ST. CHARLES SINCE 1834	**AGENDA ITEM EXECUTIVE SUMMARY**	Agenda Item number: 5.j
	Title:	Recommendation to Award Proposal for SCADA Program Management – Phase 1 to Concentric Integration
	Presenter:	Tim Wilson

Meeting: Government Services Committee	Date: October 23, 2017	
Proposed Cost: $490,000	Budgeted Amount: $1,000,000	Not Budgeted: ☐

Executive Summary (*if not budgeted please explain*)**:**

For reliability, efficiency and safety, the water and wastewater treatment and pump facilities require continuous automated operation. Currently, the backbone of this operation is controlled by the water and wastewater Supervisory Control and Data Acquisition (SCADA) systems. Both the water and wastewater utility's SCADA system are composed of computer hardware and software systems. Due to the aging infrastructure, the SCADA system lacks security constraints, backup systems, has no integration to the City network and has limited data acquisition; therefore it is nearing the end of its life.

In 2016, City Council approved Concentric Integration to complete a SCADA master plan for both the water and the wastewater system. This evaluation included: process automation, hardware, software, network/communication, security, disaster recovery, alarms, data collection, reports, and remote access. This phase of the project is completed with recommendations, implementation schedule, and long term capital planning provided.

In the next phase of this project, Concentric will provide program management services and subcontractor coordination. It will also involve technological improvements, the installation of the system at remote sites and the professional services to oversee and coordinate this phase of the project. Concentric will provide verification of installations, quality control testing of all equipment, and manage the work by subcontractors. In addition, they will configure and coordinate the SCADA network design and configuration with the City's information system network and team.

Concentric has great knowledge of the City's current networks and the 2016 SCADA Master Plan. They have collaborated closely with Public Works and the Information Systems staff during the planning phase of this project, being the most qualified firm. Public Works recommends continuing this project with Concentric Integration to implement and oversee the next phase of improvements. The $490,000 will cover Concentric Integration's portion of the contract, approximately 50% of the total project cost.

This winter, the city staff will be returning to this committee with updates and contract approvals of equipment and work being conducted by subcontractors. The estimated value for equipment is $441,000, with a cost of $66,000 for subcontracting work.

Attachments (*please list*)**:**

* SCADA Master Plan * Concentrics Proposal Phase 1

Recommendation/Suggested Action (*briefly explain*)**:**

Recommendation to Award the Proposal for SCADA Program Management – Phase 1 to Concentric Integration for a not to exceed price of $490,000.

City of St. Charles

2016-17
SCADA System Master Plan

Prepared by B&W Control Systems Integration
February 2017

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1.0 Executive Summary

The City of St. Charles provides water and wastewater services for approximately 33,000 residents, as well as business and other institutions. The City treats its raw well water at a variety of treatment facilities throughout the City, pumps the water into the distribution system, where three elevated towers with a combined storage of approximately 2.8 million gallons, keeps the water ready for usage. In addition, one larger Main and one smaller West wastewater treatment plant (currently) treat City wastewater. In addition to these facilities, the City owns and operates 17 wastewater pump stations. Solids handling and treatment facilities are provided at both the Main and West WWTPs. Lastly, the City owns and operates its own single mode fiber communication network that is physically maintained by City Electrical Department and managed by the City's Information Technology staff.

Most all water and wastewater pumping and treatment facilities require continuous operation, and St. Charles' facilities are no different. High levels of reliability and the ability to respond quickly to issues are critical requirements. Historically, the City maintains this level of reliability by utilizing selective automation, as well as monitoring and manually responding to abnormal situations when required. The City utilizes a Supervisory Control and Data Acquisition (SCADA) system for each wastewater facility, as well as a SCADA system for the water system. While the newest of the three SCADA systems at the Main WWTP is larger and more comprehensive, all three SCADA systems largely simply monitor existing equipment, provide a limited amount of data acquisition, have no remote access options, and still require Public Works Water and Environmental Operations staff to manually collect and analyze data.

With the growing need to upgrade facilities to improve treatment (phosphorus removal, for example) and aging system and distribution infrastructure, City personnel will need improved technology tools to continue operating efficiently and effectively into the future. To this end, modern comprehensive SCADA systems can provide efficient view, response, and automated control at each of the City's facilities, as well as securely and remotely. Additionally, modern SCADA systems also focus on optimizing energy usage by automated process control and automated reporting, as well as simply making operators aware of how changing process and influent flow characteristics impact energy resource efficiency.

This SCADA System Master Plan focuses on the strategic and specific steps recommended to implement appropriately automated, efficiently managed, energy optimized and securely and flexibly accessible facilities across the City. Each system and related operations was evaluated for the efficient level of automation. Information (data) management (historical data collection and reporting) was also considered and recommendations made for improvement. The report concludes with a recommended staged/phased approach to an implementation, where budget costs are provided.

2.0 Existing SCADA System Overview

2.1 Introduction

The purpose of Section 2 is to provide a review of the City's facilities and related automation infrastructure. An accurate inventory of automation and related equipment is an essential foundation to the analysis and plan of recommended improvements, which is provided in Section 3. Together with staff's assistance, we were able to successfully inventory what we believe to be 95-100% of the City's existing automation-related hardware and software.

2.2 Site Overview

The City owns and operates a number of wastewater treatment plants, sanitary lift stations, and water system facilities such as wells, PRVs and elevated tanks. A list of facilities is provide below.

2.2.1 Wastewater Treatment Plants

- Main WWTP
- West WWTP

2.2.2 Sanitary Lift Stations

- 7th and Division
- Country Club
- Eastside
- Illinois
- Kingswood
- Oak Creek
- Pheasant Run
- Pine Ridge
- Red Gate (Crane Rd)
- Reneaux Manor
- Riverside
- Royal Fox 1
- Royal Fox 2
- Washington
- Wild Rose
- Woods of Fox Glen
- Zylstra

2.2.3 Water System Facilities

- Well Nos. 3 & 4
- Well No. 7
- Well No. 8
- Well No. 9

- Well No. 11
- Well No. 13
- 10th St. Tower
- Campton Hills Tower
- Red Gate Tower
- 10th St. PRV
- 4th and Bowman PRV
- Division St. PRV
- Geneva Rd Willowgate PRV
- Madison Ave PRV
- Timbers Rte 31 PRV

2.3 Process Automation Overview

Both Water and Wastewater process were reviewed and facility tours were conducted during the SCADA evaluation for each of the City's primary facilities (photos were taken at a number of other facilities). Process automation notes were taken during the process meetings to summarize each SCADA water and wastewater potential site and related process at the City's facilities.

2.3.1 Wastewater Process Automation

The different processes at each of the facilities were briefly discussed and evaluated to determine the potential and related benefit of improved SCADA automation. When evaluating the potential for improved automation, we review automation hardware, automation software, potential improved process, efficiency, safety, reliability, or operational flexibility. In general, the Main WWTP, being the most recently improved facility from an automation perspective, had the most up-to-date hardware and software, but also had the potential to benefit from additional automation improvements. The West WWTP utilizes fairly dated (15+ years old) SCADA hardware, including the oldest computer the City utilizes for SCADA. Very few wastewater treatment processes were actually automated; most just simply reported status to the operator but required manual operator operation. Ideally, a process should be fully automated during normal, stable operations, but alert and always allow operations staff to manually operate the process during outside of normal situations.

2.3.2 Water Process Automation

The City's water treatment, distribution, and storage system utilizes a variety of typical shallow and deep well treatment systems. The water treatment facilities are independently controlled (each facility has its own controllers) but communicate with the central PLC at Public Works, which handles messaging between all of the sites and allows operations staff to select different towers or pressure setpoints to control that facility. Staff

currently "actively" operates each of the facilities during working hours (all facilities are operated one shift per day) making operational changes locally at the water facilities. Many of the facilities with a large amount of potential local data did not bring much of that data back to the SCADA Server at Public Works. Operations was clearly lacking useful detailed flows, chemical data, backwash information, and other beneficial water system data acquisition in the SCADA software.

2.3.3 Lift Station Automation

The City's lift station use a variety of methods for pump control. Some stations have PLC-based level controls with PLC-based float control, some use a single-purpose manufacturer's pump controller (such as the Metropolitan LMS-400), while others simply use float relay-based control logic. Most lift stations have limited data transmitted back to the main SCADA sites.

2.4 SCADA Hardware Overview

The following sections provide a general overview of the SCADA related hardware currently in use by the City. We have provided a short narrative for each hardware category, followed by a technical summary of what makes and models are in place. Please refer to Exhibit A for a SCADA network diagram showing existing significant automation equipment hardware and their associated locations.

2.4.1 SCADA Security Hardware

The City currently has their SCADA networks (Water and WWTP) separated from the rest of the City's networks. It is considered best practice to restrict access to SCADA networks from other networks, but carefully allow traffic between networks, where it is required or advantageous. Currently, we did not observe and connectivity between the City's SCADA and administrative networks so traffic remains appeared fully isolated from the other City networks. Typically, selective connectivity is permitted so organizations can back up, apply Windows patches, manage antivirus, view published SCADA historical data from administrative computers, or even provide remote access when needed.

The City performs network isolation for SCADA traffic by creating virtual local area networks (VLAN) on their Cisco 4948 layer 3 (IP) and remote capable switches. They do not add routing to these VLANs so they have no way of communicating outside of their segmented networks.

2.4.2 Programmable Logic Controllers (PLCs)

Programmable Logic Controllers (PLCs) are the primary devices that contain programming logic for operating the process equipment. These are a

critical part of the SCADA system, as without them, the process equipment will not operate automatically. The majority of the City's facilities utilize Allen-Bradley PLCs of varying models, including the SLC 500 Series (SLC 5/03, 5/04 and 5/05 models), MicroLogix Series (1100 and 1400 models), and the CompactLogix Series. See the images below for examples of the MicroLogix and SLC series PLCs.

A list of PLC hardware at each site is included in Exhibit B.

Figure 1 – MicroLogix 1400 PLC

Figure 2 – SLC 5/04 PLC

2.4.3 Operator Interface Terminals (OITs)

Operator Interface Terminals (OITs) are industrial panel-mounted touch screens that allow operations staff to monitor equipment status and alarms. A variety of these are used throughout the City, including Allen-Bradley Standard PanelViews, Allen-Bradley PanelView Plus, and one Automation Direct unit. Samples of two of the City's existing OITs (one older and one newer) are shown in the Figures below. A list of all of the City's OITs is included in Exhibit B.

Figure 3 – Newer PanelView Plus

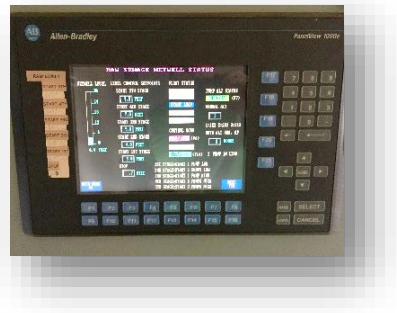


Figure 4 – Older Standard PanelView

2.4.4 SCADA Servers and Clients

The City has various SCADA Servers and clients for monitoring the water and WWTP systems. A SCADA server is responsible for communicating directly

to process PLC hardware and a client is only responsible for communicating with the SCADA server itself, and NOT to the PLC hardware.

2.4.4.1 Wastewater Treatment Plants

Both the Main and West WWTPs have single stand-alone SCADA computers that act as servers; the Main WWTP has a server class machine, and the West WWTP has a very old (8+ years) desktop computer acting as server. The Main WWTP also has an industrial panel mounted PC mounted in the Sludge Handling Building control panel that is a SCADA client node. The West WWTP does not have any SCADA client nodes. Following are images of the City's two WWTP SCADA servers.

Figure 5 - West WWTP SCADA Server

Figure 6 - Main WWTP SCADA Server

2.4.4.2 Water Facilities and Lift Stations

The SCADA Server used for monitoring the Water Facilities and Lift Stations is located at Public Works. Well 8 and Well 13 also both have SCADA computers acting as servers on site for locally viewing status and alarms for those sites. No SCADA client or remote nodes exist for the water/lift station SCADA system. Following are images of the SCADA "servers" at both Well 8 and 13. Because the two computers communicate directly with PLCs, they are considered servers, although they are more like remote SCADA view clients in their use by the City.

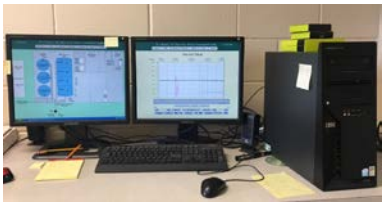


Figure 7 - Well 8 SCADA Server

Figure 8 - Well 13 SCADA Server

2.5 SCADA Software

The City uses Wonderware InTouch for its current SCADA software. The City currently does not maintain an annual support contract with Wonderware, and the versions in use are between 5 and 8 years old (have not been recently updated).

2.6 Network/Communications

2.6.1 Wastewater Treatment Plants

The Main WWTP uses Ethernet communications between the various PLC panels and the SCADA server. Fiber, CAT5e, and Ethernet radio-based physical connection types are used throughout the plant.

The West WWTP largely uses the Allen Bradley DH+ communication protocol over fiber optic cable for communications between the various PLCs and the SCADA server. See the figures below for examples of the DH+ communication in both a PLC cabinet and the West WWTP SCADA server.

Figure 9 - West WWTP Fiber to DH+ Converter

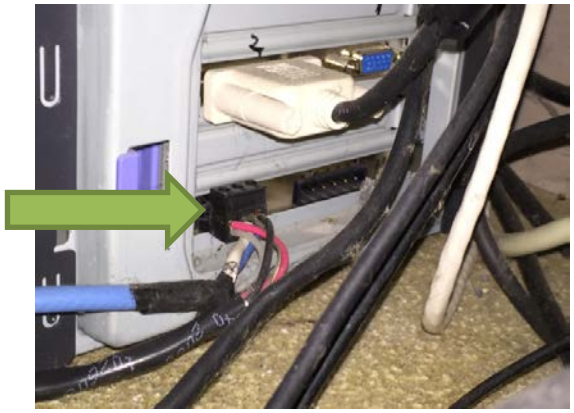


Figure 10 - West WWTP DH+ Communication Card in SCADA Server

The Main WWTP, West WWTP, and Public Works facility are all connected via City-owned fiber optic cable operating at both 10 Mbps and 100 Mbps.

2.6.2 Water System and Lift Station Facilities

The water system and some lift station sites use the extensive City fiber optic network for communications from the remote sites back to Public Works where the master PLC and SCADA Server are located. A number of the lift stations also utilize cellular communications using a Cradlepoint cellular router. To enable the use of the fiber communications, the City is encapsulating serial-based communications on some of the older PLCs within an Ethernet-based fiber communication converter. During our review, staff indicated that the serial to Ethernet communication converters periodically need to be reset for correct communications to resume. See the figures following that show a selection of converters as well as the lift station cellular Cradlepoint devices.

Figure 11 - 10st St. Tower SCADA Cabinet with Serial to Ethernet and Ethernet to Fiber Converters

Figure 12 – Campton Hills Tower SCADA Cabinet with Serial to Ethernet Converter

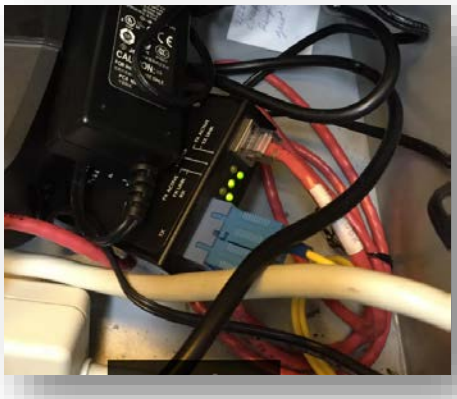


Figure 13 - Campton Hills Tower SCADA Cabinet with (Serial Encpasulated) Fiber to Ethernet Converters

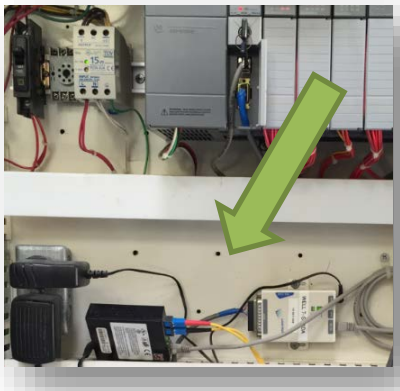


Figure 14 – Well 7 SCADA Cabinet with Serial to Ethernet and Ethernet to Fiber Converters

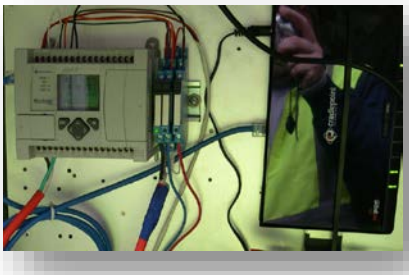


Figure 15 - 7th and Division Lift Station Telemetry PLC and Cradlepoint Cellular Radio (typical)

Figure 16 – Country Club Lift Station Telemetry PLC and Cradlepoint Cellular Radio (typical)

2.7 Security/Disaster Recovery

The City has five computers that act as SCADA servers:

- One is at the Main WWTP and is a server-class machine with the recommended redundant hard drives and power supplies and is running a server operating system. We did not observe any automatic or regular backups for disaster recovery purposes.
- The next is at the West WWTP is an older Windows XP computer with no redundancy. We did not observe any automatic or regular backups for disaster recovery purposes.
- The next TWO servers are operating at Well 8 (Windows XP operating system) and Well 13 (Windows 7 operating system) and although they are acting in a SCADA server role, they are largely just used for local viewing of SCADA data and are not in a critical alarming or informational capacity. Neither the Well 8 nor the Well 13 computers have any redundancies nor are they backed up for disaster recovery purposes.
- The last SCADA server is a desktop computer located at Public Works, is operating in a SCADA server capacity (running Windows 7), and should be considered in a critical role, as its failure would mean operations staff would have to be local onsite to view any particular locations' status.

The four desktop-class computers acting as servers are all standard desktop computers with no redundancy; a failure of any hard drive on any of these three servers would result in significant data loss for the City. Three of the SCADA servers are running Windows XP and the one at the Main WWTP was running Windows Server 2008 R2. Windows XP is not a supported operating system and computers running Windows XP in a server role are considered high risk for viruses and should be considered a priority for replacement.

The three Windows XP SCADA servers are only patched up to Windows XP Service Pack 2 (Service Pack 3 has been available since April 2008). It appears that after the SCADA servers were deployed there has not been a routine patch management procedure performed. In addition, there did not appear to be any antivirus or malware protection in place. We did not observe that any of the SCADA servers had any type of backup software in place.

2.8 Alarming

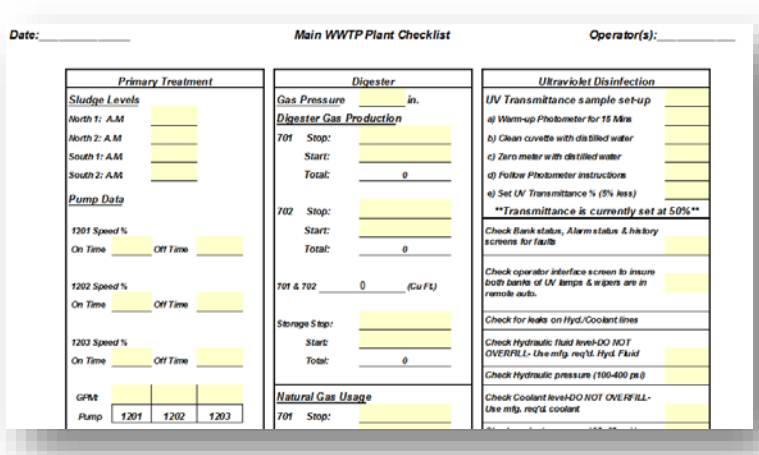
The City currently utilizes Specter Instruments Win 911 for wastewater based alarms and Wonderware SCADAlarm for water system based alarming. In addition, there is a largely custom phone notification interface that allows the public to call in a request and utilizes the water SCADA system to provide dial-out notification to Public Works staff. The Main WWTP Wonderware SCADA Server provides local notification and logging or alarms for the Main and West WWTPs.

2.9 Historical Data Collection

The City's (West WRF) SCADA server currently uses the (default) GE Classic Historian, which does not have an easy (realistically feasible) way for a City staff to extract data from the SCADA system. Classic Historian is designed to be used on the SCADA server to view basic trending information, and is not designed to be used to extract data out of the SCADA server, which would be very useful for City staff. Currently, staff has to request that data be processed for export out of the Classic Historian, at which point staff receives a Microsoft Excel® based spreadsheet of the data. Most all of the historical data analysis in St. Charles is being done essentially manually.

2.10 Reporting

There is no City *SCADA-based* reporting system in use at any of the facilities. Reporting is different than a historian; historian software allows you to see (sometimes massive amounts of data and) process trends separate from SCADA and reporting software will summarize massive amounts of data into simple reports for both the IEPA/state, as well as operations and management staff. 100% of the City water/wastewater data collection and reporting starts with manual data entry (no SCADA data is automatically entered). The figure below is a snapshot of the manual data collection template used by City WWTP staff at the Main WWTP.


Date:_____ Main WWTP Plant Checklist Operator(s):_____

Primary Treatment			
Sludge Levels			
North 1: A.M			
North 2: A.M			
South 1: A.M			
South 2: A.M			
Pump Data			
1201 Speed %			
On Time		Off Time	
1202 Speed %			
On Time		Off Time	
1203 Speed %			
On Time		Off Time	
GPM:			
Pump	1201	1202	1203

Digester	
Gas Pressure	_____ in.
Digester Gas Production	
701 Stop:	
Start:	
Total:	0
702 Stop:	
Start:	
Total:	0
701 & 702	0 (Cu Ft.)
Storage Stop:	
Start:	
Total:	0
Natural Gas Usage	
701 Stop:	

Ultraviolet Disinfection	
UV Transmittance sample set-up	
a) Warm-up Photometer for 15 Mins	
b) Clean cuvette with distilled water	
c) Zero meter with distilled water	
d) Follow Photometer instructions	
e) Set UV Transmittance % (5% less)	
Transmittance is currently set at 50%	
Check Bank status, Alarm status & history screens for faults	
Check operator interface screen to insure both banks of UV lamps & wipers are in remote auto.	
Check for leaks on Hyd./Coolant lines	
Check Hydraulic fluid level-DO NOT OVERFILL- Use mfg. req'd. Hyd. Fluid	
Check Hydraulic pressure (100-400 psi)	
Check Coolant level-DO NOT OVERFILL- Use mfg. req'd. coolant	

Figure 17 - Main WWTP Manual Data Collection Checklist

Water system data is also manually collected and manually entered into Microsoft Excel. Following is a sample of a water site data collection form that is used by City staff.

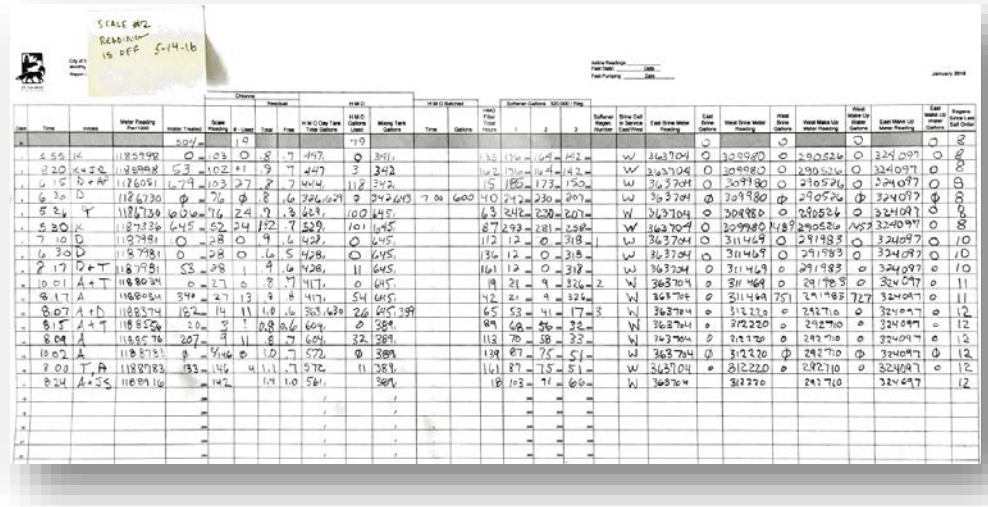


Figure 18 – Typical Water Site Manual Data Collection Form

2.11 Remote Access

There was no remote access for SCADA in use by the City. Staff indicated a long history in the City of data isolation in the SCADA system for the purpose of protecting the data from potential outside (network) risks.

3.0 Evaluation & Implementation Recommendations

The following sections review the current use of SCADA and related automation and make specific recommendations for the City to consider that provide a tactical direction to make improvements in the upcoming years.

Each hardware and software section has a corresponding budget cost associated with recommendations that is shown in the tables at the end of this report. It is also important to note that technology changes quickly and software and hardware that was state of the art a few years ago may not be the best solution for tomorrow. Consequently, the City may want to include some operating budget (maybe $5,000) every other year to update (not re-write) this report periodically to provide a much more brief, but up-to-date recommendation for future improvements, as well as consider a more thorough update in five to eight years.

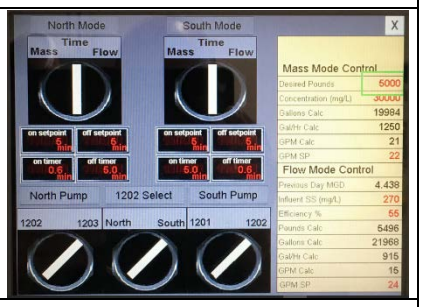
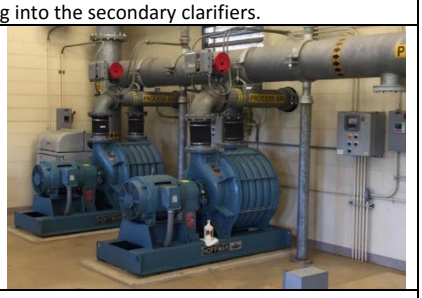
3.1 Process Automation Evaluation

BWCSI staff met with City staff to visit wastewater treatment plants, all significant water sites, and a representative of the City's lift stations. Our staff reviewed each of the two city wastewater treatment plants, the water facilities, and lift stations, and reviewed how automation was used to improve process by providing stability, reliability, and efficiency. Basically, each major system was reviewed to determine:

1. **A review of the process in light of the <u>value</u> of automation** – Just because something *can* be automated, does not mean that it *should* be automated. BWCSI discussed with staff to determine if something was considered a good candidate for automation now or in the future. Staff was told to "assume everything is a dollar" to automate to remove the negative pressure of cost consideration during discussion. In discussions with staff, if we jointly did not clearly see operational improvement potential, no further discussion took place.
2. **The <u>feasibility</u> and relative cost for automation** – What would it take (cost) to automate a particular process? Cursory discussions were conducted to evaluate the mechanical, electrical, hydraulic, and controls changes necessary to automate a particular process or part of a process.
3. **The <u>availability</u> of applicable automation technology** – While items like flow, dissolved oxygen, pressure, and chemical weights/dosing are straightforward to analyze, some technologies (like online Biological Oxygen Demand or online phosphate analysis, for example) were reviewed to see if there are technologies mature enough to consider as a reliable automation control parameter.

The following table summarizes the discussion and analysis of options for process automation improvements. A ranking of one to ten is provided (ten being the "best" potential for automation) as a means to evaluate the value, feasibility, cost, and availability of various process automation options. The Cost Summary table at the end of the report includes estimates for where automation was considered valuable, feasible, and available to implement according to the review during the report.

Table 1 – Automation Process Feasibility Summary
City of St. Charles
SCADA System Master Plan

Site/Process	Technology, Instrumentation, and Controls Recommendations
Main WWTP	
Influent Flow	Add outdoor camera to influent/excess flow weir structure and provide live feed to SCADA/HMI/Mobile.
Primary Clarification	Add programming to allow for automated wasting options, pump speed control from *SCADA* (it currently is just at the local OIT), and eliminate having to be in the building to waste primary sludge. Add camera to building interior. See existing Primary Pumping local OIT screen to the right. 
Primary Clarification	Add sludge blanket depth meter(s) to see blanket depth.
Aeration	Replace all dissolved oxygen probes with working probes with 50 ft cables on them to allow for flexible placement in tanks.
Aeration[1]	Consider Mixed Liquor Suspended Solids meter in aeration tank to allow for F/M calculations.
Aeration[1]	Add one ammonia analyzer towards the front end of the aeration tanks prior to split. Consider one or more ammonia analyzers at the tail end of the tank or just prior to heading into the secondary clarifiers.
Return Activated Sludge	Add motor operators to telescoping valves to adjust RAS rate/mass remotely.
Return Activated Sludge	Add RAS solids meter to determine mass of RAS/WAS in return and waste.
West WWTP	
Process	**Notes/ Added Instrumentation**
Alarming/General	Add detailed process alarms into a local installation of Win911.
Electrical Room	Add UPS to control panel/enclosure
Fine Screen	Tie in additional screen alarms to SCADA (i.e. – position fail) Currently the screen only has high water alarm.
Aeration	Add 2 DO probes to replace broken units. Add one ammonia analyzer towards the front end of the aeration tanks prior to split. Consider one or more ammonia analyzers at the tail end of the tank or just prior to heading into the secondary clarifiers.
Aeration	Consider turnkey (procurement) high speed blower replacement of existing Hoffman Blowers and simple automated dissolved oxygen control system. See existing Hoffman Blowers shown to the right. 
Secondary Clarifier	Add one sludge blanket level detector to each of the two secondary clarifiers.
Aerobic Digester	Replace broken supernatant flow meter. Add two alarms: Thickener arm fail, air lift fail

1 Automation to be reconsidered during a full BNR design

Site/Process	Technology, Instrumentation, and Controls Recommendations
Disinfection	Add existing Allen Bradley UV panel status to SCADA.
Water Sites	
Chemical Feed	Add chemical feed data to SCADA from select water treatment sites. Budget $50,000 to tie in existing scales and add some instrumentation.
Chemical & Related Pump Status	Add chemical and various transfer pump data from select water treatment sites. Budget $20,000 to work with staff to identify key pumps to bring status into SCADA.
Trend all water KPIs	Add all Key Performance Indicators to Water SCADA master and trend.
Well 13	Add online pH monitor and trend
Well 9	Replace mercury switches with backup local control pressure transducers
Various water sites	Review failed sensors and update or replace. Budget $50,000 to review and repair existing sensors and analyzers.
Lift Stations	
All Sites	Consider Power Monitoring for each pump to better assess pump condition and station performance.
All Sites	Poll lift stations every 10-15 seconds for status including wetwell level. Use data to estimate fill and pumping flow rates.
Multiple Sites	Some of the lift stations use PLC-based control while others do not. We recommend standardizing on PLC-based controls for all lift stations which provides more flexibility/functionality than the existing system.

3.2 Hardware

3.2.1 SCADA PLCs

The existing Allen-Bradley PLCs in use throughout the City are one of the most widely used in the area for water/wastewater applications designed in the 1990s and 2000s. The Village uses mostly "older" series PLCs (such as the SLC and MicroLogix), and a couple newer platform CompactLogix PLCs. The status of each type of PLC is provided in this section, with a replacement plan at the end of the section for those that are recommended for replacement.

The following graphic (borrowed from Rockwell Automation's Project Lifecycle Status page) illustrates the various stages Rockwell (Allen-Bradley) equipment can fall into.

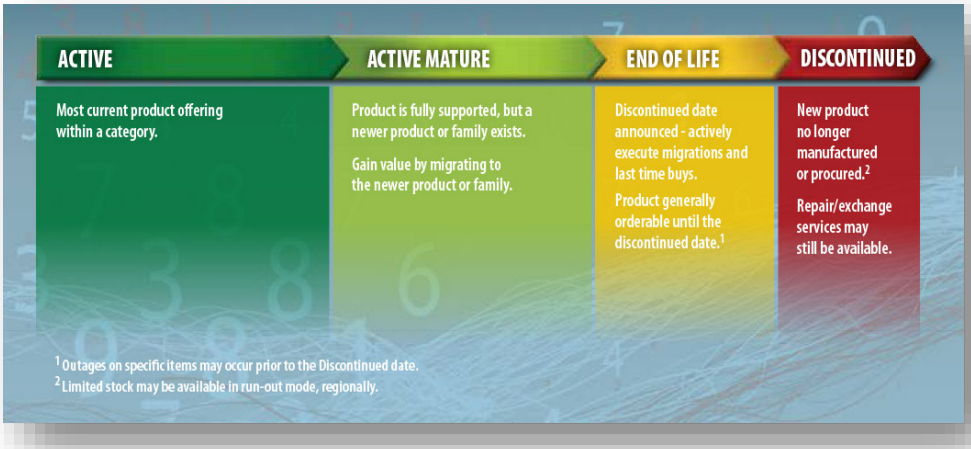


Figure 19 - Rockwell Automation Product Lifecycle Status Graphic

The SLC Series PLCs are in Active Mature status, and still currently supported by the manufacturer and spare parts are readily available. However, Allen-Bradley has started the process of discontinuing the SLC series PLCs (the SLC 500, 5/01, 5/02 models are all discontinued). Allen-Bradley has also significantly increased costs to "encourage" replacement with the newer Logix platform. As a result, we recommend budgeting to replace the existing SLC Series PLCs with the CompactLogix Series to move the City onto the newer PLC platform. Also, in the event of a partial PLC failure or an identified need to upgrade the PLC programming before the units are replaced, we would recommend the City consider a Logix-based upgrade at that time to avoid reinvesting in the older hardware platform. Replacing the SLC 5/03 and 5/04 PLCs with CompactLogix have the added benefit of providing the ability to communicate using the native Ethernet port on the PLC rather than a third party converter, which adds complexity and provides an additional point of failure.

Even though the existing CompactLogix L23E PLC at Well 13 and L35E PLC used for the UV system at the Main WWTP are a newer platform, those specific models has been discontinued as a newer model is available. The newer model (L24ER and L33ER, respectively) are basically a direct replacement, so there is no reason to proactively replace these PLCs.

The MicroLogix 1100 and 1400 PLCs are in Active status and fully supported, so there is no need to plan for their replacement at this time.

For any new projects designed and implemented by the City moving forward, the Allen-Bradley MicroLogix 1400 or CompactLogix Series PLCs should be used. The CompactLogix L1, L2, or L3 Series should be determined based on the specific application requirements. A summary of the

specifications for the different CompactLogix PLCs appears in the table below.

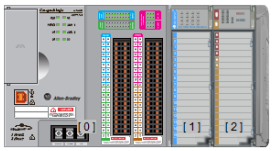
Table 2 – Recommended PLC Model Overview and Summary Capacity

PLC Model	Comm Ports	On Board I/O Capacity	Expansion I/O Type	Expansion I/O Capacity
MicroLogix 1400	ENET, 2 Serial	20 DI / 12 DO 4 AI / 2 AO	1762 Series	Qty 7 modules
Compact L18ER	ENET, USB	16 DI / 16DO	1734 Series	Qty 8 modules
Compact L24ER	ENET, USB	16 DI / 16 DO / 4 AI / 2 AO	1769 Series	Qty 4 modules
Compact L30ER	ENET, USB	None	1769 Series	Qty 8 modules
Compact L33ER	ENET, USB	None	1769 Series	Qty 16 modules
Compact L36ERM	ENET, USB	None	1769 Series	Qty 30 modules

Following are images of the MicroLogix 1400 and various CompactLogix PLCs:

MicroLogix 1400

CompactLogix L18ER


CompactLogx L24ER

CompactLogix L33ER

Specific recommendations for both PLC and OIT replacement for each site are provided in Exhibit B.

3.2.2 Operator Interface Terminals

The Allen-Bradley Standard PanelViews and PanelView Plus OITs that are used throughout the City have all been discontinued. We recommend that the City plan to upgrade any Standard PanelView with the new Allen-Bradley PanelView Plus 7 Series. The specific model and screen size is determined based on the existing PanelView being replaced. The existing PanelView Plus units, although obsolete, do have a direct replacement that requires minimal work to migrate the program as the same software is used to configure the PanelView Plus and PanelView Plus 7 units. Therefore, there is no need to proactively replace these units.

The existing Standard PanelView units should be replaced in conjunction with the PLC replacement within the same panel.

Any new projects should include using the PanelView Plus 7 Series OITs. The OIT size (7" through 15") should be determined based on the level of detail required on the screens.

Specific recommendations for both PLC and OIT replacement for each site are provided in Exhibit B.

3.2.3 SCADA Server Hardware

BWCSI typically recommends that server class, commercially manufactured machines are used for SCADA applications (like what the City uses for other IT systems). SCADA class machines should have redundant hard drives and redundant power supplies, which are the components that most often fail on a computer. Many communities choose to house SCADA server hardware in a server room or physically protected area and rack enclosures can be used to optimize floor space. Servers should be planned for physical replacement every 5 years.

Additional system resiliency can be achieved by leveraging Hyper-V replication in the virtualized SCADA environment. Copies of the main virtualization files would be replicated over the fiber optic network to the failover replicate server at City Hall to be used in the event of a major hardware or software outage.

BWCSI recommends the following resilient approach which includes two virtual host servers, each with multiple virtual machines:

- Install a new server class machine running Microsoft's Windows 2016 Server platform with Hyper-V to be the new virtual host server supporting a virtualized SCADA infrastructure. The new server should be located in a server rack or cabinet located at Public Works. Virtualization is a way of taking a larger server and partitioning it into smaller servers.
- On the new virtual host server configure two Virtual SCADA Servers (one for water and one for wastewater) with SCADA Software needed to communicate with the Programmable Logic Controllers (PLCs) and Win911 alarm software.
- On the new virtual host server configure two Virtual Remote Access Servers (RDS) with SCADA thin client licenses (one for water and one for wastewater). These licenses will provide the access to view the City's SCADA graphical software (Water, and Wastewater). Each SCADA environment will be restricted through security.
- On the new virtual host server configure two virtual servers for Mobile 911 alarming (iPhone and Android alerting). The Mobile 911 servers could be located at City Hall, if desired.

- Configure virtualization replication to a server class machine located at City Hall for all six virtual servers listed above. If the City has an existing virtual host, it may be used as the replication server if it has enough resources.

3.3 Software

3.3.1 SCADA Graphics Software

The Wonderware InTouch software currently in use by the City is one of the three most commonly used SCADA software packages for Water/Wastewater (the others being GE iFix and Rockwell FactoryTalk View SE). Wonderware System Platform (WW SP) is Wonderware's newer SCADA software application that exceeds InTouch in functionality, but is more complex to implement, with few local integrators who have expertise in the software development making long-term serviceability a liability. We recommend the City consider reviewing alternative software suppliers before upgrading and make a decision based on desired functionality, best fit and long-term serviceability.

3.3.2 SCADA Software Screens

Whether or not the City pursues a physical control room or stays with a remote software-based "control room" concept, it would be ideal for the City to have a set of standards for SCADA screens and related screen development. The existing screens show "building numbers" for navigation (see below for example) and are should be ideally set up to show the various processes *instead of* building numbers. Using building numbers for navigation may feel familiar to experienced staff but they do not mean anything to the process and require new staff to learn what building does what instead of more intuitive process based screens (i.e. – "Primary Clarifiers," or "Solids Processing"). In addition, some screens are very busy "CAD" looking screens (see WAS Screen below) and others are very different and use overly simplified shapes (see Aeration screen below) with little representation of process. For a new or even somewhat experienced operator, the existing screens and their navigation can be very confusing.

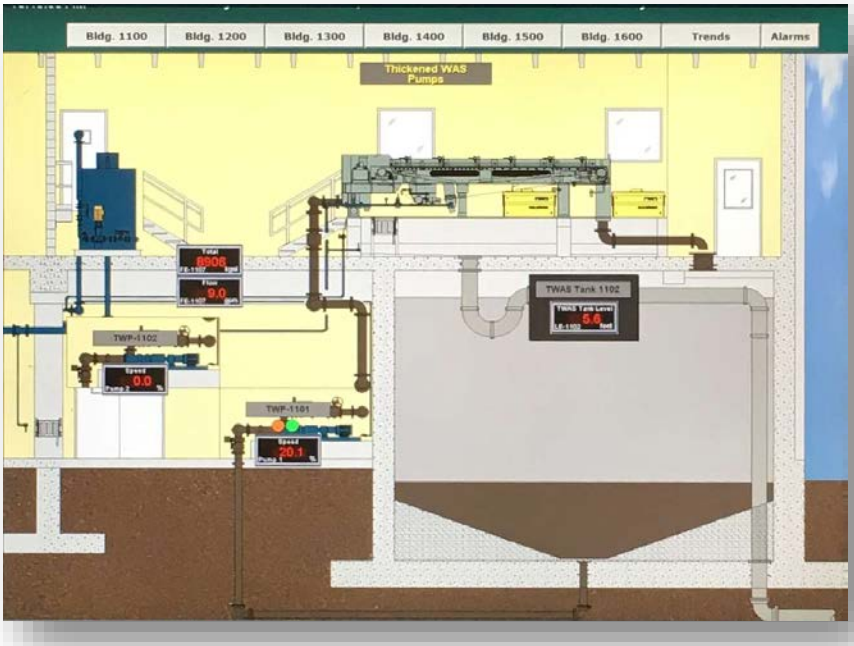


Figure 20 - St Charles Main WWTP WAS SCADA Screen

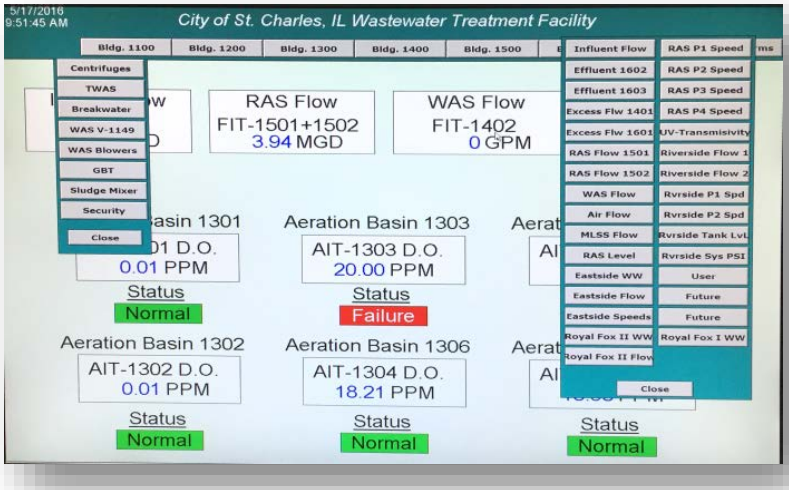


Figure 21 - St. Charles Main WWTP Aeration SCADA Screen

BWCSI typically recommends that SCADA screens follow some simple rules to help operators work with them easily, be easily updatable, as well as support more forward-facing "high performance HMI" standards. The following are a list of recommended features and attributes that we recommend the City consider for SCADA screen development:

- **SCADA Screen standards** – Some sort of HMI style guide should be used to identify the basic navigation, KPIs (see below), color use, and display functionality.

- Level 1 (overview) screens should ideally be simple, without a lot of color or distracting animations, without process detail.
- Level 2 should be a unit process (aeration, for example) and still not show a lot of detail and stick to simple colors and no animation.
- Level 3 and optionally Level 4 can show process details, diagnostics, all detailed sensors, alarms, etc., as well as we simple animations.

- **SCADA Screen Physical Design** should ideally be a 16:9 (wide screen) aspect ratio, or 1920 pixels wide by 1080 pixels tall (full high definition). All monitors and displays used for SCADA should also support this resolution natively.
- **Process KPIs** – Key Performance Indicators (KPIs) should be identified during SCADA development for each *process* and labeled as such. KPIs for each plant (usually influent and effluent flows, select loads, or system pressure and flows for water) should also be identified and labeled as such. KPIs should be prominently displayed for each process and plant SCADA screen (see below). Ideally, KPIs would also show normal ranges of operation on the graphics themselves, to allow operations staff to see "normal" values quickly.
- **Energy management** and related key KPIs/metrics should be visualized and available on every applicable process screen. Energy and process KPIs should be considered for combination and trending displays as well. The current real-time estimated cost of operations per facility should be displayed and trended for each. For example, showing the current influent MGD/Plant kW over time will help to sensitize operations staff to the result of energy efficiency changes during process or flow changes, even if there is not a strong impetus to optimize energy usage. Similarly, on a process level, showing and trending current ammonia loading rate (lbs/hr. or similar) at the WWTPs can be useful to understand the result of return flows high in ammonia and their impact over time on the aeration process.
- **SCADA Screen layout –** any new SCADA work done for the City should support the recommended layout for SCADA screens similar to what is shown below. A couple sample existing SCADA system screens from other facilities are shown below the generic recommended layout.

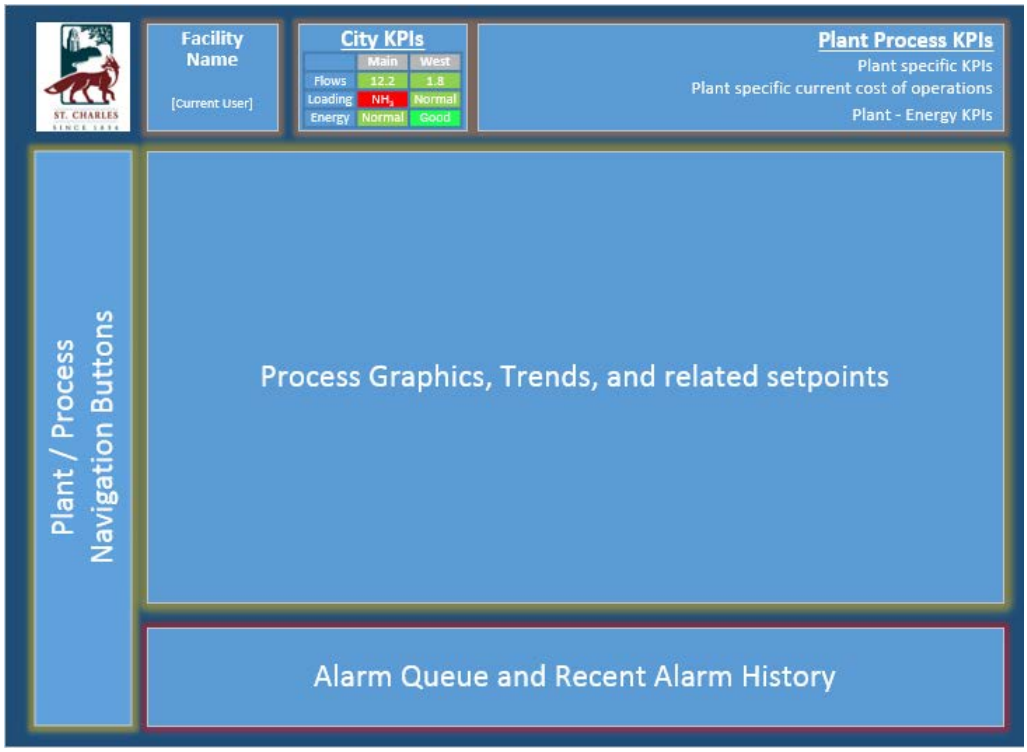


Figure 22 - Recommended SCADA Screen Layout

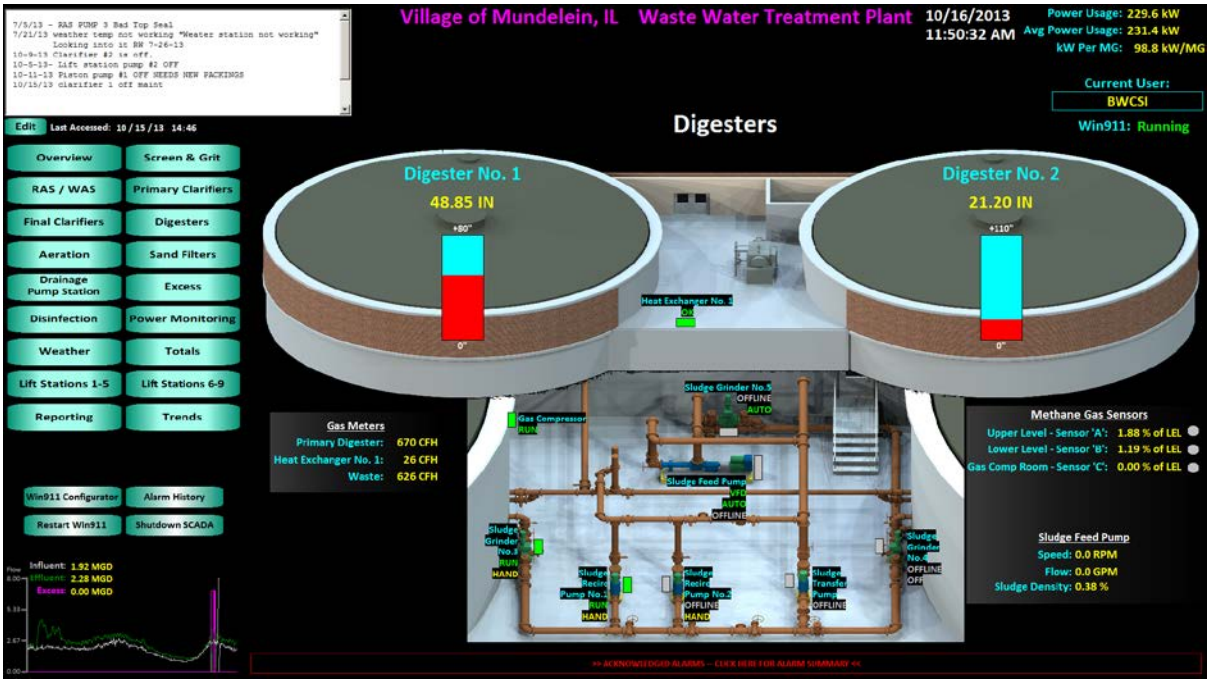


Figure 23 - Sample SCADA Screen Layout in Use (Digester Building Shown)

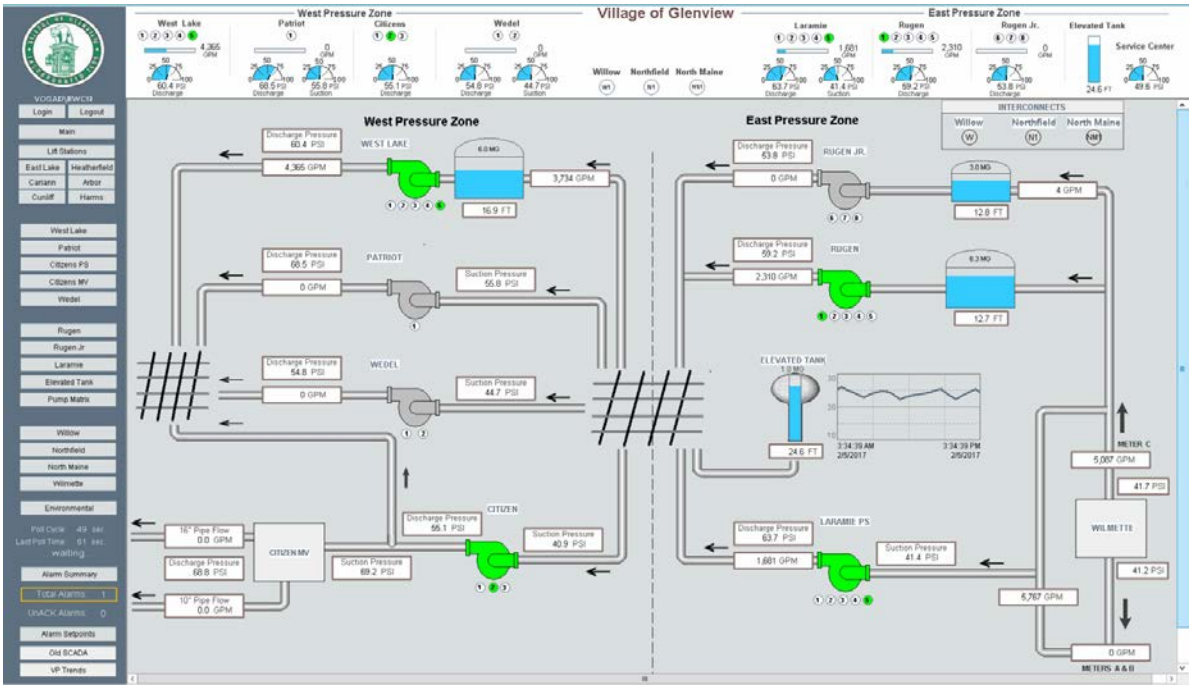


Figure 24 - Sample SCADA Screen Layout (Water System Overview)

- **Quick Trends or Sparklines** – Quick trends or "sparklines" are often small, sometimes unitless graphs that show specific key process values trended over time. They allow users to quickly glance and see if trends are going up, down, steady, or erratic and can help troubleshoot process changes. We recommend the City consider the inclusion of sparklines in the SCADA screens developed. See a sample of a SCADA sparklines in the figure below.

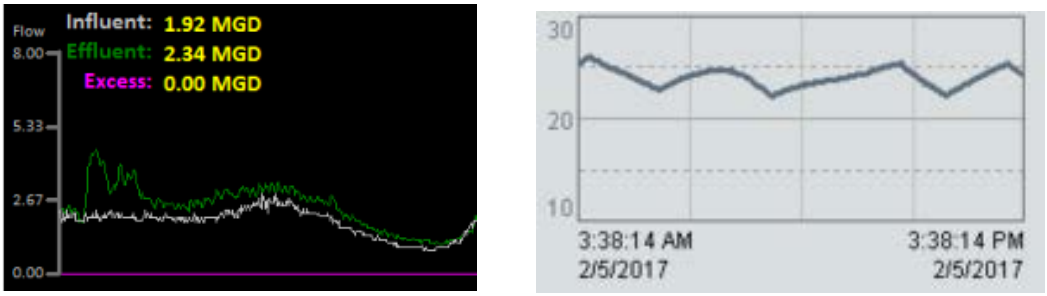


Figure 25 - Sample SCADA Sparklines (smaller in SCADA)

3.4 Network/Communications

In general, BWCSI recommends managed industrial Ethernet switches in all SCADA environments. Managed switches provide VLAN capabilities (network segmentation), health and statistics, and other key indicators. The City has standardized on Cisco for its administrative network LAN/WAN infrastructure and also use Cisco industrial switches in some process control panels. Cisco has a product line of industrial Ethernet switches. Rockwell also uses the Cisco operating system in their industrial switches branded as their Stratix line.

3.4.1 Routing and Firewalling

BWCSI recommends network isolation for SCADA servers, PLCs, and other network connected instrumentation. Users should ideally only interact with the SCADA servers through thin client terminals. Remote SCADA connections should be limited to only the ports required for communication. SCADA servers should be allowed to communicate with the City's IT management applications like Windows Patch management and Antivirus management again through the required ports needed. A syslog application can capture the traffic passing through the network devices and keep a detailed log of all communication attempts.

BWCSI recommends the City selectively turn on routing between its existing SCADA network and the existing administrative network. In addition, after the new SCADA architecture is implemented, Public Works SCADA users would connect through thin clients located on the administrative network. The City's WhatUp Gold monitoring software could also be used to monitor a few more key SCADA network and security devices to ensure the SCADA network's health and continued stability.

3.4.2 Main WWTP

There are numerous control panels where the physical network connections and network switching should be improved. We recommend that every Ethernet (Cat5/6 or fiber) cable be terminated in a patch panel with patch cables used to connect the patch panel to the Ethernet switch, rather than simply crimping ends on the cables. This would provide for a more robust connection. Also, many of the panels use consumer-grade Ethernet switches rather than industrial Ethernet switches. We recommend that all of the consumer-grade switches be replaced with industrial switches as described above.

Figure 26 – Consumer Grade Switch (Left) vs Industrial Switch (Right)

3.4.3 West WWTP

The West WWTP currently has fiber optic cabling between all PLC panels. The existing PLCs use the DH+ communication protocol over the fiber optic cabling. When the PLCs are replaced, the existing fiber optic cabling can

simply be used for Ethernet communications in lieu of the DH+ communications.

3.4.4 Water Facilities and Lift Stations

We recommend replacing the existing Cradlepoint cellular router with an industrial cellular router. The industrial cellular routers are more suitable for the application as they are designed to be installed inside control panels and have more robust environmental ratings.

3.5 Security/Disaster Recovery

BWCSI recommends several changes to address disaster recovery and overall security for the SCADA network.

3.5.1 Backup and Recovery

The City should implement network level backups for all SCADA servers to a secure location like a storage device at City Hall. BWCSI typically recommends that SCADA backup data should be retained on a rolling 4-week period. “Off the shelf” backup software has this feature built in. These backups are used to restore data files that may become corrupt or deleted. The backups could also be used to restore the system in the event a complete system outage. Cloud based backups are also a good option to keep data protected.

3.5.2 Antivirus and Patch Management

We recommend the City proactivity patch their SCADA servers with Antivirus updates and Windows Operating System Patches, addressing system security and performance. Typically SCADA patching is done by a qualified systems integrator in coordination with both Public Works and City IT. Patches should be reviewed prior to deployment for SCADA application compatibility. Most AV and patch management systems provide very good reporting on patch revisions. These reports should be reviewed by a qualified systems integrator on a periodic basis to make sure that SCADA system security is being addressed without having to interrupt the SCADA applications.

3.5.3 Standardized Logins and Password

We recommend the City consider leveraging their existing Active Directory network accounts to provide authorization and track all access to SCADA applications. On boarding and off boarding can be simplified and access can be changed / removed in a single spot rather than separate areas.

3.6 Alarm Management

We recommend that the City simply upgrade their existing Specter Instruments Win-911 alarm software for the for wastewater based alarms, and replace the Wonderware SCADAlarm software with Win-911 for water system based alarming since Wonderware SCADAlarm is an obsolete product. The newer release of Win-911 has the ability to use Voice-over-IP (VoIP) connection for making phone calls, and other methods of notification (such as iOS or Android push notification in an app) that do not rely on standard voice-grade phone lines. The newer software also provides additional benefit as it can be installed on virtualized server-class systems. In addition, standard voice-grade phone lines are becoming less prevalent, making a virtual VoIP connection more ideal.

We recommend the City also consider installing three backup hardware alarm dialers (one each for Water/Lift Stations, Main WWTP and the West WWTP) to provide alarm notification if the software-based alarming were to fail. The backup dialers would be wired directly to a local PLC and would not rely on the SCADA or Win911 alarming software to function.

3.7 Historical Data Collection / Reporting

3.7.1 SCADA Trending/Historian

The concept of the SCADA trend versus enterprise historian is often misunderstood. An enterprise historian is different than a typical (relational) database like Microsoft Access or Microsoft SQL. Enterprise process historians generally are superior in four areas:

1. Data Storage Speed
2. Data Compression
3. Ability to analyze trends outside of SCADA
4. Ability to talk to other/outside data sources

Most operators want to know the trend of many different tags (points of data) over months, days, hours, or even over minutes (rarely over seconds in the water/wastewater industry). If a typical water or wastewater facility has between one and two thousands tags of data and wants to collect data at least once or twice per minute that results in literally millions of data points per day. While many modern server-based relational databases (i.e. – Microsoft SQL) can handle that amount of data, process historians typically store that data effortlessly and will compress the data with very little user intervention or integrator configuration. For example, if a typical RAS flow rate stays the same for 4 hours, a process historian will only store a new data point every 10-15 minutes and just “flag” the tag to indicate it hasn’t changed, effectively reducing the data collected by a factor of 10 or

more. A relational database would typically have to store the same data point for each time period it was collected.

Wonderware InTouch (the City's current SCADA software vendor) has two types of process (SCADA) "historian" type tools available: **Built-in Trending** and **Wonderware** (Enterprise) **Historian**. The City is currently only licensed for the built-in trend tool, as it was included as a part of the original SCADA implementations. While the existing trend tool does a good job of regularly storing process points of data and showing a few trend screens in SCADA, it is very limited in its ability to effectively aggregate, analyze, and display the data conveniently for City staff. InTouch built-in trending requires a manual and very technical process to extract data for analysis and as such, is not typically recommended for agencies that regularly analyze process data.

Once a utility has decided to pursue a higher performance and more flexible enterprise historian, an analysis of *which* process historian to choose needs to be made. Similar to the SCADA software itself, there are a few major vendors that provide very good options for a better process historian. For the sake of simplicity and efficiency, BWCSI recommends the review of the two leading water/wastewater historian vendors in the area: Rockwell FactoryTalk Historian and the Wonderware Historian. Both Rockwell and Wonderware Historians are used by thousands of facilities world-wide and have excellent support. Their Historian clients make it easy for users NOT in SCADA to analyze data created by SCADA.

Both the Wonderware and Rockwell Historians have a full-featured separate client installation and software that allows for built-in dynamic graphing from the tag selection, built-in filtering, an advanced query tool, and other statistical analysis tools. See the figures below for examples of the Wonderware Historian Client. The Rockwell client is similar.

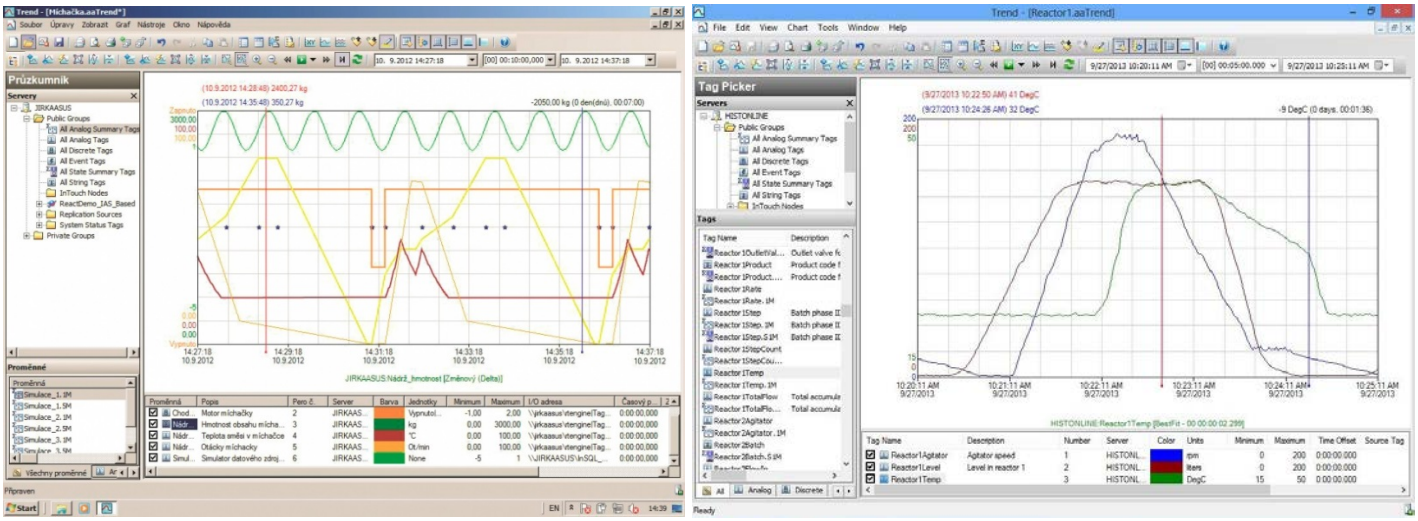


Figure 27 - Sample Screenshots of Wonderware Historian Client

Despite coming from a competing software vendor, the Rockwell Historian product is also compatible with a Wonderware-based SCADA system. A short demonstration of the Wonderware Historian product was presented to City staff during the SCADA planning workshop and staff seemed very interested in the built-in capabilities of the product. While a detailed historian product evaluation and design is outside the scope of this implementation evaluation, BWCSI recommends the City consider an investment in a one or two seats of the Rockwell or Wonderware Historian product (possibly a limited length demo license), as well as a further evaluation of both. It was clear through our evaluation that the staff could definitely use a method to quickly and easily extract SCADA data for analysis. By budgeting for a detailed historian trial and analysis, the City can expect to gain a deep understanding of the product's capabilities and potential and obtain a more detailed estimate of a full implementation. For budgeting purposes we assumed up to six concurrent users of the historian deployed across the City and have provided budget numbers that would allow the City to add SCADA servers in the future that would also "plug into" the then existing historian architecture.

3.7.2 Reporting

3.7.2.1 Summary Recommendation

We recommend the City replace most all current pencil/clipboard and Microsoft Excel data collection for both Water and Wastewater with a relational-database style browser-based reporting system.

3.7.2.2 Difference Between a Historian and Reporting Solution

Although a historian mentioned in the section above is a critical tool to manage process and related data, they typically do not provide the flexible reporting that is required for regulatory purposes and effective operations. In most water and wastewater treatment facilities, there are primarily three sources of data:

1. **SCADA data** (automatically generated)
2. **Laboratory data** (typically collected through either MS Excel™ or in some sort of Laboratory Information Management System , or LIMS). Sometimes this data comes from the operations staff as well if the tests are straightforward.
3. **Operational data** (any manually collected data, in the City's case, done by pencil and clipboard then manually transferred to Excel on a regular basis).

At the City, these three sources of data currently are each collected independently and much (but not all) of the information from laboratory and operational is currently combined manually in Excel. While Microsoft Excel is a very familiar product to many, it has many disadvantages in data-centric applications like water/wastewater. Specifically:

- **Difficult to look at more than a month** - Excel is not meant to be a database. In order to look at, say a year or two worth of data, often dozens or possibly over a hundred Excel files need to be opened. For example, if the City wanted to compare water usage in July for the past 10 years, it would take hours.

- **Lack of outside data access** - Data cannot be accessed or linked to to and from other applications into Excel easily. Rainfall data from USGS or Weather Underground, for example, cannot be easily brought into Excel operations spreadsheets, yet it impacts operations at the wastewater facilities when it comes to excess flow. On the water side, City water meter data cannot and is not currently compared monthly with water production making monthly unaccounted for (non-revenue) water loss analysis difficult.

- **Data sharing delays** - Lab result spreadsheets are typically not made available to operators until the process has long since changed. For example, wastewater operators could benefit from knowing ammonia results quickly, but do not get them until the request the data from the lab when it is done and open separate spreadsheets to see it.

There are other commercial and open architecture reporting solutions such as Hach WIMS or other database and browser-based solutions that could likely suit the City much better than Excel spreadsheets. Whatever product the City chooses, we recommend the City consider the following core components of a WRF Reporting system:

- Relational database architecture (all data stored in the same database with virtually unlimited storage)
- Option for a browser-based (clientless) software (so users don't need to install dedicated software on their computers)
- Supports full data export to Excel (for Excel graphing and additional analysis outside of the product)
- Support for simple laboratory data collection (managed laboratory data entry in the SAME SYSTEM)
- Support for automated SCADA summary data (usually daily) collection

- Supports (future) netDMR export or automated State of Illinois EPA - based reporting
- Supports manual tablet or smartphone-based data collection
- Natively designed for the water and wastewater industry

Due to the complex nature of deploying a City-wide water/wastewater reporting system, we recommend City staff consider a product summary evaluation (demonstrations) followed by a pilot project utilizing one or two reporting systems prior to a full implementation. As such, we have provided a budgeted phased approach to a Reporting deployment in the cost table in Section 4.

3.8 Remote Access

The City's administrative network currently employs a very secure and flexible remote networking authentication and remote network access protocol called Virtual Private Networking (VPN). It was operating on a Cisco ASA5510 during this study. If Public Works were to follow the recommended Remote Desktop Services (RDS) SCADA architecture described above and leverage the City's existing (VPN) infrastructure, water/wastewater staff would have fully secured, audited, and safe SCADA access from remote computers, supported tablets, as well as supported cellular smart phones. The VPN/RDS style of remote SCADA access is well supported and in use by dozens of water/wastewater utilities in the area, and will provide the City with the security they need and the added convenience of remote access to SCADA, which typically saves communities in reduced overtime labor and allows quicker response to water and wastewater emergencies. The most secure agencies utilize two-factor authentication, which requires a small key fob or app on a smart phone in conjunction with username and password to authenticate remotely.

Enabling remote access through a remote desktop application will allow Public Works staff to have remote access to SCADA screens. However even though RDS style remote apps support native applications, all must utilize the RDS environment, which can be difficult to navigate and use on a tablet or smartphone, as it is essentially a Windows computer running through a tablet or smartphone. Native applications (or "apps" as they are usually known) are specifically designed for tablet and smartphone environments and offer advantages such as larger buttons, icons, and simplified navigation (as opposed to repeatedly pinch-zooming in and out). Currently, there are not native apps for Wonderware InTouch, but there are other options for other apps that work well with Wonderware software (like SmartGlance, to the right, for example) that can be

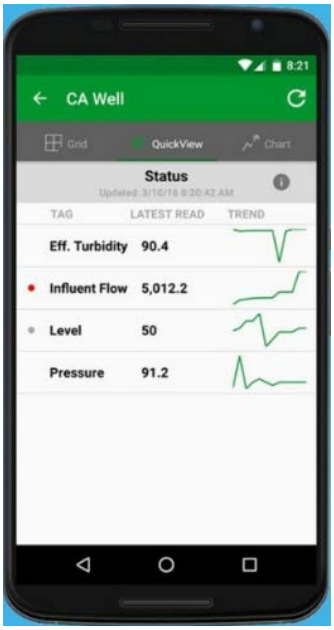


Figure 28 - Sample SmartGlance Screenshot

considered during an upgrade and would allow water/wastewater staff an improved mobile experience.

As the City moves forward with SCADA (and related) technology upgrades, and as SCADA technology itself continues to advance (and more apps become available), we recommend the City periodically (a couple times per year) evaluate potential native applications to supplement the RDS environment. Based on the City's existing information technology architecture, we do not for see a significant (>$1,000) investment to implement more tablet and smartphone-friendly apps.

4.0 Budget Costs

The tables below summarize the budget costs associated with the capital recommendations made in Section 3 of this report. Within each table, the costs are further broken down by phase. A detailed design was not included in the scope of this project, and as such, these costs are based on information collected for this planning report and should not be considered all-encompassing.

Table 3 – Budget Cost Summary for Main WWTP

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
Sludge Handling PLC-1100 PLC and OIT Replacement				$22,500	3.2.1 & 3.2.2
Headworks PLC-1200 PLC and OIT Replacement				$15,000	3.2.1 & 3.2.2
Primary Sludge PLC-1201 PLC and OIT Replacement				$15,000	3.2.1 & 3.2.2
Aeration PLC-1300 PLC and OIT Replacement				$19,500	3.2.1 & 3.2.2
RAS PLC-1600 PLC and OIT Replacement				$24,500	3.2.1 & 3.2.2
Anaerobic Digester PLC-1700 PLC and OIT Replacement				$23,000	3.2.1 & 3.2.2
Backup Dialer Installation	$6,000			$0	3.6
Influent Flow Outdoor Camera with Video Management Software				$8,000	3.1
Primary Clarification Automated Wasting and Outdoor Camera				$10,000	3.1
Primary Clarification Sludge Blanket Levels (2 total)				$30,000	3.1
Aeration – Replace DO probes *(cost per probe)*				$3,000	3.1
Aeration – MLSS meter				$20,000	3.1
Aeration – ammonia analyzer				$35,000	3.1
Return Activated Sludge – motor operators *(cost per operator)*				$10,000	3.1
Return Activated Sludge – solids meter				$20,000	3.1
Ethernet switch upgrades (PLC-1300, PLC-1600)				$10,000	3.4.1
TOTALS	**$6,000**			$265,500	

Table 4 – Budget Cost Summary for West WWTP

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
Headworks PLC-2201 PLC and OIT Replacement			$32,000		3.2.1 & 3.2.2
UV PLC-2601 PLC and OIT Replacement			$23,500		3.2.1 & 3.2.2
UV MFR Panel PLC and OIT Replacement			$11,000		3.2.1 & 3.2.2

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
RAS/WAS PLC-2701 PLC and OIT Replacement			$25,500		3.2.1 & 3.2.2
Digester PLC-2801 PLC and OIT Replacement			$23,500		3.2.1 & 3.2.2
Backup Dialer Installation	$6,000				3.6
Alarming/General	$5,000				3.1
Electrical Room UPS	$2,000				3.1
Fine Screen alarming and status		$10,000			3.1
Aeration instrumentation				$70,000	3.1
Aeration High Speed Blowers				$500,000	3.1
Secondary Clarifier sludge blanket level				$30,000	3.1
Aerobic Digester supernatant flow meter				$20,000	3.1
Disinfection UV status		$10,000			3.1
TOTALS	**$6,000**	**$20,000**	$115,500	**$620,000**	

Table 5 – Budget Cost Summary for Water Facilities

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
Public Works – Master PLC		$16,500			3.2.1 & 3.2.2
Well 3 & 4 PLC and OIT Replacement		$89,000			3.2.1 & 3.2.2
Well 7 PLC and OIT Replacement		$21,000			3.2.1 & 3.2.2
Well 8 PLC and OIT Replacement		$65,000			3.2.1 & 3.2.2
Well 9 PLC and OIT Replacement		$20,000			3.2.1 & 3.2.2
Well 11 PLC and OIT Replacement		$21,000			3.2.1 & 3.2.2
Well 13 PLC and OIT Replacement		$45,500			3.2.1 & 3.2.2
10th Street Tower PLC and OIT Replacement		$13,500			3.2.1 & 3.2.2
Campton Hills Tower PLC and OIT Replacement		$13,500			3.2.1 & 3.2.2
Backup Dialer Installation		$6,000			3.6
Chemical Feed			$50,000		3.1

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
Chemical & Related Pump Status			$20,000		3.1
Trend all water KPIs		$10,000			3.1
Well 13 pH monitor		$10,000			3.1
Well 9 pressure control		$15,000			3.1
Various water sites – misc work			$50,000		3.1
TOTALS		**$**35,000	**$120,000**		

Table 6 – Budget Cost Summary for Lift Stations

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
Eastside PLC and OIT Replacement				$20,500	3.2.1 & 3.2.2
Riverside PLC and OIT Replacement				$53,500	3.2.1 & 3.2.2
Install Power Meters *(cost per pump)*		$5,000			3.1
Pheasant Run Add PLC-based controls and level transmitter			$30,000		3.1
7th and Division Add PLC-based controls and level transmitter			$30,000		
Woods of Fox Glen Add PLC-based controls			$25,000		
Kingswood Replace cellular router and connect to pump control PLC		$8,500			
Country Club Add PLC-based controls			$25,000		
Royal Fox 1 Replace cellular router and connect to pump control PLC		$8,500			
Reneaux Replace cellular router and connect to pump control PLC		$8,500			
Oak Crest Add PLC-based controls			$25,000		
Red Gate Add PLC-based controls			$25,000		
Wild Rose Add PLC-based controls and level transmitter			$30,000		

Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
Zylstra Add PLC-based controls			$25,000		
Pine Ridge Add PLC-based controls			$25,000		
Wasshington Add PLC-based controls and level transmitter			$30,000		
TOTALS		**$30,500**	**$270,000**	$74,000	

Table 7 – Budget Cost Summary for SCADA Hardware/Software

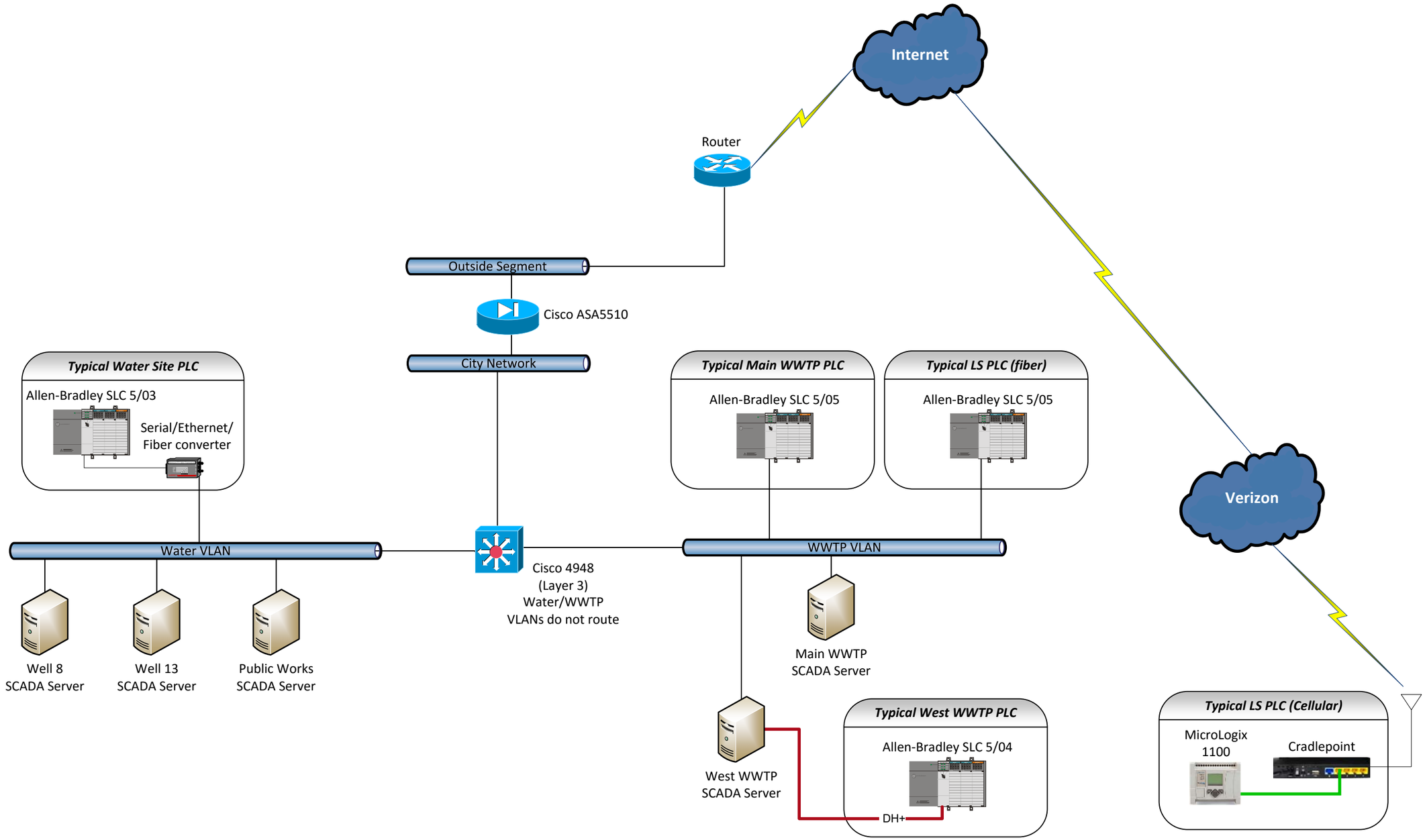
Scope of Work	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost	Reference Section
SCADA Server Hardware/Software Upgrade (includes alarm software)	$145,000				3.2.1 & 3.2.2
TOTALS	**$145,000**				

4.1 Total Budget Cost Summary Table

The following table provides a summary of the all of the costs for each phase of implementation, combining all facilities and recommendations.

Table 8 – Budget Cost Summary for Complete Improvements

	Phase 1 Cost	Phase 2 Cost	Phase 3 Cost	Phase 4 Cost
Main WWTP Upgrades	$6,000	$0	$0	$265,500
West WWTP Upgrades	$6,000	$20,000	$115,500	$620,000
Water Site Upgrades	$0	$346,000	$120,000	$0
Lift Station Upgrades	$0	$30,500	$270,000	$74,000
SCADA Hardware/Software Upgrades	$145,000	$0	$0	$0
TOTALS	**$157,000**	**$396,500**	**$505,500**	**$959,500**



REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016

City of St. Charles, Illinois

Network Diagram
Overview

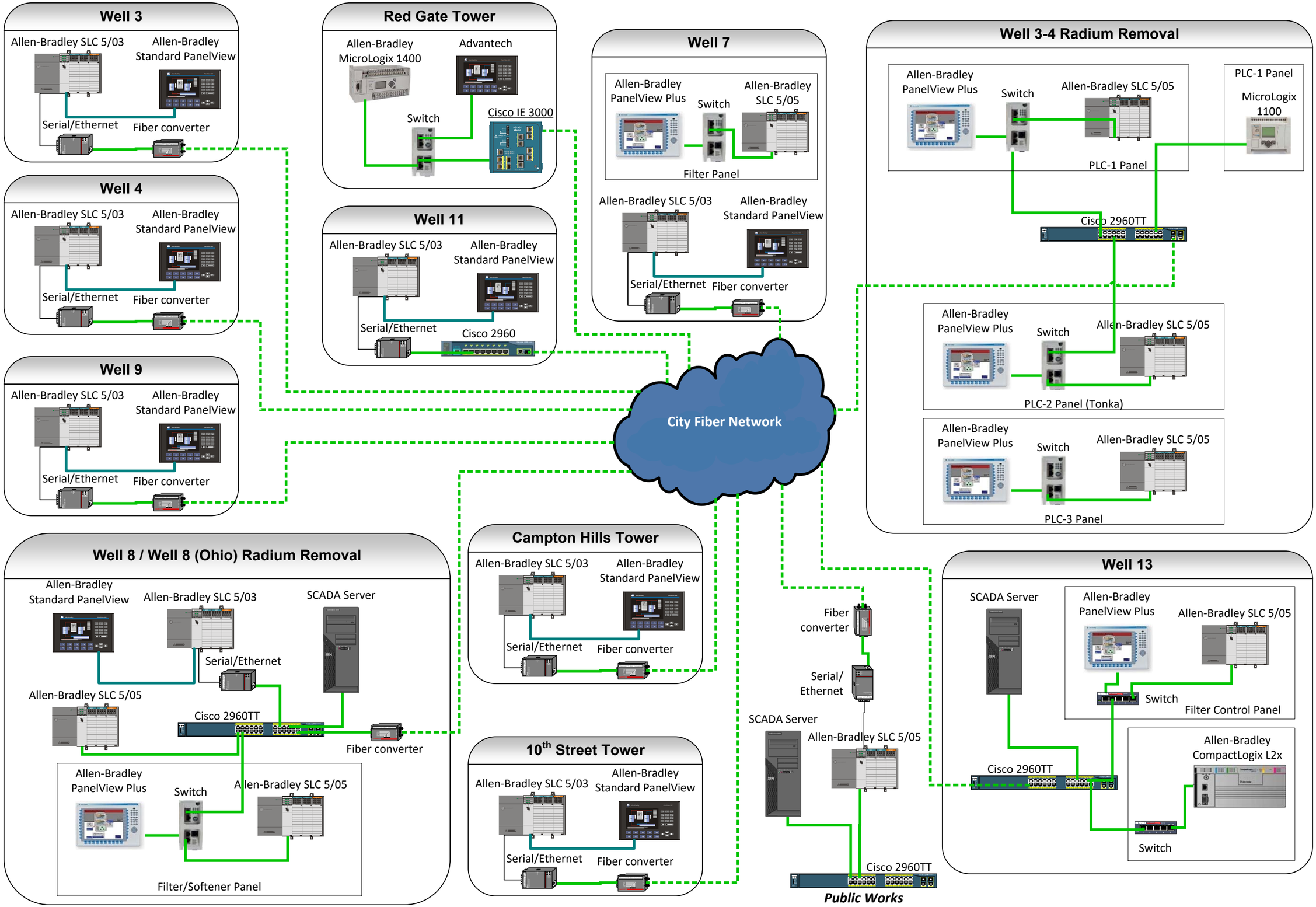
B&W Control Systems Integration

8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	**LAK**

Client ID: **STCHS**

SHEET: **1 of 1**



REVISIONS

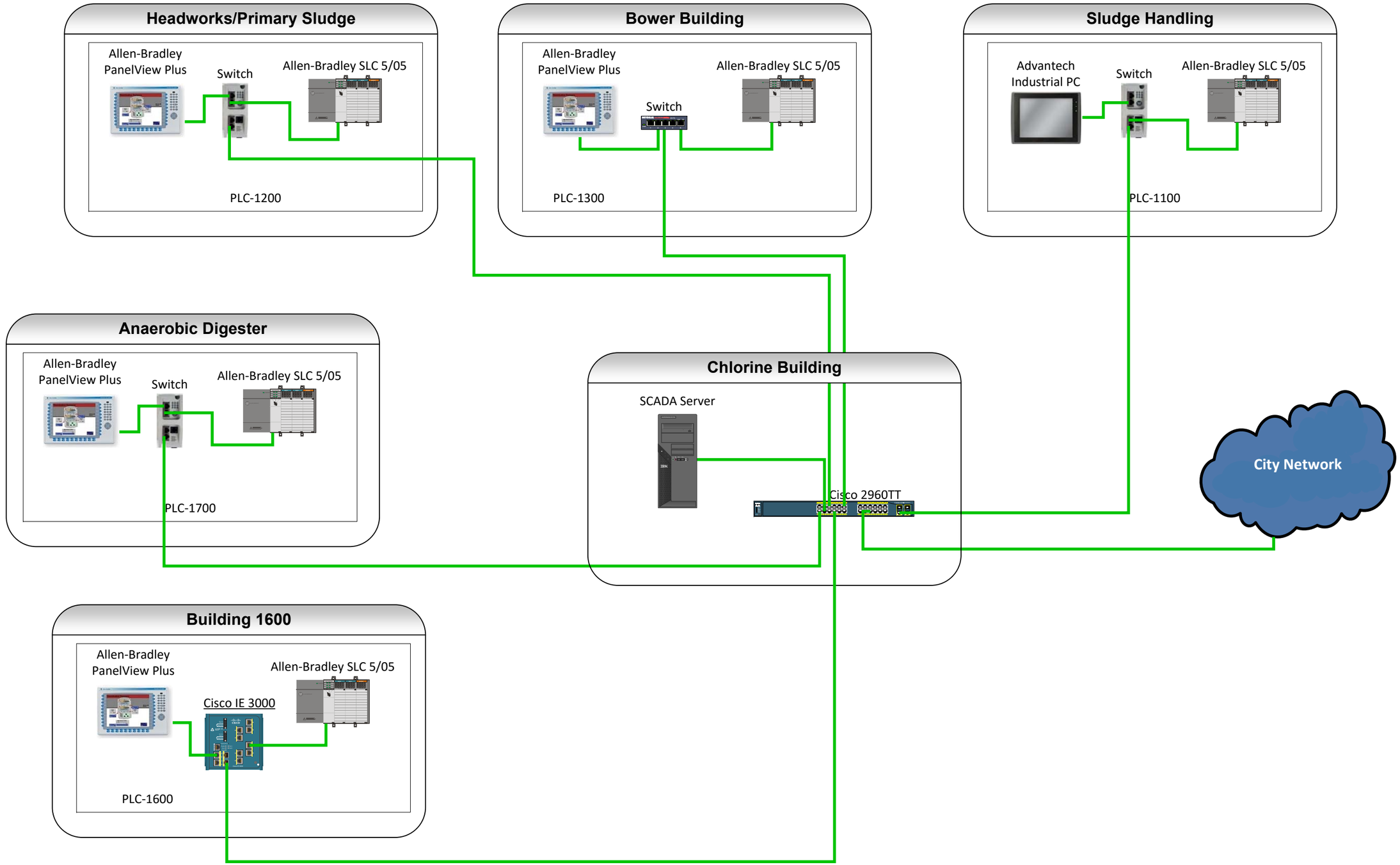
No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	MDK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

Network Diagram – Water System
Existing Physical – Layer 1

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
www.bwcsi.com
(815) 788-3600

Created: 3/2017	By: MDK
Client ID:	STCHS
SHEET:	1 of 1



Note: Physical routing of Ethernet cables requires field verification

REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	MDK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

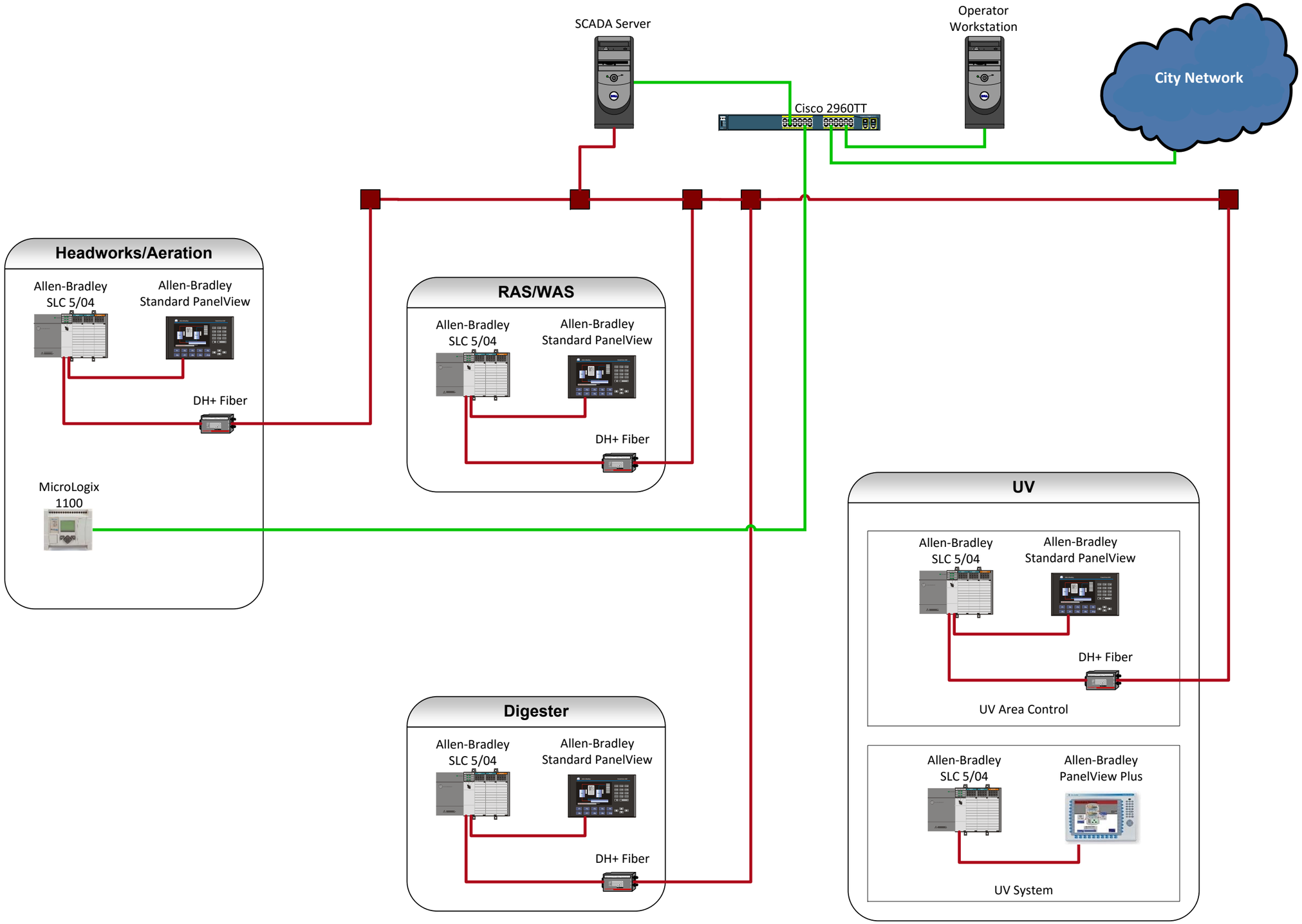
Network Diagram – Main WWTP
Existing Physical - Layer 1

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	**MDK**

Client ID: **STCHS**

SHEET: **1 of 1**



Note: Physical routing of DH+ cables requires field verification

REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	MDK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

Network Diagram – West WWTP
Existing Physical - Layer 1

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
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Created: 9/1/2016 By: MDK

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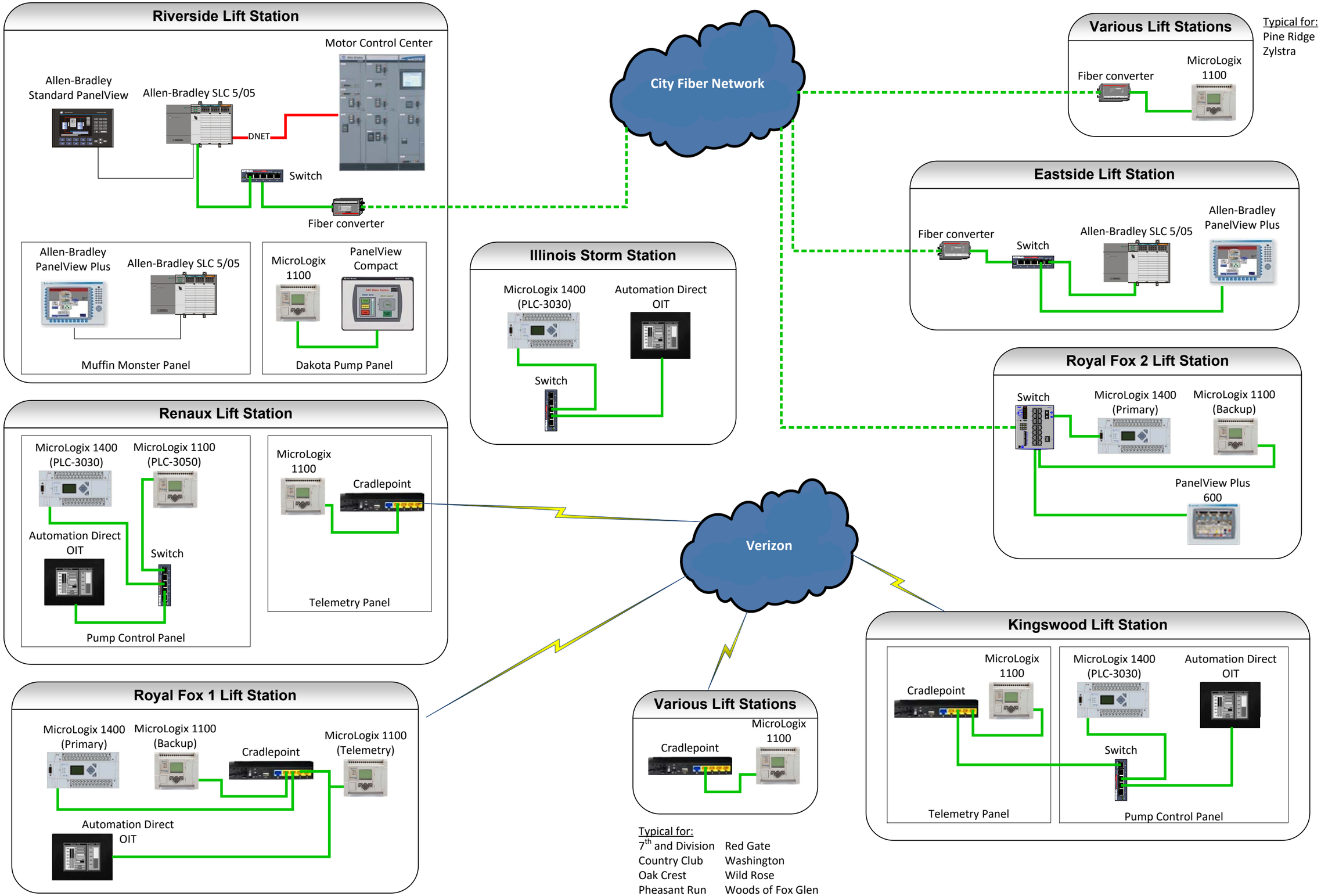

REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	MDK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

Network Diagram – Lift Stations
Existing Physical - Layer 1

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

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Client ID:	STCHS
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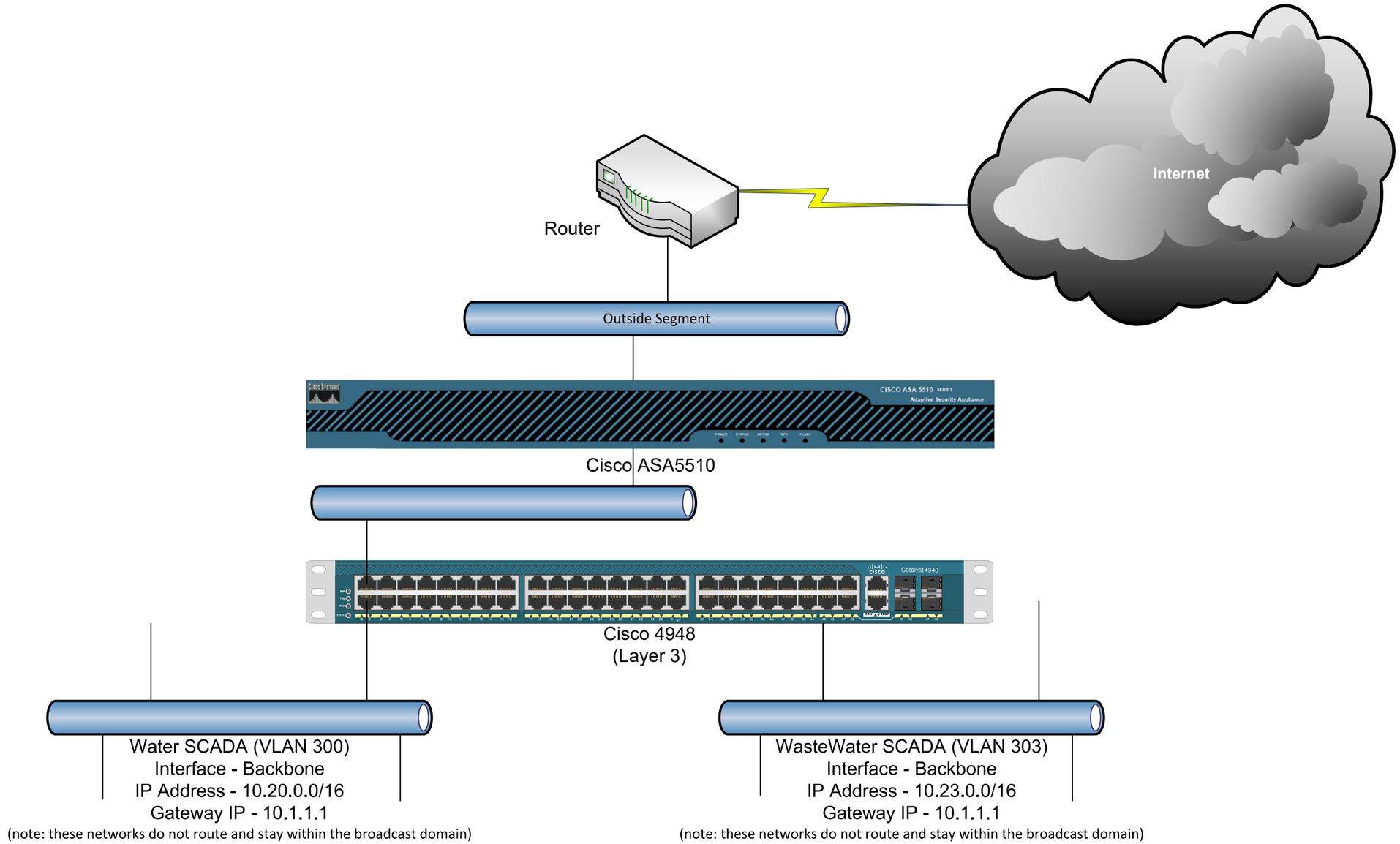

NOTE: For detailed VLAN diagram refer to City's IT network diagram.

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City of St. Charles, Illinois

Network Diagram
Network - Layer 3

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	**LAK**

Client ID: **STCHS**

SHEET: **1 of 1**

Public Works

SCH_H20_M-PC
OS: Microsoft Windows 7
Wonderware Dev Studio Unlim/60k/500
SCADA Alarm
10.20.42.150

Well 13

w13-wd-scadaserver
OS: Microsoft Windows 7 Pro
Wonderware Dev Studio Unlim/60k/500

Well 8

wl8-scada-srv1
OS: Microsoft Windows XP
Wonderware Dev Studio 250/500/100

Main Treatment Plant

MainSCADA
OS: Microsoft Windows Server 2008
Wonderware Dev Studio Unlim/60k/500
Win911
IP: 10.23.52.160/16

Main WWTP PLC-1100

Advantech Industrial PC
OS: Microsoft Windows 7
Wonderware Intouch Runtime 3k tag w/I/O

West Treatment Plant

SCADA
OS: Windows XP
Wonderware InTouch Dev. 3,000 tag
IP: 10.23.52.100/16

REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

Network Diagram
SCADA Software

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created: 9/1/2016
By: LAK

Client ID: STCHS

SHEET: 1 of 1

EXHIBIT B

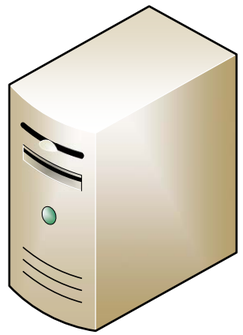
City of St. Charles
SCADA Equipment Inventory
and Replacement Plan

Panel	Category	PLC	PLC Status	PLC Replacement	OIT	OIT Status	OIT Replacement
PW	Water	SLC 5/05	Active Mature	CompactLogix L36	N/A	N/A	N/A
Well 3 & 4 - PLC-3 (Well)	Water	SLC 5/05	Active Mature	CompactLogix L36	2711P-T15C4D1	Discontinued	None
Well 3 & 4 - PLC-2 (Tonka)	Water	SLC 5/05	Active Mature	CompactLogix L36	2711P-T15C4D1	Discontinued	None
Well 3 & 4 - PLC-1 (Supervisory)	Water	SLC 5/05	Active Mature	CompactLogix L36	2711P-T15C4D1	Discontinued	None
Well 3 & 4 (Well 3 - Flolo)	Water	SLC 5/03	Active Mature	CompactLogix L30	N/A	N/A	N/A
Well 3 & 4 (Well 4 - Flolo)	Water	SLC 5/03	Active Mature	CompactLogix L30	N/A	N/A	N/A
Well 7	Water	SLC 5/03	Active Mature	CompactLogix L33	2711-B6C3	Discontinued	PanelView Plus 7 700
Well 8 (Main)	Water	SLC 5/05	Active Mature	CompactLogix L36	2711P-T12C4D2	Discontinued	None
Well 8 (Small Panel)	Water	SLC 5/05	Active Mature	CompactLogix L30	N/A	N/A	N/A
Well 8 (SCADA)	Water	SLC 5/03	Active Mature	CompactLogix L33	2711-B6C3	Discontinued	PanelView Plus 7 700
Well 9	Water	SLC 5/03	Active Mature	CompactLogix L30	2711-B6C3	Discontinued	PanelView Plus 7 700
Well 11	Water	SLC 5/03	Active Mature	CompactLogix L30	2711-B6C3	Discontinued	PanelView Plus 7 700
Well 13 (Large Panel)	Water	SLC 5/03	Active Mature	CompactLogix L36	PanelView Plus 1500	Discontinued	None
Well 13 (Small Panel)	Water	Compact L23E	Discontinued	None	N/A	N/A	N/A
10th_Tower	Water	SLC 5/03	Active Mature	MicroLogix 1400	2711-B6C3	Discontinued	PanelView Plus 7 700
CH_Tower	Water	SLC 5/03	Active Mature	MicroLogix 1400	2711-B6C3	Discontinued	PanelView Plus 7 700
RG_Tower	Water	Micro 1400	Active	None	Maple Systems	Active	None
MainWWTP (Headworks PLC-1200)	WWTP	SLC 5/05	Active Mature	CompactLogix L33	2711P-T10C15D1	Discontinued	None
MainWWTP (Primary Sludge PLC-1201)	WWTP	SLC 5/05	Active Mature	CompactLogix L33	2711P-T10C15D1	Discontinued	None
MainWWTP (Aeration PLC-1300)	WWTP	SLC 5/05	Active Mature	CompactLogix L33	2711P-T10C15D1	Discontinued	None
MainWWTP (Anaerobic Digester PLC-1700)	WWTP	SLC 5/05	Active Mature	CompactLogix L36	2711P-T10C15D1	Discontinued	None
MainWWTP (Sludge Handling PLC-1100)	WWTP	SLC 5/05	Active Mature	CompactLogix L36	Advantech IPPC-6172A	Active	
MainWWTP (UV Building 1600)	WWTP	SLC 5/05	Active Mature	CompactLogix L36	2711P-T10C15D1	Discontinued	None
MainWWTP (UV System PLC)	WWTP	Compact L35E	Discontinued	None	2711P-T7xxxx	Discontinued	None
WestWWTP (Headworks/Aeration PLC-2201)	WWTP	SLC 5/04	Active Mature	CompactLogix L36	2711E-K10C6	Discontinued	PanelView Plus 7 1000
WestWWTP (Headworks/Aeration - Alarm PLC)	WWTP	Micro 1100	Active	None	N/A	N/A	N/A
WestWWTP (RAS/WAS PLC-2701)	WWTP	SLC 5/04	Active Mature	CompactLogix L33	2711E-K10C6	Discontinued	PanelView Plus 7 1000
WestWWTP (Digester)	WWTP	SLC 5/04	Active Mature	CompactLogix L33	2711E-K10C6	Discontinued	PanelView Plus 7 1000
WestWWTP (UV PLC-2601)	WWTP	SLC 5/04	Active Mature	CompactLogix L33	2711E-K10C6	Discontinued	PanelView Plus 7 1000
WestWWTP (UV - MFR Panel)	WWTP	SLC 5/04	Active Mature	CompactLogix L30	PanelView Plus 600	Discontinued	None
7th and Division LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Country Club LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Eastside LS (Main PLC)	LS	SLC 5/05	Active Mature	CompactLogix L33	2711P-T10xxxx	Discontinued	PanelView Plus 7 1000
Eastside LS (Muffin Monster)	LS	?			2711P-B10C4D1?	Discontinued	PanelView Plus 7 1000
Illinois Storm (Pump Control)	LS	Micro 1400	Active	None	Automation Dir ?	?	?
Kingswood LS (Comms RTU)	LS	Micro 1100	Active	None	N/A	N/A	N/A
Kingswood LS (Pump Control)	LS	Micro 1400	Active	None	Automation Dir ?	?	?
Oak Crest LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Pheasant Run LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Pine Ridge LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Red Gate LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Reneaux Manor LS (Main PLC 1)	LS	Micro 1400	Active	None	Automation Dir EA7-T8C	Active	None

City of St. Charles
SCADA Equipment Inventory
and Replacement Plan

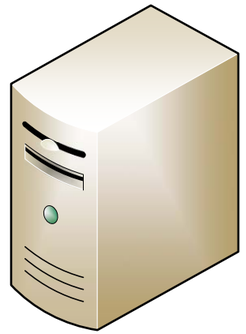
Panel	Category	PLC	PLC Status	PLC Replacement	OIT	OIT Status	OIT Replacement
Reneaux Manor LS (Main PLC 2)	LS	Micro 1100	Active	None	N/A	N/A	N/A
Reneaux Manor LS (Telemetry)	LS	Micro 1100	Active	None	N/A	N/A	N/A
Riverside LS (Dakota Pump)	LS	Micro 1100	Active	None	PanelView C600	Discontinued	PanelView Plus 7 700
Riverside LS (Main in MCC)	LS	SLC 5/05	Active Mature	CompactLogix L33	2711-K10C16	Discontinued	PanelView Plus 7 1000
Riverside LS (Muffin Monster)	LS	SLC 5/05	Active Mature	CompactLogix L33	2711P-B10C4D1	Discontinued	None
Royal Fox 1 LS (Comms RTU)	LS	Micro 1100	Active	None	N/A	N/A	N/A
Royal Fox 1 LS (Backup Float Control)	LS	Micro 1100	Active	None	N/A	N/A	N/A
Royal Fox 1 LS (Primary Pump Control)	LS	Micro 1400	Active	None	2711P-T6C20D8	Active	None
Royal Fox 2 LS (Backup Float Control)	LS	Micro 1100	Active	None	N/A	N/A	N/A
Royal Fox 2 LS (Primary Pump Control)	LS	Micro 1400	Active	None	2711P-T6C20D8	Active	None
Washington LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Wild Rose LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Woods of Fox Glen LS	LS	Micro 1100	Active	None	N/A	N/A	N/A
Zylstra LS	LS	Micro 1100	Active	None	N/A	N/A	N/A

EXHIBIT C

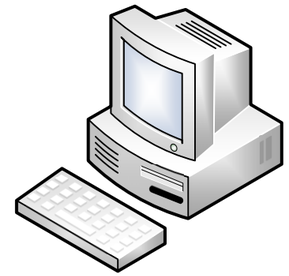


Virtualized
SCADA Server
Software Installed
- Windows 2012 R2 Standard
- SCADA Software
- Win911 Intermediate (SIP)
- Managed Antivirus
- AD Integration

(behind SCADA inline firewall)

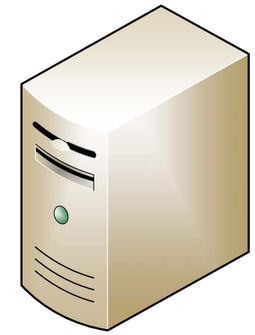


Virtualized
Remote Desktop Server
Software Installed
- Windows 2012 R2 Standard
- Windows RDS Licensing Server
- Windows RDS Licenses
- SCADA Software
- Managed Antivirus
- AD Integration

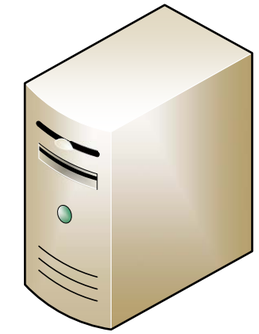


SCADA Client Workstation
RDS Connection to SCADA RDS Server
- Windows 10 Pro or thin client OS

City Hall

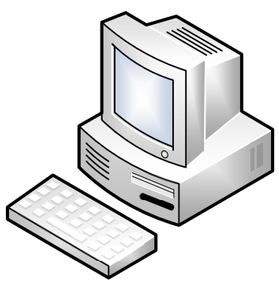


Virtualized
Win911 Mobile Server
Software Installed
- Windows Operating system (can be Windows 10)
- Win911 Mobile Application
- Managed Antivirus
- AD Integration



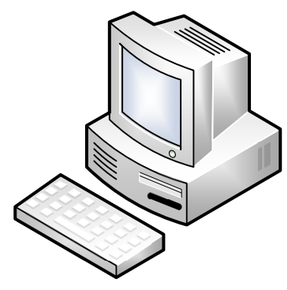
Virtualized
- Failover Servers

Well 13



SCADA Client Workstation
RDS Connection to SCADA RDS Server
- Windows 10 Pro or thin client OS

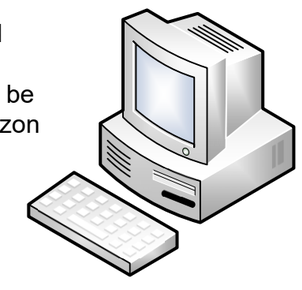
Well 8



SCADA Client Workstation
RDS Connection to SCADA RDS Server
- Windows 10 Pro or thin client OS

Other City Locations and Remote

Remote Access iPad
RDP
Note: This device could be on internet or using Verizon private



SCADA Client Workstation
RDS Connection to SCADA RDS Server
- Windows 10 Pro or thin client OS

REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

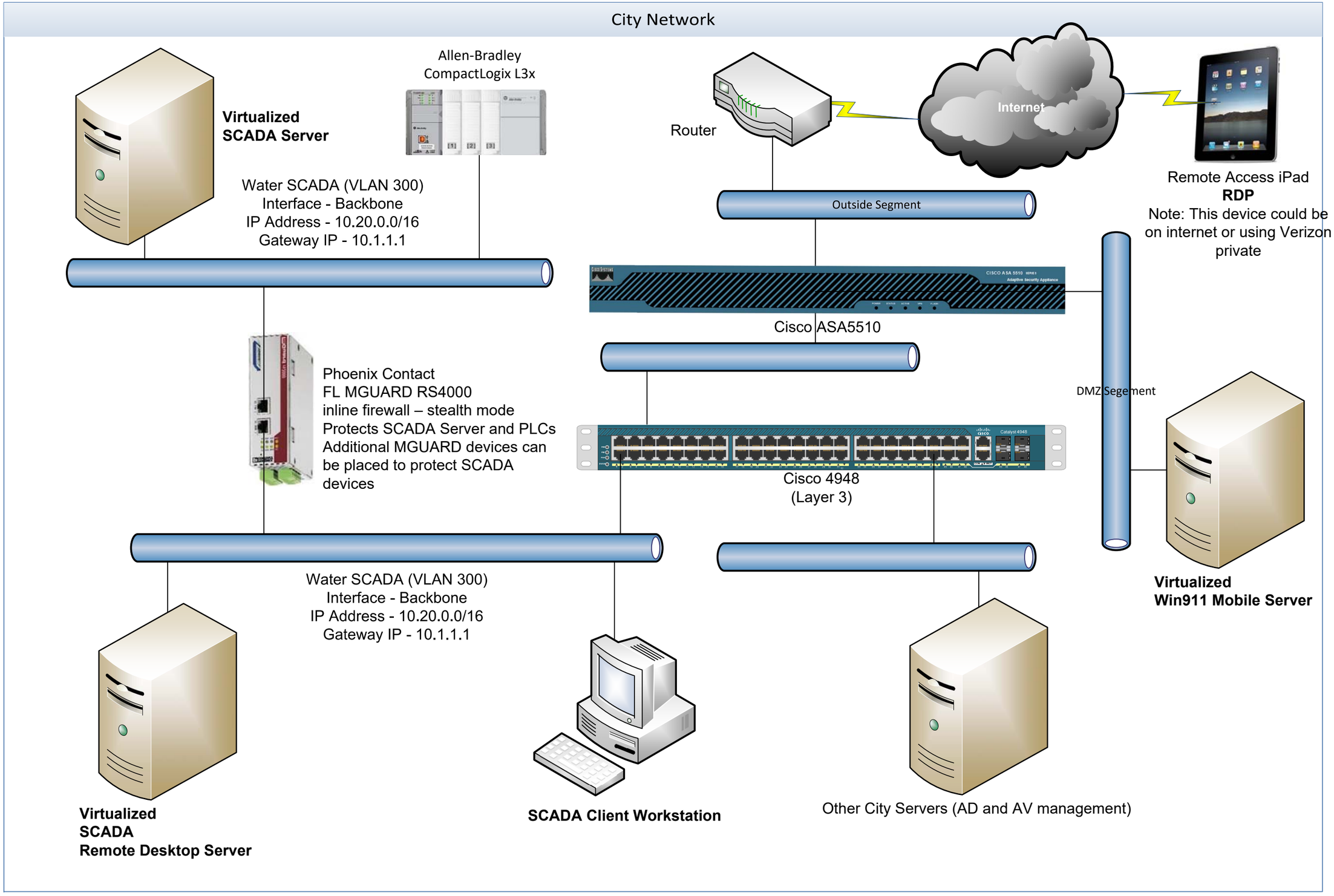
Network Diagram
SCADA Software – Water System Future

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	**LAK**

Client ID: **STCHS**

SHEET: **1 of 1**



REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016

City of St. Charles, Illinois

Network Diagram
Water SCADA Network - Future

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	LAK

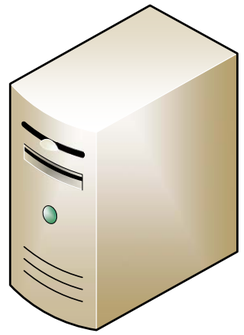
Client ID: STCHS

SHEET: 1 of 1

Public Works

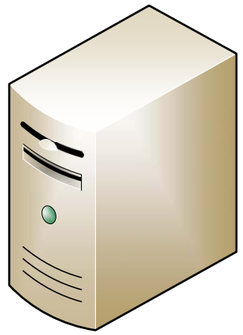
Virtualized
SCADA Server
- Windows 2012 R2 Standard
- SCADA Software
- Win911 Intermediate(SIP)
- Antivirus
- AD Integration

(behind SCADA inline firewall)



Virtualized
Remote Desktop Server
- Windows 2012 R2 Standard
- Windows RDS Licensing Server
- Windows RDS Licenses
- SCADA Software
- Managed Antivirus
- AD Integration

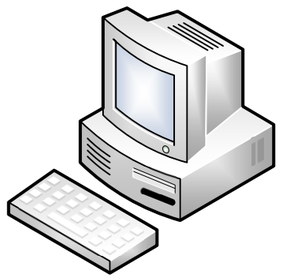
City Hall



Virtualized
Win911 Mobile Server
Software Installed
- Windows Operating system (can be Windows 10)
- Win911 Mobile Application
- Managed Antivirus
- AD Integration

Virtualized
- Failover Servers

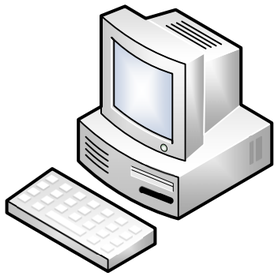
Other City Locations and remote



SCADA Client Workstation
RDS Connection to SCADA RDS Server
- Windows 10 Pro or thin client OS

Remote Access iPad
RDP
Note: This device could be on internet or using Verizon private

Main Treatment Plant



SCADA Client Workstation
RDS Connection to SCADA RDS Server
- Windows 10 Pro or thin client OS

REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016
1	UPDATED FOR REPORT	MDK	3/18/2017

City of St. Charles, Illinois

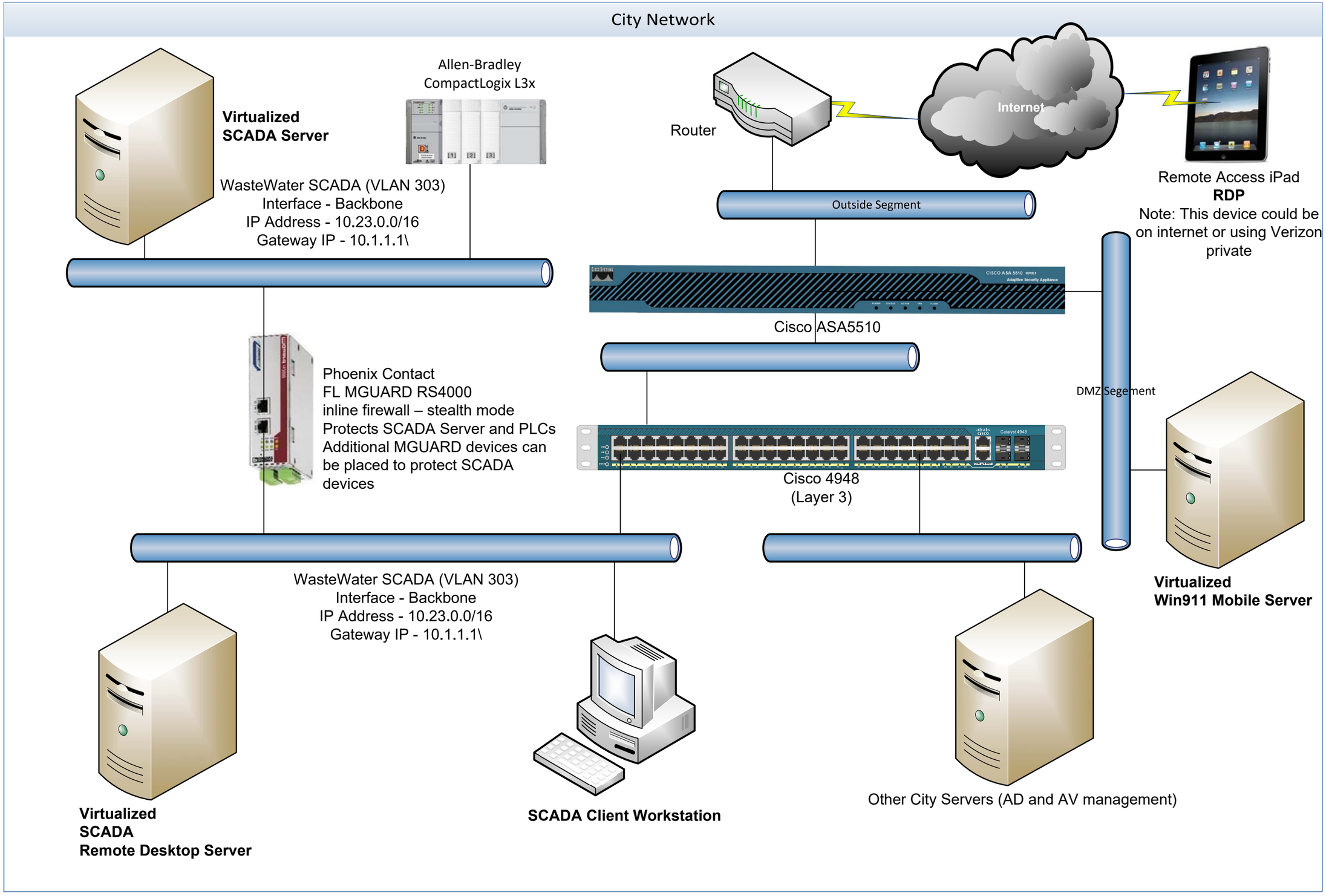
Network Diagram
SCADA Software – Wastewater Future

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	**LAK**

Client ID: **STCHS**

SHEET: **1 of 1**



REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016

City of St. Charles, Illinois

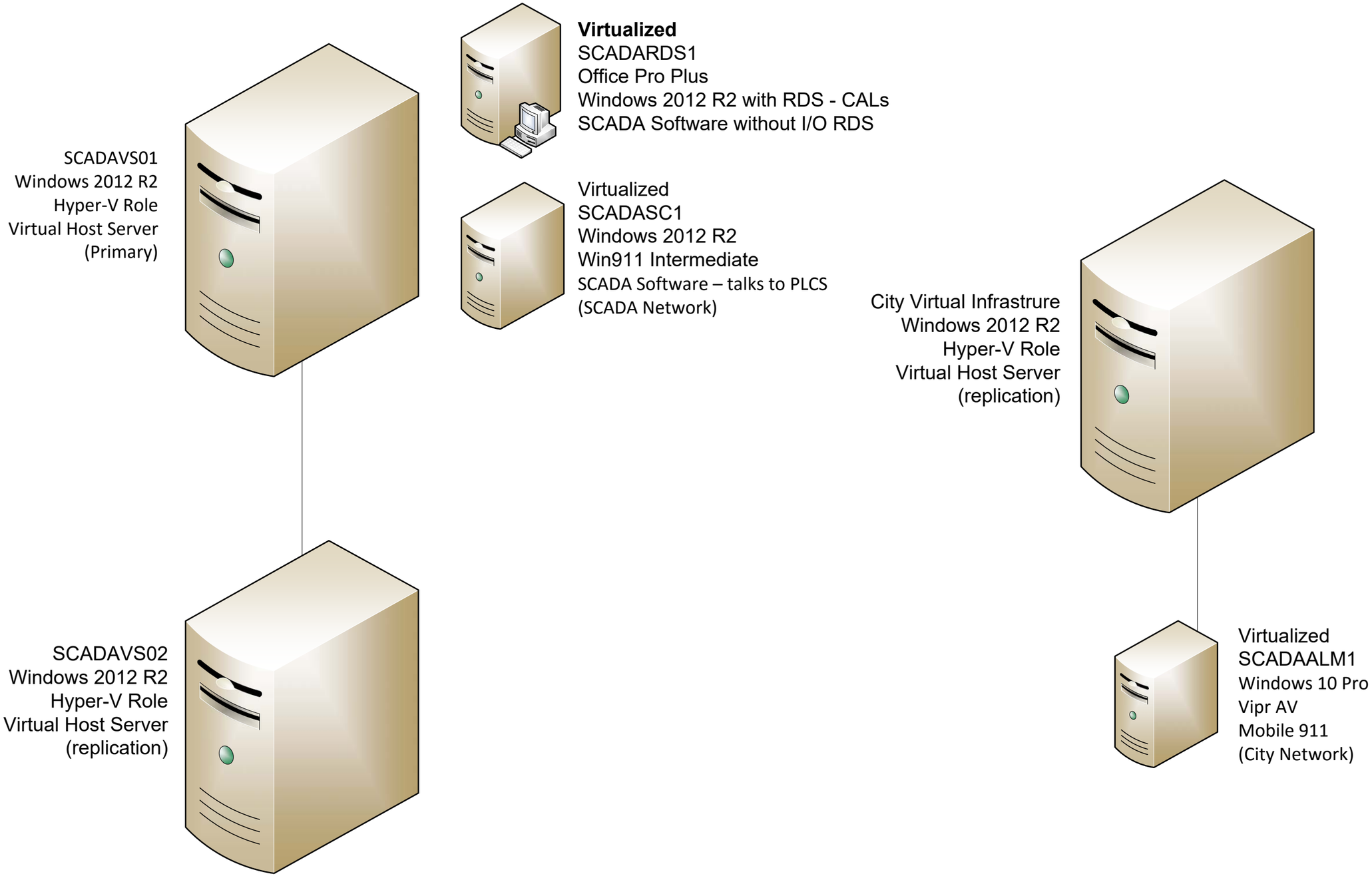
Network Diagram
Wastewater SCADA Network – Future

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	LAK

Client ID: STCHS

SHEET: 1 of 1



REVISIONS

No.	DESCRIPTION	BY	DATE
0	INITIAL RELEASE	LAK	9/1/2016

City of St. Charles, Illinois

Network Diagram
Virtualized Infrastructure

B&W Control Systems Integration
8678 Ridgefield Rd.
Crystal Lake, IL 60012
ww.bwcsi.com
(815) 788-3600

Created:	By:
9/1/2016	**LAK**

Client ID: **STCHS**

SHEET: **1 of 1**

September 6, 2017

Mr. Tim Wilson
Environmental Services Manager - Public Works
City of St. Charles
2 E. Main Street
St. Charles, IL 60174

Subject: SCADA Program Management - Phase 1 (Hardware & Software Upgrades)

Dear Mr. Wilson:

The City of St. Charles provides water and wastewater services for approximately 33,000 residents, as well as businesses and other institutions. A network of groundwater treatment facilities, water distribution, two wastewater plants, 17 wastewater pumping stations, communications, and electrical distribution all fall under the City's responsibility. City water and wastewater utility leadership worked closely with Concentric Integration over the past year to identify key areas of improvement for Supervisory Control and Data Acquisition (SCADA). During the Master Plan project, it became apparent to our leadership that the City really wants to do more than "keep the lights on;" staff really wants to improve quality and the efficiency of their operations.

Most all water and wastewater treatment and pumping facilities require continuous operation, and St. Charles' facilities are no different. High levels of reliability and the ability to respond quickly to issues are critical requirements. Historically, the City maintains this level of reliability by utilizing selective automation, as well as monitoring and manually responding to abnormal situations when required. The City utilizes a SCADA system for each wastewater facility, as well as a third separate SCADA system for the water system. While the newest of the three SCADA systems at the Main WWTP is larger and more comprehensive, all three SCADA systems largely simply monitor existing equipment, provide a very limited amount of data acquisition (historical data collection and analysis), have no remote access options, and still require Public Works staff to manually collect and analyze data.

With the growing need to upgrade facilities to improve treatment (improved water treatment and distribution, or enhanced phosphorus removal, for example) and aging system and distribution infrastructure, City personnel really need improvements to their technology tools to continue operating efficiently and effectively into the future. To this end, modern comprehensive SCADA systems can provide efficient view, response, and automated control at each of the City's facilities, as well as securely and remotely. Additionally, modern SCADA systems also embrace a "Smart City vision" by focusing on

green technologies, such as optimizing energy usage by automated process control and automated reporting, as well as simply making operators aware of how changing process and influent flow characteristics impact energy resource efficiency.

The SCADA System Master Plan that was completed earlier this year focuses on the phased strategic and specific steps recommended to implement appropriately automated, efficiently managed, energy optimized and securely and flexibly accessible facilities across the City. This SCADA Program Management proposal lays out the first phase of improvements designed to eliminate obsolete equipment, optimize and further secure communications, and enable water and wastewater utility staff to take advantage of significantly improved data acquisition. The City should note that there is a significant amount of recommendations beyond this largely "hardware and software" upgrade phase that will provide more impactful improvements to the operation of the water and wastewater systems.

The SCADA system improvements in this first phase involve a large amount of equipment that will be purchased/bid out, electrical subcontracting that will be bid out, Information Technology (IT) improvements coordinated with City staff, installation at remote sites, as well as professional services to oversee, program, coordinate, and provide a single point of responsibility for the City. Because of Concentric's close collaboration with staff during the planning phase of the improvements, we would propose the opportunity to continue to work with the City overseeing the improvements the City has budgeted for.

Following is a detailed Scope of Services to oversee the City's first SCADA System Improvements Program. It is our hope and expectation that if year one of this is successful, we would appreciate the opportunity to continue the second phase.

Scope of Services

Division of Work

Concentric Integration will be responsible for project management, detailed design, equipment procurement, sub-contracting coordination, programming (including Information Technology and security-related configuration), and start-up.

Concentric Integration will solicit quotes from multiple panel fabricators to obtain the most cost effective panel fabrication costs for new control panels.

Concentric Integration will solicit proposals from qualified electricians to perform equipment installation to obtain the most cost effective installation costs.

SCADA Infrastructure

The existing SCADA server architecture will be modified such that the existing SCADA servers for the Main WWTP, West WWTP, and Water/Lift Station Systems will be consolidated into a single server application and converted into a hardware redundant platform similar to the City's advanced virtualization IT infrastructure. This new SCADA server platform will be fully virtualized to allow more efficient use of server hardware, and allow for City IT to provide daily backups, which should allow for 1 day (or faster) restoration in the event of a catastrophic failure.

A second virtual server, used for Remote Desktop Services (RDS), will be configured to allow multiple authorized water and wastewater operators and managers to view SCADA simultaneously at any WWTP, Water Plant, Public Works, City Hall, or remotely using devices such as thin clients or tablets (with proper credentials).

The following SCADA Hardware and Software scope items are included:

- SCADA Server hardware and associated operating system, virtualization, replication, backup, and similar software licensing, including SCADA thick client machines, as indicated below. Note that all support agreements are from the date of purchase, not necessarily the date of beneficial use.
    - Two (2) HP Proliant DL380 virtual host servers, each with 64GB RAM, six 600GB hard drives with RAID controller, redundant power supplies, 3 year 24x7 4-hour response/support.
    - Six (6) HP Z440 workstation computers with six (6) 24" LCDs, four (4) 80" LCDs and two (2) 65" LCDs.
    - Twelve (12) Microsoft Windows Server 2016 single core licenses with Software Assurance for 1 year.
    - Twenty (20) Microsoft Windows User CAL licenses with Software Assurance for 1 year.
    - Twenty (20) Microsoft Windows Remote Desktop Services licenses with Software Assurance for 1 year.
    - Eight (8) Microsoft Office Pro licenses with Software Assurance for 1 year.
    - Two (2) licenses of SteelEye DataKeeper Cluster Edition replication software, including one year of support.
    - Two (2) licenses of Veeam Backup and Replication Enterprise Plus for Hyper-V, including one year of support.
- SCADA network equipment as follows:
    - One (1) Full height (42U) network rack enclosure with one 48-port copper and one 12-port fiber patch panel, rack-mount Uninterruptible

Power Supply (UPS), power distribution units, cable management, and LCD KVM. Rack will be installed in Public Works SCADA closet (where the existing master Programmable Logic Controller (PLC) is located).

- One (1) Cisco ASA5516 firewall with one year of SMARTnet support and FirePOWER services.

- All labor associated with the SCADA server replacement, including fully redeveloping all SCADA system graphics, SCADA server configuration, SCADA client configuration, network device configuration, Historian configuration, installation and testing.

The SCADA Software licenses (including SCADA graphics package, enterprise historian, and alarming software) are included in the cash allowance indicated in the Fee section.

Water System Improvements

When this phase is complete, the City will have replaced all of the "Active Mature" Allen Bradley Small Logic Controller (SLC) PLCs with fully supported Ethernet-based CompactLogix PLCs for all of the water sites (including the master site). In specific:

- Replace existing Allen-Bradley SLC Series PLCs with CompactLogix Series (L30, L33 or L36) PLCs at Well sites, and replace with MicroLogix 1400 PLCs at Water Tower sites.
- Replace existing Standard PanelViews with PanelView Plus Operator Interface Terminals (OITs).
- Migrate existing PLC programs from SLC Series PLCs to the CompactLogix or MicroLogix PLCs.
- Migrate existing Standard PanelView programs to the PanelView Plus OITs.
- Replace existing backup alarm dialer with Sensaphone SCD-PRO dialer.
- Existing control panel enclosures and other components not being replaced are to remain.
- Refer to tables below for specific control panels where PLCs and Operator Interface Terminals (OIT) are being replaced.

P/N	Description	Well 3/4 PLC-1	Well 3/4 PLC-2	Well 3/4 PLC-3	Well 3/4 Well 3	Well 3/4 Well 4
1769-L30ER	L30 PLC				1	1
1769-L33ER	L33 PLC					
1769-L36ERM	L36 PLC	1	1	1		

P/N	Description	Well 3/4 PLC-1	Well 3/4 PLC-2	Well 3/4 PLC-3	Well 3/4 Well 3	Well 3/4 Well 4
1769-SDN	DeviceNet Mod					
1769-PA2	Power Supply, 2A				1	1
1769-PA4	Power Supply, 4A	1	1	2		
1769-IF4I	4 Ch Analog In	1				1
1769-IF8	8 Ch Analog In	1	2	4		
1769-IF16C	16 Ch Analog In					
1769-OF4CI	4 Ch Analog Out	1	1	4		
1769-OW8I	8 Pt Relay Out				1	1
1769-OW16	16 Pt Relay Out	2		1		
1769-OA8	8 Pt AC Out					
1769-OA16	16 Pt AC Out					
1769-OV16	16 Pt DC Out					
1769-IA8I	8 Pt AC Input					
1769-IA16	16 Pt VAC In	1	4		1	1
1769-IQ16	16 Pt 24 VDC	1		3		
1769-IQ32	32 Pt DC In		4			
2711P-B7C22A9P	PV Plus 7 700					

P/N	Description	Water MTU	Well 7	Well 8 Treatment	Well 8 Chem	Well 8 SCADA
1769-L30ER	L30 PLC				1	
1769-L33ER	L33 PLC		1			1
1769-L36ERM	L36 PLC	1		1		
1769-SDN	DeviceNet Mod					
1769-PA2	Power Supply, 2A	1			1	
1769-PA4	Power Supply, 4A		1	2		1
1769-IF4I	4 Ch Analog In		1		1	2
1769-IF8	8 Ch Analog In			3		
1769-IF16C	16 Ch Analog In					
1769-OF4CI	4 Ch Analog Out			1		1
1769-OW8I	8 Pt Relay Out		1		1	2
1769-OW16	16 Pt Relay Out			5		
1769-OA8	8 Pt AC Out					
1769-OA16	16 Pt AC Out					
1769-OV16	16 Pt DC Out					
1769-IA8I	8 Pt AC Input					
1769-IA16	16 Pt VAC In			7		3
1769-IQ16	16 Pt 24 VDC	1	3		1	
1769-IQ32	32 Pt DC In					
2711P-B7C22A9P	PV Plus 7 700		1			1

P/N	Description	Well 9	Well 11	Well 13	10th St Tower	Campton Hills Twr
1769-L30ER	L30 PLC	1	1			
1769-L33ER	L33 PLC			1		

P/N	Description	Well 9	Well 11	Well 13	10th St Tower	Campton Hills Twr
1769-L36ERM	L36 PLC					
1769-SDN	DeviceNet Mod					
1769-PA2	Power Supply, 2A	1				
1769-PA4	Power Supply, 4A		1	3		
1769-IF4I	4 Ch Analog In	1	2	5		
1769-IF8	8 Ch Analog In					
1769-IF16C	16 Ch Analog In					
1769-OF4CI	4 Ch Analog Out	1				
1769-OW8I	8 Pt Relay Out	1	1	3		
1769-OW16	16 Pt Relay Out			3		
1769-OA8	8 Pt AC Out					
1769-OA16	16 Pt AC Out					
1769-OV16	16 Pt DC Out					
1769-IA8I	8 Pt AC Input			7		
1769-IA16	16 Pt VAC In		2			
1769-IQ16	16 Pt 24 VDC	1		4		
1769-IQ32	32 Pt DC In					
2711P-B7C22A9P	PV Plus 7 700	1	1		1	1
1766-L32BXB	MicroLogix 1400				1	1
1762-IF4	4 Ch AI				1	1

Lift Station Improvements

Lift Stations with existing Float Control

- This scope applies to lift stations that currently only have hard-wired float controls, including the following sites: Pheasant Run, 7th and Division, Wild Rose, and Washington.
- Provide new PLC-based control panel and submersible level transducer to replace existing float-based control system.
- Rewire existing floats to operate a backup float control system to be used in the event that the new PLC-based control system faults. City is responsible to ensure existing floats operate correctly and are in the correct locations.
- Provide lift station control panel consisting of the following components mounted inside an outdoor-rated fiberglass enclosure:
    - Allen-Bradley MicroLogix 1400 PLC, or equal.
    - Allen-Bradley 7" PanelView Plus OIT, or equal.
    - Industrial Cellular Router.
    - Uninterruptible Power Supply System.
    - Heater.
    - Other miscellaneous components as required for a complete panel.

- Install level transducer in wet well with conduit/wire as required to connect to PLC control panel.
- Program PLC and OIT to control pumps based on wet well level.

Lift Stations with existing non-PLC based Level Control

- This scope applies to lift stations that currently use a level transducer with a non-PLC based level controller, including the following sites: Woods of Fox Glen, Country Club, Oak Crest, Red Gate, Zylstra, and Pine Ridge.
- Provide new PLC-based control panel to replace existing control system.
- Rewire existing floats to operate a backup float control system to be used in the event that the new PLC-based control system faults.
- Provide PLC-based control panel consisting of the following components mounted inside an outdoor-rated fiberglass enclosure:
    - Allen-Bradley MicroLogix 1400 PLC, or equal.
    - Allen-Bradley 7" PanelView Plus OIT, or equal.
    - Industrial Cellular Router.
    - Uninterruptible Power Supply System.
    - Heater.
    - Other miscellaneous components as required for a complete panel.
- Program PLC and OIT to control pumps based on wet well level.

Lift Stations with existing SLC 500 Series PLCs

- This scope applies to lift stations that currently have Allen-Bradley SLC 500 Series PLCs, including the following sites: Eastside and Riverside.
- Replace existing Allen-Bradley SLC Series PLCs with CompactLogix Series (L30, L33 or L36) PLCs.
- Replace existing Standard PanelViews with PanelView Plus OITs.
- Migrate existing PLC programs from SLC Series PLCs to the CompactLogix or MicroLogix PLCs.
- Migrate existing Standard PanelView programs to the PanelView Plus OITs.
- Existing control panel enclosures and other components not being replaced are to remain.
- Refer to tables below for specific control panels where PLCs and OITs are being replaced.

P/N	Description	Eastside	Riverside Main PLC	Riverside Grinder	Riverside Dakota
1769-L30ER	L30 PLC				
1769-L33ER	L33 PLC	1	1	1	
1769-L36ERM	L36 PLC				
1769-SDN	DeviceNet Mod		1		
1769-PA2	Power Supply, 2A				
1769-PA4	Power Supply, 4A	1	1	1	
1769-IF4I	4 Ch Analog In		2		
1769-IF8	8 Ch Analog In	1		2	
1769-IF16C	16 Ch Analog In				
1769-OF4CI	4 Ch Analog Out				
1769-OW8I	8 Pt Relay Out	1	1	1	
1769-OW16	16 Pt Relay Out			1	
1769-OA8	8 Pt AC Out				
1769-OA16	16 Pt AC Out				
1769-OV16	16 Pt DC Out				
1769-IA8I	8 Pt AC Input				
1769-IA16	16 Pt VAC In		1	3	
1769-IQ16	16 Pt 24 VDC	2	3		
1769-IQ32	32 Pt DC In				
2711P-B10C22A9P	PV Plus 7 1000	1	1		
2711P-B7C22A9P	PV Plus 7 700				1

Lift Stations with existing MicroLogix Series PLCs

- This scope applies to lift stations that currently have Allen-Bradley MicroLogix 1100 or MicroLogix 1400 PLCs, including the following sites: Kingswood, Royal Fox, and Reneaux.
- Replace existing cellular router with industrial cellular router.

Concentric Assumptions / Owner Responsibilities

- Owner will provide site access for installation, programming, and startup on normal business days between 7:00 am and 5:00 pm.
- Owner understands that all existing equipment to remain is assumed to be in good, working order. In the event that any other equipment does not perform as-expected, Concentric will work with the Owner to repair, as-needed, under a separate contract.
- Owner will dispose of/recycle any removed equipment.

Annual Support

This Project will add additional hardware and software to the Owner, some of which has support or maintenance associated with it. Concentric recommends the Owner maintain any applicable support agreements once the initial support/warranty periods expire. Specific pricing for these agreements cannot be provided at this time as the SCADA software selection has not been made. Once that selection is made, Concentric will provide the estimated annual support costs. Based on our preliminary design, we expect total annual support costs for manufacturer support contracts to be $30,000. The first year of support is included in the cash allowance indicated in the Fee section below.

Project Schedule

Concentric is available to begin work upon notice to proceed.

Our estimated project schedule will be agreed upon at the project kickoff meeting.

Warranty

The warranty listed in the attached Standard Terms & Conditions document (Paragraph 13):

☒ DOES apply
☐ DOES NOT apply

Fee

Our fee for the above scope includes a **large majority of SUBCONTRACTED and BID EQUIPMENT** that we will coordinate/facilitate on behalf of the City. The table below outlines the total cost to the City, but approximately $500,000 of subcontracted installation and equipment is planned for during this project, including an $85,000 cash allowance for SCADA software licensing (once finalized).

The fee for the overall SCADA Phase 1 project is summarized in the table below. The estimated sum total of the project is $997,000, with $490,000 being related to a direct contract with Concentric (this proposal), and the additional estimated $507,000 as sub-contracted and/or bid equipment, subject to future review of final pricing by the City as subcontracted and bid pricing is finalized.

	Concentric	Estimated Amounts		
Scope Item	**Labor**	**Subcontract**	**Equipment**	**Total**
Program, Project Management, and Subs Coordination	$95,000			**$95,000**
Design (Panel Drawings, network design, etc.)	$65,500			**$65,500**
Programming (PLC, PanelView, SCADA development)	$203,000			**$203,000**
IT server, computer, network configuration	$16,500			**$16,500**
Installation verification and QC/Testing	$110,000			**$110,000**
Subcontractors (Panel fabrication and electrical installation of level transmitters and control panels)		$66,000		**$66,000**
Materials/Equipment			$356,000	**$356,000**
Cash Allowance for SCADA Software Licensing			$85,000	**$85,000**
TOTAL	**$490,000**	**$66,000**	**$441,000**	**$997,000**

This agreement is valid for 90 days from the date of this proposal.

Terms & Conditions

Refer to attached Standard Terms & Conditions document.

Acceptance

If this **$490,000** proposal is acceptable, please sign one copy and return to us. Feel free to contact us if you have any questions.

Sincerely,

CONCENTRIC INTEGRATION, LLC

Michael D. Klein, PE
Automation Department Manager/Project Manager
MDK

Christopher T. Sosnowski, PE
President

CITY OF ST. CHARLES, ILLINOIS

ACCEPTED BY: _____

TITLE: _____

DATE: _____

Above signature implies acceptance of the attached ***STANDARD TERMS & CONDITIONS***

Standard Terms and Conditions

1. The submitted proposal and these Standard Terms & Conditions constitute and are herein referred to as the Agreement.
2. Concentric Integration is herein referred to as Concentric, and the party with whom Concentric is entering into this Agreement with is herein referred to as Owner.
3. Concentric may submit requests for periodic progress payments for services rendered. Payments shall be due and owing by the Owner upon receipt of Concentric's invoice for services. Payments to Concentric after sixty (60) consecutive calendar days from the date of Concentric's invoice for services shall include an additional late payment charge computed Owner an annual rate of twelve percent (12%) from date of Concentric's invoice; and Concentric may, after giving seven (7) days written notice to the Owner, suspend services under this Agreement until Concentric has been paid in full all amounts due for services, expenses, and late payment charges.
4. This Agreement may be terminated, in whole or in part, by either party if the other party substantially fails to fulfill its obligations under this Agreement through no fault of the terminating party; or the Owner may terminate this Agreement, in whole or in part, for its convenience. However, no such termination may be effected unless the terminating party gives the other party: (1) not less than ten (10) calendar days written notice by certified mail of intent to terminate, and (2) an opportunity for a meeting with the terminating party before termination. If this Agreement is terminated by either party, Concentric shall be paid for services performed to the effective date of termination, including reimbursable expenses. In the event of contract termination, the Owner shall receive reproducible copies of Drawings, Custom Developed Applications and other documents completed by Concentric.
5. Concentric agrees to hold harmless and indemnify the Owner and each of its officers, agents and employees from any and all liability claims, losses, or damages, to the extent that such claims, losses, or damages are caused by Concentric's negligence in the performance of the services under this Agreement, but not including liability that may be due to the sole negligence of the Owner or other consultants, contractors or subcontractors working for the Owner, or their officers, agents and employees. In the event claims, losses, or damages are caused by the joint or concurrent negligence of Concentric and the Owner they shall be borne by each party in proportion to its negligence.
6. The Owner acknowledges that Concentric is a Limited Liability Company and not a Professional Service Corporation, and further acknowledges that the corporate entity, as the party to this contract, expressly avoids contracting for individual responsibility of its officers, directors, or employees.
7. The Owner and Concentric agree that any claim made by either party arising out of any act of the other party, or any officer, director, or employee of the other party in the execution or performance of the Agreement, shall be made solely against the other party and not individually or jointly against such officer, director, or employees.
8. For the duration of the project, Concentric shall procure and maintain insurance for protection from claims under worker's compensation acts, claims for damages because of bodily injury including personal injury, sickness or disease or death of any and all employees or of any person other than such employees, and from claims or damages because of injury to or destruction of property including loss of use resulting therefrom, alleged to arise from Concentric's negligence in the performance of services under this Agreement. The Owner shall be named as an additional insured on Concentric's general liability insurance policy. The limits of liability for the insurance required by this Subsection are as follows:

Workers Compensation:	Statutory Limits	Excess Umbrella Liability:	$5,000,000 per claim and aggregate
General Liability:	$1,000,000 per claim / $2,000,000 aggregate	Professional Liability:	$5,000,000 per claim
Automobile Liability:	$1,000,000 combined single limit		$5,000,000 aggregate

9. Notwithstanding any other provision of this Agreement, and to the fullest extent permitted by law, the total liability, in the aggregate, of Concentric and their officers, directors, employees, agents, and any of them, to the Owner and anyone claiming by, through or under the Owner, for any and all claims, losses, costs or damages whatsoever arising out of, resulting from or in any way related to the project or the Agreement from any cause or causes, including but not limited to the negligence, professional errors or omissions, strict liability or breach of contract or warranty expressed or implied of Concentric or their officers, directors, employees, agents or any of them, hereafter referred to as the " Owner's Claims", shall not exceed the total insurance proceeds available to pay on behalf of or to Concentric by their insurers in settlement or satisfaction of Owner's Claims under the terms and conditions of Concentric's insurance policies applicable thereto, including all covered payments made by those insurers for fees, costs and expenses of investigation, claims adjustment, defense and appeal.
10. Concentric is responsible for the quality, technical accuracy, timely completion, and coordination of all Designs, Drawings, Custom Developed Applications and other services furnished or required under this Agreement, and shall endeavor to perform such services with the same skill and judgment which can be reasonably expected from similarly situated professionals.
11. The Owner may, at any time, by written order, make changes within the general scope of this Agreement in the services to be performed by Concentric. If such changes cause an increase or decrease in Concentric's fee or time required for performance of any services under this Agreement, whether or not changed by any order, an equitable adjustment shall be made and this agreement shall be modified in writing accordingly. No service for which an additional compensation will be charged by Concentric shall be furnished without the written authorization of the Owner.
12. All Drawings, Custom Developed Applications, and other documents prepared or furnished by Concentric pursuant to this Agreement are instruments of service in respect to the project, and Concentric shall retain the right of reuse of said documents and electronic media by and at the discretion of Concentric whether or not the project is completed. Electronic copies of Concentric's documents for information and reference in connection with the use and occupancy of the project by the Owner and others shall be delivered to and become the property of the Owner; however, Concentric's documents are not intended or represented to be suitable for reuse by the Owner or others on additions or extensions of the project, or on any other project. Any such reuse without verification or adaptation by Concentric for the specific purpose intended will be at the Owner's sole risk and without liability or legal exposure to Concentric, and the Owner shall indemnify and hold harmless Concentric from all claims, damages, losses and expenses including attorneys' fees arising out of or resulting therefrom.
13. Concentric warrants that the services provided for under this Agreement will be completed in a good and workmanlike manner in accordance with applicable codes, ordinances, regulations or other legal Owner. For a period of one (1) year after the Owner receives beneficial use of the installation, Concentric will provide a limited warranty to the Owner for any defect due to improper materials or workmanship supplied by Concentric. Any such warranty provided to Owner shall be provided by Concentric without expense to the Owner for the one (1) year period described herein. CONCENTRIC'S WARRANTY IS A LIMITED WARRANTY FOR A PERIOD OF ONE (1) YEAR FROM THE DATE OF BENEFICIAL USE OF THE INSTALLATION. This warranty is limited to only defects in material and workmanship on products purchased and fully installed by Concentric and excludes defects caused by improper use, abuse, accident, acts-of-God (including but not limited to lightning), alteration, or other conditions beyond Concentric 's control, as determined by Concentric, and all manufacturer's products or workmanship as covered by their respective warranties. For manufacturer's products or workmanship, Concentric will deliver to Owner all manufacturers' warranties of products. IN CONSIDERATION OF THE LIMITED WARRANTY CONTAINED HEREIN THE OWNER AGREES AND ACKNOWLEDGES THAT SUCH WARRANTY REPLACES ALL OTHER WARRANTIES EITHER EXPRESS OR IMPLIED INCLUDING BUT NOT LIMITED TO ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Concentric's warranty is limited to repair or replacement of a defective product without cost to the Owner. OWNER WAIVES ALL CLAIMS TO INCIDENTAL OR CONSEQUENTIAL DAMAGES. This limited warranty extends only to the Owner and not to subsequent buyers/owners. Owner must give written notice of a defect within the one (1) year warranty period described above. In the event of any dispute between the Owner and Concentric, such dispute shall be resolved in accordance with these Standard Terms & Conditions and the Agreement.
14. Any provision or part thereof of this Agreement held to be void or unenforceable under any law shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon the parties. The parties agree that this Agreement shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision which comes as close as possible to expressing the intention of the stricken provision.
15. This Agreement contains and embodies the entire and integrated agreement between parties hereto and supersedes all prior negotiations, representations, or agreements, either written or oral.