensors and Electromechanical Devices
- Central Computer
- Communication Links

REMOTE TERMINAL UNITS (RTUs)

In a typical water monitor and control system, the status of the water system components, such as wells and pump sites, are locally controlled and monitored by RTUs (Remote Terminal Units). These units are hard-wired to various electro-mechanical devices and sensors which provide the RTU with various operational and status data inputs. The RTUs also provide control of water system components to which they are connected.

Some of the typical data inputs monitored by RTUs in a water distribution system include:

- Level readings of the water reservoirs and elevated storage tanks (measured by level sensors).
- Well pump status and failure alarms (measured by electro-mechanical contacts), pump flow rate (measured by flow meters), pump run time, and number of pump starts.
- Booster pumps status, bearing temperature alarms (measured by temperature sensors), power and generator failures.
- Water pressure at main supply points.

Some of the typical RTU control applications include:

- Control of well pump sites and booster sites
- Control of water valves

The MOSCAD RTU's design makes it compatible with most of the sensors typically used in water distribution systems. This includes digital, as well as analog sensors, including all of the sensors mentioned previously, and more.

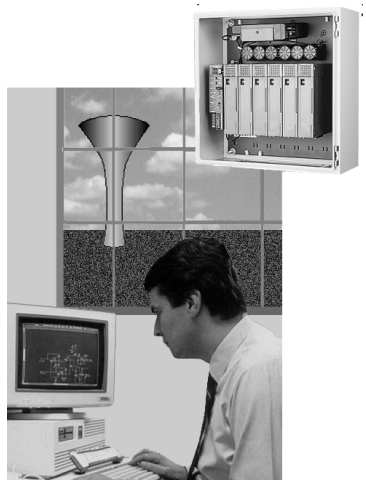
THE CENTRAL COMPUTER

The role of the central computer (also referred to as the computer central, or Computer Control Center) in most systems, is to monitor the data reported by the RTUs, to prompt operators when problem situations arise (major alarms can be sent automatically to alpha-numeric pagers). It sends automatic control commands to be executed by the RTUs, and to collect data for information processing purposes (such as analysis of trends). The benefits provided by the central computer are: more efficient utilization of manpower, energy savings, detection of problems as they occur, and improved maintenance of equipment.

Motorola offers DOS-based or Windows-based PC software packages in either standalone or Local Area Network (LAN) configurations. This includes the IGC/M Central, specially designed to monitor and control MOSCAD RTUs. Motorola can also provide interface to existing, third-party SCADA centrals, such as VAX/VMS centrals (in this case, Motorola provides the communication driver and MOSCAD RTUs).

COMMUNICATION LINKS

The communication link between RTUs, and between the central computer and RTUs, provides the data link which allows these components to talk to each other. The communication link usually found in monitor and control systems are: radio, wire lines, telephone lines, and microwave links.



INTELLIGENT vs. "DUMB" RTUs

A "dumb" RTU does not have the capability to be programmed to a specific application. Instead, it reports digital or analog inputs to the Central Computer. All decision-making and logical functions are performed at one location: the Central Computer.

An intelligent RTU, on the other hand, has the capability to be programmed to almost any specific requirement. The RTU program may be as simple as turning on or off a pump based on one water level alone, or as sophisticated as turning on or off pumps based on several conditions at several sites. Depending on how flexible the programming language is, additional functions can be integrated into the RTU, such as pump sequencing, low level pump shut-off, and more.

Intelligent RTUs, such as the MOSCAD, are ideal for use in water systems because of the variety of control strategies that can be defined. Moreover, passing of information from one site to another is prevalent in water systems (water tank to well site, booster station to booster station, well site to booster station, etc.). Many water systems require some degree of backup control. Intelligent RTUs provide an alternative solution to backup control that may be more cost effective and technically sound.

Some of the monitor and control system's decision-making and logical functions can be transferred from the Central Computer to the site, since an intelligent RTU has the power to make these decisions. High-speed calculations and decisions can be made locally. This increases overall system speed and response time, especially in potentially harmful or damaging situations.

An intelligent RTU with good mathematical functions can also save the customer money by providing internal mathematical functions that can replace external equipment. For example, a flow rate measured in gallons per minute can be programmed to totalize internally in an intelligent RTU. This saves the customer the cost of a flow totalizer.

Intelligent RTUs are also more adaptable to changes than "dumb" RTUs, and can be changed easily to reflect configuration changes in the water system. The **MOSCAD RTU is especially flexible, even when compared to other intelligent RTUs**, due to its user-friendly Toolbox program. With the Toolbox, a new application program or configuration can be prepared easily, and downloaded to the RTU from a remote site.

Motorola's MOSCAD RTU offers optimal programming flexibility through its Toolbox Software package. This powerful application generator runs on a PC and can be used to tailor the RTUs control program to the customers site requirements. The tailored RTU site program resides on a non-volatile Flash memory in the MOSCAD CPU; this memory is a type of Electronically-Erasable memory (EEROM). It will be stored there indefinitely or until another change is loaded.

Some examples of intelligent RTU applications:

a. An intelligent RTU can be placed at well sites to control well pumps, based on a water tank level.

b. The RTU can be programmed to turn off the pumps in case of failure of chlorine injection.

c. The RTU can be programmed to calculate pump efficiency, totalize water volume based on flow rate, accumulate pump run time and number of pump operations and control pumps in case of Central Computer failure.

d. An intelligent RTU located at a water tank can be used to control "dumb" RTUs located at well pump sites. The intelligent RTU can be programmed to act as an intelligent controller monitoring a water tank level. Based upon the level and user-determined set points, the RTU can send out control commands to turn well pumps on and off.

RADIO vs. WIRELINE

Many monitor and control systems communicate via wirelines or telephone lines to link the RTUs and Central Computer. Wirelines often prove unreliable, due to environmental or physical damage. Leasing telephone lines can be an expensive solution, with questionable reliability. Leasing costs are subject to increases, and are a recurring yearly expense. When the telephone company switches to fiber-optic trunk lines, leased lines incur additional charges.

A well designed radio-based system, such as the **MOSCAD, is inherently more reliable than a wireline-based system**. The radio system is customer owned and is operated by the customer. Additional benefits of radio are lower operating costs, flexible installation and convenient expansion.

Motorola's MOSCAD RTU was designed for radio-based monitor and control systems, with the additional flexibility to work with almost any communication link. MOSCAD incorporates Motorola's MDLC protocol to ensure reliable and efficient communications over a variety of radio and line communication links.

The MDLC protocol is data-packet oriented, and as such is capable of transferring large packets of data over the air. The protocol is a full seven layer Open Systems Interconnection (OSI) protocol as recommended by the Int. Org. for Standardization (ISO). The protocol makes it easy to work with any communication link type by changing only the physical layer, so that radio, leased lines, dial-up lines, RS-232 and RS-485 can be used in an integrated system. Combined with high data transmission rates, up to 9,600 bps, MDLC provides high data throughput even when the water system is spread over a large geographical area.

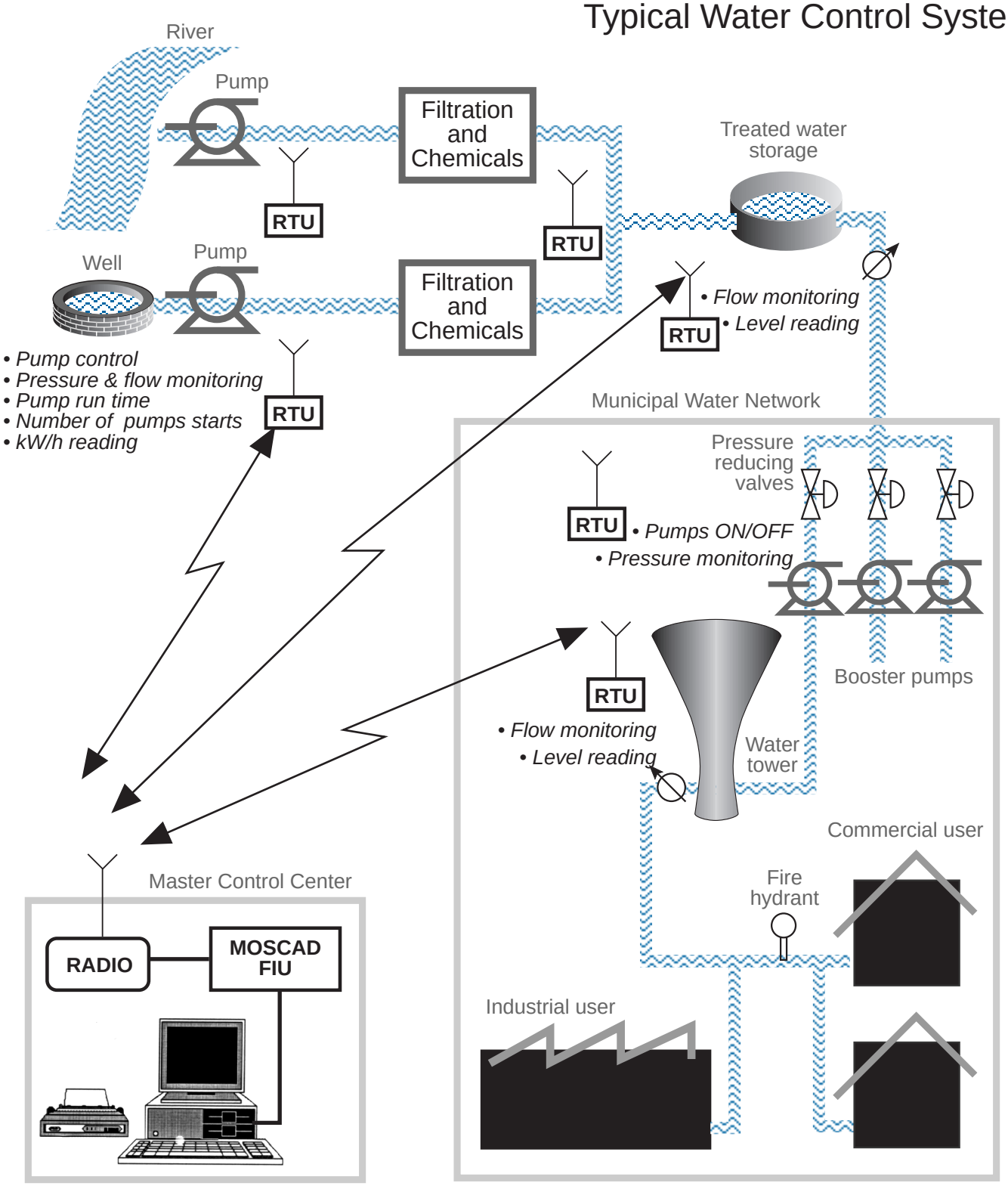
Some of the major benefits provided by MOSCAD's unique communication design include:

- **Remote Diagnostics**. If a problem occurs at one of the RTU sites, remote diagnostics are performed to either make the correction or let you analyze if maintenance personnel are required. Diagnostics can be performed to any RTU from any site in the system via the communication network.

- **Over-the-Air Programming and Monitoring**. Applications can be updated or installed from any RTU or from the Central Computer. These changes can automatically be sent via the communication link without actually visiting each site.

- **Flexible Communications Solutions**. In addition to supporting fast and accurate radio communications, MOSCAD works with virtually all types of communication methods. This inherent flexibility allows the integration of MOSCAD RTUs into existing monitor and control systems that support non-radio communication links.

Typical Water Control System



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