CITY OF WASHINGTON, ILLINOIS
Committee of the Whole Agenda Communication

Meeting Date: Monday December 12th, 2022

Prepared By: Brian Rittenhouse – Public Works Director

Agenda Item: SCADA Master Plan Discussion

Explanation: Concentric Integration has completed the Draft Report of the SCADA Master Plan for Water and Wastewater. The Master Plan evaluated the existing system and has recommendations where improvements should be made over a period of time. SCADA is currently used to control both the Water and Wastewater Treatment Processes as well as to control each Liftstation in our Collection System. A Master Plan, like a Capital Improvement Plan, will give staff professional guidance on preventative maintenance, scheduled replacement and future improvements.

Fiscal Impact: TBD.

Committee Discussion: Attached is the draft report for Council to review ahead of the upcoming FY 23-24 budget meetings. A representative from Concentric will be at Mondays Committee of the Whole meeting to answer any questions Council may have about the listed projects in the Draft Report.

Action Requested: Committee Discussion and Direction.

CONCENTRIC INTEGRATION

Memo

To:	Brian Rittenhouse		
	City of Washington		
Date:	November 10, 2022	Project:	220302.30
Subject:	SCADA Master Plan		

This memo serves to summarize and recommend various SCADA and automation-related budget items for the City of Washington. Recommendations are not meant to represent a detailed design but provide an overview with budget costs for suggested improvements. No actual pricing has been solicited from vendors. We anticipate actual costs to be at or below the numbers shown below. Recommendations are based on manufacturers' recommended equipment life span, industry best practices, and our own practical experience.

The scope of this assessment was limited to the SCADA/automation control hardware/software, and doesn't include an analysis of electrical equipment, mechanical/process equipment, or field instrumentation.

Following is a table that includes capital improvement and maintenance recommendations for the City's water, wastewater, & lift station systems. The table includes a 4% annual inflation rate.

Budget Cost Summary Table

#	Item	'22-23	'23-24	'24-25	'25-26	'26-27	'27-28
1	SCADA / OT Support		$46,400	$48,200	$50,000	$51,800	$53,600
2	Wells 11/12 Modernization	$65,000					
3	WWTP Generator Integration	$6,500					
4	Full Speed Lift Stations	$8,100					
5	WTP #1 PLC Upgrade		$73,000				
6	Central (Lift Stations) SCADA		$108,200				
7	Water SCADA Migration			$181,400			
8	Wastewater SCADA Migration			$157,800			
9	Lift Stations PLCs Upgrade				$225,100		
10	WWTP PLCs Upgrade					$24,900	
11	WTP #2 PLCs Upgrade					$16,200	
12	Water Remote Sites (PRV, BS)						$126,400
Totals		$79,600	$227,600	$387,400	$271,100	$92,900	$180,000

Budget Explanation/Narrative

General

Following is a list of the recommended budgeted items with a brief narrative explaining the specifics, benefits, any additional/optional costs, as well as general commentary on the upgrade. Overall, we look to spread larger (>$100,000) capital investments over multiple years, but there may be cost advantages to doing similar work at the same time, as well as required prerequisites that mandate upgrades happen at the same time. Budget costs assume:

1. The City is open to Design/Install Methodology (no detailed design is required, which typically would add 10%-15% the costs provided).
2. Costs provided assume the work is contracted and not performed in-house.
3. Work is not performed a-la-carte but is grouped into a few projects (not 20+ projects).

Item #1 - SCADA / OT Support

Analysis

Without ongoing SCADA support services, the SCADA system will gradually become obsolete, less reliable, more difficult to maintain, and more vulnerable to cybersecurity attacks and operational failures.

Recommendations

We recommended the City enter into an annual service agreement with a systems integrator to provide the proactive maintenance, T&M, and third-party support services for maintaining the City's SCADA system. The budget cost covers the PLCs, Network, & SCADA/HMI in all three systems (Water, Wastewater, & Lift Stations) with annual preventative maintenance, 80 hours of T&M support, & software support renewals.

Item #2 – Wells 11 / 12 Modernization

Analysis

A recent PLC failure at Wells 11/12 provides the initial justification for this project, as the discontinued (in May 2017) Allen-Bradley (A-B) MicroLogix 1500 PLC abruptly failed and Wells 11/12 ceased to be available via remote control from WTP #2. Additionally, the existing telemetry communications between Wells 11/12, Legion Road Public Works, WTP #1, & WTP #2 is temporary, unreliable, insecure, and poorly monitored via the water treatment process. Finally, the industrial (DeviceNet) communications between the Wells PLC and the Wells VFDs has become difficult to support and troubleshoot.

Recommendations

As already proposed, we recommend modernizing the controls & communications at Wells 11/12 and upgrading the communications between the water system sites (WTP #1, WTP #2, & Wells 11/2):

- Remove & replace the A-B MicroLogix 1500 PLC with the latest A-B CompactLogix 5380 PLC (including new I/O modules).
- Remove & replace the DeviceNet communications between the Wells 11/12 PLC and the wells' variable frequency drives (VFDs) with Ethernet/IP communications.
- Have MTCO provide a new Internet connection at the Wells 11/12 site, thereby replacing the water system radio communications (and temporary wireless situation).
- Build a virtual private network (VPN) across all water system sites with new firewall/routers on the MTCO network.

Item #3 - WWTP Generator Integration

Analysis

The City is upgrading their Generator & Automatic Transfer Switch (ATS) at the WWTP, and this is a great opportunity to monitor, trend, & historize the information available from each piece of equipment.

Recommendations

We recommend that the new generator and ATS be integrated into the plant's SCADA/HMI system. Research is required to determine the best communications methods available, then the installation will need to be designed. It is recommended that the typical signals (generator running / faulted) be expanded to include any power information, all generator alarms / warnings / faults, and ATS status (sources available / closed). This recommendation would include SCADA/HMI graphics, alarming, and historical trending.

Item #4 - Full Speed Lift Stations

Analysis

Over the past few years, the pumps at the lift stations have been experiencing clogging and scum/rag control issues that require significant man-hours to resolve. These clogs can be attributed to the variable pump speed feature that was recently implemented to save on electrical power at each of the lift stations.

Recommendations

We recommend that each lift station be reprogrammed to operate the pumps at full speed only, thereby efficiently flushing the entire contents of the wet well.

Item #5 - WTP #1 PLC Upgrade

Analysis

In general, Programmable Logic Controllers (PLCs) provide the automation required to operate the Village's water & wastewater system. These PLCs have a limited lifespan (typically 10-15 years) that is affected by their physical environment, the manufacturer's product lifecycle, and the availability of systems integrator support. As a PLC approaches its end-of-life, it becomes more expensive to maintain, especially in a situation where the PLC has failed, a direct replacement is unavailable, and/or the systems integrator doesn't have the correct tools, software, or experience to facilitate the replacement. When a PLC fails, the System Operator will have to manually control and monitor the process until the automation has been restored.

The PLC in WTP #1 is an Allen-Bradley SLC 5/05, and it has served the City very well. However, the processor has reached an "active mature" status, which means that it is fully supported but will be made obsolete by the manufacture in the near future, and a newer product exists and would gain value by migrating. Many of the SLC I/O modules have already reached the "end-of-life" status and will be discontinued at the end of 2022, which means that the parts will no longer be available. At this time, a new SLC 5/05 processor would cost $13,000! Given the critical nature of this control system, a proactive upgrade approach would ensure reliable plant operation.

Recommendations

Remove & replace the A-B SLC 5/05 at WTP #1 with the latest A-B CompactLogix 5380 PLC (including new I/O modules). The existing PLC panel should be reused, but some internal components (power supplies) should be upgraded as well.

Item #6 - Central (Lift Stations) SCADA

Analysis

The City has three independent SCADA/HMI systems utilizing two different software platforms. Carefully combining the three systems into one platform would create efficiencies in operational and licensing/support costs. Also, the implementation of a more modern software platform will provide the City will some new and significant features, such as secure mobile access, historical data logging, redundancy, and improved alarm management. The transition to one SCADA/HMI system will take several phases to implement, and the Lift Station SCADA/HMI system should be the first to be modernized.

Recommendations

We recommend that the City migrates & modernizes the Lift Station SCADA System to become the base of a new Central SCADA System:

- Setup a Central SCADA network between the City's Admin and existing SCADA networks
- Replace the existing Lift Station SCADA computer with new server-grade hardware
- Replace the FactoryTalk View SE/WIN-911 platform with the Ignition software
- Migrate the Lift Station SCADA application from FTViewSE / WIN-911 to Ignition

Item #7 - Water SCADA Migration

Analysis

The Water System's existing SCADA/HMI system needs to be modernized, as the current implementation is limited to just one computer at WTP #1. By upgrading and merging this SCADA/HMI system with an already implemented Central SCADA system, the operators will benefit from additional features such as secure mobile access, historical data logging, redundancy, improved alarm management, & consolidated support.

Recommendations

We recommend that the City migrates & modernizes the Water Treatment SCADA System:

- Replace the existing SCADA computer at WTP #1 with new workstation grade hardware.
- Add a new SCADA computer at WTP #2.
- Add secondary/backup SCADA computers in the process area at WTP #1 & WTP #2 using "industrial" grade hardware.
- Replace the FactoryTalk View SE/WIN-911 software platform with the Ignition software
- Migrate the Water Treatment SCADA application from FTViewSE / WIN-911 to Ignition
- Deploy the new redundant Ignition SCADA applications with mobile access, centralized alarm notification, & historical trending at the Central SCADA system

Item #8 - Wastewater SCADA Migration

Analysis

The Wastewater Treatment System's existing SCADA/HMI system needs to be modernized, as the current implementation has been developed on an older software platform with a limited feature set. By upgrading and merging this SCADA/HMI system with an already implemented Central SCADA system, the operators will benefit from additional features such as secure mobile access, historical data logging, redundancy, improved alarm management, & consolidated support.

Recommendations

We recommend that the City migrates & modernizing the Wastewater Treatment SCADA System:

- Replace the two existing SCADA computers at the WWTP with new workstation grade hardware.
- Replace the Wonderware InTouch software platform with the Ignition software
- Migrate the Wastewater Treatment SCADA application from Wonderware InTouch to Ignition
- Deploy the new redundant Ignition SCADA applications with mobile access, centralized alarm notification, & historical trending at the Central SCADA system

Item #9 - Lift Stations PLCs Upgrade

Analysis

The six existing lift stations are controlled by discontinued (as of March 2022) Allen-Bradley MicroLogix 1100 PLCs, which means that they are no longer manufactured. Also, these PLCs are installed in a variety of panel configurations which expose the maintenance personnel (sometimes operators) to electrical (shock & arc flash) hazards. The worst-case single panel configuration has the high(er) voltages of the starters/VFDs with the low(er) voltages of the PLCs and the intrinsically safe circuits (to the flammable material in the wet well). Decades ago, this single panel configuration was acceptable in the industry, but developments in the National Electric Code (NEC) & Occupational Safety and Health Administration (OSHA) have pushed designs in a different direction for safety concerns.

Recommendations

We recommend that the City modernize each of the lift station PLCs in a manner that mitigates some of the electrical hazards by incorporating the low(er) voltage (<= 120V) into a new standardized local control panel. This new panel would not include the 240/480VAC breakers, starters / VFDs, control power transformers, or seal fail relays. We also recommend a modernization of the existing Phoenix Contact firewall/routers, as they will likely reach the end of their serviceable life by the time the new panels are installed.

The new lift station local control panel would consist of the following:

- A-B CompactLogix 5380 PLC
- A-B PanelView 5000 OIT & Switches / Pilot Lights on a Dead Front Panel
- Firewall/Router with 4 LAN Switch Ports (PLC, OIT, VFDs, & MTCO)
- Intrinsically Safe Barriers for Wet Well Level Transducer & Floats
- Designed to UL 698A (for panels relating to hazardous/classified locations)

The programs of the discontinued PLC and existing OIT will be migrated & rewritten in the newer programming language of the modern PLC.

The existing Master PLC at Legion Road will be decommissioned and removed from service. The new Central SCADA System software will directly poll the lift stations via MTCO fiber optics.

Item #10 - WWTP PLCs Upgrade

Analysis

The four existing WWTP PLC processors are discontinued (as of December 2020) Allen-Bradley CompactLogix L35E controllers, which means that they are no longer manufactured. Also, the firmware of this discontinued model has not been updated since 2016, so it is a liability in the cybersecurity profile of the WWTP control system.

Recommendations

We recommend that the City replace each of the four WWTP PLC controllers with the most recent version of the CompactLogix 5370 L3 controller and reuse the existing 1769 Compact I/O modules.

Item #11 - WTP #2 PLCs Upgrade

Analysis

The existing WTP #2 PLC controls the plant through seven Ethernet remote I/O adapters, specifically A-B 1794 Flex EtherNet/IP Adaptor. These adapters have reached the "end-of-life" status, and will be discontinued in May, 2024.. The PLC Controller (1769-L30ER) is an actively available part at this time.

Recommendations

We recommend that the City budget to replace these adaptors with a 1794-AENTR adapter along with the PLC controller, as this will need to be addressed in the next 5-7 years.

Item #13 - Water Remote Sites (PRV, Booster Station)

Analysis

The Water System operations would receive significant benefit from monitoring the status of the three existing PRV and one existing booster station.

Recommendations

We recommend that the City install a new remote I/O panel at each of the three existing PRV and one existing booster station, then integrate them into the plant's PLC, HMI, and SCADA systems.

Additional Budget Considerations

The following issues were encountered during our SCADA master planning, but they did not warrant a specific budget item. However, the City should be aware of these issues and address them accordingly.

Issue #1 – SCADA System Cybersecurity

During our review of the City's SCADA system, we encountered several cybersecurity issues that need to be addressed. For security purposes, we will not specifically document them here, but we can discuss them in person (or document them separately), if necessary. In general, these issues were individually minor in nature, but when combined give the impression that cybersecurity is not the focus that it should be. Instead of developing a scope of work to address all the individual issues, we have recommended the necessary cybersecurity improvements throughout the budget items, especially the annual SCADA / OT Support and SCADA migration recommendations.

Issue #2 - WTP #1 & #2 Softener Synchronization Programming

It is possible that the City's water operations could benefit from "Softener Synchronization Technology", which keeps softener regenerations staggered and prevents regenerations from occurring at the same time. This is a technology developed by our Lead Potable Water Engineer Harry Harman at Baxter & Woodman, which is our parent company. By reprogramming the PLCs at WTP #1 & #2, the City could reduce the number of softener regenerations, reduce salt & water usage, reduce waste water production, & increase the amount of water treated. We were unable to fit the cost vs. benefit analysis of this technology improvement into the SCADA master plan's budget, but we can continue the discussion outside of the Master Plan. See page 3 of Baxter & Woodman's 2022Q2 Newsletter for more details (https://online.flippingbook.com/view/671365842/2/).

Issue #3 – Lift Station Electrical Gear Improvement

The City has a couple lift station issues that we've specifically addressed in the SCADA budget, especially with items for Full Speed Lift Stations and Lift Stations PLCs Upgrade. However, there are other issues that could not be addressed in the scope of this SCADA Master Plan, specifically as it relates to the integrity and safety of the electrical distribution between the Automatic Transfer Switch (ATS) and the Variable Frequency Drives (VFDs). With the addition of VFDs (in a previous project) and the new PLC panel (in this plan), it leaves the old / original local control panel "gutted" and used for the station's main circuit breaker, two feeder circuit breakers to the pump motors, a control power transformer, and as a junction box for motor cables. It would be good to "clean up" this panel by routing the motor cables directly to the separated VFD panels and replacing the circuit breakers with a new panelboard that would allow for a safer lock-out-tag-out of the electrical gear. We recommend additional discussions on this issue.

Issue #4 – WWTP Expansion Project Design Assistance

At some point in the future, the City has plans for another WWTP Expansion project, and Concentric Integration would like the opportunity to provide the Systems Integration in the construction phase of the project, as well as the design phase.

Issue #5 – VFD Modernizations

The City has many Variable Frequency Drives (VFDs) controlling motors throughout its water, wastewater, and lift station systems, and it has been hard to develop a budget item for modernizing these VFDs (or simply when and how to replace them before they break on their own).

Typically, we would recommend a phased replacement of VFDs based on the following factors:

1. Age & Lifespan (typically 15 years)
2. Environment (temperature, dust/dirt, electrical surges, lightning)
3. Electrical Installation (line/load reactors, sizing, motor lead length, grounding)
4. Communications for Control (DeviceNet, Ethernet)
5. Advance Features (Power Monitoring)
6. Process Installation (Criticality, Redundancy)
7. Standardization for Support & Procurement (Same Make, Similar Model)

When applying all these factors to our cursory review of the City's VFD implementations, we could not recommend a phased replacement approach that was warranted or cost-effective. If desired, we can go into more detail separately from this SCADA Master Plan.

We do recommend the following:

a. Routine Preventative Maintenance by Electrician or VFD Specialist
    a. Check for evidence of water / moisture, critters, or corrosion
    b. Check VFD status log for errors, faults, warnings, then follow-up on them
    c. Remove the dust/dirt with air, vacuum, brush, etc.
    d. Replace exhaust/intake fan filters
    e. Document (& backup, if possible) all VFDs settings (at least non-default settings)
    f. Document (& maintain history) of typical operating parameters (volts, amps, temp)
    g. Look for any wiring changes & update wiring schematics
    h. Perform an infrared inspection then compare to historical
b. Continue to standardize on Toshiba & Allen-Bradley VFDs for future VFDs
c. Continue to maintain a cooler, dryer environment for the VFDs, if possible.

Issue #6 – WTP Separate Security from Alarm Dialers

We noticed that the WTPs utilize a Sensaphone Alarm Dialer for both backup SCADA alarming and Building / Site Security. With the proposed Central SCADA System, we will be eliminating the need for a backup alarm dialer at each site. We recommend that the City consider implementing a new security system for these sites, utilizing their own security provider.

Issue #7 – Knollaire Lift Station Improvements

The City desires to add a backup generator to the Knollaire Lift Station, plus the addition of a wet well level transducer would be useful for monitoring/controlling the wet well level. As this is an electrical project, we did not include a budget item for this improvement. If interested, we would like to present the City with a proposal to design these electrical lift station improvements, then assist with the bidding and construction phases of the project.

Item #8 - WWTP Blower Remote I/O

The existing blowers and related equipment have limited information integrated with the SCADA system. WWTP operations would receive significant benefit from integrating into SCADA the many unmonitored signals located in/around the blower building, such as additional blower status info, local flow meter, valve positions, and local pump controllers. In the next WWTP expansion project, we recommend that the City install a new remote I/O panel in the existing WWTP Blower Building to monitor these various status signals, then integrate them into the plant's PLC, HMI, and SCADA systems.