ATTACHMENT A-1

AUSTIN WATER UTILITY

WALNUT CREEK WASTEWATER TREATMENT PLANT SCADA NETWORK IMPROVEMENTS

C.I.P. ID # 2015.019

PRELIMINARY ENGINEERING TECHNICAL MEMORANDUM

Submitted by:

HARUTUNIAN ENGINEERING, INC.
Engineering & Environmental Consultants
Austin, Texas
Texas Registered Engineering Firm F-2408

June 2015

STATE OF TEXAS
SHANT HARUTUNIAN
87735
REGISTERED
PROFESSIONAL ENGINEER

6/30/2015

THIS PAGE INTENTIONALLY LEFT BLANK

CITY OF AUSTIN

WALNUT CREEK WASTEWATER TREATMENT PLANT
Network Improvements

TECHNICAL MEMORANDUM

TABLE OF CONTENTS

1 INTRODUCTION 1

2 OBJECTIVE 1

3 BACKGROUND 2

4 EXISTING CONDITIONS 5

4.1 Administration Building 7

4.2 Headworks No. 1 10

4.3 Headworks No. 2 11
4.3.1 Headworks No. 2 Power Monitoring 12
4.3.2 Headworks No. 2 OIU 13

4.4 Primary Treatment Complex No. 1 13
4.4.1 Primary Treatment Complex No. 1 13
4.4.2 Process Air Blowers 14
4.4.3 Settled Wastewater Pumps 16

4.5 Primary Treatment Complex No. 2 18

4.6 Operations Raw wetwell 19

4.7 Activated Sludge Complexes 21
4.7.1 Activated Sludge Complex 1 21
4.7.2 Activated Sludge Complex 2 24
4.7.3 Activated Sludge Complex 3 27

4.8 Sludge Thickener 31

4.9 Sludge Pressurization 32

4.10 Water Reuse system **33**
4.10.1 Water Reuse System Control Panel "WR-CP-LPU1A" 34
4.10.2 Water Reuse System Control Panel "WR-CP-LPU2A" 34
4.10.3 Water Reuse System Power Monitoring 36
4.10.4 Water Reuse System Operator Interface Unit 36

4.11 Filter Building No. 1 **37**

4.12 Filter Building No. 2 **38**

4.13 Chlorine Area **39**

4.14 Dechlorination Building **40**

4.15 Substation No. 1 **41**
4.15.1 Substation No. 1 Power Monitoring 41
4.15.2 Substation No. 1 Operator Interface Unit 41

4.16 Substation No. 2 **42**
4.16.1 Substation No. 2 Power Monitoring 43
4.16.2 Substation No. 2 Operator Interface Unit 43

4.17 Influent Lift Station **45**

5 ASSESSMENT AND RECOMMENDED IMPROVEMENTS **46**

5.1 Administration Building **46**
5.1.1 Control Room Network Improvements 47
5.1.2 Control Room PLC Improvements 48

5.2 Headworks No. 1 **48**
5.2.1 Headworks No. 1 Network Improvements 48
5.2.2 Headworks No. 1 PLC Improvements 48

5.3 Headworks No. 2 **49**
5.3.1 Headworks No. 2 Network Improvements 49
5.3.2 Headworks No. 2 PLC Improvements 49

5.4 Primary Treatment Complex No. 1 (LPU-2) **50**
5.4.1 Primary Treatment Complex No. 1 Network Improvements 50
5.4.2 Primary Treatment Complex No. 1 PLC Improvements 51

5.5 Primary Treatment Complex No. 2 **51**
5.5.1 Primary Treatment Complex No. 2 Network Improvements 51
5.5.2 Primary Treatment Complex No. 2 PLC Improvements 52

5.6 Operations Raw Wetwell **52**

5.6.1 Operations Raw Wetwell Network Improvements 52
5.6.2 Operations Raw Wetwell PLC Improvements 53

5.7 Activated Sludge Complex 1 53
5.7.1 Activated Sludge Complex 1 Network Improvements 53
5.7.2 Activated Sludge Complex 1 PLC Improvements 54

5.8 Activated Sludge Complex 2 54
5.8.1 Activated Sludge Complex 2 Network Improvements 54
5.8.2 Activated Sludge Complex 2 PLC Improvements 55

5.9 Activated Sludge Complex 3 55
5.9.1 Activated Sludge Complex 3 Network Improvements 55
5.9.2 Activated Sludge Complex 3 PLC Improvements 56

5.10 Sludge Thickener 57
5.10.1 Sludge Thickener Network Improvements 57
5.10.2 Sludge Thickener PLC Improvements 57

5.11 Sludge Pressurization 57
5.11.1 Sludge Pressurization Network Improvements 58
5.11.2 Sludge Pressurization PLC Improvements 58

5.12 Water Reuse System 58
5.12.1 Water Reuse System Network Improvements 58
5.12.2 Water Reuse System PLC Improvements 59

5.13 Filter Building No. 1 59
5.13.1 Filter Building No. 1 Network Improvements 59
5.13.2 Filter Building No. 1 PLC Improvements 60

5.14 Filter Building No. 2 60
5.14.1 Filter Building No. 2 Network Improvements 61
5.14.2 Filter Building No. 2 PLC Improvements 61

5.15 Chlorine Area 61
5.15.1 Chlorine Area Network Improvements 61
5.15.2 Chlorine Area PLC Improvements 62

5.16 Dechlorination Building 62
5.16.1 Dechlorination Building Network Improvements 63
5.16.2 Dechlorination Building PLC Improvements 63

5.17 Substation No. 1 63
5.17.1 Substation No. 1 Network Improvements 63
5.17.2 Substation No. 1 PLC Improvements 64

5.18 Substation No. 2 64

5.18.1 Substation No. 2 Network Improvements 64
5.18.2 Substation No. 2 PLC Improvements 64

5.19 Influent Lift Station 64
5.19.1 Influent Lift Station Network Improvements 65
5.19.2 Influent Lift Station PLC Improvements 65

5.20 Overall Network Improvements 65
5.20.1 Communication Media 65
5.20.2 SY/NET Network Decommissioning 66
5.20.3 Modbus Plus Network 66
5.20.4 Ethernet Switching Technology 66
5.20.5 SCADA System Computers 67

6 OVERVIEW SUMMARY OF RECOMMENDATIONS 68

7 PRELIMINARY BUDGETARY COST ESTIMATE 69

LIST OF TABLES

Table 1 PLC System Overview 6
Table 2 Walnut Creek WWTP Plant SCADA System Computers and Locations 8
Table 3 Preliminary Budgetary Construction Cost Estimate 69

LIST OF FIGURES

Figure 1 Administration Building Control Room: Communication Control Panels 9
Figure 2 Administration Building Control Room: Mimic Panel PLC Cabinet 9
Figure 3 Administration Building Electrical Room: Lift Station Telemetry Servers 10
Figure 4 Headworks No. 1 LPU-1, "PLC-1" 11
Figure 5 Headworks No. 2 Control Panel "HW2-CP-LPU1" 12
Figure 6 Primary Treatment Complex No. 1 LPU-2, PLC 14
Figure 7 Process Air Blower Master PLC "OP-PLC-LPU1" 15
Figure 8 Process Air Blower Control Panel "OP-CP-LPU1" 16
Figure 9 Settled Wastewater Pump PLC "OP-PLC-SWP4" 17
Figure 10 Settled Wastewater Pumps Control Panel "OP-CP-LPU2" 18
Figure 11 Primary Treatment Complex No. 2 LPU-3, PLC 19
Figure 12 Operations Raw Wetwell LPU-4, PLC 20
Figure 13 Operations Raw Wetwell LPU-4 20
Figure 14 ASC1 MCC Electrical Room (LPU-5 lower doors ajar) 22
Figure 15 Activated Sludge Complex No. 1 LPU-5, PLC 22
Figure 16 ASC1 Control Room (ASC1-CP-LPU1 in foreground) 23
Figure 17 Activated Sludge Complex 1 PLC head rack, "ASC1-PLC-010" 24
Figure 18 ASC2 Old MCC Electrical Room (LPU-6 doors ajar) 25
Figure 19 Activated Sludge Complex No. 2 Control Room Area (south wall) 25
Figure 20 ASC2 Control Room (ASC2-CP-LPU1) 26
Figure 21 Activated Sludge Complex 2 PLC, "ASC2-PLC-010" and network equipment 27
Figure 22 Activated Sludge Complex 3 LPU-7 Control Room 28
Figure 23 Activated Sludge Complex 3 LPU-7 (PLC-7 in lower section) 29
Figure 24 Activated Sludge Complex 3 Control Room (ASC3-CP-LPU1) 29
Figure 25 Activated Sludge Complex 3 PLC, "ASC3-PLC-010" 31
Figure 26 Sludge Thickener LPU-10 32
Figure 27 Sludge Pressurization PLC-11 33
Figure 28 WRS Control Panels "WR-CP-LPU1A"(left) and "WR-CP-LPU2A" (right) 34
Figure 29 Water Reuse System Data Concentrator PLC "WR-PLC-1A" 35
Figure 30 Water Reuse System Remote I/O Fiber-to-Coaxial Transceivers 36
Figure 31 Filter No. 4 Console LPU-9D (PLC-9D) 37
Figure 32 Filter Building Control Panel "FB1-CP-WR" 38
Figure 33 Chlorine Area Control Room 39
Figure 34 Dechlorination Building Control Panel "DS01-LCP-01" 40
Figure 35 Substation No. 1 Network Equipment 42
Figure 36 Substation No. 1 "SUB1-PLC-01" Head Rack 42
Figure 37 Substation No. 2 MCC Lineups 44
Figure 38 Substation No. 2 "SUB2-CP-LPU1" 44
Figure 39 Influent Lift Station Network Equipment Panel 45

LIST OF EXHIBITS

Exhibit 1 Overall Plant SCADA Network Architecture - Existing
Exhibit 1A Overall Plant SCADA Network Block Diagram - Existing
Exhibit 2 Admin Building SCADA Network Architecture - Existing
Exhibit 3 Headworks 1 SCADA Network Architecture - Existing
Exhibit 4 Headworks 2 SCADA Network Architecture - Existing
Exhibit 5 Prim. Treat. 1/OPS SCADA Network Architecture - Existing (1 Of 3)
Exhibit 6 Prim. Treat. 1/OPS SCADA Network Architecture - Existing (2 Of 3)
Exhibit 7 Prim. Treat. 1/OPS SCADA Network Architecture - Existing (3 Of 3)
Exhibit 8 Primary Treatment Complex 2 SCADA Network Architecture - Existing
Exhibit 9 Operations Raw Wetwell SCADA Network Architecture - Existing
Exhibit 10 Activated Sludge Complex 1 SCADA Network Architecture - Existing
Exhibit 11 Activated Sludge Complex 2 SCADA Network Architecture - Existing
Exhibit 12 Activated Sludge Complex 3 SCADA Network Architecture - Existing
Exhibit 13 Sludge Thickener Building SCADA Network Architecture - Existing
Exhibit 14 Sludge Pressurization Bldg. SCADA Network Architecture - Existing
Exhibit 15 Water Reuse System SCADA Network Architecture - Existing
Exhibit 16 Filter Building No. 1 SCADA Network Architecture - Existing
Exhibit 17 Filter Building No. 2 SCADA Network Architecture - Existing
Exhibit 18 Chlorine Area SCADA Network Architecture - Existing
Exhibit 19 Dechlorination SCADA Network Architecture - Existing
Exhibit 20 Substation No. 1 SCADA Network Architecture - Existing
Exhibit 21 Substation No. 2 SCADA Network Architecture - Existing
Exhibit 22 Influent Lift Station SCADA Network Architecture - Existing
Exhibit 23 Overall Plant SCADA Network Architecture - Renovation
Exhibit 23A Overall Plant SCADA Network Block Diagram - Renovation
Exhibit 24 Admin Building SCADA Network Architecture - Renovation
Exhibit 25 Headworks 1 SCADA Network Architecture - Renovation
Exhibit 26 Headworks 2 SCADA Network Architecture - Renovation
Exhibit 27 Prim. Treat. 1/OPS SCADA Network Architecture - Renovation (1 Of 2)
Exhibit 28 Prim. Treat. 1/OPS SCADA Network Architecture - Renovation (2 Of 2)
Exhibit 29 Primary Treatment Complex 2 SCADA Network Architecture - Renovation
Exhibit 30 Activated Sludge Complex 1 SCADA Network Architecture - Renovation
Exhibit 31 Activated Sludge Complex 2 SCADA Network Architecture - Renovation
Exhibit 32 Activated Sludge Complex 3 SCADA Network Architecture - Renovation
Exhibit 33 Sludge Thickener Building SCADA Network Architecture - Renovation
Exhibit 34 Sludge Pressurization Bldg. SCADA Network Architecture - Renovation
Exhibit 35 Water Reuse System SCADA Network Architecture - Renovation
Exhibit 36 Filter Building No. 1 SCADA Network Architecture - Renovation
Exhibit 37 Filter Building No. 2 SCADA Network Architecture - Renovation
Exhibit 38 Dechlorination SCADA Network Architecture - Renovation
Exhibit 39 Substation No. 1 SCADA Network Architecture - Renovation
Exhibit 40 Admin. Building - Control Room Detailed Fiber Net. - Existing
Exhibit 41 Admin. Building - Tunney Room Detailed Fiber Net. - Existing
Exhibit 42 Admin. Building - Office 114 Detailed Fiber Net. - Existing
Exhibit 43A Admin. Bldg. - Elec. Room Detailed Fiber Net. - Existing (1 Of 2)

Exhibit 43B Admin. Bldg. - Elec. Room Detailed Fiber Net. - Existing (2 Of 2)
Exhibit 44 Headworks No. 2 Detailed Fiber Network - Existing
Exhibit 45 Operations Bldg. Detailed Fiber Network - Existing
Exhibit 46 Activated Sludge Complexes 1-3 Detailed Fiber Network - Existing
Exhibit 47 Water Reuse Detailed Fiber Network - Existing
Exhibit 48 Filter Building No. 1 Detailed Fiber Network - Existing
Exhibit 49 Substation No. 1 Detailed Fiber Network - Existing
Exhibit 50 Substation No. 2 Detailed Fiber Network - Existing
Exhibit 51 Admin. Inf. Lift Station Detailed Fiber Network - Existing
Exhibit 52 Maintenance Building Detailed Fiber Network - Existing

1 INTRODUCTION

The Walnut Creek Wastewater Treatment Plant makes extensive use of SCADA (Supervisory Control and Data Acquisition) Top-End computer system monitoring, control, and alarming. The Top-End system predominately relies on the Programmable Logic Controllers (PLCs) located throughout the plant to perform tasks for the plant operations staff. Hence, the health and reliability of the PLC system is critical to the operation of the plant. The predominance of the plant's PLC systems are the outdated Square D SY/MAX PLC's, with some Schneider Quantum PLCs added in recent renovation projects.

The PLC system relies on the plant PLC network for communication of collected data to the Top-End as well as peer-to-peer PLC communication, as required. The plant network is presently a mixture of SY/NET communication protocol over copper media type (twin co-axial cable and serial) as well as Modbus TCP Ethernet over fiber optic and copper media.

As part of this network system improvements project, the City of Austin would like to pursue alternatives to renovate the plant's PLC network and standardize on a network communication protocol and media. It is assumed that renovation of each existing outdated PLC system is addressed by other, separate projects specific to the process area within which each existing PLC system resides.

In this Technical Memorandum, HEI provides a brief summary of the existing PLC system and network, including an assessment of potential automation and existing outdated components. Thereafter, recommendations are provided for a path forward to upgrade the existing PLC system and network.

2 OBJECTIVE

The objective of this Technical Memorandum (TM) is to assess the PLC network system for the Walnut Creek Wastewater Treatment Plant and identify potential improvements in the network system. In addition, HEI has made numerous field visits to identify the existing fiber optic and copper PLC communication system. Based on the field visits, it is observed that some of the communication system architecture is poorly documented, with difficulty in determining existing interconnections. Hence, aside from providing an opportunity to upgrade the network, this assessment also provides an opportunity to enhance the existing system documentation. This should be of benefit not only in easing maintenance, but in planning and implementing future renovations and improvements to the plant automation system.

In addition to reviewing the PLC hardware system and I/O points, the HEI team has also made an extensive survey of the existing plant communication network. The existing plant automation communication network, both fiber optic and copper, has been reviewed and documented.

3 BACKGROUND

The Walnut Creek Wastewater Treatment Plant was initially constructed circa 1979. Since then, the plant has undergone a number of expansions and renovation projects. The projects that have impacted the plant's SCADA network architecture shall be summarized.

Of particular relevance to the SCADA network is the Contract 6 project, circa 1990. This project renovated the entirety of the plant network system with new SY/MAX PLC's and a dual channel, copper, daisy chain SY/NET network. The automation improvements portion of the project spanned the following process areas:

- Activated Sludge Complex 1,
- Activated Sludge Complex 2,
- Activated Sludge Complex 3,
- Administration Building,
- D.A.F. Thickener Building,
- Filter Building No. 1,
- Filter Building No. 2,
- Headworks 1,
- Operations Building,
- Primary Treatment Complex 1,
- Primary Treatment Complex 2, and
- Sludge Pressurization.

With exception of the majority of the PLCs in the Operations Building, this automation system is still in use today.

In 1996, the Chlorination Project added a new Chlorine PLC to the plant's automation system. This PLC is located in the Operations Building Chlorine/Lab area. The PLC is a SY/MAX PLC connected to the plant's SY/NET daisy chain network.

In 1996, the Dechlorination Project added a new Dechlorination Building which housed a control panel with a new PLC. The new PLC is a SY/MAX PLC connected to the plant's SY/NET daisy chain network.

In 2005, the AWU implemented an in house project wherein the entirety of the dual channel SY/NET system was changed to a single channel network. This project was implemented due to SY/NET network equipment failures and obsolete SY/NET equipment. Specifically, the project removed one of the two SY/NET network cards at each local process area PLC, leaving a single SY/NET network card for each PLC to be connected to the SY/NET network. This effectively provided spare SY/NET network cards to be used for replacement in the event of SY/NET network card failures. The dual channel SY/NET copper media remains in place. In addition, the AWU added a single SY/NET to Modbus TCP Ethernet Bridge at the Administration Building SY/MAX PLC. This bridge allows the Top-End SCADA server computers to poll the

devices on the SY/NET network. By using this Ethernet bridge device, the AWU no longer requires the obsolete SY/NET PC cards to be installed in the SCADA server computers.

In 2002, the Walnut Creek Power Distribution System Improvement Phase 1 (PDSI-1) Project added a new Main Substation No. 1 to the plant. This Substation added a new Quantum based PLC system for the local control and operation of the Substation. The project made no modifications to the plant's SCADA network.

In 2003, the Water Reuse Initiative (WRI) project added a new Water Reuse facility to the plant. The Water Reuse facility is used for the pumping of non-potable for the needs of the plant as well as pumping off site to the utility's water reuse distribution system. The project added a new Quantum based PLC system for the Water Reuse facility, as well as a new dual channel single mode fiber optic system. This fiber optic system connected the Water Reuse Electrical Building PLC system, as well as the Substation No. 1 PLC system, to the Top-End computer system located in the Administration Building. The communication protocol used is Modbus TCP over Ethernet.

In 2006, the 75MGD Upgrade Project added a new Headworks facility to the plant (Headworks No. 2), as well as made renovations to the RAS pumping system in the secondary treatment portion of the plant. The project added new Quantum based PLC systems to the Headworks No. 2 Building. The Headworks No. 2 SCADA network interconnects with the Administration Building via a dual channel fiber optic network. The communication protocol used is Modbus TCP over Ethernet. The project also added a new Quantum based PLC system to each of the three activated sludge complexes of the plant. Each quantum PLC interconnects with the existing SY/NET network via a Modbus Plus to SY/NET bridge. The Top-End computer then polls the three RAS pump PLC systems over the SY/NET single channel network. It should be noted that the 75MGD Upgrade Project made other plant improvements that are not listed here as they are unrelated to the SCADA network system.

In 2014, the Influent Flow Improvements & Equipment Replace/Rehabilitation project, added a new Lift Station control panel nearby the Administration Building. This control panel has a new M340 PLC with single Channel Ethernet fiber connection to the Administration Building. This project also replaced one of the bar screens in Headworks No. 2 with a new bar screen. This new bar screen has its own dedicated vendor control panel. The control panel houses an M340 PLC which communicates using the Modbus TCP protocol. The control panel has a single channel, copper Ethernet media routed to the Headworks No. 2 local area switch, which in turn connects to the plant fiber optic network for communication with the Administration Building Top-End computers. This project also added a new Operator Interface Unit (OIU) in the Headworks No. 2. The OIU is a workstation computer that connects to the network via the Headworks No. 2 local area switches.

In 2015, the Walnut Creek Power Distribution System Improvement Phase 2 (PDSI-2) Project, added a new Main Substation No. 2 to the plant, upgraded all the control systems, inclusive of the PLCs, for the plant's Process Air Blowers and Settled Wastewater Pumps, as well as added a new PLC system to the Secondary Treatment Process for the control and monitoring of Dissolved Oxygen in the aeration basins. The PDSI-2 project added one dedicated new Quantum PLC for each Process air blower, as well as a Master PLC for general monitoring and control of the Blower System, e.g., cooling water system, air system, etc. The Project added dedicated Quantum PLCs for each of the settled wastewater pumps, as well as a master PLC for

general monitoring and control of the Settled Wastewater Pumping System. The projects added one new PLC per Activated Sludge Complex. Each such PLC was responsible for the monitoring and control of two (2) aeration basins, where each aeration basin has motorized valving, flow instrumentation, and Dissolved Oxygen instrumentation for the monitoring and control of the dissolved oxygen in the respective basins.

The PDSI-2 Project's SCADA network improvements include additions of new nodes to the plant's dual channel Modbus TCP network. A new network was added from the Operations Building to the Substation No. 1, which then eventually interconnects with the Administration Building for communication with the Top-End computer system. This Operations Building fiber optic network allows for connectivity for the new Substation No. 2 as well as the renovated Process Air Blower and Settled Wastewater Pumping systems. The project also added a new dedicated dual channel fiber optic network from each of the Activated Sludge Complexes to the Operations Building Blower and SWP control room. These dedicated fiber connection allow for direct communication between the DO control PLCs with the Blower Master PLC for overall DO control algorithm. The fiber connection also allows for the interconnection of the new Activated Sludge Complex PLCs with the Administration Building, via the Operations Building local area switches. All proposed network communication protocol is Modbus TCP over Ethernet.

In 2015, the WRI Tank Project added a new storage tank and a High Service Pump (HSP-4) to the water reuse system. The automation improvements included that addition of a new Quantum PLC dedicated to HSP-4. The project also added new Ethernet switches and a local OIU workstation computer for the WRI area. The OIU interconnects with the plant network via the new local Ethernet switches. The local switches connect to the Administration Building Top-End system via the plant's existing Fiber Optic network.

This TM shall review the existing PLC architecture throughout the plant, on a per process area basis. Thereafter, an assessment shall be made of the existing conditions. Finally, recommendations shall be made for the improvement of the PLC system, with the goal of proposing PLC renovations as well as standardizing and renovating the SCADA network system.

4 EXISTING CONDITIONS

The Walnut Creek Wastewater Treatment plant is composed of several process areas that work together to accomplish the treatment goals of the plant. In concert with these treatment process areas, the plant electrical and I&C system is likewise subdivided. The City has expressed concern with the SCADA network of the plant. The process areas that will be observed for the purposes of this TM are as follows:

- Administration Building
- Headworks No. 1
- Headworks No. 2
- Primary Treatment Complex No. 1 (LPU-2, Operations Building)
- Primary Treatment Complex No. 2 (LPU-3)
- Operations Raw Wetwell (LPU-4)
- Activated Sludge Complex 1
- Activated Sludge Complex 2
- Activated Sludge Complex 3
- Sludge Thickener Building (LPU-10)
- Sludge Pressurization Building (LPU-11)
- Water Reuse System
- Filter Building No. 1
- Filter Building No. 2
- Chlorine Area
- Dechlorination Building
- Substation No. 1
- Substation No. 2
- Influent Lift Station

The plant PLCs are distributed throughout the site in various process areas, as applicable. Please refer to Table 1 for an overall summary of the PLC systems in the plant. Please refer to Exhibit 1 for an overview of the existing plant network architecture, and Exhibit 1A for a logical block diagram of the existing plant SCADA network.

Table 1 PLC System Overview

Plant Area	PLC	PLC Type	Network Type	Program Type
Activated Sludge Complex 1	ASC1-PLC-01A RAS Pumping	Quantum	SY/NET	Concept
	ASC1-PLC10 DO System	Quantum	Modbus TCP	Unity
	PLC-5 WAS Pumping and Sec. Clarifiers	SY/MAX	SY/NET	SY/MAX
Activated Sludge Complex 2	ASC2-PLC-01A RAS Pumping	Quantum	SY/NET	Concept
	ASC2-PLC10 DO System	Quantum	Modbus TCP	Unity
	PLC-6 WAS Pumping and Sec. Clarifiers	SY/MAX	SY/NET	SY/MAX
Activated Sludge Complex 3	ASC3-PLC-01A RAS Pumping	Quantum	SY/NET	Concept
	ASC3-PLC10 DO System	Quantum	Modbus TCP	Unity
	PLC-7 WAS Pumping and Sec. Clarifiers	SY/MAX	SY/NET	SY/MAX
Admin. Lift Station	Admin Ls	M340	Modbus TCP	Unity
Administration Building	PLC Mimic Panel/Gateway	SY/MAX	SY/NET	SY/MAX
Chlorine Area (Operations Building)	Cl2 PLC in Operations Bldg	SY/MAX	SY/NET	SY/MAX
D.A.F. Thickener Building	PLC-10 D.A.F Thickener Bldg	SY/MAX	SY/NET	SY/MAX
Dechlorination Building	Dechlor (So2) PLC-DS01	SY/MAX	SY/NET	SY/MAX
Electrical Substation No. 1	Substation No. 1 PLC	Quantum	Modbus TCP	Concept
Electrical Substation No. 2	Substation No. 2 PLC	Quantum	Modbus TCP	Unity
Filter Building 1	PLC-9A Filter 1	SY/MAX	SY/NET	SY/MAX
	PLC-9B Filter 2	SY/MAX	SY/NET	SY/MAX
	PLC-9C Filter 3	SY/MAX	SY/NET	SY/MAX
	PLC-9D Filter 4	SY/MAX	SY/NET	SY/MAX
Filter Building 2	PLC-9E Filter 5	SY/MAX	SY/NET	SY/MAX
	PLC-9F Filter 6	SY/MAX	SY/NET	SY/MAX
	PLC-9G Filter 7	SY/MAX	SY/NET	SY/MAX
	PLC-9H Filter 8	SY/MAX	SY/NET	SY/MAX
	PLC-9I Filter 9	SY/MAX	SY/NET	SY/MAX
	PLC-9J Filter 10	SY/MAX	SY/NET	SY/MAX
Headworks 1	PLC-1 Old Hw	SY/MAX	SY/NET	SY/MAX
Headworks 2	Duperon_PLC	M340	Modbus TCP	Unity
	Hw2 PLC1A	Quantum	Modbus TCP	Concept
	Hw2 PLC2A	Quantum	Modbus TCP	Concept
	Hw2 PLC3A	Quantum	Modbus TCP	Concept

Plant Area	PLC	PLC Type	Network Type	Program Type
Operations Building	LPU1 (PAB Master PLC)	Quantum	Modbus TCP	Unity
	PAB No. 1 PLC	Quantum	Modbus TCP	Unity
	PAB No. 2 PLC	Quantum	Modbus TCP	Unity
	PAB No. 3 PLC	Quantum	Modbus TCP	Unity
	PAB No. 4 PLC	Quantum	Modbus TCP	Unity
	PLC-4 Operations (Raw Wetwell)	SY/MAX	SY/NET	SY/MAX
	LPU2 (SWP Master PLC)	Quantum	Modbus TCP	Unity
	SWP No. 1 PLC	Quantum	Modbus TCP	Unity
	SWP No. 2 PLC	Quantum	Modbus TCP	Unity
	SWP No. 3 PLC	Quantum	Modbus TCP	Unity
	SWP No. 4 PLC	Quantum	Modbus TCP	Unity
	SWP No. 5 PLC	Quantum	Modbus TCP	Unity
	SWP No. 6 PLC	Quantum	Modbus TCP	Unity
	SWP No. 7 PLC	Quantum	Modbus TCP	Unity
	SWP No. 8 PLC	Quantum	Modbus TCP	Unity
Primary Treatment Complex 1	PLC-2 Primary Treatment	SY/MAX	SY/NET	SY/MAX
Primary Treatment Complex 2	PLC-3 Primary Treatment	SY/MAX	SY/NET	SY/MAX
Sludge Pressurization	PLC-11 Sludge Pressurization	SY/MAX	SY/NET	SY/MAX
Water Reuse System	Water Reuse PLC1A (Master)	Quantum	Modbus TCP	Concept
	Water Reuse PLC11A & B (LSPS)	Quantum	MB+(Local)	Concept
	Water Reuse PLC21 (HSP-1)	Quantum	MB+(Local)	Concept
	Water Reuse PLC22 (HSP-2)	Quantum	MB+(Local)	Concept
	Water Reuse PLC23 (HSP-3)	Quantum	MB+(Local)	Concept
	Water Reuse PLC24 (HSP-4)	Quantum	MB+(Local)	Concept

Detailed diagrams for the various process areas are also provided in Exhibit 40 through Exhibit 52. It is noted that these detailed diagrams are based on existing Walnut Creek WWTP SCADA Network site conditions as of September 2014. The following sections review the existing conditions of the SCADA Network throughout these various process areas.

4.1 ADMINISTRATION BUILDING

The Administration Building contains multiple offices for the plant supervisory personnel, training and meeting rooms, and the main control room from which operations personnel monitor and control the plant. The main control room contains two (2) control panels, “WC-AD-COMM-DSC1” and “WC-AD-COMM-DCS2” which are the hub of the optical fiber network throughout the plant. Please refer to Figure 1 for a picture of these control panels. All of the remote signal telemetry throughout the plant comes back to the SCADA equipment in the Administration Building. The Administration Building also contains the Austin Water Utility Lift Station Telemetry System SCADA equipment, Wide Area Network equipment and plant-wide telecommunications equipment.

The Administration Building contains most of the computers that reside on the SCADA network at the plant. These computers are located in the operations control room on the upstairs mezzanine level. The Table 2 provides a summary of the SCADA computers and their locations.

Table 2 Walnut Creek WWTP Plant SCADA System Computers and Locations

SCADA Computer Type	Name	Room	Building
Server (Primary)	WCSS01	Control Room	Administration Building
Server (Backup)	WCSS02	Control Room	Administration Building
Domain Controller	WCDC03	Control Room	Administration Building
Operator Workstation	WCOWS02	Control Room	Administration Building
Operator Workstation	WCOWS12	Control Room	Administration Building

The computers listed in the table are used for plant wide monitoring, alarming, reporting, or controlling, as applicable. It should be noted that the Administration Building Control Room also houses a multiple Lift Station Telemetry System (LSTS) computers that are on the SCADA system wide area network. The Walnut Creek WWTP plant personnel use these computers to monitor the utility's overall lift station system. Please refer to Exhibit 2 for the existing network architecture of this area.

The SCADA servers use a Modbus Ethernet driver to communicate over the network to all Ethernet devices using Modbus TCP/IP network protocol. In addition to the SCADA computers, the Administration Building control room contains a SY/MAX PLC which is used as a gateway for the entire SY/NET network throughout the plant. This SY/MAX PLC rack is located within the Mimic panel closet behind the large screen video wall (see Figure 2). This PLC shall be referred to as the SY/NET Gateway PLC. The SY/NET Gateway PLC contains a Niobrara MEB bridge module, which bridges between the SY/NET serial network segments and Modbus TCP Ethernet. The Top-End SCADA computers directly poll the bridge module over the plant's Modbus TCP Ethernet communication network.

In addition to the control room, the administration building has three (3) other locations which contain network equipment: Tunney Resource room, Northwest Electrical Room and Room 114. The Tunney Resource room lies just below the control room and contains network equipment which connects the fiber network from the control room to the Operations Building and to the Maintenance Building. The Northwest Electrical Room (northwest corner of the administration building before the lab extension) houses network equipment related to SCADA, City-wide WAN, telecommunications and the Lift Station Telemetry System. Figure 3 shows some of the lift station equipment located within the Northwest Electrical room. Finally, Room 114 is located on the far west end of the lab wing. This office provides a junction for the fiber network between the Maintenance Building and the Northwest Electrical room.

Figure 1 Administration Building Control Room: Communication Control Panels

Figure 2 Administration Building Control Room: Mimic Panel PLC Cabinet

Figure 3 Administration Building Electrical Room: Lift Station Telemetry Servers

4.2 HEADWORKS NO. 1

Headworks No. 1 receives influent raw wastewater and serves as the initial screening and classifying area before the wastewater is sent to the primary treatment complexes. Headworks No. 1 contains bar screen rakes, grit washers, screw conveyors and a sludge box for grit disposal. After the addition of Headworks No. 2, Headworks No. 1 is typically off line and not used.

The SCADA network within Headworks No. 1 consists of a single SY/MAX PLC located within control panel “LPU-1”. This PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and Headworks No. 1, a copper twin-axial SY/NET signal is routed from "PLC-1" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 3 for the existing network architecture of this area.

The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge module over Modbus TCP Ethernet to attain data from the Headworks No. 1 area. Please refer to Figure 4 for a picture of the control panel for this area.

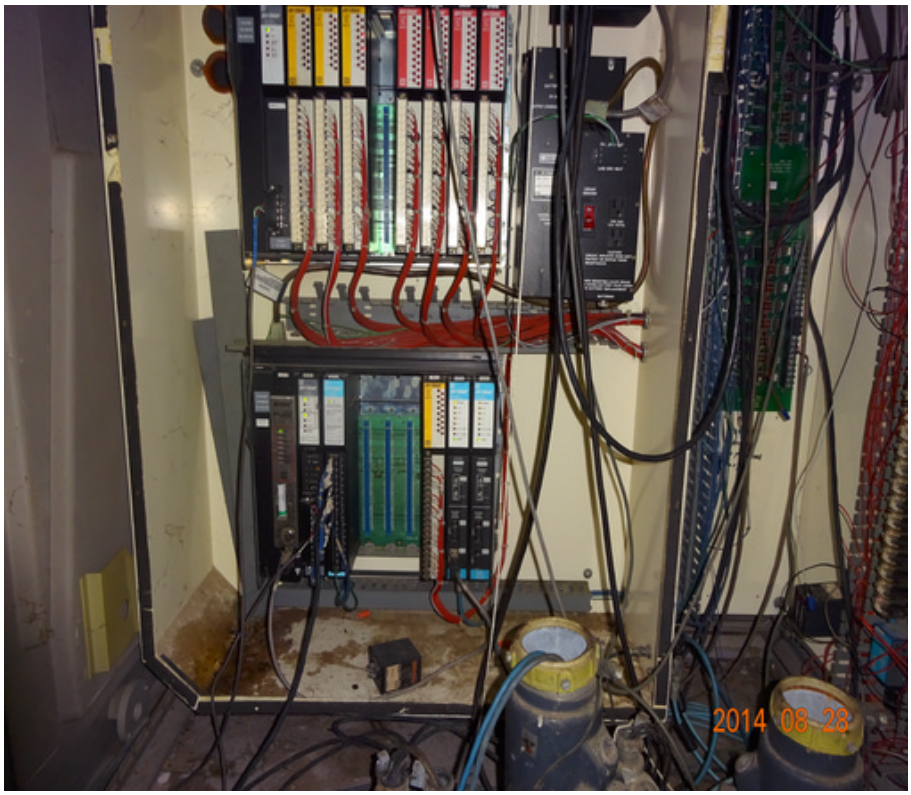

Figure 4 Headworks No. 1 LPU-1, "PLC-1"

4.3 HEADWORKS NO. 2

Headworks No. 2 receives influent raw wastewater and serves as the initial screening and grit removal area before the wastewater is sent to the primary treatment complexes. Headworks No. 2 has two (2) treatment trains which use bar screens, screw conveyors, traveling bridges, grit channels and grit washers for the treatment and removal of grit.

The Headworks No. 2 SCADA equipment is located within Control Panel "HW2-CP-LPU1" which resides in the Headworks No. 2 electrical room. The network equipment consists of four (4) PLCs. Three Modicon Quantum PLCs each connect over dual-channel copper Ethernet to local area Ethernet switches, where one switch is dedicated to channel A communication, and another for channel B communication. These three (3) PLCs are also connected to each other via Modbus Plus serial network for local peer-to-peer communications. The fourth PLC is a

Modicon M340 PLC dedicated to the bar screen. This PLC is connected over single-channel copper Ethernet to Channel B Ethernet switch. Please refer to Exhibit 4 for the Headworks No. 2 area PLC network architecture. Please refer to Figure 5 for a picture of control panel "HW2-CP-LPU1".

Figure 5 Headworks No. 2 Control Panel "HW2-CP-LPU1"

Each Ethernet switch has a copper connection to a media converter which converts to single mode fiber optic media. The single mode fiber optic patch cables are then connected to fiber optic patch panels which are connected directly to dedicated fiber optic patch panels in the Administration Building Control Room via loose tube single mode optical fiber. Thus the Top-End SCADA system collects and sends data to the Headworks No. 2 facility across this direct optical fiber link.

4.3.1 Headworks No. 2 Power Monitoring

The Headworks No. 2 area consists of two 480VAC Motor Control Centers that contain power quality monitors (PQM). These PQMs monitor the electrical data for each MCC. This data is polled by the master Quantum PLC through its local serial Modbus port over Modbus serial RS-232, via a RS-232 to RS-485 converter, connected to each PQM. This data is then polled by the Top-End computer system from the Quantum PLC.

4.3.2 Headworks No. 2 OIU

Headworks No. 2 has a desktop computer which serves at the Operator Interface Unit (OIU) for this plant area. This computer is connected to the SCADA system and local PLCs via copper Ethernet through the local Ethernet switches in control panel "HW2-CP-LPU1". This OIU can be used for monitoring and control of Headworks No. 2 as well as other process areas throughout the plant.

In addition to the workstation computer OIU, an OIU touchscreen unit is mounted on the control panel. This OIU touchscreen is connected to the three Quantum PLCs over single channel, copper, Modbus TCP Ethernet. In addition, this OIU uses a Modbus serial RS-232 network connection to each PLC. While this serial connection and wiring is available, the OIU does not use the serial connection for communication with the PLCs in this area. Also, it appears that this panel mounted OIU has been abandoned and is no longer in use.

s

4.4 PRIMARY TREATMENT COMPLEX NO. 1

For the purposes of this technical memorandum, our discussion of the network equipment for Primary Treatment Complex No. 1 will include the network for additional process equipment located within the Operations Building. The Operations Building constitutes a hub for the electrical, instrumentation, and control needs for several process areas of the plant. These areas may be divided into three categories:

1) Primary Treatment Complex No.1
2) Process Air Blowers
3) Settled Wastewater Pumps

The Operations Building ground level has two electrical rooms which contain the network equipment for these three areas. The first electrical room is air conditioned and houses some 480 volt Motor Control Centers, and Control panels with SY/MAX PLC systems dedicated to the Primary Treatment Complex No. 1 and the Operations Building Raw Wetwell. The second electrical room is a newly-renovated control room with conditioned and scrubbed air that contains the control panels for the Process Air Blowers and the Settled Wastewater Pumps. The following subsections discuss each of the categories in further detail.

4.4.1 Primary Treatment Complex No. 1

Primary Treatment Complex No. 1 receives wastewater from Headworks and processes it through two trains, each consisting of a clarifier and two flow equalization basins. The clarifiers have scum pumps and sludge pumps that remove heavier solids and eventually send them to Hornsby Bend or back to the Raw Wetwell at the head of the plant.

The entire Primary Treatment Complex No. 1 is served by a single SY/MAX PLC tagged "PLC-2" and located within control panel "LPU-2" inside the Operations Building electrical room. This PLC is made up of two racks. The first is the main rack containing the CPU,

network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and Primary Treatment Complex No. 1, a copper twin-axial SY/NET signal is routed from "PLC-2" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 5 for the existing network architecture of Primary Treatment Complex No. 1. Refer to Figure 6 for a picture of the interior of the control panel for this area.

Figure 6 Primary Treatment Complex No. 1 LPU-2, PLC

4.4.2 Process Air Blowers

Walnut Creek Wastewater Plant has four (4) Process Air Blowers which provide low pressure air to the aeration basins, flocculation basins, chlorine contact basins, and other process areas throughout the plant. The blowers recently underwent a major mechanical, electrical and controls upgrade during the PDSI-2 project. Previously, the blower control room contained both the control panels as well as the electrical medium voltage gear for all four blowers. The renovations replaced the old electrical gear and safely located the new gear within the Substation No. 2 area. Furthermore, the old SY/MAX PLC-based controls were replaced by an entirely new Quantum Unity PLC-based control system within the Operations Building control room.

The network equipment is now all located within the Operations Building control room inside of control panel "OP-CP-LPU1". This control panel contains a total of five (5) PLCs, each of which consists of a Modicon Quantum Unity processor. PLC "OP-PLC-LPU1" is the master blower PLC which contains general blower system signals that are not specific to a single blower. This master PLC uses the Ethernet port on the CPU to connect to the local machine monitoring network through an Ethernet switch connected to the Motor Management Relays for each of the blowers. This PLC also has four (4) Ethernet network cards for network connectivity. Two (2) cards are for channel A and channel B connectivity to the SCADA system. The other two (2) Ethernet cards facilitate a peer-to-peer connection between the blower PLCs and the Activated Sludge Complex PLCs for overall automated control of the modulating valves on the aeration basins. See Figure 7 for a picture of this PLC.

Figure 7 Process Air Blower Master PLC "OP-PLC-LPU1"

The other four (4) PLCs are each dedicated to a single blower: "OP-PLC-PAB1", "OP-PLC-PAB2", "OP-PLC-PAB3" and "OP-PLC-PAB4". Each blower PLC consists of one head rack and one Remote I/O rack, connected via copper coaxial cable. Each dedicated blower PLC uses the Ethernet port on the CPU to connect to the local machine monitoring network for dedicated polling of the respective blower's Motor Management Relay. Each PLC also has two (2) Ethernet network cards for channel A and channel B connectivity to the SCADA system. Please refer to Exhibit 6 for the existing network architecture of this area.

Two Operator Interface Units (OIU) with integral touchscreen interfaces are mounted on the front of the control panel "OP-CP-LPU1" for control of the blowers. These units have three (3) Ethernet connections: two connections to channel A switch (SCADA network and PLC A network), and one connection to channel B switch (PLC B network). Please refer to Figure 8 for a picture of this control panel.

Figure 8 Process Air Blower Control Panel "OP-CP-LPU1"

4.4.3 Settled Wastewater Pumps

Walnut Creek Wastewater Plant has eight (8) Settled Wastewater Pumps which move wastewater from the flow equalization basins of the Primary Treatment Complexes into the flow splitter box and then the Aeration Basins. The pumps were recently renovated with new motors, motor starters, and controls during the PDSI-2 project.

The PLC and network equipment for the settled wastewater pumps is now all located within the Operations Building control room inside of control panel "OP-CP-LPU2". This control panel contains a total of nine (9) PLCs, each of which consists of a Modicon Quantum Unity processor. PLC "OP-PLC-LPU2" is the master settled wastewater pump PLC which contains general pump system and control room signals that are not specific to a single pump. This PLC uses the Ethernet port on the CPU to connect to the local machine monitoring network through an Ethernet switch connected to the Motor Management Relays for each of the blowers. This PLC also has two (2) Ethernet network cards for connectivity to channel A and channel B of the SCADA system.

The other eight (8) PLCs are specific to each Settled Wastewater Pump: “OP-PLC-SWP1”, “OP-PLC-SWP2”, “OP-PLC-SWP3”, “OP-PLC-SWP4”, “OP-PLC-SWP5”, “OP-PLC-SWP6”, “OP-PLC-SWP7” and “OP-PLC-SWP8”. Each settled wastewater pump PLC consists of one rack only containing CPU, communication cards and I/O. See Figure 7 for a picture of a typical SWP PLC. Each dedicated Settled Wastewater Pump PLC uses the Ethernet port on the CPU to connect to the local machine monitoring network for dedicated polling of the respective Settled Wastewater Pump’s Motor Management Relay. Each PLC also has two (2) Ethernet network cards for channel A and channel B connectivity to the SCADA system. Please refer to Exhibit 7 for the existing network architecture of this area.

Figure 9 Settled Wastewater Pump PLC “OP-PLC-SWP4”

Two Operator Interface Units (OIU) with integral touchscreen interfaces are mounted on the front of the control panel “OP-CP-LPU1” for control of the settled wastewater pumps. These units also have three (3) Ethernet connections: two connections to channel A switch (SCADA network and PLC A network), and one connection to channel B switch (PLC B network). Please refer to Figure 10 for a picture of this control panel.

Figure 10 Settled Wastewater Pumps Control Panel "OP-CP-LPU2"

4.5 PRIMARY TREATMENT COMPLEX NO. 2

Primary Treatment Complex No. 2 receives wastewater from Headworks and processes it through two trains, with each train consisting of a clarifier and two flow equalization basins. The clarifiers have scum pumps and sludge pumps that remove heavier solids and eventually send them to Hornsby Bend or back to the Raw Wetwell at the head of the plant.

The entire Primary Treatment Complex No. 2 is served by a single SY/MAX PLC tagged "PLC-3" and located within control panel "LPU-3" inside the electrical room on the lower level of Primary Treatment Complex No. 2. This PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and Primary Treatment Complex No. 2, a copper twin-axial SY/NET signal is routed from "PLC-3" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 8 for the existing network architecture of Primary Treatment Complex No. 2. Refer to Figure 11 for a picture of the interior of the control panel "LPU-3" for this area.

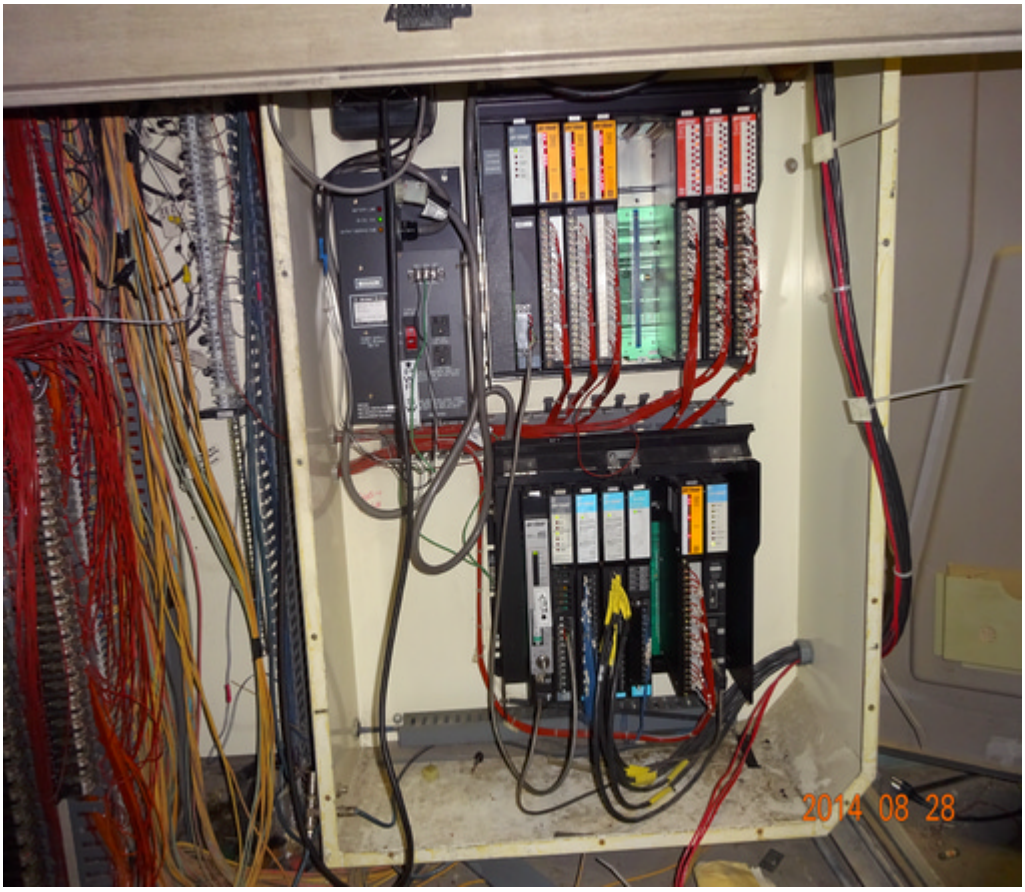

Figure 11 Primary Treatment Complex No. 2 LPU-3, PLC

4.6 OPERATIONS RAW WETWELL

The Operations Building Raw Wetwell receives raw wastewater from utility service areas nearby the plant and sludge from primary treatment clarifiers. Influent to this wetwell is then pumped back to the front of the plant to the influent flow distribution box. Because this wetwell is located within the Operations Building, the electrical and controls equipment are also located inside the Operations Building electrical room.

The Operations Raw Wetwell is served by a SY/MAX PLC tagged “PLC-4” and located within control panel “LPU-4” inside the electrical room on the ground level of the Operations Building. Please see Figure 13 for a picture of this control panel. This PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and the operations raw wetwell, a copper twin-axial SY/NET signal is routed from “PLC-4” to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 9 for the existing

network architecture of “LPU-4”. Refer to Figure 12 for a picture of the interior of the control panel “LPU-4” for this area.

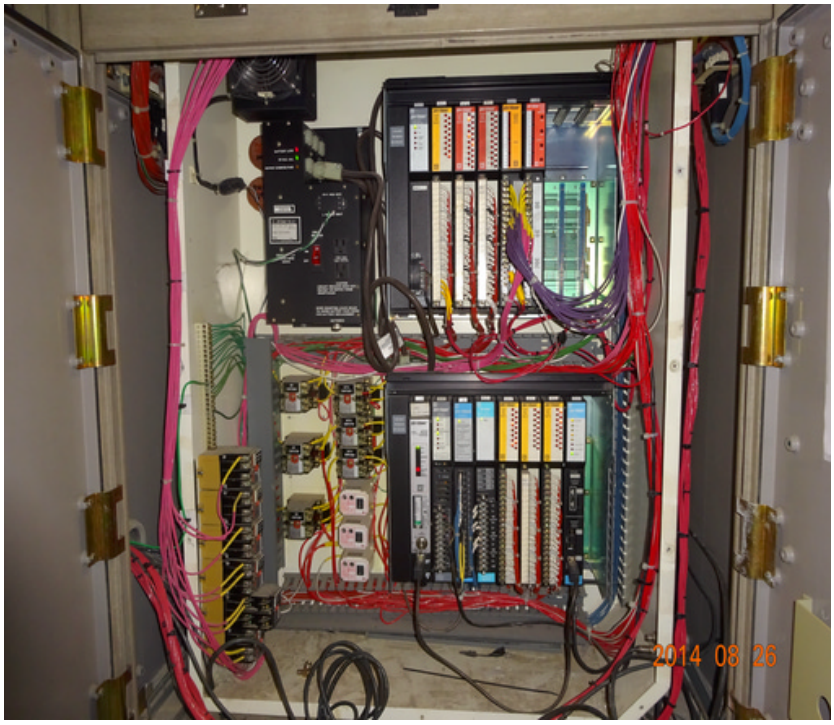

Figure 12 Operations Raw Wetwell LPU-4, PLC

Figure 13 Operations Raw Wetwell LPU-4

4.7 ACTIVATED SLUDGE COMPLEXES

The Activated Sludge Complexes are comprised of aeration basins, flocculation basins and final clarifiers. Settled wastewater is pumped from the Flow Equalization Basins into the flow splitter box, then to the aeration basins for the activated sludge treatment process. From the aeration basins the wastewater flows into the flocculation basins and then into the final clarifiers. Return Activated Sludge pumps send sludge back to the front of the aeration basins while Waste Sludge Pumps remove sludge from the system and send it to sludge treatment for thickening. Effluent wastewater continues to the Chlorine Contact Basins. Walnut Creek has a total of three (3) Activated Sludge Complexes, where each complex consists of two trains of aeration basin, flocculation basin, final clarifier, and chlorine contact basins.

4.7.1 Activated Sludge Complex 1

There are three (3) PLCs that monitor and control Activated Sludge Complex 1. “PLC-5” is a SY/MAX PLC that resides in control panel “LPU-5” inside the old Motor Control Center electrical room. Please see Figure 14 thru Figure 15 for pictures of this room and control panel. “PLC-5” is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable. Also on the remote I/O rack is an MEB communications module. This MEB module contains an Ethernet port, but this port is not currently used. Rather, the module behaves as a network bridge to connect “PLC-5” via Modbus Plus to the CPU of PLC “ASC1-PLC-01A”, a Quantum Concept PLC that resides within control panel “ASC1-CP-LPU1”. This control panel is within the control room immediately adjacent to the “LPU-5” control room. Please see Figure 16 for a picture of this control room.

Figure 14 ASC1 MCC Electrical Room (LPU-5 lower doors ajar)

Figure 15 Activated Sludge Complex No. 1 LPU-5, PLC

Figure 16 ASC1 Control Room (ASC1-CP-LPU1 in foreground)

PLC "ASC1-PLC-01A" also consists of two racks: a head rack and a remote I/O rack. The remote I/O network for this PLC is a dual channel coaxial cable connection. A dual channel Modbus Plus (MB+) connection exists from PLC "ASC1-PLC-01A" to the MEB module at "PLC-5". This MB+ connection provides a gateway for SCADA communications to PLC "ASC1-PLC-01A" through the SY/NET network. All data from "ASC1-PLC-01A" is read by the SCADA system over SY/NET via the MB+ connection. Therefore, the Top-End can communicate to both "PLC-5" and "ASC1-PLC-01A" over the SY/NET network.

Also connected via copper Ethernet to PLC "ASC1-PLC-01A" is a local touchscreen OIU. This OIU provides local control only of the Activated Sludge Complex 1. The OIU also uses the Modbus Plus network for communications with "PLC-5". In addition, there is a GE Multilin Power Quality Monitor located on Motor Control Center "ASC1-MCC-1". This device is connected to "ASC1-PLC-01A" through the Modbus serial port on the CPU module of the PLC. This modbus serial connection is converted from RS232 to RS485 serial and then connected to the GE Multilin Power Quality Monitor. Please refer to Exhibit 10 for the existing network architecture of Activated Sludge Complex 1.

The third PLC located at Activated Sludge Complex 1 is a Quantum Unity processor PLC that is dedicated to the Dissolved Oxygen control system for the aeration basins. PLC "ASC1-PLC-010" is located within control panel "ASC1-CP-LPU2". This PLC has one main rack, pictured in Figure 17, and two Remote I/O racks which are connected to the main rack via dual channel coaxial copper remote I/O network. This PLC does not interface directly with the other PLCs in this process area. Rather, it is connected to two local Ethernet switches via copper Ethernet

cabling. These switches are then connected to fiber optic patch panels which route to the Administration building across the single mode fiber network. It is noted here that 72-strand single-mode fiber cable is installed to each of the fiber optic patch panels in this area. However, only 12 strands are connected to the patch panel, while 60 strands remain spare and un-landed. This is typical for channels A and B of the fiber network in this area.

Figure 17 Activated Sludge Complex 1 PLC head rack, "ASC1-PLC-010"

4.7.2 Activated Sludge Complex 2

The network for Activated Sludge Complex 2 is similar to that for Activated Sludge Complex 1. There are three (3) PLCs that monitor and control Activated Sludge Complex 2. "PLC-6" is a SY/MAX PLC that resides in control panel "LPU-6" inside the old Motor Control Center electrical room. Please see Figure 18 for a picture of this room and control panel. This room is adjacent to the north wall of the control rooms pictured in Figure 19. "PLC-6" is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable. Also on the remote I/O rack is an MEB communications module. This MEB module contains an Ethernet port, but this port is not currently used. Rather, the module behaves as a network bridge to connect "PLC-6" via Modbus Plus to the CPU of PLC "ASC2-PLC-01A", a Quantum Concept PLC that resides within control panel "ASC2-CP-LPU1". This control panel is within the control room immediately adjacent and south of the "LPU-6" control room. Referring to Figure 19, "ASC2-CP-LPU1" resides in the control room on the left-hand side.

Figure 18 ASC2 Old MCC Electrical Room (LPU-6 doors ajar)

Figure 19 Activated Sludge Complex No. 2 Control Room Area (south wall)

Figure 20 ASC2 Control Room (ASC2-CP-LPU1)

PLC "ASC2-PLC-01A" also consists of two racks: a head rack and a remote I/O rack. The remote I/O network for this PLC is a dual channel coaxial cable connection. A dual channel Modbus Plus (MB+) connection exists from PLC "ASC2-PLC-01A" to the MEB module at "PLC-6". This MB+ connection provides a gateway for SCADA communications to PLC "ASC2-PLC-01A" through the SY/NET network. All data from "ASC2-PLC-01A" is read by the SCADA system over SY/NET via the MB+ connection. Therefore, the Top-End can communicate to both "PLC-6" and "ASC2-PLC-01A" over the SY/NET network.

Also connected via copper Ethernet to PLC "ASC2-PLC-01A" is a local touchscreen OIU. This OIU provides local control only of the Activated Sludge Complex 2. The OIU also uses the Modbus Plus network for communications with "PLC-6". In addition, there is a GE Multilin Power Quality Monitor located on Motor Control Center "ASC2-MCC-1". This device is connected to "ASC2-PLC-01A" through the Modbus serial port on the CPU module of the PLC. This modbus serial connection is converted from RS232 to RS485 serial and then connected to the GE Multilin Power Quality Monitor. Please refer to Exhibit 11 for the existing network architecture of Activated Sludge Complex 2.

The third PLC located at Activated Sludge Complex 2 is a Quantum Unity processor PLC that is dedicated to the Dissolved Oxygen control system for the aeration basins. PLC "ASC2-PLC-010" is located within control panel "ASC2-CP-LPU2" which resides in a control room adjacent to the "ASC2-CP-LPU1" control room (refer to the right hand door in the picture in Figure 19). This PLC has one main rack and two Remote I/O racks which are connected to the main rack via dual channel coaxial copper remote I/O network. This PLC does not interface directly with the other PLCs in this process area. Rather, it is connected to two local Ethernet switches via copper Ethernet cabling. These switches are then connected to fiber optic patch panels which route to the Administration building across the single mode fiber network. It is noted here that 72-strand single-mode fiber cable is installed to each of the fiber optic patch panels in this area. However, only 12 strands are connected to the patch panel, while 60 strands remain spare and un-landed. This is typical for channels A and B of the fiber network in this area. Please refer to Figure 21.

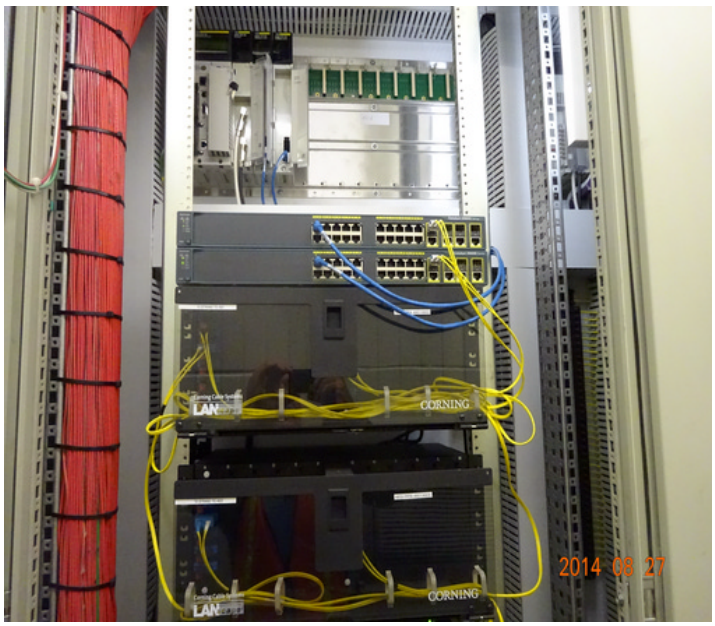

Figure 21 Activated Sludge Complex 2 PLC, "ASC2-PLC-010" and network equipment

4.7.3 Activated Sludge Complex 3

The network for Activated Sludge Complex 3 is similar to that for Activated Sludge Complexes 1 and 2. There are three (3) PLCs that monitor and control Activated Sludge Complex 3. "PLC-7" is a SY/MAX PLC that resides in control panel "LPU-7" inside the old Motor Control Center electrical room. Please see Figure 22 for a picture of this room. "PLC-7" resides within Control Panel "LPU-7" (see Figure 23) and is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable. Also on the remote I/O rack is an MEB communications module. This MEB module

contains an Ethernet port, but this port is not currently used. Rather, the module behaves as a network bridge to connect “PLC-7” via Modbus Plus to the CPU of PLC “ASC3-PLC-01A”, a Quantum Concept PLC that resides within control panel “ASC3-CP-LPU1”. This control panel is in a separate control room adjacent and south of the “LPU-7” control room. Refer to Figure 24.

Figure 22 Activated Sludge Complex 3 LPU-7 Control Room

Figure 23 Activated Sludge Complex 3 LPU-7 (PLC-7 in lower section)

Figure 24 Activated Sludge Complex 3 Control Room (ASC3-CP-LPU1)

PLC “ASC3-PLC-01A” also consists of two racks: a head rack and a remote I/O rack. The remote I/O network for this PLC is a dual channel coaxial cable connection. A dual channel Modbus Plus (MB+) connection exists from PLC “ASC3-PLC-01A” to the MEB module at “PLC-7”. This MB+ connection no longer provides a gateway for SCADA communications to PLC “ASC3-PLC-01A” through the SY/NET network, since “ASC3-PLC-01A” is connected directly to the Ethernet network.

Also connected via copper Ethernet to PLC “ASC3-PLC-01A” is a local touchscreen OIU. This OIU is shown in Figure 24, and provides local control only of the Activated Sludge Complex 3. The OIU uses the Modbus Plus network for communications with “PLC-7”. In addition, there is a GE Multilin Power Quality Monitor located on Motor Control Center “ASC3-MCC-1”. This device is connected to “ASC3-PLC-01A” through the Modbus serial port on the CPU module of the PLC. This modbus serial connection is converted from RS232 to RS485 serial and then connected to the GE Multilin Power Quality Monitor. Please refer to Exhibit 12 for the existing network architecture of Activated Sludge Complex 3.

The third PLC located at Activated Sludge Complex 3 is a Quantum Unity processor PLC that is dedicated to the Dissolved Oxygen control system for the aeration basins. PLC “ASC3-PLC-010” is located within control panel “ASC3-CP-LPU2” which resides in a control room adjacent to the “ASC3-CP-LPU1” control room. This PLC has one main rack and two Remote I/O racks which are connected to the main rack via dual channel coaxial copper remote I/O network. This PLC does not interface directly with the other PLCs in this process area. Rather, it is connected to two local Ethernet switches via copper Ethernet cabling. These switches are then connected to fiber optic patch panels which route to the Administration building across the single mode fiber network. It is noted here that 72-strand single-mode fiber cable is installed to each of the fiber optic patch panels in this area. However, only 12 strands are connected to the patch panel, while 60 strands remain spare and un-landed. This is typical for channels A and B of the fiber network in this area. Please refer to Figure 25.

Figure 25 Activated Sludge Complex 3 PLC, "ASC3-PLC-010"

4.8 SLUDGE THICKENER

Sludge Thickener receives sludge from primary and secondary treatment areas for further processing. Sludge Thickener contains a thickening clarifier and sludge pumps which send the thickened sludge to Hornsby Bend.

The SCADA network within Sludge Thickener consists of a single SY/MAX PLC tagged "PLC-10" and located within control panel "LPU-10". This PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and the sludge thickener area, a copper twin-axial SY/NET signal is routed from "PLC-10" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 13 for the existing network architecture of this area.

The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge module over Modbus TCP Ethernet to attain data from the Sludge Thickening area. Please refer to Figure 26 for a picture of the control panel for this area.

Figure 26 Sludge Thickener LPU-10

4.9 SLUDGE PRESSURIZATION

The Sludge Pressurization system receives effluent from the thickener for further processing before being sent back to the Sludge Thickener. The Sludge Pressurization system consists of pressurization pumps, pressurization tank and air compressors.

The SCADA network within Sludge Pressurization consists of a single SY/MAX PLC tagged "PLC-11" and located within control panel "LPU-11". To facilitate communication between the Top-End and the sludge pressurization area, a copper twin-axial SY/NET signal is routed from "PLC-11" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 13 for the existing network architecture of this area.

The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge module over Modbus TCP Ethernet to attain data from the Sludge Pressurization area. Please refer to Figure 26 for a picture of "PLC-11".

Figure 27 Sludge Pressurization PLC-11

4.10 WATER REUSE SYSTEM

The Water Reuse System provides Non-Potable Water (reuse water) for use by the plant and for distribution into a city-wide NPW system for large-scale commercial irrigation or industrial purposes. This system consists of two pump stations (Low Service and High Service), a ground storage tank, an offsite elevated storage tank (51st Street Tank) and the associated distribution piping and appurtenances.

The Water Reuse System SCADA equipment is located within Control Panel "WR-CP-LPU1A" and "WR-CP-LPU2A" inside the Water Reuse System electrical building. The network equipment consists of seven (7) Modicon Quantum PLCs. The seven Modicon Quantum PLCs are interconnected with a dual-channel copper Modbus Plus network used for peer-to-peer communications within the pump station. These PLCs are distributed throughout the two control panels and perform a variety of tasks related to the different process areas of the Water Reuse System. Please refer to Figure 28 for a picture of the control panels "WR-CP-LPU1A" and "WR-CP-LPU2A". An additional Modbus Plus network is used to gather electrical data from four (4) power monitoring units located within the Water Reuse Electrical Building.

Figure 28 WRS Control Panels "WR-CP-LPU1A"(left) and "WR-CP-LPU2A" (right)

4.10.1 Water Reuse System Control Panel "WR-CP-LPU1A"

Control panel "WR-CP-LPU1A" consists of the PLC systems responsible for the monitoring and control of high service pump station, ground storage tank and associated equipment. This includes four (4) PLCs tagged "WR-PLC-21", "WR-PLC-22", "WR-PLC-23" and "WR-PLC-24". Each PLC is dedicated to one of the four high service pumping units, and they each consist of one rack with the CPU, the I/O cards and the Modbus Plus network module for communication on the local Modbus Plus network.

4.10.2 Water Reuse System Control Panel "WR-CP-LPU2A"

Control panel "WR-CP-LPU2A" consists of the PLC systems responsible for the monitoring and control of low service pump station and the Data Concentrator. The Data Concentrator PLC "WR-PLC-1A" polls all Water Reuse data across the local Modbus Plus network, and then re-maps this data for use by the Top-End. A second Modbus Plus network connected to "WR-PLC-1A" gathers electrical data from the four (4) power monitoring units located in the Motor Control Centers within the electrical building. Therefore, the local Modbus Plus networks are critical for getting data to PLC "WR-PLC-1A". The Data Concentrator PLC also contains two (2) Ethernet network modules that are connected via copper Ethernet to local Ethernet switches. Each Ethernet switch has a copper cable connected to a fiber optic transceiver that converts to single mode fiber optic media. Single mode fiber optic patch cables are routed to fiber optic patch panels which are connected directly to dedicated fiber optic patch panels in the Administration

Building Control Room via loose tube single mode optical fiber. Thus, the Top-End SCADA system collects and sends all data to the Water Reuse System facility across this direct optical fiber link to the Data Concentrator PLC. The Data Concentrator PLC consists of a head rack with two remote I/O racks connected via dual channel copper coaxial remote I/O network. The second remote I/O rack is located within control panel "WR-CP-LPU1A". Please refer below to Figure 29 for a picture of the Data Concentrator PLC.

Figure 29 Water Reuse System Data Concentrator PLC "WR-PLC-1A"

Two additional Modicon Quantum PLCs control the low service pump station, "WR-PLC-11A" and "WR-PLC-12A". These PLCs are configured in a "hot-standby" mode such that both processors contain identical programs. If one PLC fails, the other will continue logical processing without interruption. Each of these PLCs consists of a head rack and four (4) remote I/O racks. Two of the remote I/O racks are located exterior to control panel "WR-CP-LPU2A". These remote I/O racks are located in the Filter Building No. 1 control panel "FB1-CP-WR" and are connected via a dual channel dedicated fiber optic link between fiber-to-coaxial transceivers. Please refer to Figure 30 for a picture of these fiber-to-coaxial transceivers. Please refer to Exhibit 15 and Exhibit 16 for details of the network architecture.

Figure 30 Water Reuse System Remote I/O Fiber-to-Coaxial Transceivers

Control Panel "WR-CP-LPU2A" also contains the Ethernet switches and fiber optic patch panels which connect the Water Reuse System to the Top-End SCADA system. Additional fiber optic patch panels reside in this control panel which patch through the fiber connections to the other process areas of the plant including Substation No. 1, Substation No. 2, Operations Building and the Activated Sludge Complexes.

4.10.3 Water Reuse System Power Monitoring

The Water Reuse System area consists of two 4160VAC Motor Control Centers and two 480VAC Motor Control Centers that contain power quality monitors (PQM). These PQMs monitor the electrical data for each MCC. This data is polled by the Data Concentrator PLC from a BridgeMUX that resides on the local Modbus Plus network. The BridgeMUX converts Modbus Plus to Modbus serial which the goes through a RS-232 to RS-485 serial converter which is then connected to the PQMs. This data is then polled by the Top-End computer system from the Data Concentrator PLC.

4.10.4 Water Reuse System Operator Interface Unit

Water Reuse System has a desktop computer which serves at the Operator Interface Unit (OIU) for this plant area. This computer is connected to the SCADA system via copper Ethernet through the local Ethernet switches in control panel "WR-CP-LPU2A". This OIU can be used for monitoring and control of Water Reuse System as well as other process areas throughout the plant.

4.11 FILTER BUILDING NO. 1

Filter Building No. 1 contains four media filters for filtration and final treatment of the wastewater before it is sent to the clearwell for use by the Water Reuse system, or for discharge out to the Colorado River after dechlorination.

The SCADA network within Filter Building No. 1 consists of four filter consoles which each contain a SY/MAX PLC dedicated to a filter. These PLCs are tagged “PLC-9A”, “PLC-9B”, “PLC-9C” and “PLC-9D” and are associated with filters 1 thru 4, respectively. Each PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable. This is typical for each of the filter units. To facilitate communication between the Top-End and the Filter Building No. 1 PLCs, a copper twin-axial SY/NET signal is routed in series with each filter PLC and eventually back to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge module over Modbus TCP Ethernet to attain data from Filter Building No. 1. Please refer to Figure 31 for a picture inside of a typical filter unit console.

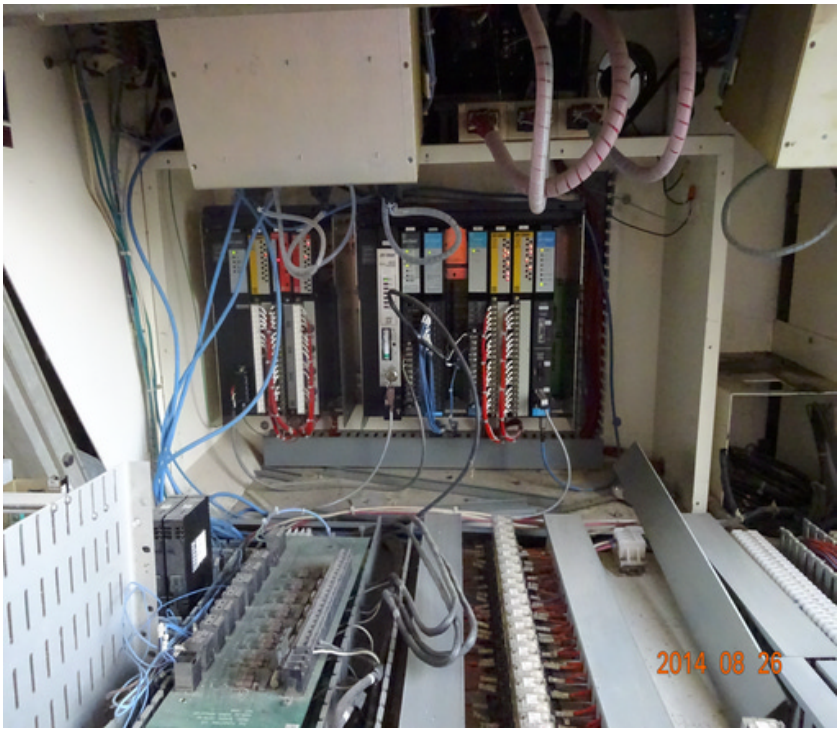

Figure 31 Filter No. 4 Console LPU-9D (PLC-9D)

An additional control panel labeled “FB1-CP-WR” is located within Filter Building No. 1. This panel contains the remote I/O equipment for the Low Service Pump Station PLCs of the Water Reuse System. These remote I/O racks handle all the signals for the Chlorine and Turbidity analytical instrumentation associated with the Filter Clearwell. Please refer to Exhibit 16 for the

existing network architecture of Filter Building No. 1. Please refer to Figure 32 for a picture of control panel “FB1-CP-WR”.

Figure 32 Filter Building Control Panel “FB1-CP-WR”

4.12 FILTER BUILDING NO. 2

Filter Building No. 2 contains six media filters for filtration and final treatment of the wastewater before it is sent to the clearwell for use by the Water Reuse system, or for discharge out to the Colorado River after dechlorination.

The SCADA network within Filter Building No. 2 consists of six filter consoles which each contain a SY/MAX PLC dedicated to a filter. These PLCs are tagged “PLC-9E”, “PLC-9F”, “PLC-9G”, “PLC-9H”, “PLC-9I” and “PLC-9J” and are associated with filters 5 thru 10 respectively. Each PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable. This is typical for each of the filter units. To facilitate communication between the Top-End and the Filter Building No. 2 PLCs, a copper twin-axial SY/NET signal is routed in series with each filter PLC and eventually back to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge

module over Modbus TCP Ethernet to attain data from Filter Building No. 2. Please refer to Figure 31 for a picture inside of a typical filter unit console.

4.13 CHLORINE AREA

The Chlorine Area is at the north end of the Operations Building and includes the chlorine cylinder storage area, chlorinators, chlorine evaporators and distribution piping to feed chlorine throughout the applicable plant process areas.

The SCADA network within Chlorine Area consists of a SY/MAX PLC located within control panel "CS01-LCP-01". This PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and Chlorine Area, a copper twin-axial SY/NET signal is routed from "CS01-LCP-01" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 18 for the existing network architecture of this area. The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge module over Modbus TCP Ethernet to attain data from the Chlorine Area. Please refer to Figure 33 for a picture of the Chlorine area control room equipment.

Figure 33 Chlorine Area Control Room

In addition to the SY/MAX PLC within control panel "CS01-LCP-01", there also exists a desktop computer which is configured as an operator workstation tagged "WCOWS02". This

workstation is connected to the SCADA system via copper Ethernet through a fiber media converter which then connects to a fiber optic patch panel. This patch panel is then connected back to the Administration Building via multi-mode fiber. This workstation is used for monitoring and control of the entire plant. The workstation can be seen in the lower left-hand portion of the picture in Figure 33.

4.14 DECHLORINATION BUILDING

The Dechlorination Building houses the sulfur dioxide cylinders, evaporators and sulfinators that control the chlorine levels of the plant effluent at the outfall discharge.

The SCADA network within Dechlorination Building consists of a single SY/MAX PLC located within control panel "DS01-LCP-01". This PLC is made up of two racks. The first is the main rack containing the CPU, network cards and some I/O cards. The second is the remote I/O rack containing additional I/O cards. The two racks are connected via a copper Remote I/O serial cable.

To facilitate communication between the Top-End and Dechlorination Building, a copper twin-axial SY/NET signal is routed from "DS01-LCP-01" to the SY/MAX Gateway PLC within the Administration Building Control Room Mimic panel. Please refer to Exhibit 19 for the existing network architecture of this area. The SCADA computers each poll the SY/MAX Gateway PLC MEB bridge module over Modbus TCP Ethernet to attain data from the Dechlorination Building. Please refer to Figure 34 for a picture of the control panel for this area.

Figure 34 Dechlorination Building Control Panel "DS01-LCP-01"

4.15 SUBSTATION NO. 1

Substation No. 1 contains the main electrical switchgear that receives incoming 15KV power from Austin Energy and distributes 15KV power throughout the plant. The switchgear circuit breakers can be controlled from the local Substation OIU by qualified electrical personnel.

Substation No. 1 SCADA equipment is located within Control Panel "SUB1-CP-MCP" and communications closet #107 inside the Substation No. 1 building. Control panel "SUB1-CP-MCP" contains PLC "SUB1-PLC-01". This PLC gathers all electrical and switchgear data from within the Substation. The PLC consists of a head rack and three (3) remote I/O racks that are all connected via dual channel copper coaxial remote I/O network cabling.

PLC "SUB1-PLC-01" contains two (2) Ethernet network modules that are connected to media converters. Each media converter converts copper Ethernet to single mode fiber optic media. Single mode fiber optic patch cables are then connected to fiber optic patch panels located in communications closet #107. These fiber optic patch panels are connected to patch panels in the Water Reuse System Building. From there, the fiber patches through to the Administration Building Control Room via loose tube single mode optical fiber. Thus, the Top-End SCADA system collects all data to the Substation No. 1 facility across this optical fiber link to PLC "SUB1-PLC-01". Please refer to Exhibit 20 for the existing network architecture of Substation No. 1.

4.15.1 Substation No. 1 Power Monitoring

Two dual-channel Modbus Plus copper serial networks connect "SUB1-PLC-01" to the Breaker Management Relays that are within the electrical switchgear lineups. Each dual-channel Modbus Plus network connects to a single Modicon Bridge MUX which acts as a gateway between the Modbus Plus network and four (4) Modbus serial networks. Each Modbus serial network connects to an RS232 to RS485 converter. At this point, each RS485 serial network connects multiple Feeder Protective Relays for data gathering. There are a total of 21 Feeder Protective Relays connected to these serial networks. Please refer to Figure 35 for a picture of some of the network equipment in Control Panel "SUB1-CP-MCP".

4.15.2 Substation No. 1 Operator Interface Unit

A single channel local Modbus Plus network is connected from "SUB1-PLC-01" to a Modicon Magelis touchscreen Operator Interface Unit. This unit provides local access for control and monitoring of the electrical switchgear within the Substation.

Figure 35 Substation No. 1 Network Equipment

Please refer to Figure 36 for a picture of the main rack of PLC "SUB1-PLC-01". Please refer to Exhibit 20 for details of the network architecture.

Figure 36 Substation No. 1 "SUB1-PLC-01" Head Rack

4.16 SUBSTATION NO. 2

Substation No. 2 contains two lineups of loadbreak switchgear that receives power from Substation No. 1 and distributes that power throughout the Operations Building and other areas of the plant. The substation also contains six Motor Control Center lineups that are associated with the Process Air Blowers and the Settled Wastewater Pumps within the Operations Building.

Substation No. 2 SCADA equipment is located within Control Panel "SUB2-CP-LPU1". One Modicon Quantum PLC tagged "SUB2-PLC-01" gathers all electrical and switchgear data from within the Substation. The PLC consists of a head rack and three (3) remote I/O racks that are all connected via dual channel copper coaxial remote I/O network cabling. Please refer to Figure 38 for a picture of the main control panel "SUB2-CP-LPU1".

PLC "SUB2-PLC-01" contains two (2) Ethernet network modules that are connected to channel A Ethernet switch and channel B Ethernet switch. Single mode fiber optic patch cables route from the fiber optic patch panels located in the control panel to media converters that in turn connect via copper Ethernet to each Ethernet switch. These fiber optic patch panels are patched through Substation No. 1, then Water Reuse Building and finally to the Administration Building Control Room via loose tube single mode optical fiber. Thus, the Top-End SCADA system collects all data to the Substation No. 2 facility across this optical fiber link to PLC "SUB2-PLC-01". Please refer to Exhibit 21 for the existing network architecture of Substation No. 2.

4.16.1 Substation No. 2 Power Monitoring

There are a total of eight (8) power quality monitoring units throughout Substation No. 2. These are all Ethernet devices that are connected with copper Ethernet cabling to an Ethernet switch within "SUB2-CP-LPU1". This switch is then connected to the CPU port of "SUB2-PLC-01" so that all electrical data can be gathered to the PLC. Please refer to Figure 37 for a picture of the Motor Control Center lineups within Substation No. 2.

4.16.2 Substation No. 2 Operator Interface Unit

An Operator Interface Unit (OIU) with integral touchscreen interface is mounted on the front of the control panel "SUB2-CP-LPU1" for control and monitoring of the loadbreak switchgear. This OIU has three (3) Ethernet connections: two connections to channel A Ethernet switch (SCADA network and PLC A network), and one connection to channel B Ethernet switch (PLC B network).

Figure 37 Substation No. 2 MCC Lineups

Figure 38 Substation No. 2 "SUB2-CP-LPU1"

4.17 INFLUENT LIFT STATION

The Walnut Creek WWTP has an influent lift station that collects wastewater from the service area immediately adjacent the plant.

The Influent Lift Station SCADA equipment resides in two control panels mounted adjacent to the west wall of the Administration Building facing the Maintenance Building. The larger panel contains a Modicon M340 PLC which interfaces with the lift station equipment. The smaller panel contains a media converter and fiber optic patch panel. Therefore, the PLC is connected via copper Ethernet to the media converter. The media converter then has a single mode fiber patch cable to connect to the fiber optic patch panel. The patch panel then connects to fiber patch panels located inside the Administration Building electrical room. This facilitates a connection from the Influent Lift Station PLC to the SCADA system network. Please refer to Figure 39 for a picture of the Influent Lift Station network equipment panel, and Exhibit 22 for the existing network architecture of this area.

Figure 39 Influent Lift Station Network Equipment Panel

5 ASSESSMENT AND RECOMMENDED IMPROVEMENTS

This section will step through the various process areas of the Walnut Creek WWTP to assess their existing conditions and provide recommended modifications to the existing PLC system and associated network. The areas to be assessed are as follows:

- Administration Building
- Headworks No. 1
- Headworks No. 2
- Primary Treatment Complex No. 1 (LPU-2, Operations Building)
- Primary Treatment Complex No. 2 (LPU-3)
- Operations Raw Wetwell (LPU-4)
- Activated Sludge Complex 1
- Activated Sludge Complex 2
- Activated Sludge Complex 3
- Sludge Thickener Building (LPU-10)
- Sludge Pressurization Building (LPU-11)
- Water Reuse System
- Filter Building No. 1
- Filter Building No. 2
- Chlorine Area
- Dechlorination Building
- Substation No. 1
- Substation No. 2
- Influent Lift Station

5.1 ADMINISTRATION BUILDING

The Administration building serves as the hub of the SCADA network for the Walnut Creek plant. The root switches, SCADA servers and operator workstations reside within the Control Room on the upper floor Mezzanine. However, other SCADA equipment also resides in the the Tunney Resource Room, Northwest Electrical Room and Room 114. The following section details proposed changes to the control room area only.

5.1.1 Control Room Network Improvements

It is recommended that two proposed fiber optic patch panels be installed within control panels "WC-AD-COMM-DCS1" and "WC-AD-COMM-DCS2". Dual channel single-mode fiber can then be installed from these proposed fiber optic patch panels and connected to the proposed fiber optic patch panels in the proposed control panel in the MCC electrical room within the Operations Building. This fiber connection will provide an important improvement to the backbone network of the plant by converting the network from a "ring" topology to a "star" topology. Additional fiber optic patch cords can be installed from the proposed fiber patch panels to the Ethernet root switches in order to connect the proposed expansions of the fiber network listed throughout this TM. Please refer to Exhibit 24.

The SY/MAX PLC located behind the Mimic panel inside the control room currently has a copper Ethernet connection which serves as a bridge to the SY/NET network throughout the rest of the plant. This connection must be maintained as long as any SY/NET devices exist on the SY/NET network.

An alternative improvement is to move the majority of SCADA equipment out of the control room and locate them and the proposed fiber optic patch panels elsewhere in a more secure area of the Administration Building. One possible location is the Tunney Resource Room, which is located immediately below the plant control room. It is proposed that the fiber optic patch panels and the Ethernet root switches that reside in the control room, in control panels "WC-AD-COMM-DCS1" and "WC-AD-COMM-DCS2", be relocated to this Tunney Resource Room location beneath the control room and the corresponding plant SCADA fiber optic cabling interfacing with the Administration Building be renovated to interface with the new location of the fiber optic patch panels. It is also recommended that the SCADA servers be relocated to the Tunney Resource Room. Due to its proximity to the Control Room, if desired, the operator workstation computers can also be located in the Tunney Resource Room, with USB and video cables to the keyboard/mouse/monitor in the control room. Whereas moving this networking and computer equipment out of the control room will result in extensive fiber optic cabling renovation and re-location of the plant root switches, it is nonetheless an important step toward increasing the plant SCADA network security. It is noted that the existing available space in the Tunney Resource Room communication closet is very limited. To create additional space, it is required to demolish existing partition walls, remove the existing office adjacent to the communication room, and construct new walls to encompass a larger area room that accommodates the plant SCADA computers and networking equipment. When performing renovation in this area, consideration should also be given to improved HVAC cooling capacity to address added heat load of the equipment relocated to this room.

There has been consideration of re-locating this equipment into the Northwest Electrical Room of the Administration Building. This is not recommended due to the space constraints within the electrical room and the significant distance between this room and the Operations control room. Further, there exists 15kV electrical gear that is proposed to be removed during future plant improvements of the Power Distribution System Improvements (PDSI) project. Only after this gear is removed from this location would there be adequate space for additional SCADA network equipment. Further, this room has a large double door to the building exterior and therefore the space within the room is less secure and more difficult to condition against

humidity and heat. Hence, use of this room would also require consideration for better insulation of the existing double door and consideration for improved HVAC cooling capacity to address added heat load of the equipment relocated to this room.

5.1.2 Control Room PLC Improvements

The SY/MAX PLC located behind the Mimic panel inside the control room contains the MEB bridge module that allows the SCADA servers to talk to the devices on the SY/NET network. The Remote I/O rack appears to be disconnected and is no longer in use. This rack can be demolished at any time. At a minimum, the power supply and the rack containing the MEB module must be maintained. After all other SY/MAX PLCs in the plant have been replaced or converted to the Ethernet network, this SY/MAX PLC can be demolished in its entirety.

5.2 HEADWORKS NO. 1

Because of the very corrosive environment of the existing Headworks No. 1 control room, it is recommended that the network and PLC equipment be re-located to a dedicated control room at or within the vicinity of Headworks No. 1 that contains conditioned and scrubbed air. However, the construction of a new dedicated control room is beyond the scope of this project. Nonetheless, the following minimal improvements are recommended to the network.

5.2.1 Headworks No. 1 Network Improvements

It is recommended that a dual channel fiber, Modbus TCP Ethernet network be installed from the Headworks No. 1 control room to the Headworks No. 2 electrical room. This will include the installation of a proposed free-standing control panel inside Headworks No. 1 control room which will contain two fiber optic patch panels, two (2) Ethernet switches, and an uninterruptible power supply. Single-mode fiber will then be installed to connect this control panel to the existing fiber optic patch panels within Headworks No. 2 electrical room. This will facilitate Modbus TCP Ethernet connection from Headworks No. 1 all the way back to the Administration Building. Please refer to Exhibit 25 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing PLC is converted to Modbus TCP Ethernet protocol.

5.2.2 Headworks No. 1 PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP

over Ethernet network during a future improvements project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

Although not within the scope of this SCADA network assessment, an alternative PLC improvement that may also be considered in the future is to demolish the existing SY/MAX PLC in its entirety, and move all Headworks No. 1 I/O points to a nearby process area PLC such as Headworks No. 2. Because of the minimal quantity of I/O points, these could be extended to the adjacent process area via direct copper wiring or remote I/O cabling.

5.3 HEADWORKS NO. 2

The existing Headworks No. 2 has a more updated SCADA system due to its more recent installation date. Headworks No. 2 has City standard PLC equipment, with power monitoring, and Modbus TCP Ethernet networking back to the Top-End. However, to take full advantage of more recent SCADA improvements, some improvements can be recommended for this area.

5.3.1 Headworks No. 2 Network Improvements

Based on recent improvements to the plant SCADA network Ethernet root switches located at the Administration Building, it is recommended that the existing 10/100Base-TX to 100Base-FX media converters be demolished and Gigabit Small-Form Pluggable modules be installed into the available slots on the existing Ethernet switches. Fiber optic patch cables can then be installed from the Gigabit modules to the fiber optic patch panels. Existing fiber strands in the 72-strand fiber going back to the Administration Building can then be connected with a patch cable straight to an available Gigabit Ethernet port on the Ethernet root switches located in the Control Room of the Administration Building. Please refer to Exhibit 26 for an overview of the renovated PLC network architecture of this area.

5.3.2 Headworks No. 2 PLC Improvements

The three main PLC systems located in Headworks No. 2 are each of the Modicon Quantum Type, which is consistent with the City standard PLC type. All of these PLCs have Modbus TCP Ethernet network connections over dual channel copper to redundant local Cisco Managed Ethernet switches. These Ethernet switches then have single mode fiber links, via media converters, to the plant SCADA network Ethernet root switches. The PLC systems and network equipment are in good working condition and do not show signs of degradation.

An item to note is that these PLCs use the more antiquated single slot Quantum CPUs with Concept software. At the time of the writing of this TM, the current Quantum CPU technology is a two (2) slot CPU, with ample memory and processing power for Unity programming software. Since the PLC manufacturer no longer supports the Concept programming language, it is recommended that each CPU be upgraded to a Unity Based two (2) slot CPU. The existing PLC racking does have room for the addition of a two slot CPU. If the Unity processor is

employed, additional effort is required for programming the proposed processors with the Unity software, based on the existing Concept programs. This would also allow for demolition of the Modbus Plus peer-to-peer network between these PLCs. This network could be replaced by configuring Modbus TCP over Ethernet via the CPU Ethernet ports of the renovated Unity PLC processors. If the processors are not replaced, a Network Option Ethernet card can be added to the PLCs to implement peer-to-peer communications over Ethernet and remove the Modbus Plus peer-to-peer network. This option would also require additional programming effort. It is noted that the PLC renovations listed here may go beyond the scope of this present network improvements project.

It is also noted that the existing IP addressing of the PLC Ethernet network equipment within Headworks No. 2 is based on an outdated AWU IP addressing scheme. It is recommended that the existing PLC equipment be re-addressed to the current AWU IP addressing scheme that is in use throughout many areas of the plant. This will serve to standardize the Ethernet network throughout the plant and provide redundant network communications to Ethernet channels A and B. Additional effort is required for programming the existing Quantum PLCs to integrate the proposed Ethernet addressing system.

In addition, the Modicon M340 PLC for the bar screen was recently installed with only a single Ethernet connection. It is recommended that an additional Ethernet module be installed on this PLC such that dual channel redundant communications can be established. It is assumed that both communications channels would be programmed using the current IP addressing scheme. Additional effort is required for programming the existing bar screen PLC to integrate the proposed Channel B Ethernet communications.

5.4 PRIMARY TREATMENT COMPLEX NO. 1 (LPU-2)

The Primary Treatment Complex No. 1 consists of a single SY/MAX PLC (PLC-2) which resides on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to local control panel “LPU-2” be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic communication network.

5.4.1 Primary Treatment Complex No. 1 Network Improvements

Based on recommendations from an ongoing project involving Operations Building pumping renovations, it is assumed that a portion of the existing MCC electrical room on the upper level (level 1) of the Operations Building be converted into an air conditioned control room. It is recommended that a dual channel, Modbus TCP Ethernet network be installed in this proposed control room and then connected to the Administration Building and to the existing control panel “OP-CP-LPU2” located in the Process Air Blower and Settled Wastewater Pump control room on the upper level of the Operations Building.

This will include the installation of a proposed free-standing control panel inside the existing MCC electrical room which will contain two fiber optic patch panels, two (2) Ethernet switches, and an uninterruptible power supply. Single-mode fiber will then be installed to connect this control panel to the proposed fiber optic patch panels within the Administration Building, and to

the existing fiber optic patch panels within existing control panel "OP-CP-LPU2". This will facilitate Modbus TCP Ethernet connection from Primary Treatment Complex No. 1 area all the way back to the Administration Building. Please refer to Exhibit 27 and Exhibit 28 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing "PLC-2" is converted to Modbus TCP Ethernet protocol.

Please note that a raceway system between the Administration Building and the Operations Building was installed on a previous security improvements project. This raceway system was installed with two additional conduits which were designated spare for future SCADA network use only. Based on recent field investigations it appears that one spare conduit remains empty while the other spare conduit contains telecomm cabling. It is recommended that the SCADA communications cabling still be installed in these two conduits which will result in one conduit that will contain both telecomm and SCADA cables. This is recommended as a cost savings measure versus the installation of an entirely new raceway system.

5.4.2 Primary Treatment Complex No. 1 PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

5.5 PRIMARY TREATMENT COMPLEX NO. 2

The Primary Treatment Complex No. 2 control room houses the local control panel LPU-3 which contains a SY/MAX PLC system (PLC-3). This PLC system serves the entire Primary Treatment Complex No. 2. Because of the corrosive environment and the possibility of flooding of the existing Primary Treatment Complex No. 2 control room, it is recommended that the network and PLC equipment be re-located to a dedicated control room exterior to Primary Treatment Complex No. 2. Since this is beyond the scope of this project, the following improvements are recommended.

5.5.1 Primary Treatment Complex No. 2 Network Improvements

It is recommended that a dual channel, Modbus TCP Ethernet network be installed from the Primary Treatment Complex No. 2 control room to the Substation No. 2 control panel SUB2-CP-LPU1. This will include the installation of a proposed free-standing control panel inside Primary

Treatment Complex No. 2 lower level which will contain two fiber optic patch panels, two (2) Ethernet switches, and an uninterruptible power supply. Please note that additional verification will be required to determine available room and sizing for this proposed control panel, since there exist space constraints within the Primary Treatment Complex No. 2 control room. Single-mode fiber will then be installed to connect this proposed control panel to the existing fiber optic patch panels within Substation No. 2 control panel SUB2-CP-LPU1. This will facilitate Modbus TCP Ethernet connection from Primary Treatment Complex No. 2 all the way back to the Administration Building. Please refer to Exhibit 29 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing PLC is converted to Modbus TCP Ethernet protocol.

5.5.2 Primary Treatment Complex No. 2 PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

5.6 OPERATIONS RAW WETWELL

The Operations Raw Wetwell consists of a single SY/MAX PLC (PLC-4) which resides on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to local control panel “LPU-4” be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic DCS communication network.

5.6.1 Operations Raw Wetwell Network Improvements

Based on recommendations from an ongoing project involving Operations Building pumping renovations, it is assumed that a portion of the existing MCC electrical room on the upper level (level 1) of the Operations Building be converted into an air conditioned control room. It is recommended that a dual channel, Modbus TCP Ethernet network be installed from this proposed control room to the existing patch panels in existing control panel OP-CP-LPU2 located in the Process Air Blower and Settled Wastewater Pump control room on the upper level of the Operations Building.

This will include the installation of a proposed free-standing control panel inside the existing MCC electrical room which will contain two fiber optic patch panels, two (2) Ethernet switches,

and an uninterruptible power supply. Please note that this proposed panel is the same panel discussed in the Primary Treatment Complex No. 1 improvements section of this technical memorandum. Single-mode fiber will then be installed to connect this control panel to the existing fiber optic patch panels within existing control panel OP-CP-LPU2. This will facilitate Modbus TCP Ethernet connection from Operations Raw Wetwell area all the way back to the Administration Building. Please refer to Exhibit 27 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing "PLC-4" is demolished or converted to Modbus TCP Ethernet protocol.

5.6.2 Operations Raw Wetwell PLC Improvements

Because many of the I/O points on "PLC-4" have already been demolished or moved to other PLC systems, it is recommended to move any remaining I/O points from "PLC-4" to another nearby PLC, such as "PLC-2" or "OP-PLC-LPU2". If migration of these I/O points is beyond the scope of this current network project, another alternative is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

5.7 ACTIVATED SLUDGE COMPLEX 1

The existing network equipment at Activated Sludge Complex 1 already consists of fiber optic patch panels and dual channel Ethernet switches which provide Modbus TCP Ethernet connectivity to this plant area. However, not all local PLC systems are connected to this Ethernet network. The following recommendations will extend the Modbus TCP Ethernet network to all the PLCs within this process area.

5.7.1 Activated Sludge Complex 1 Network Improvements

The existing fiber optic patch panels and Ethernet switches provide dual channel Modbus TCP Ethernet connectivity. However, the initial installation of these fiber patch panels only included connection of 12 fibers from each 72-strand cable. It is recommended that the 60 un-landed fibers are to be connected to fiber connector panels at each patch panel in order to complete the fiber patch panel installation in this area. Please refer to Exhibit 30 for an overview of the renovated network architecture of this area.

The Operator Interface Unit that exists at the Activated Sludge Complex No. 1 is an Ann Arbor touchscreen that resides on a local Ethernet network with PLC "ASC1-PLC-01A". This

equipment is outdated and both the hardware and programming software are no longer supported by the manufacturer. It is recommended to replace the existing OIU with a new OIU implemented either as an operator workstation or a panel door mounted computing device, as desired by COA during the final design phase. This node will be connected directly to the Ethernet network via copper Ethernet cabling to the existing Ethernet switches inside the Control Panel "ASC1-CP-LPU".

5.7.2 Activated Sludge Complex 1 PLC Improvements

It is recommended to add two (2) Modicon Quantum Network Option Ethernet (NOE) modules to the main rack of PLC "ASC1-PLC-01A". This will facilitate connection of copper Ethernet cables to the two Ethernet switches located within control panel "ASC1-CP-LPU". This will enable Modbus TCP connectivity to the Top-End control system. Additional effort is required for programming the existing PLC to integrate the proposed Ethernet communications.

Also, the SY/NET "PLC-5" already has a Niobrara Modbus Ethernet Bridge module installed with Ethernet connectivity. This module currently is connected via Modbus Plus network to "ASC1-PLC-01A" for peer-to-peer communications. It is recommended that the module be connected via copper Ethernet cable to the existing Ethernet channel A switch to enable Modbus TCP connectivity to the Top-End control system. Additional effort is required for programming the existing "PLC-5" to integrate the proposed Ethernet communications. After these proposed renovations, the existing Modbus Plus dual channel network between "PLC-5" and "ASC1-PLC-01A" can be demolished.

An alternative recommendation is to replace the existing SY/MAX "PLC-5" with a Modicon Unity-based Remote I/O system with this Remote I/O system connected to existing PLC "ASC1-PLC-01A". This would reduce the number of PLC processors in this process area from three (3) to two (2). Additional programming would be required to implement this replacement.

5.8 ACTIVATED SLUDGE COMPLEX 2

The existing network equipment at Activated Sludge Complex 2 already consists of fiber optic patch panels and dual channel Ethernet switches which provide Modbus TCP Ethernet connectivity to this plant area. However, not all local PLC systems are connected to this Ethernet network. The following recommendations will extend the Modbus TCP Ethernet network to all the PLCs within this process area.

5.8.1 Activated Sludge Complex 2 Network Improvements

The existing fiber optic patch panels and Ethernet switches provide dual channel Modbus TCP Ethernet connectivity. However, the initial installation of these fiber patch panels only included connection of 12 fibers from each 72-strand cable. It is recommended that the 60 un-landed fibers are to be connected to fiber connector panels at each patch panel in order to complete the fiber patch panel installation in this area. Please refer to Exhibit 31 for an overview of the renovated network architecture of this area.

The Operator Interface Unit that exists at the Activated Sludge Complex No. 2 is an Ann Arbor touchscreen that resides on a local Ethernet network with PLC "ASC2-PLC-01A". This equipment is outdated and both the hardware and programming software are no longer supported by the manufacturer. It is recommended to replace the existing OIU with a new OIU implemented either as an operator workstation or a panel door mounted computing device, as desired by COA during the final design phase. This node will be connected directly to the Ethernet network via copper Ethernet cabling to the existing Ethernet switches inside the Control Panel "ASC2-CP-LPU".

5.8.2 Activated Sludge Complex 2 PLC Improvements

It is recommended to add two (2) Modicon Quantum Network Option Ethernet (NOE) modules to the main rack of PLC "ASC2-PLC-01A". This will facilitate connection of copper Ethernet cables to the two Ethernet switches located within control panel "ASC2-CP-LPU". This will enable Modbus TCP connectivity to the Top-End control system. Additional effort is required for programming the existing PLC to integrate the proposed Ethernet communications.

Also, the SY/NET "PLC-6" already has a Niobrara Modbus Ethernet Bridge module installed with Ethernet connectivity. This module currently is connected via Modbus Plus network to "ASC2-PLC-01A" for peer-to-peer communications. It is recommended that the module be connected via copper Ethernet cable to the existing Ethernet channel A switch to enable Modbus TCP connectivity to the Top-End control system. Additional effort is required for programming the existing "PLC-6" to integrate the proposed Ethernet communications. After these proposed renovations, the existing Modbus Plus dual channel network between "PLC-6" and "ASC2-PLC-01A" can be demolished.

An alternative recommendation is to replace the existing SY/MAX "PLC-6" with a Modicon Unity-based Remote I/O system with the Remote I/O connected to existing PLC "ASC2-PLC-01A". This would reduce the number of PLC processors in this process area from three (3) to two (2). Additional programming would be required to implement this replacement.

5.9 ACTIVATED SLUDGE COMPLEX 3

The existing network equipment at Activated Sludge Complex 3 already consists of fiber optic patch panels and dual channel Ethernet switches which provide Modbus TCP Ethernet connectivity to this plant area. However, not all local PLC systems are connected to this Ethernet network. The following recommendations will extend the Modbus TCP Ethernet network to all the PLCs within this process area.

5.9.1 Activated Sludge Complex 3 Network Improvements

The existing fiber optic patch panels and Ethernet switches provide dual channel Modbus TCP Ethernet connectivity. However, the initial installation of these fiber patch panels only included

connection of 12 fibers from each 72-strand cable. It is recommended that the 60 un-landed fibers are to be connected to fiber connector panels at each patch panel in order to complete the fiber patch panel installation in this area. Please refer to Exhibit 32 for an overview of the renovated network architecture of this area.

It is recommended that dual channel single-mode fiber be extended from the existing fiber patch panels and connected to the existing fiber patch panels in the Water Reuse System electrical building. This fiber connection will provide an important improvement to the backbone network of the plant by extending an additional path of redundancy to the Activated Sludge Complexes. This fiber connection will also help convert the network more toward a “star” topology.

The Operator Interface Unit that exists at the Activated Sludge Complex No. 3 is an Ann Arbor touchscreen that resides on a local Ethernet network with PLC “ASC3-PLC-01A”. This equipment is outdated and both the hardware and programming software are no longer supported by the manufacturer. It is recommended to replace the existing OIU with a new OIU implemented either as an operator workstation or a panel door mounted computing device, as desired by COA during the final design phase. This node will be connected directly to the Ethernet network via copper Ethernet cabling to the existing Ethernet switches inside the Control Panel “ASC3-CP-LPU”.

5.9.2 Activated Sludge Complex 3 PLC Improvements

PLC “ASC3-PLC-01A” is already connected to the Ethernet network. However, it is only connected via a single Modicon Quantum Network Option Ethernet (NOE) module to Ethernet Switch channel A. It is recommended to add one additional Modicon Quantum Network Option Ethernet (NOE) module to the main rack of PLC “ASC3-PLC-01A”. This will facilitate connection of copper Ethernet to Ethernet switche channel B located within control panel “ASC3-CP-LPU”. This will enable dual channel Modbus TCP Ethernet connectivity to the Top-End control system. Additional effort is required for programming the existing PLC to integrate the proposed Ethernet communications.

The SY/NET “PLC-7” already has a Niobrara Modbus Ethernet Bridge module installed with Ethernet connectivity. This module currently is connected via Modbus Plus network to “ASC3-PLC-01A” for peer-to-peer communications. It is recommended that the module be connected via copper Ethernet cable to the existing Ethernet channel A switch to enable Modbus TCP connectivity to the Top-End control system. Additional effort is required for programming the existing “PLC-7” to integrate the proposed Ethernet communications. After these proposed renovations, including replacement of the OIU, the existing Modbus Plus dual channel network between “PLC-7” and “ASC3-PLC-01A” can be demolished.

An alternative recommendation is to replace the existing SY/MAX “PLC-7” with a Modicon Unity-based Remote I/O system with this Remote I/O system connected to existing PLC “ASC3-PLC-01A”. This would reduce the number of PLC processors in this process area from three (3) to two (2). Additional programming would be required to implement this replacement.

5.10 SLUDGE THICKENER

The Sludge Thickener network consists of a single SY/MAX PLC which resides on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to local control panel "LPU-10" be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic DCS communication network.

5.10.1 Sludge Thickener Network Improvements

It is recommended that a dual channel, Modbus TCP Ethernet network be installed from the Sludge Thickener control room to the Water Reuse System electrical building. This will include the installation of a proposed free-standing control panel inside Sludge Thickener control room which will contain two fiber optic patch panels, two (2) Ethernet switches, and an uninterruptible power supply. Single-mode fiber will then be installed to connect this control panel to the existing fiber optic patch panels within the Water Reuse System electrical building. This will facilitate Modbus TCP Ethernet connection from Sludge Thickener all the way back to the Administration Building, via the Water Reuse System patch panels. Please refer to Exhibit 33 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing PLC is converted to Modbus TCP Ethernet protocol.

5.10.2 Sludge Thickener PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

5.11 SLUDGE PRESSURIZATION

The Sludge Pressurization network consists of a single SY/MAX PLC which resides on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to local control panel "LPU-11" be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic DCS communication network.

5.11.1 Sludge Pressurization Network Improvements

It is recommended that a dual channel, Modbus TCP Ethernet network be installed from the Sludge Pressurization control room to the Water Reuse System electrical building. This will include the installation of a proposed free-standing control panel inside Sludge Pressurization control room which will contain two fiber optic patch panels, two (2) Ethernet switches, and an uninterruptible power supply. Single-mode fiber will then be installed to connect this control panel to the existing fiber optic patch panels within the Water Reuse System electrical building. This will facilitate Modbus TCP Ethernet connection from Sludge Pressurization all the way back to the Administration Building, via the Water Reuse System patch panels. Please refer to Exhibit 34 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing PLC is converted to Modbus TCP Ethernet protocol.

5.11.2 Sludge Pressurization PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

Although not within the scope of this SCADA network assessment, an alternative PLC improvement that may be considered in the future is to demolish the existing SY/MAX PLC in its entirety, and move all Sludge Pressurization I/O points to a nearby process area PLC such as Water Reuse. Because of the minimal quantity of I/O points, these could be extended to the adjacent process area via direct copper wiring or remote I/O cabling.

5.12 WATER REUSE SYSTEM

The Water Reuse System electrical building serves as an important hub for the fiber optic network that travels throughout the plant. The WRS fiber optic patch panels have direct connections to the Administration Building, Substation No. 1, and Filter Building No. 1.

5.12.1 Water Reuse System Network Improvements

As described in other sections of this technical memorandum, there will be three (3) fiber connections added to the Water Reuse System fiber optic patch panels. Fiber connections to the Sludge Thickener Building and to the Sludge Pressurization area will both be added to extend the

Modbus TCP over Ethernet network into these areas of the plant. Fiber connection to the Activated Sludge Complex No. 3 will be added to help enhance the plant network more toward a "star" topology. In this process area, the existing patch panels currently have empty sections. These sections will be filled with proposed connector panels. Therefore, proposed equipment for these fiber connections within the WRS electrical building control panel "WR-CP-LPU2A" include fiber connector panels and fiber jumpers. Fiber connector panels will be installed into the existing fiber optic patch panels. Fiber jumpers will then be added between the connector panels in order to extend the fiber network to the aforementioned areas. Please refer to sections 5.9.1, 5.10.1 and 5.11.1 of this technical memorandum for additional information. Please refer to Exhibit 35 for an overview of the renovated PLC network architecture of this area.

5.12.2 Water Reuse System PLC Improvements

Water Reuse System PLC network communicates to the plant SCADA system using Modbus TCP Ethernet at the main Data Concentrator PLC. However, it also utilizes older generation Modicon Quantum Concept processors and has extensive use of Modbus Plus networking for peer-to-peer communications. A complete PLC improvements review would include an upgrade of the processors to the two-slot Unity-based processors for each of the PLCs in this area, a demolition of the Modbus Plus networking and a replacement of the peer network with Modbus TCP Ethernet. It is noted that the CPU renovations listed here are beyond the scope of this present network improvements project and are offered as a recommendation during future project renovations in this area.

In addition, the existing IP addressing of the PLC equipment within Water Reuse System is based on an outdated network addressing system. It is recommended that the existing PLC equipment be re-addressed to the current IP addressing scheme that is in use throughout many areas of the plant. This will serve to standardize the Ethernet network throughout the plant and provide redundant network communications to Ethernet channels A and B. Additional effort is required for programming the existing Quantum PLCs to integrate the proposed Ethernet addressing system.

5.13 FILTER BUILDING NO. 1

While Filter Building No. 1 does contain dual channel, fiber optic network for Water Reuse System Remote I/O data, the predominant Filter Building No. 1 network consists of multiple SY/MAX PLCs (one per filter) which reside on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to each of the local filter control panels be replaced with an Ethernet network connection that will interface with the existing plant fiber optic DCS communication network.

5.13.1 Filter Building No. 1 Network Improvements

It is recommended that the existing dual channel, fiber optic network be utilized for Modbus TCP Ethernet in order to add filter telemetry to the Top-End system. This recommendation includes the installation of a proposed free-standing control panel inside Filter Building No. 1

which will contain two (2) Ethernet switches, and an uninterruptible power supply. These switches will contain small form factor, pluggable Gigabit Ethernet modules that will connect via fiber optic patch cord to the fiber optic patch panels inside of control panel "FB1-CP-WR". Please refer to Exhibit 36 for an overview of the renovated PLC network architecture of this area.

The installation of a new SCADA Operator Workstation computer or operator interface unit is also recommended for Filter Building No. 1 or No. 2. Exact location of this node can be determined based on plant preferences. For the purpose of these exhibits, the network architecture will show this proposed Operator Workstation in Filter Building No. 1.

5.13.2 Filter Building No. 1 PLC Improvements

It is recommended to replace the existing SY/MAX PLC within each local filter console with a new Schneider Unity-based PLC system installed in its place. It is also known that the City of Austin presently has an ongoing separate project involving improvements to the filter control system. Therefore, it is recommended that any filter improvements implemented under this project include dual channel Modbus TCP Ethernet connectivity to each filter.

The recommendations below assume that improvements from the ongoing filter project have not yet been implemented. Until such time that the permanent improvements are implemented for this area, as a cost saving interim solution, it is recommended to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack of filter no. 3, and connect this card to the proposed Ethernet network. The MEB module will behave as a gateway to the Ethernet Network for the ten (10) filters communicating over SY/NET. This will facilitate Modbus TCP Ethernet connection from each filter all the way back to the Administration Building.

Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLCs within the Filter Buildings will remain on the SY/NET network, and filter no. 3 will poll data from the other filter PLCs on the SY/NET network through the MEB Ethernet Bridge. This would require maintenance of the SY/NET network locally within Filter Building No. 1 and No. 2 until the existing SY/MAX PLCs are replaced with new Unity based PLCs using Modbus TCP Ethernet protocol.

5.14 FILTER BUILDING NO. 2

Filter Building No. 2 network consists of multiple SY/MAX PLCs (one per filter) which reside on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to each of the local filter control panels be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic DCS communication network.

5.14.1 Filter Building No. 2 Network Improvements

It is recommended that the dual channel, fiber optic network that exists in Filter Building No. 1 be extended to Filter Building No. 2 to add filter telemetry to the Top-End system. This recommendation includes usage of the proposed free-standing control panel inside Filter Building No. 1 which will contain two (2) Ethernet switches, and an uninterruptible power supply. Refer to section 5.13.1 of this TM. From these proposed Ethernet switches, a copper Ethernet connection will be routed to each of the six (6) filters inside Filter Building No. 2.

This will facilitate Modbus TCP Ethernet connection from each filter all the way back to the Administration Building. Please refer to Exhibit 37 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network be maintained until the existing SY/MAX PLCs are converted to Modbus TCP Ethernet protocol.

5.14.2 Filter Building No. 2 PLC Improvements

It is recommended to replace the existing SY/MAX PLC within each local filter console with a new Schneider Unity-based PLC system installed in its place. It is also known that the City of Austin presently has an ongoing separate project involving improvements to the filter control system. Therefore, it is recommended that any filter improvements implemented under this project include dual channel Modbus TCP Ethernet connectivity to each filter.

The recommendations below assume that improvements from the ongoing filter project have not yet been implemented. It is recommended to maintain the SY/NET network throughout Filter Building No. 2 and in series with Filter Building No. 1. The proposed installation of a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack of filter no. 3 will then connect all of the filters in building no. 2 to the proposed Ethernet network. This would require maintenance of the SY/NET network locally within Filter Building No. 1 and No. 2. Please refer to section 5.13.2 of this TM.

5.15 CHLORINE AREA

The Chlorine area network consists of a SY/MAX PLC which resides on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to the local PLC be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic DCS communication network within the Operations Building.

5.15.1 Chlorine Area Network Improvements

Based on recommendations from an ongoing project involving Operations Building pumping improvements, it is assumed that a portion of the existing MCC electrical room on the upper level (level 1) of the Operations Building be converted into an air conditioned control room. As previously described in Section 5.4.1, it is proposed to install a free-standing control panel inside the existing MCC electrical room which will contain two fiber optic patch panels, two (2)

Ethernet switches, and an uninterruptible power supply. It is recommended that this panel shall also include a copper patch panel so that the network can be extended from this proposed panel to the Operations Building Chlorine Area control room via copper Ethernet connection. Preliminary review of the cable routing in the area has found that the distance limitations of copper Ethernet will not be exceeded. This will facilitate Modbus TCP Ethernet connection from Chlorine Area to the Administration Building, while minimizing the amount of proposed network equipment inside the corrosive environment of the Chlorine Area control room. Please refer to Exhibit 27 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network at control panel "CS01-LCP-01" be maintained until the existing PLC is converted to Modbus TCP Ethernet protocol.

Because of the corrosive environment of the Chlorine Area control room in the Operations Building, the operator workstation computers have experienced a very rapid failure rate. It is recommended that an operator workstation computer be installed in the proposed air conditioned control room within the existing MCC electrical room, along with Ethernet keyboard, mouse and video extenders. Within the Chlorine Area control room, a keyboard, mouse and video display will be installed and connected to the computer across the copper Ethernet network. In this way, an operator workstation can be made accessible to the Chlorine Area control room without the risk of rapid failure of the computer.

5.15.2 Chlorine Area PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. Furthermore, it is recommended that this PLC be located outside of the Chlorine Control Room, due to the corrosive nature of this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

5.16 DECHLORINATION BUILDING

The Dechlorination Building network consists of a SY/MAX PLC which resides on the SY/NET copper serial network. The design concept for the network improvements proposes that the existing SY/NET communication network connection to the local PLC be replaced with an Ethernet communication connection that will interface with the existing plant fiber optic DCS communication network within the Operations Building.

5.16.1 Dechlorination Building Network Improvements

It is recommended that a dual channel, Modbus TCP Ethernet network be installed from the Dechlorination Building control room to the proposed control room in the Operations Building MCC electrical room. This will include the installation of a proposed free-standing control panel inside Dechlorination Building control room which will contain two fiber optic patch panels, two (2) Ethernet switches, and an uninterruptible power supply. Single-mode fiber will then be installed through existing duct bank system to connect this control panel to the proposed control panel within the Operations Building MCC electrical room. This will facilitate a Modbus TCP Ethernet connection from the Dechlorination Building to the Administration Building, via the fiber optic network. Please refer to Exhibit 38 for an overview of the renovated PLC network architecture of this area. It is also recommended that the twin-axial copper SY/NET network at control panel "DS01-LCP-01" be maintained until the existing PLC is converted to Modbus TCP Ethernet protocol.

5.16.2 Dechlorination Building PLC Improvements

It is recommended to replace the existing SY/MAX PLC with a Modicon Unity-based PLC system with Modbus TCP over Ethernet communications protocol when a renovation project occurs in this area. While this PLC change out is beyond the scope of this current network project, a minimum improvement is to install a Niobrara MEB Ethernet Bridge into the existing SY/MAX PLC rack and connect this card to the proposed Ethernet network. Additional programming effort would be required to facilitate communications between the proposed Ethernet bridge module and the SCADA system. In this case, the PLC could then be removed from the SY/NET network. If no PLC changes are implemented during this current project, the PLC can remain on the SY/NET network, and it can be integrated to the proposed Modbus TCP over Ethernet network during a future project. This would require continued maintenance of the SY/NET network. The reason that the continued maintenance of the SY/NET network is required is because it is daisy chained and its removal will affect the remainder of the plant.

5.17 SUBSTATION NO. 1

Substation No. 1 already consists of a dual-channel Modbus TCP Ethernet network. The design concept for the network improvements in this area consist of expanding the Ethernet capacity of this network, and updating some older network equipment.

5.17.1 Substation No. 1 Network Improvements

Currently only PLC "SUB1-PLC-01" is connected to the Modbus TCP Ethernet network. This PLC has copper Ethernet connections that are routed through media converters, and then fiber optic jumpers connect back to the fiber optic patch panels in the patch panel closet within the Substation. It is recommended to install two Ethernet switches within the Main Control Panel so as to increase the capacity of connections for local devices to the SCADA network. Then the media converters for the PLC can be demolished, and the PLC can be connected directly to the Ethernet switches.

The Operator Interface Unit that exists at the Substation No. 1 is a Schnieder Electric Magelis unit that resides on a local Modbus Plus network with the PLC. This equipment is outdated and both the hardware and programming software are no longer supported by the manufacturer. It is recommended to replace the existing OIU with a new OIU implemented either as an operator workstation or a panel door mounted computing device, as desired by COA during the final design phase, for SCADA control and monitoring capabilities at the Substation. This node will be connected directly to the Ethernet network via copper Ethernet cabling to the proposed Ethernet switches inside the Main Control Panel inside the Substation. Please refer to Exhibit 39 for an overview of the renovated PLC network architecture of this area.

5.17.2 Substation No. 1 PLC Improvements

The PLC at Substation No. 1 utilizes an older generation Modicon Quantum Concept processor that is no longer supported by the manufacturer. A complete PLC improvements review would include an upgrade of the processor to the two-slot Unity-based processor for the PLC in this area. Whereas the existing PLC backplane does have enough room for the addition of the two-slot processor, additional effort would be required to program the proposed Unity-based processor. It is noted that the CPU renovations listed here are beyond the scope of this present network improvements project and are offered as a recommendation during future project renovations in this area.

5.18 SUBSTATION NO. 2

The dual-channel fiber optic network within Substation No. 2 is recently installed and is in very good condition.

5.18.1 Substation No. 2 Network Improvements

The recommended network improvements in this area include the extension of the Modbus TCP Ethernet fiber network from Substation No. 2 to Primary Treatment Complex No. 2. Please refer to section 5.5.1 of this TM for a description of these improvements.

5.18.2 Substation No. 2 PLC Improvements

The PLC system at Substation No. 2 is a Modicon Unity-based 2-slot processor that was recently installed and meets the current AWU standard for PLC installation. The PLC system requires no improvements at this time.

5.19 INFLUENT LIFT STATION

The Influent Lift Station utilizes a single-channel multi-mode fiber network connection to the plant SCADA system.

5.19.1 Influent Lift Station Network Improvements

While the network to the Influent Lift Station is only single-channel multi-mode fiber, the installation is relatively recent and shows no signs of wear or degradation. Therefore, no changes are recommended at this time.

5.19.2 Influent Lift Station PLC Improvements

The PLC installation is a Modicon M340 PLC per the current Austin Water Utility Lift Station Telemetry standards. While this standard does not provide for dual-channel Ethernet connectivity, the single-channel Ethernet is sufficient for this plant area and is suited to the existing network architecture.

5.20 OVERALL NETWORK IMPROVEMENTS

In general, the Walnut Creek WWTP has a mixture of SY/NET communication protocol over copper media type (twin co-axial cable and serial) as well as Modbus TCP Ethernet over fiber optic and copper media technology used for the PLC communication network, as well as a mixture of single channel and dual channel communication network topology. The following subsections further discuss the plant's PLC and SCADA communication media, the SY/NET network, the Modbus Plus network, Ethernet Switching technology, and SCADA system computers. Please refer to Exhibits 23 and 23A for an overview of the proposed plant PLC network renovations.

5.20.1 Communication Media

In general, Headworks No. 2, Water Reuse System, Filter Building No. 1, Substation No. 1, Substation No. 2, Operations Building and the Activated Sludge Complexes have employed a dedicated, dual channel, single mode fiber link that eventually interconnect to the Administration Building for communication, whereas most other areas of the plant have employed a single channel, twin-axial SY/NET copper network.

By adding fiber optic cabling to existing patch panels in the Administration Building, Water Reuse System and Operations Building, this dual channel single mode fiber network can be extended to the remaining plant areas that currently do not contain SCADA fiber network connectivity. For the purposes of this TM, a dual channel single mode fiber optic connection renovation is recommended for the following:

- Headworks No. 1
- Primary Treatment Complex No. 1
- Raw Wetwell
- Primary Treatment Complex No. 2
- Sludge Thickener
- Sludge Pressurization
- Chlorine Area
- Dechlorination Building

It is recommended that, in future renovation projects, single mode fiber optic cable be used for the PLC and SCADA communication system with a dedicated fiber optic cable system that is independent from other communication systems, such as security or City IT systems. To the extent possible, the existing fiber infrastructure, such as the link between the Administration Building and the Water Reuse System may be used for this connectivity.

In order to add redundancy to the existing fiber network, it is recommended that additional fiber connections be installed to provide secondary paths for network traffic in case of failure in one portion of the network. Specifically, this includes installing fiber from the Administration Building to the Operations Building, and installing fiber from the Water Reuse fiber patch panel to the Activated Sludge Complex No. 3 fiber patch panel. These recommendations will enhance the redundancy of the network topology of the plant. Please refer to Exhibit 23A for a logical block diagram of the proposed plant SCADA network.

For cost reduction measures, to the extent possible, existing raceway is to be reused. However, based on preliminary investigation, it appears insufficient raceway is available to route all the fiber cables of each channel in separate raceway. Therefore, it is proposed that new duct bank be installed to allow for the routing of redundant raceways for the proposed fiber system.

5.20.2 SY/NET Network Decommissioning

Caution should be exercised in the decommissioning of the SY/NET network. In particular, the network is a daisy chained network which traverses through several process areas of the plant. While a certain process area may be upgraded to a proposed Ethernet Communication protocol, the existing SY/NET network must be healed to maintain its daisy chain continuity for the remainder of the plant's SY/MAX PLCs using this network. Furthermore, while SY/MAX PLC's are present on the plant network, the SY/NET peer-to-peer communication programming should be reviewed to assure no loss of communication occurs upon the disconnection of the SY/NET network and upgrade to Ethernet.

5.20.3 Modbus Plus Network

The Modbus Plus networks that exist throughout the plant are located only within local process areas, such as Headworks No. 2, Water Reuse System, Substation No. 1 and the Activated Sludge Complexes. Modifications to these networks will be recommended only in concert with more complete PLC improvement projects within these areas, as future renovation projects are instituted for these areas. Therefore, it is recommended that the existing Modbus Plus Networks remain in place.

5.20.4 Ethernet Switching Technology

The Ethernet root switches for the dual channel plant network located in the Control Room of the Administration Building have been recently upgraded by the City to Cisco 3750-X Series switches. These switches consist of multiple single mode fiber optic ports with gigabit

capability, Small Form Factor Pluggable (SFP) modules, and multiple copper Ethernet ports for 100Mb/s Ethernet connectivity. Therefore, the switches require no improvements and currently have adequate spare ports for the network expansion discussed throughout this TM.

5.20.5 SCADA System Computers

The Walnut Creek WWTP has SCADA system computers distributed throughout the plant. Presently, the main location where these computers are located are the Administration Building, Water Reuse System, and Headworks No. 2. It is noted that the Maintenance Building does have SCADA network connectivity, but only for the Lift Station Telemetry System. The Maintenance Building has offices for the plant's maintenance personnel. It is recommended that the plant SCADA system be extended to the Maintenance Building by installing a plant SCADA system computer for use by maintenance personnel. A SCADA system operator workstation computer or view node in the Maintenance Building would allow maintenance personnel convenient access to monitor plant process conditions or view trends.

It is also recommended to install a SCADA system computer inside Filter Building No. 1 or Filter Building No. 2 to allow operations and maintenance staff a convenient access and monitoring of plant process conditions. Please refer to section 5.13.1 of this TM for more information regarding installation of the filter building operator workstation. Exact location of this SCADA node can be determined during final design phase.

6 OVERVIEW SUMMARY OF RECOMMENDATIONS

The following provides an overview summary of the proposed recommendations for the plant:

- Where a SY/MAX PLC system exists, extend the Modbus TCP over Ethernet network to this PLC such that when the SY/MAX PLC can be demolished it can be replaced with a Modbus TCP over Ethernet PLC system.
- Standardize on one network protocol for communication amongst PLCs and between the PLC and the Top-End computer system. The standard communication protocol should be Modbus TCP over Ethernet. To the extent possible, fiber optic communication should be used for communication between process areas, particularly if the areas are in separate buildings on the plant site.
- Where proposed communication is required with a local device, such as a Power Monitoring Device, in a proposed renovation project, the Modbus TCP over Ethernet protocol shall be used between the PLC and device.
- It is recommended that the plant PLC network be a Star Ethernet Network topology, with the root Ethernet Switch located in the Administration Building. It is recommended that this star topology be extended with future renovations in the network architecture of the plant.
- It is recommended that two additional SCADA operator workstation computers be installed: one in the Maintenance Building and another in the Filter Building. These additional workstations allow for more convenient monitoring and control of the plant process conditions.

7 PRELIMINARY BUDGETARY COST ESTIMATE

The following table provides an overview of the preliminary budgetary cost estimate for each of the renovated areas and their SCADA network options, where applicable. While the TM has discussed PLC renovations as a convenience for planning and future look ahead for the City, such PLC improvements are beyond the SCADA plant network improvements objective of this TM and are not included in the costs below. Please note that these costs are for electrical and I&C installation and materials only. The costs include a 30% mark up for a general/trade contractor's mark up. They do not include costs for process mechanical, civil, architectural, structural, HVAC, etc. These items are beyond the scope of this project.

Table 3 Preliminary Budgetary Construction Cost Estimate

Area Description	Notes	Construction Cost Opinion	TOTAL Cost with 25% Contingency
Administration Building	1,3	$0.00	$0.00
Headworks 1	1,4	$144,896.00	$181,120.00
Headworks 2	1	$0.00	$0.00
Primary Treatment Complex No. 1	2	$144,896.00	$181,120.00
Primary Treatment Complex No. 2	1,2	$144,896.00	$181,120.00
Operations Raw Wetwell	2	$42,500.00	$53,125.00
Activated Sludge Complex No. 1	2	$84,112.00	$105,140.00
Activated Sludge Complex No. 2	2	$84,112.00	$105,140.00
Activated Sludge Complex No. 3	2	$84,112.00	$105,140.00
Sludge Thickener	1,2	$144,896.00	$181,120.00
Sludge Pressurization Bldg.	1,2	$144,896.00	$181,120.00
Water Reuse System	1	$0.00	$0.00
Filter Building No. 1	2	$190,896.00	$238,620.00
Filter Building No. 2	1,2	$0.00	$0.00
Chlorine Area	4	$76,500.00	$95,625.00
Dechlorination Area	1,4	$144,896.00	$181,120.00
Substation No. 1	1	$0.00	$0.00
Substation No. 2	1	$0.00	$0.00

Table 3 (Continued) Preliminary Budgetary Construction Cost Estimate

Area Description	Notes	Construction Cost Opinion	TOTAL Cost with 25% Contingency
Overall Site Network Improvements:		$1,286,327.47	$1,607,909.34
	Administration Building	*$203,879.69*	*$254,849.61*
	Activated Sludge Complex 3	*$90,292.88*	*$112,866.10*
	Dechlorination Building	*$121,791.04*	*$152,238.80*
	Headworks 1	*$46,028.28*	*$57,535.35*
	Headworks 2	*$14,264.64*	*$17,830.80*
	Operations Building	*$226,221.72*	*$282,777.15*
	Sludge Pressurization Bldg.	*$81,444.76*	*$101,805.95*
	Primary Treatment Complex 2	*$173,446.40*	*$216,808.00*
	Substation No. 2	*$14,264.64*	*$17,830.80*
	Sludge Thickener Building	*$74,176.20*	*$92,720.25*
	Water Reuse Electrical Building	*$42,793.92*	*$53,492.40*
	Site Misc.	*$197,723.30*	*$247,154.13*
TOTAL		$2,717,935.47	$3,397,419.34

Notes:

1. This area does involve modifications in the fiber system. Costs associated with fiber termination, fiber cable, etc., are included in the "Overall Site Network Improvements" category

2. It should be noted that there are other ongoing improvements projects for this area. Costs presented are for network improvements only based on existing automation equipment already present in these areas

3. It is assumed the City has an ongoing projects for the upgrade of the network equipment in the Administration Building. Therefore, costs are not shown here for this required network equipment upgrade.

4. As this project is to address network improvements only, PLC improvements are not included. However, it is noted that these areas have antiquated Sy/Max equipment that will remain and that should be upgraded.

As identified in the notes for Table 3, it should be noted that there are ongoing projects that are planned to address certain Instrumentation and Controls improvements within the Walnut Creek WWTP. If these projects are executed, then the particular item outlined in the table would be addressed under the respective project. However, should the City decide to implement a short term, interim fix in a network improvement for the particular area prior to commencement of the respective project, then the table provides a preliminary budgetary cost estimate for the associated network improvement.