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# Technical Memorandum

**To:** Robert Therres, George Linngren and Paul Grosse, City of Blaine
**From:** Sheldon Sorensen and Michelle Stockness, Barr Engineering Co.
**Subject:** City of Blaine SCADA Assistance –Final Project Recommendations
**Date:** April 13, 2017
**Project:** 23021056.00
**c:** Brian LeMon, Barr Engineering Co.

## 1.0 Executive Summary

The City of Blaine (City) has requested Barr's review of the overall supervisory control and data acquisition (SCADA) system for the water and sewer utilities for reliability and redundancy. The SCADA system provides control and monitoring the City's water system and sanitary sewer lift station sites. In the water system, each site contains a local control panel, local operational controls, and a method to communicate back to the master control panel(s) which operates the system as a whole. In the sewer system, each site contains a local control panel, local operational controls, and a method to communicate back to SCADA, which monitors the system. Utility operators use SCADA to gather data on how the system is functioning on a near real time basis.

SCADA systems need frequent maintenance and upgrades. It is a routine procedure for cities to upgrade their SCADA communication systems, equipment hardware, and software. Communication methods are constantly being upgraded for faster and newer systems, electrical equipment components usually only have a 10-20 year useful life, and software systems need frequent maintenance to stay current with new technology or security or new site installations. Most cities have major SCADA system upgrades every 10 years or so, and have smaller SCADA system updates every few years.

Barr reviewed the available existing record drawings of each site and the SCADA system programming with In Control, and came up with the following general recommendations for the SCADA communication system, hardware, and software. The recommendations are categorized into either high-priority improvements (tasks that should be implemented as soon as possible to increase system reliability), or long-term improvements (improvements that are generally recommended as part of an up to date SCADA system but can be implemented on a regular project schedule).

- **High-priority improvements:** The following measures are recommended to be implemented as soon as possible to provide immediate redundancy and reliability of the City's water and sanitary system controls:
    - Expanded after-hours monitoring of the system by operations staff until interim improvements are made to increase the reliability and redundancy of the system.

  - Install water tower backup alarm systems at each tower as an independent alarm to operations that water tower levels are low in the event of an emergency.
  - Instead of having a single master control panel, distribute the automation to each of the three WTPs so that each plant can back up the system and run independently of a master control system in the event of an emergency.

- **Long-term improvements:** The following measures are recommended as part of an overall SCADA system upgrade, and can be implemented on a regular project schedule given the completion of the high-priority improvements.
  - The City should utilize a single reliable primary communication network to all areas of the City.
  - The City should conduct field investigations of critical panels or equipment that are missing documentation, and maintain up to date record drawings as equipment is upgraded.
  - Panels should be replaced or upgraded once they are obsolete or have reached their useful life. As panels are upgraded and/or replaced, a standard design methodology should be employed.
  - The existing software should be cleaned up, alarm functions should be verified and tested, and new equipment installations or control revisions should be revised per City SCADA standards by a software integrator.

# 2.0 Background Information and Project Overview

The City experienced two failures of its supervisory control and data acquisition (SCADA) system that led to low water system pressure events in early 2017. The SCADA system provides control and monitoring of multiple water system sites and sanitary sewer lift station sites. In the water system, each site contains a local control panel, local operational controls, and a method to communicate back to the master control panel(s) which operates the system as a whole. In the sewer system, each site contains a local control panel, local operational controls, and a method to communicate back to SCADA, which monitors the system. An overview map of the existing systems showing the various sites is included in the appendices (Section 7.0).

The City has requested Barr's review of the overall SCADA system for the water and sewer utilities for reliability and redundancy, especially with regard to failure modes and alarm reporting. Barr's scope of services currently includes overall review of hardware, system configuration, communication methods, reliability, and redundancy. Complete SCADA system reviews and system upgrades are common for all water and wastewater utilities.

The City's SCADA system has had several integrators. It was originally constructed in the 1990s by Total Control Systems, Inc., and later supported by Superior Control Systems. In 2015, the City developed

contract documents for upgrades to the SCADA master panel at Water Tower 1, SCADA computers and software. The City awarded the work to In Control, Inc. The current In Control contact is underway, but not complete.

Since the existing system includes programmable logic controller (PLC) software programs that were original to the system, and were later modified by multiple vendors over the years, Barr recommended a parallel review of the PLC code to accompany this study. Since In Control is currently under contract, and the City has decided to continue forward with the In Control contract, the City has retained In Control for the PLC code review to increase efficiency. The intent of the PLC code review is to determine if there are portions of the code that are not inherently reliable, and to make recommendations for PLC code revisions. Barr and In Control have conducted meetings to coordinate Barr's review with In Control's software review.

The SCADA system review also includes assessment of the system's capability for handling alternative communication mediums (radio, cellular, fiber optic, etc.), and expandability for handling future additional sites, including the northeast well field and water treatment facility.

Objectives of the preliminary system review are:

- Develop a comprehensive understanding of the City's existing water and sewer system components including SCADA equipment, software, hardware, and communications, and how they function together during daily operation.
- Provide recommendations on improvements to system controls and operations based on operations staff preferences, industry standards, and risk assessments.
- Provide recommendation on both high-priority and long-term improvements.
- Provide comprehensive documentation of the system so all stakeholders can be aware of operational parameters.
- Reduce risk of system failures and add redundancies.

Barr has conducted the preliminary review outlined above, and has developed preliminary recommendations in conjunction with the software review provided by In Control. The remainder of the report is outlined as follows:

- Section 2.0 Review of Existing SCADA system
    - Communication
    - Hardware
    - Software
    - Alarms

    - Process equipment
- Section 3.0 High-priority interim improvements
- Section 4.0 Long-term improvements
- Section 5.0 Suggested schedule
- Section 6.0 Certification
- Section 7.0 Appendices

# 3.0 Review of the Existing SCADA System

To review and document the existing system, Barr has reviewed available controls and SCADA documentation and record drawings on many of the water system sites and sanitary lift stations. The existing system consists of 48 separate sites. We have reviewed write-ups prepared by In Control on the system hardware and software programming. Barr has met with City staff and had separate coordination meetings with In Control.

The following observations are based on the above document review and meetings, and are based on Barr's typical design practices used on other projects of similar size and scope.

## 3.1 Communication Networks

The existing Blaine SCADA system communicates over three different networks:

- 450 MHz licensed radio network, owned by the City.
- Motorola "Canopy" Ethernet radio network, owned by the City.
- Fiber optic lines extended to two of the Water Treatment Plants, owned by Anoka County and leased by the City.

Each of the three networks have limitations that preclude the use of any one network to reliably serve all of Blaine's SCADA sites. The City needs to utilize a reliable primary communication network to all areas of the City.

Observations and recommendations on each network are as follows:

### 3.1.1 450 MHz Licensed Radio Network

This system uses a licensed radio frequency to transmit and receive data between each site in the network. The 450 MHz system is reliable, but is based on "Modbus RTU" protocol at a very low communication speed of 300 baud. This is a holdover from the original 1990s SCADA network, which is an out of date technology. The low baud rate makes it impractical to use this network for remote monitoring or control due to long delays in data updates.

The 450 MHz system has a single master antenna located at Tower 1 in the southwest portion of Blaine. The signal is not strong enough at some sites in northern and eastern portions of the City to receive and transmit data.

A review of the City's existing FCC license indicates that the system is not currently operated in strict compliance with the FCC license. The existing license limits antennas to 20-foot height (some sites exceed this height), and remote radios are limited to 2 watts output power (some radios are currently operating at 5 watts). The City will need to obtain license modifications and/or make revisions to the existing installations to comply with the FCC license.

### 3.1.2 Motorola "Canopy" Ethernet Radio Network

The Motorola canopy network uses Ethernet protocol to communicate data across the network. The City has experienced reliability problems with the Canopy network. The reliability is not sufficient for operating and monitoring the City's water and wastewater infrastructure as a primary communication channel.

The Canopy network serves other City functions, including networks for monitoring of video cameras at some remote sites and water meter data. For water system reliability and security, it is recommended that the water and wastewater SCADA networks operate separately from all other City networks.

### 3.1.3 Fiber Optic Network

Fiber optic communication can provide excellent speed and reliability. However, installation of the system is expensive. Only two sites are currently served, and the installation of a new complete fiber network by the City without other partners or projects already in progress would probably be cost and schedule prohibitive.

## 3.2 Hardware Documentation

Documentation on existing control systems will generally include schematic drawings showing all of the components and wiring at each site. The record drawings are necessary for service technicians to maintain and troubleshoot the control panels.

The City has gathered panel documentation from various project files going back to the date of the oldest panels (circa 1994). The table in the appendices shows the current status of panel documentation. Barr and the City will continue to review the City's files for additional drawings. The following hardware summaries are based on available data.

The City should conduct field investigations of critical panels or equipment that are missing documentation, and maintain up to date record drawings as equipment is upgraded.

### 3.2.1 Control Panel Hardware Components

Water system panels (water treatment plants, wells, water towers) and wastewater lift station control panels vary in age and condition and design standard. The control panel equipment specified and installed are of good quality. However, the issue is with the age and the technology of the installed equipment. The older panels get, the more their technology is out of date and they are hard to service. The oldest panels date back to 1994. New panels have been included on many infrastructure projects over the 23 years that followed, and the City is continuing to expand the system as the City's infrastructure grows. Currently, the water system is being expanded to incorporate new wells in northeast Blaine, and a new Water Treatment Plant 4 is planned.

The panels include a variety of programmable logic controllers (PLCs). The PLCs provide the system automation, and serve as the device for SCADA communication. Several sites have older PLCs that do not support newer communication protocols (Ethernet), and are obsolete.

Many of the panels include an uninterruptible power supply (UPS) system having battery backup for short-term communication during power loss. The UPS units provide the advantage of operation during power loss, but they can also fail, leaving a station inoperative. Current design practice is to monitor the UPS units for alarm conditions, and to automatically bypass the UPS in the event of UPS failure. These features do not exist within some of the panels in Blaine.

For lift station control panels, it is common practice to include a separate redundant system to control the pumps using float switches, in the event of failure of the primary level control system. The Blaine lift station control panels have a variety of schemes for level control and backup level control.

Panels should be replaced or upgraded once they are obsolete or have reached their useful life. As panels are upgraded and/or replaced, a standard design methodology should be employed.

## 3.3 PLC Software Programming

In Control, Inc. has provided a preliminary review of the existing PLC programs for each site. The following is a summary overview of PLC programming issues from In Control's reports, and our general recommendations:

- Automation for control of the City wells and water supply system resides in a single PLC at Water Tower 1. If this PLC is not functioning (as occurred during the second low-pressure event), the wells will not be called to operate and will remain offline. This is a single point of failure without redundancy.
    - This situation should be corrected by distributing control of wells to multiple sites (see the recommended improvements).

- The existing system does not provide a uniform method for monitoring "communication failure" to each site. If communications are down, at a minimum a fail-safe alarm should notify operations.
    - All programs should be reviewed, corrected, and tested to confirm that communication failure is alarmed for each site.
- In Control found areas where there is unused PLC code, and points that are wired to the PLC but not used in the PLC program to initiate alarms.
    - The existing software should be reviewed and cleaned up to function properly.

## 3.4 Alarm Reporting

SCADA system alarms are handled by "WIN911" computer software installed at Water Treatment Plant 1. This is a system commonly used by municipalities that receives local alarms and remotely alerts the appropriate staff or emergency personnel. The upgraded WIN911 software was installed by In Control, Inc. as part of the 2015 SCADA upgrade specification. In Control and the City expanded the project scope to include a second computer running WIN911 software for redundancy.

In addition to the WIN911 software, a hardware auto-dialer is provided within the new Tower 1 SCADA panel. When this panel is installed (following completion of Tower 1 rehabilitation), the backup dialer will provide an independent callout to City staff if an alarm condition remains unacknowledged for a predetermined period of time, which is a third level of emergency alarm reporting. This is a common method of backing up the computer-based alarm software.

To ensure that the alarm systems are monitoring all possible failure conditions, the following features are recommended to be included in new installations:

- The PLC at Tower 1 must have a "self-check" program that confirms the PLC has not failed or halted. The self-check circuit must be failsafe, and wired to an input on the hardware auto-dialer.
- The PLC at Tower 1 should include a "token" program that communicates with the plant computers, and issues an alarm via the hardware auto-dialer if the plant computer fails or halts.

## 3.5 Process Equipment Issues

Although not directly related to the SCADA system performance, it appears there is a high incidence for pump "failure" alarms at some sites. These failures could be related to utility power, the application of pumping equipment and electrical equipment, or problems with field components. Further review of the pump failures is recommended. The review may include power system measurements and field testing.

There is also not an existing functional description of how the utility systems should operate under normal day and emergency conditions. This document is useful as a reference for operations staff and for emergency situations, and can help troubleshoot lack of redundancy or backups.

# 4.0 High-Priority Interim Improvements

In an effort to immediately add reliability to the system and prevent reoccurring failures, Barr provided early recommendations for two high-priority interim improvements noted below. In addition, In Control's software review has exposed a potential single point of failure that is the reason for Barr's third recommended interim improvement. Each of the three interim improvements are outlined below:

## 4.1 Interim Improvement No. 1 – Expanded After-Hours Monitoring

After the low water pressure events, the City instituted expanded hours for water system operators to check on the water system more often during nights and weekends. Barr agrees with this interim step.

The expanded hours should continue until Interim Improvements No. 2 and No. 3 have been placed in service. Once the Interim Improvements are complete, the City may consider reducing the night and weekend hours.

## 4.2 Interim Improvement No. 2 – Water Tower Backup Alarm Systems

The City solicited proposals for backup alarm systems to be installed at each of the four water towers, with input from Barr. Each backup alarm system consists of a pressure switch and automatic telephone dialer at each tower location. The systems will simply call a list of City personnel if a low pressure condition is detected, independent of the existing SCADA system. The pressure settings will be selected to provide the City with enough time to respond, assess the alarm, and take corrective action.

Cellular phone dialers were selected due to reliability issues with other copper phone services in Blaine. Unfortunately, the supplier of the cellular dialers recently backordered the units, so the City is in the process of installing two traditional dialers using copper phone services. The dialers will be replaced with the cellular units when available from the manufacturer.

## 4.3 Interim Improvement No. 3 – Revise to Distributed Control of Wells at WTP1, WTP2, and WTP3

In Control's PLC software review found that a single programmable logic controller (PLC) at Water Tower 1 contains the setpoint logic for start/stop control of the City well pumps. All of the City water tower levels are forwarded to this master PLC, and the PLC issues "required" signals to all of the wells as needed to maintain tower levels.

This system architecture is not inherently reliable, since failure of this PLC will disable automatic control of all of the City wells (this occurred during the second low pressure event).

We recommend an interim project to provide greater reliability by distributing the well pump control, as follows:

- Install pressure transmitters at the discharge piping of Water Treatment Plants (WTP1, WTP2, and WTP3). From record drawings, it appears that two of the plants may have pressure transmitters already.
- Reprogram the PLCs at WTP1, WTP2, and WTP3 to revert to local pressure control in the event of SCADA communication loss or abnormally low local system pressure. The wells that are local to each plant would be controlled to maintain local system pressure:
    - WTP1: Local control of Well 3 and Well 4
    - WTP2: Local control of Well 12 and Well 13
    - WTP3: Local control of Well 6 and Well 11

The local pressure control mode will increase reliability of the water supply by providing multiple sources of well control automation. Even in the event of total system communication failure, each of the three plants could continue to automatically deliver water to the distribution system.

The local pressure control is less accurate than sensing pressure at a tower standpipe, since operation of the plant high-service pumps will cause pressure fluctuation at the plant discharge. However, this control mode can be programmed to partially compensate for pressure variations from operation of the high-service pumps, and is still a good backup control scheme

# 5.0 Recommended Long-Term Improvements

The overall reliability of Blaine's SCADA system is hindered by several interrelated factors:

- Network communication, and the use of multiple communication platforms, is complicated and unreliable. The Motorola Canopy system is used for several critical sites, and has frequent communication issues. The 450 MHz licensed system does not cover all of the service area.
- The SCADA network is shared with other City network functions.
- Documentation is not available for several of the existing panels. This will lead to extended outages if a service technician does not have drawings to work from.
- Several panels are in need of updates, including new PLCs and the addition of critical alarms.
- PLC software is in need of cleanup and standardization.

We recommend a multi-step process to provide needed improvements in reliability, while equipping the City for continued infrastructure monitoring and growth. The recommended engineering services are not within Barr's current scope, but can be included in a future proposal from Barr.

## 5.1 Implement High-Priority Interim Improvements

As described previously.

## 5.2 Perform Field Radio Study and Design New Communication Network(s)

Utilize the services of a qualified radio and network design organization to review radio communication paths, perform field study and signal strength measurements, and assist in the design of a new radio network that will cover all water and wastewater sites. Barr has worked with such organizations on past similar projects, and can assist in obtaining a proposal for these services.

Further inquiry should also be made with Anoka County to determine if additional fiber optic lines are available. The City may also want to explore options for City-owned fiber optic in areas where the fiber optic lines would be cost-effective or could serve multiple City functions.

Once the radio organization has provided their initial results and recommendations, the proposed single dedicated network design should be reviewed in conjunction with the City IT staff, operations staff, Barr, and the control system software integrator.

## 5.3 Audit all 48 Sites to Determine Specific Hardware Upgrades at Each Site

An electrical engineer should conduct field audits of the 48 existing sites, in conjunction with City staff. Existing hardware, control components, and general condition of equipment will be evaluated at each site against industry and city standards. These field visits will generate a prioritized list of recommended improvements for each site, as well as documentation of existing conditions.

## 5.4 Project Design – Hardware and Contractor Installation Work

Once Steps 2 and 3 are complete, an overall SCADA upgrade project and final design can commence. The design should be led by an electrical engineer and will include panel work, components, wiring, installation, and field wiring for each of the SCADA sites with the goal of providing reliable communications, operations, up to date equipment, and standardized designs across the system. The SCADA improvements project can be implemented using a traditional design/bid/build contracting method.

As an option, the City could elect to implement only portions of the project over a multi-year time period. However, stretching the project over multiple years may lead to complexity and reduced overall reliability until the project is completed.

### 5.5 Software Integration Services

As previously discussed, the following software improvements are recommended:

- Provide a uniform method for monitoring "communication failure" at each site.
- Where an automatic telephone dialer exists, the local PLC should have a "self-check" program that confirms the PLC has not failed or halted. The self-check circuit should be fail-safe.
- The existing software needs to be cleaned up, and any new equipment installations or control revisions need to be revised in the SCADA software by an integrator.

Two methods of contracting for software integration services are commonly employed:

- The software services can be described in detail, and included as part of the overall system integration supplied under Step 4; o*r*
- The software services can be provided under a separate professional services contract. In this case, the City can select the software integrator based on qualifications.

Barr has served as project engineer on several SCADA projects using both of the above methods. The options and associated pros/cons can be reviewed with the City during the design phase.

## 6.0 Suggested Schedule

A preliminary project timeline of all recommended improvements is included in the appendices for reference.

## 7.0 Certification

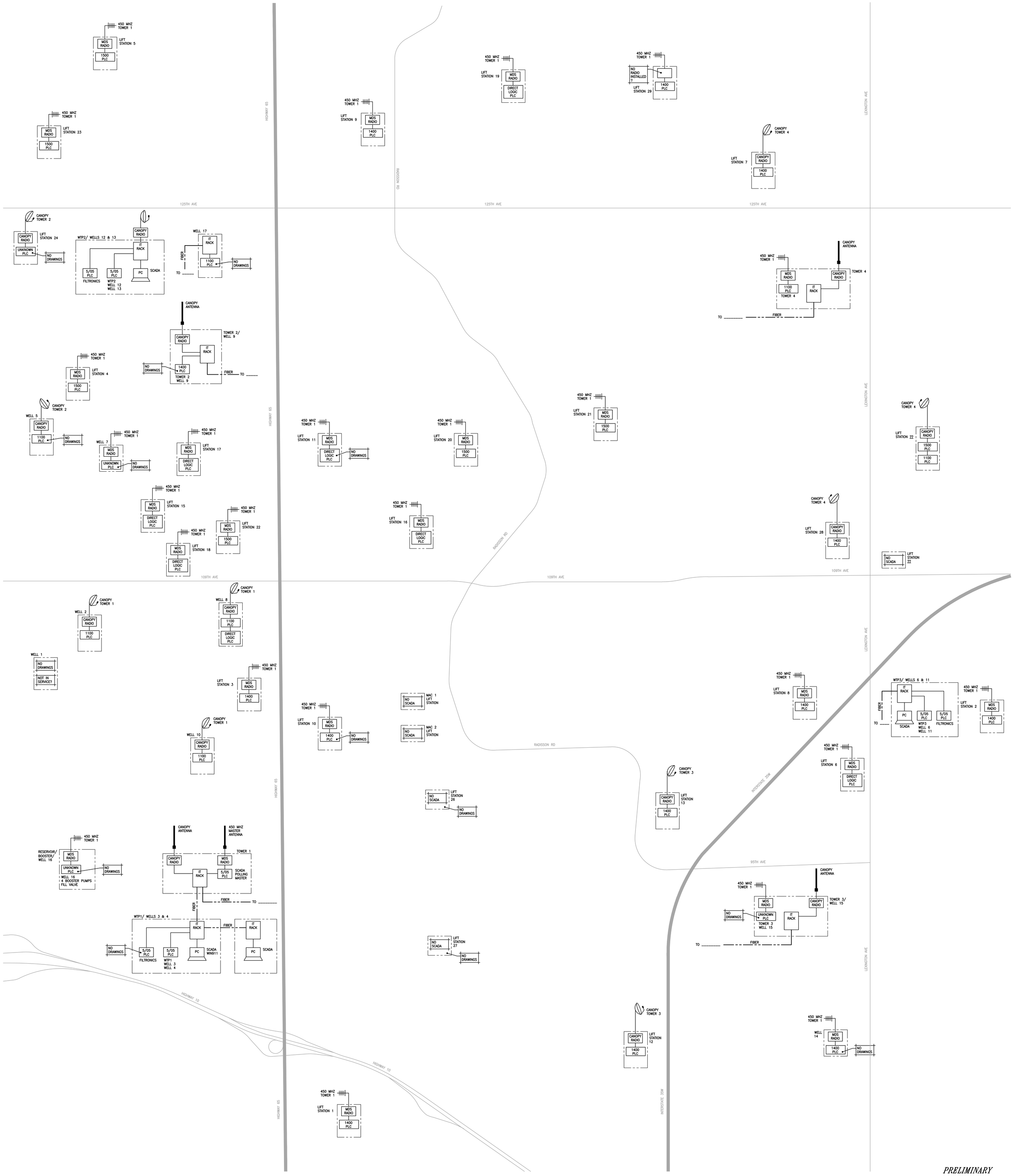
I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Sheldon J. Sorensen
PE #: 18925

April 13, 2017
Date

## 8.0 Appendices

### 8.1 System Overview Drawing




## CONTROL SYSTEM DIAGRAM

NO SCALE

*PRELIMINARY DRAFT*

| NO. | BY | CHK. | APP. | DATE | REVISION DESCRIPTION |
|---|---|---|---|---|---|

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME SHELDON J. SORENSEN

SIGNATURE

DATE 03/01/2017 LICENSE # 18925

| CLIENT | A | B | C | 0 | 1 | 2 | 3 |
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| BID | | | | | | | |
| CONSTRUCTION | | | | | | | |
| RELEASED TO/FOR | DATE RELEASED | | | | | | |


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| | |
|---|---|
| Scale | AS SHOWN |
| Date | 03/01/2017 |
| Drawn | CML2 |
| Checked | SJS |
| Designed | SJS |
| Approved | SJS |

CITY OF BLAINE
BLAINE, MINNESOTA

# SCADA SYSTEM ASSISTANCE
BLAINE, MINNESOTA

SYSTEM OVERVIEW DRAWING

BARR PROJECT No. 23/02-1056
CLIENT PROJECT No.
DWG. No. E1
REV. No. 0


CADD USER: Chad LaKose FILE: M:\ADEPTWORK\CH4D LAKOSE\23021056.00_E1.DWG PLOT SCALE: 1:1 PLOT DATE: 3/3/2017 8:49 AM
BAR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot at 1 10/05/2010 14:03:50

## 8.2 Status of Control Panel (Hardware) Documentation

| Site | Record Drawings on File? | | | Drawing Comments / Concerns |
|---|---|---|---|---|
| | No | Yes | Dated | |
| **Well 1** | | X | 1994 | Old drawings not up-to-date |
| **Well 2** | | X | 1994 | Old drawings not up-to-date |
| **Well 3** | | X | 2006 | (See WTP1 drawings) |
| **Well 4** | | X | 2006 | (See WTP1 drawings) |
| **Well 5** | X | | | |
| **Well 6** | | X | 2007 | (See WTP3 drawings) |
| **Well 7** | X | | | |
| **Well 8** | | X | 1995 | Old drawings not up-to-date |
| **Well 9** | X | | | |
| **Well 10** | X | | | |
| **Well 11** | | X | 2007 | (See WTP3 drawings) |
| **Well 12** | | X | 2006 | (See WTP2 drawings) |
| **Well 13** | | X | 2006 | (See WTP2 drawings) |
| **Well 14** | X | | | |
| **Well 15** | X | | | |
| **Well 16** | | X | 1987 | Old drawings not up-to-date |
| **Well 17** | X | | | |
| **Well 18** | | | 2016 | Project under construction -- Shop Drawings will need to be revised to "As-Built" |
| **Well 19** | | | 2016 | Project under construction -- Shop Drawings will need to be revised to "As-Built" |
| **Well 20** | | | 2016 | Project under construction -- Shop Drawings will need to be revised to "As-Built" |
| **Well 21** | | | 2016 | Project under construction -- Shop Drawings will need to be revised to "As-Built" |
| **WTP1 (Filtronics System)** | X | | 2006 | Missing first 6 pages from drawing set. Drawings to not appear to include all past updates. |
| **WTP1 (Rest-of-Plant)** | | X | 2006 | Drawings do not appear to include all past updates |
| **WTP2 (Filtronics System)** | | X | 2005 | Missing first 5 pages from drawing set. Drawings to not appear to include all past updates. |
| **WTP2 (Rest-of-Plant)** | | X | 2006 | Drawings do not appear to include all past updates |
| **WTP3 (Filtronics System)** | | X | | |

| Site | Record Drawings on File? | | | Drawing Comments / Concerns |
|---|---|---|---|---|
| | No | Yes | Dated | |
| **WTP3 (Rest-of-Plant)** | | X | 2007 | Drawings do not appear to include all past updates |
| **Booster Station** | | X | 1987 | Old drawings not up-to-date |
| **Tower 1** | | X | 2016 | In Control drawings for new replacement panel |
| **Tower 2** | X | | | |
| **Tower 3** | X | | | |
| **Tower 4** | | X | 2009 | |
| **Lift Station 1** | | X | 2011 | Drawings do not appear to include all past updates |
| **Lift Station 2** | | X | 2012 | Drawings do not appear to include all past updates |
| **Lift Station 3** | | X | 2013 | |
| **Lift Station 4** | | X | 2004 | Drawings do not appear to include all past updates |
| **Lift Station 5** | | X | 2003 | Drawings do not appear to include all past updates |
| **Lift Station 6** | | X | 1999 | Drawings do not appear to include all past updates |
| **Lift Station 7** | | X | 2006 | Drawings do not appear to include all past updates |
| **Lift Station 8** | | X | 2015 | Drawings noted "Submitted for Approval", should be field-verified. |
| **Lift Station 9** | | X | 2015 | Drawings do not appear to include all past updates |
| **Lift Station 10** | X | | | |
| **Lift Station 11** | X | | | |
| **Lift Station 12** | | X | 2015 | Drawings noted "Submitted for Approval", should be field-verified. |
| **Lift Station 13** | | X | 2015 | Drawings noted "Submitted for Approval", should be field-verified. |
| **(Lift Station 14)** | (Removed from Service) | | | |
| **Lift Station 15** | | X | 1996 | Drawings do not appear to include all past updates |
| **Lift Station 16** | | X | 2000 | Drawings do not appear to include all past updates |
| **Lift Station 17** | | X | 2000 | Two different sets of drawings, with hand-drawn revisions. Needs field verification. |
| **Lift Station 18** | | X | 2000 | Drawings do not appear to include all past updates |
| **Lift Station 19** | | X | 2000 | Drawings do not appear to include all past updates |
| **Lift Station 20** | | X | 2001 | Drawings do not appear to include all past updates |
| **Lift Station 21** | | X | 2003 | Drawings do not appear to include all past updates |
| **Lift Station 22** | | X | 2006 | Drawings do not appear to include all past updates |
| **Lift Station 23** | | X | 2006 | Drawings do not appear to include all past updates |
| **Lift Station 24** | X | | | |
| **Lift Station 25** | | X | 2006 | Drawings do not appear to include all past updates |

| Site | Record Drawings on File? | | | Drawing Comments / Concerns |
|---|---|---|---|---|
| | No | Yes | Dated | |
| **Lift Station 26** | **X** | | | |
| **Lift Station 27** | **X** | | | |
| **Lift Station 28** | | **X** | 2015 | |
| **Lift Station 29** | | **X** | 2016 | |
| **Lift Station 'MAC 1'** | | **X** | 1999 | |
| **Lift Station 'MAC 2'** | | **X** | 2000 | |

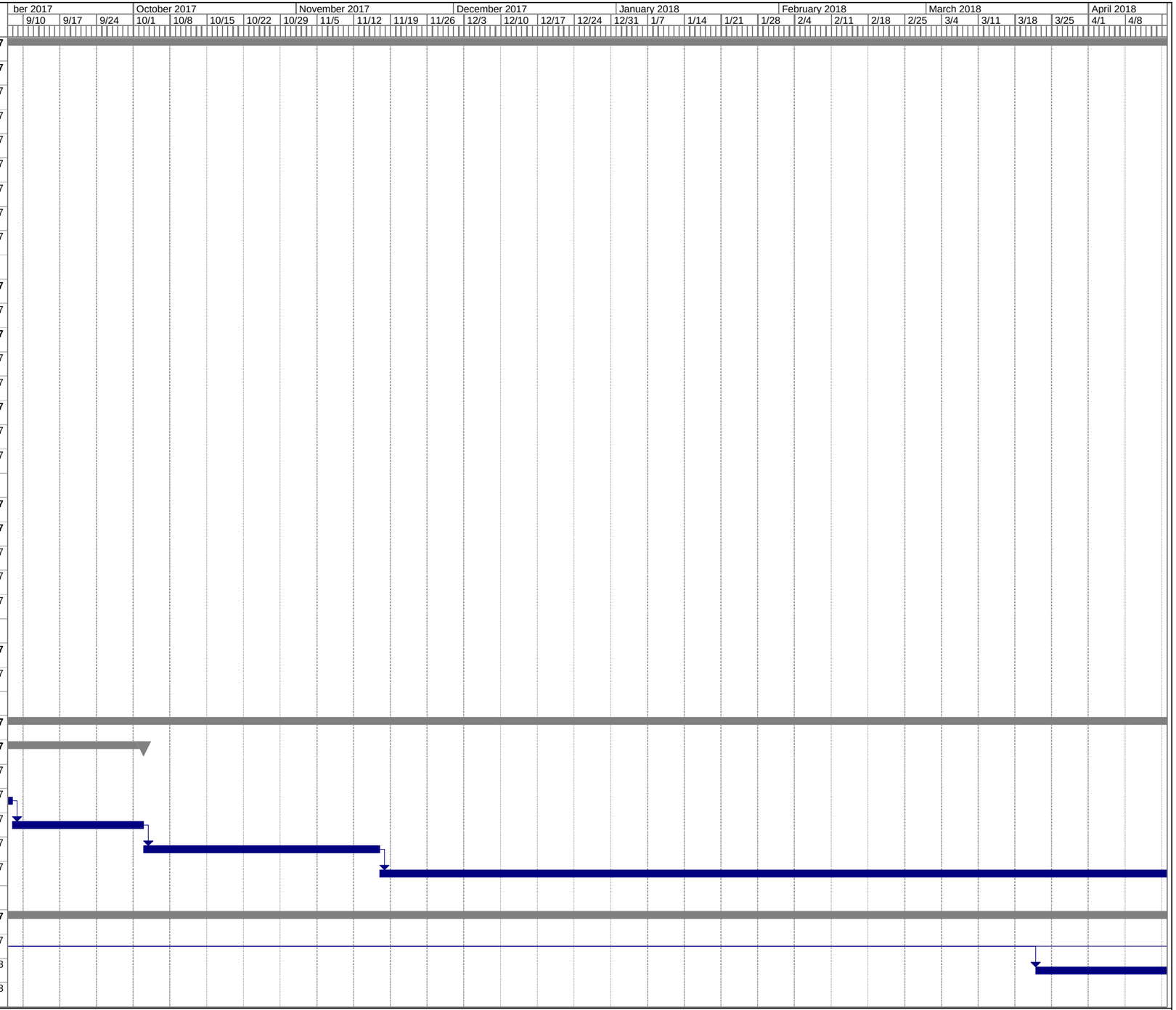
## 8.3 Preliminary Project Timeline

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | **BLAINE, MN SCADA IMPROVEMENTS** | **641 days** | **2/14/2017** | **11/16/2018** |
| 2 | **Analysis and Scoping** | **81 days** | **2/14/2017** | **5/5/2017** |
| 3 | High-Priority Assessment - Early Recommendations | 18 days | 2/14/2017 | 3/3/2017 |
| 4 | Preliminary Hardware Review | 25 days | 2/14/2017 | 3/10/2017 |
| 5 | Preliminary Software Review (In Control, Inc.) | 39 days | 2/14/2017 | 3/24/2017 |
| 6 | Coordination with In Control | 39 days | 2/14/2017 | 3/24/2017 |
| 7 | Develop Draft Recommendations | 14 days | 3/25/2017 | 4/7/2017 |
| 8 | Workshop session with City | 14 days | 4/8/2017 | 4/21/2017 |
| 9 | Develop Final Recommendations | 14 days | 4/22/2017 | 5/5/2017 |
| 10 | | | | |
| 11 | **Step 1 - Implement High-Priority Interim Improvements** | **103 days** | **2/14/2017** | **5/27/2017** |
| 12 | Increase Operator Monitoring - After-Hours and Weekends | 103 days | 2/14/2017 | 5/27/2017 |
| 13 | Water Tower Backup Low Level Alarms | **53 days** | **2/14/2017** | **4/7/2017** |
| 14 | Recommendations | 4 days | 2/14/2017 | 2/17/2017 |
| 15 | Procurement, Implementation | 49 days | 2/18/2017 | 4/7/2017 |
| 16 | Interim Control Revisions at WTP1, WTP2 and WTP3 | **64 days** | **3/25/2017** | **5/27/2017** |
| 17 | Recommendations | 14 days | 3/25/2017 | 4/7/2017 |
| 18 | Procurement, Implementation | 50 days | 4/8/2017 | 5/27/2017 |
| 19 | | | | |
| 20 | **Step 2 - Field Radio Study and Design New Communication Network(s)** | **91 days** | **4/8/2017** | **7/7/2017** |
| 21 | Radio Path Study / Radio System Recommendations | **70 days** | **4/8/2017** | **6/16/2017** |
| 22 | Scope / Cost Proposal from Radio Testing Organization | 10 days | 4/8/2017 | 4/17/2017 |
| 23 | Conduct Study, Design Meetings | 60 days | 4/18/2017 | 6/16/2017 |
| 24 | Network Design - Barr, City IT, Radio Testing Org., Software Integrator | 21 days | 6/17/2017 | 7/7/2017 |
| 25 | | | | |
| 26 | **Step 3 - Audit 48 sites** | **50 days** | **5/6/2017** | **6/24/2017** |
| 27 | Develop Scope of Work - Approximately 50 Sites | 50 days | 5/6/2017 | 6/24/2017 |
| 28 | | | | |
| 29 | **Step 4 - Project Design - Hardware and Contactor Installation Work** | **510 days** | **6/25/2017** | **11/16/2018** |
| 30 | Develop Construction Plans and Specifications | **100 days** | **6/25/2017** | **10/2/2017** |
| 31 | 60% Design, Review with City | 45 days | 6/25/2017 | 8/8/2017 |
| 32 | 90% Design, Review with City | 30 days | 8/9/2017 | 9/7/2017 |
| 33 | Final Design for Bidding | 25 days | 9/8/2017 | 10/2/2017 |
| 34 | Bidding, Award, Contracts | 45 days | 10/3/2017 | 11/16/2017 |
| 35 | Construction | 365 days | 11/17/2017 | 11/16/2018 |
| 36 | | | | |
| 37 | **Step 5 - Software Integration Services** | **497 days** | **7/8/2017** | **11/16/2018** |
| 38 | Develop System-Wide Programming Standards for Water / Wastewater | 30 days | 7/8/2017 | 8/6/2017 |
| 39 | PLC and OIT Programming - Approximately 50 Sites | 240 days | 3/22/2018 | 11/16/2018 |
| 40 | SCADA Computers Programming | 180 days | 5/21/2018 | 11/16/2018 |


Project: Blaine SCADA Improvements
Date: 4/6/2017

Task
Progress
Baseline
Milestone
Baseline Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Baseline Summary
Rolled Up Baseline
Rolled Up Baseline Milestone
Rolled Up Progress
Split
Baseline Split
External Tasks
Project Summary
Group By Summary
Deadline

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 1 | **BLAINE, MN SCADA IMPROVEMENTS** | **641 days** | **2/14/2017** |
| 2 | **Analysis and Scoping** | **81 days** | **2/14/2017** |
| 3 | High-Priority Assessment - Early Recommendations | 18 days | 2/14/2017 |
| 4 | Preliminary Hardware Review | 25 days | 2/14/2017 |
| 5 | Preliminary Software Review (In Control, Inc.) | 39 days | 2/14/2017 |
| 6 | Coordination with In Control | 39 days | 2/14/2017 |
| 7 | Develop Draft Recommendations | 14 days | 3/25/2017 |
| 8 | Workshop session with City | 14 days | 4/8/2017 |
| 9 | Develop Final Recommendations | 14 days | 4/22/2017 |
| 10 | | | |
| 11 | **Step 1 - Implement High-Priority Interim Improvements** | **103 days** | **2/14/2017** |
| 12 | Increase Operator Monitoring - After-Hours and Weekends | 103 days | 2/14/2017 |
| 13 | Water Tower Backup Low Level Alarms | **53 days** | **2/14/2017** |
| 14 | Recommendations | 4 days | 2/14/2017 |
| 15 | Procurement, Implementation | 49 days | 2/18/2017 |
| 16 | Interim Control Revisions at WTP1, WTP2 and WTP3 | **64 days** | **3/25/2017** |
| 17 | Recommendations | 14 days | 3/25/2017 |
| 18 | Procurement, Implementation | 50 days | 4/8/2017 |
| 19 | | | |
| 20 | **Step 2 - Field Radio Study and Design New Communication Network(s)** | **91 days** | **4/8/2017** |
| 21 | Radio Path Study / Radio System Recommendations | **70 days** | **4/8/2017** |
| 22 | Scope / Cost Proposal from Radio Testing Organization | 10 days | 4/8/2017 |
| 23 | Conduct Study, Design Meetings | 60 days | 4/18/2017 |
| 24 | Network Design - Barr, City IT, Radio Testing Org., Software Integrator | 21 days | 6/17/2017 |
| 25 | | | |
| 26 | **Step 3 - Audit 48 sites** | **50 days** | **5/6/2017** |
| 27 | Develop Scope of Work - Approximately 50 Sites | 50 days | 5/6/2017 |
| 28 | | | |
| 29 | **Step 4 - Project Design - Hardware and Contactor Installation Work** | **510 days** | **6/25/2017** |
| 30 | Develop Construction Plans and Specifications | **100 days** | **6/25/2017** |
| 31 | 60% Design, Review with City | 45 days | 6/25/2017 |
| 32 | 90% Design, Review with City | 30 days | 8/9/2017 |
| 33 | Final Design for Bidding | 25 days | 9/8/2017 |
| 34 | Bidding, Award, Contracts | 45 days | 10/3/2017 |
| 35 | Construction | 365 days | 11/17/2017 |
| 36 | | | |
| 37 | **Step 5 - Software Integration Services** | **497 days** | **7/8/2017** |
| 38 | Develop System-Wide Programming Standards for Water / Wastewater | 30 days | 7/8/2017 |
| 39 | PLC and OIT Programming - Approximately 50 Sites | 240 days | 3/22/2018 |
| 40 | SCADA Computers Programming | 180 days | 5/21/2018 |




Project: Blaine SCADA Improvements
Date: 4/6/2017

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Task | Milestone | Rolled Up Task | Rolled Up Baseline | Split | Project Summary | | |
| Progress | Baseline Milestone | Rolled Up Milestone | Rolled Up Baseline Milestone | Baseline Split | Group By Summary | | |
| Baseline | Summary | Baseline Summary | Rolled Up Progress | External Tasks | Deadline | | |

| ID | Task Name | Duration | Start |
|---|---|---|---|
| 1 | **BLAINE, MN SCADA IMPROVEMENTS** | **641 days** | **2/14/2017** |
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| 11 | **Step 1 - Implement High-Priority Interim Improvements** | **103 days** | **2/14/2017** |
| 12 | Increase Operator Monitoring - After-Hours and Weekends | 103 days | 2/14/2017 |
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| 18 | Procurement, Implementation | 50 days | 4/8/2017 |
| 19 | | | |
| 20 | **Step 2 - Field Radio Study and Design New Communication Network(s)** | **91 days** | **4/8/2017** |
| 21 | Radio Path Study / Radio System Recommendations | **70 days** | **4/8/2017** |
| 22 | Scope / Cost Proposal from Radio Testing Organization | 10 days | 4/8/2017 |
| 23 | Conduct Study, Design Meetings | 60 days | 4/18/2017 |
| 24 | Network Design - Barr, City IT, Radio Testing Org., Software Integrator | 21 days | 6/17/2017 |
| 25 | | | |
| 26 | **Step 3 - Audit 48 sites** | **50 days** | **5/6/2017** |
| 27 | Develop Scope of Work - Approximately 50 Sites | 50 days | 5/6/2017 |
| 28 | | | |
| 29 | **Step 4 - Project Design - Hardware and Contactor Installation Work** | **510 days** | **6/25/2017** |
| 30 | Develop Construction Plans and Specifications | **100 days** | **6/25/2017** |
| 31 | 60% Design, Review with City | 45 days | 6/25/2017 |
| 32 | 90% Design, Review with City | 30 days | 8/9/2017 |
| 33 | Final Design for Bidding | 25 days | 9/8/2017 |
| 34 | Bidding, Award, Contracts | 45 days | 10/3/2017 |
| 35 | Construction | 365 days | 11/17/2017 |
| 36 | | | |
| 37 | **Step 5 - Software Integration Services** | **497 days** | **7/8/2017** |
| 38 | Develop System-Wide Programming Standards for Water / Wastewater | 30 days | 7/8/2017 |
| 39 | PLC and OIT Programming - Approximately 50 Sites | 240 days | 3/22/2018 |
| 40 | SCADA Computers Programming | 180 days | 5/21/2018 |


Project: Blaine SCADA Improvements
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Task
Milestone
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External Tasks
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