PA Rural Water Association Featured Water System, Fall 2005 – Implementing an Affordable, Small-Scale, Turn-Key SCADA System.

The Borough of Mont Alto, located in south-central Pennsylvania, recently installed a 436,000 gallon water storage tank to supplement the 600,000 gallon capacity of their existing reservoir. With the new tank came the need for additional instrumentation to monitor and control it. The existing control and alarm system at the water plant, that was to feed the new tank, did not have the capacity to add additional inputs. There were also future wells planned that would need monitoring and controlling. Rather than adding individual dial-up alarm and control systems at each site, the decision was made to move-up to a fully-featured SCADA system with radio links to each site ("SCADA" is an acronym for Supervisory Control And Data Acquisition).

The Borough's existing water system consisted of a spring and a well that feed a reservoir. The water in the reservoir flowed through a small water treatment plant by water use demand, where it was chlorinated, pH balanced, and checked for turbidity. The treated water then flows to distribution at the bottom of the hill. Prior to an upgrade in 1994, there was no formal water treatment plant other than a small building along the side of the road below the reservoir. At that time, the reservoir was uncovered and the well fed directly into the distribution system. The 1994 upgrade added a floating geotextile cover and liner to the reservoir and a pipeline from the well directly to the reservoir. This allowed all the water to be treated from a single point in the new treatment plant. The 2004 upgrade would add a secondary storage tank below the reservoir, with a secondary chlorine residual control system, and a SCADA system that would link all of the facilities together. The SCADA system was designed with expansion room to handle future links for data collection and control of up to 3 additional wells, the existing wastewater treatment plant, a stream flowmeter, and a rain gauge. To date, all but the additional wells have been added to the system.

To ensure that all the existing water treatment control instrumentation would work with the new equipment and SCADA system, Foxcroft Equipment & Service Co. Inc. was chosen as the System Integrator and supplier for all the instrumentation, radio, and SCADA system aspects of the contract job for the new water tank. Foxcroft worked closely with the Borough's engineers, Nasaux-Hemsley Inc., and the water system operator, Ed Nunemaker, before the contract documentation was finalized, to make sure that everything would work together, and that nothing important was left out of the job. It was also important to make sure that it all stay within the proposed budget for the work. This included equipment selection, design aspects of the chlorine control system at the new tank, SCADA system design, fabrication, programming, on-site supervision of the entire instrumentation and SCADA system installation, and final programming adjustments after the installation was complete.

The SCADA system, using a Sensaphone SCADA 3000 RTU and expansion modules, was designed to operate primarily as a central data monitoring and alarm system, with automated control of up to 4 wells. The SCADA system collects information via local hard-wired inputs and/or remote radio-linked locations, and monitors the externally controlled water treatment, and data logs the readings at regular intervals. It then alarms the water system operator if and when, the readings go out of normal operating range. The alarms are shown locally by a site location indicator lamp, and a more

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specific text alarm, which shows up on the real-time SCADA screen at the water plant computer. The alarms are then called-out by telephone, after individually preset time delays, to one or more destinations. The destinations can be voice calls, fax report, pager notification, e-mail message, or web page update. The web page feature allows the operator to see the selected inputs from virtually anywhere there is a computer, or web-enabled cell phone. The SCADA system generates the web-page and uploads it through a DSL (or dial-up) connection every 5 minutes. It has the added benefit of being secure from access through the internet by any potential hacker or virus, as it is a read-only web page on the Borough's internet provider's web space, not at the water plant.

In the nature of good system design, certain aspects of the SCADA system as a whole, were isolated in such a way as to allow continued normal operation of the water treatment control process, in the event of a failure of some type, in one or more parts of the SCADA system or radio links. The radio system includes remote manual control of the well(s), from the water plant, even if just the SCADA system were to fail. This includes the proper operation of the local automatic well shutdown instrumentation, such as: high turbidity, low level, no-flow, etc. The well control panel has the same type of local manual control even if the SCADA system and radio links were to somehow totally fail.

Automatic control of the existing well and future wells by the SCADA system has been programmed to function in such a way as to keep in compliance with DEP requirements. The SCADA system will automatically turn on the well(s) if: the stream flowrate going past the water plant is low, the reservoir level is low, the flowrate from the new tank is at a fire flow level, or daily water use from the spring that flows into the reservoir has been exceeded. The SCADA system will turn off the well(s) if: the stream flowrate is back to normal, the reservoir is full, fire flowrates have returned to normal, or the daily reset time (midnight) has been reached.

The ladder logic, "C," and real-time screen programs in the SCADA RTU (Remote Terminal Unit) are really the heart of the SCADA system, providing custom functions through software programming. Memory is shared between the ladder and C programs, which allows easy transfer of data between the programs. The ladder logic program converts and stores flow totalizer data from all the flowmeters, and controls the wells based on the plant total flows, reservoir level, and an internal 24 hour clock. It also does the same for the daily use of chlorine gas cylinder and carboy liquid weight from the digital scales. Among the many other functions that the ladder logic program provides, it collects readings from a rain gauge and a nearby battery powered, radio-linked, ultrasonic flowmeter, that reads the stream flow going past the water plant. In conjunction with the "C" program, it will even send a phone call to the plant operator if he forgets to switch the wireless flowmeter deep-cycle battery every Monday, with a freshly charged one.

The datalogger can track virtually any input, output, or other internal ladder logic or C variable, at whatever rate needed. It is currently setup to log every 5 minutes, which matched the web page updates, and yields plenty of detail about what's going on with flows, levels, total gallons used, and water treatment parameters such as: chlorine residual, pH, and turbidity. The data can be graphed and printed, or exported as a text file for analysis in other software. With datalog polling enabled, the datalogs in the RTU are automatically saved to the PC hard-drive, where they can be analyzed at the operator's convenience or permanently archived on CD Rom.

The real-time screen on the plant computer shows all the important data from the SCADA system, formatted in a user-friendly, multi-paged arrangement. The first page shows the current status of the entire water and sewer systems at a glance. It includes: flowrates, general site alarms, and radio signal status for all sites; reservoir, tank, and well levels; turbidity, chlorine residuals, and pH readings; well control setpoints and status; and well control switch positions. The second page shows color-coded alarm status from all sites with text specifying the exact alarm and it's location. The alarm page includes remote resets for the wells, which will reset any automatic well shutdown

alarms just as if you had pushed the reset button at the well or the plant SCADA panel. The remote resets can also be activated by a password-protected voice call to the RTU. The reset will disable automatic well shutdown for 1⁄2 hour to allow turbidity level readings to return to normal after well startup, thus enabling the operator to restart the well without having to go to the site, unless additional attention to the alarm is necessary. There are future plans to add an automatic turbidity blowoff valve system to the well. Additional pages show: flowmeter, rain gauge, and chemical scale weight totals; water flow and treatment parameter trending in a line graph format; alarm setpoints; diagnostics, and a user help page.

All sites have security, fire, low temperature, and power loss alarms, which are connected to the SCADA system. All of the radios and SCADA hardware are battery-backed to enable operation in the event of a power failure for several hours, and to protect the system from lightning and power surges.

The link to the wastewater treatment plant will enable various alarms from the site, and allow the operator to easily make an I&I study (inflow & infiltration) of the wastewater plant effluent flows versus the flows leaving the water tank.

The SCADA system has allowed the water plant operator to focus on other more important aspects of running and maintaining the water system, without worrying about the everyday time-consuming tasks of manually logging and calculating daily flows and chemical use weights, changing chart-recorder paper, and other functions, that the SCADA system has now automated. It also insures accuracy in the readings taken, as there is no human intervention that might lead to an error in copying or calculating numbers, or a missed reading due to operator attention to a more important task. It has also added the "peace-of-mind" for the operator of knowing that everything in the system is running properly when he doesn't get any phone calls, faxes, or web page alarms from the SCADA system.

The total cost for the initial SCADA system hardware, process control instrumentation, and system integration was $92,934, which was under 10% of the total contract cost of $933,642. Additions to the SCADA system and instrumentation since the project ended, have only added another $39,810. Typically the acronym "SCADA" is associated with the word "Expensive." This project showed that this does not necessarily have to be the case. Careful product selection, system design, and a system integrator dedicated to the project, and involved with the project engineers from the initial design stage, can help to lower costs, and ensure that the water and sewer authority get exactly what they need. The Borough of Mont Alto now has a "state-of-the-art" SCADA system that was affordable, and includes features that many other water and wastewater plant operators would like to have.

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