

FINAL REPORT

Pump Station SCADA Improvements PRELIMINARY ENGINEERING REPORT



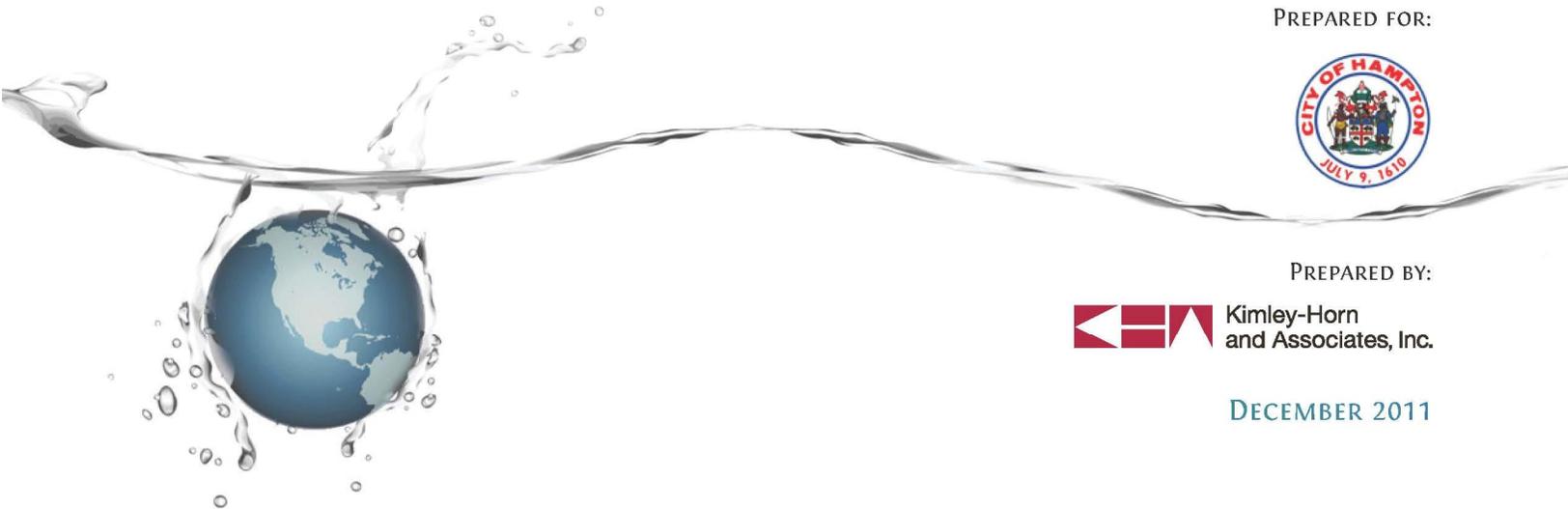
PREPARED FOR:



PREPARED BY:



DECEMBER 2011



City of Hampton Wastewater Division

Pump Station SCADA Improvements

Preliminary Engineering Report – DRAFT FINAL

December 1, 2011

Prepared for:



Prepared by:



Kimley-Horn
and Associates, Inc.

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1. INTRODUCTION

The age and limitations of the City of Hampton's existing wastewater SCADA (Supervisory Control And Data Acquisition) system have contributed to the recommendation that a new SCADA system be installed. Major features of this new system include replacing the SCADA/Historian system platform and the replacement of the existing 400MHz wireless communications with a new wireless communications system comprised of either 900MHz and/or narrow-banded 400MHz frequencies, and potentially some shared resource fiber optic access points. Kimley-Horn and Associates, Inc. (KHA herein) has been tasked with assisting the City in creating a Request For Proposal (RFP) to upgrade the existing central hardware and software, field equipment and communications as they relate to the monitoring and control of the City's sanitary sewer pump stations.

During the course of this task, KHA reviewed the "Technical Survey Wastewater System Controls" assessment report of the SCADA controls that was conducted by InstruLogic in 2010 (Appendix A. This survey assessed the conditions of each station's components as well as the type of sensors and control equipment in use at each location. Site security observations were also identified for each location within the Survey. A few of the key recommendations in the Technical Survey include:

- Use of current PLC's (programmable logic controllers) and industry standard RTUs
- Upgrading the Intouch Wonderware-based Human Machine Interface (HMI) to current version or new industry standard package
- Upgrading the radio network to provide a high speed/data throughput
- Provide ability to add video and other security enhancements in the future

KHA interviewed City staff to establish a baseline set of functional requirements for the proposed system upgrades. Additionally, KHA and the City gathered information from other regional agencies that have undergone similar upgrades to obtain lessons learned from those deployments. The City visited the New Kent County facility, and KHA interviewed the City of Virginia Beach in support of this effort. KHA and the City conducted informal Request For Information (RFI) presentations in order to assist with refining the City's functional requirements.

The objective of this document is to provide a summary of proposed SCADA solutions and their impact to the City if included as part of the aforementioned upgrade. This document and the recommended functional requirement upgrades will form the basis for the RFP to upgrade the system.

2. EXISTING CONDITIONS

2.1 *Functionality*

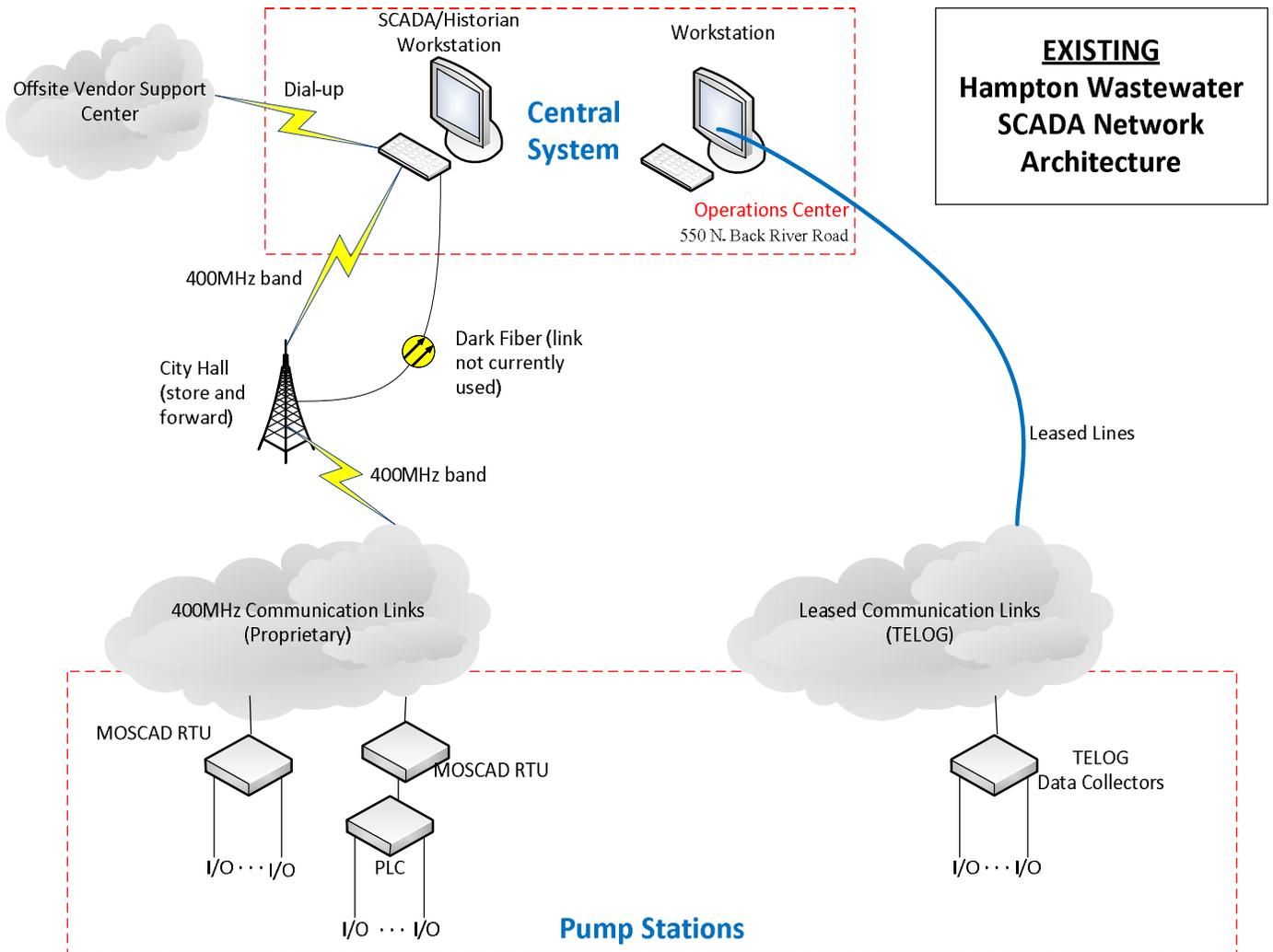
The existing SCADA system is set-up to monitor a mixture of door switches, discharge pressure sensors, flow meters, rainfall, high-level float, and wet-well/tank level gauge data of sanitary sewer pump stations throughout the City. Some locations are equipped with Variable Frequency Drive (VFD) motors with locally autonomous controls. The Supervisory System and Human-Machine Interface (HMI) central system components are located in an office in the City's Public Utilities building located at 550 N. Back River Road. Remote Terminal Units (RTUs) and Programmable Logic Controllers (PLCs) at the pump stations connect to analog and digital sensors within each facility. A network of RTUs and PLCs communicates with the Supervisory System at the Public Utilities building via licensed 400 Mhz wireless radios. The Telog Historian runs across a separate leased communication network to a separate dedicated computer. **Figure 1** below illustrates the connectivity of the existing SCADA network.

2.2 *Central Hardware/Software*

Existing HMI hardware consists of Windows[®] based workstations. The City uses a SCADA platform known as Wonderware[®] *In Touch* (version 10.0.100), by Invensys. George Butler & Associates' (GBA) maintenance management software is used to log service call information related to problems identified by the Wonderware software. The City does not favor the existing Wonderware software interface because it does not provide the features and flexibility the City needs to do its job more effectively. For example, the City currently has to rely on a separate Telog package due to the inability of the Wonderware software to provide the level of monitoring for the Regional Consent Order. The City is not having any issues with the reliability of the central hardware (i.e. servers/workstations), but envisions upgrading all hardware and software for an improved overall system. It should be noted that other integrators have developed a different user interface based on the same Wonderware development system framework.

Pump Station SCADA Improvements

Figure 1: Existing Wastewater SCADA Network Architecture



2.3 Field Equipment

There are approximately 104 existing sanitary sewer pump stations throughout the City but only 100 are being monitored by SCADA. Each pump station's sensors are connected to a local RTU, and/or PLC in some locations, that communicates with the central system as shown in **Figure 1**. A map of the existing pump station locations, towers and City facilities is provided on **Appendix A**.

2.4 Communications

Existing communication between each RTU and the Supervisory System at the Public Utilities building is achieved via a licensed, 400MHz radio network.

2.5 Known Issues

2.5.1 Communications

The Federal Communications Commission (FCC) is requiring the existing radio system to be narrow banded by January 2013. Narrowbanding is the process by which radios are required to be replaced and/or converted to use less of the radio frequency (RF) spectrum than they use presently. As such, spare parts for the existing radios have become scarce, and the City is in need of quickly upgrading the SCADA communications platform. Additionally, the Central Software has polling limitations, which are attributed to routinely skipping over some of the SCADA locations.

2.5.2 Hampton Roads Regional Consent Order

Under this regional consent order, the City is required to monitor and report wastewater system data to ensure compliance with applicable environmental regulations. Therefore, the proposed Central Software solution will be required to have reporting capabilities in compliance with the consent order.

2.5.3 Power

Many of the pump stations are susceptible to losing power during strong storm events. However, the City would like to continue monitoring pump station performance during these events, such as inflow/outflow data and wet-well levels. The existing system records this data to a Historian, but it is not readily accessible through the Central Software. Therefore, backup power for the SCADA system has been identified as an overall need.

3. PROPOSED CONDITIONS

3.1 Functional Requirements

The design of the new SCADA system will be based on meeting the functional and communication needs of the pump station equipment and security sensors as desired by

the City for monitoring and control of the wastewater facilities (**Figure 2**). Specifically, Hampton's Public Works staff has identified a series of high-level functional needs that consist of the following:

- Monitor and control approximately 104 wastewater pump stations initially in a wireless Ethernet network;
- Establish a new system that is sufficiently stable to run continuously (i.e. 24 hours a day/7 days a week) and unattended outside of standard operating hours;
- Centralized pump station monitoring (and optional control functionality in some locations);
- Replace existing RTUs with devices supporting Ethernet, serial, other interfaces as needed to integrate with existing PLCs and input/output devices;
 - Utilize standards-based PLCs, radios, and/or RTUs for long-term migration;
- Migrate flow data into the proposed SCADA/Historian system (as opposed to separate systems today);
- Support a client-server architecture and be Microsoft Windows-based (Windows 7 workstations, and Windows 2008 servers);
- Optional capability to support polling, viewing, and controlling future CCTV cameras in the pump stations.
- Remote monitoring capability via web interface
- The new system will need to be designed for expansion to cover at least 180 pump stations.

The first phase of the system installation will include upgrading the central system hardware and software and upgrading the wireless communications. Sensor upgrades, site security improvements, and additional SCADA remote control capabilities are anticipated for subsequent phases as funding permits.

3.2 Central Hardware/Software

The proposed pump station control system software will use a real-time, multitasking operating system and employ a graphical user interface (GUI) for system operation. The system will be required to operate in a distributed environment with pump, rainfall and flow data stored and implemented by the local station and monitored by the central system computer(s). Local alarms will notify the central system, and the CCTV, when available, will have the ability to be monitored and controlled by the central computer(s).

3.3 Field Equipment

New RTUs or Micro-PLCs with external Ethernet-based Radios will replace the functionality of existing PLCs to improve the speed and efficiency of data processing and communication, while establishing an open architecture system.

CCTV cameras are planned for a future phase, and should be considered an optional element to the system.

3.4 Communications

The City's existing radio system will need to either be upgraded by "narrowbanding" or by migrating to an alternate frequency band. The City is considering two primary replacement options: migration to 900MHz, or narrow banding the existing 400MHz license.

3.4.1 Intermodulation Interference Study

900MHz frequency equipment is anticipated to require additional towers to cover the same area that is presently handled by the single tower/node at City Hall. For this to be a cost effective upgrade alternative, the City is working to establish access options for mounting antennae to the Public Safety towers. In order to effectively access their options, an Intermodulation Interference (IM) study should be performed to ensure there is no interference with existing communication equipment. For the time being, it is presumed there would need to be a minimum separation of 20 feet between any existing antennae. A radio frequency communication master plan is recommended for assessing frequency availability and coverage footprints prior to releasing the RFP for system upgrades.

3.4.2 Proposed Communications

The proposed system may need to support narrow banding of the existing 400MHz equipment in the event that sufficient tower space cannot be acquired. A 900MHz system is desired for the purpose of providing more robust, open architecture communications. Communications between the central control center and the field equipment will use Ethernet over the proposed wireless communications. The proposed system is currently planned to use RTUs that support the use of an Ethernet port as well as serial port(s) for backwards compatibility with the City's existing PLC equipment, allowing the SCADA system communications to take place in an entirely internet protocol (IP) environment. However, the City is also considering micro-PLC units with flash memory storage and off-the-shelf communications radios in lieu of single-vendor RTUs. **Figure 2** below illustrates the proposed architecture envisioned for the new system.

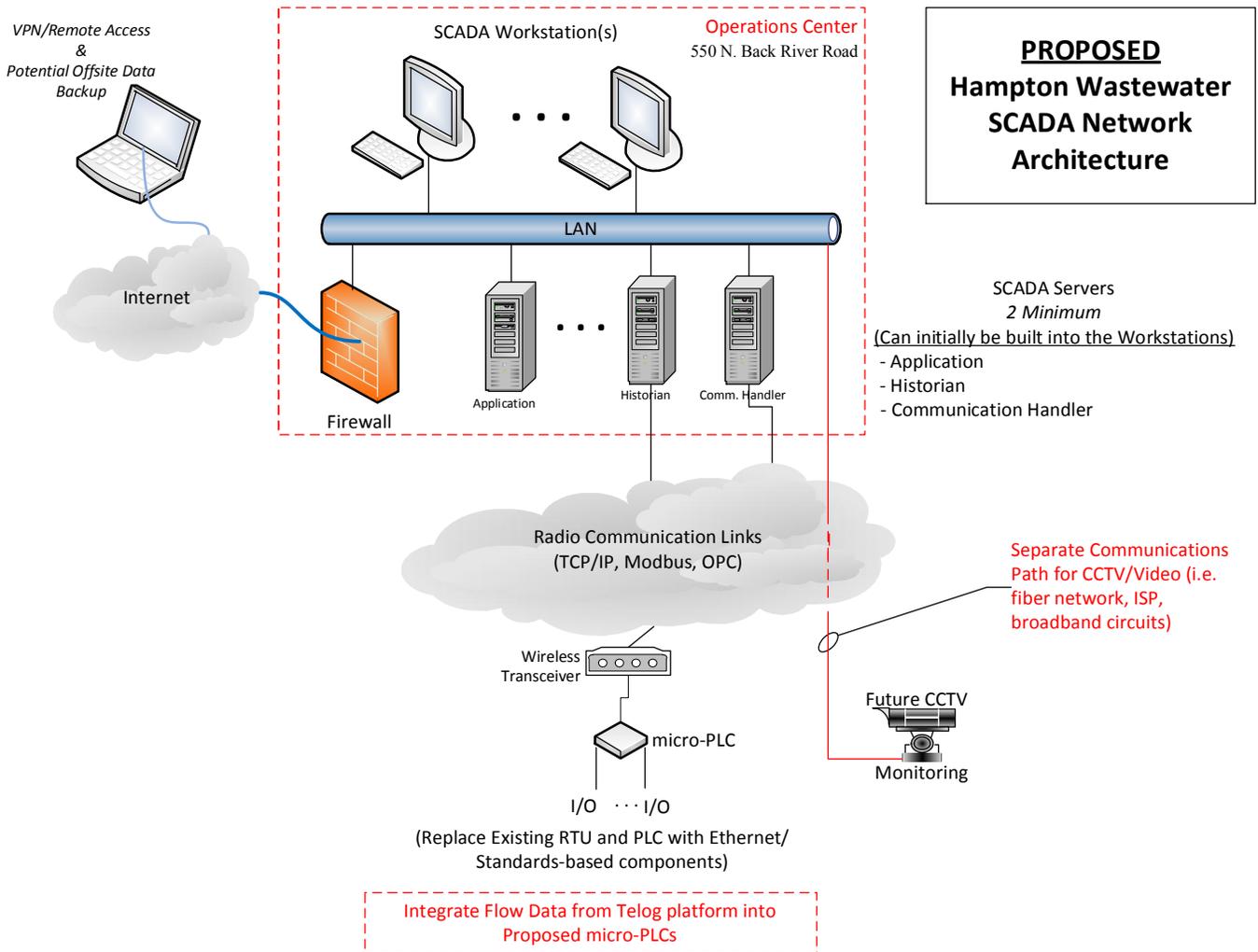
In addition to Public Safety tower space, the steering committee is looking into resource sharing options for City-owned fiber optics. Fiber-optics may be used to provide primary or backup communications connections between one or more radio tower locations, City Hall and Operations, and/or future CCTV monitoring locations.

3.5 Vendor Solutions

An informal RFI was sent to various known vendors to assist the City with identifying a software and communication hardware functionality. Four vendors (E-Merge/AutomaTech, CEC/Weidmuller, CCU and ITS/Motorola) responded to the RFI and gave presentations to the City on potential solutions for the SCADA upgrade.

Appendix B summarizes the solutions proposed by these vendors.

Figure 2: Proposed Wastewater SCADA Network Architecture



3.6 Recommendations

Based on the functional requirements identified by the City and the information provided by the vendors and subsequent research, the following recommendations are made:

- Conduct a communications master plan to determine available licensed frequency options in the 900MHz band in the City.
 - Based on the available frequencies, the plan should also assess the predictive coverage using tower space identified through other City resources.
 - Otherwise, narrow banding of the existing 400MHz channels is recommended.
- Upgrade the existing RTUs to an open-architecture involving:
 - Ethernet-based components with interfaces to legacy serial (i.e. EIA-232, 422, 485) components
 - Off-the-shelf mini-PLC components for localized automation of site controls, and data reliability.
- Upgrade the central system platform to address the functional requirements identified above including redundant backup site capabilities.
 - Select an open-architecture central system platform that supports a seamless transition from the existing MOSCAD radios to the proposed radio communications equipment during cutover.
 - Establish a unified platform for SCADA, Historian, and Alarm Management to minimize integration and configuration effort and costs.
 - Select an Integrator/Support contractor that is located within a four hour driving distance of the City for more timely support.
- Prepare a Request for Proposal (RFP) for advertisement following the completion of the communications master plan which will allow the City to select and implementation provider for the above referenced system component upgrades.

4. OPINION OF PROBABLE COSTS

As design progresses, KHA will work with the City of Hampton and potential vendors to further define estimated costs for the proposed SCADA components including, but not limited to, PLCs, RTUs, wireless radio equipment and Software upgrades and integration.

Table 1 below provides a preliminary Opinion of Probable Costs of the SCADA upgrades factoring in the variance between high and low-end software packages.

Pump Station SCADA Improvements

Table 1: Preliminary Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount
Programmable Logic Controller	100	EA	\$1,000	\$100,000
UPS Back-Up (option)	100	EA	\$600	\$60,000
Wireless Radio	100	EA	\$2,000	\$200,000
Tower attachment modifications (for potential coverage expansion for 900MHz alternative)	3	EA	\$10,000	\$30,000
SCADA Software (Low-End)	1	LS	\$100,000	\$100,000
SCADA Software (High-End)	1	LS	\$500,000	\$500,000
Low-End Sub-Total				\$490,000
10% Contingency				\$49,000
Total				\$539,000
High-End Sub-Total				\$890,000
10% Contingency				\$89,000
Total				\$979,000

