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APPENDIX 'C' – PROCESS CONTROL NARRATIVE

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CITY OF WINNIPEG

Process Control Narrative and Requirements

Riverbend Lift Pumping Station

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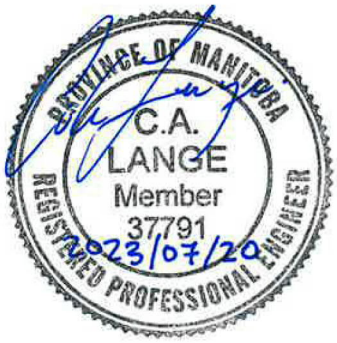
Revision History

ENGINEER'S SEAL



Revision History

Rev. #	Description	Date	By
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1.0 General

1.1 Overview

The Riverbend Lift Station is a separate wet well and dry well arrangement. Wastewater enters the wet well through one influent pipe from the exterior of the building. The drywell contains two wastewater pumps, manual control valves and instrumentation. Additionally, the Riverbend Lift Station contains Combined Sewer Overflow (CSO) instrumentation. The Lift Station, including the CSO instrumentation, is monitored via the City of Winnipeg's SCADA system.

The control system for the Riverbend Lift Station shall consist of a main Programmable Logic Controller (PLC), Operator Graphic Interface (OGI), Remote Terminal Unit (RTU) interface cards, and a City operated Clearview SCADA system and modem.

It is expected that in the development of the Lift Station Control Logic, the information provided in the Project Drawings, Appendix A – DNP3 PLC Input/Output (I/O) Index and Appendix B – Instrumentation Index shall be utilized. In combination with this Process Control Narrative, all four documents will be living documents updated throughout the lifecycle of the Lift Station. Any deviations or changes made to the Station shall be recorded and updated in the relevant documentation.

1.2 Shared Requirements

The following control logic requirements are shared requirements for each of the sections within this Process Control Narrative.

1. PLC control logic shall be developed using Derived Data Types (DDT), function block programming language and custom function blocks.
2. I/O signals shall be mapped from the fixed X80 I/O Variable Tags to internal PLC tags. This shall be completed using a custom MOVE function block.
3. Discrete input signals shall be programmed using de-bounce logic. The time delay shall be adjusted throughout commissioning but shall start with a half (0.5) second.
4. PLC and OGI Variable and Internal Tag Names shall follow the requirements set out in the most recent version of the City of Winnipeg Identification Standard.
5. Additional alarm signals shall be added during commissioning as identified by the City of Winnipeg and the Contract Administrator. All alarm logic shall be programmed in the PLC, not the OGI. The various alarm set points shall be programmed in accordance with this Process Control Narrative and Appendix A – DNP3 PLC I/O Index.

1.3 Discrete Alarming Requirements

All discrete alarms shall be programmed using a Digital Alarm Derived Function Block (DFB). The Digital Alarm DFB shall be capable of accepting the discrete input and generating an alarm output. Additionally, the DFB shall have the ability to:

1. Reset the alarm output;
2. Set the alarm to Latching or Non-latching;
3. Provide an adjustable alarm delay timer; and
4. Enable or Disable the alarm.

1.4 Analog Alarming Requirements

All analog alarms shall be programmed using an Analog Alarm DFB. The Analog Alarm DFB shall be capable of accepting an analog input and generating multiple alarm outputs. Additionally, the DFB shall have the ability to:

1. Reset the alarm output;
2. Set the alarm to Latching or Non-Latching;
3. Provide and adjustable alarm delay timer;
4. Enable or Disable the alarm;
5. Provide adjustable set points for Low-low, Low, High, and High-High alarm outputs; and
6. Provide and adjustable dead-band set point.

2.0 General Automation and Control

2.1 Heartbeat

The PLC shall be programmed with a "Heartbeat":

- The PLC shall increment a register named "PLC_Heartbeat" every one (1) second to a set maximum value (e.g., 32767), at which point it shall reset to zero and then continue to increment; and
- The register shall be monitored by the City of Winnipeg's SCADA system.

2.2 DNP3 Event Generation

The CSO instrumentation at the Riverbend Lift Station requires On-Demand DNP3 event generation. The NOR card shall be required to send all DNP3 events to the SCADA system every one (1) minute regardless of the change in data (i.e., even if point values have not changes, a new DNP3 event shall be sent).

2.3 Alarms

Alarm reset shall be available on the OGI and the SCADA system and operate as follows:

1. To reset alarms from SCADA, one (1) DNP3 Digital Output (Reset Command) and two (2) DNP3 Digital Inputs (Reset Status) and (ECHO -- Reset Command) are needed.
   1.1. SCADA will send a "Reset Command" signal to the NOR card, and the PLC will need to activate the reset. The PLC will also need to control a DNP3 digital input "Reset Status" status signal to ON that will signify that the Reset is activated. Then, the PLC will change the status of "Reset Command" from state 1 to 0 after a short time delay.
   1.2. After another short time delay, the PLC will then deactivate the reset and change the "Reset Status" status signal to OFF.
   1.3. The DNP3 Digital Input "ECHO -- Reset Command" is mirrored from the DNP3 Digital Output "Reset Command".

The following alarm signals shall be programmed for the General Control.

Alarm Name	Alarm Logic	Reset Mode
Loss of Communication	Each item shown in the Riverbend Lift Station Network Diagram shall have a loss of communication alarm. When communication with the device over the Ethernet Network is lost for a period of ten (10) seconds, an alarm shall be raised.	Auto

3.0 Pump Automation and Control

3.1 Wastewater Pump Control

The pump control configuration shall operate as a Lead/Lag parallel system. A maximum of two (2) wastewater pumps shall operate at a time. The pumps shall have the ability to run in both Alternating and Non-Alternating Mode as described in the following section. The Lead/Lag Pump designation shall only select in-service, non-faulted and available pumps in "Local Automatic" mode.

The START and STOP pump control shall be based on the wet well level as measured by level/pressure transmitters LIT-L100-1 and LIT-L100-2. The pump control level set points are as follows:

- Start Lead Pump: 1.379 metres (m)
- Start Lag Pump: 1.529 m
- Stop Lead Pump: 0.459 m
- Stop Lag Pump: 0.919 m

Level control set points shall be adjustable from the OGI and the City of Winnipeg SCADA system. The final settings shall be determined by the Contract Administrator during commissioning. The control program shall be designed such that only safe, correct, and logical level control set points are accepted. Each set point above shall have a minimum and maximum allowable set point of ±0.5 m but no less than 0.36 m and no more than 1.859 m.

The lift pumps are operated by Variable Frequency Drives (VFD) programmed to run at a fixed speed. The ramp up and ramp down time shall be set at ten (10) seconds and adjusted during commissioning. The control logic for the VFDs shall utilize a Variable Frequency Drive DFB with adjustable parameters accessible to operations staff.

3.1.1 Alternating and Fixed Duty Modes

The pumps within the Lift Station shall have the ability to run in Alternating Mode and in Non-Alternating (Fixed Duty) Mode. The mode selection shall be available on the OGI as well as the SCADA system.

1. When Alternating Mode is selected, the Lead/Lag Pump designations shall cycle through the two (2) wastewater pumps after each start/stop cycle.
2. When Fixed Duty Mode is selected, the Lead/Lag Pump designation will only change should a pump become no longer available.

In both scenarios, the PLC shall allow the pump that is currently running to complete its cycle and pump down the wet well. At no point should the PLC stop a pump in order to change the Lead/Lag designation.

3.1.2 Control Modes

The lift pumps shall be controlled via Local Manual, Local Automatic and Remote Manual operation.

- Local Manual Mode:
  - Local manual mode shall start when the Hand-Off-Auto (HOA) Switch is in the "Hand" position, the pump is "Ready", and the "Start" button is pressed.
  - Manual operation shall stop when the "Stop" button is pressed, the HOA is moved to the "Off" or "Auto" position, the pump is no longer "Ready", or an emergency stop is activated.
  - The speed shall be adjustable by using a panel mounted speed control potentiometer when in local manual mode.
- Local Automatic Mode:
  - Local automatic mode shall start when the HOA switch is in "Auto" mode and the PLC Auto/Manual mode selection is set to "Auto".
  - The Lead pump shall start when the first high level set point in the wet well has been reached and it shall run until the wet well reaches the corresponding low level set point.
  - The Lag pump shall start when the second high level set point in the wet well has been reached and it shall run until the wet well reaches the corresponding low level set point.
  - The pumps shall run at a fixed speed that is adjustable from both the OGI and the City of Winnipeg SCADA system.
- Remote Manual Forward Mode:
  - Remote manual operation shall start when the HOA switch in "Auto" mode and the PLC Auto/Manual mode selection is set to "Manual".
  - The pump shall start when the OGI sends the "RUN FWD" command, the RTU asserts the "ECHO – RUN FWD" input, and the PLC activates the start forward output.
  - The pump shall stop when the OGI sends the "STOP" command, the RTU asserts the "ECHO – STOP" input, and the PLC deactivates the start forward output.
  - The pumps shall run at a fixed speed that is adjustable from both the OGI and the City of Winnipeg SCADA system.
- Reverse Mode:
  - The reversing function shall be programmed such that it is only accessible and initiated through the PLC clean-in-place/backflush cycle. There shall be no other method of running the pumps in reverse outside of this backflush cycle.
  - The clean-in-place/backflush cycle will be adjustable from either the OGI or SCADA system as outlined in the "Pump Backflush Cycle" section.

3.1.3 Pump Available

The Pump "Available" logic shall be determined by the following:

- The pump motor has power;
- The pump VFD alarm is not present;

- The pump overload (O/L) alarm is not present;
- None of the three (3) emergency stop pushbuttons are active;
  - In other words, if pump "Ready" is active.
- The pump "Failed to Start" alarm is not present; and
- The pump is in "Local Automatic" mode.

3.1.4 Pump In-Service

The pump "In Service" logic shall be determined by the pump station PLC and monitored by the SCADA system using the DNP3 communication. It shall operate as follows:

- Out of Service – Operations will set a pump as "OUT OF SERVICE" by the use of a button on the OGI. The PLC will set a variable "IN SERVICE STATUS" to OFF that will signify that the pump is out of service. The SCADA system will monitor the "IN SERVICE STATUS" variable.
- In Service – when the pump needs to be placed back into service, Operations will set the pump as "IN SERVICE" by the use of a button on the OGI. The PLC will set the "IN SERVICE STATUS" variable to ON that will signify that the pump is back in service. The SCADA system will monitor the "IN SERVICE STATUS" variable.

3.1.5 Level Control in Precision Digital Level Control Mode

Pump control will default to the Precision Digital Controllers in the case of a PLC failure. All scenarios in which the PLC drops the "PLC Mode" output will cause the system to fall back on the Precision Digital controllers.

3.1.6 Pump Backflush Cycle

The pump backflush cycle will be programmed as follows:

- The operator will set the desired backflush time by adjusting the backflush cycle timer on the OGI or SCADA system.
- The backflush speed set point shall be a fixed value as determined during Commissioning and adjustable only through a password protected input on the OGI. The input shall not accept values outside of a minimum and maximum allowable range.
- The operator will then press the "Backflush Cycle Initiate" button and the selected pump will go through the following sequence:
  - The pump is requested "out-of-service".
  - The pump is commanded to run in reverse for the amount of time as indicated by the backflush timer.
  - The pump is commanded to stop.
  - The pump is requested back "in-service".

- During this sequence the "Backflush Cycle Initiate" button should be greyed out and the OGI or SCADA should indicate that the cycle is taking place. Following the cycle the "Backflush Cycle Initiate" button should be made available.

3.2 Level Monitoring

The level in the wet well is measure by two (2) level/pressure transmitters LIT-L100-1 and LIT-L100-2. The measured wet well level shall be determined by the following three (3) modes:

- Control signal is from LIT-L100-1;
- Control signal is from LIT-L100-2; or
- Control signal is the average of LIT-100-1 and LIT-100-2.

The three (3) level measuring modes shall be selectable via the OGI and the SCADA system using "SELECT AVERAGE, SELECT LIT-L100-1 or SELECT LIT-100-2" commands. When a transmitter has faulted, the PLC should utilize the healthy transmitter for control regardless of the selection. On a PLC reset (e.g., loss of power or cold start) a default selection should be made without requiring operator interaction.

3.3 Alarms

The following alarm signals shall be programmed for the Wastewater Pump Control.

Alarm Name	Alarm Logic	Reset Mode
Pump – Fail to Start	Pump start forward or start reverse active output active for five (5) seconds without receiving the running status input.	Latched
Pump – Fail to Stop	Pump start signal inactive for five (5) seconds without the running status input going low.	Latched
Pump – VFD Fault	VFD Fault input received from the VFD.	Latched
Pump – Bypass Overload Fault	Overload Fault input received from the MCC circuit.	Latched
Pump – Low Flow	Pump running in "Local Automatic" mode and flow less than 80% for one (1) pump running and less than 50% when two (2) pumps running.	Auto
Pump – Seal Water Alarm	Pump is running and seal water flow switch indicated a loss of flow for two (2) seconds or the pump is not running and the seal water flow switch indicates flow for two (2) seconds.	Latched
Pump – High Temperature	Pump bearing RTDs indicate temperature above high alarm set point.	Latched
Pump – High Vibration	Pump vibration sensors indicate a vibration reading above the high alarm set point.	Latched
Motor – High Temperature	The motor winding RTDs indicate a temperature above the high alarm set point.	Latched

Alarm Name	Alarm Logic	Reset Mode
Motor – High Vibration	The motor vibration sensors indicate a vibration reading above the high alarm set point.	Latched
Pump – No Pump in "Local Automatic Mode"	Neither pump is in "Local Automatic Mode".	Auto
Pump – Only 1 Pump in "Local Automatic Mode"	Only one (1) pump is available in "Local Automatic Mode".	Auto

4.0 Building Systems Automation and Control

4.1 HVAC System Interlocks

The HVAC system within the Riverbend Lift Pumping Station will be interlocked with the Main Floor Light Switch. When the Main Floor Light Switch is turned on, indicating occupancy in the building, the HVAC system shall be run at 100%.

- Station occupancy is set to high as determined by the Main Floor Light Switch (HS-L600);
- The main floor light switch sends a signal to TIC-L600 to provide damper controls as well as to the Station PLC to indicate "Station Occupied";
- The Main Floor HVAC Controller (TIC-L600) commands the dampers to provide 100% Fresh Air; and
- When the signal is deactivated, and the station is not occupied, TIC-L600 commands the Dampers to provide 25% fresh air and 75% recirculation air.

4.2 HVAC Control

The Station's HVAC control is through two (2) independent HVAC Controllers TIC-L600 and TIC-L680. The Main Floor HVAC Controller (TIC-L600) controls the dampers as well as the Main Level Duct Heater (HCE-L60). The Motor Room HVAC Controller (TIC-L680) controls the Motor Room Duct Heater (HCE-L68). Both controllers operate in a similar fashion by accepting a sensor input to control a 0-10V output.

4.3 Alarms

The following alarm signals shall be programmed for the Building Systems.

Alarm Name	Alarm Logic	Reset Mode
Station – Seal Water Loss	Station pressure switch (PSL-526) indicated low pressure for five (5) seconds.	Auto
Station – Flow Transmitter Fault	Flow transmitter input fault is received by the PLC.	Latched
Station – Room Low Temperature	Station temperature drops below the low alarm set point.	Auto
Station – Room High Temperature	Station temperature rises above the high alarm set point.	Auto
Station – Doors Open	Station door contacts (ZSC-L531, -L532) fail-safe signal is lost for a period of one (1) hour.	Auto
HVAC – Air Filter Plugged	HVAC Air Filter Plugged Switch signal is high for a period of ten (10) minutes.	Latched

Alarm Name	Alarm Logic	Reset Mode
HVAC – Low Air Flow	HVAC Low Flow Switches signals are high for a period of one (1) minute.	Auto
HVAC – Supply Fan Off	When either Supply Fan SF-L66 or Supply Fan SF-L67 running control relay is low.	Auto
Wet Well – High Level, Analog	The wet well level reading from the analog level transmitter exceeds the high alarm set point.	Auto
Wet Well – High Level, Discrete	The wet well high level float switch indicates and alarm condition for five (5) seconds.	Auto
Wet Well – High High Level	The wet well high high level float switch indicates an alarm condition for five (5) seconds.	Latched
Wet Well – Level Transmitter Variance	Level transmitter signals differ by more than 15% of full range.	Auto
Dry Well – Pump Room Flood	Dry well float switch in the Pump Room is activated for five (5) seconds.	Latched
Dry Well – Communitor Chamber Flood	Dry well float switch in the Communitor Chamber is activated for five (5) seconds.	Latched
Electrical – UPS Power Fail	UPS indicates an alarm condition.	Latched
Electrical – 24VDC Power Fail	Either power supply within the Main Control Panel has lost their fail-safe status for three (3) seconds.	Latched
Electrical – 120VAC Power Fail	The 120VAC power control relay loses fail-safe signal for three (3) seconds.	Latched
Electrical – 600VAC Power Fail	The MCC power monitoring relay loses fail-safe signal for three (3) seconds.	Latched

5.0 Operator Graphic Interface

5.1 Overview

The main control panel at Riverbend Lift Station shall include an OGI. Screens shall be made to display:

- An overview of the station and process flow diagram;
- Display of all instrumentation signals;
- Set-point adjustment graphic screens and pop-ups;
- Instrumentation calibration graphics screen;
- An Active alarm banner and historical alarm screen; and
- Individual trend screens for all instrumentation and pump signals. Trend screens shall be configurable to have multiple pens.

The following symbol colours shall be used for all pumps, devices, and instrumentation at the station when displayed on the OGI:

- Running: Red
- Stopped: Green
- Alarm: Magenta

All equipment and instrumentation shall make use of graphic screen pop-ups where variables and set-points can be altered and adjusted by Operations personnel.

5.2 OGI Screen Requirements

The following screens shall be created for the OGI. This following list is not exhaustive and additional screens shall be create as required.

1. Alarm Banner;
2. Historical Alarms Screen;
3. Process Overview:
   - 3.1. Pumps and motors; and
   - 3.2. Process instrumentation including flow, pressure and temperature.
4. Station Overview:
   - 4.1. HVAC equipment, damper status, room temperatures and supply fan run status; and
   - 4.2. Door Contact and Station Occupied status.
5. Station Electrical Overview:
   - 5.1. MCC and power status; and
   - 5.2. PLC Rack Health and Networking Status.

6.0 City of Winnipeg Clearview SCADA

6.1 City SCADA Interface

The Contractor shall ensure and integrate SCADA control within the Riverbend Lift Station in conjunction with the City of Winnipeg. The overall SCADA system configuration shall be done by the City of Winnipeg. However, the Contractor shall be required to duplicate any functionality required by the DNP3 mapping list for the SCADA system as well as any requirements for the DNP3 communication protocol.