Memorandum

November 27, 2017

To:	Michael Quinn, PE	Ref. No.:	11144128.0
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cc:	Robert Butterworth, PE Cosimo Pagano, PE Noah Melnick		
Subject:	SCADA Evaluation – Wastewater Treatment Plant and Pump Stations Town of Yorktown, NY		

1. INTRODUCTION

The Town of Yorktown, NY has contracted GHD to perform an evaluation of the SCADA system at the Water Pollution Control Facility (WPCF) and pump stations. GHD performed a site visit to the WPCF and seven of the pump stations, which are considered representative of the Town's facilities. Included herein is a prioritized list of recommendations for standardized controls and monitoring equipment within the Town's wastewater treatment and collection system. A standard instrumentation and controls philosophy will enable the Town to optimize process performance, develop an operation and maintenance improvements schedule, and facilitate detailed monitoring of the WPCP and pump stations.

The objective of this assessment is to:

- Assess functionality and improvements for the WPCF's SCADA system HMI software and associated computers.
- Develop a standard methodology to facilitate monitoring and/or control of remote stations from the WPCF.
- Identify need for new or replacement instrumentation at the WPCF and remote stations.
- Evaluate communication mediums employed at the WPCF and remote stations.

2. PUMP STATIONS – EXISTING CONDITIONS

The Town of Yorktown is in the process of implementing a pump station upgrade program which involves replacement/upgrade of mechanical equipment and electrical, structural, architectural, and controls improvements. The Town selected seven pump stations as being representative of all pump stations within the Town for assessment by GHD, including the Cedar Pond, Curry Street, Hunterbrook, Mohansic, Mohegan East, Farmwalk, and Salem Pump Stations.

2.1 Pump Station Assessment

Visual inspection of the pump stations and discussions with operations staff identified variable controls methodologies, instrumentation, and conditions at each pump station. The Cedar Pond, Curry Street, Mohansic, Mohegan East, Farmwalk, and Salem Pump Stations utilize float-based controls coupled with a pump control panel (PCP) originally supplied by the pump manufacturers. Continuous-reading level transmitters that were once in operation have failed and have been replaced with float-based controls integrated into the PCPs. In general, PCP equipment and wiring has been modified through maintenance activities and record documentation of the PCPs is not available. Visual inspection of the instrumentation and controls equipment identified corrosion within each PCP. In some cases, the PCP enclosure did not close or antiquated, through-the-door-mounted equipment has been removed.

The Hunterbrook Pump Station includes a PLC-based control panel that utilizes a continuous reading bubbler level monitoring system and VFD-driven pumps and is an exception. The bubbler system is equipped with a purge system that currently utilizes a manual purge cycle.

2.2 Remote Monitoring

Remote monitoring of each pump station is conducted by one of two methods: a Marshall alarm monitoring service or a Mission RTU. The Curry Street, Hunterbrook, Mohansic, Mohegan East, and Farmwalk Pump Stations utilize a Marshall alarm monitoring service which includes a NEMA 1 enclosure capable of accepting up to four dry contact alarm inputs. When an alarm input is energized, the Marshall controller notifies Marshall's call center via a cellular modem, at which point the call center places a voice call to the list of recipients supplied by the Town. Two distinct and separate alarms are wired to the Marshall system (station power loss and wet well high level). Farmwalk is an exception, where a third distinct intrusion detection alarm is wired to the Marshall panel.

Operations staff indicate the Marshall alarm is the sole mechanism for notification of problems at a station and has been reliable to date. The two alarm conditions monitored are very high priority conditions that require immediate reaction times.

Table 1 provides a summary of the pump stations' remote monitoring systems.

Table 1 Pump Station Remote Monitoring

Pump Station	Marshall Dialer	Mission RTU
Cedar Pond	No	Yes
Curry Street	Yes	No
Hunterbrook	Yes	No
Mohansic	Yes	No
Mohegan East	Yes	No
Farmwalk	Yes	No
Salem	No	No

To date, 14 Marshall alarm systems are utilized at pump stations throughout the Town. Marshall alarm collects a monthly fee of $40 per pump station. As such, the annual fee paid by the Town to monitor pump stations via the Marshall alarm service is $7,000.

Pump stations where a Marshall alarm system is not used are equipped with a Mission RTU. Of the field inspected pump stations, only the Cedar Pond Pump Station utilizes a Mission RTU.

The Mission RTU achieves remote monitoring through a hosted, subscription service that makes alarms and select process data accessible via a customized client web portal. Alarms are dispatched via phone call, text message, and email. Mission collects an annual service fee for web-based services including, but not limited to, streaming process data, historical trending, and alarm history.

A standard Mission RTU is equipped with two analog inputs, eight discrete inputs, three relay outputs, and is expandable to accommodate an additional discrete or analog input card. Each digital input has the ability to record the accumulation of runtimes and start counts of equipment, and each analog input is capable of flow totalization. Mission units include cellular radios for data transmission over 3G or 4G cellular networks. An optional driver is available for integration into a traditional HMI application, such as Wonderware which is currently utilized at the Yorktown WPCF. Currently, none of the RTUs utilized by the Town are integrated into the WPCF HMI application.

Mission RTUs may utilize phone calls, text messages, or email to notify the end user of high priority alarm conditions. In addition to alarming on its discrete inputs, each Mission RTU is equipped with four diagnostic alarms to monitor performance of the RTU itself. These diagnostic alarms include: (1) Loss of AC Power to RTU; (2) Low RTU Battery; (3) High RTU Enclosure Temperature; and (4) RTU Communication Failure. Limitations of the Mission system are that it accommodates a finite quantity of signals, is incapable of controlling pumps, and is a packaged, non-customizable controller.

2.3 Pump Station Controls

The majority of the pump stations visually inspected utilize relay-based control panels in lieu of customizable PLCs. Utilizing relay-based controls with float controls requires operations staff to manually adjust float levels to adjust alarm setpoints and pump start/stop levels. Existing PCPs utilize the majority of auxiliary input signals, which limits the Town's ability to interface with an alarming or monitoring system, such as the installed Marshall system or a future PLC-based system.

Table 2 displays the controls method for the pump stations evaluated.

Table 2 Pump Station Controls Method

Pump Station	PLC Controls	Float-Based Controls
Cedar Pond	No	Yes
Curry Street	No	Yes
Hunterbrook	Yes	No
Mohansic	No	Yes
Mohegan East	No	Yes
Farmwalk	No	Yes
Salem	No	Yes

2.4 Wet Well Level Monitoring

Continuous level monitoring, which indicates the actual depth of wastewater in a station's wet well, is largely absent at the pump stations. When remotely monitored, indication of the actual wet well depth is helpful in optimizing controls; facilitating operator-adjustable alarm setpoints; and indicating whether the wet well level is trending up, down, or overflowing. As an alternative to continuous level monitoring, the majority of the stations utilize point level monitoring of a high-high wet well level only. When the high-high wet well level float is tripped, it typically indicates the pumps have failed to start or are not achieving their rated pump capacity. When high-high level is reached in a wet well, the operator response is to visit the station and troubleshoot the cause of the condition. A very short reaction time is necessary to prevent an overflow event. Lastly, when continuous level monitoring is in place, bubblers are often installed. However, the bubblers have been a frequent source of maintenance, especially the customized bubbler level systems that incorporate customized purging cycles.

2.5 Emergency Power

A backup emergency generator exists at most pump stations to mitigate the impact of utility power loss. Sites not currently backed by emergency generator power include Cedar Pond, Mohegan East, and Farmwalk. Of the sites currently utilizing a generator, some include an automatic transfer switch (ATS) that automatically senses loss of utility power and transitions to generator power, while others must be manually started and transferred. Without remote monitoring of the generator, the only way for the operations and maintenance staff to determine the status of the generators is by visiting each site.

2.6 Pump Station Controls

The operations and maintenance staff indicated that time is spent replacing damaged motor starters and performing routine maintenance at each pump station. A common cause of motor starter failure is short cycling of the pump stations, which can occur when a wet well is undersized or when the pump start and stop setpoints are not optimized. Both cases result in motors exceeding the starter's service rating (starts/hour). In the absence of communication of station operational data to a SCADA system, chart recorders, or dataloggers, efficient troubleshooting of operational issues is minimized.

Table 3 is a summary of the pump stations evaluated.

Table 3 Pump Station Summary

Pump Station	Site Characteristics	Marshall Dialer	Mission RTU	PLC	Emergency Generator	Structure
Cedar Pond	Submersible	No	Yes	No	No	None; controls outdoors
Curry Street	Wet pit	Yes	No	No	Yes	Yes
Hunterbrook	Dry pit	Yes	No	Yes	Yes	Yes
Mohansic	Wet pit	Yes	No	No	Yes	Yes
Mohegan East	Wet pit	Yes	No	No	No	Yes
Farmwalk	Wet pit	Yes	No	No	No	Yes
Salem	Wet pit	No	No	No	Yes	Yes

3. PUMP STATIONS – RECOMMENDATIONS

3.1 General Station Recommendations

Implementation of the recommendations described herein will facilitate improved monitoring, alarming, and control of all pump stations from the WPCF. It is not necessary that all recommendations occur in one phase; however, to achieve an optimal level of automation, control and monitoring provisions should be made to accommodate each recommendation.

At pump stations not currently utilizing a Mission RTU, it is recommended a PLC-based station control panel (SCP) be installed. An SCP is a scalable, PLC-based, and equipped to accommodate variability of pump station configurations. Installing an SCP within a building is recommended to protect it from adverse weather conditions. An SCP also allows the pump stations to be controlled remotely, provides the ability to produce intelligent alarms, and allows for integration of process data into the WPCF SCADA system.

Installation of a PLC is required to allow remote control of process equipment. This is a distinguishing factor between a Mission RTU and an SCP. The Mission RTU units are incapable of control, whereas a PLC-based solution, such as an SCP, is capable of control. Once integrated into the WPCF SCADA system, operators will be able to remotely control and monitor pumps via the WPCF HMI application. Additionally, custom PLC programs tailored to the specific conditions of a pump station may be developed. It should be noted that an SCP is not suitable for sites that utilize more than three pumps. If four or more pumps exist on a site, a more complex solution will be required for adequate control.

GHD recommends the installation of a PLC-based SCP at pump stations that are not currently equipped with a Mission RTU to facilitate monitoring.

3.2 Intelligent Derived Alarming

An additional benefit of a PLC-based SCP is its ability to be programmed with customized intelligent alarms. Intelligent alarming provides operators with predictive information on process performance. Predictive information is real-time data that aides in identifying under-performing equipment in advance of equipment or process failure. For example, if a pump cycle was extended over a period of operation due to seal failure, intelligent alarming can aid in identifying the extended cycle time prior to catastrophic failure. Another common alarm at pump stations is high wet well level which is typically caused by a pump failing to start, a pump not running at full capacity, or an insufficient number of pumps running during periods of high flow. The PLC could be used to derive the alarm conditions with predictive diagnosis to troubleshoot issues as shown in Table 4.

Table 4 Applicable Intelligent Derived Alarms

Derived Alarm	Predictive Diagnosis
Pump excessive starts in 1 hour	Obstructed impeller, optimization required
Pump excessive runtime	Obstructed impeller
Motor current high	Obstructed impeller
Level signal under-range	Failed level signal

Through predictive alarming, maintenance staff will be alerted of an impending condition that would result in a catastrophic if unattended. As such, the maintenance staff will be able to schedule maintenance at appropriate sites prior to catastrophic failure. Once an SCP has been established at a pump station, GHD recommends PLC programming be implemented to facilitate intelligent derived alarms as described in Table 4.

3.3 Remote Communication

To create a central hub for alarming, monitoring, and control, provisions should be made to integrate operational data into the WPCF HMI application. As a result, site visits by the operation and maintenance staff will not be required to ascertain the operating status at each pump station.

To achieve operational data transmission from each pump station to the WPCF, two communication options exist: radio and cellular. Due to topographical constraints, radio telemetry is not recommended. Most of the pump stations do not have a clear line of sight to the WPCF, which is required for reliable data transmission via radio. To determine whether radio communication is viable at a particular pump station, an in-field path attenuation study will be necessary to determine the amount of expected attenuation (loss of data). Due to the number of pump stations within the collection system, capital cost to perform an in-field path attenuation study is high when compares to establishing a cellular network.

To establish a cellular network, a Master Telemetry Unit (MTU) must be installed at the WPCF, with additional cellular modems installed at each pump station. The Town will need to maintain a cellular data plan with a provider such as Verizon or AT&T. The MTU, configured as the master, will poll data from the pump station cellular modems. Data polling is a user-adjustable operation in which the interval of data transmission may be specified. As such, the rate at which new data is received at the WPCF from each pump station may be controlled. Defining the polling rate allows selection of a cost-effective cellular data plan, thereby reducing annual fees.

GHD recommends the installation of a cellular network in lieu of a radio telemetry network to facilitate communications between the WPCF and each pump station.

3.4 Remote Alarm Notification

Establishing communication between the WPCF and a SCP will allow the WPCF's existing WIN911 software-based alarm notification program to be utilized to dispatch alarm notifications for critical alarms at the pump stations. Please note, the Marshall alarm service has been valuable to date in notifying the operation and maintenance staff of critical alarms. Although not required, it would be beneficial to the Town to maintain the use of the Marshall alarm service as a redundant method of alarm notification. Wiring a "Problem" and "Critical Problem" signal to the Marshall panel will eliminate the WPCF SCADA as a single point of failure. As such, if communication between a pump station and the WPCF were disrupted, the Marshall alarm system would continue to maintain a basic level of remote monitoring.

GHD recommends utilizing the WIN911 autodialer installed at the WPCF as the primary alarm notification system, but maintaining the Marshall alarm system as a backup dialer. The Town currently pays approximately $40 per station per month for the Marshall alarm service. Elimination of the Marshall alarm service is estimated to reduce annual costs by approximately $8,000.

3.5 Backup Float Control Panel (BUFCP)

A BUFCP may be utilized to provide a backup control mechanism to maintain operations in the event the primary control system fails. A BUFCP consists of a stand-alone, float-based control panel that is separate from the SCP or pump manufacturer's panel, and is typically equipped with a set of five floats. Installing a BUFCP is recommended in stations with wetwells large enough to accommodate the system as it provides redundancy with the wetwell level control system.

A typical BUFCP utilizes a High Level float, Pump 1 Start float, Pump 2 Start float, All Pumps Off float, and a Low-Low level float. Relay-based control logic in the BUFCP functions in the following sequence:

1. Wet well level rises to the High Level float. An alarm is generated and both Lead and Lag pumps start. Triggering of a float inhibits primary controls from functioning to prevent pumps from being controlled from multiple sources, e.g. the primary control system and BUFCP.

2. Wet well level lowers to All Pumps Off level and all pumps stop.

3. Level rises to Pump 1 Start level and Pump 1 starts.

4. If level continues to rise to Pump 2 Start level, Pump 2 starts.

5. Wet well level lowers to All Pumps Off level and all pumps stop.

6. Pumps remain under BUFCP control until an operator visits the site and presses a button on the BUFCP.

The BUFCP is designed as a temporary method of control. When used as a backup to the primary method of control, it is effective in reducing overflows and nuisance call-out alarms. The BUFCP energizes auxiliary relay outputs to indicate BUFCP Active, High Level, and Low-Low Level.

GHD recommends a BUFCP for all sites with wet wells large enough to accommodate an additional set of floats. As such, a BUFCP would not be recommended for sites with a very small wet well, such as the Cedar Pond Pump Station. Of the sites visited, it is recommended to include a BUFCP for the Salem, Farmwalk, Mohansic and Curry Street pump stations.

3.6 Recommended Monitoring of Pump Stations

As the Town proceeds with capital improvement projects to upgrade their pump stations, GHD has developed a standard input/output (I/O) list intended for use when designing SCPs at each site. Use of Table 5 will standardize the PLC logic, enable a phased implementation plan for individual sites, and provide the ability for each site's SCP to facilitate both monitoring and control.

Table 5 Standard Instrumentation and Associated Signals

Equipment	Signal Description	Input/Output	I/O Type	Priority
High Float	Level High-High	Input	Discrete	High
Pump 1	In Remote Indication	Input	Discrete	Medium
	Run Indication	Input	Discrete	High
	Failure Indication	Input	Discrete	High
	Motor Current	Input	Analog	High
	Start/Stop Control	Output	Discrete	Medium
	Speed Control	Output	Analog	Medium
	Speed Indication	Input	Analog	Medium
Pump 2	In Remote Indication	Input	Discrete	Medium
	Run Indication	Input	Discrete	High
	Failure Indication	Input	Discrete	High
	Motor Current	Input	Analog	High
	Start/Stop Control	Output	Discrete	Medium
	Speed Control	Output	Analog	Medium
	Speed Indication	Input	Analog	Medium
Pump 3	In Remote Indication	Input	Discrete	Medium
	Run Indication	Input	Discrete	High
	Failure Indication	Input	Discrete	High
	Motor Current	Input	Analog	High
	Start/Stop Control	Output	Discrete	Medium
	Speed Control	Output	Analog	Medium
	Speed Indication	Input	Analog	Medium
Generator	Run Indication	Input	Discrete	High
	Failure Indication	Input	Discrete	High
	Generator Low Fuel Level	Input	Discrete	Medium
ATS	On Utility Power	Input	Discrete	High
	On Generator Power	Input	Discrete	Medium
	Failure Indication	Input	Discrete	Medium
Alarm System	Intrusion Detected	Input	Discrete	High
Submersible Pressure Transducer	Continuous Level Indication	Input	Analog	High
Backup Float Control Panel	Active	Input	Discrete	Medium
Station Control Panel	Loss of AC Power	Input	Discrete	High
	UPS Fault	Input	Discrete	High
	Panel Temperature	Input	Analog	High
	Panel Open	Input	Discrete	High

Collectively, the signals allow maintenance staff to efficiently monitor, maintain, and control each of the pump stations. However, to develop prioritized plan to advance each pump station to full monitoring and automation, the signals have been grouped into two categories (High and Medium Priority) as further explained below.

High Priority Improvements

High priority signals are those that achieve a base-level of monitoring and alarming for a site. Inclusion of these input signals in the SCP PLC will achieve the intent of intelligent derived alarming and will enable the WPCF's HMI application to facilitate real-time monitoring, alarming, and historization (data log/record) of key parameters at each site. Many of these signals may currently be available at each site, while others will require wiring modifications, new instrumentation, and equipment replacement. It is anticipated that most sites will require the following new equipment:

1. Current Monitoring – New current monitors installed on power feed to each motor starter. One per pump.

2. Continuous Wet Well Level Monitoring – New submersible pressure transducers installed in the wet well. One per site.

3. Intrusion Door Switches – One per building entrance, below-grade hatch, and/or to the SCP door.

Medium Priority Improvements

Medium priority signals are those that achieve PLC-based control of the pumps through the SCP PLC, more advanced monitoring of the generator, and integration of a BUFCP at the site. It is expected that High Priority improvements will precede Medium Priority improvements. The majority of sites will require infield modification of motor starting circuits, a new BUFCP, and, in some cases, new motor starters. The signals required for VFD-driven pumps are included; however, these are included to accommodate circumstances in which VFD-driven pumps exist. Pump stations that utilize motor starter-equipped pumps would not require the "Speed Control" and "Speed Indication" I/O.

GHD recommends wiring the signals designated in Table 5 to each respective SCP where the signals are available, with the anticipation that the signals listed as High Priority will be wired to the SCP prior to Medium Priority signals.

3.7 Implementation of Station Control Panel Improvements

When the Town proceeds with the implementation of PLC-based SCPs at each site, it is recommended that each SCP be fabricated similarly, sized to be expanded to achieve both High and Medium Priority signals, and that signals be wired in a fault-tolerant manner. Consistency in the fabrication of the SCPs will simplify troubleshooting and maintenance of the SCP by the Town's maintenance staff. It will also reduce overall programming costs by allowing consistency in PLC programming. Wiring the panels in a fault-tolerant manner will reduce the effect from failure of any single PLC I/O module and will simplify SCP maintenance by making it more modular. In short, it is recommended the panels be fabricated with the same equipment, components, reserve capacity, and programs. Fabricating the panels with this level of consistency will enable each site to improve the extent of monitoring and control at different rates without rebuilding or replacement of SCP panels and components.

Although Mission RTU units are sufficient in monitoring gazebo-like sites, such as Cedar Pond, the SCP is preferred because it can afford control over a process. Additionally, value is present solely by the installation of an SCP at a site. Although most sites will require a process-mechanical upgrade (upgrades to pumps, piping, or instrumentation) the presence of an SCP will create a noticeable difference in monitoring capabilities and ease of upkeep. As a result, the Town will see prolonged lifetimes of equipment and a decrease in time-critical emergencies.

GHD recommends the SCPs be fabricated in such a way to standardize the buildup, wiring, and programming of each SCP. Having a standard design across multiple projects will allow the projects to be streamlined, and as a result, costs of design and programming will decrease.

A standard panel design may be developed by the Town's engineering consultant and then utilized on all future pumping station projects thereafter. Consistency of panel components, layout, and labeling may be achieved across projects bid at different times by incorporating the standard panel design into each project's bid documents as a "fabrication-level design," which means the design documents are "fabrication-ready." Shop drawings for the panel are not required and the competitive aspect of the design is in the labor to construct the panel in lieu of the selection of hardware. As such, the contractor will provide the panel exactly as designed without changes to equipment, labeling, or layout. In this way, a standard panel design may be achieved.

4. WPCF – EXISTING CONDITIONS

4.1 SCADA/HMI Hardware and Software

The Town of Yorktown's WPCF SCADA system is comprised of a redundant pair of SCADA computers that communicate with an Ethernet-based network of PLCs throughout the facility. The SCADA computers (SCADA1 and SCADA2) utilize Wonderware's Classic InTouch application for HMI visualization, alarming and historization. Also utilized by the SCADA computers are SyTech's XLReporter and WIN911. SyTech's XLReporter automatically generates regulatory reports by populating Excel-based spreadsheets with data obtained from Wonderware's Classic Historization program. WIN911 is a software that utilizes an analog telephone line to notify the Town's operation and maintenance staff of select alarm conditions via an automated dialing service that runs in the background of the HMI application. In 2017, the plant's SCADA computer hardware and software were replaced and upgraded.

4.2 SCADA Network

The plant's SCADA Local Area Network (LAN) is an Ethernet-based network that is propagated through a combination of fiberoptic and wireless networks. Communication between the Main Control Building, Trickling Filter Building, and Microfiltration Building is achieved by an Ethernet-based frequency hopping spread section (FHSS) MDS iNET radio. Communication between the Advanced Waste Treatment (AWT) Building and the Microfiltration Building is via hardwired fiberoptic cabling. This hybrid network architecture functions; however, there is latency in the network that causes periodic losses of communications between the SCADA computers. This latency also limits the ability to remotely support PLCs and the SCADA2 computer that is located on the Microfiltration Building side of the Town's activity trail that bisects the plant's grounds.

4.3 Programmable Logic Controllers

The PLC network is comprised of seven PLCs:

1. Main Control Building PLC-1
2 Influent Pump Control Building PLC-1A
3 Advanced Waste Treatment Building PLC-2
4 Microfiltration Building PLC-3
5 Microfiltration System PLC-3A
6 UV Disinfection System PLC-3B
7 Trickling Filter Building PLC-4

The AWT Building PLC, PLC-2, has had multiple component failures. As characterized by the operations and maintenance staff, the panel's uninterruptible power supply (UPS) fails to provide backup power to the panel when utility power is lost, the Ethernet switch has failed, and the PLC loses its program whenever power to the panel is momentarily lost. The remainder of the PLCs are in good working order. Their enclosures appear to be unaffected by any significant corrosion, and the components within the panels are current manufacturer-supported equipment.

4.4 Instrumentation

Existing instrumentation has been well maintained and is in good working order. The operations staff has requested select new instrumentation, detailed in Table 6, to achieve improved process control and monitoring.

Table 6 WPCF New Instrumentation and Monitoring

Description	Type	Purpose
Digester Tank 1 and 2 level monitoring	Radar level	Alarm on high level
Primary clarifier sludge blanket level	Ultrasonic sludge blanket level detector	Optimize wasting and biology
Main Control Building power status	SCADA monitoring	Monitoring and alarming via SCADA
AWT Building power status	SCADA monitoring	Monitoring and alarming via SCADA
Chemical bulk tank level monitoring	SCADA monitoring	Monitoring and alarming via SCADA
Hypochlorite feed pumps	SCADA monitoring	Monitoring and alarming via SCADA
Rotating biological contactors	SCADA monitoring	Monitoring and alarming via SCADA

5. WPCF – RECOMMENDATIONS

5.1 SCADA/HMI Hardware and Software

Replacement of the SCADA computers in 2017 resulted in the establishment of a five-year computer hardware warranty that covers physical damage to the system as well as component failures. The SCADA computers are at the beginning of this five-year warranty and have been upgraded to the latest version of the Wonderware's Classic InTouch HMI application. GHD recommends the SCADA computers be reassessed when the hardware warranty expires in 2022.

5.2 SCADA Network

GHD recommends replacement of the critical components that serve as frequent points of failure for PLC-2. Specifically, the Ethernet switch installed in the PLC-2 enclosure should be replaced to maintain proper communication with the other Ethernet-based equipment on the SCADA LAN, such as the SCADA computers. Additionally, the UPS designed to provide backup power to PLC-2 should be replaced to assure that monitoring and control of equipment located in the AWT Building is not lost during a power outage. It is anticipated that prior to performing other enhancements at the WPCF, the issues with critical components in the PLC-2 enclosure be addressed to rehabilitate the facility's PLC network.

To address latency issues and prepare the network for an increase in data transfer, GHD recommends replacing the portion of the network that utilizes (FHSS) MDS iNET radios with a hardwired fiberoptic connection. The installation of a plant-wide fiberoptic network would be identical to that of the connection run between the Microfiltration and AWT Buildings, but it would encompass all buildings that house a PLC. The fiberoptic network should be that of a trunk configuration, with only one strand of fiberoptic cabling between each building. Upgrading the network will equip it with the capacity to accommodate the increase in data on the network due to increased monitoring of equipment via SCADA. Additionally, upgrading the network will alleviate the experienced latency and SCADA2 connectivity issues, and amend the ability to remotely support SCADA2 and PLCs on the Microfiltration Building side of the activity trail.

5.3 Instrumentation

The new instrumentation and monitoring demonstrated in Table 6 will allow the operation and maintenance staff better insight into performance and allow operators to optimize plant operations. Additionally, the recommended instrumentation will allow for the creation of intelligent derived alarms, such as a digester tank high level, which will aid the operations and maintenance staff in preventing overflow events. Monitoring the new instrumentation via the WPCF HMI application will enable the maintenance staff to optimize performance of the plant and create an ease in upkeep of equipment.

6. PROJECT APPROACH AND PROBABLE COST

6.1 Prioritization and Project Approach

The recommended improvements to both the WPCF and pump stations are designed in such a way that the project may be a multi-phase or single-phase project. Table 7 assigns a priority to each recommendation described herein. Additionally, the items that are assigned identical priorities are included within the same phase of a multi-phase project. That is, Priority 1 items would be Phase 1, Priority 2 items would be Phase 2, and Priority 3 items would be Phase 3 of a multi-phase project.

Table 7 Recommended Upgrade Prioritization

Item	Recommendation	Priority
1	Equip pump stations with SCPs; wire High Priority I/O to SCPs; establish a cellular network; install MTU at WPCF; and implement PLC and SCADA/HMI programming to facilitate monitoring, alarming, and historization via the WPCF's existing SCADA system.	1
2	Replace faulty components in AWT Building PLC enclosure, PLC-2.	2
3	Upgrade network between the Administration Building and Microfiltration Building to utilize fiberoptic cabling.	2
4	Wire Medium Priority items (per Table 5) to SCPs.	3
5	Implement instrumentation improvements detailed in Table 6.	3

6.2 Estimate of Probable Cost

The estimate of probable cost for both the pump stations and WPCF improvements can be found in Appendices A and B, respectively. The cost estimate for the pump station upgrades includes the price for one upgrade and is scaled to accommodate the number of sites that do not utilize a Mission RTU. Also, as shown in Appendix A, there are common costs for the pump station upgrades that are not applicable to every upgrade. For example, the PLC programming and OIT configuration software will only need to be purchased once. Furthermore, the variability in the control methodologies, instrumentation, and condition of each pump station will likely result in a fluctuation of project price per upgrade. The appendices capture the cost of construction as if the upgrades to both the WPCF and pump stations were completed as one project. Additionally, the costs provided do not include engineering design or construction administration services associated with performing the upgrades under a capital improvements project.

EXHIBIT A

Town of Yorktown
Waste Water Pumping Station Upgrades
ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST - 2018

PROBABLE CONSTRUCTION COST - 2018

Description	Basis	Material: No. Units	Material: Per Unit	Material: Subtotal	Installation (1): Per Unit	Installation (1): Subtotal	Total Cost (2)	Comments
Construction								
Submittals	EA	16			$ 2,000	$ 32,000	$ 32,000	
CSI Services	EA	16			$ 10,000	$ 160,000	$ 160,000	
Station Control Panel (SCP)								
Enclosure Components	EA	16	$ 20,000	$ 320,000	$ 10,000	$ 160,000	$ 480,000	Per Kaman quote dated 7/28/17
SCP Installation	EA	16			$ 3,000	$ 48,000	$ 48,000	Per Kaman quote dated 7/28/17
Wetwell Level Transducer	EA	16	$ 1,500	$ 24,000	$ 750	$ 12,000	$ 36,000	
Intrusion Door Switch	EA	16	$ 500	$ 8,000	$ 500	$ 8,000	$ 16,000	
Pump Motor Current Monitor	EA	32	$ 1,500	$ 48,000	$ 500	$ 16,000	$ 64,000	
Backup Float Control Panel (BUFCP)	EA	16	$ 5,000	$ 80,000	$ 1,500	$ 24,000	$ 104,000	
Programming								
PLC programming	EA	16			$ 6,000	$ 96,000	$ 96,000	
SCADA/HMI Modifications	EA	16			$ 3,000	$ 48,000	$ 48,000	
Common Project Costs								
PLC programming and OIT configuration software	LS	1	$ 6,000	$ 6,000			$ 6,000	
Master Telemetry Unit (MTU) at the WPCF	EA	1	$ 15,000	$ 15,000	$ 3,000	$ 3,000	$ 18,000	
Cellular Plan (Recurring Monthly Fee)	EA	16	$ 60	$ 960			$ 960	

(1) For items without installation cost, installation cost is included in material price.
(2) Year 2017 dollars.

Subtotal (Rounded)	**$ 1,110,000**
Mobilization/Demobilization (2% of Subtotal)	**$ 22,000**
Bonds & Insurance (3% of Subtotal)	**$ 33,000**
General Conditions (8% of Subtotal)	**$ 89,000**
Subtotal (Rounded)	**$ 1,254,000**
Contingency (20%, Rounded)	**$ 251,000**
Total Probable Construction Cost	**$ 1,510,000**

EXHIBIT B

GHD CLIENTS | PEOPLE | PERFORMANCE

Town of Yorktown
Water Pollution Control Facility Upgrades
ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST - 2018

PROBABLE CONSTRUCTION COST - 2018

Description	Material				Installation (1)		Total Cost (2)	Comments
	Basis	No. Units	Per Unit	Subtotal	Per Unit	Subtotal		
Construction								
Submittals	EA	1			$ 3,000	$ 3,000	$ 3,000	
CSI Services	EA	1			$ 7,000	$ 7,000	$ 7,000	
PLC-2								
Replace Ethernet Switch	EA	1	$ 2,500	$ 2,500	$ 500	$ 500	$ 3,000	
Replace UPS	EA	1	$ 2,000	$ 2,000	$ 500	$ 500	$ 2,500	
SCADA LAN								
Fiberoptic Cabling	LS	1	$ 5,500	$ 5,500	$ 10,000	$ 10,000	$ 15,500	
Fiberoptic Media Converters	EA	2	$ 1,000	$ 3,000	$ 500	$ 500	$ 3,500	
Rotating Biological Contactor								
pH Monitoring	EA	1	$ 5,000	$ 5,000	$ 2,500	$ 2,500	$ 7,500	
Digestor Tanks								
Digestor Tank Level Monitoring	EA	1	$ 3,000	$ 3,000	$ 3,000	$ 3,000	$ 6,000	
Primary Clarifier								
Sludge Blanket Level Monitoring	EA	2	$ 5,000	$ 10,000	$ 3,000	$ 3,000	$ 13,000	
Secondary Clarifier								
Sludge Blanket Level Monitoring	EA	2	$ 5,000	$ 10,000	$ 3,000	$ 3,000	$ 13,000	
Control Building Power Status								
Wire, Conduit, and Signal Wiring	LS		$ 1,500	$ 1,500	$ 2,500	$ 2,500	$ 4,000	
AWT Building Power Status								
Wire, Conduit, and Signal Wiring	LS		$ 1,500	$ 1,500	$ 2,500	$ 2,500	$ 4,000	
Chemical Bulk Tanks								
Wire, Conduit, and Signal Wiring	LS		$ 1,000	$ 1,000	$ 1,500	$ 1,500	$ 2,500	
Hypochlorite Feed Pumps								
Wire, Conduit, and Signal Wiring	LS		$ 500	$ 500	$ 1,000	$ 1,000	$ 1,500	
Programming								
PLC Programming Modifications	LS					$ 10,000	$ 10,000	
SCADA/HMI Modifications	LS					$ 8,000	$ 8,000	

(1) For items without installation cost, installation cost is included in material price.
(2) Year 2017 dollars

Subtotal (Rounded)	**$ 100,000**
Mobilization/Demobilization (2% of Subtotal)	**$ 2,000**
Bonds & Insurance (3% of Subtotal)	**$ 3,000**
General Conditions (8% of Subtotal)	**$ 8,000**
Subtotal (Rounded)	**$ 113,000**
Contingency (20%, Rounded)	**$ 23,000**
Total Probable Construction Cost	**$ 140,000**