APPENDIX B – DESCRIPTION OF THE PLC SYSTEMS

1 Regional Pumping Stations PLC system

1.1 Overview

1.1.1 The primary task of the control systems at the three (3) Regional Pumping Stations (Hurst, MacLean, and McPhillips) is to maintain the discharge pressure of each station at the appropriate setpoint by starting, stopping, and controlling the speed of the pumps.

1.1.2 The control system also provides pump sequencing and protection functions, as well as control and monitoring of other station services such as chlorine dosing and residuals, reservoirs levels, and alarms.

1.2 Hardware and PLC Programming

1.2.1 The control systems at the three (3) regional pumping stations are PLC based architectures. The existing PLC hardware consists of Modicon Compact series PLCs with E984-255 and A984-145 processors.

1.2.2 The PLC control logic is implemented in Modicon 984 ladder logic and was originally programmed using ProWorx programming software. The PLC control logic has been converted to FasTrak Softworks PLC Workshop for Modicon (32-bit) programs since the original implementation.

1.2.3 While the current PLC hardware and control logic continues to function as designed, it is reaching the end-of-life in terms of spare parts availability.

1.3 Control System Architecture Station Programmable Logic Controller (SPLC)

1.3.1 Each Regional Pumping Station consists of a series of pumps that are driven by either electric or natural gas engines (Hurst – six (6) electric, MacLean – three (3) electric & two (2) gas, McPhillips – three (3) electric & three (3) gas).

1.3.2 Each pump has a local control panel (LCP) for control and monitoring of the pump which contains: a dedicated Modicon Compact A984-145 series Pump PLC (PPLC); local pump Inputs/Outputs (I/O); and a Bently Nevada temperature/vibration monitor.

1.3.3 Every Regional Pumping Station has a station PLC panel that houses four (4) PLCs. Station PLC1 (SPLC1) and Station PLC33 (SPLC33) are identical Modicon Compact E984-255 series PLCs configured to operate in a quasiredundant hot/standby configuration, where both PLCs execute logic concurrently with the Regional SCADA system communicating only to the primary SPLC under normal operating conditions. If a failure occurs communicating to the primary SPLC, the Regional SCADA system will switch the route to communicate with the secondary SPLC.

1.3.4 The primary SPLC1 and secondary SPLC33 pair function as Station Master PLCs that are responsible for: monitoring pump, engine, and motor statuses; pump control by starting and stopping required pumps via a pump sequencer to maintain station discharge pressure at the desired setpoint; as well as monitoring and control of other station functions such as chlorine dosing and burglar alarms.

1.3.5 The remaining two (2) PLCs in the station PLC panel, PLC11 and PLC12, are Modicon Compact A984-145 series PLCs that function as I/O PLCs, as they are responsible for collection of digital and analog I/O from all other station devices and instrumentation other than the pumps.

1.3.6 The Station Master PLCs do not have any local I/O. They obtain pump and station device I/O, required for control and monitoring of pumps and station functions, from the individual pump PLCs and I/O PLCs via Modbus Plus communications.

1.4 Communication

1.4.1 The Station Master, Pump, and I/O PLCs in each regional pumping station are connected via a Modbus Plus network setup in a ring configuration. The Modbus Plus network connects the PLCs (Pump, Station Master, and I/O), a Modicon BP85 Bridge Plus module, a Modicon BM85 Bridge Multiplexer module, and a Modicon Modbus+/Ethernet Bridge.

1.4.2 The Modbus+/Ethernet Bridge allows the Regional SCADA system to communicate with the Station Master PLCs and Bently Nevada units, via Ethernet WAN, for remote control and monitoring of the pumping station.

1.4.3 The BM85 Bridge Multiplexer allows the Regional SCADA system to communicate with Modbus devices, such as the Bently Nevadas, over the Modbus Plus network.

1.4.4 The BM85 Bridge Multiplexer also acts as the tie in point for radio communications, which serves as the backup communications medium for the Regional SCADA system to devices such as the Station Master PLCs in the event of a failure of the Ethernet WAN or Modbus+/Ethernet Bridge.

1.4.5 The BP85 Bridge Plus connects the two (2) ends of the Modbus Plus network ring and is intended to allow the Modbus Plus network to continue operation even with a single break in the network ring.

2 Tache Booster Pumping Station PLC System

2.1 Overview

2.1.1 The primary task of the control system at the Tache Booster Pumping Station is to provide control and monitoring of the three (3) single-speed station pumps for the purpose of providing additional flow to the McPhillips Regional Pumping Station via the Branch I Aqueduct.

2.1.2 The control system also provides pump protection functions, as well as control and monitoring of other station equipment and services such as motorized valves, surge tower, electrical distribution, and station alarms.

2.2 Hardware and PLC Programming

2.2.1 The control system at the Tache Booster Pumping Station is a PLC based architecture. The existing PLC hardware consists of Modicon Compact series PLCs with A984-145 processors.

2.2.2 The PLC control logic is implemented in Modicon 984 ladder logic and was originally programmed using ProWorx programming software. The PLC control logic has been converted to FasTrak Softworks PLC Workshop for Modicon (32-bit) programs since the original implementation.

2.2.3 While the current PLC hardware and control logic continues to function as designed, it is reaching the end-of-life in terms of spare parts availability.

2.3 Control System Architecture

2.3.1 The Tache Booster Pumping Station consists of three (3) single-speed pumps driven by electric motors.

2.3.2 Each pump has a LCP for local control and monitoring of the pump which contains: start/stop buttons, a computer/hand switch, alarm lamps, and a Bently Nevada temperature/vibration monitor.

2.3.3 In addition to the LCPs for the pumps, the Tache Booster Pumping Station has a station PLC panel that houses three (3) PLCs. Station PLC2 (SPLC2) and Station PLC34 (SPLC34) are identical Modicon Compact A984-145 series PLCs configured to operate in a quasi-redundant hot/standby configuration, where both PLCs execute logic concurrently with the Regional SCADA system communicating only to the primary SPLC under normal operating conditions. If a failure

occurs communicating to the primary SPLC, the Regional SCADA system will switch the route to communicate with the secondary SPLC.

2.3.4 The primary SPLC2 and secondary SPLC34 pair function as Station Master PLCs that are responsible control and monitoring of all three (3) station pumps as well as all other station functions such as surge tower control.

2.3.5 Pump control and monitoring logic is located in the Station Master PLCs, as each pump does not have a dedicated pump PLC.

2.3.6 The remaining PLC in the station PLC panel is PLC11, is a Modicon Compact A984-145 series PLC which functions as the I/O PLC responsible for collection of digital and analog I/O from all station devices and instrumentation, including the electric pumps.

2.3.7 The Station Master PLCs do not have any local I/O. They obtain pump and station device I/O, required for control and monitoring of pumps and station functions, from the I/O PLC via Modbus Plus communications.

2.4 Communication

2.4.1 The Station Master and I/O PLCs in the Tache Booster Pumping Station are connected via a Modbus Plus network setup in a ring configuration. The Modbus Plus network connects the PLCs (Station Master and I/O), a Modicon BP85 Bridge Plus module, a Modicon BM85 Bridge Multiplexer module, and a Modicon Modbus+/Ethernet Bridge.

2.4.2 The Modbus+/Ethernet Bridge allows the Regional SCADA system to communicate with the Station Master PLCs and Bently Nevada units, via Ethernet WAN, for remote control and monitoring of the Tache Booster Pumping Station.

2.4.3 The BM85 Bridge Multiplexer allows the Regional SCADA system to communicate with Modbus devices, such as the Bently Nevadas, over the Modbus Plus network.

2.4.4 The BM85 Bridge Multiplexer also acts as the tie in point for radio communications, which serves as the backup communications medium for the Regional SCADA system to devices such as the Station Master PLCs in the event of a failure of the Ethernet WAN or Modbus+/Ethernet Bridge.

2.4.5 The BP85 Bridge Plus connects the two (2) ends of the Modbus Plus network ring and is intended to allow the Modbus Plus network to continue operation even with a single break in the network ring.

3 Deacon Booster Pumping Station and Deacon Chemical Feed Facility PLC System

3.1 Overview

3.1.1 The control systems at the Deacon Booster Pumping Station and the Deacon Chemical Feed Facility are responsible for control and monitoring of three (3) key tasks:

(b) maintaining station water flow from the WTP to the Regional Pumping Stations via the Branch I & II Aqueducts at the desired flow rate setpoint by starting, stopping, and controlling pump speeds and discharge valves;

(c) maintaining UV treatment dosage at setpoints required by the City of Winnipeg's operating licence by starting and stopping reactors and controlling reactor flow and UV output; and

(d) maintaining chemical dosages of fluoride and phosphate at desired setpoints by flow pacing the chemical injection based on water flow rate out of the Deacon Booster Pumping Station.

3.1.2 The control systems also provide pump protection functions, UV reactor sequencing and protection functions, as well as control and monitoring of other station equipment and services

such as reservoir levels, chemical dosing level monitoring, surge towers, electrical distribution, and station alarms.

3.1.3 The station control system for the Deacon Booster Pumping Station and the Deacon Chemical Feed Facility is similar in design to the control systems for the Regional Pumping Stations.

3.1.4 The Deacon Booster Pumping Station and the Deacon Chemical Feed Facility contain three (3) distinct control systems:

(a) the station control system for control and monitoring of the:

(i) two-speed electric pumps (P-D003A, P-D004A, and P-D005A),

(ii) chemical feed systems (fluoride and phosphate), and

(iii) general Deacon Booster Pumping Station and Deacon Chemical Feed Facility systems (reservoir levels, electrical distribution, security, alarms);

(b) the UV system for the control and monitoring of the UV treatment process; and

(c) the D21 PLC system for control and monitoring of the variable speed electric pumps (P-D001A and P-D002A).

3.2 Hardware and PLC Programming

3.2.1 The control systems at the Deacon Booster Pumping Station and the Deacon Chemical Feed Facility are PLC based architectures.

3.2.2 The existing PLC hardware consists of two (2) distinct vintages of Modicon PLCs:

(a) Modicon Compact series PLCs (A984-145 processors) used for the Station Master, I/O and Pump (two-speed) PLCs at the Deacon Booster Pumping Station; and

(b) Modicon Quantum series PLCs (140-113, 140-434 and 140-671 processors) used for the UV Master, UV Reactor, and Pump (variable speed) D21 PLC in the Deacon Booster Pumping Station as well as the Chemical Feed PLC in the Deacon Chemical Feed Facility.

3.2.3 The PLC control logic implemented in all the Modicon Compact PLCs, as well as the Modicon Quantum PLCs for the UV Reactor and Chemical Feed PLCs, is Modicon 984 ladder logic. Originally programmed using ProWorx programming software, their PLC logic has since been converted to FasTrak Softworks PLC Workshop for Modicon (32-bit).

3.2.4 The PLC control logic used in the UV Master and Pump D21 PLCs is Modicon IEC 1131-3 Defined Function Block logic, developed with Modicon Unity Pro programming software.

3.2.5 While the current PLC hardware and control logic continues to function as designed, the Modicon Compact series PLC hardware at the Deacon Booster Pumping Station is reaching the end-of-life in terms of spare parts availability.

3.2.6 The Modicon Quantum series PLCs continue to be supported by Schneider Electric and spare parts are readily available.

3.3 Control System Architecture

3.3.1 Station Control System Architecture

3.3.1.1 The Deacon Booster Pumping Station consists of three (3) two-speed electric pumps responsible for providing all or part of the desired water flow to the Regional Pumping Stations. Each pump has a LCP for control and monitoring of the pump which contains: a dedicated Modicon Compact A984-145 series PPLC; local pump I/O; and a Bently Nevada temperature/vibration monitor.

3.3.1.2 In addition to the LCPs for the pumps, the Deacon Booster Pumping Station has a station PLC panel that houses four (4) PLCs.

(a) In the station PLC panel, Station PLC2 (SPLC2) and Station PLC34 (SPLC34) are identical Modicon Compact A984-145 series PLCs configured to operate in a quasiredundant hot/standby configuration, where both PLCs execute logic concurrently with the Regional

SCADA system communicating only to the primary SPLC under normal operating conditions. If a failure occurs communicating to the primary SPLC, the Regional SCADA system will switch the route to communicate with the secondary SPLC.

(i) The primary SPLC2 and secondary SPLC34 pair function as Station Master PLCs that are responsible for monitoring the two-speed pump statuses, pump control by starting and stopping required two-speed pumps via operator command, as well as all other station functions such as reservoir level monitoring, surge tower control and alarms.

(ii) In addition, the Station Master PLCs transmit permissives, statuses, and data to/from the UV Master PLC, via the Modbus Plus network, to ensure coordinated operation of UV and booster pump station systems.

(b) The remaining two (2) PLCs in the station PLC panel, PLC11 and PLC12, are Modicon Compact A984-145 series PLCs that function as I/O PLCs, as they are responsible for collection of digital and analog I/O from all other station devices and instrumentation other than the pumps.

3.3.1.3 The Station Master PLCs do not have any local I/O. They obtain pump and station device I/O, required for control and monitoring of pumps and station functions, from the individual pump PLCs and I/O PLCs via Modbus Plus communications.

3.3.1.4 The Deacon Chemical Feed Facility has a chemical feed PLC panel with a single PLC. The Deacon Chemical Feed Facility PLC panel houses a Modicon Quantum 140-113 series Chemical Feed PLC (PLC24), which is responsible for the control and monitoring of fluoride and phosphate dosing.

(a) Chemical dosing is proportionally controlled based on water flow from the Deacon Booster Pumping Station. Water flows required for chemical dosing are written directly from the Regional SCADA system to Chemical Feed PLC, there is no direct transmission of process information and/or data between the Station Master and Chemical Feed PLCs.

(b) The Chemical Feed PLC is also responsible for monitoring Deacon Chemical Feed Facility equipment and services such as chemical tanks, analyzers, and facility alarms.

3.3.2 UV Control System Architecture

3.3.2.1 The UV system located in the Deacon Booster Pumping Station consists of six (6) UV reactors responsible for UV treatment of all finished water flow to the Regional Pumping Stations.

3.3.2.2 Each reactor has a LCP for control and monitoring of the reactor which contains: a dedicated Modicon Quantum 140-434 series Reactor PLC (UVR PLC); local pump I/O; and a Pro-Face Digital touchscreen HMI.

3.3.2.3 In addition to the LCPs for the UV reactors, the Deacon Booster Pumping Station has a UV PLC panel that contains a hot/standby PLC pair. In the UV PLC panel, UV Master PLC1 (UVM PLC1) and UV Master PLC33 (UVM PLC33) are identical Modicon Quantum 140-671 series PLCs configured to operate in a fully redundant hot/standby configuration, where the hot PLC executes logic and transmits operating data to the standby PLC. If a failure occurs with the hot PLC, the logic execution is taken over immediately by the standby PLC.

3.3.2.4 The primary UVM PLC1 and secondary UVM PLC33 pair function as UV Master PLCs that are responsible for monitoring reactor statuses, reactor control by starting and stopping required reactors via a UV sequencer, as well as other UV and station functions such as station emergency shutdown protection, station flow control, and alarms.

3.3.2.5 The UV Master PLCs share common local I/O, which they access via remote I/O also located in the UV PLC panel. In addition, the UV Master PLCs transmit permissives, statuses, and data to/from the Station Master PLCs, via the Modbus Plus network, and the D21 PLC, via the Ethernet network, to ensure coordinated operation of UV, Deacon Booster Pumping Station, and WTP systems.

3.3.2.6 The UV Master PLCs use both their local I/O along with permissives, statuses and I/O they obtain from the Reactor, Station Master and D21 PLCs, to control and monitor the UV system and some Deacon Booster Pumping Station equipment and functions.

3.3.3 D21 PLC System Architecture

3.3.3.1 The D21 PLC system in the Deacon Booster Pumping Station consists of two (2) variable speed electric pumps responsible for providing all or part of the desired water flow to the Regional Pumping Stations.

3.3.3.2 Each pump has a LCP for control and monitoring of the pump which contains local pump I/O and a Telemecanique Magelis touchscreen HMI.

3.3.3.3 In addition to the LCPs for the pumps, the Deacon Booster Pumping Station has a D21 PLC panel that houses a hot/standby PLC pair. In the D21 PLC panel, D21 PLC1 and D21 PLC33 are identical Modicon Quantum 140-671 series PLCs configured to operate in a fully redundant hot/standby configuration, where the hot PLC executes logic and transmits operating data to the standby PLC. If a failure occurs with the hot PLC, the logic execution is taken over immediately by the standby PLC.

3.3.3.4 The primary D21 PLC1 and secondary D21 PLC33 pair are responsible for monitoring the variable speed pump statuses, pump control by starting and stopping required variable speed pumps via operator command, as well as all other functions such as clearwell level monitoring and alarms. In addition, the D21 PLCs transmit permissives, statuses and data to/from the UV Master PLCs, via the Ethernet network, to ensure coordinated operation of UV, Deacon Booster Pumping Station, WTP systems.

3.3.3.5 The D21 PLCs use both their local I/O along with permissives, statuses and I/O they obtain from the variable speed pump LCPs, via remote I/O, and UV Master PLCs to control and monitor the variable speed pumps along with some Deacon Booster Pumping Station equipment and functions.

3.4 Communication

3.4.1 The Station UV and D21 PLC control systems within the Deacon Booster Pumping Station and the Deacon Chemical Feed Facility vary in design with regard to the communication networks used to transmit process information such as I/O, permissives, commands, and data.

3.4.2 Further, the communication networks used by these three (3) control systems are interconnected, as noted earlier, for the purpose of transmitting permissives, statuses, and data between the Station Master, UV Master, and D21 PLCs to ensure coordinated operation of the UV system, Deacon Booster Pumping Station, and WTP systems.

3.4.3 Station Control System Communication

3.4.3.1 The station control system uses a communications network similar in design to that of the Regional Pumping Stations. The Station Master, Pump, I/O, and Chemical Feed PLC that are part of the station control system are connected via a Modbus Plus network setup in a line configuration with a terminating end resistor.

(a) The Modbus Plus network connects the PLCs (Pump, Station Master, Chemical Feed, and I/O), a Modicon BM85 Bridge Multiplexer module, and a Modicon Modbus+/Ethernet Bridge. In addition, the UV Master PLC resides on this Modbus Plus network to transmit permissives, statuses, and data to/from the Station Master PLCs.

(b) The Modbus+/Ethernet Bridge allows the Regional SCADA system to communicate with the Station Master, Chemical Feed and UV Master PLCs as well as Bently Nevada units, via Ethernet WAN, for remote control and monitoring of the Deacon Booster Pumping Station and the Deacon Chemical Feed Facility.

(c) The BM85 Bridge Multiplexer allows the Regional SCADA system to communicate with Modbus devices, such as the Bently Nevadas, over the Modbus Plus network.

(d) The BM85 Bridge Multiplexer also acts as the tie in point for radio communications, which serves as the backup communications medium for the Regional SCADA system to devices such as the Station Master PLCs in the event of a failure of the Ethernet WAN or Modbus+/Ethernet Bridge.

3.4.4 UV Control System Communication

3.4.4.1 The UV control system uses a Modbus Plus communications network that connects the UV Master and Reactor PLCs, as well as an RSView HMI workstation. Much like the station control system, the Modbus Plus network for the UV control system is a line topology with a terminating end resistor.

3.4.4.2 The UV Master PLCs transmit permissives, statuses, and data to/from the individual Reactor PLCs on the Modbus Plus network, while the RSView HMI workstation allows the UV SCADA system to control and monitor the UV system directly over the Modbus Plus network. The UV Master PLCs are also connected to the Modbus Plus network for the station control system, as noted earlier, to transmit permissives, statuses, and data to/from the Station Master PLCs.

3.4.4.3 In addition, the UV Master PLCs are connected to the Ethernet networks of both the Regional SCADA and WTP SCADA systems.

3.4.4.4 The Regional SCADA and UV SCADA servers/clients access the UV Master PLCs for remote control and monitoring purposes, via the Modbus+/Ethernet Bridge, which bridges the station control system Modbus Plus network and the Regional SCADA Ethernet WAN.

3.4.4.5 The UV Master PLCs reside directly on the WTP SCADA Ethernet network as they are equipped with Quantum NOE modules.

3.4.4.6 WTP SCADA servers/clients and the D21 PLCs connect directly to the UV Master PLCs via the WTP SCADA Ethernet network, for the purpose of remote control and monitoring of the UV system, as well as transmission of permissives, statuses, and data to/from the UV Master PLCs.

3.4.5 D21 PLC System Communication

3.4.5.1 The D21 PLC control system communications network is a hybrid of remote I/O and Ethernet communications.

3.4.5.2 The pump LCPs for the variable speed pumps contain remote I/O drops that are directly connected to a remote I/O head located in the D21 PLC panel. All local pump I/O for both variable speed pumps are transmitted to the D21 PLCs via this remote I/O connection, for remote control and monitoring of the variable speed pumps.

3.4.5.3 The Telemecanique Magelis touchscreen HMIs in the variable speed pump LCPs have built-in Ethernet cards and the D21 PLCs are equipped Quantum NOE modules, which are all directly connected to the WTP SCADA Ethernet network.

3.4.5.4 Local control of the variable speed pumps from the touchscreen HMIs is achieved via the direct Ethernet links from the HMIs to the D21 PLCs. WTP SCADA servers/clients and UV Master PLCs also connect directly to the D21 PLCs via the WTP SCADA Ethernet network, for the purpose of remote control and monitoring of the variable speed pumps, as well as transmission of permissives, statuses, and data to/from the D21 PLCs.

4 Shoal Lake Intake Facility

4.1 Overview

4.1.1 The primary task of the control system at the Shoal Lake Intake Facility is to provide basic control functions and monitoring of various systems, buildings, and operational conditions at the Shoal Lake Intake Facility and Aqueduct Solar sites.

4.1.2 The control system primarily monitors equipment status and alarm conditions for the various Intake and Aqueduct systems and buildings. These monitored statuses and alarms, such as building intrusion, electrical faults, PLC faults, equipment statuses, and communications alarms, are enunciated by HMIs located in the Intake Control Room, Staffhouse, and residences, for operator notification and action.

4.1.3 In addition, the control system provides basic control and monitoring functions such as the Emergency Remote Chlorine Shutdown system, alarm setpoint control for aqueduct and chlorine mass flows, and monitoring of aqueduct levels, lake levels, and valve positions.

4.2 Hardware and PLC Programming

4.2.1 The control system at the Shoal Lake Intake Facility is a PLC based architecture with supporting touchscreen and PC based HMIs for operator monitoring, alarm annunciation, and acknowledgement. The existing PLC hardware consists of Modicon Compact series PLCs with E984-255 and A984-145 processors.

4.2.2 The PLC control logic is implemented in Modicon 984 ladder logic and was originally programmed using ProWorx programming software. The PLC control logic has been converted to FasTrak Softworks PLC Workshop for Modicon (32-bit) programs since the original implementation.

4.2.3 There are two (2) types of HMI hardware used at the Shoal Lake Intake Facility: GE QuickPanels touchscreens and a Microsoft Windows based PC. The GE QuickPanel HMI software was developed with QuickDesigner software while the PC based HMI was developed with CitectSCADA.

4.2.4 While the current PLC hardware and control logic continues to function as designed, it is reaching the end-of-life in terms of spare parts availability.

4.2.5 Both the touchscreen and PC HMI hardware continue to be supported and spare parts readily available. However, the two (2) systems use disparate development tools that require duplication of effort when HMI software modifications are required.

4.3 Control System Architecture

4.3.1 The Shoal Lake Intake Facility control system consists of eleven PLCs comprised of a Station PLC pair in the Intake Control Room Panel and nine (9) PLCs distributed throughout the Shoal Lake Intake Facility site, each dedicated to a specific operational area.

4.3.2 Similar to the Regional Pumping Stations, Station PLC1 (SPLC1) and Station PLC33 (SPLC33) are identical Modicon Compact E984-255 series PLCs configured to operate in a quasi-redundant hot/standby configuration, where both PLCs execute logic concurrently with the Regional SCADA system communicating only to the primary SPLC under normal operating conditions. If a failure occurs communicating to the primary SPLC, the Regional SCADA system and Intake HMIs will switch the route to communicate with the secondary SPLC.

4.3.3 The primary SPLC1 and secondary SPLC33 pair function as Station Master PLCs responsible for collecting I/O, via Modbus Plus communications, from the nine (9) PLCs distributed throughout the Shoal Lake Intake Facility site. The Station Master PLCs use the collected I/O to provide operational data and alarms, as well as basic control functions, to the Regional SCADA system.

4.3.4 The remaining nine (9) PLCs are Modicon Compact A984-145 series PLCs, located in panels throughout the Shoal Lake Intake Facility site, include the following:

(a) Standby Generator PLC (PLC23);

(b) Transfer Switch PLC (PLC24);

(c) Acid Building PLC (PLC25);

(d) Chlorine Building PLC (PLC26);

(e) De-Chlorination PLC (PLC27);

(f) Electrical Room PLC (PLC28);

(g) Pump Room PLC #1 (PLC29);

(h) Pump Room PLC #2 (PLC30); and

(i) Domestic Water Pumps PLC (PLC31).

4.3.5 These nine (9) PLCs are responsible for basic control functions, as well as collection of digital and analog I/O from devices and instrumentation in their specific operational area which is written to both Station Master PLCs.

4.3.6 The Station Master PLCs do not have any local I/O. They obtain station device I/O, required for control and monitoring of Shoal Lake Intake Facility and Aqueduct Solar site functions, from the nine (9) PLCs noted above via Modbus Plus communications.

4.3.7 The control system at the Shoal Lake Intake Facility has six (6) HMIs used by operators for control and monitoring of the various operational areas of the Shoal Lake Intake Facility and Aqueduct Solar sites.

4.3.7.1 The Intake Control Room houses one QuickPanel touchscreen HMI located in the Intake Control Room Panel and a CitectSCADA PC HMI at the control room desk. Both of the Intake Control Room HMIs provide operators: basic control functions such as setpoint entry; displays operational information such as aqueduct flows and equipment statuses; and alarm annunciation and acknowledgement.

4.3.7.2 The other four (4) HMIs are QuickPanel Junior touchscreens located in the Staffhouse and residences. The QuickPanel Junior HMIs only provide alarms annunciation and the ability to silence the local alarm buzzer in the location of the HMI.

4.4 Communication

4.4.1 The Station Master and nine (9) area PLCs at the Shoal Lake Intake Facility are connected via a Modbus Plus network setup in a ring configuration. The Modbus Plus network connects the Station Master PLCs, nine (9) area PLCs, a Quickpanel touchscreen HMI, a Modicon BP85 Bridge Plus module, a Modicon BM85 Bridge Multiplexer module, and a Modicon Modbus+/Ethernet Bridge.

4.4.2 The Modbus+/Ethernet Bridge allows the Regional SCADA system and Citect SCADA HMI to communicate with the Station Master PLCs, via Ethernet WAN, for remote control and monitoring of the Shoal Lake Intake Facility.

4.4.3 The BM85 Bridge Multiplexer allows the Staffhouse and residence Quickpanel Junior touchscreen HMIs and Aqueduct Solar sites to connect to the Modbus Plus network.

4.4.4 In addition, the BM85 Bridge Multiplexer allows the Regional SCADA system and CitectSCADA HMI to communicate with Modbus devices over the Modbus Plus network and acts as the tie in point for radio communications, which serves as the backup communications medium for the Regional SCADA system to devices such as the Station Master PLCs in the event of a failure of the radio TCP/IP link to McPhillips Control Centre or the Modbus+/Ethernet Bridge.

4.4.5 The BP85 Bridge Plus connects the two (2) ends of the Modbus Plus network ring and is intended to allow the Modbus Plus network to continue operation even with a single break in the network ring