AquaServ™

User's Guide
v1.9
(Revision 1)

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Audience

This guide is intended for plant operators/managers, engineers, contractors, metrologists, and any other industry professionals who will be using, servicing, calibrating, or installing AquaServ systems, or designing systems to interface with AquaServ.

Typographic Conventions

Literal text that appears on the computer screen is printed in `this font`.

[Key] refers to a key on the keyboard.

In the PDF version of this document, all cross-references to Sections, Chapters, Tables, and Figures are clickable. Click on the Section/Chapter/Table/Figure number to access the referenced page.

TABLE OF CONTENTS

TABLES AND FIGURES

1.1 – A Brief Introduction to Analog Signaling

An analog signal, like any other electrical signal, is formed by moving electrons through a conductor. The electrons move in response to an electrical potential, or "voltage," which represents a difference in strength between two points in the electric field. If one point in the circuit has a higher potential than another point, then the electrons will flow in the direction of increasing potential (since they are negatively charged.) Voltage across an electrical circuit causes the electrons to move through the circuit in much the same way that pressure causes water to move through a pipe, and the effect of voltage on current (electron flow) is similar to the effect of pressure on liquid flow.

What makes an electrical signal an "analog" signal is that the current in the circuit or the voltage across the circuit is varied over time in proportion to some physical quantity. In other words, the current in the circuit or the voltage across the circuit is "analogous" to that physical quantity. There are many examples of this in everyday life. For instance, audio signals in a stereo system are analog signals whose voltage varies in proportion to the intensity of vibrations of the air (sound waves.) Similarly, video signals are analog signals whose voltage varies in proportion to the intensity of light striking a small area inside of a camera. The purpose of analog signaling is to communicate the value of a physical quantity across long distances. A "sensor" or "transducer" is used to convert some form of physical energy (such as temperature, pressure, or sound) into an electrical signal that is passed to a "transmitter." The "transmitter" sits at one point on a long-distance circuit and varies the current in the circuit or the voltage across the circuit in proportion to the signal it receives from the transducer. A "receiver" sits at another point along the circuit and monitors the change in current or voltage, which tells it that the physical quantity being measured at the other end has changed.

In order for the receiver to know how to interpret the signal from the transmitter, both instruments must agree on both an "input range" and a "signal standard." The input range is the range of values over which the physical quantity will be measured. Input ranges are most often linear, meaning that they can be fully defined by specifying the minimum and maximum points of the range. For instance, if water temperature is being measured, then the transmitter and receiver may both agree that anything outside of the range of 32 to 212 degrees Fahrenheit (0 to 100 degrees Centigrade) can be ignored (for obvious reasons.) Once an input range is agreed upon, then the transmitter and receiver must then agree upon how the input range will correspond to the amount of current in the circuit or the amount of voltage across the circuit. This relationship defines the "signal standard."

Since the analog signal is almost always designed to vary linearly with the physical quantity being measured, it is usually only necessary to specify two voltage or current levels to define the signal standard. One of these levels corresponds to the minimum value of the input range, and the other corresponds to the maximum value of the input range. Together, these minimum and maximum signal values form a continuous "signal range" that relates to the input range by a constant factor. For long-distance signaling, it is most common to use a 4-20 milliamp (mA) or 10-50 milliamp (mA) "current loop." Current loops are based on the principle that the current is the same at all points in an electrical circuit. Thus, if the transmitter ensures that 4 mA of current is being delivered into the circuit, it is guaranteed that 4 mA of current will be received at the other end. Another common signal standard is the 1-5 Volt (V) standard. Voltage-based signal standards are prone to signal loss (because there is no such thing as a perfect conductor), and thus they are generally used only over

short distances. However, it is common for a current signal to be converted into a voltage signal prior to being measured by the receiver, because it is generally easier to measure voltage than current.

The 4-20 mA standard specifies that the minimum point of the input range is represented by 4 milliamps (mA) of current in the circuit and that the maximum point of the input range is represented by 20 mA in the circuit (1 milliamp = 6.25 million billion electrons per second.) The 1-5 V standard specifies that 1 V of potential across the circuit represents the minimum point of the input range and that 5 V of potential represents the maximum (1 V = 1 Watt/Amp, or the amount of electrical potential required to sustain a 1 Amp current flow with 1 Watt of applied power.) Both 4-20 mA and 1-5 V signal standards use what is called a "live zero." This means that the minimum point of the input range is represented by some signal other than 0 mA or 0 V. Without a live zero, the receiver would have no idea whether a 0 mA or 0 V signal was intentional or whether it was due to a transmitter failure.

Once the receiver knows the input range and the signal range, it can translate the value of the analog signal it receives into an accurate estimate of the value of the physical quantity being measured. This is accomplished by using the following formula:

$$PhysicalQuantity_{now} = (InputRange_{max} - InputRange_{min}) \cdot \frac{AnalogSignalValue_{now} - SignalRange_{min}}{SignalRange_{max} - SignalRange_{min}} + InputRange_{min}$$

For instance, using the above example of water temperature, if it was agreed that 4 mA of electron flow in the circuit corresponded to 32 degrees Fahrenheit (0 degrees Centigrade) and that 20 mA of electron flow in the circuit corresponded to 212 degrees Fahrenheit (100 degrees Centigrade), then, if the receiver measured the current in the circuit to be 8.4 mA, it would know that the water temperature at the remote sensor was:

$$(212^O F - 32^O F) \cdot \frac{8.4\,mA - 4\,mA}{20\,mA - 4\,mA} + 32^O F = 81.5^O F$$

When measuring other quantities, such as flow rate, the minimum of the input range (InputRange$_{min}$ in the above equation) is often 0, which means that it can be eliminated from the equation altogether to simplify the math.

"Metrology" is the science of measurement and deals with accuracy in measurement instrumentation. A metrologist's primary concern is how accurately the read-out of a measuring device reflects the physical quantity being measured. Even if the transmitter and receiver agree that 4 mA and 20 mA correspond to a particular value of the input range, the two instruments may not always agree exactly on what 4 mA and 20 mA are. Thus, it is necessary to adjust the receiver so that it knows what "minimum" and "maximum" signals from the transmitter look like and so that it can scale the signals it receives accordingly. This adjustment process is known as "calibration." In the case of AquaServ, the adjustment is performed within the software (see CHAPTER 4), so no hardware modifications are necessary in order to calibrate the system.

When a computer or other digital device is acting as the receiver in an analog circuit, it is necessary to convert the analog signal to a digital signal so that the computer will be able to correctly interpret its value. A digital signal, like an analog signal, is simply a variation in current or voltage over time, but what makes a digital signal special is the signal standard it uses. The signal standards for digital signals typically specify two voltage or current ranges, a high range and a low range. Digital signal standards must also specify a time interval at which the signal value is to be measured. At the appointed time, if the signal value falls within the high range, then this is interpreted as a value of 1, and if the signal value falls within the low range, then this is interpreted as a value of 0. There is always a gap (called the "noise margin") between the high range and the low range, and if the receiver detects a signal value that falls within the noise margin, it knows that the signal value is not valid. One example of a digital signal standard is TTL (Transistor-Transistor Logic), which uses a low range of 0-0.8 V and a high range of 2-5 V.

Unlike an analog signal, a digital signal can carry information over long distances with 100% accuracy. Even if some voltage drop is experienced during transit, or if electromagnetic interference causes the signal to fluctuate, it would have to fluctuate outside of the high or low range to be considered an error. If the signal does fluctuate that much, it is easy for the receiver to detect that the signal is in error and to take appropriate action. For this reason and others, computers and most other modern electronic devices use digital signals.

Using what is known as "binary notation" (also known as "Base 2"), it is possible to represent any number as a group of ones and zeroes. Since any number can be represented as a string of ones and zeroes, any number can be represented as a digital signal as well. Individual binary digits ("bits") that make up the number can either be sent back-to-back on the same wire ("serial communications") or simultaneously over multiple wires ("parallel communications.") Additionally, mathematical operations can be performed on these binary digits, the digits can be stored for later recall, and they can be moved around inside the computer or from computer to computer. All of this is accomplished using digital signaling.

So, in order for a computer to understand and interpret an analog signal's value, that signal value must first be converted into a digital signal. This is done by digitally "sampling" the analog signal. A device called an "analog-to-digital converter", or ADC, first splits the analog signal range into a number of discrete steps, and the ADC then determines between which two of these steps the analog signal value falls. This process is called "quantization." The step number corresponding to the value of the analog signal is then converted to a binary (Base 2) number and transmitted by the ADC as a digital signal, a stream of ones and zeroes that the computer can understand. This process is repeated over and over, and the rate at which it repeats is called the "sampling rate."

The number of quantization steps is always a power of 2, such as 256, 1024, or 4096. An ADC that is capable of dividing the signal range into 256 steps would output a number between 0 and 255 (between 0 and 11111111 in binary) based on which steps the input signal value fell between. Since a number between 0 and 255 requires as many as 8 binary digits ("bits") to represent it as a digital signal, an ADC with 256 quantization steps is called an 8-bit ADC. An 8-bit ADC is capable of measuring the input signal's value accurately to within $1/256^{th}$ (0.39%) of the full-scale signal range. Thus, we say that the ADC has a "resolution" of 0.39% of full scale. If the input signal is between 0 and 5 V, an 8-bit ADC can measure its value accurately to within 0.02 V. Similarly, a 12-bit ADC is capable of measuring the input signal's value accurately to within $1/4096^{th}$ (0.024%) of the full-scale

signal range. A 12-bit ADC requires 50% more bits than an 8-bit ADC in order to represent the value of the analog signal, but in exchange, the 12-bit ADC has a resolution that is 16 times better.

ADC's are generally designed to convert analog voltage signals without a live zero. If the input signal has a live zero, then only part of the ADC's quantization range is used. On a 12-bit ADC, for instance, the low point of a 1-5 V signal range would ideally correspond to a digital output of 819 (1/5 of the maximum value of 4095), and the high point would ideally correspond to a digital output of 4095. These two numbers are respectively referred to as the "zero reference" and the "full-scale reference." If the 12-bit ADC (which is acting as an analog receiver) and the transmitter have a discrepancy in their interpretation of the signal range, then the ADC will output a digital value other than 819 when a zero input signal is received and a number other than 4095 when a full-scale input signal is received. The computer attached to the ADC can store these adjusted reference signal values and use them to correct any additional signal values it receives.

1.2 – Totalizer Theory

When measuring flow, be it liquid through a weir or widgets through a widget factory, one is always interested in measuring the quantity of an item or substance that passes by a given point in a given period of time. Typically, this is accomplished by measuring the "instantaneous flow rate." The instantaneous flow rate is so named because it represents the relationship between flow and time (the "flow rate") only at the instant it is measured. For example, if a flow rate of 10 gallons per minute is measured at this instant, it does not mean that 10 gallons have actually flowed within the last minute. What it means is that, if the flow were to remain at this same intensity for one minute, 10 gallons would pass by this point. Similarly, the speedometer on a car may show that it is currently traveling at 70 miles per hour, but one cannot tell just by reading the speedometer how far the car has traveled in the last hour. The speedometer simply says that, if the car were to continue at this same rate of speed for one hour, it would be 70 miles farther down the road. However, the odds of the car remaining at the same speed are very slim, just as the odds of instantaneous flow rate remaining steady are very slim.

In order to find out how much stuff has actually flowed past a given point in a given period of time, it is necessary to compute "total flow." Whereas instantaneous flow rate is similar to the speed on a speedometer, total flow is similar to the mileage measured on the odometer. In the example above, if a steady flow rate of 10 gallons per minute had been maintained for one minute, then 10 gallons of total flow would have passed by the measurement point. But what if the flow rate was not steady?

As it turns out, total flow is simply the area under the curve formed by plotting instantaneous flow rate vs. time. In mathematical lingo, this area is referred to as the "integral" of the curve. Refer to FIGURE 1 below.

FIGURE 1 - Total Flow vs. Instantaneous Flow Rate
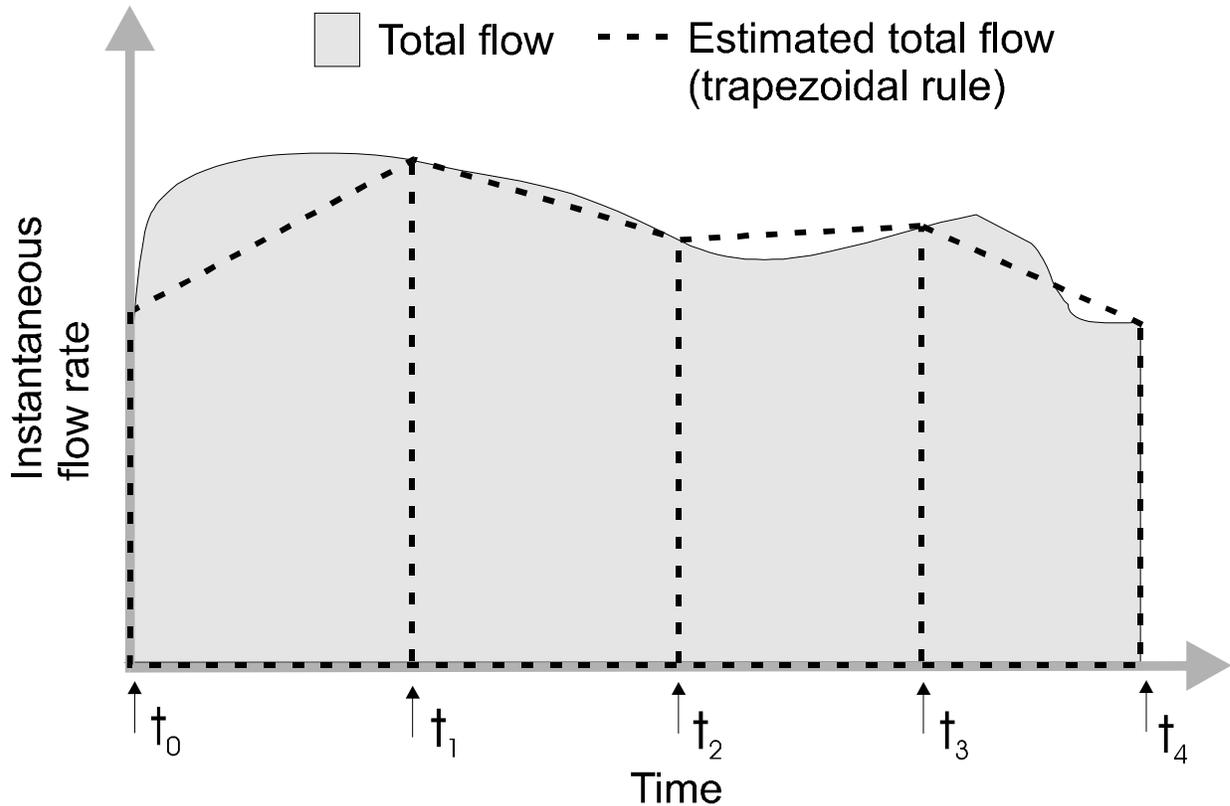
Although computing the exact area under the curve in FIGURE 1 would be impossible, it is possible to estimate the area by taking periodic samples and connecting each sample with straight lines to produce a series of trapezoids, as the figure shows. This method is known as the "trapezoidal rule" and is the method employed by most digital totalizers to estimate the total flow from a series of instantaneous flow rate samples.

In order to compute the total flow between two samples using this method, the totalizer must remember the value of the last sample and when that sample was taken. Knowing this, the total flow between the current sample and the last sample is computed as:

$$TotalFlow = \frac{InstantaneousFlowRate_{now} + InstantaneousFlowRate_{LastSample}}{2}$$
$$\cdot (Time_{now} - Time_{LastSample}) \cdot TotalizerConversionFactor$$

This value can then be added to a running total that represents the total flow over a much longer period of time, such as days or even years.

In this equation, the total flow is in units of whatever is "flowing" (gallons, widgets, etc.), the instantaneous flow rates are in units of whatever is flowing per unit of time (gallons per minute, widgets per second, etc.), and the times are in seconds. Thus, the "Totalizer Conversion Factor" is a number that converts the units of instantaneous flow rate into units of total flow per second. For instance, if the instantaneous flow rate is measured in millions of gallons per day (MGD) but the total flow is in gallons, then it would be necessary to convert MGD into gallons per second to make

the above equation work:

$$1\,MGD = \frac{1,000,000\ gallons}{1\ day} = \frac{1,000,000\ gallons}{86,400\ seconds} = 11.57\,\overline{407}\ gallons/sec$$

Thus, the totalizer conversion factor would be approximately 11.57407 in this case (note that the line over the last three digits indicates that they repeat infinitely.) TABLE 1 lists the Totalizer Conversion Factors corresponding to the units of measure supported by AquaServ:

TABLE 1 - Totalizer Conversion Factors for Units of Measure Supported by AquaServ

Unit of Measure	*Totalizer Conversion Factor*
MGD *(millions of gallons per day)* **MLD** *(millions of liters per day)*	$\dfrac{1,000,000}{86,400} = 11.57\,\overline{407}$
GPD *(gallons per day)* **LPD** *(liters per day)*	$\dfrac{1}{86,400} = 11.57\,\overline{407}\cdot 10^{-6}$
GPM *(gallons per minute)* **LPM** *(liters per minute)* **PPM** *(pulses per minute)*	$\dfrac{1}{60} = 0.01\overline{6}$
OTHER *(widgets per second)* **CFS** *(cubic feet per second)* **CMS** *(cubic meters per second)* **PPS** *(pulses per second)*	1

One other concept that is important to introduce is "average flow rate." Average flow rate is simply the average value of instantaneous flow rate within a given time period. In FIGURE 1, the average height of the curve is the average flow rate. Average flow rate is very closely linked to total flow. In fact, it is simply the total flow in a given period of time divided by the total time. For instance, if a process produced 10 million gallons of liquid in a day, its average flow rate was 10 MGD. This does not mean that the instantaneous flow rate was 10 MGD all day. Similarly, if a car was driven 150 miles in three hours, the *average* rate of travel was 50 miles per hour, even though the car probably did not travel at 50 MPH the whole time.

In situations where a very large number of items (widgets, gallons, etc.) pass by the measurement point every second, it is customary to use a "totalizer multiplier."   The totalizer multiplier is so named because the totalizer reading must be multiplied by it in order to get the actual total flow. For

instance, if a multiplier of 100 is used, then 100 items must pass by the measurement point before the totalizer's right-most digit changes. Using a totalizer multiplier makes the totalizer easier to read in situations where millions of items pass through a plant in a given day. It also can be used to decrease the rate at which the totalizer advances, so that the totalizer reading can be more easily tracked and recorded. Care should be taken not to set the totalizer multiplier too high, since the accuracy of the totalizer display decreases as the multiplier increases. In most cases, however, this loss of accuracy is negligible. For instance, if 1 million gallons flowed in a given day, a totalizer with a multiplier of 100 would be able to measure that total flow to within 0.01% accuracy. In most cases, this is less than the error introduced by the measurement instrumentation and the analog signaling process.

It is important to note one interesting feature of the trapezoidal rule: as the samples get closer together, the approximation becomes more accurate. Thus, it is always desirable for a totalizer to take samples that are relatively close together. As long as the quantity being measured does not vary wildly during the time between samples, the accuracy of the trapezoidal rule is quite good. Liquid flow in a treatment plant, for instance, will not vary significantly over a period of a few seconds, so sampling intervals of 5 or 10 seconds produce excellent totalizer accuracy.

1.3 – Two-Hour Peak Flow

The previous section introduced the concepts of "instantaneous flow rate," "average flow rate," and "total flow." Once these concepts are understood, then understanding two-hour peak flow is relatively straightforward. Two-hour peak flow is simply the maximum total flow over any two-hour period. If a two-hour period contains the peak flow, then no other two-hour period will have a total flow that is higher. Sometimes, two-hour peak flow is also defined as the maximum average flow rate over any two-hour period, but this is really the same thing. The average flow rate in a two-hour period will always relate to the total flow by a constant factor (see TABLE 2 below.)

TABLE 2 – Two-Hour Average Flow Rate vs. Two-Hour Total Flow

Flow rate is in ...	Relationship between Two-hour average flow rate and Two-hour total flow
Units per second	$FlowRate_{average} \cdot 7200\, seconds = TotalFlow$
Units per minute	$FlowRate_{average} \cdot 120\, minutes = TotalFlow$
Units per day	$FlowRate_{average} \cdot \dfrac{1}{12}\, days = TotalFlow$

For instance, if a two-hour peak total flow of 1 million gallons is measured, then the average flow rate during that same two-hour period was 0.5 million gallons per hour, or 12 million gallons per day (MGD).

The Texas Commission on Environmental Quality (TCEQ) requires some treatment plants to submit monthly two-hour peak flow computations. This is particularly problematic for two reasons. To

start with, it is unclear from the TCEQ Rules how exactly they wish to define "two-hour peak flow." The most sensible definition comes from Texas Administrative Code (TAC) Title 30, Part 1, Chapter 317.4: Design Criteria for Sewerage Systems, Wastewater Treatment Facilities:

> (4) Peak flow. For treatment unit design purposes, peak flow is defined as the highest two-hour average flow rate expected to be delivered to the treatment units under any operational condition, including periods of high rainfall (generally the two-year, 24-hour storm is assumed) and prolonged periods of wet weather.

This matches one of the definitions above. However, the wastewater discharge permits themselves attempt to define two-hour peak flow as follows:

> d. 2-hour peak flow (domestic wastewater treatment plants) - the maximum flow sustained for a two-hour period during the period of daily discharge. Multiple measurements of instantaneous maximum flow within a two-hour period may be compared to the permitted 2-hour peak flow.

> e. Maximum 2-hour peak flow (domestic wastewater treatment plants) - the highest 2-hour peak flow for any 24-hour period in a calendar month.

This wording is somewhat confusing. One must assume that, in (d), "flow" means "total flow," since a flow rate is almost never "sustained" for a two-hour period. One must also assume that what the TCEQ is looking for is a computation of the highest two-hour total flow within a given day and then the highest of these daily peaks within a given month.

So, the question now becomes how to compute two-hour peak flow, and the answer is that, without a computer, an accurate computation of two-hour peak flow is nearly impossible. As described in the previous section, the total flow is always the area under the flow rate curve, and this area cannot be computed exactly. It can only be approximated, and the accuracy of the approximation depends on how often the curve is sampled. Let's say that you had a month's worth of paper charts for which you wanted to compute the two-hour peak flow. You could eyeball each day's chart to guess where the highest two-hour total flow was observed, but it would only be a crude guess. You could then apply the trapezoidal rule to several flow rate readings within that two-hour period, but as was mentioned in the previous section, the trapezoidal rule is only accurate if the samples are very close together.

If there's one thing at which computers excel, however, it's repetitive tasks. If a data acquisition system is already collecting samples of instantaneous flow, it can easily scan through this data and perform peak flow computations as well. AquaServ can compute both two-hour peak total flow and two-hour average flow rate over an arbitrary period of time (see Section 5.3.) This should satisfy all current TCEQ two-hour peak flow reporting requirements.

1.4 – The Virtual Chart Concept

In essence, AquaServ acts as two different instruments: a chart recorder and a data acquisition system. However, the two instruments can share and enhance each other's capabilities.

AquaServ periodically samples the input data and plots these samples on the "active chart" (the chart visible on the screen.) If the data acquisition system is enabled, then AquaServ also stores some of these samples to a "virtual chart", which is simply a file on the hard drive. Data stored to a virtual chart can later be recalled and used to reconstruct a chart on the screen. Regardless of whether the data acquisition system is active, AquaServ stores samples of the input data to a file called the "active virtual chart."   The active virtual chart is similar to the virtual charts stored by the data acquisition system, but it differs in the following ways:

- The active virtual chart is sampled at a constant rate of one sample every 5 seconds, regardless of the sampling interval selected for the data acquisition system. As long as AquaServ remains running, the active virtual chart may never actually be used. However, if AquaServ is restarted for any reason, then the data from the active virtual chart is used to reconstruct the active chart on the screen. Referring to the AquaServ Administrator's Guide, a 5-second sampling interval exceeds the temporal resolution of even a 1200 DPI (dots per inch) printer, and in fact, the human eye is incapable of resolving any finer level of detail than this on an AquaServ chart. Thus, it is guaranteed that the active chart will appear the same regardless of whether it was drawn from data collected in real time or data recalled from the active virtual chart.

- The active virtual chart is not tied to a particular date. As with a real chart recorder, if the chart is not changed (manually or automatically), it will continue tracing over itself forever. The data acquisition system always collects its data from midnight to midnight of each day, whereas the active chart can be configured either for manual change or to be automatically changed at any hour of the day or night.

2.1 – Screen Layout

FIGURE 2 shows the AquaServ screen layout for a typical chart.

FIGURE 2 - AquaServ Screen Layout

AquaServ 4000 v1.6

2:05:58 PM   [8] 3/10/2009

Influent [1]
1: **5.19 MGD** [2]
TOT: **25313** [3]
x 100 = GAL [4]

Effluent
2: **4.50 MGD**
TOT: **25412**
x 100 = GAL

Cl2 Residual
3: **0.901 MG/L**
TOT:

Tower Level
4: **22.8 FEET**
TOT:

AQUASERV MAIN MENU [6]
[1] + Plant setup
[2] + Calibration
[3] + Chart Viewer
[4] Change chart
[5] Print chart
[6] About AquaServ

Read Err. [5]

[7]   [10]   [9]

[F9] Page 4   [F10] Page 2   [11] PAGE 1   Page 2
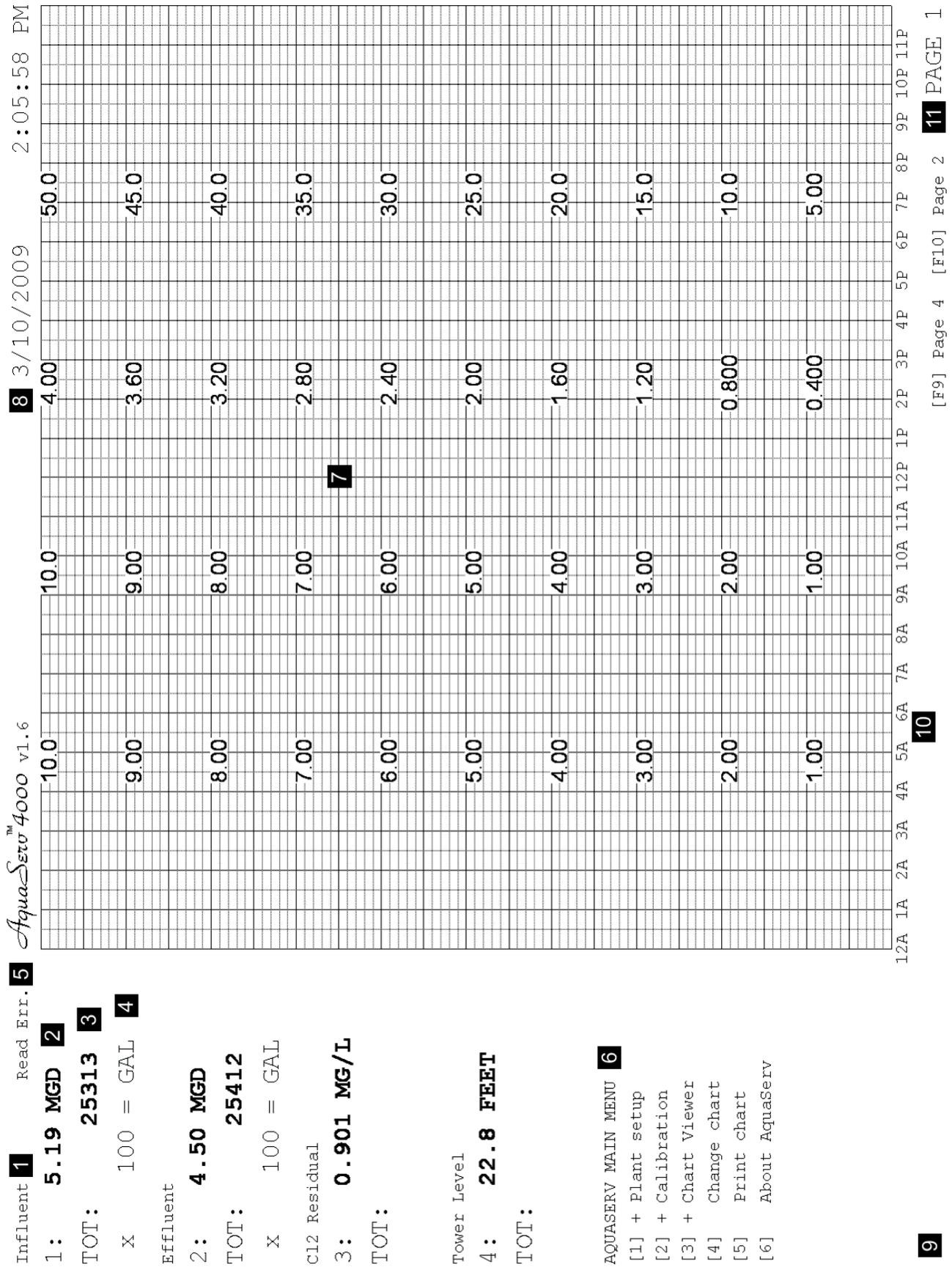
1 Input Description

A word or phrase that describes what this input is measuring. See Section 3.1.

2 Input Read-out

The instantaneous value of the physical quantity that this input is measuring.   This can be an instantaneous flow rate or some other quantity, such as liquid level, turbidity, etc.   See Section 1.1 for more information on how this value is computed.

3 Input Totalizer

The total flow for this input (since the last time the totalizers were cleared.) Note that this field only appears if the units are MGD, GPM, GPD, OTHER, PPS, PPM, CFS, CMS, MLD, LPM, or LPD.

4 Totalizer Multiplier

Multiply the totalizer reading by this number to get the actual number of items (gallons, liters, widgets, pulses, etc.) of total flow. Note that this field only appears if the units are MGD, GPM, GPD, OTHER, PPS, PPM, CFS, CMS, MLD, LPM, or LPD.

5 Device Status

See Section 2.2.

6 Menus

Press the number key on the keyboard corresponding to your selection, or click on the desired menu option using the mouse. See Section 2.4.

7 The Chart

The numbers in the chart mark each input's scale in increments of 10% of full scale. These scales appear in the same color as the virtual pen that they represent (see Section 3.1.)

8 Date and Time

Shows the current date and time for your time zone. AquaServ is fully locale-sensitive, so the date and time will appear in the correct format for your region of the world.

9 Message Area

AquaServ uses this area of the screen to display status and error messages.

10 Chart Timeline

These values indicate which time of the day corresponds to each vertical line on the chart. AquaServ is fully locale-sensitive, so the chart timeline markers will appear in the correct format for your region of the world.

11 Current Page Number (AquaServ 2000 and 4000 only)

In AquaServ 2000 and 4000, the charts are divided into multiple pages of 4 inputs each. At any point within AquaServ, you can view the next 4-input page by pressing the **[F10]** key or using the mouse to click on the [F10] Page # gadget at the bottom of the screen.   In AquaServ 4000, you can also view the previous 4-input page by pressing the **[F9]** key or using the mouse to click on the [F9] Page # gadget at the bottom of the screen.

2.2 – Device Status

The Device Status field appears next to an input only if AquaServ cannot communicate with the A/D converter or other device that is mapped to the input. The following table lists common device status messages and their probable cause:

Status	Probable Cause
Inv. Port	If this input is mapped to a device that uses serial communications, then the "Port" setting for the input does not specify a valid serial port on the system. This can be configured in the `Plant Setup: Configure Inputs` menu (see Section 3.1.)
Inv. Addr	If this input is mapped to a device that uses Ethernet communications, then the "IP Address" or "IP Port" setting for the input may not match the IP address or IP port of the device. This can be configured in the `Plant Setup: Configure Inputs` menu (see Section 3.1.) This error can also be displayed if the device is unplugged or malfunctioning whenever AquaServ starts up or whenever failed devices are retried.
Read Err.	The device may be unplugged or malfunctioning. If this input is mapped to an Opto 22 serial brain, then the "Address" setting for the input may not match the base address of the brain. This can be configured in the `Plant Setup: Configure Inputs` menu (see Section 3.1.)
Retry	AquaServ is attempting to re-establish communication with the device.

2.3 – Messages and Errors

AquaServ will occasionally display informational messages in the lower left-hand corner of the screen. These inform the user of any errors that are encountered as well as any pertinent information about what is going on "behind the scenes."

Messages are color-coded by their content:

- **Yellow** messages indicate warnings to the user.

- **Red** messages indicate that an error was encountered or invalid user input was received (for example, entering an incorrect passcode.)

- **Green** messages indicate that an operation was completed successfully.

- **White** messages convey general status, progress, or other information.

All errors and warnings are additionally recorded to a file named `c:\aquaserv\aquaserv.log`, which can be viewed by the system administrator.

If AquaServ encounters a critical, unexpected error that might interfere with the correct operation of the system (for instance, running out of disk space), then it will pop up an error dialog box. The error dialog will remain visible unless the user clicks OK to acknowledge it. Contact Aquatic Services if any error dialogs are encountered during the normal operation of the system.

2.4 – Navigating the Menus and Changing Configuration Parameters

AquaServ's features are organized into a series of hierarchical menus, each of which has its own unique function. A particular menu may have one or more "sub-menus" attached to it. These sub-menus are always identified by a "+" (plus sign) next to the option number. If a sub-menu is selected, then the current menu will disappear and be replaced by that sub-menu. However, you can always go back to the previous menu by pressing **[0]** or **[Esc]**, or by using the mouse to click on menu option `[0]` or on `Press [Esc] to cancel`.

Some menus contain configuration parameters that can be modified in order to change the behavior of AquaServ. Each of these parameters has an option number and a value associated with it, which will always appear in the following form:

> `[#] Option: VALUE`

If you wish to change the value of this option, select the option by pressing the key on the keyboard corresponding to the option number or by using the mouse to click on the option. Each menu option will be highlighted whenever you hover the mouse pointer over it.

VALUE is color-coded to indicate the type of "gadget" that will be used to change it. TABLE 3 lists the various types of gadgets that appear in AquaServ's menus and explains how they are used:

TABLE 3 - AquaServ Input Gadgets and How to Use Them

Type of Gadget	Color	To Change the Value...
LIST or ON/OFF	**White**	Continue selecting the option until the desired value appears. When the end of the option list is reached, then the gadget will start over at the beginning of the list. An ON/OFF gadget is a list gadget with only two options, and selecting the option number toggles between them.
STRING or NUMERIC	**Yellow**	Select the option, and a yellow line will appear. Type the desired value on the keyboard, then press **[Enter]** when done (or **[Esc]** to cancel.) Press **[Backspace]** to correct mistakes. The text you type will appear yellow until you press **[Enter]**, then it will change to white to indicate that AquaServ has accepted it. If the text you entered was erroneous or the number was out of the acceptable range, then AquaServ will automatically correct it.
DATE	**Yellow**	A date gadget is similar to a numeric gadget, except that the number being entered is a date in the appropriate short date format for your region (for instance, MM/DD/YYYY or YYYY-MM-DD, where MM is the 2-digit month, DD is the 2-digit day, and YYYY is the 4-digit year.) Select the option, and a template (such as `MM / DD / YYYY)` will appear. Type the desired date (it is not necessary to type the slashes or dashes separating the month, day, and year) and press **[Enter]** when done (or **[Esc]** to cancel.) Press **[Backspace]** to correct mistakes.

Type of Gadget	Color	To Change the Value...
TIME	**Yellow**	A time gadget is similar to a numeric gadget, except that the number being entered is a time in the appropriate format for your region (for instance, HH:MM:SS, where HH is the 2-digit hour, MM is the 2-digit minute, and SS is the 2-digit second.) Select the option, and a template (such as `HH : MM : SS XM)` will appear. Type the desired time (it is not necessary to type the colons separating the hour, minute, and second.) If your region uses 12-hour time, then also type the first character of the AM/PM designator. Press **[Enter]** when done (or **[Esc]** to cancel.) Press **[Backspace]** to correct mistakes.
SYSTEM	**Green**	These gadgets have values that are computed based upon the value of other gadgets in the menu or based upon information gathered about your system. If a SYSTEM gadget has an option number assigned to it, then it can behave like a LIST or NUMERIC gadget (depending on what type of parameter is being configured.) Otherwise, it behaves like an INFO gadget.
INFO	**Purple**	These gadgets contain information about the operation of AquaServ.

When a configuration parameter has been altered in the current menu, you will see the text for option `[0]` change from:

> `[0] Return to Previous Menu`

to

> `[0] < COMMIT CHANGES >`

This signifies that, if you select option `[0]`, not only will AquaServ return to the previous menu, but it will also save the changes you made in this menu to the configuration file. To return to the previous menu without saving the changes you made in this menu, press **[Esc]** or click on the INFO gadget that reads `Press [Esc] to cancel`.

2.4.1 – Multi-Page Menus

There are several multi-page menus within AquaServ. A multi-page menu behaves as if all of its pages were part of the same menu. You can switch pages in the menu without losing any changes you made to other pages. As with a normal menu, changes are only committed when you select option `[0]`, and all changes to all pages will be forgotten if you press **[Esc]** or click on `Press [Esc] to cancel`.

Multi-page menus contain an INFO gadget that reads `[Page Down] for next page`. Clicking on this gadget or pressing **[Page Down]** on the keyboard will display the next page in the menu. Some multi-page menus also contain an INFO gadget that reads `[Page Up] for previous page`. Clicking on this gadget or pressing **[Page Up]** on the keyboard will display the previous page in the menu. If your mouse has a scroll wheel, then you can also scroll down one click to display the next page in the menu or up one click to display the previous page.

2.5 – Using Passcodes

AquaServ has the ability to lock out the `Plant Setup` and `Calibration` menus with "passcodes." A "passcode" is simply a series of numbers that must be typed by the user before access to these areas is granted. Passcodes prevent unwanted changes to the instrument configuration and calibration parameters. By default, the passcodes are disabled, but you can add a passcode by selecting option `[9]` in either the `Plant Setup` or the `Calibration` menu. Note that the passcode for each menu is separate. If you set the Plant Setup passcode, it does not automatically set the Calibration passcode (and vice versa.) This makes it possible to control which people can access certain areas of the system.

If you choose to use a passcode, it is important to remember some simple guidelines:

1. Select a passcode that is easy to remember. It is not impossible to break into an AquaServ system when the passcode has been forgotten, but it is not easy either.

2. If you need to write the passcode down to remember it, be sure that you place the piece of paper in a safe or other secure location (such as a locked drawer.)

3. Only distribute the passcode to trusted users. Haphazardly changing settings in the `Calibration` or `Plant Setup` menus can lead to loss of data or other problems.

2.6 – The Main Menu

The "Main Menu" is the menu that appears when AquaServ is started. It contains the following options:

```
AQUASERV MAIN MENU
[1] + Plant Setup
[2] + Calibration
[3] + Data Analysis
[4]   Change Chart
[5]   Print Chart
[6]   About AquaServ
```

Option 1: Plant Setup

This brings up the `Plant Setup` menu, which is described in detail in CHAPTER 3.

Option 2: Calibration

This brings up the `Calibration` menu, which is described in detail in CHAPTER 4.

Option 3:	Data Analysis

This brings up the `Data Analysis` menu, which is described in detail in CHAPTER 5.

Option 4:	Change Chart

This option only appears if auto-change is turned off (see Section 3.2.) Selecting "Change Chart" will erase any traces on the active chart and continue recording on a fresh one.

Option 5:	Print Chart

This option appears regardless of whether auto-print is turned on. Selecting this option will print the active chart to the printer defined in the `Plant Setup: Hardware` menu (see Section 3.5.) In AquaServ 2000 and 4000, only chart pages that contain active inputs will be printed.

NOTE: if the printer is currently offline, then the print job will be put into the printer's queue and will print once the printer is back online. You can view the print queue by using the option provided in the `Plant Setup: Hardware` *menu.*

Option 6:	About AquaServ

This displays a few self-serving words about those who made AquaServ possible.

Selecting option [1] from the Main Menu brings up the Plant Setup menu, which contains AquaServ's many configuration parameters. From within this menu, the behavior of the chart, data acquisition system, and other subsystems can be configured to meet the needs of a particular facility. The Plant Setup menu contains the following options:

```
PLANT SETUP
[1] + Configure Inputs
[2]   Chart/Display
[3]   Clear Totalizers
[4]   Data Acquisition
[5]   Hardware
[6]   Set Date/Time
[7]   Regional Options
Startup: 2/14/2008 3:15 PM
[9]   Set/Change Passcode
[0] Return to Main Menu
```

3.1 – PLANT SETUP: Configure Inputs

Selecting this menu brings up a sub-menu that allows you to choose which input to configure:

```
CONFIGURE INPUTS
[1] + Input 1
[2] + Input 2
[3] + Input 3
[4] + Input 4
...
[0] Return to Previous Menu
```

Select the menu option corresponding to the input you wish to configure. In AquaServ 4000, this is a multi-page menu (see Section 2.4.1.)

Once you have selected an input to configure, the following menu appears (factory default settings are shown):

```
INPUT X (page 1)
[1] Active:  X
[2] Descr.:  *No Description
[3] Input Range:  1.00
[4] Chart Range:  1.00
[5] Units:  MGD
[6] Tot. Mult.:  100
[7] Sig. Figures:  3

[Page Down] for next page
Press [Esc] key to cancel
[0] Return to Previous Menu
```

This is a multi-page menu (see Section 2.4.1.) Page 2 of the menu offers the following additional options:

```
INPUT X (page 2)
[1] Device:  Opto22(Ethernet)
[2] Channel:  0
[3] IP Port:  Default
[4] Module:  0
[5] IP Addr:  192.168.1.150

[Page Down] for next page
Press [Esc] key to cancel
[0] Return to Previous Menu
```

The options in this menu are described in greater detail below.

Page 1, Option 1:	Active
Gadget type:	ON/OFF
Factory default:	Input 1 active, all others inactive

When an input is deactivated, its read-out and chart trace are no longer displayed on the screen. Deactivating an input also prevents that input from being sampled by the data acquisition system, and charts with no active inputs are not automatically printed when AquaServ performs daily auto-maintenance. This feature is useful if your plant does not currently require all of the inputs that are available to the system. It is also useful for temporarily removing an input from the collected data without physically disconnecting its signal.

Page 1, Option 2:	Description
Gadget type:	STRING
Accepted values:	Must be between 1 and 15 characters in length; cannot contain the "_" (underline) character
Factory default:	*[No Description] (all inputs)*

Input descriptions are a convenient way to remember what an input is measuring. In a wastewater treatment plant, for instance, the descriptions might be "Influent", "Effluent", "Stormwater", and "Wet Well Level." The description will appear immediately above the input's read-out on the screen and on printed charts. If you wish to clear this input's description, simply select this option and press **[Enter]** before typing any text.

Page 1, Option 3:	Input Range
Gadget type:	NUMERIC
Accepted values:	0.0 < range ≤ 100,000.0
Factory default:	*1.0 (all inputs)*

The "input range" determines how AquaServ matches this input's signal to the physical quantity being measured. For instance, if a flowmeter connected to Input 1 is set to deliver a 20 mA signal when a 10 MGD instantaneous flow rate is measured, then the input range for Input 1 should be "10.0". In AquaServ, zero is always the minimum point of the input range, so this option sets only the maximum point of the range. See Section 1.1 for more information.

Page 1, Option 4:	Chart Range
Gadget type:	NUMERIC
Accepted values:	0.0 < range ≤ 100,000.0
Factory default:	*1.0 (all inputs)*

This option controls the range of values that are actually displayed on the chart for this input. The chart range is completely independent of the input range. For instance, if a flowmeter is configured to deliver a 4-20 mA signal over a range of 0 to 10 MGD as per above, but the flow usually stays well below 1 MGD, then you could keep the chart range set to 1 MGD for most days and bump it up to 10 only when the flow is abnormally high. Changing the chart range has no effect on the data that AquaServ collects. The chart range merely "zooms in" or "zooms out" on a particular region of the chart scale. Each input has its own chart range, and these are indicated on the chart by color-coded numbers at every 10% of full scale.

Page 1, Option 5:	Units	
Gadget type:	LIST	
Choices:	MGD (Million Gallons per Day) *	PPM (Pulses Per Minute) *
	GPD (Gallons Per Day) *	PH (pH)
	GPM (Gallons Per Minute) *	CFS (Cubic Feet per Second) *
	FEET	CMS (Cubic Meters per Second) *
	MG/L (Milligrams per Liter)	GAL (Gallons)
	NTU (Nephelometric Turbidity Units)	MLD (Millions of Liters per Day) *
	DEG F (Degrees Fahrenheit)	LPD (Liters Per Day) *
	DEG C (Degrees Celsius)	LPM (Liters Per Minute) *
	PSI (Pounds per Square Inch)	meters
	OTHER (items per second) *	Liters
	PPS (Pulses Per Second) *	
	* = Totalizer active	
Factory default:	MGD (all inputs)	

Changing the units of measure for a given input will change the read-out corresponding to that input. An input's units of measure also determine its "Totalizer Conversion Factor," which governs how often the totalizer advances. For more information on totalizer conversion factors, see Section 1.2.

Page 1, Option 6:	Totalizer Multiplier
Gadget type:	LIST
Choices:	1 – 10 – 100 – 1000 – 10,000 – 100,000
Factory default:	100

The totalizer multiplier will appear below the totalizer in the on-screen read-out and on the printed charts. The totalizer reading must be multiplied by this number to get the real total flow. Refer to Section 1.2 for more information.

Page 1, Option 7:	Digits After Decimal
Gadget type:	LIST
Choices:	[Depends on Input Range]
Factory default:	3

This option allows you to specify the number of digits that will be displayed after the decimal point on the chart scale and read-out for this input. The choices available for this option depend on the input range. If the input range is less than 1000, then AquaServ will allow you to choose from three different values, corresponding to a maximum read-out error of 0.5%, 0.05%, and 0.005% (more digits means less error, but no hardware that AquaServ currently supports can produce better than 0.005% accuracy.) For instance, if the input range is greater than or equal to 1 but less than 10, then 2 digits are required after the decimal to ensure that the read-out is accurate to within 0.5% of the input range. In this case, AquaServ will allow you to specify 2, 3, or 4 digits after the decimal. If the input range is greater than or equal to 1000 but less than 10000, then AquaServ will allow you to specify 0 or 1 digits after the decimal. If the input range is 10000 or higher, then no digits after the decimal may be specified.

The Digits After Decimal option is purely cosmetic and has no effect on the underlying data, which is always stored with the maximum possible accuracy.

Page 2, Option 1:	Device
Gadget type:	LIST
Choices:	Opto 22 (Mistic), Opto 22 (Optomux), Opto 22 (Ethernet)
Factory default:	Opto 22 (Ethernet)

This gadget allows you to specify the type of device from which this input's data should be acquired. Currently, AquaServ supports Opto 22 Ethernet brains and (discontinued) Opto 22 serial brains that use the mistic or Optomux protocol.

Page 2, Option 2:	Channel
Gadget type:	NUMERIC
Accepted values:	0 through 63 (Opto 22 Ethernet) 0 through 15 (Opto 22 mistic/Optomux)
Factory default:	Odd-numbered inputs mapped to Channel 0 Even-numbered inputs mapped to Channel 1 (Appropriate configuration for Opto 22 Ethernet brain with 2-channel analog modules)

This option allows you to specify which channel on the input device will be used to acquire the data for this input. When using an Opto 22 Ethernet brain, this option selects a channel on the specified input module (see below.) Opto 22 Ethernet brains support input modules with up to 32 channels each and racks with up to 16 modules each, so theoretically, AquaServ could acquire its data from any of 512 channels on a fully-loaded Opto 22 rack.

When using Opto 22 mistic or Optomux brains, which are limited to 2 channels per module, then Channels 0-1 in AquaServ map to Channels 0-1 on Module 0, Channels 2-3 in AquaServ map to Channels 0-1 on Module 1, etc., up to a maximum of 8 modules. This is the same convention used by Opto 22.

Any channel from any device attached to the system can be mapped to any input of AquaServ. You can even map multiple AquaServ inputs to the same channel, although it is unclear why this would be useful.

Page 2, Option 3:	Port
Gadget type:	LIST
Choices:	COM1: – COM2: – COM3: – COM4:
Factory default:	*COM1:*

If this input will be acquiring its data from a device that uses serial communications, then option [3] changes to Port, allowing you to specify the serial port to which the device (or the RS-485 loop) is connected.

Page 2, Option 3:	IP Port
Gadget type:	NUMERIC
Accepted values:	$0 \le$ IP Port ≤ 65535
Factory default:	*0 (Use the default IP port for the device)*

If this input will be acquiring its data from a device that uses Ethernet communications, then option [3] changes to IP Port, allowing you to specify the IP port of the device. Specifying an IP port of 0 will cause AquaServ to use the default port for whatever device is selected (for instance, port 2001 is the default for Opto 22 Ethernet brains.)

Page 2, Option 4:	Address
Gadget type:	NUMERIC
Accepted values:	Any number ≥ 0
Factory default:	*0*

If "Device" is set to "Opto 22 (Mistic)" or "Opto 22 (Optomux)", then this gadget appears. It allows you to specify the address of the Opto 22 brain from which this input's data should be acquired. Since Opto 22 equipment communicates using RS-485 instead of RS-232, multiple brains with different addresses can reside on the same RS-485 loop, and these can all be accessed through the same serial port on the AquaServ computer. In order for this to work, however, all of the brains on the loop must use the same protocol (mistic or Optomux) and the same baud rate. The address entered in this gadget represents the "base address" of the brain. AquaServ automatically adds 2 to this address, since the analog inputs are accessed at Base Address + 2.

Page 2, Option 4:	Module
Gadget type:	NUMERIC
Accepted values:	0 ≤ Module ≤ 15
Factory default:	Inputs 1 & 2 mapped to Module 0 Inputs 3 & 4 mapped to Module 1 Inputs 5 & 6 mapped to Module 2 etc. (Appropriate configuration for Opto 22 Ethernet brain with 2-channel analog modules)

If "Device" is set to "Opto 22 (Ethernet)", then option `[4]` changes to `Module`. This gadget allows you to specify the input module from which this input's data should be acquired. SNAP series racks can accommodate between 4 and 16 analog modules, depending on the specific model. So, for instance, the 16 inputs on an AquaServ 4000 system could be mapped to 16 different analog modules with 1 channel each, or they could be mapped to 4 different analog modules with 4 channels each.

Page 2, Option 5:	IP Addr
Gadget type:	STRING
Accepted values:	Any valid IP address
Factory default:	192.168.1.150

An IP address uniquely identifies any device that is connected to an Ethernet network. If this input is acquiring its data from an input device that uses Ethernet communications, then this gadget will appear, thus allowing you to specify the IP address of the input device. The IP address of the input device was previously configured when the device was installed (see the AquaServ System Administrator's Guide.)

3.2 – PLANT SETUP: Chart/Display

Option 1:	Chart Damping
Gadget type:	LIST
Choices:	NONE – 10 – 20 – 30 – 40 – 50 – 60 – 90 – 120 – 150 – 180 (seconds)
Factory default:	NONE

Chart damping describes the virtual pen's responsiveness (measured in seconds) to sudden changes in the input value. With no damping, a sudden change in the value of a particular input would cause the pen to instantly move to the new value. With chart damping enabled, however, the virtual pen takes one damping interval to move from the old value to the new. Damping has the effect of smoothing out any sudden spikes in the input data (for the engineers in the audience, it acts as a low-pass filter.) Changing the chart damping interval affects both the traces on the active chart as well as the data stored in the Data Acquisition System.

Option 2:	Read-out Delay
Gadget type:	LIST
Choices:	NONE – 0.1 – 0.2 – 0.5 – 1.0 – 1.5 – 2.0 – 2.5 – 3.0 – 3.5 – 4.0 – 4.5 – 5.0 (seconds)
Factory default:	0.5 seconds

Since the on-screen read-out changes instantly to reflect any change in the input signal, it can become unreadable if the input signal fluctuates rapidly. Setting a read-out delay will cause AquaServ to wait for the specified number of seconds before updating the read-out again. Usually 0.5 seconds of delay is sufficient, but a larger delay can be introduced if it is desired. This setting has no effect on the rate at which data is stored to disk or plotted on the active chart.

Option 3:	Printout Color Scheme
Gadget type:	LIST
Choices:	1 – 2
Factory default:	1

When printing charts, AquaServ's default behavior is to use magenta, light blue, green, and yellow as the colors for Pens 1-4 (respectively.) On some printers, however, green and light blue look very similar, which makes it hard to distinguish Pen 2 from Pen 3. If this is the case for your printer, you can select Color Scheme 2, which uses red for Pen 3 instead of green.

Option 3:	Auto-Maintenance: Auto-Change
Gadget type:	ON/OFF
Factory default:	ON

When auto-change is on, the active chart is automatically cleared at the specified auto-maintenance time (see below), and the virtual pens start drawing on a fresh chart. Note that this does not affect the data acquisition system, which always collects its virtual charts from midnight to midnight.

Option 4:	Auto-Maintenance: Auto-Print
Gadget type:	ON/OFF
Factory default:	ON

When auto-print is on, the active chart is automatically printed at the specified auto-maintenance time (see below.) If auto-change is also active, then the active chart is printed immediately before it is changed. Using these two features together provides fully automated operation. In situations where paperless operation is desired, auto-change can be used without auto-print, and the Chart Viewer can be used to recall stored data at a later date for printing or export. In such cases, setting the auto-maintenance time (see below) to midnight makes the most sense, since it will force the active chart to be in sync with the data stored by the data acquisition system.

NOTE: only chart pages with active inputs will be printed.

Option 5:	Auto-Maintenance: Time
Gadget type:	LIST
Choices:	12:00 AM through 11:00 PM (0:00 through 23:00)
Factory default:	*12:00 AM* *(00:00)*

This option specifies the hour of the day at which auto-change and auto-print will occur. Since the active chart is independent of the data acquisition system, the active chart can be changed or printed at any time during the day, even though the stored virtual charts are always collected from midnight to midnight. This gadget will use the correct time format for your region of the world.

3.3 – PLANT SETUP: Clear Totalizers

Options 1-4: (1-8 in AquaServ 2000)	Clear the totalizer for the corresponding input
Gadget type:	ON/OFF

In this menu, selecting an option will place an "X" next to it. Selecting the option again will clear the "X". When **[0]** is pressed, the totalizers for any inputs whose options have an "X" next to them will be reset to 0.

*NOTE: to avoid accidental mouse clicks, you cannot click on option [0] to clear the totalizers. You must press the **[0]** key.*

Clearing totalizers is useful if total flow needs to be measured for a certain period of time, such as a month. At the end of the month, the totalizers can be reset, much like the trip odometer in a car. This feature is also useful for monitoring short-term total flow, such as storm water overflow during a rainfall runoff event.

In AquaServ 4000, this menu is a multi-page menu with four inputs per page (see Section 2.4.1.) The selected totalizers from all pages will be cleared when **[0]** is pressed.

NOTE: Use caution when clearing totalizers. Once a totalizer is reset to zero, its previous value cannot be recovered.

3.4 – PLANT SETUP: Data Acquisition

Option 1:	Sampling Interval
Gadget type:	NUMERIC
Accepted values:	5 $\leq$ sampling interval $\leq$ 1800 sec.
Factory default:	*5 sec.*

This option specifies how often the data acquisition system should take samples of the input data.

With each sample, the data acquisition system stores the value and units of measure for each of the inputs and the time at which the sample was taken. This data can be later used to reconstruct the chart in the Chart Viewer or to perform computations such as two-hour peak flow.

This option is mostly a carryover from the early days of AquaServ, in which hard drives were limited to at most a few hundred megabytes in size and it was sometimes necessary to use a larger sampling interval in order to store the desired number of days of data. At the time of this writing, even the smallest hard drives available on the market can store literally hundreds of years of AquaServ data at the default sampling interval. Thus, only in very rare cases, such as running AquaServ from a small solid state drive, would it be necessary to use a larger sampling interval.

Referring to Section 1.3 of the AquaServ System Administrator's Guide, the default sampling interval of 5 seconds is sufficient to exceed the temporal resolution of most modern monitor and printer equipment, and in fact, using a smaller sampling interval would not likely produce any visible improvement on printed charts, due to the limitations of human vision.

NOTE: Data is stored to AquaServ's active virtual chart every 5 seconds, regardless of the sampling interval chosen for the data acquisition system.

Option 2:	Days to Keep
Gadget type:	SYSTEM (NUMERIC)
Accepted values:	0 to disable the DAS, or any number of days less than or equal to the maximum allowed (maximum allowed is determined by the sampling interval and free disk space.)
Factory default:	365 (1 year)

This field should be set to the number of days of data (virtual charts) that you wish AquaServ to store. AquaServ will modify this value if it exceeds the limits imposed by the sampling interval and the amount of available disk space. Note also that if the number of days to keep is reduced, then upon committing changes to this menu, AquaServ will delete any charts older than the new number of days. For instance, if AquaServ is currently storing 60 days and the days to keep is changed to 30, then the oldest 30 days of data will be deleted upon committing changes to this menu. AquaServ prints a warning message to remind you of this.

"Max. Days":	The maximum number of days that the system can store
Gadget type:	SYSTEM (INFO)

This gadget is updated every time the sampling interval or days to keep are changed. It is computed based on the amount of available disk space on the hard drive (see below) as well as the size of the hard drive's clusters (the cluster size determines how much space each data file will require.)

"Disk space":	Hard drive space available for data acquisition
Gadget type:	SYSTEM (INFO)

This gadget indicates the amount of total disk space available to the data acquisition system, including the amount taken up by existing data files. It is used to compute the maximum number of days that the system can store without running out of hard drive space.

3.5 – PLANT SETUP: Hardware

Option 1:	Default Printer
Gadget type:	LIST
Choices:	Cycles among all printers that are currently installed on the system
Default:	[Determined by system administrator]

When installing an AquaServ system, the system administrator may choose to install multiple printer drivers on the system. For instance, it might be desirable to install a virtual printer that prints PDF files (such as PDFCreator) in addition to a physical printer. This gadget allows you to choose which of these printers will be used by AquaServ when it prints charts.

To add and remove printers from this list, it is necessary to exit AquaServ, log into the system as an administrator, and configure the printers using Windows Settings. See the AquaServ System Administrator's Guide for information on how to exit AquaServ and access the operating system.

Option 2:	Show Print Queue

This option pops up the Windows print queue dialog box for the default printer. This dialog box shows a list of any pending print jobs from AquaServ. A print job can get stuck in the queue if, for instance, the printer is offline when AquaServ tries to print. The print queue dialog shows a list of these failed jobs, allowing them to be resubmitted when the printer is back online, or cancelled. The print queue dialog can also be used to check the status of the printer, to determine why a particular chart or report failed to print.

System administrators can also access advanced printer options, such as changing the printer port, from within this dialog.

Option 3:	Screen Blanker
Gadget type:	NUMERIC
Accepted values:	1 ≤ screen blanker timeout ≤ 120 minutes, or 0 to disable the screen blanker
Factory default:	*10 minutes*

If a computer displays the same image on the screen for an extended period of time, then that image can become permanently "burned in" to the monitor. To prevent this, most modern software packages and operating systems use what is called a "screen blanker." A screen blanker will display a black screen after a specified period of inactivity (no keyboard commands or mouse movement.) This option lets you adjust the period of time that must pass without keyboard/mouse input before AquaServ will blank the screen. Whenever the screen blanks, pressing any key on the keyboard (including **[Shift]**, **[Ctrl]**, and **[Alt]**) or moving the mouse will restore it.

Option 4:	Power Off Monitor
Gadget type:	NUMERIC
Accepted values:	1 ≤ monitor timeout ≤ 120 minutes, or 0 to leave monitor on all the time
Factory default:	*20 minutes*

Windows can power down the monitor when it is not being used, which saves electricity as well as prolongs the life of the monitor. However, it can take a few seconds for CRT monitors to "warm up" again after being powered down. If your AquaServ system uses a CRT monitor and it is necessary to access the system frequently during the day, then you may wish to set the monitor timeout to a higher value, so that the monitor only powers off at night. This is not an issue with digital flat panel monitors, which power on and off almost instantaneously.

Option 5:	RETRY FAILED DEVICES

If AquaServ is unable to communicate with the device attached to a particular input, it will display an error status next to that input (see Section 2.2.) When an input has a device error, then AquaServ will stop attempting to acquire data for that input but will try to re-establish communications every 5 minutes. Selecting the RETRY FAILED DEVICES option tells AquaServ to immediately try to re-establish communications with any devices that are in an error state, rather than waiting 5 minutes. This is useful when moving an A/D converter from one port to another or if, for some reason, the device loses power momentarily.

3.6 – PLANT SETUP: Set Date/Time

This menu option pops up the Windows Date and Time dialog, which allows the system time and time zone for the AquaServ system to be configured. If the AquaServ system is networked, then this dialog also allows a network time server to be specified.   Correctly setting the time zone is important, since it determines whether (and when) the system will "spring forward" or "fall back" in observance of Daylight Saving Time.

3.7 – PLANT SETUP: Regional options

This menu option pops up the Windows Region dialog, which allows the system administrator to select the region of the world in which the system is being used. AquaServ uses this information to display dates and times using the correct format for the region.

3.8 – PLANT SETUP: Startup

This INFO gadget indicates the time at which the system was last restarted.   This is useful for determining when the power came on after a power failure so that this can be compared to the chart behavior during that time. This gadget is displayed using the appropriate date/time formats for your region of the world.

3.9 – PLANT SETUP: Change Passcode

This option allows the passcode for the `Plant Setup` menu to be set or changed. See Section 2.5 for more information.

Selecting option [2] from the Main Menu brings up the Calibration menu, which contains tools that can aid in calibrating the AquaServ system. Although these tools are designed to make the calibration process easier, this process should still be performed solely by an experienced metrologist. The following sections describe the sub-menus available under the Calibration menu.

4.1 – CALIBRATION: ADC Zero Reference

Options 1-4: (1-8 in AquaServ 2000)	Changes the zero reference for the corresponding input
Gadget type:	SYSTEM
Factory default:	4.00 (all inputs) NOTE: The default is meaningless unless you are using an Opto 22 Ethernet brain with a 4-20 mA analog module. If you are using an Opto 22 mistic brain with a 4-20 mA analog module, then this value will be approximately 5000 after calibration.

Different A/D converters produce different zero reference values when a zero reference signal from the transmitter is sent, and a variety of factors may also cause the zero reference signal to be measured differently by the transmitter and the A/D converter. Thus, this menu allows the metrologist to tell AquaServ exactly which digital value should correspond to a zero reference signal from the transmitter.

Using either the test mode on the transmitter or an external current/voltage source, supply a constant zero reference signal (such as 4 mA) to the device channel corresponding to the input you wish to calibrate, then select that input's number from this menu. Selecting an input in this menu will cause AquaServ to digitally sample the device channel mapped to that input and place the result of the sample next to the input's number in the menu. This result shows the digital value that AquaServ received when a zero reference signal was transmitted. AquaServ uses this reference value, along with the full-scale reference value set in the next menu, to perform adjustments on any additional digital values it receives. Selecting option [0] saves all zero references for all inputs in this menu.

See Section 1.1.1 for more information on analog/digital conversion.

In AquaServ 4000, this is a multi-page menu with 4 inputs per page.

4.2 – CALIBRATION: ADC Full-Scale Reference

Options 1-4 *(1-8 in AquaServ 2000)*	***Changes the full-scale reference for the corresponding input***
Gadget type:	SYSTEM
Factory default:	*20.00 (all inputs)* *NOTE: The default is meaningless unless you are using an Opto 22 Ethernet brain with a 4-20 mA analog module. If you are using an Opto 22 mistic brain with a 4-20 mA analog module, then this value will be approximately 25000 after calibration.*

This menu is similar to the previous menu, except that it allows the metrologist to set the full-scale references for each input. Supply a constant full-scale reference signal (such as 20 mA) to the device channel corresponding to the input you wish to calibrate, then select the option number corresponding to that input. AquaServ will digitally sample the device channel mapped to that input and place the result of the sample next to the input's number in the menu. This result shows the digital value that AquaServ received when a full-scale reference signal was transmitted. AquaServ uses this reference value, along with the zero reference value set in the previous menu, to perform adjustments on any additional digital values it receives. Selecting option [0] saves all full-scale references for all inputs in this menu.

See Section 1.1.1 for more information on analog/digital conversion.

In AquaServ 4000, this is a multi-page menu with 4 inputs per page.

4.3 – CALIBRATION: Time Totalizers

This feature greatly facilitates the measurement of AquaServ's totalizer accuracy.   Normally, a totalizer is calibrated using the following method:

1. A full-scale, 50%, or 20% reference signal is supplied to a given input.

2. A specified number of ticks (changes in the last totalizer digit) is timed with a stopwatch.

3. The totalizer error is computed using the following formula:

$$TotalizerError[\%]=(\frac{Ticks \cdot TotalizerMultiplier}{Seconds \cdot TotalizerConversionFactor \cdot InputRange \cdot Signal_{Ref}}-1) \cdot 100\%$$

The totalizer timer in AquaServ is a convenience function that performs these calculations automatically if the number of ticks, the elapsed time (in seconds) for the ticks, and the magnitude of the reference signal (as a percentage of full scale) are specified.

The Time Totalizers feature behaves as a multi-page menu (see Section 2.4.1), and you can move the scroll wheel on the mouse or press the **[Page Down]** and **[Page Up]** keys to specify which

input's totalizer you are timing. Since the totalizer error depends on the totalizer multiplier, the totalizer conversion factor, and the input range for a particular input, it is important to select the correct input, or else the error computation will not be correct.

Option 1:	Number of Ticks
Gadget type:	NUMERIC
Accepted values:	1 ≤ number of ticks ≤ 99,999

This specifies the number of ticks (changes in the totalizer's right-most digit) that were measured. The system multiplies this value by the totalizer multiplier to get the total flow for the measurement period.

Option 2:	Seconds
Gadget type:	NUMERIC
Accepted values:	0.00 < seconds ≤ 3600.00

This specifies the amount of time that it took the totalizer to count off the number of ticks entered in option [1]. This should be measured with a precision stopwatch, and great care should be taken to ensure that the watch is started and stopped at the exact moment that the totalizer digit changes. Be sure to enter both seconds and hundredths of seconds into this gadget, i.e. "43.19" rather than just "43".

Option 3:	Signal
Gadget type:	NUMERIC
Accepted values:	0.1% ≤ signal ≤ 100.0%

This specifies the magnitude of the reference signal (as a percentage of full scale) that was supplied to the input whose totalizer is being timed. The reference signal can be supplied either from a field calibrator or from a field transmitter. 20%, 50%, and 100% (respectively, 7.2 mA, 12 mA, and 20 mA in a 4-20 mA current loop) are the most common reference signals, since they correspond to "typical" and "maximum" readings.

"Error":	The computed totalizer error for the selected input
Gadget type:	SYSTEM (INFO)

This gadget displays the computed totalizer error (in percent) for the selected input.

4.4 – CALIBRATION: Startup

This INFO gadget indicates the time at which the system was last restarted.   This is useful for determining when the power came on after a power failure so that this can be compared to the chart behavior during that time. This gadget is displayed using the appropriate date/time formats for your region of the world.

4.5 – CALIBRATION: Change Passcode

This option allows the passcode for the `Calibration` menu to be set or changed. See Section 2.5 for more information.

Selecting option [3] from the AquaServ Main Menu brings up the Data Analysis menu, which provides several options for working with previously stored virtual charts.

```
DATA ANALYSIS
[1]   Recall Chart
[2]   2-Hour Peak Flow
[3]   Multi-Day Total Flow
[4]   Multiple Chart Backup
[5]   Backup Drive
      F:\ (Removable Drive)
[0] Return to Main Menu
```

5.1 – Setting the Backup Drive

Option 5:	Backup Drive
Gadget type:	LIST
Choices:	A: through Z:

The backup drive can be used to back up raw virtual chart files from the data acquisition system, which is particularly desirable for paperless facilities and facilities that rely on stored data for two-hour peak flow and other computations. The backup drive is also used to export CSV files from the Chart Viewer (which can later be imported into a spreadsheet program running on another PC– see Section 5.2.3.) Selecting this option cycles through the available drives on the system, including any external hard drives or flash drives that are connected. If the previously-selected backup drive is not connected, then its status will appear as (OFFLINE). Connecting the drive, then exiting and re-entering the Data Analysis menu, should restore the status of the backup drive. Drives that are online will show up as (Removable Drive), (Local Hard Disk), or (Network Drive).

5.2 – The Chart Viewer

The Chart Viewer is one of AquaServ's most powerful features. Using the Chart Viewer, any data stored in the data acquisition system can be recalled and displayed as an on-screen chart—all while AquaServ continues to collect data for today's chart quietly in the background.

To access the Chart Viewer, select option

```
[1]   Chart Viewer
```

from the Data Analysis menu. This will display the following screen:

```
ENTER DATE TO VIEW:
Press [Enter] when done
Press [Esc] key to cancel

MM / DD / YYYY
```

Type the desired date into this Date gadget (for more information about how to use Date gadgets, see TABLE 3.)

If AquaServ cannot find data for the specified date, it will print a message saying `Could not open input file`. A possible cause for this message is that the specified date is outside of the range of days that the data acquisition system is configured to store (see Section 3.4.) Another possibility is that the date was mistyped. If the date is invalid (examples of invalid dates are 02/31/1998 or 13/25/1998), then AquaServ will print a message that says `Bad date`. Otherwise, if the date is valid and a data file exists for that date, then AquaServ will display a chart with the requested data, and the `Chart Viewer` menu will appear.

5.2.1 – The Red Bar

In the Chart Viewer, AquaServ displays a red bar on the reconstructed chart. This is actually a pointer that can be moved to any sample in the stored data. Whenever the pointer points to a particular sample, the input readings for that particular sample appear in the read-out at the top left of the screen, and the time that the sample was taken appears in the date/time display at the top right.

The easiest way to move the red bar is by using the mouse. As you move the mouse over the chart area, a white bar will follow the movement of the mouse pointer. Clicking the left mouse button will move the red bar to the position of the white bar. The position of the red bar can then be fine-tuned using the scroll wheel on the mouse.

The red bar can also be moved by using special keys on the keyboard. Refer to TABLE 4.

TABLE 4 - Keys Used to Control the Red Bar

To move the red bar...	Hold down...	Then press...
Forward 1 sample		Right Arrow key [⇢]
Backward 1 sample		Left Arrow key [⇠]
Forward 5 minutes	[Shift]	Right Arrow key [⇢]
Backward 5 minutes	[Shift]	Left Arrow key [⇠]
Forward 15 minutes	[Ctrl]	Right Arrow key [⇢]
Backward 15 minutes	[Ctrl]	Left Arrow key [⇠]
Forward 2 hours	[Alt]	Right Arrow key [⇢]
Backward 2 hours	[Alt]	Left Arrow key [⇠]

An on-line "cheat sheet" with this information can be accessed by selecting the `Keyboard Help` option from the `Chart Viewer` menu.

5.2.2 – The Reconstructed Totalizers

AquaServ's data acquisition system does not store the totalizer readings with each virtual chart. Instead, it reconstructs the total daily flow whenever the virtual chart is loaded into the Chart Viewer. While in the Chart Viewer, the totalizer display indicates the total flow for a given input on the date being viewed. For instance, if the reconstructed totalizer for the effluent input reads `4502 x 1000 = GAL`, then 4,502,000 gallons were discharged from the plant on that day. `(D)` is displayed next to the reconstructed totalizer to indicate that it is the total flow for this day only and not the running total.

5.2.3 – The Chart Viewer Menu

Option 1:	Save as CSV File

Selecting this option will save the virtual chart data as a comma-separated values (CSV) file, which can be opened in a spreadsheet program such as Microsoft Excel or OpenOffice Calc. The CSV file will be saved to the backup drive specified in the `Data Analysis` menu and will reside in a subdirectory on that drive named:

> `AquaServ_Data.{COMPUTERNAME}`

where `{COMPUTERNAME}` is the name of the AquaServ system (this is configured by the system administrator whenever Windows is installed.) The CSV file will be named

> `YYYYMMDD.csv`

where `YYYY` is the year of the virtual chart being viewed, `MM` is the month, and `DD` is the day.

Once the data has been exported as a CSV file, the backup drive can be taken to another computer, and the CSV file can be loaded into a spreadsheet program for further analysis.

NOTE: In AquaServ 2000 and 4000, this option saves the data from all chart pages, even though only one of them is currently visible.

NOTE: When opening the CSV file with Excel, you may need to select "Text Files" under "Files of Type:" in the "Open" dialog in order for the CSV file to be visible.

Option 2:	**Print Page 1/2/3/4**
	("Print Chart" in AquaServ 1000)

This option prints the chart page that is currently visible on the screen. To print other chart pages (AquaServ 2000 and 4000), use the **[F10]** key or click on the `[F10] Page #` gadget at the bottom of the screen to activate the page you wish to print, then select this menu option.

Option 3:	**Print All Pages**

In AquaServ 2000 and 4000, this prints all of the chart pages that contain valid data. If all inputs on a chart page were inactive throughout the entire day being viewed, then that page will not be printed.

Option 4:	**Print 15-Min. Readings**

This option prints a 2-page table that contains instantaneous readings at 15-minute intervals for all four inputs on the chart page currently being viewed. The TCEQ requires certain treatment plants to generate this data, so this feature is meant to make that process easier (otherwise, it would require exporting the data to a spreadsheet or manually recording the values using the red bar.)

Option 5:	**Back Up Chart**

This option will back up the virtual chart file currently being viewed. The virtual chart file will be saved to the backup drive specified in the `Data Analysis` menu and will reside in a subdirectory on that drive named:

`AquaServ_Backup.{COMPUTERNAME}`

where `{COMPUTERNAME}` is the name of the AquaServ system (this is configured by the system administrator whenever the system is installed.) The virtual chart file will be named

`YYYYMMDD.ASD` for AquaServ 1000 systems,
`YYYYMMDD.AS2` for AquaServ 2000 systems,
or
`YYYYMMDD.AS4` for AquaServ 4000 systems,

where `YYYY` is the year of the virtual chart being viewed, `MM` is the month, and `DD` is the day.

Option 6:	**Keyboard Help**

Displays a "cheat sheet" of keystrokes used to move the red bar around the screen. See Section 5.2.1 for more details.

5.3 – Computing Two-Hour Peak Flow for a Series of Charts

To access the two-hour peak flow calculator, select

        [2]   2-Hour Peak Flow

from the Data Analysis menu. This brings up the following menu:

        2-HOUR PEAK FLOW
        From beginning of
        [1]   MM / DD / YYYY

        To end of
        [2]   MM / DD / YYYY

        Press [Esc] key to cancel
        [0] < COMPUTE >

This menu allows you to select a range of charts over which to compute the two-hour peak flow. As mentioned in Section 1.3, two-hour peak flow is defined as the highest total flow or the highest average flow rate for any two-hour period within the day and then the highest of these daily peaks within the selected range of days. Performing a two-hour peak flow computation on the previous month's stored data should comply with TCEQ monthly reporting requirements.

When the 2-Hour Peak Flow menu is accessed, the default start date is set to one month ago, and the default end date is set to yesterday. In other words, if today were January 12, 2009, then the default would be to compute two-hour peak flow from midnight on December 12, 2008 up to midnight on January 12, 2009. However, both the start and end dates can be set to any date, such as the first day of last month and the last day of last month.

Options [1] and [2] are date gadgets, the behavior of which is described in TABLE 3. These gadgets use the appropriate short date format for your region of the world.

When option [0] is selected, AquaServ will begin scanning through the stored charts and computing two-hour peaks. You can press **[Esc]** at any time to abort the scan. AquaServ will show its progress in the message area of the screen. Note that scanning an entire month may take as long as 30 seconds to a minute, during which time the data acquisition system cannot store new data. For this reason, do not perform a two-hour peak flow scan except when needed.   When the scan completes, AquaServ will display the following multi-page menu (example values are shown):

        2-HOUR PEAK FLOW
        Input #**1**   Date: **01/22/2007**
        Start: **04:19:50 PM**
        Tot. Flow: **8.278 MGal**
        Avg. Rate: **99.34 MGD**
        Avg. Rate: **68983 GPM**
        [1] View Chart
        [2] Print Report
        [Page Down] for next page
        [Page Up] for previous page
        [0] Return to Previous Menu

Use the **[Page Down]** and **[Page Up]** keys or the mouse to cycle through all of the inputs, displaying the two-hour peak total flow and two-hour peak average flow rate for each. Additionally, the date and time for the beginning of the two-hour peak window is shown for each input. Selecting option `[1]` will load the chart for this date into the Chart Viewer so that it can be verified visually. Selecting option `[2]` will print a tabular report of these results to the default AquaServ printer.

The two-hour peak average flow rate is displayed both in the "native" units of measure for the input as well as in gallons per minute, as a convenience to the user. Both of these numbers can also be easily calculated from the two-hour peak total flow. For instance, in the above example, the two-hour average flow rate in MGD is equal to the two-hour total flow (in millions of gallons) multiplied by 12. The two-hour average flow rate in GPM is equal to the two-hour total flow (in gallons) divided by 120. See TABLE 2.

5.4 – Computing Multi-Day Total Flow for a Series of Charts

To access the multi-day total flow calculator, select

```
[3]   Multi-Day Total Flow
```

from the `Data Analysis` menu. This brings up the following menu:

```
MULTI-DAY TOTAL FLOW
From:
[1]   MM / DD / YYYY
[2]   12 : 00 : 00 AM

To:
[3]   MM / DD / YYYY
[4]   12 : 00 : 00 AM

Press [Esc] key to cancel
[0] < COMPUTE >
```

The AquaServ Chart Viewer computes the daily total flow for a single virtual chart, but sometimes it is also necessary to know how much flow occurred during a period of time that spans multiple days and does not begin or end at midnight. The multi-day total flow feature performs the same total flow computation that the Chart Viewer performs, except that it performs this computation over an arbitrary span of time. This feature could be used, for instance, to figure out the exact amount of flow that occurred during a rainfall runoff event.

Options `[1]` and `[3]` are date gadgets, and options `[2]` and `[4]` are time gadgets. The behavior of these gadgets is described in TABLE 3. These gadgets use the appropriate short date and time format for your region of the world.

When option `[0]` is selected, AquaServ will begin scanning through the stored chart(s) and computing the total flow. You can press **[Esc]** at any time to abort the scan. AquaServ will show its progress in the message area of the screen. When the scan completes, AquaServ will display the following multi-page menu (example values are shown):

```
MULTI-DAY TOTAL FLOW
Input #1
Tot. Time: 0d 22h 20m 0s
Tot. Flow: 3.268 MGal
Avg. Rate: 3.512 MGD
Avg. Rate: 2439 GPM

[1] Print Report
[Page Down] for next page
[Page Up] for previous page
[0] Return to Previous Menu
```

Use the **[Page Down]** and **[Page Up]** keys or the mouse to cycle through all of the inputs, displaying the total flow and average flow rate for each. Additionally, the total elapsed time between the start/end dates and times entered in the previous menu is shown for each input. Selecting option `[1]` will print a tabular report of these results to the default AquaServ printer.

The average flow rate is displayed both in the "native" units of measure for the input as well as in gallons per minute, as a convenience to the user. Both of these numbers can also be calculated from the total flow. For instance, in the above example, the average flow rate in MGD is equal to the total flow (in millions of gallons) divided by the total time in days ([22 + 20/60]/24 = 0.9306 days.) The average flow rate in GPM is equal to the total flow (in gallons) divided by the total time in minutes (22*60 + 20 = 1340 minutes.)

5.5 – Backing Up Multiple Charts

To access the multiple chart backup feature, select

```
[4]    Multiple Chart Backup
```

from the `Data Analysis` menu. This brings up the following menu:

```
MULTIPLE CHART BACKUP
from beginning of:
[1]    MM / DD / YYYY

to end of:
[2]    MM / DD / YYYY

Press [Esc] key to cancel
[0] < BACK UP >
```

This feature allows you to back up multiple virtual chart files to the backup drive specified in the `Data Analysis` menu. The results are the same as if you had opened each chart individually in the Chart Viewer and selected the `Back Up Chart` option (see Section 5.2.3.)

The default is to back up all charts stored during the past year, but this can be changed by adjusting the start and end date using menu options `[1]` and `[2]`. These are both date gadgets, whose behavior is described in TABLE 3.

Anywhere in AquaServ

[1] through **[9]**	Menu options
[0]	Save changes (if any) from current menu and return to previous menu
[Esc]	Return to previous menu without saving changes
[Page Down]	Advance to the next page in a multi-page menu
[Page Up]	In a multi-page menu with more than two pages, this accesses the previous page
[F10]	Display the next 4-input chart page
[F9]	(AquaServ 4000 only) Display the previous 4-input chart page

String/Numeric Gadgets

[Esc]	Cancel input
[Enter]	Accept input
[Backspace]	Delete the character you just typed

Chart Viewer

To move the red bar...	Hold down...	Then press...
Forward 1 sample		Right Arrow key [→]
Backward 1 sample		Left Arrow key [←]
Forward 5 minutes	[Shift]	Right Arrow key [→]
Backward 5 minutes	[Shift]	Left Arrow key [←]
Forward 15 minutes	[Ctrl]	Right Arrow key [→]
Backward 15 minutes	[Ctrl]	Left Arrow key [←]
Forward 2 hours	[Alt]	Right Arrow key [→]
Backward 2 hours	[Alt]	Left Arrow key [←]