Control Narrative

Government of Canada
Innisfail Dog Training Facility
Water and Sewer System
Upgrades

Prepared for:
Government of Canada

Prepared by:
Stantec Consulting Ltd.

April 1, 2016

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Table of Contents

1.0 INTRODUCTION ............................................................................................................. 1
1.1 DESCRIPTION .................................................................................................................. 1
1.2 ABBREVIATIONS ............................................................................................................. 1

2.0 SYSTEM CONTROL ......................................................................................................... 1
2.1 OVERVIEW ..................................................................................................................... 1
2.2 CONTROL PHILOSOPHY ............................................................................................... 1
2.3 OPERATING PHILOSOPHY .......................................................................................... 2
  2.3.1 Non-Potable Water System ........................................................................... 2
  2.3.2 Potable Water System .................................................................................... 3
  2.3.3 Wastewater Treatment System (WWTS) ....................................................... 5
2.4 GENERAL ALARM – POTABLE/NON-POTABLE WATER SYSTEMS ......................... 7
1.0 INTRODUCTION

1.1 DESCRIPTION

The Control Narrative describes the control philosophy and lists the variables used in the control program. The variables include parameters measured by field instruments; status signals from pumps, valves and other equipment; and information passed between the field instruments, equipment, and the smart relay. The Control Narrative establishes the requirements for the programs of the system.

1.2 ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AI</td>
<td>Analog input to a device</td>
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<td>AIT</td>
<td>Analog Indicating Transmitter</td>
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<tr>
<td>AO</td>
<td>Analog output from a device</td>
</tr>
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<td>CHEM</td>
<td>Chemical dosing system</td>
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<td>CP</td>
<td>Control Panel</td>
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<td>DI</td>
<td>Digital input to a device</td>
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<td>DO</td>
<td>Digital output from a device</td>
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<tr>
<td>ESD</td>
<td>Emergency Shutdown Device</td>
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<td>FCV</td>
<td>Flow Control Valve</td>
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<tr>
<td>FIT</td>
<td>Flow Indicating Transmitter</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>HP</td>
<td>Horse Power</td>
</tr>
<tr>
<td>IJB</td>
<td>Instrumentation Junction Box</td>
</tr>
<tr>
<td>kPa</td>
<td>Kilopascals</td>
</tr>
<tr>
<td>L</td>
<td>Liter</td>
</tr>
<tr>
<td>L/R</td>
<td>&quot;Local Remote&quot;</td>
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<tr>
<td>LCP</td>
<td>Local Control Panel</td>
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<tr>
<td>LIT</td>
<td>Level Indicating Transmitter</td>
</tr>
<tr>
<td>LSH</td>
<td>Level Switch High</td>
</tr>
<tr>
<td>LSHH</td>
<td>Level Switch High High</td>
</tr>
<tr>
<td>LSL</td>
<td>Level Switch Low</td>
</tr>
<tr>
<td>LSLL</td>
<td>Level Switch Low Low</td>
</tr>
<tr>
<td>N/A</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>OI</td>
<td>Operator Interface</td>
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<tr>
<td>PID</td>
<td>Proportional Integral Derivative</td>
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<tr>
<td>PSV</td>
<td>Pressure Sustaining Valve</td>
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<tr>
<td>PWDS</td>
<td>Potable Water Distribution System</td>
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<tr>
<td>UPS</td>
<td>Uninterruptable Power Supply</td>
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<tr>
<td>WTS</td>
<td>Water Treatment System</td>
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<td>WWTS</td>
<td>Wastewater Treatment System</td>
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2.0 SYSTEM CONTROL

2.1 OVERVIEW

The Police Dog Services Training Center (PDSTC) upgrades have been designed to increase the supply and flow of the potable water system servicing all buildings and to provide a functional WWTS. As part of the system requirements, a new raw water well, WTS, septic tank, effluent dosing tank, and subsurface disposal field shall be installed in accordance with regulatory standards in Alberta.

This document describes the control of the PDSTC water and wastewater systems. The pumps and field instruments, in conjunction with a smart relay, will control the process of providing potable water throughout the site based on the integration of the various field instruments and the system requirements.

The site’s smart relay (mounted in the Water Treatment Shed-CP) monitors process variables such as tank levels, valve positions, pump status information, pressure indication, flow indication, and control panel selectors. Field alarms and faults (such as high level, low level or pump/system faults) will be visually displayed on the local control panels and on the Water Treatment Shed by an indicating strobe.

Unless otherwise stated, the default position of a FCV in this document is the closed position. If, for example, a list of valves is stated to be open, by default the remaining valves that were not mentioned in the list are closed. The default position of any level switch shall be failsafe and in the normally closed position when not in the energized state.

As part of the system requirements, the potable water and waste water systems shall be supplied only from power sources that are connected to the emergency generator network on site.

2.2 CONTROL PHILOSOPHY

The control system has three main goals:

- Supply raw water to maintain the fire water storage tank and potable water storage tank levels;
- Treat and provide sufficient potable water at a stable pressure to connected buildings;
- Provide primary treatment of sewage and dispose of clarified wastewater to a subsurface field.

The facility’s upgraded water system design consists of three main networks:

- Non-potable water system (including existing fire network)
- Potable water treatment and distribution system
- Wastewater treatment system
CONTROL NARRATIVE

System Control
April 1, 2016

2.3 OPERATING PHILOSOPHY

2.3.1 Non-Potable Water System

The existing non-potable water system consists of a water supply from the onsite Raw Water North and South Wells (WELL-002, WELL-003) distributing to the existing fire network and WTS. An additional Well (WELL-001), is added to the system in order to provide additional flow for current and future use as well as providing a backup supply. Each raw water well, consisting of a respective Well Pump (P-001, P-002, P-003), distributes flow into the existing non-potable network loop. The raw water well pumps operate simultaneously when either the fire storage tank or potable water tank requires water as determined by the required pre-set levels for tank filling. Each well pump, consisting of a local starter (Well-001 Starter, Well-002 Starter, and Well-003 Starter), is capable of operating in either the HAND or AUTO mode as well as having a local disconnect to each pump in order to easily and effectively remove it from the system should there be a need for servicing the well or any of the three pumps. Each well pump will have a local Flow Meter (FIT-001, FIT-002, and FIT-003) measuring totalized flow from each well. Well production data for WELL-001 and WELL-002 is displayed on above ground totalizers installed locally near each of the flow meters. WELL-003 flow meter is situated in the WTS shed.

The operation of the well pumps is determined by the level in either the existing Fire Water Storage Tank (TNK-103) or the new Potable Water Storage Tank (TNK-201). When the monitored level in either tank drops below the preset value as seen by the respective Level Indicating Transmitter (LIT-109 and LIT-201), the respective FCV (FV-101 and FV-201) modulates to open position and the well pumps turn on and run until the fill set point requirements of each tank system are met. TNK-103 level operating and alarm set points are preset by the Fire Pump Package manufacturer. TNK-201 level operating and alarm set points are presented in the next section.

Ultrasonic transducers, as part of each level indicating transmitter, provide continuous feedback signals of real time tank levels and work in conjunction with their respective FCV to fill each tank based on the level set points.

The existing non-potable water piping network is a pressurized piping loop connected to the fire protection system. Well pumps connect to the non-potable loop and maintain a minimum loop pressure to prevent the fire pump from starting in non-emergency situations. Pressure Sustaining Valves (PSV-101 and PSV-201) located on the inlet side of fire water storage tank and potable water storage tank respectively maintain the fire protection system pressure. The PSVs are set at a pressure of 35 kPa over the fire protection system’s Jockey Pump (P-101) stop pressure set point to prevent it from operating when either the fire water or potable water storage tanks are filling.

FCVs are installed downstream of the PSVs, on the inlet process piping of each storage tank. FCVs determine which of the fire storage or potable water tanks is filled when the raw water pumps operate according to LIT signals. When either tank LIT signal is below the preset low set point, the corresponding FCV will OPEN and the well pumps will turn on to refill the tank.
the tank LIT signal reaches the high level fill set point, the raw water well pumps will shut off and the FCV will CLOSE after the well pumps have been inoperable for five seconds.

The following interlocks are installed in order to maintain pressure in the loop and meet the system demands of the non-potable network:

1. Fire pump (P-102) in the ON state: FV-101 and FV-201 remain/modulate to the closed position in order to isolate the tanks from receiving water. All well pumps in operation are disabled. After the fire pump has stopped running, the interlock to lock out the FCVs will be removed allowing the system to return to normal operation.

2. Filling of Fire Water Storage Tank (TNK-103): Run command for Well Pumps (P-001, P-002, and P-003) only occurs when the FV-101 is in the OPEN position for the tank to receive water, and indicates such state. FV-101 is to remain open for 5 seconds after P-001, P-002, and P-003 are disabled and have indicated such state.

3. Filling of Potable water Storage Tanks (TNK-201): Run command for Well Pumps (P-001, P-002, and P-003) only occurs when the FV-201 is in OPEN position for the tank to receive water, and indicates such state to the pumps. FV-201 to remain open for 5 seconds after P-001, P-002, and P-003 are disabled and have indicated such state.

2.3.1.1 Non-Potable Water System Monitoring

2.3.1.1.1 Raw Water Wells
Raw Water Well (WELL-001, WELL-002, and WELL-003) totalized production is monitored through the respective Flow Meter (FIT-001, FIT-002, and FIT-003). Collection of flow data is a manual process.

2.3.1.1.2 Fire Water Storage Tank
The level in the tank is monitored through an existing Level Indicating Transmitter (LIT-109) to control the water demand.

2.3.1.1.3 Non-Potable System Loop
The pressure in the loop is monitored through a Pressure Gauge (PI-101 and PI-201) installed upstream of the firewater storage and potable water storage tanks.

2.3.2 Potable Water System

The disinfection process of the non-potable water network is achieved by the chlorine injection system installed at the inlet to the potable water storage tank. The chlorine injection is part of a vendor package (Chem-01) comprised of a duty/standby pumping arrangement (P-301A/B) that doses chlorine into the non-potable line upstream of the potable water storage tank. The chlorination process is flow-paced based on the inlet raw water flow reported by Flow Meter (FIT-201) and the operator set point for desired chlorine residual adjustable via the chemical pump controller. Sodium hypochlorite is used for chlorination and the injection point is downstream of both FV-201 and FIT-201. FIT-201 provides instantaneous and totalized inlet raw water flow received by the potable water storage tank.
CONTROL NARRATIVE

System Control
April 1, 2016

The level in the Potable Water Storage Tank (TNK-201) is monitored by a Level Indicating Transmitter (LIT-201), with the interface located in the WTS Shed. In the instance of the level drops below or rises above the predetermined level alarm set points programmed into the transmitter, a visual alarm signal will initiate at the WTS indicating an alarm condition. The following are the initial level transmitter tank level set points for alarms and control operatives:

1. Level Alarm High: 98%, only visual alarms
2. Level Control High: 95% turn OFF the well pumps
3. Level Control low: 50% turn ON the well pumps
4. Level Alarm Low: 10%, only visual alarms; turn OFF the Potable Water Distribution System pumps

Alarm set points can be modified by the Operator.

In the event a level indicating transmitter failure, back up level elements are installed in both TNK-103 and TNK-201. The level elements provide a redundancy in level control to prevent the well pumps from filling either tank above the High High level set point. The height of each element will be just above the LIT level alarm high set point in order to avoid interference with the primary level indicating transmitter. An additional level element, Low Low, is installed in TNK-201 to shut down the potable water distribution system in the event it is triggered. The Height of the Low Low level element shall be right below the Level Alarm Low setpoint and shall issue a run command to the raw water well pumps in the event they are not in operation.

Treated water from the potable water storage tank is distributed into the potable water network via Potable Water Distribution Pumps (P-201A/B/C) and pressure tanks (TNK-202 and TNK-203). The Potable Water Distribution System (PWDS) is a pre-packaged system with a local control panel (PWDS-CP) located in the Water Treatment Shed. To protect the distribution pump from running dry in the event the level in the potable water storage tank goes below the Low Low level alarm set point, the PWDS-CP will disable the distribution pumps. The distribution pumps are connected in parallel and operate in a Lead/Lead/Lag configuration based on the distribution system pressure. Respective Pressure Switches (P-201A/B/C) provide distribution interlocks for pump starting and stopping based on the configured set point of each switch. As the pressure tank service range is drawn down, and the pressure in the potable water distribution system falls, the lead pumps start and operate until the desired set point of the line is achieved. If there is a further drop in pressure and the lead pumps are not able to meet the requirements of the system to satisfy the desired pressure, the lag pump will start. Pressure Tank (TNK-202 and TNK-203) is installed downstream of the potable water distribution pumps to assist in balancing line pressure. The pressure switch set points to control the operation of Lead/Lead/Lag distribution pumps are:

1. Lead Pumps (P-201A/B):
   a. Start Set Point: Set @ 276 kPa (40 psi)
   b. Stop Set Point: Set @ 414 kPa (60 psi)
2. Lag Pump (P-201C):
   c. Start Set Point: Set @241 kPa (35 psi)
   d. Stop Set Point: Set @ 379 kPa (55 psi)

Flow Meter (FIT-202) downstream of the distribution pumps measures the totalized potable water utilization. The totalized flow is displayed locally on the flow meter located in the WTS shed.

Downstream of the potable water distribution pumps are turbidity and chlorine instruments: Turbidity Analyzer (AIT-201) and Chlorine Analyzer (AIT-202). Each instrument has its own local transmitter which displays values read by the system prior to entering the potable water distribution network. These instruments are for monitoring purpose only and are located in the Water Treatment Shed.

### 2.3.2.1 Potable Water System Monitoring

#### 2.3.2.1.1 Potable Water Storage Tank

Multiple attributes are monitored within the storage tank.

1. The instantaneous flow and totalized volume which has entered the tank is monitored by Flow Meter (FIT-201).
2. The level in the tank is monitored through a Level Indicating Transmitter (LIT-201) situated in the Water Treatment Shed.

#### 2.3.2.1.2 Potable Water Distribution Demand

Multiple attributes are monitored within the potable water distribution system.

1. Potable water Distribution system pressure is reported by a pressure gauge (PI-201).
2. Turbidity is reported by a Turbidity Analyzer (AIT-201).
3. Free chlorine residual is monitored by a Chlorine Analyzer (AIT-202).
4. Distribution flow rate and daily volume are reported by a Flow Meter (FIT-202).

### 2.3.3 Wastewater Treatment System (WWTS)

The WWTS receives sanitary sewage from the existing wastewater collection system. Raw sewage flow from the existing system is received in Septic Tank (TNK-501). Level switch (LSHH-501) within the septic tank provides a high-high level alarm when the tank level is above the predetermined set point. Local control panel (WWTS CP-01) situated within the vicinity of the wastewater treatment system provides an auditory and visual indication when an alarm condition occurs within the septic tank. TNK-501 is a solids storage tank that normally operates at a fixed volume.

Clarified effluent overflows from TNK-501 to Effluent Tank (TNK-502). Clarified effluent from TNK-502 is pumped to the subsurface disposal fields. TNK-502 has pumps (P-501A and P-501B) that operate in a Duty/Standby configuration. Hour meters and event counters attached to each pump will monitor the total running time and operation cycles of each pump to allow for future determination of total sewage generated at site. Level switches (LSL-504, LSH-503, and LSHH-502) are utilized for pump controls and alarm annunciation. The switches are installed at...
predetermined heights based on the system requirements and work in conjunction with a programmable timer to spread the dosing of the daily wastewater volume over a 24-hour period. The following interlocks are described by the level in the tank and the position of each switch:

1. Tank level below LSL-504: All pumps OFF
2. Tank level above LSL-504 and below LS-503: Duty pump ENABLED, controlled by a timer
3. Tank level above LSL-504 and LSH-503: Standby pump ENABLED, controlled by a timer
4. Tank level above LSL-504, LSH-503 and LSHH-502: Duty and standby pump ON and audible and visual alarm signaled

When an alarm condition occurs within TNK-501 or TNK-502, local control panel (WWTS CP-01) located within the vicinity of the wastewater treatment system provides an auditory and visual indication. WWTS CP-01 is equipped with a UPS capable of providing power to the audible and visual alarms for up to 8 hours in the event of a power outage.

2.3.3.1 WWTS Monitoring

The WWTS relies on ongoing monitoring to operate effectively. There are a number of system components that can be monitored to confirm adequate performance as well as identify issues that could potentially cause service outages in the future. Early detection will allow the owner to rectify the situation before a service outage occurs.

2.3.3.1.1 WWTS Monitoring Wells

Three types of monitoring wells shall be provided for ground water monitoring.

1. Trench monitoring wells have been included near both ends of each pressure distribution lateral within the trench media to enable inspection of the effluent ponding depth that may result.
2. Vertical separation monitoring within each sub-surface disposal field allow inspection of soil saturation above the required vertical separation depth.
3. Three 50 mm ground water monitoring wells were installed as part of the AMEC Hydrogeological Assessment in March of 2015. These monitoring wells will permit collection of groundwater samples downstream of the disposal field to measure the efficacy of treatment.

2.3.3.1.2 Pressure Distribution Lateral Service Ports

Service ports have been provided at the end of each pressure distribution lateral with access to grade through an access box. Access boxes are not rated for vehicle loading and vehicles should never drive over the disposal field area.

2.3.3.1.3 Effluent Quality Sampling

Clarified effluent samples can be collected from TNK-502.

2.3.3.1.4 Flow Monitoring

Pump run time can be converted into flow using the pump curves provided with the pumps and the total run time. The daily pump run hours, which allows for volumetric conversion, should be documented.
2.4 GENERAL ALARM – POTABLE/NON-POTABLE WATER SYSTEMS

In the event of an alarm within the potable or non-potable water system, an indicating strobe connected to the outside of the Water Treatment Shed will illuminate notifying the onsite operator, requiring their attention at the Water Treatment Shed for further alarm investigation. Upon entering the Water Treatment Shed when the alarm strobe is initiated, the operator will be able to decipher what the alarm condition is based on the state of the visual indicators provided by each sub-system. The following subsystem alarms include:

1. Potable Water Distribution System Fault: AMBER LED – Illuminated when there is a general fault at the pre-packaged distribution system control panel (PWDS-CP) or the panel has been disabled due to low low level. Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
2. Chlorine Injection System Fault (Chem-01): AMBER LED – illuminated on the pre-packaged injection skid when there is a general fault condition of the system or the pumps. Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
3. Well-001, Well-002, Well-003 Fault: AMBER LED – Illuminated on the WTS-CP when there is an overload condition with any of the three Well pumps (P-001, P-002, and P-003) or a run command has been issued and the run status signal is not received by the smart relay in the predetermined amount of time (30 sec.) Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
4. FV-101/FV-201 Fault: AMBER LED – Illuminated on the WTS-CP when a valve status for OPEN or CLOSE is not received by the smart relay in the preset amount of time when the corresponding OPEN or CLOSE command is given (120 sec) Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
5. TNK-201 Low Level: AMBER LED – illuminated on the WTS-CP when the level in the tank is below the low level setpoint, as well disables the Potable Water Distribution System from operating in order to prevent the distribution pumps from running dry. Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
6. LSLL-201: AMBER LED – illuminated on the WTS-CP (TNK-201 Low Level light). Low Low Level Switch, that when triggered, will disable the Potable Water Distribution Pumps, preventing them from running dry. In addition the output command for the well pumps to run will be issued (if no command has been given yet due to transducer failure). Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
7. TNK-201 High Level: AMBER LED – illuminated on the WTS-CP when the level in TNK-201 has risen above the high level set point. Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
8. LSHH-201: AMBER LED – illuminated on the WTS-CP (TNK-201 High Level light). High High Level Switch, that when triggered, will turn off all well pumps in order to prevent TNK-201 from overflowing. Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.
9. LSHH-101: High High Level Switch, that when triggered, will turn off all well pumps in order to prevent TNK-103 from overflowing. Simultaneous fault output is sent to the WTS-CP to be relayed to the indicating strobe outside.

Each sub-system alarm will continue until acknowledged by the operator or until the alarm condition no longer exists.