APPENDIX I

LIFT STATION AND SCADA STANDARDS

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PART I – DESIGN

1.0 SANITARY AND STORM WATER PUMP STATIONS

1.1 General

.1 Wherever possible, every reasonable effort should be made in the design to provide a drainage system for the Development that relies solely on gravity for conveyance in order to minimize the overall operation and maintenance requirements and life cycle costs of the system.

.2 Where absolutely necessary, the City may accept design proposals which include pump stations and force mains to convey wastewater and/or storm water out of the Development.

.3 The Consultant shall consult with the City while conducting the Design to obtain the City's preliminary comments and input regarding any proposed pump station and force main. The City may have additional requirements for the Design in this respect.

.4 Force mains shall be designed and constructed in accordance with the same requirements for water mains, as specified in the applicable articles of Section 5.0.

.5 The Design shall fully describe the details regarding any proposed pump station and force main system. The City may request additional details regarding the design in order to ascertain its acceptability.

1.2 Minimum Flow Requirements and Pumping Capacity

1.2.1 Sanitary Pump Station

The wastewater collection system shall be designed with sufficient capacity to convey peak wet weather flows, including an allowance for inflow and infiltration (I/I). Designer shall submit a technical document outlining the method for flow calculations and required sanitary pump station capacity, for City's review and approval.

1.2.2 Storm Pump Station

The designer shall submit a technical document for City's review and approval that establishes:

- Design frequency
- Peak outflow
- Design philosophy
- Minimum storage volume
- Maximum allowable highwater
- Discharge velocity

1.3 Regulatory Standards

In addition to meeting the requirements as laid out in this chapter, the design and construction of pumping facilities must meet all the current requirements of other governmental authorities having jurisdiction, including:

a) Alberta Environment and Parks;

b) Alberta Occupational Health and Safety;

c) Electrical Protection Branch - Alberta Municipal Affairs and Housing;

d) Plumbing and Gas Safety Branch - Alberta Municipal Affairs and Housing; and

e) Building Standards Branch - Alberta Municipal Affairs and Housing as laid out in the Alberta Building Code.

Additional requirements for individual pump stations may be imposed by the City as conditions warrant.

1.3.1 Standardization

.1 The City of St. Albert encourages consistency and standardization in the design and construction of pump stations.

.2 This standardization is intended to promote designs that facilitate economical construction and operation and increased reliability. Standardization in equipment and controls will reduce the inventory of spare parts, allow for interchangeability and promote safe and efficient operation and maintenance.

1.4 Site Location

.1 All new pump stations shall be located on a separate Public Utility Lot (PUL) with appropriate land-use designation and must have a legal and physical address. The final legal plans must be submitted to the City.

.2 Special consideration should be given to the location of pump stations relative to existing or proposed adjacent development, in order to minimize the facilities aesthetic impact in terms of visibility, odour and noise. The location of pump stations in the immediate proximity of school sites and playgrounds should be avoided if possible. Safety and security measures are to be given special consideration in such cases.

.3 Pump stations are to be located outside of the limits of any area subject to surface ponding or inundation by surface flow during major runoff events so that they are accessible in all weather conditions.

.4 Additionally, the site must have proper drainage to ensure all surface water is sufficiently directed away from the site. If applicable, reference in detail the related Master Drainage Plan for the land area that includes the pump station site.

1.5 Site Layout Requirements

.1 Vehicle access and parking space must be provided at the pump station. Minimum of 2 hard surface parking spaces are required conforming to the Land Use Bylaw. Vehicle access road minimum width shall be 4.5m and road and parking area must be paved. Pavement structure must be robust enough to handle loads from heavy trucks (HS 20). The proponent shall request the dimensions and details of City's service vehicles and prepare a vehicle truck analysis drawing. The City's service vehicles should be able to turn around within the pump station site and not be required to back in or back out of the site.

.2 A security fence must be installed around the perimeter of the pump station site. The fence must be at least 1.8 m high and have a 1 m wide man-gate and a double 2.4 m (4.8 m total) swinging gate for access. The security fence should be a chain link fence however, other types of fence materials, to match the subdivision's aesthetics, maybe permitted at City's discretion. The access gate must be large enough to allow entry by a 35 feet Vactor type truck. All gates must swing open all the way and have provision for chains and locks. All posts to be set in concrete.

.3 Appropriate signage must be affixed on the fence listing the following information:

a) Pump station name

b) Building address

c) City contact number, or in the case of private pump station, contact number of the operating group.

d) "No Trespassing" Statement

e) "No Parking" sign within the limits of pump station site access

.4 Landscaping around the pump station fence line is permitted as required to match the subdivision's aesthetics. Otherwise, the landscaping must blend into the surroundings; should require less water and low maintenance.

.5 Landscaping around the pump station must not impede on building components such as generator exhaust, access roads, and odour control ventilation. Additionally, landscaping around the building shall also conform to the Landscaping Standards of the City of St. Albert Municipal Engineering Standards.

.6 The pump station must not be located in proximity to any overhead utilities. Designers must comply with any setback requirements outlined by the utility provider. In addition, maintenance equipment cannot interfere with overhead utilities or structures.

1.6 Station Configuration

.1 Depending on the hydraulics of the specific application, a variety of pump suction configurations may be used. Wet wells are typically used to provide storage volumes or a hydraulic break.

.2 Either wet well only or wet well/dry well configurations for pump stations are acceptable, subject to the preferences stated in the following sections. Wet well/dry well configuration for pump station is preferred. Wet well only option is acceptable subject to the requirements stated in the following section.

.3 The wet well (submersible pump) configuration is acceptable for facilities with pumping requirements of less than approximately 75 kW and if the pump is to be located 8.0 meters or less below ground elevation in the wet well, facilitating maintenance. The Consultant shall meet with the City to assure accessibility issues are discussed and addressed in design, and the required horizontal and vertical reach is available. The capacity for lifting equipment must be provided.

.4 As pumping requirements increase, the designer should give more preference to provision of separate wet and dry wells, with pumps located in the dry well.

.5 Where technically viable options exist in the choice of the type of pumps or in the station arrangement, a present-worth analysis should be undertaken to determine the most cost-effective equipment and arrangement, taking into account such factors as:

a) Cost of the facility and its life;

b) Energy cost over the life of the facility;

c) Life and replacement cost of the pumping equipment, including ancillary items such as switch gear, lifting, and ventilation equipment;

d) The cost of operation and maintenance;

e) Reliability;

f) Safety;

g) Local availability of repair services and spare parts and equipment suppliers;

h) Flood proofing;

i) Nuisance to residents of adjacent homes, or users of parks, facilities and developments in the area;

j) The facility as a possible source of contamination to the environment;

k) Compatibility with existing pumping station units.

.6 The design is to address the required functional lifetime of the facility structure. This is deemed to be 50 years unless the Engineer specifically approves a different lifetime. The pumping equipment should be assumed to receive a major overhaul involving renewal of the wearing components at 7 to 10-year intervals, dependent on service conditions.

.7 The analysis should bear in mind that the pumping units may have to be replaced every 15 years, as many manufacturers do not hold spare parts for pumps that have been out of production for longer than this period.

1.7 Building Architecture

.1 A building will be required at all pump stations to house all electrical and control equipment and provide tool storage space, working space and a washroom. The structures are to be designed for the "post-disaster" importance category.

.2 The building shall be designed to comply with the current Alberta Building Code.

.3 All heating and ventilating equipment and valves are to be housed in the building or a dry well.

.4 The building or dry well is to be completely isolated from the pump station wet well and provision for access to the wet well shall only be from the outside, through gas sealed access hatches with suitable locking devices. For details on doors and access hatches, please refer to Section 2.2.

.5 Locking systems for pump stations shall be confirmed by the City.

1.7.1 Building Interior

At a minimum, the following criteria for the station configuration should be met for the interior of the building. Furthermore, it is the responsibility of the design engineer to identify any additional items that should be included inside the building that would aid in the day-to-day operations of the pump station.

.1 The wet well area will be separated by a wall from the rest of the pump station. The wet well side will meet Class 1, Zone 1 of the Canadian Electrical Code. These electrical components must be explosion proof or in explosion proof enclosures. All other electrical components (i.e. PLC, MCC, etc.) will be located within the pump station building;

.2 Provide the pump station with a unisex washroom that has a tankless hot water heater, sink, mop sink and dual-flush low-water toilet;

.3 Provide floor drains for each separate room or section that cannot share a common drain (e.g. boiler room or generator room);

.4 There will be an entrance large enough to facilitate the removal of the generator, if required;

.5 Equip all doors with an interior panic bar;

.6 Equip pump station with CO, H_2S and LEL (NOX as required) gas sensors and transmitters for rooms or sections around the hazardous areas (e.g. stand-by generators, boilers, natural gas area heaters, wet wells). The gas sensors and transmitter must be rated to operate between -30° Celsius and +60° Celsius, and 5% and 95% relative humidity (non-condensing), be CSA approved Class 1, Zone 1, Groups B, C, and D, and meet the National Electrical Manufacturers 4X enclosure rating. The transmitter must also have 4-20mA output, sensor diagnostics, remote reset capabilities, and be capable of sensor separation distances of at least 100 feet. Placement of these sensors must be shown in the detailed design drawings. Equip pump station with heat and smoke detectors. The heat detector fixed temperature setting will be 57° Celsius. The smoke detector will be dual ionization/photoelectric type. Placement of these sensors must be shown in the detailed design drawings;

.7 Equip pump station buildings with an intrusion alarm for each exterior door and access hatch. All detectors are to be connected to the control panel;

.8 All pump station buildings will have a non-strobe warning beacon that turns from green to red in the alarm state, inside the pump station, with an auditory alarm inside the pump station. Warning beacons shall be installed adjacent to the entry doors that are inside and outside the hazardous areas. The warning beacon inside the wet well area must comply with Class 1 Zone 1 regulations. These warning beacons will activate upon the following alarms:

a) High H_2S levels (set to the OH&S 8-hour exposure limit);

b) High CO levels (set to the OH&S exposure limit);

c) High LEL and NOX, if applicable; and

d) Heat/smoke alarm.

.9 Provide a hoist system with rail and electric hoist for pump removal. Manually operated hoists for pump removal are not acceptable. The hoist rail is to provide access from immediately above the pump removal hatch and extend to the pump room door to facilitate loading on to a truck. The hoist and support must be certified by the Manufacturer and Structural Engineer.

.10 The hoist and rail shall be suitable to handle the weight of the ultimate equipment based on any future staging. The capacity shall be 1.5 times the weight of the pumping equipment or minimum 2.0 ton, which is greater.

.11 Piping within the pump station shall be labeled and color coded according to Alberta Environment Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems.

1.7.2 Building Exterior

The building exterior must meet the following criteria at a minimum:

.1 All pump station buildings will have a non-strobe warning beacon that turns from green to red in the alarm state installed at the exterior of the building above the main entrance where it can be easily seen. These warning beacons will activate upon the following alarms:

a) High H_2S levels (set to the OH&S 8 hour exposure limit);

b) High CO levels (set to the OH&S exposure limit);

c) High LEL and NOX, if applicable; and

d) Heat/smoke alarm.

.2 Motion detector lights will be installed at the front entrance, sides and at the back of the pump station. Include by-pass switch to allow exterior lights to be turned-on manually with switch just inside the entry door;

.3 Architectural specifications require City's review and approval;

.4 The wet well will have a separate entrance from the rest of the pump station; and

.5 All doors will have concrete entrance pads flush with the bottom of the door and appropriate weather stripping.

.6 The pump room door will be equipped with overhead rolling door with sufficient width and height to facilitate removal of the sanitary pumps from the building using the hoist system and loaded on a truck bed.

1.8 Mechanical Redundancy

A minimum of two pumps are required for each pump station and three is preferred. Generally, these pumps should be identical and interchangeable. Where only two pumping units are provided they shall each be of the same pumping capacity and each unit, operating independently, shall be capable of pumping at the design capacity flow rate for the station under the service conditions. Where three or more pumping units are provided they shall have pumping capacity such that with the largest unit out of service, the remaining units operating in parallel are capable of pumping at the design capacity flow rate for the station under the service conditions.

1.8.1 Emergency Backup and Operational Reliability

.1 The design of pump stations must identify and anticipate all events that affect the functioning of the facility. Provisions must be made to mitigate the consequences of failure of the facility by any mode, so as to prevent property damage, the endangerment of public health or environmental damage.

.2 Power supply reliability provisions:

a) Independent power supply sources: Whenever it is feasible, the electric power supply to the facility is to be provided from two or more independent distribution sources;

b) Emergency standby power: In cases where redundant electric power supply is not feasible, provision of an on-site installed emergency standby power equipment is required; and

c) Refer to electrical design requirements, section 3.0 for further details on emergency backup power supply sources.

.3 **Alarm telemetry - general requirements**: Automated remote sensing and SCADA equipment shall be provided at each pump station. This equipment shall provide for detection of the status of selected operating conditions and transmission of appropriate alarms to the monitoring facilities established and operated by the City. Refer to the City's SCADA standards.

.4 **Overflow connections**: In anticipation of the potential operational failure of a pump station and its backup provisions, the feasibility of providing a gravity overflow to the sanitary sewer system is to be evaluated. The elevation and hydraulic capacity of overflow connections are to be optimized to minimize the risk of basement flooding due to sanitary system backup.

.5 **Overflows to storm drainage systems**: Overflow connections to storm drainage sewers, storage facilities, natural water courses or surface outfall points will only be permitted for Stormwater pump stations.

.6 **Bypass pumping and pigging:** The pump discharge piping shall incorporate a bypass pumping connection with companion flange and hose connection coupling provided outside the building to allow using temporary pumps in the collection manhole and pump through the forcemain to bypass the pumping facility during major maintenance. This connection should also allow for pigging of the forcemain.

.7 **Emergency response time:** The designer is required to calculate and document the emergency response time estimate for pump stations. This is the estimated time based on the upstream storage capacity within the sanitary sewer network before the lowest elevation basement flooding occurs in case on an emergency causing pump station failure. The minimum required emergency response time is 4 hours, wherever feasible.

1.8.2 Staging

.1 Where warranted, due to economic considerations or to accommodate extended periods of development of the contributing area, the provision of pumping capacity and/or the construction of a pump station may be staged appropriately. Where such staging is proposed, all stages are to be defined and related to the anticipated development scenario for the contributing area. A plan of action is to be established as part of the initial design to define the process for the implementation of future stages. The plan should consider continuity of service, the responsibility and financial arrangements for future stage implementation and the most cost-effective method for implementing the capacity changes;

.2 A modular approach to the arrangement of structural components and/or pumping units may facilitate staging and this should be reviewed as part of the design; and

.3 For interim pump stations, there will be no relaxation of the criteria for design and construction for pump stations that are anticipated to be required for a limited time period.

1.9 Preliminary Design Report Requirements

.1 All pump station design projects must have a Preliminary Design Report submission which provides high level information on the background of the proposed pump station project and shall be submitted before proceeding with the detailed design. The Preliminary Design Report should also address all options for servicing the area under consideration and do a TBL or cost/benefit analysis to justify the recommended option. If there are outstanding risks involved with the recommended option, the report should outline how these will be mitigated. This report shall address the following items as applicable to the project.

- A brief description of the project and purpose;
- The justification for a pump station;

- Design period;
- Area serviced;
- Population densities and ultimate total population;
- Commercial and industrial contributing areas;
- Projected year wise average, peak and minimum daily dry weather flow, related to anticipated development staging and ultimate build-out;
- Average and peak wet-weather flow;
- Infiltration and extraneous flow allowances;
- Design flow rates proposed;
- Number, type, capacity and motor power of the proposed pumping units;
- Forcemain design basis and transient analysis;
- System head curves, including head computations for the pumping system;
- Sewage detention times in the wet well and forcemain under various operating conditions;
- Construction cost estimates;
- Projected present value of operating costs including those for power, operation and maintenance over the design life of the facility;
- Ventilation requirements;
- Odour control measures;
- Emergency backup systems, including overflow provision, bypass pumping and a standby power generator, to address mechanical, electrical or operational failures or catastrophic events;
- Environmental considerations and impacts;
- Station location considerations, accessibility, site security and fencing, landscaping, and site grading;
- Staging provisions, if required;
- Operating control philosophy;
- Description of design features, equipment information and preliminary design drawings;
- Public consultation process undertaken or proposed; and
- Additional information as requested by the City.

The below breakdown of the preliminary design report contents is provided for reference and general guideline.

Preliminary Design Report
Introduction: • Background • Project scope • Purpose of the Report
Site Descriptions and Conditions:

Preliminary Design Report
• Locations, conditions and existing grade • Lot delineation and dimensions, land use designation, building outline and dimensions • Preliminary site plans (roads, access, general site drainage, existing site and surrounding topography) • Geotechnical conditions of the site based on two boreholes preferably within 10 m of each and to a minimum depth of 5m below the sub-structure depth
Design Considerations • Detailed compliance of design with City of St. Albert standards and Alberta Environment and Parks standards and guidelines for municipal waterworks, wastewater and storm drainage systems
Phased Design Flow Rate Calculations • Phase of development area • Number of units and type • Assumed population to service • Per capita flow rate • Infiltration average and peak • Average total flow rate estimate • Peak flow rate and peak factor • Appropriate service phasing
Final Development Area Information • Population density • Area to be serviced • Per capita flow rate • Infiltration average and peak • Average flow rate estimate • Peak flowrate and peak factor Forcemain Sizing and Hydraulic Grade Line Analysis • Pipe size and material • Forcemain plan and profile • Flow rates designed according to City design criteria • Design average flow and peak flow • Consideration of velocities during initial development stages and at completion • Hydraulics included in design and drawing package • Hydraulic Transient Analysis with report • Pump working pressure and shut-off pressure • Pipe pressure rating • By-pass measures
Wet Well Sizing • Active capacity (include pump calculations) • Maximum storage capacity (include pump calculations)

Preliminary Design Report
• Dimensions of all wet well areas, location and elevation of influent line within wet well
Station Overflow • Mitigation measures for outages or failures • Level of redundancy for each potential failure mode
Pump Station Site and Building Layout Details • General description • Architectural and landscape description • Fencing and access • Security considerations (e.g. fencing design, exterior lighting etc.) • Site drainage and low impact development strategies when applicable • Civil plan • Building plan
Equipment and Instrumentation Overview • Pump (include forcemain and pump curve) • Grinders and mixers • Wet well liquid level monitoring systems • Piping and Instrumentation Single Line Diagram • HVAC (include blower and furnace specifications) • Odour control for wet well exhaust • Mechanical plans
Electrical and Controls System • Utility power supply, and utility transformer and utility line location • Power quality meter, transient voltage surge suppressor, main breaker size • Back-up power generator specifications and related systems (e.g. automatic transfer switch, battery charger etc.) • Station interior and exterior lightning • Primary and secondary pump control systems • Pump Station monitoring system and network architecture • Operation control philosophy
Temporary Elements • Propane tanks, potable water tanks, access roads • Phased elements (wet well expansion, additional pump installation, electrical / gas demand changes)
Projected present value of annual operating costs over service life of facility

2.0 DETAILED DESIGN REQUIREMENTS

2.1 Wastewater Inlet

.1 **Single sewer entry to wet wells**: Only one sewer connection shall be provided into a wet well to convey sewage from the contributing collection system;

.2 **Collection manhole**: A collection manhole within the pump station site shall be provided as a junction point for the incoming sanitary sewers. Appropriate stubs are to be provided for future connections. Only a single connection is to be made from the collection manhole to the wet well of the pump station. The access covers on collection manholes or manholes that will be used for bypass pumping shall be rectangular hatches of minimum 600 mm x 1,000 mm opening and shall be gas tight complete with fall through prevention system. In addition, the manhole specifications must also conform to the City of St. Albert Municipal Engineering Standards;

.3 **Inlet sewer elevation**: Excessive entrainment of air into the flow stream entering the wet well should be avoided to prevent entrained air from reducing pump performance or causing loss of prime. Provisions necessary to address this may include drop tubes inside wet wells of small facilities, or grade adjustments or a drop manhole upstream from the pump station to lower the elevation of the inlet to the station. However, inlet sewers shall not enter the wet well at an elevation lower than the normal high liquid level for the design capacity flow rate; and

.4 **Inflow shutoff provisions**: An inflow shutoff valve or sluice gate installation is to be provided on the inlet to the wet well so that inflow to the wet well can be stopped. Shutoff valves or slide gates should be installed in the first manhole upstream (collection manhole) from the pump station. The shutoff equipment shall be of a type and materials suitable for raw sewage service. The installation of shutoff devices within the wet well is not recommended unless there is no alternative. Under these circumstances provisions must be made for operating them without entry to the wet well.

2.2 Wet Well and Dry Well (Structural Requirements)

.1 Wet Well

a) Buoyant forces for empty wet well prior to backfill are to be considered during the design. The consultant will indicate the factor of safety used in their design. Should be designed to withstand buoyancy of 1:100 yr. return period flood, if applicable.

b) Wet wells are to be sized such that:

- It is small enough to minimize total retention time, the time sewage is held in the wet well and any rising forcemain, and yet be large enough to control the frequency of pump starts;

- It should be sized large enough to maximize pump life by decreasing the frequency of pump starts. However, in the interest of limiting excessive detention time, pump stations will inherently be subject to relatively high frequencies of switching cycles. Exceeding a frequency of 12 starts per hour for motors of above 30 kW increases the cost of switch gear and motor maintenance and the reliability and life of the machinery and electric components will decrease. Accordingly, sufficient storage between switching levels should be provided to limit the number of pump starts, normally to 6 per hour with pump alternation and 10 per hour with the standby pump inoperative. The manufacturers' recommendations with regards to the allowable frequency of pump starts for the specific size and type of motor are to be satisfied.
- It can accommodate the peak wet weather flow at full build-out with the forcemain draining back to the wet well through a failed check valve without the pumping flow rate exceeding the firm capacity of the pump station;
- Pump starts do not exceed the pump manufacturer's maximum starts per hour during peak wet weather flow at full build out, and where the forcemain is draining back to the wet well through a failed check valve;
- Maximum time between pump cycles does not exceed two hours during minimum dry weather flow;
- The maximum retention time in wet well should not exceed 30 minutes for the design minimum flow rate anticipated when the contributing area is fully developed;
- The total retention time in the wet well and forcemain should be kept to a minimum (generally less than 4 hours) to avoid anaerobic fermentation and the resultant production of odorous, hazardous and corrosive gases. It is desirable to have a wet well with sufficient active volume so that all sewage within the discharge forcemain will be replaced during one pumping cycle, especially if sags exist in the forcemain profile;
- It should allow for the pump starting sequence. The starting sequence usually takes between one to three minutes, depending on the required opening and closing time of the pump control valves or the pump ramp up and ramp down times based on transient analysis recommendations. The opening and closing delays may be field adjusted to prevent extended operation of the pumps between shut off and operating duty point; and
- It can accommodate the overflow during the event of power outage by providing the freeboard. This overflow provision is only applicable when the SCADA system is not present in the pump station.

c) The bottom of the wet well may be designed as follows depending on the type of the accumulated water. In any case, the wet well bottom should be designed to limit dead spaces where solids can accumulate and provide smooth, uniform and unobstructed flow to the pump suction influence zones.

- Hopper bottom with a minimum slope of 1:1 for accumulation of waste matter. Typically, hopper bottom is used for solids bearing fluids such as raw sewage, grit chamber, sludge, raw water, etc.;
- Sloped bottom and flow distribution inlet channel for sewage and sludge pump stations; and

- Open-trench type wet well with an ogee weir for liquids bearing solids especially raw unscreened municipal sewage.

d) Construct wet wells using concrete designed for an A-1 exposure class and a cement type suitable for the site's sulphate content as measured by the Geotechnical consultant;

e) The exterior of the wet well should have the appropriate waterproofing to ensure that there is no infiltration going into the structure;

f) The wet well interior should have waterproofing beyond the high-high liquid level. The waterproofing must be able to withstand sewage and durable enough to withstand high pressure washing. Coatings applied to concrete surfaces are subject to approval prior to installation;

g) A visual hydrostatic test of the wet well must be completed after internal waterproofing is complete and before external waterproofing and backfilling (Backfilling should meet the specifications of the City of St. Albert Municipal Engineering Standards). There is zero tolerance for leakage; any evidence of leakage is a just cause for failure. In the event of failure, wet well must be re-coated and re-tested to the satisfaction of the City;

h) All joints in the concrete to include an appropriate waterstop. All penetrations through the concrete will be grouted with non-shrink grout on both sides of the joint or penetration;

i) Groove joints are not allowed for buried application because they are prone to leakage.

j) Additionally, the depth from the "pump off" level to the floor of the wet well should be kept to an acceptable minimum that shall provide adequate submergence over the pump suction bell or adequate NPSH margin over the pump datum. The required depth will be dictated by suction pipe inlet conditions, pump manufacturer's requirements for submergence or cooling, net positive suction head, priming requirements and vortex control;

k) The cross-sectional area and shape of the wet well above the benching are to be constant or increasing from the bottom towards the top;

l) Lifting chains in wet wells shall be of grade 316 stainless steel, nickel plated or galvanized and have a molybdenum-based corrosion protection coating. Systems, where the chain is not required to stay in the raw sewage, are preferred;

m) Only one inlet pipe or channel may connect to the wet well. If there are multiple sanitary sewers, they must connect the collection manhole or a manhole outside the pump station;

n) Provide a flow control method inside the wet well on the inlet pipe or inside the collection manhole on the outlet pipe (e.g. slide gate), which must be operational on main ground level where it is clear of any obstacles (i.e. roads, landscaping, etc.);

o) All nuts, bolts, fasteners, fixtures and other supports such as brackets, gratings and ladders used within the wet well will be corrosion resistant (such as grade 316 stainless steel);

p) Provide solids grinder on the wet well inlet pipe or in the collection manhole. Screens and baskets are not acceptable. The need for solids grinders is to be reviewed depending on the sewage characteristics and type of land use in the servicing area;

q) Provide an air vent sized to release or admit outside air due to the rise and fall in water levels. For sewage or sludge pump station, vent pipe shall be connected to the foul air scrubber system to mitigate odour issues in the surrounding areas. In addition, a 200 mm diameter vent pipe with gas tight flange shall be provided to attach portable ventilation system during maintenance operations;

r) Provide access to wet well by staircases where possible. Use corrosion resistant materials such as FRP, aluminum, or 316 stainless steel. The staircase will meet applicable building and safety codes. If access can only be facilitated by a ladder, provisions must be made for fall protection. The ladder will be constructed of the materials noted above. The ladder must extend above the entry level for ease of entry and egress;

s) Depending on the shape and size of the wet well, a means to access all sides of the wet well must be provided for cleaning. This will require either a very large hatch or two hatches to allow for hoses/equipment/ropes and worker rescue operations;

t) Removable equipment must be accessible via hatch positioned directly above;

u) Minimum hatch size must accommodate removal of equipment (pumps, valves, check valves, etc.) but in no case be less than 900 mm by 900 mm. Use corrosion resistant materials such as FRP, aluminum, or 316 stainless steel. Minimum hatch loading rating is 14.4 kPa (300 lb/ft^2). All access hatches for wet well and collection manhole must be gas tight. All hatches should have built-in fall through prevention system, preferably safety grates or alternately safety nets where safety grates cannot be provided. Hatch frames must be poured in place or if mechanically fastened, shall be surface mounted on the slab. Installation of electrical equipment and wiring within the wet well is to be avoided whenever it is not essential there;

v) Sewage pumps are typically controlled by water surface elevations in wet well, equip wet well with at least two level sensors – one primary and one backup. The primary level sensor to be of ultrasonic type and secondary can be level float bulbs or pressure transducers; and

w) If staging the wet well with partition walls each chamber must have a mixer and also have a water tight valve or gate isolating it from the adjacent wet well chamber. Storage volumes for capturing peak wet weather flows must have floor elevations above the pump stop elevation and sloped toward the wet well volume at a 2% or greater slope. Provide mechanical ventilation.

.2 Grease Control for Wet Wells

a) Wet wells are to have a non-stick coating or similarly functioning surface installed, to reduce the amount of grease building up on the walls to facilitate wet well cleaning; and

b) A mixer/sprayer or similar system to limit grease build-up shall be installed in the wet well.

c) Clogging Prevention

- To deal with ragging (pump plugging) issues, provision must be included in the design process for full installation of a solids grinder device to reduce pump clogging. The actual mechanical unit installation will not normally be required for station with mostly residential service area; and
- For replacement pump stations, the requirement for solids grinder should be confirmed with City based on the historical sewage characteristics of the area.

.3 Dry Well

a) Pump stations with a wet well and dry well configuration, the dry well is to be designed such that:

- Buoyant forces for the empty dry well prior to backfill are to be considered during the design. The consultant will indicate the factor of safety used in their design. Should be designed to withstand buoyancy of 1:100 yr. return period flood, if applicable;
- Construct dry wells using concrete designed for an A-1 exposure class and a cement type suitable for the site's sulphate content as measured by the Geotechnical consultant;
- The exterior of the dry well should have the appropriate waterproofing to ensure that there is no infiltration going into the structure;
- The dry well to be sized so that there is sufficient space between the pumps for the operator to access and remove them if necessary. In addition, there must be enough space for associated piping and other ancillary equipment;
- Provide sump pump for all dry wells and including isolation valve and check valve. Discharge the sump pump to the wet well above the high-high water level of the wet well. Slope the dry well floor toward the sump. The sump pump to operate via level switch;
- The sump pump to be suitable for raw wastewater solids handling and appropriate sump pump removal system to be provided if it is not accessible through the above ground chain and hoist system;
- Special attention is to be given to the dry well pump inlet pipe to minimize pipe entrance effects. For inlet pipes 150 mm diameter and less, the inlet pipe opening must be at least twice the diameter of the inlet pipe diameter. For pipes greater than 150 mm diameter the inlet pipe opening will be at least twice the cross-sectional area of the inlet pipe;
- All joints in the concrete to include an appropriate waterstop. All penetrations through the concrete must be grouted with non-shrink grout on both sides of the joint or penetration;
- Pressure pipe penetrations between the wet well and dry well must be secured with the appropriate link seal and grouted;
- The design for installation of the dry well pumps must take into consideration keeping vibration at acceptable levels to avoid fatigue, noise and wear. Use adequate pipe and pump support/anchors and flexible joints at the pump tie-ins. The tie-in should also conform to the City of St. Albert Municipal Engineering Standards.
- Provide permanent mechanical ventilation for the dry well. All systems must be capable of 6 air changes per hour when occupied;
- Pumps must be mounted on a minimum 100 mm housekeeping pad;
- Provide a hoist system with rail and electric hoist for pump removal from the dry well. The hoists to be rated for minimum 2.0 ton;

- Provide access to the dry well by staircases where possible. Use corrosion resistant materials such as FRP, aluminum, or 316 Stainless Steel. The staircase will meet applicable building and safety codes. If access can only be facilitated by a ladder, requirements for fall protection will apply. The ladder will be constructed of the materials noted above. Ladder cages are not permitted. The ladder must extend above the entry level for ease of entry and egress. The maximum spacing between the platforms shall not be more than 3.0 m. The ladders between platforms to be offset and provide a rope anchor point at the top of each ladder;
- Minimum hatch size must accommodate removal of equipment (pumps, valves, check valves, etc.) but in no case be less than 900 mm by 900 mm. Use corrosion resistant materials such as FRP, aluminum, or 316 stainless steel. Minimum hatch loading rating is 14.4 kPa (300 lb/ft^2). All access hatches for dry wells must be watertight. All hatches should have built-in fall through prevention system, preferably safety grates or alternately safety nets where safety grates cannot be provided. Hatch frames must be poured in place or if mechanically fastened, shall be surface mounted on the slab; and
- Installation of electrical equipment and wiring within the dry well is to be such that there are no splices or junction box within the dry well.

2.3 PUMP SELECTION

.1 Use pumps designed specifically for wastewater pumping with solids passing capability. Submersible pumps are preferred in all situation (wet or dry mounted). Where dry wells could become flooded, design of the cables, seals, and connectors and electronic controls should allow dry mounted pumps to operate under water. Pumps are to be removable and replaceable without dewatering the wet well or requiring personnel to enter wet well;

.2 For submersible pump, guide rails shall be provided to allow for removal of the pumps from the exterior of wet well;

.3 Other types or makes of pumps will require written approval from the City. A reason with supporting documentation must be provided and included in the Preliminary Design Report;

.4 Flush valves or recirculation pipes from the pump discharge to the wet well are to be provided for aeration and suspension of grit and solids in wet well. For dry well pump installation, the recirculation line to the wet well shall be equipped with the wet well washer for agitation and cleaning of the wet well walls during pump operation. Provision shall be made for automating the cleaning and agitation system;

.5 Dry well pumps to be mounted on a base designed for the application with the proper supports included;

.6 For duplex pump installation (two pumps), each pump to be sized for 100% firm capacity at peak design flow. This will allow for 100% redundant pumping capacity. For triplex systems (or more), units will have capacity such that, with any one unit out of service, the remaining units must have firm capacity to handle the peak wastewater design flow;

.7 Select pumps to minimize energy consumption and maximize pumping efficiency. Minimum power factor of 0.9 (or higher) is required for pumps greater than 40 HP;

.8 NPSH design information, pump curve and system curve for the pumps must be included in the detailed design drawings;

.9 Use identical sewage pumps in multi-pump applications;

.10 Each pump shall have “HAND, OFF, AUTO” (HOA) switch at MCC, ON/OFF momentary push button control and emergency stop button at each pump hatch. A water level indicator shall be added near the ON/OFF switch;

.11 Provide quick-connect/disconnect power supply cables and mechanical connections so that pumps can be easily taken out of service and replaced by a spare if necessary. The quick connect will be located above ground on the main level. The quick connect will adhere to electrical requirements to meet Class 1, Zone 1 classification;

.12 Quick connect to be designed for safe disengagement under load;

.13 Soft starters must be provided for transient control and pump ramp-up and ramp down. Use variable frequency drives for pumps only if flow control is required due to the design conditions;

.14 Pump start frequency must not exceed pump manufacturer’s specifications;

.15 Select pumps with the operating point near the best efficiency point. Where possible, the best efficiency point shall be as close as possible to the optimized flow or near the exceedance flow and head point in the system head curve. Exceedance point is defined as the flow in which the pump will operate between 10 to 95 percent at times or operating point of the pump most of the time; and

.16 Select pumps with locally available repair service. Pumps selected to be the product of a manufacturer with lengthy experience in the design and manufacture of pumps for raw sewage service. The pump manufacturer or authorized vendor representative must go to site once the pumps are installed to complete verification testing. This task and the results must be noted in the Commissioning Report. Proper documentation of this verification testing must be included in the Operations and Maintenance Manual and the Commissioning Report. City will be present to witness the verification testing.

2.4 FORCEMAIN DESIGN REQUIREMENTS

2.4.1 Forcemain Size Considerations

.1 The design of a sewage forcemain is to include study of the comparative costs of construction and long-term operation for alternative sizes. There are, however, practical limitations to the size options which may be considered, as flow velocities are required to exceed certain minimum values to prevent slime growth within the forcemain and to ensure solids are not deposited within the forcemain. It is also necessary to minimize the residence time of sewage within pump station wet wells and forcemains to avoid anaerobic fermentation and the resultant production of odorous, hazardous and corrosive gases such as hydrogen sulphide.

2.4.2 Flow Velocity Limits

.1 To prevent slime growth on the pipe walls of the forcemain and to transport solids, the minimum velocity of flow in the pipe should exceed the velocity determined by:

$$V = -0.3 \log (0.1/D);$$

Where: V = velocity in m/s;
And: D = pipe internal diameter in mm

.2 Optimum design velocities, in the range of 0.9 to 1.5 m/s, are recommended, considering both operating costs and prevention of solids accumulation. When the forcemain grade profile includes steep slopes or vertical sections, the minimum design velocity should be increased by an order of 50%. Based on the design flow velocities in buried forcemains, any special provisions required to ensure stability of the forcemain shall be identified and incorporated in the design. The maximum flow velocity should not exceed 3.0 m/s.

2.4.3 Design Pressures

.1 The pressure design for forcemains shall consider normal static and dynamic operating pressures, the potential conditions that may occur due to outlet surcharge or blockages and transient pressure (water hammer) effects. A transient pressure analysis is required to determine if protection is required and appropriate provisions are to be incorporated into the pumping system design.

2.4.4 Surge Protection Devices

.1 Where necessary, surge relief valves shall be designed with a suitable discharge location and be located with a suitable method of access. Surge relief valves that regulate with external springs or counterweights and dashpots are preferred to valves regulated with pilot pressure piping systems, for sanitary wastewater and liquids with substantial solids content. Rupture discs shall not be used.

2.4.5 Slope

.1 All forcemains shall be sloped sufficiently to promote the discharge of air during filling and to permit the forcemain to be drained. Forcemains shall not be installed at zero slope.

2.4.6 Alignment

.1 Forcemains should have a straight alignment wherever possible. The use of 90 degree bends and long sweep elbows in forcemains is to be avoided. A series of 45 degree or smaller deflection bends are to be used where extreme direction changes are required. The forcemain should also adhere to the requirements laid out in other sections of the City of St. Albert Municipal Engineering Standards.

2.4.7 Air Release

.1 Automatic air release valves shall be provided at all relative high points along the forcemain. The need for air release valves should be minimized by establishing the grade profile to eliminate summits. Air release valves are to be installed in waterproof concrete access chambers, insulated to prevent freezing and with provisions for drainage.

2.4.8 Vacuum Relief

.1 Provision for vacuum relief shall be made as necessary where forcemains are proposed to drain by gravity between pumping cycles.

2.4.9 Forcemain Outlet

.1 The forcemain should enter the receiving manhole horizontally at an invert elevation no more than 300 mm above the flow line of the receiving sewer. A smooth flow transition to the gravity sewer is to be designed to minimize turbulence at the point of discharge. Additionally, inert materials or protective coatings shall be used for areas subject to sulphide attack.

2.4.10 Requirements for Locating Forcemains

.1 To facilitate location, a tracing wire shall be placed along all forcemains at the time of construction. The wire shall be terminated in a labelled electrical box in the pump station (or appropriate secure location) and looped in any valve chambers and blow-off chambers to allow for connection of an electronic locator at intervals of not greater than every 300 m along the length of the forcemain. If a chamber is not available to provide this interval, the wire shall be looped into a cast iron valve box set at grade level. Locator wire shall be stranded 12-gauge copper with insulation for direct burial. Underground splice connections shall be minimized and shall be rated for direct burial service. Prior to acceptance of the forcemain, a continuity check shall be conducted to verify that the wire has not been broken during installation.

2.4.11 Requirements for Forcemain Inspection and Cleaning

.1 A pig launch port is to be provided at the pump station for cleaning and inspection of the forcemain. The intent of this provision is to allow cleaning using conventional pigs and inspection using smart pigs, televising or other equipment without significant pipe dis-assembly. Similar provisions are to be made wherever the forcemain changes direction with an elbow of more than 45 degrees.

2.4.12 Transient Analysis

.1 Hydraulic transient analysis, preliminary or detailed surge analysis is required for all pressurized pumping systems.

2.5 VALVES AND PIPING ARRANGEMENT

.1 For pump header piping, use only stainless steel or steel pipe with external corrosion resistant coating. The coating specification must be included in the relevant drawings and manuals. Plastic pipe for headers is not acceptable. Plastic pipes (PVC, HDPE) may be used for the forcemain outside the pump station. Transition pipe from header through wall and connecting to the forcemain must be stainless steel or steel with corrosion resistant coating and shall extend beyond any roof overhang by a minimum of 5.0 m;

.2 Include provision for a pig launch in the pipe work for the launching of pipe pigs or inspection equipment. The piping for pig launch shall have full port isolating valves;

.3 Suction pipe shall be sized to maintain a maximum flow velocity between 0.5 m/s to 1.5 m/s at maximum pump flow rate. Typically, suction side velocity is low to minimize the impact on NPSHa. High velocities induce suction side losses which reduces the overall NPSHa and could lead to potential cavitation in the pump;

.4 Pipe materials are to withstand twice the maximum anticipated pressure for all fittings;

.5 Weld neck type flanges to be used in process piping;

.6 Arrows indicating direction of flow shall be placed on process piping;

.7 Install an isolating valve and a check valve between the pump and the header (check valve closest to the pump). Knife gate valves are not acceptable alternatives except for on the pump suction piping. Hand-wheels shall be provided for larger isolation valves;

.8 Install two pressure gauges on a horizontal portion of the pump header. One analog gauge (for local display) and one digital gauge (connected to the programmable logic controller). Gauges may be on the same pressure tap;

.9 A magnetic-type flow meter must be installed on the forcemain, inside the pump station. The flow meter shall capture instantaneous and totalized flow. (connected to the programmable logic controller) Installation of the meter to follow the recommendations of the manufacturer. The display screen to be mounted in such a way that is visible and accessible to the operators;

.10 Do not bury pump header piping outside the pump station. The header and other process piping must be accessible for inspection and maintenance purposes;

.11 Provide an isolating valve on the forcemain with full port opening. If the pump station has more than one forcemain, each forcemain must have a separate valve. All valves and appurtenances on the pumps and header must be contained within the pump station and easily accessible for maintenance. Burying valves outside the wet well or dry well is not acceptable;

.12 Corrosion protection features on metal pipes must be specified in the drawings and follow the current edition of the Standard Specifications Waterworks Construction;

.13 Ensure the pump header and forcemain can be drained into the wet well. The discharge to be located above the high liquid level;

.14 Use tracer wire on all non-ferrous metal forcemains;

.15 Provide a by-pass connection on the forcemain to the exterior of the building terminating in a Camlock connector complete with isolating valve and check valve. The by-pass valving shall be stainless steel or epoxy-coated steel. Camlock fitting to face the location of the tanker truck;

.16 All forcemains and pump header piping within the wet well/dry well to be supported and mechanically restrained as required. Process piping may not be cast in concrete for supporting or restraining the pipe;

.17 Site pumping must be adequately anchored and isolated in a manner that prevents forces being transmitted to the pump and appurtenant fittings. Typically, concrete thrust blocks or wall flanges are used for anchorage, however the engineer can choose the alternative at his/her discretion. Furthermore, continuously joined and buried pipe may be self-anchored if the length of pipe and type of soils are suitable;

.18 High temperature piping shall be designed by calculating the thermal expansion of the pipe per unit length. The piping system shall be supported using pipe anchors, fixed and sliding supports strategically located along the piping alignment to direct the expansion away from the pipe anchor and contained within the expansion joints;

.19 All process piping must be designed to ensure it can handle 2 times design pressures. Pressure testing of the system will be required. Results from the pressure testing must be noted in the Commissioning Report. Proper documentation of this verification testing must be included in the Operations and Maintenance Manual;

.20 Design wet wells to provide easy access to all valves and equipment without the use of ladders or scaffolding. If possible, valves and equipment to be located on the main floor of the pump station, inside a valve chamber, or in the dry well. Provide access hatch for easy removal using permanently installed hoist. Also, piping should be configured such that removal of multiple pieces isn't required to remove a given piece;

.21 Wheel chains to be provided for elevated equipment (i.e. valves) that cannot be operated on the main floor. Otherwise, permanent platforms are to be provided;

.22 Two or more pumps shall be connected in a parallel arrangement to a common header, which must be located within a control building or dry well, such that all isolation and check valves are accessible for operation and maintenance;

.23 Each pump shall have its own individual intake and/or suction connection to the wet well;

.24 In wet well/dry well stations, shutoff valves shall be placed on the pump suction pipes. The piping and valve arrangement shall be suitable to permit isolation of any individual pump for maintenance or removal;

.25 Piping and valves shall be provided to back flush each pumping unit and its suction, using the discharge flow from another pump directed through the discharge of the unit being flushed;

.26 Flow velocities in the discharge pipe should be more than 0.9 m/s to maintain solids in suspension. Discharge piping should be as large as possible while maintaining this minimum velocity for scouring. For slurries, the minimum flow velocity should be more than 1.5 m/s in the discharge pipe; and

.27 Where differential settlement of buried piping is anticipated and cannot be prevented, means must be provided to prevent damage to the pump and/or stresses on the pump or appurtenant fittings.

2.5.1 Check Valves

.1 A check valve shall be installed on the discharge line between each pump and an isolation valve. These check valves should not be mounted in a vertical position. When vertical mounting of a check valve is necessary, it shall not be of the flapper type;

.2 A check valve shall be installed after the bypass tee connection shutoff valve to prevent backflow to any connected auxiliary pump. This valve may be mounted vertically if necessary; and

.3 Check valves shall be supplied with external levers and spring and limit switches to indicate and prove valve opening.

2.5.2 Isolation Valves

.1 To permit isolation of each pumping unit and check valve for removal or repair, include shutoff valves on the discharge lines from each pump between the pump check valve and the discharge header within the dry well;

.2 A bleed valve and a priming valve should be installed between the discharge valve and the pump header in the dry well in order to relieve pressure when servicing pumps and to allow pump priming;

.3 A forcemain isolation valve shall be included on the main discharge pipe where it connects to the discharge forcemain leaving the facility, to isolate the forcemain from the pump station;

.4 All isolating valves on the pump discharge piping shall be full port ball valves or plug valves; and

.5 Provisions shall be provided for easy access and removal of all valves and equipment. Appropriately located vent and drain valves shall be provided to permit drainage of all piping to facilitate valve and equipment removal.

2.6 PUMP CONTROL AND INSTRUMENTATION REQUIREMENTS

.1 The control panel must be located so that it cannot be flooded under any foreseeable circumstances. Control panels shall be mounted on a concrete base or plinth, or steel support posts founded in concrete bases that ensure stability of the control panel; and

.2 Taps with shutoff valves suitable for portable quick connect pressure gauges are to be provided on each suction and discharge pipe at suitable locations. See section 3.0, electrical design requirements, for specifications on gauges.

2.7 EQUIPMENT IDENTIFICATION

.1 The instrumentation tagging to follow this format: YYYCCC-XX

Where:
YYY - Functional Identification Code as shown in Appendix C (i.e. IP = influent / sewage pump);
CCC - Station code designated by The City; and
XX - Tag number;

.2 Lamacoid labels of appropriate size will be affixed on or near pertinent functional equipment (as outlined in the P&ID). The lamacoid will be white Helvetica lettering on black. The label will indicate the following:

Line 1: Name / Description of the equipment as per the P&ID; and
Line 2: Voltage, Phase, HP;

2.8 MAINTENANCE ACCESS PROVISIONS

.1 Permanent hoist equipment and access hatches are to be provided to permit removal and replacement of any piece of station equipment requiring routine maintenance or replacement. Hoists and beams should allow for placement of equipment onto service vehicles without double handling or use of mobile cranes. Hoists and beams must be robust, allowing for dynamic loads in case of hoist failure. Load rating for beam and hoist in wet well conditions must include provision for the additional load caused by rags and slid buildup on pumps;

.2 As an alternative in specific cases, appropriate vehicle access and adequate access hatches must be provided to allow the use of exterior mobile cranes. Hoists and beams must be robust, allowing for dynamic loads in case of hoist failure. Load rating for beam and hoist in wet well conditions must include provision for the additional load caused by ragging;

.3 For wet well pump installations, the provision and arrangement of lifting equipment is to be such that the necessity for personnel to enter the wet well for removal of equipment is minimized;

.4 Lifting equipment should have sufficient capacity to handle the heaviest load anticipated, including an allowance for dynamic forces due to load shifting and debris loads, safe working load on the beams of at least 1.5 times the expected pump weight or minimum 2.0 ton. The capacity of all lifting equipment is to be clearly posted and the safe working load marked on hoist beams. Eyebolts in the walls and/or ceilings should be provided for rigging chain hoists or come-alongs where hoists are heavier than 20 kg;

.5 A load-rated swivel shall be installed between the load chain and the equipment attachment point. The hoist system should also not require chains residing in the sewage to pass through the lifting mechanism at any point during pump removal to prevent grit build-up within the hoist mechanism;

.6 Suitable and safe means of access shall be provided to all equipment requiring inspection or maintenance and to the wet well for inspection and cleaning;

.7 Stairways and ladders, including fall arrest hoops and rest platforms shall comply with the requirements of Occupational Health and Safety. All stairs shall be of a non-skid type. Areas that are designated as confined spaces shall have a system of rescue made available. This shall include standard davit bases to be installed at access openings, as well as the provision for a straight line lifting rescue path out of confined spaces. Provision of fall protection for ladders exceeding 3.0 metres is preferable to hoops.

.8 Access into wet wells shall be from the outside and not through buildings or dry wells. Stairways should be given preference over ladders whenever possible. Anchor points for safety ropes are to be provided above ladders, especially where the drop in height is greater than 2.5 meters;

.9 Doors and access hatches shall have suitable locking devices in accordance with the City’s locking standards. All external access hatches shall be pad-lockable and all padlocks supplied keyed to suit City’s security key system;

.10 For all entry hatches, non-protruding extension ladders are to be provided, which must be located far enough away from the walls to be able to be pulled up through the access opening and extended to a height of at least 1.0 m above the surface. Guard rails are required around access openings. Chains are prohibited;

.11 Access hatches covers for all roof openings to wet or dry wells must be sealed or have sufficient overhang to prevent rainwater inflow. Flood tight and gas tight aluminum hatch covers must be used; and

.12 Floors and platforms shall be provided to allow access to all components to facilitate maintenance, repair, removal and replacement tasks. Such floors and platforms shall not obstruct access to any other component.

2.9 BUILDING MECHANICAL

2.9.1 Heating, Ventilation and Air Conditioning (HVAC)

.1 General Requirements

Heating and ventilation will be provided by air-handling units, supply fan units, exhaust fans, unit heaters and baseboard heaters as described below. All HVAC systems will be controlled by the programable logic controller (PLC). Pneumatic control lines are not acceptable.

a) General Requirements for Ventilation: Forced mechanical ventilation is required at all pump stations. Suitable equipment shall be installed to provide continuous ventilation at a rate of six air changes per hour in each of the wet well and dry well areas. Separate systems are required for each well and there must be no interconnection between the wet well and dry well ventilation systems.

b) Ventilation systems shall not transfer air between unclassified interior spaces and classified interior spaces.

c) All fans serving hazardous areas must be fabricated in accordance with AMCA Type A or Type B spark-resistant construction and rated for a Class 1 Zone 1 environment. Provision shall be made to ensure that there is enough distance between the exhaust and intake to prevent cross-over. The intakes and exhausts shall be free of any impedance (i.e. landscaping, snow removal locations, storage, etc.) at all times.

d) HVAC sizing calculations must be provided.

e) Ventilation to be thermostatically controlled by the pump station PLC. Operations must be able to control the room temperature within the pump station building by either manual or electronic thermostat.

f) Ventilation systems serving unclassified areas adjacent to classified areas shall maintain a differential pressure relative to ambient air pressure of 25 Pa under all operating conditions.

g) Make-up air unit and supply air fan unit shall be complete with removable filters, and the pressure differential across the filters to be monitored by the PLC and visually indicate the need for cleaning or replacement.

h) All continuous ventilation systems that are used to reduce the classification of a space shall be fitted with flow detection devices connected to alarm signaling system to indicate inadequate ventilation and ventilation system failure.

i) The flow detection devices shall monitor both the supply and exhaust fans.

j) Ventilation system supplying or exhausting air at a rate greater than 2,000 cfm shall include listed smoke dampers, listed fire dampers and smoke detection, and shall cause the ventilation system to shut down upon detection of smoke.

k) The HVAC system may use natural gas and must have a thermal efficiency of 90% or greater. If propane gas is to be used because natural gas is unavailable, the equipment must be able to be converted to natural gas. Conversion must be completed at the time of FAC.

l) When HVAC systems are operating, the noise levels adjacent to the pump station building cannot exceed The City's Noise Bylaw requirement.

m) All fresh air intakes must be sufficiently separated from any exhausts to ensure good air quality in the building.

n) Ventilation failure alarm provisions: Provision shall be made to detect and actuate an alarm if the ventilation system should fail. A local alarm indicator, noticeable prior to station entry but not to be noticeable to the public, is required. A volume controllable buzzer and red beacon on the inside of a building, visible as soon as the doors open, is acceptable.

o) Provisions must be made for odour control system when the pump station is near a residential area. Odour control systems may be required at wastewater pump stations for wet well ventilation and other areas. Exhaust system must permit the installation of odour control system that is accessible from the floor level.

2.9.2 Pump Station Wet Well

.1 A make-up (MAU) air unit must provide continuous ventilation air into the wet well at a minimum rate of 6 ACH (air-changes per hour). The indirect gas-fired heat exchanger in MAU shall be modulated to maintain the temperature of the air discharged by the unit at minimum 13°C. The air shall be discharged at 150 mm above the high level of the water inside the wet well.

.2 The air from inside the wet well to be exhausted through an exhaust fan outside of the wet well and discharged above roof level directly via a vent pipe. The exhaust air intake to be at high elevation in the wet well. The exhaust fan must be equipped with a VFD. The speed of the exhaust fan shall be modulated to adjust the exhaust air flow and maintain the wet well under negative pressure of 25 Pa.

.3 No terminal heating devices shall be provided in the wet well. The ventilation system shall be designed to maintain 7°C operational temperature.

.4 Increased Ventilation on Access: Consideration should be given to provide an automatic control to increase ventilation rates to 12 air changes per hour, interlocked to turn on with light switches or door switches, in addition to the continuous ventilation requirements.

.5 Provision for Backup Ventilation to Wet Wells: Provision is to be made for ventilation of wet wells using portable ventilation equipment, in case of failure of the built-in system. This provision is to consist of a standpipe with a diameter sized for 6 ACH extending from inside the wet well to a flanged connection on the exterior of the facility. The end of the standpipe is to be located so as to permit discharge of air through the standpipe to a point 150 mm above the normal high operating level of the wet well.

.6 A bubble-tight motorized damper must be installed on the supply air duct at the point of the duct passing through the exterior walls to prevent the air backing up from the wet well into the pump room when the system is not operating. Bubble-tight motorized dampers are also to be installed on the inlet air duct of odour scrubber and the bypass air duct of exhaust fan to prevent any backflow from the wet well into the odour control room when the system is not operating.

.7 Provision for Exhaust Air through Odour Scrubber: Provision is to be made when the relief air from the wet well is exhausted via an odour scrubber system to outdoor. A direct outside discharge shall be provided by a separate exhaust fan when the odour scrubber is off. The maximum capacity of the make-up air system will match that of the odour scrubber.

2.9.3 Dry Well

.1 The ventilation for dry well can be supplied by the same make-up air unit as that for the pump room. The unit must provide continuous ventilation air into the dry well at a minimum rate of 6 ACH. The indirect gas-fired heat exchanger of MAU shall be modulated to maintain the temperature of the air discharged by the unit at the minimum of 13°C. Air will be discharged at 150 mm above bottom of the dry well.

.2 The air inside the dry well to be exhausted directly by the exhaust fan to the outdoor via a duct extending through the roof and terminating above roof level. The exhaust air intake will be at high elevation in the drywell. The exhaust fan located outside of the dry well and in the pump room must be equipped with a VFD. The speed of the exhaust fan shall be modulated to adjust the exhaust air flow and maintain the dry well under negative pressure of 25 Pa.

.3 No heating devices shall be installed in the dry well. The ventilation system shall be designed to maintain the dry well’s operational temperature. The setpoint is typically at 7°C. The space temperature can be raised up to 21°C by pump station PLC if the space will be occupied.

2.9.4 Pump Room

.1 The ventilation for pump room can be supplied by the same make-up air unit as that for the dry well. The system will provide ventilation air at a rate of minimum 6 ACH, which will also be used to cool the space due to heat gains from equipment and by solar radiation when indoor air temperature is higher than outdoor air temperature.

.2 The ventilation air to be relieved to outdoor through a roof mounted hood with backdraft relief dampers and maintain the positive air pressure in the pump room.

.3 A gas-fired/electric unit heater controlled by the pump station PLC will operate to maintain the space temperature at its setpoint, typically at 7°C. The space temperature can be raised up to 21°C by PLC if the space will be occupied.

2.9.5 Washroom

.1 An exhaust fan must be provided for the washroom. It shall be interlocked with the lighting switch. The fan can be overridden by the pump station PLC. There will be no mechanical forced air supply system for the washroom.

.2 An electric baseboard heater to be provided in the washroom and will be controlled by the pump station PLC with a temperature transmitter in the room. The setpoint is typically at 7°C. The space temperature can be raised up to 21°C by PLC if the space will be occupied.

2.9.6 Electrical Room

.1 A supply fan unit (complete with removable filter) will provide cooling for the electrical room. The pump station PLC to control the supply fan unit including the supply fan and air dampers to maintain the space temperature setpoint. When the supply fan starts to run, the outdoor air damper and recirculating/return air dampers shall be open and modulated to bring the outdoor/mixed air into the space and cool down the room temperature to the setpoint (maximum 35ºC without the generator in operation).

.2 The exhaust air to be exhausted to outdoor through a roof mounted hood with backdraft relief dampers or a wall mounted louver with insulated motorized relief dampers.

.3 A PLC controlled natural-gas-fired/electric unit heater will heat the electrical room at its setpoint of 7°C. The space temperature can be raised up to 21°C by pump station PLC if the space will be occupied.

2.9.7 Generator Room

.1 The exhaust pipe from the generator engine should be piped through the roof of the building to the exterior of the building. A critical-grade muffler (for superior high sound-attenuation) shall be used. The exhaust pipe and muffler must be insulated to provide safety from hot surfaces and to reduce heat transmitted to the space inside the building.

.2 Air-flow required to discharge heat from the engine’s radiator should be exhausted from the building using an electrically-powered, industrial fan with VFD that will discharge the air to outdoor through a roof mounted hood. This arrangement for air exhaust provides advantages over side-wall exhaust by requiring smaller penetrations in the building envelope and discharging the air above roof level where its noise is not subject to reflection from nearby buildings and is less objectionable. The PLC will modulate the recirculating damper and discharge damper to maintain the temperature of the room above 21°C if the generator is operating in winter.

.3 Air for fuel-combustion by the engine and for engine cooling to be drawn into the building as natural draft through two separate louvers on the wall of the generator room. The combustion air intake to be complete with an insulated two position motorized damper. The outdoor air intake to be complete with insulated modulated motorized dampers. All dampers will be closed and seal the room when the engine is not operating.

.4 A PLC controlled natural-gas-fired/electric unit heater will heat the generator room at its setpoint of 7°C. The space temperature can be raised up to 21°C by pump station PLC if the space will be occupied. The unit heater shall not be allowed to operate while the generator engine is operating.

2.9.8 Odour Control Room

.1 An explosion proof electric makeup air unit (rated for the hazardous classification of the space - such as a Dexon type blower) shall provide continuous ventilation air into the odour control room at 6 ACH. The air flow rate can be raised up to 12 ACH, by pump station PLC or an outdoor manual switch, upon detection of elevated gas level or prior to entry to the space. The supply air temperature to be minimum 7°C. The air to be exhausted directly to the outdoor via a VFD exhaust fan ducted through the roof.

.2 An electric explosion proof unit heater controlled by the pump station PLC will maintain a minimum room temperature of 7°C under the unoccupied condition. The room temperature setpoint can be raised to 21°C by PLC prior to the space being occupied.

.3 The operation of the make-up air system shall be monitored by the pump station PLC system. Trouble alarm will be sent to the pump station's overall alarm system.

2.9.9 Plumbing System

.1 The building's domestic water service will connect to the utility's main from the City domestic water system. A backflow preventer shall be installed inside the building, directly downstream of the water meter, to serve the pump station.

.2 No bypass piping or other device capable of reducing the effectiveness of a backflow preventer shall be installed in a water supply system.

.3 Hose bibbs shall be provided inside the pump room and the generator room. A non-freeze hose bibb shall be provided on the building's exterior wall above the wet well.

.4 Where a hose bibb is installed outside a building or in an area where there is an identifiable risk of contamination, the potable water system shall be protected against backflow through the hose bibb.

.5 Air gap shall not be used in such noxious environment.

.6 Floor drains shall be provided inside the pump room, and the generator room. The sanitary drains will combine with the washroom sanitary and discharged into the wet well. A drain trap shall be provided upstream of where the sanitary main is discharged into the wet well for contamination protection. The plumbing vent stack will extend through and beyond the roof.

.7 All sanitary drain traps shall be primed from the water supply system using solenoid valves and electronic timers.

.8 The washroom shall include a flush-tank water closet and lavatory with hot and cold water supplies. An electric water heater shall be installed in the washroom to provide domestic hot water to the lavatory and eyewash station (if is provided).

.9 Roof drainage to be splashed to grade and directed away from the building. The splash points shall be located away from people and vehicle traffic areas to minimize dangerous icy patches from occurring in the winter.

.10 Provision for eyewash station may be required when hazardous chemical is to be processed and handled within the station. Tempered water for eyewash station shall be provided from the same water heater installed in the washroom.

2.9.10 Fire Protection

.1 Portable fire extinguishers shall be installed, located, and maintained in accordance with the requirements of the Alberta Building Code, the Fire Code of Canada, and the National Fire Protection Agency NFPA 10 "Standard for Portable Fire Extinguishers." Portable fire extinguishers to be mounted on brackets affixed to the walls in all areas.

.2 The requirement for portable fire extinguishers may be permitted to be waived where areas are not commonly occupied, and the approval of the Authority Having Jurisdiction has been obtained.

.3 Combustible gas detectors shall be located in the wet well, and shall be set to alarm at 10 percent of the lower explosive limit in accordance with the manufacturer's calibration instructions.

2.9.11 Natural Gas

.1 A gas supply line shall be installed to serve the pump station for the make-up air unit and other equipment. In addition to the shut-off valve required at the meter, a shut-off valve to be provided inside the pump station building.

.2 A gas meter with regulator to be located outside of the building. The location of the gas regulator and the associated vent shall be located with sufficient separation from the building fresh air intakes.

.3 A concrete pad is required for the installation of the gas meter per the service provider's requirements.

.4 Bollards shall also be provided to protect the gas meter from physical damage.

2.9.12 Area Classification

.1 The area classification of each distinct space within the pump station should be described, along with any requirements required to designate the area as such. The design should ensure equipment is rated to operate for the classification in the area.

.2 If an unclassified space is connected to a classified space via openings or unsealed wall penetrations in the wall, floor, or ceiling, positive air pressure shall be maintained in the classified space. Effective safeguards shall be provided against failure of the ventilation system, and an alarm light and horn shall be triggered in the event of a failure. Glands and/or seals shall be added between unclassified and classified spaces.

2.10 HEALTH & SAFETY

.1 The designer shall include all the provisions required to ensure the utmost health and safety of the personnel working in the building during construction as well as the operation of the facility. Refer to the City's safety standards and requirements.

2.11 ENGINEERING DESIGN DRAWINGS

.1 Engineering Design Drawings are to be submitted along with the detailed design package. The drawings should adhere to the City of St. Albert Municipal Engineering Standards.

.2 The Engineering Drawings shall include system head and pump curves for each forcemain, considering the wet well liquid level at its lowest and highest points and for each different pump operation combinations possible. The plans shall include a notation of the design basis, which shall specify the design friction coefficients, equivalent hydraulic length and design operating conditions. The Engineering Drawings shall also include the pump manufacturer's pump curve page of the technical information sheet with duty point clearly marked. The pump operation and building mechanical system operating/control philosophy shall be incorporated on the detailed design drawings

3.0 ELECTRICAL DESIGN REQUIREMENTS

3.1 General

.1 Cables and wires shall be labeled at all junctions, junction boxes and terminal boxes. Labeling to be referenced on drawings.

3.2 Stand-by Power

.2 At a minimum, the stand-by generator will have the following components:

a) An electrical single line diagram will be included in the design drawings to show the load requirements of each electrical component and the generator rating. At a minimum, generator sizing must take into account of all loads at the pump station. Sizing of the generator should be for all pumps running with up to one pump starting at any given time, taking into account the in-rush current of the pumps. The Design should ensure that only one pump starts at any given time.

b) Generator sizing calculations shall be submitted for City records.

c) Use models that are common to the North American market for the stand-by generator and stand-by generator engine with service and parts available upon 24 hours notice. The City will provide final approval of the recommended stand-by generator.

d) The stand-by generator will be fuelled by diesel. Double wall fuel storage tanks located inside the generator building with a level sensor that is brought back to the PLC and a visual level indicator. Fuel tank to be sufficient to run the standby generator at full load for a minimum of 24 hours. Alternative fuel sources must be approved of by the City. However, the generator must be able to be converted to natural gas.

e) There shall be an exterior mounted lockable fuel fill panel, complete with indicator lights and an audible level indication. The fuel fill cabinet shall be located to allow for a fuel truck to be located within 5 meters.

f) Size the stand-by generator so that 75% generator load capacity meets 100% of the total possible pump station electrical demand. Generator shall be sized to accommodate future loads. If the pump station is to be expanded over time, compare the life cycle of the generator to the projected timeline for expansion.

g) Generator engines will be cooled with radiators. The louvers for generator cooling must be powered directly by the generator.

h) A battery charger and block heater must be incorporated with stand-by generator.

i) When the generator is operation the noise levels adjacent to the pump station building cannot exceed the dBA requirements s outlined in the city's noise bylaw.

j) Generators shall be in a separate room where applicable.

k) Use an automatic transfer switch with full phase protection for the stand-by generator.

l) Test the stand-by generator to full load capacity to verify functionality. Any deficiencies must be recorded and repaired before CCC is issued. The results must be noted in the Commissioning Report. Documentation of the verification testing must be included in the Operations and Maintenance Manual.

3.3 Electrical Building Provisions

.1 At minimum, the pump station building will have the following:

a) Convenience receptacles (120V, 20A) will be provided inside and outside the building (including the washroom) for the use of appurtenant electrical devices. Outdoor receptacles will be located by entrances and be weather proof.

b) When there is a likelihood of expansion of the pump station in the future, future conduits for power cables that are through the walls and floors should be provided.

c) Single phase cut-out protection will be provided for three phase motors.

d) Lightning arrestors will be provided for the building.

3.4 Lighting

.1 All lighting at the pump station shall be LED type.

.2 Use explosion proof fixtures in wet wells. Fixtures shall be accessible without ladders, scaffolding or any special equipment.

.3 Motion sensing `and photo cell controlled light fixtures shall be added to the building exterior.

.4 Emergency lighting shall be included in the design and MUST be powered through battery packs and not through the generator. In addition, pictogram LED exit signs shall be provided.

3.5 Motor Control Centre (MCC)

.1 Provide 100 mm high housekeeping pads for the MCC (and other electrical equipment) mounted on the floor.

.2 Distribution panels must have 20% spare circuit breakers for future loads. This is in addition to any provisions made for future expansion of the pump station.

.3 A minimum of one spare MCC bucket shall be provided in additional to any provisions made for future expansion of the pump station.

.4 Panels must have provision for lockout/tag out for a minimum of two locks.

.5 HP rated electrical quick disconnects.

.6 Use LED type indicator lights for visual indicators. The convention to be used for indicating equipment status is:

.7 Device Off/switch open/circuit de-energized – redlight

.8 Device on/switch closed/circuit energized – green light

.9 Faults (include MiniCAS faults) – amber light

.10 A smart meter power monitoring GE Multiline or approved equal (non-revenue) will be included to monitor energy consumption and quality. This will be located inside the MCC, and interfaced to the PLC

.11 A hand-off-auto switch must be included in the MCC for the pumps, grinder and mixers (as applicable). On the main level of the wet well side, there will be a start/stop station and an emergency stop button for each of the pumps, grinder and mixer. The start stop functionalities shall be separate push buttons and the station will be labeled according to the pump number. City field staff will turn the HOA switch at the MCC and then use the start/stop station in the wet well. The main breaker, automatic transfer switch, and pump starters are to form a part of the MCC. Pump starters must have provision for VFDs, should they be used in the future. The transformer will be wall mounted above the 120/208V wall mounted distribution panel and not inside the MCC.

.12 If the MCC is not visible from the Start/Stop station, indicator lights (Green/Red/Amber) should also be displayed there. A level indicator display should be placed by the start/stop station to allow Operations to view the water level.

.13 MCC panels and switchgear to have labels indicating the Arc Flash incident energy rating. The arc flash labels shall follow the latest CSA Z462 standards. Arc Flash study report shall be submitted during the project stage (60%, 90%) as well as a final submittal at the end of the project. The electrical model should be completed using the latest version of ETAP and submitted to The City as part of the final submittal.

3.6 MOTORS

.1 Main pump motors shall operate on 600 volt, 60 Hz, 3 phase power. Pump drives shall be equipped with appropriately sized harmonic power filters for all process pumps. Pumps shall be powered by constant speed drives complete with pilot lights (run, fault), hour meters, and Hand-Off-Auto switch. Soft starter shall be supplied for each pump drive.

.2 Pump power and control junction box shall be located above the highest anticipated flood elevation but still remain accessible. The power and control cables between the pump and the jjunciton box shall be easily removable and replaceable when the pump is removed or replaced.

3.7 INSTRUMENTATION

3.7.1 Requirements

a. A magnetic flow meter is required on the discharge header with a bypass line around the meter. Metering accuracy shall be no less than actual flow +/- 1%.

b. Pressure transmitter with valve manifold to be installed on discharge header.

c. 12mm pipe taps with shut off valves suitable for quick connect pressure gauges shall be provided on each pump suction and discharge. Locations of these taps shall be easily accessible.

d. An ultrasonic level instrument is required and to be installed in stilling well. The level control instruments are to be installed so that it can be activated or removed from the wet well platform for testing and servicing. Water level control sensing devices should be located so that performance is not affected by turbulent flows and so that cables do not get tangled. Level sensors require intrinsically safe barriers if installed in a hazardous location.

e. Two (2) backup level bulbs are required. Each level bulb is to be installed such that it can be removed from the wet well platform level for cleaning and servicing. All level bulbs installed in hazardous rated areas are required to be intrinsically safe or be connected to intrinsically safe barriers. The level control bulbs are to be hard wired to a pump control system (separate from the PLC) that will take over control of the pumps if the PLC fails. High level shall start the pumps automatically and low level shall stop the pumps automatically.

f. The dry well sump shall be equipped with a flood detection level bulb that is connected to the PLC.

g. Level instruments shall be terminated in junction boxes located above the wet well sump in an area above the flood zone, and connected to intrinsically safe interfaces. A

h. Smoke and/or heat detector to be located in the electrical and generator room.

i. All exterior doors and hatches shall have switches for intrusion alarms connected to the PLC.

<u>PART II – MATERIALS</u>

4.0 Pump Station Equipment

.1 The City of St. Albert encourages consistency and standardization in the design and construction of pump stations and all equipment make and model shall be provided during the preliminary design for City's review and approval.

.2 The pumps including sump pumps shall be suitable for wastewater application and preferably manufactured by Xylem, Sulzer or approved alternate.

.3 The piping inside the pump station and exterior buried pipe within the pump station shall be stainless steel or steel with corrosion resistant coating.

.4 Combination air valves shall be ARI or approved alternate with non-slam discharge throttling attachment.

.5 Electric hoist shall be Kito or approved alternate.

.6 All davit bases shall comply with the City's safety requirements and be compatible with the existing safety equipment. Please consult with the City during preliminary design stage.

PART III – CONSTRUCTION

5.0 PUMP STATION CONSTRUCTION DOCUMENTATION

5.1 Operation and Maintenance Manuals

.1 Details regarding the temporary or phased construction must be included in the Operations & Maintenance Manual explaining the nature of each temporary or phased construction element.

.2 Two hard copies and one digital copy of the manual are to be provided prior to the transfer of facility operation to City, as well as a version in electronic format compatible with the City's computer software. This will generally be at the time of approval of a construction completion certificate (C.C.C.). When completion of a finalized manual prior to C.C.C. is not feasible, then to facilitate the timely transfer of operational responsibility, the Engineer may accept an interim form of the operation maintenance and service manual at C.C.C.. The completed final version of the manual must be provided prior to approval of a final acceptance certificate for the improvement. If a C.C.C. inspection occurs after October 15 of any year, additional warranty is required as described in Appendix B-2 of the City of St. Albert Municipal Engineering Standards.

.3 The Manual shall include:

a) Complete equipment manufacturers' operation, maintenance, service and repair instructions and complete workshop manuals and parts lists for all mechanical and electrical equipment, including all control diagrams and schematics with wires individually numbered and identified. Each set shall be firmly bound in a hard-covered binder and include test results and calibration of all equipment from commissioning and testing conducted by the equipment manufacturers and engineer prior to the application for a construction completion certificate.

b) A description of the nature and function of the station:

- Name and address and name of developer
- Type of effluent
- Location and size of contributing area in terms of the design number of lots and industrial and commercial effluent flows and gross storm drainage area
- Drawing showing the contributing area boundary, pump station location and forcemain alignment
- Statement of the control sequence identifying the controlled equipment and set point values including any equations or tables of values from which set points are derived, including operation of backup facilities such as emergency generators and storage tanks
- List all monitored quantities, statuses and alarms and their set point values
- Instrument calibration and device settings

5.2 As-built Drawings

- As-built Drawings showing all changes from approved drawings.

5.3 Miscellaneous Items

- Control Process Narrative
- Issued for Tender Drawings for City Built Pump Stations
- Issued for Construction Drawings (City-Built) /Final Detailed Design Drawings (Developer-Built)
- Contract Specifications
- Shop drawings for all equipment including valves, pumps, generators, MCC, PLC etc. and Factory Acceptance Testing documentation.
- PLC Program in PDF and submitted electronically on a USB Drive
- Commissioning Report (outlining deficiencies)
- Record Drawings should conform to Article 1.21 of the City of St. Albert Municipal Engineering Standards.
- Construction Completion Certificate (CCC)
- Final Acceptance Certificate (FAC) as outlined in Article 1.22 of the City of St. Albert Municipal Engineering Standards

APPENDIX B

City of St. Albert

Sanitary Lift Stations
Control Project Standards

May 2019

Table of Contents

List of Tables

1 Introduction

The purpose of the Sanitary Lift Station Control Project Standards is to clearly define the products used for the control of the sanitary lift stations' infrastructure, the signalling requirements of equipment within the facility, and the communications requirements to allow for control from a central Master HMI.

Note that all tags used in this document are general. Refer to the City of St. Albert's Standards for tagging convention.

1.1 DEFINITIONS

In these Standards, unless suggested otherwise by context, the following definitions will apply:

.1 "City" will refer to the City of St. Albert.

.2 "City Engineer" will refer to the professional engineer, or designated representative, authorized by the City to authorize changes to these Standards.

.3 "Commissioning Program": The Commissioning Program is responsible for transitioning the installed equipment into a fully integrated and live operating facility. The Commissioning Program consists of six phases: Planning, Pre-Start-Up, Start-Up, Site Acceptance Testing, Commissioning and Performance Acceptance.

.4 "Commissioning Plan": The Commissioning Plan defines the scope, roles, responsibilities, systems, subsystems, schedules and testing procedures for the Commissioning Program.

.5 "Commissioning Team": The Commissioning Team consists of the Commissioning Manager, Commissioning Operator, Owner, Contractor, Subcontractor and Engineer.

.6 "Commissioning Manager": The Commissioning Manager is the individual or firm responsible for the planning, preparation, implementation and management of the Commissioning Program. They are also responsible for coordinating the activities of the Commissioning Team members.

.7 "Commissioning Operator": The commissioning operator is a qualified operator responsible for coordinating with the Commissioning Manager and Contractor for starting up the systems and managing the daily operations and maintenance until Substantial Performance. They are required to ensure a satisfactory transfer of knowledge to ensure the Owner's Operator can operate the facility.

.8 "Commissioning Planning": The planning phase covers pre-work involved to develop the Commissioning Plan and execute the Commissioning Program. This is the responsibility of the Commissioning Manager and includes the preparation of the Commissioning Plan, scheduling of commissioning meetings, preparation of training plan, development of checkout lists and collation of all other necessary documentation to execute the Pre-Start-Up Phase.

.9 "Commissioning": Commissioning consists of placing all the various systems in Work into continuous automatic operation in an orderly manner. The Contractor is responsible for the commissioning activities and shall have the equipment manufacturer representatives at the site, as well as qualified mechanical, electrical, control and instrumentation personnel. The Contractor may be assisted by the City Engineer relative to process considerations and by Owner's operations and maintenance staff.

.10 "Contractor" will mean the person, firm, or corporation that undertakes the installation of municipal infrastructure on behalf of the Developer or the City.

.11 "Design" will mean the designs, reports, studies, engineering drawings, technical specifications, and associated documents, including the execution and implementation of such, pertaining to a Development, Subdivision, or other municipal improvement within the City of St. Albert.

.12 "Designer" or "Consultant" will mean the professional engineer responsible for the Design. Where applicable throughout these Standards, this term may refer to or include the Landscape Architect.

.13 "ERIO" will mean the Ethernet Remote I/O modules are RIO modules that communicate to the PLC via IP over Ethernet hardware.

.14 "Ethernet" will mean a physical implementation of IP hardware. This includes ethernet switches, ethernet cables, fibre ethernet, etc.

.15 "EDIO" will mean the Ethernet Distributed I/O are Ethernet-enabled devices that provide industrial automation communications. These allow a PLC to request data from the device using ethernet communications.

.16 "Engineering Drawings" will mean the detailed engineering drawings and specifications prepared by the Consultant for a Subdivision that form part of a development agreement.

.17 "Factory Acceptance Test (FAT)": A complete off-site simulated test of control system PLC and HMI logic.

.18 "HART" will mean the Highway Addressable Remote Transducer. A protocol used to transmit additional signals superimposed on a 4-20 mA analog signal.

.19 "HMI" will mean the Human Machine Interface. This is an appliance or software program that provides a graphical interface to an operator allowing the operator to steer the process control system.

.20 "HOA" will mean Hand/Off/Auto. A three-position selector switch that chooses between local-on (Hand), Local-off (Off), or Remote (Auto) operation.

.21 "IP" will mean the Internet protocol. The basic protocol used for all internet communications.

.22 "IGMP" will mean Internet Group Management Protocol. This is a communications protocol in use by some equipment that produces multicast traffic that can congest industrial systems.

.23 "MODBUS TCP" will mean the Modbus protocol wrapped in TCP. This allows industrial automation devices to communicate over IP network infrastructure.

.24 "PCS" will mean the Process Control System. This is the system of controllers, networks, instruments, computers, software, etc. that are used in the control of a process.

.25 "PLC" will mean the Programmable Logic Controller.

.26 "Performance Acceptance": Performance acceptance is considered to be complete when all systems have been operating continuously for a period of the cities choosing (normally 720 hours) without fault and in accordance with the specified performance requirements. Performance must be demonstrated to be in compliance with the intent for which it is installed.

.27 "Pre-Start-Up: Consists of the non-operating functions required to bring Work to a state of readiness for placing systems into service. It includes, but is not limited to: cleaning, leakage and pressure testing, cold alignment checks, disinfection, system flushing, lubrication of mechanical equipment, rotation checks and wiring loop checks. Contractor shall conduct inspections of all components and sub-components and shall arrange for inspections of equipment installations by qualified equipment manufacturers' representatives as required by Contract Documents. At this stage, deficiency lists are prepared, and Contractor is to remedy outstanding incomplete or incorrect work in accordance with terms of Contract. Contractor shall obtain completed Equipment Installation Certification Forms for each specified piece of equipment and shall submit these to Engineer for review.

.28 "Prime Contractor" has the meaning assigned by the Occupational Health and Safety Act – Alberta.

.29 "Ready-to-Start": Once the City Engineer is satisfied that each piece of equipment in a system or subsystem has been properly checked out and all apparent deficiencies have been remedied, a Green tag shall be placed on the equipment designating that the Pre-Start-Up Phase for that particular system is complete.

.30 "RIO" will mean the Remote Input/Output modules that provide I/O in locations distant from the main PLC. These do not have any local processing power and require communications to a PLC to control a system.

.31 "SCADA" will mean Supervisory Control and Data Acquisition. The system that acquires data from geographically separate locations and provides some control or visibility to an operator or manager.

.32 "SCC" will mean the Standards Council of Canada. This organization accredits testing laboratories.

.33 "Standards" refers to the latest version of these municipal engineering standards in their entire scope, as further defined in Article 1.3.

.34 "Start-Up": Once each piece of equipment within a defined system carries a "Ready-to-Start" tag, then that individual system shall be started and tested. Contractor shall conduct performance tests of all equipment in conjunction with the manufacturers' representatives as required by the Contract Documents and under the witness of Engineer. Deficiencies that are uncovered shall be corrected and retesting shall be conducted as required. Start-Up Completion Certificates shall be prepared by Contractor certifying that the equipment or system is complete, successfully tested, started and ready for commissioning and continuous operation.

.35 "Site Acceptance Test (SAT)": A complete on-site live test of the facility's control systems against the Control Philosophy completed after the system Start-Up and prior to the Commissioning Period beginning.

.36 "Strong Password" will mean that a strong password is at least 8 characters and must be checked prior to use against a blacklist of compromised passwords.

.37 "TCP" will mean the Transmission Control Protocol. A sub-protocol of IP. It includes checksums to ensure that all data is successfully delivered and uncorrupted before processing the data.

.38 "UPS" will mean Uninterrupted Power Supply. A backup power system that provides emergency power in the event of a power failure. A UPS seamlessly takes over in a power failure and is intended to outlast brief power interruptions.

.39 Facilities:

a) "DRLS" means the Deer Ridge Lift Station.
b) "ERLS" means the Erin Ridge Lift Station.
c) "FHLS" means the Fire Hall Lift Station.
d) "GALS" means the Gate Avenue Lift Station.
e) "GPSF" means the Glacier Park Storm Facility.
f) "HBS" means the Henday Booster Station.
g) "JKPW" means the Jack Kraft Public Works Facility.
h) "KWDP" means the Kingswood Day Park Sanitary Lift Station.

i) “LLP” means the Lacombe Lake Park Facility (Lift Station).
j) “LPS” means the Lacombe Pup Station and Reservoir.
k) “MHG” means the Mission Hill Grinder Sanitary Installation.
l) “OLS” means the Oakmont Lift Station.
m) “OPS” means the Oakmont Pump Station and Reservoir.
n) “RCLS” means the Rivercrest Lift Station.
o) “RPALS” means the Riel Park Amenities Lift Station.
p) “RPRVLS” means the Riel Park RV Lift Station.
q) “RRLS” means the Riel Road Lift Station.
r) “RSLS” means the Riverside Lift Station.
s) “SPS” means the Sturgeon Pumphouse and Reservoir.
t) “TLS” means the Twilight Sanitary Lift Station.
u) “WLS” means the Walmart Storm Water Lift Station. This site will be decommissioned by the City, so there is not any scope of work included.

1.2 REFERENCE STANDARDS

.1 NIST Special Publication 800-63B.

.2 AWWA Process Control System Security Guidance for the Water Sector.

.3 ANSI/ISA 62443-3-3 99.03.03-2013 Security for Industrial Automation and Control Systems Part 3-3 System Security Requirements and Security Levels.

.4 ANSI/ISA-101.01-2015 – Human Machine Interfaces for Process Automation Systems

1.3 REFERENCE DOCUMENTS

.1 Lift Station Control Philosophy.

1.4 OBJECTIVE

.1 The purpose of this standards document is to guide the development of the City of St. Albert’s sanitary lift station infrastructure in a consistent and predictable manner. The information contained in this standard is specific to sanitary lift stations and is intentionally generic. Specific design requirements, conditions, area classifications or code changes may require deviation from this standard and will need to be approved by the City before implementation. This standard should be followed as closely as possible for consistency between lift stations.

.2 The generic lift station design criteria will consider instrumentation, SCADA integration, radio connectivity, PLC/HMI hardware and software, control cabinet design, generator integration, gas monitoring requirements, building security, and cyber security. A generic lift station control philosophy is available from the city and provides the basis for lift station programming. The control philosophy assumes a typical two-pump station in a duty/standby arrangement using standardized PLC hardware and instrumentation.

2 Controller and HMI

2.1 HARDWARE

.1 Schneider M580 PLC controllers will be used in combination with panel-mounted Schneider Magelis HMI touchscreens.

.2 The PLC backplane will be an Ethernet (BME-series) Backplane sized to allow room for at least 20% spare slots. Spare slots will be equipped with slot covers. Where multi-rack configurations are needed, only use Ethernet backplanes with ERIO drop adapters. An individual PLC power supply is required for each rack. 36 W, 120 VAC PLC rack-mounted power supplies must be used.

.3 Where ERIO is used, an ethernet ring architecture will be used. Where rings are used, no two ring branches will run in the same conduit or cable.

.4 All new installations will use 24 VDC instrumentation and I/O cards. Where HART capable instrumentation is present, separate HART analog input cards will be included. Provide screw-in terminal blocks as needed to suit the I/O card.

.5 New installations with more than one pump will include at least two of each of the Discrete Input and Discrete Output modules. Split pump controls, and signals from other equipment with redundancy, between each of two cards to provide redundancy in case of card failure.

.6 In retrofit applications, match PLC cards in voltage and quantity of I/O as closely as possible to existing to minimize wiring and/or equipment changes. Only retrofit installations will use 120 VAC cards. All retrofit installations will continue using the same voltage for PLC and Instrumentation as is currently present.

.7 All new and retrofit installations will use 24 VDC solid-state non-isolated discrete output cards with interposing relays per device.

.8 Table 2-1 identifies standard PLC equipment for new installations. Quantities will vary with specific site requirements. Existing installations have more flexibility with the PLC modules, as these may be varied to match closer with existing controller I/O.

.9 Where HMI is installed outdoors, the cabinet will be a door-in-door type installation. The HMI will be mounted on the interior door, and the cabinet will be heated to ensure HMI temperature remains above 0°C, while operating. HMI will be 12" or greater. Give preference to indoor locations when selecting a location for an HMI.

.10 Mount HMIs 1500 mm above floor or concrete slab grade: typical eye level height.

.11 Provide HMIs with an SD card. Save the final configuration and graphics to this SD card.

.12 Provide PLCs with an SD card. Save the final configuration to this SD card.

.13 Only in-rack MODBUS RTU modules will be permitted, no external adapters will be accepted.

.14 All analog signals must use 4-20 mA signaling.

.15 At least one Analog Input card per site must be capable of reading and requesting data using HART Communications.

.16 Intrinsically safe (IS) barriers will be used where instruments are located inside a wetwell or other hazardous areas.

.17 Where Flygt pumps are used, Minicas relays or approved alternate pump-control relays suited for the specific submersible pumps will be used to provide signalling to the control system.

Table 2-1
Standard PLC Equipment for New Installations

Manufacturer	Description	Model Number
Schneider	M580 Central Processing Unit – 1 Ethernet TCP/IP Service Port, 2 Ethernet TCP/IP Device Network Ports	BMEP582020
Schneider	X-Bus and Ethernet Backplane – DIN Rail Mounting	BMEXBP****
Schneider	X80 Ethernet RIO Drop Adapter	BMECRA31210
Schneider	X80 120 V_{AC} Power Supply	36W – BMXCPS3500
Schneider	X80 24 V_{DC} Discrete Input Module – 16 pts	BMXDDI1602
Schneider	X80 24 V_{DC} Discrete Output Module – 16 pts Solid-State Output	BMXDDO1602
Schneider	X80 Isolated Analog Input – 8 pts	BMXAMI0810
Schneider	X80 Isolated Analog Input HART – 8 pts	BMEAHI0812
Schneider	X80 Isolated Analog Output – 4 pts	BMXAMO0410
Schneider	X80 Slot Cover	BMXXEM010
Schneider	X80 Serial Card	BMXNOM0200
Schneider	12.1” Magelis GTO Advanced Touchscreen Panel	HMIGTO6310

2.2 SOFTWARE

.1 Schneider Vijeo Designer V13.0, the HMI graphical development package, is used to develop the Magelis HMIs. A copy of the HMI configuration and graphics, compatible with this version of Vijeo will be provided to City after the project is completed. The configuration and graphics will not be password-protected and will be provided in editable form. The HMI configuration and graphics will be set to be retrievable from a PC that does not have a working copy of the existing configuration and graphics. Alarms may be displayed and acknowledged using this program.

.2 Schneider Unity Pro Extra Large V13.0, the PLC programming software package, is used to program the M580 PLCs. Both an archive (.STA) and a live backup will be provided to the city natively programmed in this version of Unity Pro. The program will not be password-protected and will be provided as editable code.

.3 Schneider Wonderware 2017, an industrial HMI program, is used at the Jack Kraft facility to monitor all remote sites. Graphics displaying the status of each remote site are created in this program, displaying important values from each site. Alarms may be displayed and acknowledged using this program.

.4 Win911, an industrial software alarm dialing program is used at the Jack Kraft facility to call out alarms from all remote sites.

3 Control Cabinet Design

3.1 ENCLOSURES

.1 Control cabinets will be NEMA 12 rated and approved by an SCC-accredited testing laboratory.

.2 Size control cabinets to accommodate control system equipment plus 20% spare.

.3 Cabinets will use LED cabinet lighting wired to a door switch.

.4 Where free-standing enclosures are used, cabinet to be installed on 100mm thick concrete housekeeping pad. Where wall-mount enclosures are used, the cabinet will be mounted on the wall using appropriate anchors and channels.

.5 All cabinets will be furnished with suitable back panel.

.6 Interior cabinet door will have a data pocket for storing drawings, CD containing PLC, HMI program, etc. All cabinets will be labelled with Lamicoid Tags identifying the cabinet number: “CC-XXX”, using 20 mm high lettering where “XXX” represents a three-digit index. Coordinate with city to ensure that the three-digit index is unique.

.7 Outdoor cabinets will be fully insulated and complete with suitably sized 120 VAC strip heaters. Heater sizing should consider electrical heat loading from other equipment installed within the cabinet to prevent overheating. Heaters are to be controlled using adjustable thermostats. Heaters will be installed at or near the bottom of the cabinet. Outdoor cabinets will have suitably sized fans and louvres for summer ventilation cooling to keep temperature at or below maximum operating temperature of equipment inside. All air intakes will be filtered. Fans are to be controlled using adjustable thermostats.

.8 Within the cabinet, all wiring will be routed through wiring ducts, at least 50 mm wide and 100 mm deep with covers. These ducts will be sized for instrument wiring plus 50% spare.

.9 Table 3-1 identifies standard control cabinet equipment.

Table 3-1
Standard Control Cabinet Equipment

Manufacturer	Description	Model Series
Hoffman	NEMA 12 Painted steel enclosure: CSA approved; lockable.	Hoffman Mild Steel enclosures (or equivalent)
Hoffman	Back panel: Supplied with enclosure and powder coated	Hoffman 12-gauge steel panels (or equivalent)
Hoffman	Cabinet Light w/ Door Switch	Hoffman PANELITE (or equivalent)
Weidmüller	(2) 24Vdc Power Supply, sized to suit	ProMAX series
Weidmüller	(1) 24Vdc Redundancy Module, sized to suit	PRO RM series
Weidmüller	Duplex AC Receptacle – DIN rail mounted	21T9208 (or equivalent)
Weidmüller	Slotted Steel Rail	TS35 (or equivalent)
Weidmüller	Terminal	WDU 2.5 (or equivalent)

Manufacturer	Description	Model Series
Weidmüller	Fused Terminal w/ LED indicator	WSI 6LD (or equivalent)
Weidmüller	Ground Terminal	WDE 2.5 (or equivalent)
Omron	Relay Terminal w/ LED indicator	G2R-1 Series (or equivalent)
Hoffman or equivalent	Data Pocket	ADP1 (or equivalent)
Phoenix Contact	5-Port Managed Ethernet Switch	FL Switch 2205 (or equivalent)
PolyPhaser	Lighting Arrestor	Provided by Radio Vendor

3.2 ELECTRICAL REQUIREMENTS

.1 AC power will be filtered with an Eaton AEGIS power filter installed in series. This will be used to feed a 120 V_{AC} UPS. The UPS will be an Eaton PowerWare 9130 series with integral bypass switch with 1500 VA minimum, but sized to allow for 30 minutes of control system runtime.

.2 UPS will be provided with relay-interface card following AS/400 standards. Relay interface card will be used to provide signalling to the PLC.

a) Signals:
- Battery Low (Discrete, Normally-Open)
- Fault (Discrete, Normally-Open)
- UPS on-Battery (Discrete, Normally-Open)

.3 Provide an isolated instrument grounding bar, with dedicated green TWU wire to electrical ground. Provide electrical grounding bar, with dedicated wire to electrical ground.

.4 DC Power Supplies will include over-voltage shutdown, 120 V_{AC} inputs, and approval by an SCC-accredited laboratory. Dual supplies will be used with redundancy modules. Size power supplies to accommodate full 24 V_{DC} loading of PLC cabinet and all connected instruments, including loop powered devices with capacity for a 20% increase. DC power supplies will provide signals to the PLC.

a) Signals:
- Power Supply 1 Fault (Discrete)
- Power Supply 2 Fault (Discrete)

.5 Provide at least one Duplex 120 V_{AC} convenience receptacle in the cabinet, not powered from the UPS. Provide machine-printed label indicating “Utility-Powered”.

3.3 HAZARDOUS AREAS REQUIREMENTS

.1 All instrumentation and equipment installed within hazardous areas must be rated according to the explosive area zone classification. These requirements apply where equipment is modified or installed new.

a) Typically, the wetwell will be considered a Class I Zone 1 hazardous area.

b) If a drywell is present, and shares a wall with a wetwell, all equipment installed within it will be considered a Class I Zone 2 hazardous area.

c) If a building is installed atop a ventilated drywell, it will be considered an ordinary location with no corrosive, flammable, or explosive atmospheres.

d) If a building is installed atop an unventilated drywell, it will not be considered a hazardous location, but it will be considered a Category 2 location in which corrosive liquids, vapours, or excessive moisture are likely to be present.

e) If a building is installed atop a wetwell and has adequate continuous positive pressure ventilation, all electrical equipment must be installed as though it were a Class 1 Zone 2 location.

f) If a building is installed atop a wetwell and does not have adequate continuous positive pressure ventilation, all electrical equipment must be installed as though the building is a Class 1 Zone 1 location.

.2 Instruments will use 24 VDC as a power supply, especially in zone-rated areas.

.3 All wiring in the wetwell will terminate in a junction box outside the hazardous and/or corrosive area. Conduits from this junction box leading to the control cabinet will be sealed. This will facilitate equipment replacement on the wetwell side without breaking the seals.

.4 Instruments in the wetwell or other Class I Zone 1 Areas will use intrinsically safe barriers for all wiring entering the hazardous area with conduit seals on the wiring.

.5 All instrumentation in hazardous locations should be 24 VDC and have suitable intrinsically safe (IS) barriers. The IS area will be separated by barriers from non-IS portions of the cabinet and IS wiring will be identified with blue wiring duct. IS wiring will not be mixed with wiring that is not zone-rated.

.6 Only zone-rated lights, switches, and motor disconnects may be used in the hazardous area. Starters or VFDs may not be installed in the hazardous area. All motor and PLC controls will be installed in the non-hazardous area.

3.4 CONTROL EQUIPMENT AND TERMINALS

.1 Selector switches will be water and dust-proof with internal gasket, standard black lever actuator, maintained position.

.2 Control Relays will come with built-in LED operation indicator, push-to-operate button, and be approved by an SCC-accredited laboratory. Contacts will be able to switch 5A 120/240 VAC inductive or resistive.

.3 Terminal strips and wiring will be labelled with machine-printed text. Write-on labels are not acceptable.

.4 Power distribution will be designed with the use of master- and sub-fusing for each instrument or device.

3.5 COMMUNICATIONS EQUIPMENT

.1 Ethernet Switch:

a) All control cabinets including a PLC will include a DIN-rail mounted managed Ethernet switch. Minimum Specifications:

- Five 100BASE-TX Ethernet ports

- IGMP packet snooping and an IGMP querier.
- Status Contact
- 24 V_{DC} input power

b) Base Models:

- Phoenix Contact FL-SWITCH 2000 Series
- Hirschmann RS20 series
- Approved alternates.

c) The PLC, HMI, and all other Ethernet equipment will be connected to the managed switch. IGMP packet snooping, and querying must be enabled on the network switch. The switch will have its firmware updated to the most recent stable version available at the time of installation. The managed switch will be password protected by a Strong Password provided by the City. The City will provide IP network addresses to be used.

d) Signals:

- Switch Fault (Discrete, Normally Closed, Open on fault or power fail).

.2 Radio:

a) Licensed GE SD4 400 MHz radio, antenna with PolyPhaser lighting arrestor c/w dedicated ground wire, wired to main ground bus in cabinet.

b) Connect in-rack serial card to radio. Provide serial cables as required.

4 PCS Design

4.1 POWER METER

.1 Where a power meter is present, some data may be integrated into the PLC. All new installations shall be provided with a power meter.

a) Where its data is available via Modbus TCP, the power meter will be connected to the managed Ethernet Switch. The following signals will be provided via Modbus TCP to the PLC and made available on the HMI.

- Overall Power (kVA) (Analog).
- Overall Power (kW) (Analog).
- Power Factor (Analog).
- Phase A Voltage (V) (Analog).
- Phase B Voltage (V) (Analog).
- Phase C Voltage (V) (Analog).
- Phase A Current (A) (Analog).
- Phase B Current (A) (Analog).
- Phase C Current (A) (Analog).
- Utility Power Fail Alarm (Discrete, Normally Closed).

b) Where its data is not available via Modbus TCP, but has available analog and discrete signals, the following signals will be wired to the PLC and made available on the HMI.

- Overall Power (kVA) (Analog).
- Overall Power (kW) (Analog).
- Overall Voltage (V) (Analog).
- Utility Power Fail Alarm (Discrete, Normally Closed).

4.2 BACKUP POWER SYSTEM

Where backup is provided by a permanent generator, the following signals will be integrated into the PLC, either using direct-wired signalling or over Modbus TCP.

.1 Generator:

a) Running Status (Discrete).
b) Fault Status (Discrete, Normally Closed).
c) Not-in-Auto (Discrete, Closed when in Auto).
d) Fuel Level (mm) (0 mm = empty) (Analog).

.2 Automatic Transfer Switch

a) On Utility (Discrete) (Close on utility).
b) On Generator (Discrete) (Close on Generator).
c) Fault (Discrete) (Close on Fault).
d) Power Fail Alarm (Discrete) (Open on failure of both Utility and Backup Power supplies).

4.3 BUILDING EQUIPMENT

.1 Temperature:

a) Industrial high and low temperature switches. Type as specified by others. Quantity as required for heating and cooling design. Provide auxiliary contact to PLC for at least one of each high- and low-temperature switch per room, as available. All temperature switches should display units of °C.

b) Signals:

- High Temperature (Discrete, Close on Falling Temperature).
- Low Temperature (Discrete, Close on Rising Temperature).

.2 Security: Security system as specified by others. The security system will provide one normally-closed contact to the PLC which will open in an intrusion alarm state.

a) Signals:

- Security Alarm (Discrete, Normally Closed).

.3 Smoke Detection: Smoke detection as specified by others. Smoke detector system will provide one normally-closed contact to the PLC which will open in a smoke-alarm state from any smoke detector. Signals:

a) Smoke Alarm (Discrete, Normally Closed).

.4 H2S Transmitter:

a) Sensor as specified by others. Only applicable where required in the station.

b) Signals:

- H_2S Concentration (ppm) (Analog).
- Fault (Discrete, Normally Closed).
- High Concentration Alarm (Discrete, Normally Closed)
- High-High Concentration Alarm (Discrete, Normally Closed).

4.4 INLET GRINDER

Where an inlet grinder is provided in the lift station, the following signals will be provided to the control system.

.1 Grinder

a) Run Status

b) Common Fault Alarm

4.5 INSTRUMENTATION

Flow meter, level transducer, and other instruments installed in hazardous areas must be rated for the hazardous area in which they are installed. See section 3.3.

.1 Flow

a) Flow Transmitter Signals:

- Flow (L/s) (Analog).
- Flow Total (m^3) (Analog Via HART protocol).

- Fault (Discrete).

.2 Pressure

a) Pressure Transmitter Signals
- Pressure (kPa) (Analog).

.3 Level Signals

a) Level transmitter will be complete with anti-submergence shield.
b) Level Transmitter Signals:
- Level (mm) (0 mm = empty) (Analog).
- Fault (Discrete).

c) Low-Low and High-High backup bulbs
- Low-Low Level Alarm (Discrete, Close on Rising Level).
- High-High Level Alarm (Discrete, Close on Falling Level).

4.6 HARDWIRED PUMP CONTROL

.1 Signals from each motor/starter/pump:

a) Remote/Off/Local Switch: Remote Status (Discrete, Close on Remote Status).
b) Fault Alarm: Fault/overload Status (Discrete, Close on Fault).
c) Leak Detected (If available): Leak Alarm (Discrete, Close on Fault).
d) Pump Overtemperature (if available): Overtemperature Alarm (Discrete, Close on Fault).

4.7 TYPICAL CONTROL PHILOSOPHY

.1 Two (2) pump lift station with Duty/Standby configuration. Refer to Appendix A.

.2 Three (3) pump lift station with Lead/Lag/Standby configuration. Refer to Appendix A.

4.8 ALARMING

.1 All alarm calling is handled via the Master HMI located at JKPW. There will be no local alarm dialers.

.2 Alarm Acknowledgement states will be shared between the local site and the Master HMI such that if an alarm is acknowledged at the local site, it will appear as acknowledged at the Master HMI.

4.9 CYBER SECURITY

.1 Provide a copy of the HMI program, PLC program, Memory Map, and Ethernet switch configuration to the City after the project is complete in a version compatible with the software versions listed above. Provide passwords, including operator and management passwords for HMI, and management ethernet switch password to the City.

.2 Ensure HMI and PLC have machine-retrievable code/configurations without having access to live code.

.3 Install machine-printed labels on all IP-enabled and Serial equipment in the PLC Cabinet, identifying the device serial or IP address.

.4 Network separation will be maintained. At no point should non-PCS networks or devices be connected to the PCS. PCS devices should not be able to access the internet.

.5 Ensure that HMI displays are password protected by a Strong Password common to all operators; provided by the City.

5 SCADA Configuration

5.1 SCADA COMMUNICATIONS CONFIGURATION

.1 Each remote site PLC will be programmed to collate all information that will be displayed at the JKPW into two blocks of contiguous registers, numerically separated from the registers used in the local station operations. One set of registers will be used for “read-only” information, such as values and statuses. The second set of registers will be used for “write” information, such as setpoint and command entries. The Master PLC in JKPW will query the remote site PLC for this data. Provide at least 20% spare registers in these ranges for potential expansion of read and write information.

.2 The Local PLC must be programmed such that if values are modified from the local HMI, they are accepted and retained. The Local PLC must also be programmed such that if values are modified from the SCADA HMI by way of the Master PLC, they are accepted and retained. If communications between the Master PLC and Local PLC are interrupted, the local PLC will continue to operate as normal.

.3 The JKPW HMI will display copies of all remote site screens. This computer also runs the common alarm dialing program for the PCS. If any remote site receives an alarm, or if communications to any remote site are lost, the HMI computer at the JKPW is configured to call operators. If alarms for this site are acknowledged at JKPW, this acknowledgement will be passed to the local HMI. If alarms at the site are acknowledged at the local HMI, the alarms for that site will be acknowledged at JKPW.

.4 Each remote site will be able to be fully controlled both from the local HMI, and from the JKPW master HMI. All values will be displayed at both sites, and all actions able to be taken from the local HMI must be able to be taken from the JKPW master HMI.

.5 A complete memory map of all registers to be used by the JKPW will be provided to the City. A complete alarm list must also be provided to the City.

.6 The remote site PLCs will not initiate any communications: all communications will be initiated by the Master PLC in the JKPW. The Master and remote sites will exchange “heartbeat” signals to be used in determining if a communications failure has occurred.

5.2 SERIAL RADIO CONFIGURATION

.1 The remote site will communicate with the JKPW master PLC via GE SD4, 400 MHz, serial licensed radios using the Modbus RTU protocol.

.2 Where radio towers are required, CSA towers will be used.

a) Towers must be complete with suitable anti-climb guards, and appropriate obstruction marking and lighting as required by regulations.

b) Obstruction lighting must be provided a dedicated circuit and breaker.

.3 Vendor will configure radio and verify that communications are successful as well as register the site with Industry Canada under the existing City license.

.4 The developer is responsible for following the City’s development standards, regarding antenna infrastructure, including the application process and community consultations, as required.

5.3 REMOTE ACCESSIBILITY

.1 No remote accessibility to the sanitary lift stations is planned other than serial radio communications to the Master PLC. The sites will be stand-alone. Remote viewing of the remote site status will be available via the JKPW.

6 Commissioning Program

6.1 QUALIFICATIONS, ROLES & RESPONSIBILITIES

6.1.1 Commissioning Manager:

.1 Experience and Qualifications:

a) When commissioning services are warranted, a professional engineer or qualified operations specialist is to be appointed as a Commissioning Manager to manage, implement, and coordinate the Commissioning Program. Qualifications to include minimum 5 years' experience in managing the testing, start-up and commissioning of mechanical, building, electrical, instrumentation, piping systems, control systems and operating process systems.

b) Commissioning Manager cannot be the project manager, superintendent, construction manager.

.2 Responsibilities:

a) The Commissioning Manager will be responsible for planning, preparation, coordination, implementation and management of the Commissioning Program including detailed co-ordination of the commissioning operator, owner's operator, contractor, engineer and owner.

b) Schedule, chair, minute and attend all commissioning meetings.

c) Develop the Commissioning Plan for review and acceptance by the City Engineer and Owner.

d) Develop the commissioning schedule for review and acceptance by the Engineer and Owner. Must include all phases (Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance) of the Commissioning Program.

e) Provide a detailed list and schedule of specific tasks for each system, subsystem and equipment throughout all phases (Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance) of the Commissioning Program.

f) Develop and maintain Pre-Start-Up, Start-Up and Commissioning and Performance Acceptance checkout lists for review and acceptance by Engineer.

g) Develop SAT Plan for review and acceptance by Engineer and maintain until completion.

h) Develop comprehensive training program for review and acceptance by City Engineer.

i) Provide all documentation for handover of the commissioned equipment to the owner.

6.1.2 Commissioning Operator:

.1 Experience and Qualifications:

a) When commissioning services are warranted, a qualified operator shall be appointed to start-up, operate and maintain the equipment under commissioning from Start-Up to the end of Performance Acceptance.

b) Commissioning Operator must have a valid Operators Certification for Wastewater at a level equal to the level of the facility being commissioned, and have a minimum 5 years' experience operating similar facilities.

c) Commissioning Operator cannot be the Commissioning Manager, project manager, superintendent, construction manager.

.2 Commissioning Operator Responsibilities:

a) Co-ordinates start-up, commissioning and operating the facility with Commissioning Manager.

b) Be the on-call point of contact between Owner's operator and City Engineer

c) Must have daily onsite presence from Start-Up to end of Performance Acceptance.

d) Must attend all vendor operator training.

e) Manage operations and routine maintenance of the facility until end of performance acceptance period.

f) Identify and notify all parties of deficiencies when exposed.

g) Provide water/wastewater quality analysis as required (laboratory testing).

h) Demonstrate routine operations and maintenance of the facility to Owner's operator.

6.1.3 General Contractor:

.1 General Contractor Responsibilities:

a) Direct, supervise, and help coordinate manufacturers, suppliers, contractors and subcontractors throughout the Commissioning Program.

b) All documentation and submittals as required to support the completion of the Commissioning Program.

c) Execute all activities and submissions throughout the Commissioning Program and in accordance with the contract specifications.

d) Execution of additional activities and tasks as defined in the Commissioning Plan.

e) Attend all commissioning related meetings.

f) Co-ordinate and execute work to adhere to commissioning schedule dates, milestones and deadlines.

g) Execute all system, subsystem tests, equipment and instrumentation tests providing all required documentation.

h) Execute SAT inspection plan with Engineer as witness.

i) Execute training plan and demonstrations to ensure complete transfer of knowledge to City Operations team.

j) Transfer functioning facility to qualified and trained facility operators.

6.1.4 Owner:

.1 City Operations Team Responsibilities:

a) Coordination of activities with Owner's Operations and Maintenance Departments.

b) Assign City Operator for onsite presence from Start-Up.

c) Witness testing as required.
d) Coordination of City's personnel for vendor training activities during Start-Up and Commissioning Phase.
e) Record and log deficiencies during the warranty period and submit to the City Engineer.

6.1.5 City Engineer

.1 City Engineer Responsibilities:

a) Witness testing as required per the Contract.
b) Coordinate and execute additional activities as defined in the Commissioning Plan.

6.2 COMMISSIONING PLAN (SUBMITTAL)

.1 The Commissioning Plan shall be developed and submitted by the Commissioning Manager and must include the following as a minimum:

a) Project Commissioning Scope
b) Define System Areas and Subsystems
c) Commissioning Schedule
d) Define the Commissioning Team
- Include names and contact information for lead representatives of the Commissioning Team including the Commissioning Manager, Commissioning Operator, Owner, Operations, Contractor, Subcontractors, and City Engineer.
- Define the responsibilities of the above-mentioned parties.

e) Systems
- Describe the facility system areas and systems. Provide a breakdown of each system and include all equipment and instrumentation.
- Systems must incorporate all process mechanical, building mechanical, electrical, instrumentation equipment, and HMI and Security systems.

f) Proposed Testing Procedures
- Develop a proposed plan for testing each system, including a step-by-step procedure incorporating each equipment and requirements to meet a successful test.
- Include a testing plan for all instrumentation.
- List all Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance activities.

g) Commissioning Sequence
- For each system area:
  - List commissioning sequence incorporating each piece equipment.
  - Each system must detail the pass requirements before the next system can be commissioned.
- Include any feed requirements and preparation work such as:
  - Potable water service, facility service water.
  - Draining, disinfection, and flushing of tanks and lines.

h) Isolation procedures.
i) Equipment warm-up.
j) Sampling and testing requirements.
k) Verification of equipment and instrumentation.
l) Management of created waste.
m) Filling of tanks with chemicals.
n) Specific activities for Commissioning Team.
o) Training
   - Include detailed training plan highlighting prerequisites for training.
   - Specify classroom and on-site training plan and schedule.
p) Additional Supporting Documentation as may be required.
q) Include reviewed and accepted documentation including but not limited to:
   - Pre-Start-Up and Start-Up Checkout List.
   - Supplier Equipment Checkout list and Commissioning Forms.
   - Relevant special procedures e.g. AWWA Disinfection procedures.
   - Safety and Job Hazard Analysis.
   - Equipment Check Forms and Calibration Sheets.
   - Installation Pre-Commissioning Forms.
   - Calibration Sheets.
   - O&M Table of Contents.
   - Vendor/Manufacturer Inspection Sheets.
   - Testing Documents/Forms.
   - Safety Data Sheets (SDS).
   - Hazard Assessments.
   - Safe Handling Procedures.

6.3 FACTORY ACCEPTANCE TEST (FAT)

.1 Complete Factory Acceptance Test (FAT) of control system and HMI prior to scheduling first commissioning meeting. Contractor to provide test package designed for their program:

a) Provide a Factory Acceptance Test Plan for review by the City Engineer one month prior to the scheduled FAT.
b) The test plan must include procedures for testing all aspects of the PLC and HMI control logic, including communication to devices, alarms, shutdown, failure modes, and any other features of the logic.
c) The test plan created by the contractor is specific to the project and is based on logical functionality.
d) The test plan shall correlate to the project specific control philosophy and be separated out into logical sections.

.2 Provide a 100% completion Factory Acceptance Test at 50% overall project completion, witnessed by the City Engineer at the programming facility.

.3 Tests are to be performed using actual controllers and I/O cards being provided for the work, I/O simulation can be done using hardware or software-based simulation equipment.

.4 FAT test will not be conducted on the City's premises.

.5 The FAT cannot be done on a "live" system.

.6 Provide written documentation of all tests successfully completed with deficiencies corrected to City Engineer.

.7 FAT Test Plan must be submitted for review 1 month prior to scheduling FAT test. Test plan must be reviewed and accepted by City Engineer.

.8 City Engineer must be present to witness and pass the FAT Test. A failure will require the test to be rescheduled and costs for owner and engineer covered by the Contractor.

6.4 PLANNING PHASE

.1 Develop and submit the following documentation for review and acceptance by Engineer:

a) Commissioning Plan.
b) Pre-Start-Up Checkout List
c) Prepare and maintain Pre-start-up Checkout List, which includes all Process Mechanical, Commodity-retaining Structures, Building Mechanical, Instrumentation and Controls and Electrical Wiring and Equipment. Group list into logical systems areas or sub-systems as per the Commissioning Plan for orderly progression of activities during start-up.
d) Track and maintain pressure and leak test certificates, hydrostatic test certificates, disinfection certificates, regulatory sign-offs, alignment data records, equipment installation certifications, instrumentation loop checks, calibration sheets, electrical wiring checks, and deficiency list.
e) Start-Up Checkout List
   - Prepare and maintain Start-up Checkout List, which includes tracking of JHA sign-off, Training, O&M Manuals, Functional Test, SAT, and Commissioning Team Sign-off.
f) Performance Acceptance Checkout List
g) Prepare and maintain Performance Acceptance Checkout List, to capture the completion of Manual Run Test, Automatic Run Test, SAT, Operating Permit, Regulatory Permit, Chemical Analyses, Bacteriological Analyses, Commissioning Sign-off, 30-Day Performance Acceptance Run, Training, O&M Manuals, JHA, Deficiencies, and Commissioning Team Sign-off.
h) SAT Inspection Plan.
i) Detailed Training Plan.

6.5 PRE-START-UP PHASE

.1 Cleaning:

a) To extent practical, remove all scaffolding, debris, planks, tools, and other construction-related material.
b) Remove all sand, silt, dirt, and debris, channels, chambers, instrumentation and control panels and electrical panels and vacuum clean.

c) Clean all surfaces of tanks and conduits, including walls, roofs, floors, and columns with high pressure water jets or as specified in individual Sections.
d) Clean interior of all pipes and fluid-carrying equipment, including pumps and inspect with Engineer present.
e) Complete the following tests in accordance with the respective individual sections:
  - Leakage and pressure tests.
  - Hydrostatic tests.
  - Disinfection procedures.
  - Alignment data records.
  - Generate Equipment Installation Certificate.
  - Instrumentation Loop Checks.
  - Instrumentation Calibration Records.
  - Electrical Wiring Checks and Megger Test.
  - Regulatory Sign-off.

.2 Tagging:

a) Identify all pieces of equipment by Tag Numbers.
b) Provide Checkout Tag for each piece of equipment.
c) Checkout Tags to be filled in by each applicable trade verifying that all appropriate checks have been made, including but not limited to, cleaning, inspection, leakage testing, lubrication, rotation, calibration, adjustment and wire loop checks.
d) Equipment Manufacturer's Representatives to inspect equipment in accordance with applicable individual Sections. Certify equipment has been properly installed and is ready to start.
e) Contractor to submit Equipment Checkout List to Engineer. Equipment Checkout Listing to include the following:
  - System description.
  - Equipment Name and Tag Number of each component within System.
  - Supplier's Name of each equipment component, complete with sign-off where applicable.
  - Mechanical Trade sign-off (Trade certificates completed).
  - Electrical/Instrumentation Trades sign-off (Trade certificates completed).
  - Contractor sign-off (all certificates completed).
  - Attach the following to Equipment Checkout List:
    - Manufacturer's Representatives' Installation Certification Form.
    - Hydrostatic Test Certification Forms.
    - Weld Test Certificates.
    - Pressure Test Certification Forms.
    - Disinfection Certification Forms.
    - Instrumentation and Electrical Equipment Loop Check Forms.
    - Instrumentation Calibration Forms.
    - List of outstanding contract deficiencies for each system.

- Request, in writing, a Pre-Start-Up Inspection by Engineer. Once Engineer has conducted the Pre-Start-Up Inspection and is satisfied that each piece of equipment has been properly checked-out, a green “Ready-to-Start” tag will be attached to each piece of equipment in the system.

f) Red “Installed” Tag:

- Clearly identify all equipment and/or systems that are completely installed and wired with a red tag to indicate that the contractor is responsible for the equipment.
- Develop and submit Red Tag for review and acceptance by Engineer before implementing onsite.

6.6 START-UP PHASE

.1 The Commissioning Program can move to the Start-Up Phase can after all requirements in the Pre-Start-Up phase is completed.

.2 Green “Ready to Start” Tag:

a) Once the piece of equipment has been installed, aligned, tested and certified by manufacturer/vendor as having been installed properly, remove the red tag from the equipment and replace with a green tag.

b) Once each piece of equipment within a defined system carries a Green “Ready-to-Start” tag, then that individual system shall be started and tested.

c) All parties must sign the tag to acknowledge that the equipment is ready for start up.

.3 Conduct workshop with Owner’s Representatives and City Engineer to identify and integrate activities of all parties in Start-up phase. Prepare Start-up Plan which includes the following:

a) Plan objectives.
b) Facilities, systems and subsystems to be started.
c) Sequence of events and start-up schedule.
d) Responsibilities of each party.
e) List of individuals involved complete with contact telephone numbers.
f) English language description of each system’s intended means of operation.
g) Initial operating conditions and parameters.
h) Intended final operating conditions and parameters.
i) Filling of chemicals in chemical systems.
j) Laboratory requirements and arrangements for outside testing services.
k) Sampling and monitoring requirements and testing plan.
l) Contingency plans to respond to potential emergencies.
m) Safety and environmental considerations.

.4 Ensure Operating and Maintenance Manuals is reviewed and accepted by City Engineer.

.5 Correct any deficiencies uncovered during testing

6.7 SITE ACCEPTANCE PHASE (SAT)

.1 Complete Site Acceptance Testing of Control System:

a) Provide a Site Acceptance Test Plan for review by City Engineer one month prior to the scheduled SAT.
b) The test plan should be substantially similar to the FAT test plan with changes applicable to site testing.
c) The test plan shall correlate to the project specific control philosophy, in addition to the expected site testing procedures which are typically separated out by process area.

.2 Pre-test all wiring and instruments for functionality prior to conducting site acceptance testing. Provide written documentation to Engineer detailing testing of all loops.

.3 Site acceptance testing will occur under operating conditions, with process fluid in the vessels and piping, and equipment operational. Simulation equipment is not required, and testing shall be conducted by setpoint manipulation.

.4 Provide a Site Acceptance Test for each unit process, prior to commissioning, witnessed by the City Engineer at the Owner's facility.

.5 Execute all tests as described in the test plan.

.6 Any deficiencies resulting from the SAT will be rectified prior to retesting.

.7 Address any deficiencies identified by site acceptance testing and obtain Engineers sign-off on all components after testing is complete.

.8 City Engineer must be present to witness and pass all tests in the SAT.

6.8 COMMISSIONING PHASE

.1 Commissioning Phase can begin once all requirements in the Start-Up and SAT phases are completed.

.2 Blue "Commissioning" Tag:

a) Once each piece of equipment within a defined system has passed SAT, remove the Green Tag and replace with a Blue "Ready-to-Commission" tag.
b) Once all systems and subsystems have a blue tag commissioning can begin.
c) All parties must sign the tag.

.3 Commissioning Phase cannot proceed until:

a) All safety systems including but not limited to safety showers and gas detections system are fully functional.
b) All HVAC systems are fully functional and operating as per design intent.
c) All spill containment and spill cleanup equipment are in place and client's operation team trained to clean up any chemical spills.
d) Contractor to provide commissioning support including representatives of Contractor and Contractor's mechanical, electrical, and instrumentation staff or subcontractors, as appropriate.
e) Contractor to execute commissioning packages to commission. Each commissioning package to consist of fully functional portions or groups of operationally tested systems capable of operating in concert to provide a complete service or function that is of value to Owner.

f) Remove and clean or replace as required all permanent and temporary filters and strainers in pipeline systems; replace HVAC filters; dewater and clean sumps and leave process systems clean and filled with clean water, unless otherwise directed by City Engineer.

g) Commissioning to be generally conducted in manual mode first, followed by automatic operation. During the initial part of commissioning phase, the contract must provision to allow for the system to recirculate, discharge to sanitary sewer or have the water produced haul to the nearest waste receiving station.

6.9 PERFORMANCE ACCEPTANCE PHASE

.1 The Period of time for continuous automatic operation to pass Performance Acceptance is 720 hours with all systems operating continuously without fault and all process, mechanical, control and electrical equipment free of vibration, overloading or overheating and functioning in accordance with specified rates, methods and performance.

.2 The City Engineer will establish the operating conditions for the performance test that must be maintained. The commissioning operator must record the data daily or submit trending reports. This may include:

a) Chemical or Bacteriological Effluent/Distribution/Discharge conditions.

b) Operational readings: Flow, temperature, pressure, chemical dosing rates.

c) Pump, VFD or Motor readings.

d) Analyzer or instrumentation readings.

e) Any other pertinent data.

.3 Performance Acceptance can begin when the facility operates under steady controlled conditions where all temperatures, pressures, flows, pH levels, bacteriological conditions, chemical conditions and analyses are constant and within operational parameters. All required regulatory water quality specifications must also be consistently achieved as per codes, standards and approvals.

.4 Failure of any part of Work during the period of performance acceptance will require restart of that portion or system of Work, following rectification of the fault or failure.

.5 Implement detailed training plan.

.6 Training must be held with a minimum 360 hours remaining in the performance acceptance in order for the Owner's Operator to effectively observe the daily routine of the Commissioning Operator.

.7 The facility will be handed over to the Owner's operations after:

a) The performance acceptance phase been completed and accepted by the Owner and Engineer.

b) All major deficiencies have been corrected.

c) The Facility has met design and operational intent.

d) Adherence to Substantial Performance as defined in the Builders' Lien Act.

6.10 FACILITY COMMISSIONING PLAN – PROCESS FLOW

7 Submissions

The following typical electrical and instrumentation submissions are expected from new stations. Where stations are modified, the relevant drawings and/or documents are expected to be red-lined.

.1 As-built drawings in AutoCAD and PDF format.

.2 Operations and Maintenance Manuals (O&M Manuals).

.3 Network block diagram indicating all IP and radio hardware including IP addresses, physical port numbers, serial port assignments, and radio addresses.

.4 Card drawings for PLC.

.5 Cabinet layout drawing, including bill of materials detailing all equipment.

.6 Detailed Control Philosophy.

.7 Site layout

.8 Electrical layout

.9 Single line diagram

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APPENDIX C

City of St. Albert

Storm Lift Stations
Control Project Standards

May 2019

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List of Tables

1 Introduction

The purpose of the Storm Lift Station Control Project Standards is to clearly define the products used for the control of the storm lift stations' infrastructure, the signalling requirements of equipment within the facility, and the communications requirements to allow for control from a central Master HMI.

Note that all tags used in this document are general. Refer to the City of St. Albert's Standards for tagging convention.

1.1 DEFINITIONS

In these Standards, unless suggested otherwise by context, the following definitions will apply:

.1 "City" will refer to the City of St. Albert.

.2 "City Engineer" will refer to the professional engineer, or designated representative, authorized by the City to authorize changes to these Standards.

.3 "Commissioning Program": The Commissioning Program is responsible for transitioning the installed equipment into a fully integrated and live operating facility. The Commissioning Program consists of six phases: Planning, Pre-Start-Up, Start-Up, Site Acceptance Testing, Commissioning and Performance Acceptance.

.4 "Commissioning Plan": The Commissioning Plan defines the scope, roles, responsibilities, systems, subsystems, schedules and testing procedures for the Commissioning Program.

.5 "Commissioning Team": The Commissioning Team consists of the Commissioning Manager, Commissioning Operator, Owner, Contractor, Subcontractor and Engineer.

.6 "Commissioning Manager": The Commissioning Manager is the individual or firm responsible for the planning, preparation, implementation and management of the Commissioning Program. They are also responsible for coordinating the activities of the Commissioning Team members.

.7 "Commissioning Operator": The commissioning operator is a qualified operator responsible for coordinating with the Commissioning Manager and Contractor for starting up the systems and managing the daily operations and maintenance until Substantial Performance. They are required to ensure a satisfactory transfer of knowledge to ensure the Owner's Operator can operate the facility.

.8 "Commissioning Planning": The planning phase covers pre-work involved to develop the Commissioning Plan and execute the Commissioning Program. This is the responsibility of the Commissioning Manager and includes the preparation of the Commissioning Plan, scheduling of commissioning meetings, preparation of training plan, development of checkout lists and collation of all other necessary documentation to execute the Pre-Start-Up Phase.

.9 "Commissioning": Commissioning consists of placing all the various systems in Work into continuous automatic operation in an orderly manner. The Contractor is responsible for the commissioning activities and shall have the equipment manufacturer representatives at the site, as well as qualified mechanical, electrical, control and instrumentation personnel. The Contractor may be assisted by the City Engineer relative to process considerations and by Owner's operations and maintenance staff.

.10 "Contractor" will mean the person, firm, or corporation that undertakes the installation of municipal infrastructure on behalf of the Developer or the City.

.11 "Design" will mean the designs, reports, studies, engineering drawings, technical specifications, and associated documents, including the execution and implementation of such, pertaining to a Development, Subdivision, or other municipal improvement within the City of St. Albert.

.12 "Designer" or "Consultant" will mean the professional engineer responsible for the Design. Where applicable throughout these Standards, this term may refer to or include the Landscape Architect.

.13 "ERIO" will mean the Ethernet Remote I/O modules are RIO modules that communicate to the PLC via IP over Ethernet hardware.

.14 "Ethernet" will mean a physical implementation of IP hardware. This includes ethernet switches, ethernet cables, fibre ethernet, etc.

.15 "EDIO" will mean the Ethernet Distributed I/O are Ethernet-enabled devices that provide industrial automation communications. These allow a PLC to request data from the device using ethernet communications.

.16 "Engineering Drawings" will mean the detailed engineering drawings and specifications prepared by the Consultant for a Subdivision that form part of a development agreement.

.17 "Factory Acceptance Test (FAT)": A complete off-site simulated test of control system PLC and HMI logic.

.18 "HART" will mean the Highway Addressable Remote Transducer. A protocol used to transmit additional signals superimposed on a 4-20 mA analog signal.

.19 "HMI" will mean the Human Machine Interface. This is an appliance or software program that provides a graphical interface to an operator allowing the operator to steer the process control system.

.20 "HOA" will mean Hand/Off/Auto. A three-position selector switch that chooses between local-on (Hand), Local-off (Off), or Remote (Auto) operation.

.21 "IP" will mean the Internet protocol. The basic protocol used for all internet communications.

.22 "IGMP" will mean Internet Group Management Protocol. This is a communications protocol in use by some equipment that produces multicast traffic that can congest industrial systems.

.23 "MODBUS TCP" will mean the Modbus protocol wrapped in TCP. This allows industrial automation devices to communicate over IP network infrastructure.

.24 "PCS" will mean the Process Control System. This is the system of controllers, networks, instruments, computers, software, etc. that are used in the control of a process.

.25 "PLC" will mean the Programmable Logic Controller.

.26 "Performance Acceptance": Performance acceptance is considered to be complete when all systems have been operating continuously for a period of the cities choosing (normally 720 hours) without fault and in accordance with the specified performance requirements. Performance must be demonstrated to be in compliance with the intent for which it is installed.

.27 "Pre-Start-Up: Consists of the non-operating functions required to bring Work to a state of readiness for placing systems into service. It includes, but is not limited to: cleaning, leakage and pressure testing, cold alignment checks, disinfection, system flushing, lubrication of mechanical equipment, rotation checks and wiring loop checks. Contractor shall conduct inspections of all components and sub-components and shall arrange for inspections of equipment installations by qualified equipment manufacturers' representatives as required by Contract Documents. At this stage, deficiency lists are prepared, and Contractor is to remedy outstanding incomplete or incorrect work in accordance with terms of Contract. Contractor shall obtain completed Equipment Installation Certification Forms for each specified piece of equipment and shall submit these to Engineer for review.

.28 “Prime Contractor” has the meaning assigned by the Occupational Health and Safety Act – Alberta.

.29 “Ready-to-Start”: Once the City Engineer is satisfied that each piece of equipment in a system or subsystem has been properly checked out and all apparent deficiencies have been remedied, a Green tag shall be placed on the equipment designating that the Pre-Start-Up Phase for that particular system is complete.

.30 “RIO” will mean the Remote Input/Output modules that provide I/O in locations distant from the main PLC. These do not have any local processing power and require communications to a PLC to control a system.

.31 “SCADA” will mean Supervisory Control and Data Acquisition. The system that acquires data from geographically separate locations and provides some control or visibility to an operator or manager.

.32 “SCC” will mean the Standards Council of Canada. This organization accredits testing laboratories.

.33 “Standards” refers to the latest version of these municipal engineering standards in their entire scope, as further defined in Article 1.3.

.34 “Start-Up”: Once each piece of equipment within a defined system carries a “Ready-to-Start” tag, then that individual system shall be started and tested. Contractor shall conduct performance tests of all equipment in conjunction with the manufacturers’ representatives as required by the Contract Documents and under the witness of Engineer. Deficiencies that are uncovered shall be corrected and retesting shall be conducted as required. Start-Up Completion Certificates shall be prepared by Contractor certifying that the equipment or system is complete, successfully tested, started and ready for commissioning and continuous operation.

.35 “Site Acceptance Test (SAT)”: A complete on-site live test of the facility’s control systems against the Control Philosophy completed after the system Start-Up and prior to the Commissioning Period beginning.

.36 “Strong Password” will mean that a strong password is at least 8 characters and must be checked prior to use against a blacklist of compromised passwords.

.37 “TCP” will mean the Transmission Control Protocol. A sub-protocol of IP. It includes checksums to ensure that all data is successfully delivered and uncorrupted before processing the data.

.38 “UPS” will mean Uninterrupted Power Supply. A backup power system that provides emergency power in the event of a power failure. A UPS seamlessly takes over in a power failure and is intended to outlast brief power interruptions.

.39 Facilities:

a) “DRLS” means the Deer Ridge Lift Station.

b) "ERLS” means the Erin Ridge Lift Station.

c) “FHLS” means the Fire Hall Lift Station.

d) “GALS” means the Gate Avenue Lift Station.

e) “GPSF” means the Glacier Park Storm Facility.

f) “HBS” means the Henday Booster Station.

g) “JKPW” means the Jack Kraft Public Works Facility.

h) “KWDP” means the Kingswood Day Park Sanitary Lift Station.

i) “LLP” means the Lacombe Lake Park Facility (Lift Station).
j) “LPS” means the Lacombe Pup Station and Reservoir.
k) “MHG” means the Mission Hill Grinder Sanitary Installation.
l) “OLS” means the Oakmont Lift Station.
m) “OPS” means the Oakmont Pump Station and Reservoir.
n) “RCLS” means the Rivercrest Lift Station.
o) “RPALS” means the Riel Park Amenities Lift Station.
p) “RPRVLS” means the Riel Park RV Lift Station.
q) “RRLS” means the Riel Road Lift Station.
r) “RSLS” means the Riverside Lift Station.
s) “SPS” means the Sturgeon Pumphouse and Reservoir.
t) “TLS” means the Twilight Sanitary Lift Station.
u) “WLS” means the Walmart Storm Water Lift Station. This site will be decommissioned by the City, so there is not any scope of work included.

1.2 REFERENCE STANDARDS

.1 NIST Special Publication 800-63B

.2 AWWA Process Control System Security Guidance for the Water Sector.

.3 ANSI/ISA 62443-3-3 99.03.03-2013 Security for Industrial Automation and Control Systems Part 3-3 System Security Requirements and Security Levels.

.4 ANSI/ISA-101.01-2015 – Human Machine Interfaces for Process Automation Systems

1.3 REFERENCE DOCUMENTS

.1 Lift Station Control Philosophy.

1.4 OBJECTIVE

.1 The purpose of this standards document is to guide the development of the City of St. Albert’s storm lift station infrastructure in a consistent and predictable manner. The information contained in this standard is specific to storm lift stations and is intentionally generic. Specific design requirements, conditions, area classifications or code changes may require deviation from this standard and will need to be approved by the City before implementation. This standard should be followed as closely as possible for consistency between lift stations.

.2 Note that if a stormwater lift station may be connected or receive sewage from a sanitary or combined sewer system, its control system shall be designed to the Sanitary Lift Station Control Standard.

.3 The generic lift station design criteria will consider instrumentation, SCADA integration, radio connectivity, PLC/HMI hardware and software, control cabinet design, generator integration, gas monitoring requirements, building security, and cyber security. A generic lift station control philosophy is available from the city and provides the basis for lift station programming. The control philosophy assumes a typical two-pump station in a duty/standby arrangement using standardized PLC hardware and instrumentation.

2 Controller and HMI

2.1 HARDWARE

.1 Schneider M580 PLC controllers will be used in combination with panel-mounted Schneider Magelis HMI touchscreens.

.2 The PLC backplane will be an Ethernet (BME-series) Backplane sized to allow room for at least 20% spare slots. Spare slots will be equipped with slot covers. Where multi-rack configurations are needed, only use Ethernet backplanes with ERIO drop adapters. An individual PLC power supply is required for each rack. 36 W, 120 VAC PLC rack-mounted power supplies must be used.

.3 Where ERIO is used, an ethernet ring architecture will be used. Where rings are used, no two ring branches will run in the same conduit or cable.

.4 All new installations will use 24 VDC instrumentation and I/O cards. Where HART capable instrumentation is present, separate HART analog input cards will be included. Provide screw-in terminal blocks as needed to suit the I/O card.

.5 New installations with more than one pump will include at least two of each of the Discrete Input and Discrete Output modules. Split pump controls, and signals from other equipment with redundancy, between each of two cards to provide redundancy in case of card failure.

.6 In retrofit applications, match PLC cards in voltage and quantity of I/O as closely as possible to existing to minimize wiring and/or equipment changes. Only retrofit installations will use 120 VAC cards. All retrofit installations will continue using the same voltage for PLC and Instrumentation as is currently present.

.7 All new and retrofit installations will use 24 VDC solid-state non-isolated discrete output cards with interposing relays per device.

.8 Table 2-1 identifies standard PLC equipment for new installations. Quantities will vary with specific site requirements. Existing installations have more flexibility with the PLC modules, as these may be varied to match closer with existing controller I/O.

.9 Where HMI is installed outdoors, the cabinet will be a door-in-door type installation. The HMI will be mounted on the interior door, and the cabinet will be heated to ensure HMI temperature remains above 0°C, while operating. HMI will be 12" or greater. Give preference to indoor locations when selecting a location for an HMI.

.10 Mount HMIs 1500 mm above floor or concrete slab grade: typical eye level height.

.11 Provide HMIs with an SD card. Save the final configuration and graphics to this SD card.

.12 Provide PLCs with an SD card. Save the final configuration to this SD card.

.13 Only in-rack MODBUS RTU modules will be permitted, no external adapters will be accepted.

.14 All analog signals must use 4-20 mA signaling.

.15 At least one Analog Input card per site must be capable of reading and requesting data using HART Communications.

.16 Intrinsically safe (IS) barriers will be used where instruments are located inside a wetwell or other hazardous areas.

.17 Where Flygt pumps are used, Minicas relays or approved alternate pump-control relays suited for the specific submersible pumps will be used to provide signalling to the control system.

Table 2-1
Standard PLC Equipment for New Installations

Manufacturer	Description	Model Number
Schneider	M580 Central Processing Unit – 1 Ethernet TCP/IP Service Port, 2 Ethernet TCP/IP Device Network Ports	BMEP582020
Schneider	X-Bus and Ethernet Backplane – DIN Rail Mounting	BMEXBP****
Schneider	X80 Ethernet RIO Drop Adapter	BMECRA31210
Schneider	X80 120 V_{AC} Power Supply	36W – BMXCPS3500
Schneider	X80 24 V_{DC} Discrete Input Module – 16 pts	BMXDDI1602
Schneider	X80 24 V_{DC} Discrete Output Module: 16 pts Solid-State Output	BMXDDO1602
Schneider	X80 Isolated Analog Input HART: 8 pts	BMEAHI0812
Schneider	X80 Slot Cover	BMXXEM010
Schneider	X80 Serial Card	BMXNOM0200
Schneider	12.1” Magelis GTO Advanced Touchscreen Panel	HMIGTO6310

2.2 SOFTWARE

.1 Schneider Vijeo Designer 6.2, the HMI graphical development package, is used to develop the Magelis HMIs. A copy of the HMI configuration and graphics, compatible with this version of Vijeo will be provided to City after the project is completed. The configuration and graphics will not be password-protected and will be provided in editable form. The HMI configuration and graphics will be set to be retrievable from a PC that does not have a working copy of the existing configuration and graphics. Alarms may be displayed and acknowledged using this program.

.2 Schneider Unity Pro Extra Large V13.0, the PLC programming software package, is used to program the M580 PLCs. A copy of the PLC program, compatible with this version of Unity Pro will be provided to City after the project is completed. Both an archive (.STA) and a live backup will be provided to the city natively programmed in this version of Unity Pro. The program will not be password-protected and will be provided as editable code.

.3 Schneider Wonderware 2017, an industrial HMI program, is used at the Jack Kraft facility to monitor all remote sites. Graphics displaying the status of each remote site are created in this program, displaying important values from each site. Alarms are displayed and acknowledged using this program.

.4 Win911, an industrial software alarm dialing program is used at the Jack Kraft facility to call out alarms from all remote sites.

3 Control Cabinet Design

3.1 ENCLOSURES

.1 Control cabinets will be NEMA 12 rated and approved by an SCC-accredited testing laboratory.

.2 Size control cabinets to accommodate control system equipment plus 20% spare.

.3 Cabinets will use LED cabinet lighting wired to a door switch.

.4 Where free-standing enclosures are used, cabinet to be installed on 100mm thick concrete housekeeping pad. Where wall-mount enclosures are used, the cabinet will be mounted on the wall using appropriate anchors and channels.

.5 All cabinets will be furnished with suitable back panel.

.6 Interior cabinet door will have a data pocket for storing drawings, CD containing PLC, HMI program, etc. All cabinets will be labelled with Lamicoid Tags identifying the cabinet number: “CC-XXX”, using 20 mm high lettering where “XXX” represents a three-digit index. Coordinate with city to ensure that the three-digit index is unique.

.7 Outdoor cabinets will be fully insulated and complete with suitably sized 120 VAC strip heaters. Heater sizing should consider electrical heat loading from other equipment installed within the cabinet to prevent overheating. Heaters are to be controlled using adjustable thermostats. Heaters will be installed at or near the bottom of the cabinet. Outdoor cabinets will have suitably sized fans and louvres for summer ventilation cooling to keep temperature at or below maximum operating temperature of equipment inside. All air intakes will be filtered. Fans are to be controlled using adjustable thermostats.

.8 Within the cabinet, all wiring will be routed through wiring ducts, at least 50 mm wide and 100 mm deep with covers. These ducts will be sized for instrument wiring plus 50% spare.

.9 Table 3-1 identifies standard control cabinet equipment.

Table 3-1
Standard Control Cabinet Equipment

Manufacturer	Description	Model Series
Hoffman	NEMA 12 Painted Steel Enclosure – CSA approved; lockable.	Hoffman Mild Steel enclosures (or equivalent)
Hoffman	Back panel – Supplied with enclosure, powder coated	Hoffman 12-gauge steel panels (or equivalent)
Hoffman	Cabinet Light w/ Door Switch	Hoffman PANELITE (or equivalent)
Weidmüller	(2) 24Vdc Power Supply, sized to suit	ProMAX series
Weidmüller	(1) 24Vdc Redundancy Module, sized to suit	PRO RM series
Weidmüller	Duplex AC Receptacle – DIN rail mounted	21T9208 (or equivalent)

Manufacturer	Description	Model Series
Weidmüller	Slotted Steel Rail	TS35 (or equivalent)
Weidmüller	Terminal	WDU 2.5 (or equivalent)
Weidmüller	Fused Terminal w/ LED indicator	WSI 6LD (or equivalent)
Weidmüller	Ground Terminal	WDE 2.5 (or equivalent)
Omron	Relay Terminal w/ LED indicator	G2R-1 Series (or equivalent)
Hoffman or equivalent	Data Pocket	ADP1 (or equivalent)
Phoenix Contact	5-Port Managed Ethernet Switch	FL Switch 2205 (or equivalent)
PolyPhaser	Lighting Arrestor	Provided by Radio Vendor

3.2 ELECTRICAL REQUIREMENTS

.1 AC power will be filtered with an Eaton AEGIS power filter installed in series. This will be used to feed a 120 V_{AC} UPS. The UPS will be an Eaton PowerWare 9130 series with integral bypass switch with 1500 VA minimum, but sized to allow for 30 minutes of control system runtime.

.2 UPS will be provided with relay-interface card following AS/400 standards. Relay interface card will be used to provide signalling to the PLC.

a) Signals:
- Battery Low (Discrete)
- Fault (Discrete)

.3 Provide an isolated instrument grounding bar, with dedicated green TWU wire to electrical ground. Provide electrical grounding bar, with dedicated wire to electrical ground.

.4 DC Power Supplies will include over-voltage shutdown, 120 V_{AC} inputs, and approval by an SCC-accredited laboratory. Dual supplies will be used with redundancy modules. Size power supplies to accommodate full 24 V_{DC} loading of PLC cabinet and all connected instruments, including loop powered devices with capacity for a 20% increase. DC power supplies will provide signals to the PLC.

a) Signals:
- Power Supply 1 Fault (Discrete)
- Power Supply 2 Fault (Discrete)

.5 Provide at least one Duplex 120 V_{AC} convenience receptacle in the cabinet, not powered from the UPS.

3.3 CONTROL EQUIPMENT AND TERMINALS

.1 Selector switches will be water and dust-proof with internal gasket, standard black lever actuator, maintained position.

.2 Control Relays will come with built-in LED operation indicator, push-to-operate button, and be approved by an SCC-accredited laboratory. Contacts will be able to switch 5A 120/240 VAC inductive or resistive.

.3 Terminal strips and wiring will be labelled with machine-printed text. Write-on labels are not acceptable.

.4 Power distribution will be designed with the use of master- and sub-fusing for each instrument or device.

3.4 COMMUNICATIONS EQUIPMENT

.1 Ethernet Switch:

a) All control cabinets including a PLC will include a DIN-rail mounted managed Ethernet switch. Minimum Specifications:
- Five 100BASE-TX Ethernet ports
- IGMP packet snooping and IGMP query.
- Status Contact
- 24 V_{DC} input power

b) Base Models:
- Phoenix Contact FL-SWITCH 2005
- Hirschmann RS20 series
- Approved alternates.

c) The PLC, HMI, and all other Ethernet equipment will be connected to the managed switch. IGMP packet snooping, and querying must be enabled on the network switch. The switch will have its firmware updated to the most recent stable version available at the time of installation. The managed switch will be password protected by a Strong Password provided by the City. The City will provide IP network addresses to be used.

d) Signals:
- Switch Fault (Discrete, Normally Closed, Open on fault or power fail).

.2 Radio:

a) Licensed GE SD4 400 MHz radio, antenna with PolyPhaser lighting arrestor c/w dedicated ground wire, wired to main ground bus in cabinet.

b) Connect in-rack serial card to radio. Provide serial cables as required.

4 PCS Design

4.1 POWER METER

.1 Where a power meter is present, some data may be integrated into the PLC. All new installations shall be provided with a power meter.

a) Where its data is available via Modbus TCP, the power meter will be connected to the managed Ethernet Switch. The following signals will be provided via Modbus TCP to the PLC and made available on the HMI.

- Overall Power (kVA) (Analog).
- Overall Power (kW) (Analog).
- Power Factor (Analog).
- Phase A Voltage (V) (Analog).
- Phase B Voltage (V) (Analog).
- Phase C Voltage (V) (Analog).
- Phase A Current (A) (Analog).
- Phase B Current (A) (Analog).
- Phase C Current (A) (Analog).
- Utility Power Fail Alarm (Discrete, Normally Closed).

b) Where its data is not available via Modbus TCP, but has available analog and discrete signals, the following signals will be wired to the PLC and made available on the HMI.

- Overall Power (kVA) (Analog).
- Overall Power (kW) (Analog).
- Overall Voltage (V) (Analog).
- Utility Power Fail Alarm (Discrete, Normally Closed).

4.2 BACKUP POWER SYSTEM

Where backup is provided by a permanent generator, the following signals will be integrated into the PLC, either using direct-wired signalling or over Modbus TCP.

.1 Generator:

a) Running Status (Discrete).
b) Fault Status (Discrete, Normally Closed).
c) Not-in-Auto (Discrete, Closed when in Auto).
d) Fuel Level (mm) (0 mm = empty) (Analog).

.2 Automatic Transfer Switch

a) On Utility (Discrete) (Close on utility).
b) On Generator (Discrete) (Close on Generator).
c) Fault (Discrete) (Close on Fault).
d) Power Fail Alarm (Discrete) (Open on failure of both Utility and Backup Power supplies)

4.3 BUILDING EQUIPMENT

.1 Temperature:

a) Industrial high and low temperature switches. Type as specified by others. Quantity as required for heating and cooling design. Provide auxiliary contact to PLC for at least one of each high- and low-temperature switch per room, as available. All temperature switches should display units of °C.

b) Signals:

- High Temperature (Discrete, Close on Falling Temperature).
- Low Temperature (Discrete, Close on Rising Temperature).

.2 Security: Security system as specified by others. The security system will provide one normally-closed contact to the PLC which will open in an intrusion alarm state.

a) Signals:

- Security Alarm (Discrete, Normally Closed).

.3 Smoke Detection: Smoke detection as specified by others. Smoke detector system will provide one normally-closed contact to the PLC which will open in a smoke-alarm state from any smoke detector. Signals:

a) Smoke Alarm (Discrete, Normally Closed).

4.4 INLET GRINDER

Where an inlet grinder is provided in the lift station, the following signals will be provided to the control system.

.1 Grinder

- Run Status
- Common Fault Alarm
-

4.5 INSTRUMENTATION

.1 Flow

a) Flow Transmitter Signals:

- Flow (L/s) (Analog).
- Flow Total (m^3) (Analog Via HART protocol).
- Fault (Discrete).

.2 Pressure

a) Pressure Transmitter Signals

- Pressure (kPa) (Analog).

.3 Level Signals

a) Level transmitter will be complete with anti-submergence shield.

b) Level Transmitter Signals:

- Level (mm) (0 mm = empty) (Analog).
- Fault (Discrete).

c) Low-Low and High-High backup bulbs

- Low-Low Level Alarm (Discrete, Close on Rising Level).
- High-High Level Alarm (Discrete, Close on Falling Level).

4.6 HARDWIRED PUMP CONTROL

.1 Signals from each motor/starter/pump:

a) Remote/Off/Local Switch: Remote Status (Discrete, Close on Remote Status).
b) Fault Alarm: Fault/overload Status (Discrete, Close on Fault).
c) Leak Detected (If available): Leak Alarm (Discrete, Close on Fault).
d) Pump Overtemperature (if available): Overtemperature Alarm (Discrete, Close on Fault).

4.7 TYPICAL CONTROL PHILOSOPHY

.1 Two (2) pump lift station with Duty/Standby configuration. Refer to Appendix A.

.2 Three (3) pump lift station with Lead/Lag/Standby configuration. Refer to Appendix A.

4.8 ALARMING

.1 All alarm calling is handled via the Master HMI located at JKPW. There will be no local alarm dialers.

.2 Alarm Acknowledgement states will be shared between the local site and the Master HMI such that if an alarm is acknowledged at the local site, it will appear as acknowledged at the Master HMI.

4.9 CYBER SECURITY

.1 Provide a copy of the HMI program, PLC program, Memory Map, and Ethernet switch configuration to the City after the project is complete in a version compatible with the software versions listed above. Provide passwords, including operator and management passwords for HMI, and management ethernet switch password to the City.

.2 Ensure HMI and PLC have machine-retrievable code/configurations without having access to live code.

.3 Install machine-printed labels on all IP-enabled and Serial equipment in the PLC Cabinet, identifying the device serial or IP address.

.4 Network separation will be maintained. At no point should non-PCS networks or devices be connected to the PCS. PCS devices should not be able to access the internet.

.5 Ensure that HMI displays are password protected by a Strong Password common to all operators; provided by the City.

5 SCADA Configuration

5.1 SCADA COMMUNICATIONS CONFIGURATION

.1 Each remote site PLC will be programmed to collate all information that will be displayed at the JKPW into two blocks of contiguous registers, numerically separated from the registers used in the local station operations. One set of registers will be used for “read-only” information, such as values and statuses. The second set of registers will be used for “write” information, such as setpoint and command entries. The Master PLC in JKPW will query the remote site PLC for this data. Provide at least 20% spare registers in these ranges for potential expansion of read and write information.

.2 The Local PLC must be programmed such that if values are modified from the local HMI, they are accepted and retained. The Local PLC must also be programmed such that if values are modified from the SCADA HMI by way of the Master PLC, they are accepted and retained. If communications between the Master PLC and Local PLC are interrupted, the local PLC will continue to operate as normal.

.3 The JKPW HMI will display copies of all remote site screens. This computer also runs the common alarm dialing program for the PCS. If any remote site receives an alarm, or if communications to any remote site are lost, the HMI computer at the JKPW is configured to call operators. If alarms for this site are acknowledged at JKPW, this acknowledgement will be passed to the local HMI. If alarms at the site are acknowledged at the local HMI, the alarms for that site will be acknowledged at JKPW.

.4 Each remote site will be able to be fully controlled both from the local HMI, and from the JKPW master HMI. All values will be displayed at both sites, and all actions able to be taken from the local HMI must be able to be taken from the JKPW master HMI.

.5 A complete memory map of all registers to be used by the JKPW will be provided to the City. A complete alarm list must also be provided to the City.

.6 The remote site PLCs will not initiate any communications: all communications will be initiated by the Master PLC in the JKPW. The Master and remote sites will exchange “heartbeat” signals to be used in determining if a communications failure has occurred.

5.2 SERIAL RADIO CONFIGURATION

.1 The remote site will communicate with the JKPW master PLC via GE SD4, 400 MHz, serial licensed radios using the Modbus RTU protocol.

.2 Where radio towers are required, CSA towers will be used.

- a) Towers must be complete with suitable anti-climb guards, and appropriate obstruction marking and lighting as required by regulations.
- b) Obstruction lighting must be provided a dedicated circuit and breaker.

.3 Vendor will configure radio and verify that communications are successful as well as register the site with Industry Canada under the existing City license.

.4 The developer is responsible for following the City’s development standards, regarding antenna infrastructure, including the application process and community consultations, as required.

5.3 REMOTE ACCESSIBILITY

.1 No remote accessibility to the lift stations is planned other than serial radio communications to the Master PLC. The sites will be stand-alone. Remote viewing of the remote site status will be available via the JKPW.

6 Commissioning Program

6.1 QUALIFICATIONS, ROLES & RESPONSIBILITIES

6.1.1 Commissioning Manager:

.1 Experience and Qualifications:

a) When commissioning services are warranted, a professional engineer or qualified operations specialist is to be appointed as a Commissioning Manager to manage, implement, and coordinate the Commissioning Program. Qualifications to include minimum 5 years' experience in managing the testing, start-up and commissioning of mechanical, building, electrical, instrumentation, piping systems, control systems and operating process systems.

b) Commissioning Manager cannot be the project manager, superintendent, construction manager.

.2 Responsibilities:

a) The Commissioning Manager will be responsible for planning, preparation, coordination, implementation and management of the Commissioning Program including detailed co-ordination of the commissioning operator, owner's operator, contractor, engineer and owner.

b) Schedule, chair, minute and attend all commissioning meetings.

c) Develop the Commissioning Plan for review and acceptance by the City Engineer and Owner.

d) Develop the commissioning schedule for review and acceptance by the Engineer and Owner. Must include all phases (Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance) of the Commissioning Program.

e) Provide a detailed list and schedule of specific tasks for each system, subsystem and equipment throughout all phases (Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance) of the Commissioning Program.

f) Develop and maintain Pre-Start-Up, Start-Up and Commissioning and Performance Acceptance checkout lists for review and acceptance by Engineer.

g) Develop SAT Plan for review and acceptance by Engineer and maintain until completion.

h) Develop comprehensive training program for review and acceptance by City Engineer.

i) Provide all documentation for handover of the commissioned equipment to the owner.

6.1.2 Commissioning Operator:

.1 Experience and Qualifications:

a) When commissioning services are warranted, a qualified operator shall be appointed to start-up, operate and maintain the equipment under commissioning from Start-Up to the end of Performance Acceptance.

b) Commissioning Operator must have a valid Operators Certification for Wastewater at a level equal to the level of the facility being commissioned, and have a minimum 5 years' experience operating similar facilities.

c) Commissioning Operator cannot be the Commissioning Manager, project manager, superintendent, construction manager.

.2 Commissioning Operator Responsibilities:

a) Co-ordinates start-up, commissioning and operating the facility with Commissioning Manager.
b) Be the on-call point of contact between Owner's operator and City Engineer
c) Must have daily onsite presence from Start-Up to end of Performance Acceptance.
d) Must attend all vendor operator training.
e) Manage operations and routine maintenance of the facility until end of performance acceptance period.
f) Identify and notify all parties of deficiencies when exposed.
g) Provide water/wastewater quality analysis as required (laboratory testing).
h) Demonstrate routine operations and maintenance of the facility to Owner's operator.

6.1.3 General Contractor:

.1 General Contractor Responsibilities:

a) Direct, supervise, and help coordinate manufacturers, suppliers, contractors and subcontractors throughout the Commissioning Program.
b) All documentation and submittals as required to support the completion of the Commissioning Program.
c) Execute all activities and submissions throughout the Commissioning Program and in accordance with the contract specifications.
d) Execution of additional activities and tasks as defined in the Commissioning Plan.
e) Attend all commissioning related meetings.
f) Co-ordinate and execute work to adhere to commissioning schedule dates, milestones and deadlines.
g) Execute all system, subsystem tests, equipment and instrumentation tests providing all required documentation.
h) Execute SAT inspection plan with Engineer as witness.
i) Execute training plan and demonstrations to ensure complete transfer of knowledge to City Operations team.
j) Transfer functioning facility to qualified and trained facility operators.

6.1.4 Owner:

.1 City Operations Team Responsibilities:

a) Coordination of activities with Owner's Operations and Maintenance Departments.
b) Assign City Operator for onsite presence from Start-Up.

c) Witness testing as required.
d) Coordination of City's personnel for vendor training activities during Start-Up and Commissioning Phase.
e) Record and log deficiencies during the warranty period and submit to the City Engineer.

6.1.5 City Engineer

.1 City Engineer Responsibilities:

a) Witness testing as required per the Contract.
b) Coordinate and execute additional activities as defined in the Commissioning Plan.

6.2 COMMISSIONING PLAN (SUBMITTAL)

.1 The Commissioning Plan shall be developed and submitted by the Commissioning Manager and must include the following as a minimum:

a) Project Commissioning Scope
b) Define System Areas and Subsystems
c) Commissioning Schedule
d) Define the Commissioning Team
    - Include names and contact information for lead representatives of the Commissioning Team including the Commissioning Manager, Commissioning Operator, Owner, Operations, Contractor, Subcontractors, and City Engineer.
    - Define the responsibilities of the above-mentioned parties.
e) Systems
    - Describe the facility system areas and systems. Provide a breakdown of each system and include all equipment and instrumentation.
    - Systems must incorporate all process mechanical, building mechanical, electrical, instrumentation equipment, and HMI and Security systems.
f) Proposed Testing Procedures
    - Develop a proposed plan for testing each system, including a step-by-step procedure incorporating each equipment and requirements to meet a successful test.
    - Include a testing plan for all instrumentation.
    - List all Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance activities.
g) Commissioning Sequence
    - For each system area:
        - List commissioning sequence incorporating each piece equipment.
        - Each system must detail the pass requirements before the next system can be commissioned.
    - Include any feed requirements and preparation work such as:
        - Potable water service, facility service water.
        - Draining, disinfection, and flushing of tanks and lines.

h) Isolation procedures.
i) Equipment warm-up.
j) Sampling and testing requirements.
k) Verification of equipment and instrumentation.
l) Management of created waste.
m) Filling of tanks with chemicals.
n) Specific activities for Commissioning Team.
o) Training
   - Include detailed training plan highlighting prerequisites for training.
   - Specify classroom and on-site training plan and schedule.
p) Additional Supporting Documentation as may be required.
q) Include reviewed and accepted documentation including but not limited to:
   - Pre-Start-Up and Start-Up Checkout List.
   - Supplier Equipment Checkout list and Commissioning Forms.
   - Relevant special procedures e.g. AWWA Disinfection procedures.
   - Safety and Job Hazard Analysis.
   - Equipment Check Forms and Calibration Sheets.
   - Installation Pre-Commissioning Forms.
   - Calibration Sheets.
   - O&M Table of Contents.
   - Vendor/Manufacturer Inspection Sheets.
   - Testing Documents/Forms.
   - Safety Data Sheets (SDS).
   - Hazard Assessments.
   - Safe Handling Procedures.

6.3 FACTORY ACCEPTANCE TEST (FAT)

.1 Complete Factory Acceptance Test (FAT) of control system and HMI prior to scheduling first commissioning meeting. Contractor to provide test package designed for their program:

a) Provide a Factory Acceptance Test Plan for review by the City Engineer one month prior to the scheduled FAT.
b) The test plan must include procedures for testing all aspects of the PLC and HMI control logic, including communication to devices, alarms, shutdown, failure modes, and any other features of the logic.
c) The test plan created by the contractor is specific to the project and is based on logical functionality.
d) The test plan shall correlate to the project specific control philosophy and be separated out into logical sections.

.2 Provide a 100% completion Factory Acceptance Test at 50% overall project completion, witnessed by the City Engineer at the programming facility.

.3 Tests are to be performed using actual controllers and I/O cards being provided for the work, I/O simulation can be done using hardware or software-based simulation equipment.

.4 FAT test will not be conducted on the City's premises.

.5 The FAT cannot be done on a "live" system.

.6 Provide written documentation of all tests successfully completed with deficiencies corrected to City Engineer.

.7 FAT Test Plan must be submitted for review 1 month prior to scheduling FAT test. Test plan must be reviewed and accepted by City Engineer.

.8 City Engineer must be present to witness and pass the FAT Test. A failure will require the test to be rescheduled and costs for owner and engineer covered by the Contractor.

6.4 PLANNING PHASE

.1 Develop and submit the following documentation for review and acceptance by Engineer:

a) Commissioning Plan.

b) Pre-Start-Up Checkout List

c) Prepare and maintain Pre-start-up Checkout List, which includes all Process Mechanical, Commodity-retaining Structures, Building Mechanical, Instrumentation and Controls and Electrical Wiring and Equipment. Group list into logical systems areas or sub-systems as per the Commissioning Plan for orderly progression of activities during start-up.

d) Track and maintain pressure and leak test certificates, hydrostatic test certificates, disinfection certificates, regulatory sign-offs, alignment data records, equipment installation certifications, instrumentation loop checks, calibration sheets, electrical wiring checks, and deficiency list.

e) Start-Up Checkout List

- Prepare and maintain Start-up Checkout List, which includes tracking of JHA sign-off, Training, O&M Manuals, Functional Test, SAT, and Commissioning Team Sign-off.

f) Performance Acceptance Checkout List

g) Prepare and maintain Performance Acceptance Checkout List, to capture the completion of Manual Run Test, Automatic Run Test, SAT, Operating Permit, Regulatory Permit, Chemical Analyses, Bacteriological Analyses, Commissioning Sign-off, 30-Day Performance Acceptance Run, Training, O&M Manuals, JHA, Deficiencies, and Commissioning Team Sign-off.

h) SAT Inspection Plan.

i) Detailed Training Plan.

6.5 PRE-START-UP PHASE

.1 Cleaning:

a) To extent practical, remove all scaffolding, debris, planks, tools, and other construction-related material.

b) Remove all sand, silt, dirt, and debris, channels, chambers, instrumentation and control panels and electrical panels and vacuum clean.

c) Clean all surfaces of tanks and conduits, including walls, roofs, floors, and columns with high pressure water jets or as specified in individual Sections.

d) Clean interior of all pipes and fluid-carrying equipment, including pumps and inspect with Engineer present.

e) Complete the following tests in accordance with the respective individual sections:
- Leakage and pressure tests.
- Hydrostatic tests.
- Disinfection procedures.
- Alignment data records.
- Generate Equipment Installation Certificate.
- Instrumentation Loop Checks.
- Instrumentation Calibration Records.
- Electrical Wiring Checks and Megger Test.
- Regulatory Sign-off.

.2 Tagging:

a) Identify all pieces of equipment by Tag Numbers.

b) Provide Checkout Tag for each piece of equipment.

c) Checkout Tags to be filled in by each applicable trade verifying that all appropriate checks have been made, including but not limited to, cleaning, inspection, leakage testing, lubrication, rotation, calibration, adjustment and wire loop checks.

d) Equipment Manufacturer’s Representatives to inspect equipment in accordance with applicable individual Sections. Certify equipment has been properly installed and is ready to start.

e) Contractor to submit Equipment Checkout List to Engineer. Equipment Checkout Listing to include the following:
- System description.
- Equipment Name and Tag Number of each component within System.
- Supplier’s Name of each equipment component, complete with sign-off where applicable.
- Mechanical Trade sign-off (Trade certificates completed).
- Electrical/Instrumentation Trades sign-off (Trade certificates completed).
- Contractor sign-off (all certificates completed).
- Attach the following to Equipment Checkout List:
  - Manufacturer’s Representatives’ Installation Certification Form.
  - Hydrostatic Test Certification Forms.
  - Weld Test Certificates.
  - Pressure Test Certification Forms.
  - Disinfection Certification Forms.
  - Instrumentation and Electrical Equipment Loop Check Forms.
  - Instrumentation Calibration Forms.
  - List of outstanding contract deficiencies for each system.
  - Request, in writing, a Pre-Start-Up Inspection by Engineer. Once Engineer has conducted the Pre-Start-Up Inspection and is satisfied that each piece

of equipment has been properly checked-out, a green “Ready-to-Start” tag will be attached to each piece of equipment in the system.

f) Red “Installed” Tag:

- Clearly identify all equipment and/or systems that are completely installed and wired with a red tag to indicate that the contractor is responsible for the equipment.
- Develop and submit Red Tag for review and acceptance by Engineer before implementing onsite.

6.6 START-UP PHASE

.1 The Commissioning Program can move to the Start-Up Phase can after all requirements in the Pre-Start-Up phase is completed.

.2 Green “Ready to Start” Tag:

a) Once the piece of equipment has been installed, aligned, tested and certified by manufacturer/vendor as having been installed properly, remove the red tag from the equipment and replace with a green tag.

b) Once each piece of equipment within a defined system carries a Green “Ready-to-Start” tag, then that individual system shall be started and tested.

c) All parties must sign the tag to acknowledge that the equipment is ready for start up.

.3 Conduct workshop with Owner’s Representatives and City Engineer to identify and integrate activities of all parties in Start-up phase. Prepare Start-up Plan which includes the following:

a) Plan objectives.
b) Facilities, systems and subsystems to be started.
c) Sequence of events and start-up schedule.
d) Responsibilities of each party.
e) List of individuals involved complete with contact telephone numbers.
f) English language description of each system’s intended means of operation.
g) Initial operating conditions and parameters.
h) Intended final operating conditions and parameters.
i) Filling of chemicals in chemical systems.
j) Laboratory requirements and arrangements for outside testing services.
k) Sampling and monitoring requirements and testing plan.
l) Contingency plans to respond to potential emergencies.
m) Safety and environmental considerations.

.4 Ensure Operating and Maintenance Manuals is reviewed and accepted by City Engineer.

.5 Correct any deficiencies uncovered during testing

6.7 SITE ACCEPTANCE PHASE (SAT)

.1 Complete Site Acceptance Testing of Control System:

a) Provide a Site Acceptance Test Plan for review by City Engineer one month prior to the scheduled SAT.

b) The test plan should be substantially similar to the FAT test plan with changes applicable to site testing.

c) The test plan shall correlate to the project specific control philosophy, in addition to the expected site testing procedures which are typically separated out by process area.

.2 Pre-test all wiring and instruments for functionality prior to conducting site acceptance testing. Provide written documentation to Engineer detailing testing of all loops.

.3 Site acceptance testing will occur under operating conditions, with process fluid in the vessels and piping, and equipment operational. Simulation equipment is not required, and testing shall be conducted by setpoint manipulation.

.4 Provide a Site Acceptance Test for each unit process, prior to commissioning, witnessed by the City Engineer at the Owner's facility.

.5 Execute all tests as described in the test plan.

.6 Any deficiencies resulting from the SAT will be rectified prior to retesting.

.7 Address any deficiencies identified by site acceptance testing and obtain Engineers sign-off on all components after testing is complete.

.8 City Engineer must be present to witness and pass all tests in the SAT.

6.8 COMMISSIONING PHASE

.1 Commissioning Phase can begin once all requirements in the Start-Up and SAT phases are completed.

.2 Blue "Commissioning" Tag:

a) Once each piece of equipment within a defined system has passed SAT, remove the Green Tag and replace with a Blue "Ready-to-Commission" tag.

b) Once all systems and subsystems have a blue tag commissioning can begin.

c) All parties must sign the tag.

.3 Commissioning Phase cannot proceed until:

a) All safety systems including but not limited to safety showers and gas detections system are fully functional.

b) All HVAC systems are fully functional and operating as per design intent.

c) All spill containment and spill cleanup equipment are in place and client's operation team trained to clean up any chemical spills.

d) Contractor to provide commissioning support including representatives of Contractor and Contractor's mechanical, electrical, and instrumentation staff or subcontractors, as appropriate.

e) Contractor to execute commissioning packages to commission. Each commissioning package to consist of fully functional portions or groups of operationally tested systems capable of operating in concert to provide a complete service or function that is of value to Owner.

f) Remove and clean or replace as required all permanent and temporary filters and strainers in pipeline systems; replace HVAC filters; dewater and clean sumps and leave process systems clean and filled with clean water, unless otherwise directed by City Engineer.

g) Commissioning to be generally conducted in manual mode first, followed by automatic operation. During the initial part of commissioning phase, the contract must provision to allow for the system to recirculate, discharge to sanitary sewer or have the water produced haul to the nearest waste receiving station.

6.9 PERFORMANCE ACCEPTANCE PHASE

.1 The Period of time for continuous automatic operation to pass Performance Acceptance is 720 hours with all systems operating continuously without fault and all process, mechanical, control and electrical equipment free of vibration, overloading or overheating and functioning in accordance with specified rates, methods and performance.

.2 The City Engineer will establish the operating conditions for the performance test that must be maintained. The commissioning operator must record the data daily or submit trending reports. This may include:

a) Chemical or Bacteriological Effluent/Distribution/Discharge conditions.

b) Operational readings: Flow, temperature, pressure, chemical dosing rates.

c) Pump, VFD or Motor readings.

d) Analyzer or instrumentation readings.

e) Any other pertinent data.

.3 Performance Acceptance can begin when the facility operates under steady controlled conditions where all temperatures, pressures, flows, pH levels, bacteriological conditions, chemical conditions and analyses are constant and within operational parameters. All required regulatory water quality specifications must also be consistently achieved as per codes, standards and approvals.

.4 Failure of any part of Work during the period of performance acceptance will require restart of that portion or system of Work, following rectification of the fault or failure.

.5 Implement detailed training plan.

.6 Training must be held with a minimum 360 hours remaining in the performance acceptance in order for the Owner’s Operator to effectively observe the daily routine of the Commissioning Operator.

.7 The facility will be handed over to the Owner’s operations after:

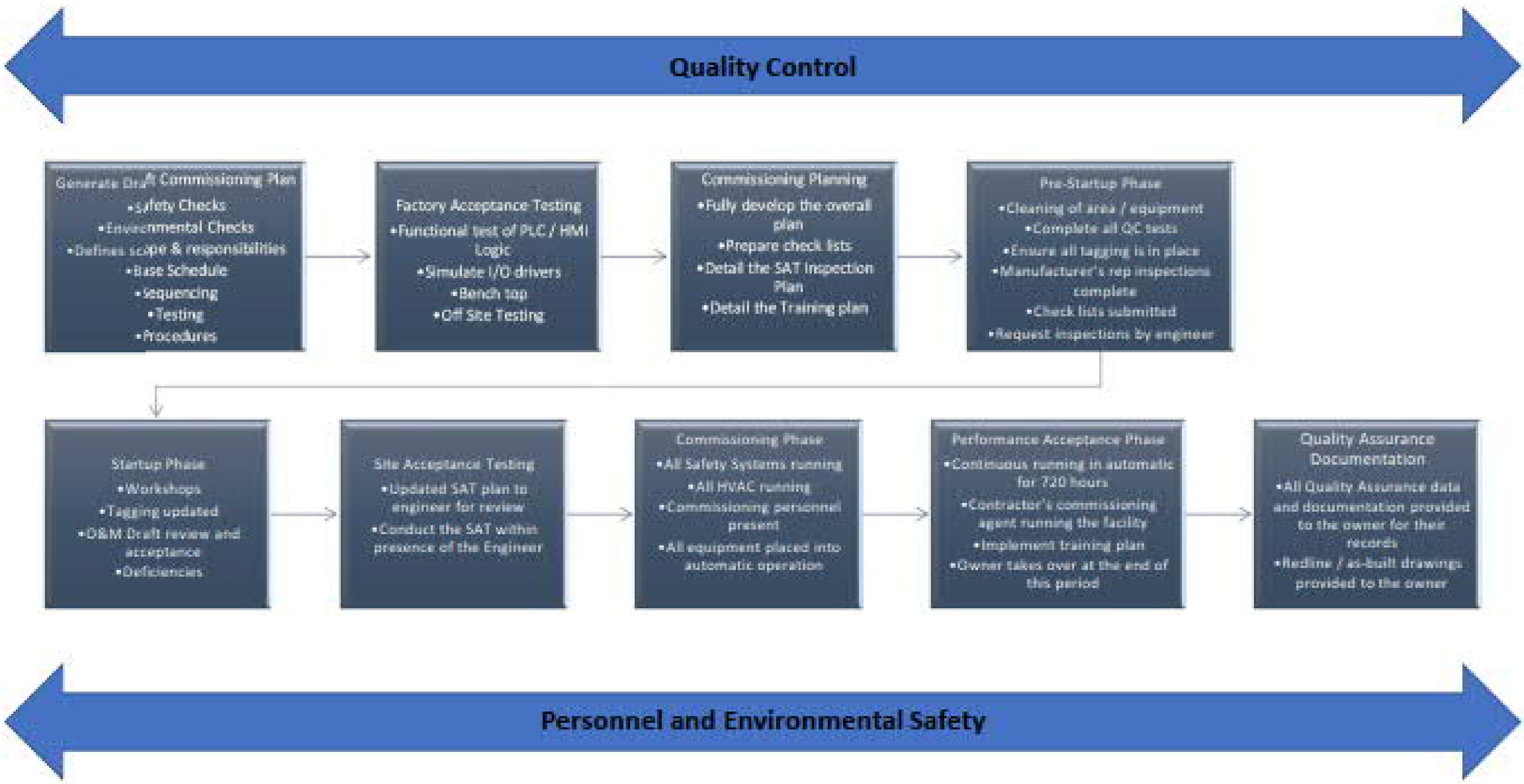
a) The performance acceptance phase been completed and accepted by the Owner and Engineer.

b) All major deficiencies have been corrected.

c) The Facility has met design and operational intent.

d) Adherence to Substantial Performance as defined in the Builders’ Lien Act.

6.10 FACILITY COMMISSIONING PLAN PROCESS FLOW



7 Submissions

The following typical electrical and instrumentation submissions are expected from new stations. Where stations are modified, the relevant drawings and/or documents are expected to be red-lined.

.1 As-built drawings in AutoCAD and PDF format.

.2 Operations and Maintenance Manuals (O&M Manuals).

.3 Network block diagram indicating all IP and radio hardware including IP addresses, physical port numbers, serial port assignments, and radio addresses.

.4 Card drawings for PLC.

.5 Cabinet layout drawing, including bill of materials detailing all equipment.

.6 Detailed Control Philosophy.

.7 Site layout

.8 Electrical layout

.9 Single line diagram

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

APPENDIX D

City of St. Albert

Pumphouses and Reservoirs
Control Project Standards

May 2019

Table of Contents

List of Tables

1 Introduction

The purpose of the Control Philosophy is to clearly define the detailed functionality of the pumphouse and reservoir infrastructure. The Control Philosophy must be read in conjunction with the corresponding standards and specifications.

Note that all tags used in this document are general. Refer to the City of St. Albert's standards for tagging convention.

1.1 DEFINITIONS

In these Standards, unless the context otherwise indicates, the following definitions will apply:

.1 "City" will refer to the City of St. Albert.

.2 "City Engineer" will refer to the professional engineer, or designated representative, authorized by the City to authorize changes to these Standards.

.3 "Commissioning Program": The Commissioning Program is responsible for transitioning the installed equipment into a fully integrated and live operating facility. The Commissioning Program consists of six phases: Planning, Pre-Start-Up, Start-Up, Site Acceptance Testing, Commissioning and Performance Acceptance.

.4 "Commissioning Plan": The Commissioning Plan defines the scope, roles, responsibilities, systems, subsystems, schedules and testing procedures for the Commissioning Program.

.5 "Commissioning Team": The Commissioning Team consists of the Commissioning Manager, Commissioning Operator, Owner, Contractor, Subcontractor and Engineer.

.6 "Commissioning Manager": The Commissioning Manager is the individual or firm responsible for the planning, preparation, implementation and management of the Commissioning Program. They are also responsible for coordinating the activities of the Commissioning Team members.

.7 "Commissioning Operator": The commissioning operator is a qualified operator responsible for coordinating with the Commissioning Manager and Contractor for starting up the systems and managing the daily operations and maintenance until Substantial Performance. They are required to ensure a satisfactory transfer of knowledge to ensure the Owner's Operator can operate the facility.

.8 "Commissioning Planning": The planning phase covers pre-work involved to develop the Commissioning Plan and execute the Commissioning Program. This is the responsibility of the Commissioning Manager and includes the preparation of the Commissioning Plan, scheduling of commissioning meetings, preparation of training plan, development of checkout lists and collation of all other necessary documentation to execute the Pre-Start-Up Phase.

.9 "Commissioning": Commissioning consists of placing all the various systems in Work into continuous automatic operation in an orderly manner. The Contractor is responsible for the commissioning activities and shall have the equipment manufacturer representatives at the site, as well as qualified mechanical, electrical, control and instrumentation personnel. The Contractor may be assisted by the City Engineer relative to process considerations and by Owner's operations and maintenance staff.

.10 “Contractor” will mean the person, firm, or corporation that undertakes the installation of municipal infrastructure on behalf of the Developer or the City.

.11 “Design” will mean the designs, reports, studies, engineering drawings, technical specifications, and associated documents, including the execution and implementation of such, pertaining to a Development, Subdivision, or other municipal improvement within the City of St. Albert.

.12 “Designer” or “Consultant” will mean the professional engineer responsible for the Design. Where applicable throughout these Standards, this term may refer to or include the Landscape Architect.

.13 “ERIO” will mean the Ethernet Remote I/O modules are RIO modules that communicate to the PLC via IP over Ethernet hardware.

.14 “Ethernet” will mean a physical implementation of IP hardware. This includes ethernet switches, ethernet cables, fibre ethernet, etc.

.15 “EDIO” will mean the Ethernet Distributed I/O are Ethernet-enabled devices that provide industrial automation communications. These allow a PLC to request data from the device using ethernet communications.

.16 “Engineering Drawings” will mean the detailed engineering drawings and specifications prepared by the Consultant for a Subdivision that form part of a development agreement.

.17 “Factory Acceptance Test (FAT)”: A complete off-site simulated test of control system PLC and HMI logic.

.18 “HART” will mean the Highway Addressable Remote Transducer. A protocol used to transmit additional signals superimposed on a 4-20 mA analog signal.

.19 “HMI” will mean the Human Machine Interface. This is an appliance or software program that provides a graphical interface to an operator allowing the operator to steer the process control system.

.20 “HOA” will mean Hand/Off/Auto. A three-position selector switch that chooses between local-on (Hand), Local-off (Off), or Remote (Auto) operation.

.21 “IP” will mean the Internet protocol. The basic protocol used for all internet communications.

.22 “MODBUS RTU” will mean an industrial automation serial communications protocol.

.23 “MODBUS TCP” will mean the Modbus protocol wrapped in TCP. This allows industrial automation devices to communicate over IP network infrastructure.

.24 “PCS” will mean the Process Control System. This is the system of controllers, networks, instruments, computers, software, etc. that are used in the control of a process.

.25 “PLC” will mean the Programmable Logic Controller.

.26 “Performance Acceptance”: Performance acceptance is considered to be complete when all systems have been operating continuously for a period of the cities choosing (normally 720 hours) without fault and in accordance with the specified performance requirements. Performance must be demonstrated to be in compliance with the intent for which it is installed.

.27 “Pre-Start-Up: Consists of the non-operating functions required to bring Work to a state of readiness for placing systems into service. It includes, but is not limited to: cleaning, leakage and pressure testing, cold alignment checks, disinfection, system flushing, lubrication of mechanical equipment, rotation checks and wiring loop checks. Contractor shall conduct inspections of all components and sub-components and shall arrange for inspections of equipment installations by qualified equipment manufacturers’ representatives as required by Contract Documents. At this stage, deficiency lists are prepared, and Contractor is to remedy outstanding incomplete or incorrect work in accordance with terms of Contract. Contractor shall obtain completed Equipment Installation Certification Forms for each specified piece of equipment and shall submit these to Engineer for review.

.28 "Prime Contractor" is as defined by the Occupational Health and Safety Act – Alberta.

.29 "Ready-to-Start": Once the City Engineer is satisfied that each piece of equipment in a system or subsystem has been properly checked out and all apparent deficiencies have been remedied, a Green tag shall be placed on the equipment designating that the Pre-Start-Up Phase for that particular system is complete.

.30 "RIO" will mean the Remote Input/Output modules that provide I/O in locations distant from the main PLC. These do not have any local processing power and require communications to a PLC to control a system.

.31 "SCADA" will mean the Supervisory Control and Data Acquisition. The system that acquires data from geographically separate locations and provides some control or visibility to an operator or manager.

.32 "Standards" refers to the latest version of these municipal engineering standards in their entire scope, as further defined in Article 1.3.

.33 "Start-Up": Once each piece of equipment within a defined system carries a "Ready-to-Start" tag, then that individual system shall be started and tested. Contractor shall conduct performance tests of all equipment in conjunction with the manufacturers' representatives as required by the Contract Documents and under the witness of Engineer. Deficiencies that are uncovered shall be corrected and retesting shall be conducted as required. Start-Up Completion Certificates shall be prepared by Contractor certifying that the equipment or system is complete, successfully tested, started and ready for commissioning and continuous operation.

.34 "Site Acceptance Test (SAT)": A complete on-site live test of the facility's control systems against the Control Philosophy completed after the system Start-Up and prior to the Commissioning Period beginning.

.35 "Strong Password" will mean that a strong password is at least 8 characters and must be checked prior to use against a blacklist of compromised passwords.

.36 "TCP" will mean the Transmission Control Protocol. A sub-protocol of IP. It includes checksums to ensure that all data is successfully delivered and uncorrupted before processing the data.

.37 "UPS" will mean the Uninterrupted Power Supply. A backup power system that provides emergency power in the event of a power failure. A UPS seamlessly takes over in the event of a power failure and is intended to outlast brief power interruptions.

.38 Facilities:

a) "DRLS" means the Deer Ridge Lift Station.

b) "ERLS" means the Erin Ridge Lift Station.

c) "FHLS" means the Fire Hall Lift Station.

d) "GALS" means the Gate Avenue Lift Station.

e) "GPSF" means the Glacier Park Storm Facility.

f) "HBS" means the Henday Booster Station.

g) "JKPW" means the Jack Kraft Public Works Facility.

h) "KWDP" means the Kingswood Day Park Sanitary Lift Station.

i) "LLP" means the Lacombe Lake Park Facility (Lift Station).

j) "LPS" means the Lacombe Pup Station and Reservoir.

k) "MHG" means the Mission Hill Grinder Sanitary Installation.

l) "OLS" means the Oakmont Lift Station.

m) "OPS" means the Oakmont Pump Station and Reservoir.

n) "RCLS" means the Rivercrest Lift Station.

o) "RPALS" means the Riel Park Amenities Lift Station.

p) "RPRVLS" means the Riel Park RV Lift Station.

q) "RRLS" means the Riel Road Lift Station.

r) "RSLS" means the Riverside Lift Station.

s) "SPS" means the Sturgeon Pumphouse and Reservoir.

t) "TLS" means the Twilight Sanitary Lift Station.

u) "WLS" means the Walmart Storm Water Lift Station. This site will be decommissioned by the City, so there is not any scope of work included.

1.2 REFERENCE STANDARDS

.1 NIST Special Publication 800-63B.

.2 AWWA Process Control System Security Guidance for the Water Sector.

.3 ANSI/ISA 62443-3-3 99.03.03-2013 Security for Industrial Automation and Control Systems Part 3-3 System Security Requirements and Security Levels.

1.3 OBJECTIVE

.1 The purpose of this standards document is to guide the development of the City's pumphouse and reservoir infrastructure in a consistent and predictable manner. The information contained in this standard is specific to Pumphouses and Reservoirs and is intentionally generic. Specific design requirements, conditions, or code changes may require deviation from this standard and need to be approved by the City before implementation; however, this standard should be followed as closely as possible to maintain consistency between Pumphouses and Reservoirs.

.2 The generic design criteria will consider instrumentation, SCADA integration, radio connectivity, PLC/HMI hardware and software, control cabinet design, generator integration, and building security.

2 PLC and HMI Hardware

.1 Schneider M580 PLC controllers will be used in combination with Fanless Industrial computers running Schneider Wonderware and panel-mounted touchscreens.

.2 The PLC backplane will be an Ethernet Backplane sized to provide room for 20% spare slots. Spare slots will be equipped with slot covers. Where multi-rack configurations are required, use Ethernet backplanes with ERIO drop adapters. An individual power supply is required for each rack. 36 W, 120 VAC PLC rack-mounted power supplies must be used.

.3 All new installations will use 24 VDC instrumentation and I/O cards. Where HART capable instrumentation is present, separate HART analog input card will be included. Provide appropriate screw-in terminal blocks as required to suit the I/O card.

.4 All retrofit installations will continue using the same voltage for PLC and instrumentation as is currently present.

.5 All new and retrofit installations will use non-isolated discrete output cards with interposing relays.

.6 Table 2-1 identifies standard PLC equipment. Substitutions are only permitted when required by external equipment and subject to approval by the City.

Table 2-1
Standard PLC Equipment

Manufacturer	Description	Model Number
Schneider	M580 Central Processing Unit – 1 Ethernet TCP/IP Service Port, 2 Ethernet TCP/IP Device Network Ports	BMEP584040
Schneider	X-Bus and Ethernet Backplane – DIN Rail Mounting	BMEXBP****
Schneider	X80 Ethernet RIO Drop Adapter	BMECRA31210
Schneider	X80 120 V_{AC} Power Supply	36W – BMXCPS3500
Schneider	X80 120 V_{AC} Isolated Discrete Input Module – 8 pts	BMXDAI0814
Schneider	X80 120 V_{AC} Non-Isolated Discrete Input Module – 16 pts	BMXDAI1604
Schneider	X80 24 V_{DC} Discrete Input Module – 32 pts	BMXDDI3202K
Schneider	X80 120 V_{AC} Discrete Output Module – 16 pts Triac	BMXDAO1605
Schneider	X80 24 V_{DC} Discrete Output Module – 16 pts Relay Output	BMXDRA1605
Schneider	X80 Isolated Analog Input – 8 pts	BMXAMI0810
Schneider	X80 Isolated Analog Input HART – 8 pts	BMEAHI0812
Schneider	X80 Isolated Analog Output – 4 pts	BMXAMO0410
Schneider	X80 Slot Cover	BMXXEM010

Manufacturer	Description	Model Number
Schneider	X80 Serial Card	BMXNOM0200

Table 2-2 identifies standard HMI equipment and networking equipment.

Table 2-2
Standard HMI and Networking Equipment

Manufacturer	Description	Model Number
Hope Industrial	19.5” Hope Industrial Panel-Mount Monitor and Resistive Touch Screen	HIS-ML19.5
Phoenix Contact	Industrial Managed Ethernet Switch, Gigabit Ethernet, 6 8P8C Ports, 2 SFP ports.	FL Switch 2306-2SFP
AAEON	Industrial Fanless PC, Intel Core i7, Quad Core, 2.4 GHz, 16 GB RAM, Windows 10	Boxer-6640

2.1 PLC CABINET DESIGN

2.1.1 Enclosures

.1 PLC cabinets are to be fully sealed, NEMA12 rated and CSA approved. Control cabinets will be sized to accommodate control system equipment plus 20% spare. Cabinets will use LED cabinet lighting wired to an automatic door switch. Where free-standing enclosures are required, cabinet to be installed on 100mm thick concrete housekeeping pad. Where wall-mount enclosures are required, the cabinet will be mounted on the wall using appropriate anchors and channels. All cabinets will be furnished with suitable back panel. Cabinet door will have a data pocket for storing drawings, CD containing PLC, HMI program, etc. All cabinets will be labelled with Lamicoid Tags identifying PLC number: “PLC-XXX”, using 20mm high lettering.

.2 Within the cabinet, all wiring will be routed through wiring ducts, at least 50 mm wide and 100 mm deep with covers. These ducts will be sized for instrument wiring plus 50% spare.

.3 Industrial PC will be securely wall-mounted inside the cabinet. A keyboard mouse, using a USB-dongle for communications not Bluetooth, will be provided with the PC.

.4 Two panel-mount USB 2.0-pass-throughs must be installed in cabinet door. Hoffman CCUSB or equal.

.5 Connect pass-through to the USB 2.0 ports of the computer.

.6 A Hoffman CKBT 24" or equal keyboard and mouse tray shall be required on exterior door of cabinet.

.7 Provide a water-resistant keyboard and mouse set.

2.1.2 Electrical Requirements

.1 AC power will be filtered with an Eaton AEGEIS power filter installed in series. This will be used to feed a 120V UPS. The UPS will be an Eaton PowerWare 9130 series with integral bypass switch with 1500 VA minimum, sized to allow for 30 minutes of control system runtime.

.2 Provide an isolated instrument grounding bar, with dedicated green-insulated wire to MCC or system ground. Provide electrical grounding bar, with dedicated wire to MCC or system ground.

.3 DC Power Supplies will include over-voltage shutdown, 120 VAC inputs, and CSA approval. Dual supplies will be used with redundancy modules. The power supplies will be sized to accommodate full 24 VDC loading of PLC cabinet and all connected instruments, including loop powered devices.

.4 One Duplex AC receptacle powered from the UPS will be provided in the cabinet.

2.1.3 Control Equipment and Terminals

.1 Selector switches will be water and dust-proof with internal gasket, standard black lever actuator, maintained position.

.2 Control Relays will come with built-in LED operation indicator, push-to-operate button, and be CSA approved. Contacts will be able to switch 5A 120/240 VAC inductive or resistive.

.3 Terminal strips will be labelled. Write-on labels are not acceptable.

.4 All wiring will be labelled. Write-on labels are not acceptable.

2.1.4 Communications Equipment

.1 All cabinets will include a DIN-rail mounted managed Ethernet switch. This switch will have, at minimum, five 100BASE-TX Ethernet ports. The PLC, HMI, and all other Ethernet equipment to be connected to the managed switch.

.2 Radio requirements: Licensed 400 MHz radio, antenna with PolyPhaser lighting arrestor c/w dedicated ground wire, wired to main ground of cabinet.

Table 2-3 identifies standard PLC cabinet equipment.

Table 2-3
PLC Cabinet Equipment

Manufacturer	Description	Model Series
Hoffman	NEMA12 Painted Steel Enclosure – CSA Approved; lockable.	Hoffman Mild Steel enclosures
Hoffman	Back panel – Supplied with Enclosure, powder coated	Hoffman 12-gauge steel panels
Hoffman	Cabinet Light w/ Door Switch	Hoffman PANELITE
Weidmüller	(2) 24Vdc Power Supply, 15 A, 360 W	CP-T SNT 360W 24V 15A
Weidmüller	(1) 24Vdc Redundancy Module, 15 A, 360 W	CP T RM 10
Weidmüller	Duplex AC Receptacle – DIN rail mounted	21T9208
Weidmüller	Slotted Steel Rail	TS35
Weidmüller	Terminal	WDU 2.5
Weidmüller	Fused Terminal w/ LED indicator	WSI 6LD
Weidmüller	Ground Terminal	WDE 2.5
Omron	Relay Terminal w/ LED indicator	G2R-1
Hoffman or equivalent	Data Pocket	ADP1
Sixnet	5-Port Managed Ethernet Switch	SLX-5MS-1
PolyPhaser	Lighting Arrestor	

2.1.5 HMI Equipment

Computer specifications change regularly. Confirm with the City prior to ordering HMI equipment.

.1 HMI at Pumphouses shall use a full desktop version of Microsoft Windows 10 running Wonderware InTouch 2017:

.2 Computer shall meet the following requirements:

a) Compact Fanless Wall-mount Chassis.
b) Power supply via 24 VDC distribution.
c) Minimum one hard drive, minimum size 250 GB.
d) Minimum of two 1000BASE-T Gigabit network interfaces.
e) Minimum of four USB ports, of which at least two must be USB 3.0 and at least two must be USB 2.0 or better.
f) Graphics card capable of rendering 1920 x 1080 resolution natively.

g) AAEON AEC-6638 or approved alternative.

.3 Computers shall be complete with the following software installed and licensed.

a) Microsoft Windows 10 Professional, Retail copy (64-bit).
b) Wonderware InTouch 2017, Runtime,
c) All software must be licensed in the name of the City.
d) Where licenses must be bound to an email address, contractor must request a City email address for use. This email address should not be bound to a specific user, and passwords for this account must be documented.
e) Turn over all license documentation, email addresses, and license files/keys to the City.

.4 Monitor must meet the following requirements:

a) 19.5" LCD panel-mount touch screen monitor,
- Hope Industrial Systems HIS-ML19.5 or equal.
- Monitor must be capable of operating at 1920 x 1080 resolution natively, without distortion.
- Manufacturer display drivers must be installed on HMI computer.

b) Develop Wonderware InTouch 2017 graphics complying with ANSI/ISA-101.01-2015 and complying with the design guidelines of the existing systems.
c)
d) Prior to developing graphics, arrange a meeting with operations staff, Consultant, and City project team to determine functional requirements, changes sought from existing system, and present nuisances. This meeting shall set HMI design guidelines, including use of color codes, general idea of line sizes and objects, navigation between pages, etc.
e) Create draft HMI graphics and submit screenshots of all pages with identification of functions and operations as a shop drawing for review by Consultant, Operations Staff, and City Project Team.
f) Conduct a Factory-Acceptance Test and Site Acceptance test.
g) Design graphics to operate at 1920 x 1080 resolution.
h) Ensure that computer automatically powers on after a power outage is resolved and power returns.
i) Ensure that Wonderware graphics and all associated systems automatically launch on computer restart.
j) Ensure that all alarm logging is functional, local historical trends are functional, and industry- and software-standard alarm database maintenance is automatically handled.

2.1.6 PLC and HMI program back-ups.

.1 Supply and install two minimum 500 GB external USB 3.0-powered Hard Disk Drives (HDDs).

.2 Apply machine printed labels to each HDD identifying them with HDD number and site name.

.3 Connect one HDD to USB 3.0 ports of computer, ensuring that USB 3.0 cable is of sufficient length, and that HDD is fully secured, and removable when required.

.4 Provide other HDD to City for off-site swapping

.5 Configure computer to automatically back up critical directories to external HDD. This includes but is not limited to:

a) Wonderware application path
b) Wonderware trend-file path.

.6 Configure all databases to automatically back up to External HDD.

.7 City shall own a copy of Acronis Backup, available at Jack Kraft Public Works. Use this to create a complete disk image of the computer after configuration is complete. Save this image to the City-Owned SCADA network attached storage and the external hard drives.

3 Instrumentation

3.1 OVERVIEW

Flow	Magnetic flow meter with remote transmitter and display, grounding rings, 4-20mA HART compliant, sized for piping flow requirements and area classification. Use Endress & Hauser 400W or ABB WaterMaster.
Pressure	Transducer-based pressure sensor with remote transmitter and display, sized for piping pressure requirements, isolation diaphragm (ring). Endress & Hauser PMC71.
Gauges	Minimum 4", dual scale, ring seals, bourdon tube, liquid filled. Scale range sized for piping pressure requirements, nominal pressure reading will be near middle of gauge reading. Ashcroft 1279 or Wika.
Level Transmitter	Ultrasonic transducer with remote transmitter and display; map out obstacles, level triggers via software setpoints. Siemens Milltronics Multi-Ranger Plus, with XPS-10/15 transducer depending on angle requirements.
Level Switches	LALL and LAHH backup bulbs; set just higher and lower than the level transmitter trigger points. Flygt ENM-10.
Temperature	Industrial-grade high and low temperature switches.
Chlorine Analyzer	Reagentless chlorine analyzer (Total CL2) with remote transmitter, maintenance and calibration kit, plastic tubing for instrument inlet connections, clear PVC tubing for drain lines. Analyzer shall come as a complete ready to mount package with all necessary plumbing, flow devices and pressure regulating devices. Use Hach CL10sc Amperometric Chlorine Analyzer. Requires SC200 controller.
Turbidity Analyzer	Process turbidity meter with remote transmitter, maintenance and calibration kit, plastic tubing for instrument inlet connections, clear PVC tubing for drain lines. Include Flow Sensor and Automatic Cleaning options. Use Hach TU5 Series Turbidimeters (TU5300sc). Requires SC200 Controller.

4 Alarming and Building Security

.1 All alarming is handled via the Master HMI, located at Jack Kraft Public Works Facility. Local alarm diallers will not be required.

.2 Existing installations will maintain existing alarming philosophy. At new installations, alarm acknowledgement states will be shared between the local site and the Master HMI such that if an alarm is acknowledged at the local site, it will appear as acknowledged at the Master HMI and vice versa.

4.1 BUILDING SECURITY

.1 Building and outdoor panel security is handled using door and hatch contacts wired back to a commercial security controller and keypad. The common alarm output from the security controller is wired to the PLC for alarming.

.2 The security system will be supplied with all required accessories to create a functional security system as described above, including all control panels and I/O terminal boards necessary.

.3 Doors should use plunger style industrial switches, hatches should use roller and arm style switches.

.4 Where installations include video security cameras, all videography will be stored to a local digital video recorder and preserved per city standards. This data is not intended to be transmitted over the SCADA network.

5 Generator Integration

.1 Where generators are used, the Run, Fault, and HOA in-auto signals will be connected to the PLC. An automatic transfer switch will control the start and stop of the generator directly as well as provide “On Utility” and “On Generator”, “Utility power available”, “Generator power available” status signals to the PLC.

6 SCADA Configuration

6.1 SCADA COMMUNICATIONS CONFIGURATION

.1 Each remote site PLC will be programmed to collect all information that will be displayed at the Jack Kraft Facility into two blocks of contiguous registers, numerically separated from the registers used in the local station operations. One set of registers will be used for “read-only” information, such as values and statuses. The second set of registers will be used for “write” information, such as setpoint and command entries. These registers will be read by the Master PLC to Jack Kraft. Provide at least 20% spare registers in these ranges for potential expansion of read and write information.

.2 The Local PLC must be programmed such that if values are modified from the local HMI, they are accepted and retained. The Local PLC must also be programmed such that if values are modified from the SCADA HMI by way of the Master PLC, they are accepted and retained. If communications between the Master PLC and Local PLC are interrupted, the local PLC will continue to operate as normal.

.3 The Jack Kraft Facility HMI will display copies of all remote site screens. This computer also runs the common alarm dialing program for the PCS. If any remote site receives an alarm, or if communications to any remote site are lost, the HMI computer at the Jack Kraft Facility is configured to call Operators. If alarms for this site are acknowledged at Jack Kraft, this acknowledgement will be passed to the local HMI. If alarms at the site are acknowledged at the local HMI, the alarms for that site will be acknowledged at Jack Kraft. Individual alarms must be able to be acknowledged from Jack Kraft to the remote site and vice versa.

.4 Each remote site will be able to be fully controlled both from the local HMI, and from the Jack Kraft master HMI. All values will be displayed at both sites, and all actions able to be taken from the local HMI must be able to be taken from the Jack Kraft master HMI.

.5 A complete memory map of all registers to be used by the Jack Kraft Facility will be provided to the City.

.6 A complete alarm list must also be provided to the City.

.7 The remote site PLCs will not initiate any communications: all communications will be initiated by the Master PLC in the Jack Kraft Facility. The Master and remote sites will exchange “heartbeat” signals to be used in determining if a communications failure has occurred.

6.2 SERIAL RADIO CONFIGURATION

.1 The remote site will communicate with the Jack Kraft master PLC via GE SD4, 400 MHz, serial licensed radios using the Modbus RTU protocol.

.2 A manufacturer-licensed and qualified radio vendor will verify the radio path and set the antenna height above ground level. Vendor will configure radio and verify that communications are successful as well as register the site with Industry Canada under the existing City license.

.3 The developer is responsible for following the City’s development standards regarding antenna infrastructure including the application process and community consultations, as required.

6.3 IP NETWORK CONFIGURATION

.1 The HMI and PLC will be configured to communicate with each other using Modbus TCP. They will be connected to each other through a managed Ethernet switch installed in the PLC control panel. This switch will have its status made available by Modbus TCP, and will be monitored by the local PLC. If communications to the switch are lost or the OK status is lost, an alarm will be activated. The managed switch will be configured for IGMP packet snooping to reduce multicast traffic. The switch will have its firmware updated to the most recent stable version available at the time of installation. The managed switch will be password protected by a Strong Password. City will provide IP network addresses to be used for the PLC, HMI, and Ethernet switch.

6.4 SOFTWARE

.1 Schneider Vijeo Designer 6.2, a proprietary HMI graphical development package, is used to develop the Magelis HMIs. A copy of the HMI graphics, compatible with this version of Vijeo will be provided to the City after the project is completed. The program will not be password-protected and will be editable.

.2 Schneider Unity Pro Large V12.0, a proprietary PLC programming software package, is used to program the M580 PLCs. A copy of the PLC program, compatible with this version of Unity Pro will be provided to the City after the project is completed. Both an archive (.STA) and a live backup will be provided to the City. The program will not be password-protected and will be editable.

.3 Schneider Wonderware 2017, an industrial HMI program, is used at the Jack Kraft Facility to monitor all remote sites. Graphics displaying the status of each remote site are created in this program, displaying important values from each site. Alarms are displayed and acknowledged using this program.

.4 Win911, an industrial software alarm dialing program is used at the Jack Kraft Facility to call out alarms from all remote sites.

6.5 REMOTE ACCESSIBILITY

.1 No direct remote accessibility to the water facilities local HMI is planned. The sites will be stand-alone. Remote viewing and control of the site will be available via the Jack Kraft Facility.

6.6 SECURITY

6.6.1 Cyber Security

.1 Provide a copy of the HMI program, PLC program, and the Ethernet switch configuration to the City, after the project is complete, in a version compatible with the software versions listed above. Provide passwords, including operator and management passwords for the HMI, and the management ethernet switch password to the City.

.2 Install machine-printed labels on all IP-enabled and Serial equipment in the PLC cabinet, identifying the device serial or IP address.

.3 Network separation will be maintained. At no point should non-PCS networks or devices be connected to the PCS. PCS devices should not be able to access the internet.

.4 Ensure that HMI displays are password protected by a Strong Password common to all Operators.

.5 Each HMI computer must be provided with at least two USB 3.0 external USB-powered Hard Disk Drives (HDDs) sized to contain at least double the capacity of the HMI computer. Each are to be labelled with the site and HMI they back up. One is kept plugged into the HMI computer, and one is returned to the City for storage. Every six months, the on-site and City-storage HDDs should be switched. The HMI must be configured to automatically back up critical directories, including but not limited to the HMI program path including all settings and INIS, and HMI configuration path including all graphics, animations, and scripts. The local trend folder should be automatically backed up to the HDD at least daily. While HMI program paths should automatically back up monthly. Differential backups are acceptable for trends, but not for HMI program paths.

.6 Additionally, copies of all software installers should be saved to both HDDs for use in case of catastrophic computer failure.

.7 Each HMI computer must have a complete disk image provided to the City including the complete installation and configuration of the HMI at the time of installation. This may be obtained by using the City's copy of Acronis Backup. This file must be stored on the City's SCADA Network Attached Storage device.

6.6.2 Personnel Security

.1 For outdoor installations, provide a door contact on the outer panel door, wired to a security controller with a keypad mounted in the inner panel door, such that if the passcode is not successfully entered after opening the door, a PLC alarm activates.

.2 Provide a red push-to-test light on the inner door connected to the security controller. Program the controller to flash the light upon alarm warning (entry) and alarm arming (exit). A solid light indicates armed, no light indicates disarmed.

.3 For indoor installations, provide door contacts on all exterior doors, wired to a security controller with keypad, such that if the password is not successfully entered upon the door opening, an alarm activates on the PLC. This is communicated back to the Master PLC for alarming.

7 Commissioning Program

7.1 QUALIFICATIONS, ROLES & RESPONSIBILITIES

7.1.1 Commissioning Manager

.1 Experience and Qualifications:

a) When commissioning services are warranted, a professional engineer or qualified operations specialist is to be appointed as a Commissioning Manager to manage, implement, and coordinate the Commissioning Program. Qualifications to include minimum 5 years' experience in managing the testing, start-up and commissioning of mechanical, building, electrical, instrumentation, piping systems, control systems and operating process systems.

b) Commissioning Manager cannot be the project manager, superintendent, construction manager.

.2 Responsibilities:

a) The Commissioning Manager will be responsible for planning, preparation, coordination, implementation and management of the Commissioning Program including detailed co-ordination of the commissioning operator, owner's operator, contractor, engineer and owner.

b) Schedule, chair, minute and attend all commissioning meetings.

c) Develop the Commissioning Plan for review and acceptance by the City Engineer and Owner.

d) Develop the commissioning schedule for review and acceptance by the Engineer and Owner. Must include all phases (Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance) of the Commissioning Program.

e) Provide a detailed list and schedule of specific tasks for each system, subsystem and equipment throughout all phases (Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance) of the Commissioning Program.

f) Develop and maintain Pre-Start-Up, Start-Up and Commissioning and Performance Acceptance checkout lists for review and acceptance by Engineer.

g) Develop SAT Plan for review and acceptance by Engineer and maintain until completion.

h) Develop comprehensive training program for review and acceptance by City Engineer.

i) Provide all documentation for handover of the commissioned equipment to the owner.

7.1.2 Commissioning Operator

.1 Experience and Qualifications:

a) When commissioning services are warranted, a qualified operator shall be appointed to start-up, operate and maintain the equipment under commissioning from Start-Up to the end of Performance Acceptance.

b) Commissioning Operator must have a valid Operators Certification for Wastewater at a level equal to the level of the facility being commissioned, and have a minimum 5 years' experience operating similar facilities.

c) Commissioning Operator cannot be the Commissioning Manager, project manager, superintendent, construction manager.

.2 Commissioning Operator Responsibilities:

a) Co-ordinates start-up, commissioning and operating the facility with Commissioning Manager.

b) Be the on-call point of contact between Owner's operator and City Engineer

c) Must have daily onsite presence from Start-Up to end of Performance Acceptance.

d) Must attend all vendor operator training.

e) Manage operations and routine maintenance of the facility until end of performance acceptance period.

f) Identify and notify all parties of deficiencies when exposed.

g) Provide water/wastewater quality analysis as required (laboratory testing).

h) Demonstrate routine operations and maintenance of the facility to Owner's operator.

7.1.3 General Contractor:

.1 General Contractor Responsibilities:

a) Direct, supervise, and help coordinate manufacturers, suppliers, contractors and subcontractors throughout the Commissioning Program.

b) All documentation and submittals as required to support the completion of the Commissioning Program.

c) Execute all activities and submissions throughout the Commissioning Program and in accordance with the contract specifications.

d) Execution of additional activities and tasks as defined in the Commissioning Plan.

e) Attend all commissioning related meetings.

f) Co-ordinate and execute work to adhere to commissioning schedule dates, milestones and deadlines.

g) Execute all system, subsystem tests, equipment and instrumentation tests providing all required documentation.

h) Execute SAT inspection plan with Engineer as witness.

i) Execute training plan and demonstrations to ensure complete transfer of knowledge to City Operations team.

j) Transfer functioning facility to qualified and trained facility operators.

7.1.4 Owner:

.1 City Operations Team Responsibilities:

a) Coordination of activities with Owner's Operations and Maintenance Departments.

b) Assign City Operator for onsite presence from Start-Up.

c) Witness testing as required.
d) Coordination of City's personnel for vendor training activities during Start-Up and Commissioning Phase.
e) Record and log deficiencies during the warranty period and submit to the City Engineer.

7.1.5 City Engineer

.1 City Engineer Responsibilities:

a) Witness testing as required per the Contract.
b) Coordinate and execute additional activities as defined in the Commissioning Plan.

7.2 COMMISSIONING PLAN (SUBMITTAL)

.1 The Commissioning Plan shall be developed and submitted by the Commissioning Manager and must include the following as a minimum:

a) Project Commissioning Scope
b) Define System Areas and Subsystems
c) Commissioning Schedule
d) Define the Commissioning Team
   - Include names and contact information for lead representatives of the Commissioning Team including the Commissioning Manager, Commissioning Operator, Owner, Operations, Contractor, Subcontractors, and City Engineer.
   - Define the responsibilities of the above-mentioned parties.
e) Systems
   - Describe the facility system areas and systems. Provide a breakdown of each system and include all equipment and instrumentation.
   - Systems must incorporate all process mechanical, building mechanical, electrical, instrumentation equipment, and HMI and Security systems.
f) Proposed Testing Procedures
   - Develop a proposed plan for testing each system, including a step-by-step procedure incorporating each equipment and requirements to meet a successful test.
   - Include a testing plan for all instrumentation.
   - List all Planning, Pre-Start-Up, Start-Up, SAT, Commissioning and Performance Acceptance activities.
g) Commissioning Sequence
   - For each system area:
     - List commissioning sequence incorporating each piece equipment.
     - Each system must detail the pass requirements before the next system can be commissioned.
   - Include any feed requirements and preparation work such as:
     - Potable water service, facility service water.
     - Draining, disinfection, and flushing of tanks and lines.

h) Isolation procedures.
i) Equipment warm-up.
j) Sampling and testing requirements.
k) Verification of equipment and instrumentation.
l) Management of created waste.
m) Filling of tanks with chemicals.
n) Specific activities for Commissioning Team.
o) Training
   - Include detailed training plan highlighting prerequisites for training.
   - Specify classroom and on-site training plan and schedule.
p) Additional Supporting Documentation as may be required.
q) Include reviewed and accepted documentation including but not limited to:
   - Pre-Start-Up and Start-Up Checkout List.
   - Supplier Equipment Checkout list and Commissioning Forms.
   - Relevant special procedures e.g. AWWA Disinfection procedures.
   - Safety and Job Hazard Analysis.
   - Equipment Check Forms and Calibration Sheets.
   - Installation Pre-Commissioning Forms.
   - Calibration Sheets.
   - O&M Table of Contents.
   - Vendor/Manufacturer Inspection Sheets.
   - Testing Documents/Forms.
   - Safety Data Sheets (SDS).
   - Hazard Assessments.
   - Safe Handling Procedures.

7.3 FACTORY ACCEPTANCE TEST (FAT)

.1 Complete Factory Acceptance Test (FAT) of control system and HMI prior to scheduling first commissioning meeting. Contractor to provide test package designed for their program:

a) Provide a Factory Acceptance Test Plan for review by the City Engineer one month prior to the scheduled FAT.
b) The test plan must include procedures for testing all aspects of the PLC and HMI control logic, including communication to devices, alarms, shutdown, failure modes, and any other features of the logic.
c) A template test plan has been provided to show expected information the plan should contain; the test plan created by the contractor is specific to the project and is based on logical functionality.
d) The test plan shall correlate to the project specific control philosophy and be separated out into logical sections.

.2 Provide a 100% completion Factory Acceptance Test at 50% overall project completion, witnessed by the City Engineer at the programming facility.

.3 Tests are to be performed using actual controllers and I/O cards being provided for the work, I/O simulation can be done using hardware or software-based simulation equipment.

.4 FAT test will not be conducted on the City's premises.

.5 The FAT cannot be done on a "live" system.

.6 Provide written documentation of all tests successfully completed with deficiencies corrected to City Engineer.

.7 FAT Test Plan must be submitted for review 1 month prior to scheduling FAT test. Test plan must be reviewed and accepted by City Engineer.

.8 City Engineer must be present to witness and pass the FAT Test. A failure will require the test to be rescheduled and costs for owner and engineer covered by the Contractor.

7.4 PLANNING PHASE

.1 Develop and submit the following documentation for review and acceptance by Engineer:

a) Commissioning Plan.
b) Pre-Start-Up Checkout List
c) Prepare and maintain Pre-start-up Checkout List, which includes all Process Mechanical, Commodity-retaining Structures, Building Mechanical, Instrumentation and Controls and Electrical Wiring and Equipment. Group list into logical systems areas or sub-systems as per the Commissioning Plan for orderly progression of activities during start-up.
d) Track and maintain pressure and leak test certificates, hydrostatic test certificates, disinfection certificates, regulatory sign-offs, alignment data records, equipment installation certifications, instrumentation loop checks, calibration sheets, electrical wiring checks, and deficiency list.
e) Start-Up Checkout List
   - Prepare and maintain Start-up Checkout List, which includes tracking of JHA sign-off, Training, O&M Manuals, Functional Test, SAT, and Commissioning Team Sign-off.
f) Performance Acceptance Checkout List
g) Prepare and maintain Performance Acceptance Checkout List, to capture the completion of Manual Run Test, Automatic Run Test, SAT, Operating Permit, Regulatory Permit, Chemical Analyses, Bacteriological Analyses, Commissioning Sign-off, 30-Day Performance Acceptance Run, Training, O&M Manuals, JHA, Deficiencies, and Commissioning Team Sign-off.
h) SAT Inspection Plan.
i) Detailed Training Plan.

7.5 PRE-START-UP PHASE

.1 Cleaning:

a) To extent practical, remove all scaffolding, debris, planks, tools, and other construction-related material.

b) Remove all sand, silt, dirt, and debris, channels, chambers, instrumentation and control panels and electrical panels and vacuum clean.

c) Clean all surfaces of tanks and conduits, including walls, roofs, floors, and columns with high pressure water jets or as specified in individual Sections.

d) Clean interior of all pipes and fluid-carrying equipment, including pumps and inspect with Engineer present.

e) Complete the following tests in accordance with the respective individual sections:

- Leakage and pressure tests.
- Hydrostatic tests.
- Disinfection procedures.
- Alignment data records.
- Generate Equipment Installation Certificate.
- Instrumentation Loop Checks.
- Instrumentation Calibration Records.
- Electrical Wiring Checks and Megger Test.
- Regulatory Sign-off.

.2 Tagging:

a) Identify all pieces of equipment by Tag Numbers.

b) Provide Checkout Tag for each piece of equipment.

c) Checkout Tags to be filled in by each applicable trade verifying that all appropriate checks have been made, including but not limited to, cleaning, inspection, leakage testing, lubrication, rotation, calibration, adjustment and wire loop checks.

d) Equipment Manufacturer’s Representatives to inspect equipment in accordance with applicable individual Sections. Certify equipment has been properly installed and is ready to start.

e) Contractor to submit Equipment Checkout List to Engineer. Equipment Checkout Listing to include the following:

- System description.
- Equipment Name and Tag Number of each component within System.
- Supplier’s Name of each equipment component, complete with sign-off where applicable.
- Mechanical Trade sign-off (Trade certificates completed).
- Electrical/Instrumentation Trades sign-off (Trade certificates completed).
- Contractor sign-off (all certificates completed).
- Attach the following to Equipment Checkout List:
  - Manufacturer’s Representatives’ Installation Certification Form.
  - Hydrostatic Test Certification Forms.
  - Weld Test Certificates.
  - Pressure Test Certification Forms.
  - Disinfection Certification Forms.
  - Instrumentation and Electrical Equipment Loop Check Forms.
  - Instrumentation Calibration Forms.

- List of outstanding contract deficiencies for each system.
- Request, in writing, a Pre-Start-Up Inspection by Engineer. Once Engineer has conducted the Pre-Start-Up Inspection and is satisfied that each piece of equipment has been properly checked-out, a green “Ready-to-Start” tag will be attached to each piece of equipment in the system.

f) Red “Installed” Tag:
- Clearly identify all equipment and/or systems that are completely installed and wired with a red tag to indicate that the contractor is responsible for the equipment.
- Develop and submit Red Tag for review and acceptance by Engineer before implementing onsite.

7.6 START-UP PHASE

.1 The Commissioning Program can move to the Start-Up Phase can after all requirements in the Pre-Start-Up phase is completed.

.2 Green “Ready to Start” Tag:

a) Once the piece of equipment has been installed, aligned, tested and certified by manufacturer/vendor as having been installed properly, remove the red tag from the equipment and replace with a green tag.
b) Once each piece of equipment within a defined system carries a Green “Ready-to-Start” tag, then that individual system shall be started and tested.
c) All parties must sign the tag to acknowledge that the equipment is ready for start up.

.3 Conduct workshop with Owner’s Representatives and City Engineer to identify and integrate activities of all parties in Start-up phase. Prepare Start-up Plan which includes the following:

a) Plan objectives.
b) Facilities, systems and subsystems to be started.
c) Sequence of events and start-up schedule.
d) Responsibilities of each party.
e) List of individuals involved complete with contact telephone numbers.
f) English language description of each system’s intended means of operation.
g) Initial operating conditions and parameters.
h) Intended final operating conditions and parameters.
i) Filling of chemicals in chemical systems.
j) Laboratory requirements and arrangements for outside testing services.
k) Sampling and monitoring requirements and testing plan.
l) Contingency plans to respond to potential emergencies.
m) Safety and environmental considerations.

.4 Ensure Operating and Maintenance Manuals is reviewed and accepted by City Engineer.

.5 Correct any deficiencies uncovered during testing

7.7 SITE ACCEPTANCE PHASE (SAT)

.1 Complete Site Acceptance Testing of Control System:

a) Provide a Site Acceptance Test Plan for review by City Engineer one month prior to the scheduled SAT.
b) The test plan should be substantially similar to the FAT test plan with changes applicable to site testing.
c) The test plan shall correlate to the project specific control philosophy, in addition to the expected site testing procedures which are typically separated out by process area.

.2 Pre-test all wiring and instruments for functionality prior to conducting site acceptance testing. Provide written documentation to Engineer detailing testing of all loops.

.3 Site acceptance testing will occur under operating conditions, with process fluid in the vessels and piping, and equipment operational. Simulation equipment is not required, and testing shall be conducted by setpoint manipulation.

.4 Provide a Site Acceptance Test for each unit process, prior to commissioning, witnessed by the City Engineer at the Owner's facility.

.5 Execute all tests as described in the test plan.

.6 Any deficiencies resulting from the SAT will be rectified prior to retesting.

.7 Address any deficiencies identified by site acceptance testing and obtain Engineers sign-off on all components after testing is complete.

.8 City Engineer must be present to witness and pass all tests in the SAT.

7.8 COMMISSIONING PHASE

.1 Commissioning Phase can begin once all requirements in the Start-Up and SAT phases are completed.

.2 Blue "Commissioning" Tag:

a) Once each piece of equipment within a defined system has passed SAT, remove the Green Tag and replace with a Blue "Ready-to-Commission" tag.
b) Once all systems and subsystems have a blue tag commissioning can begin.
c) All parties must sign the tag.

.3 Commissioning Phase cannot proceed until:

a) All safety systems including but not limited to safety showers and gas detections system are fully functional.
b) All HVAC systems are fully functional and operating as per design intent.
c) All spill containment and spill cleanup equipment are in place and client's operation team trained to clean up any chemical spills.
d) Contractor to provide commissioning support including representatives of Contractor and Contractor's mechanical, electrical, and instrumentation staff or subcontractors, as appropriate.

e) Contractor to execute commissioning packages to commission. Each commissioning package to consist of fully functional portions or groups of operationally tested systems capable of operating in concert to provide a complete service or function that is of value to Owner.

f) Remove and clean or replace as required all permanent and temporary filters and strainers in pipeline systems; replace HVAC filters; dewater and clean sumps and leave process systems clean and filled with clean water, unless otherwise directed by City Engineer.

g) Commissioning to be generally conducted in manual mode first, followed by automatic operation. During the initial part of commissioning phase, the contract must provision to allow for the system to recirculate, discharge to sanitary sewer or have the water produced haul to the nearest waste receiving station.

7.9 PERFORMANCE ACCEPTANCE PHASE

.1 The Period of time for continuous automatic operation to pass Performance Acceptance is 720 hours with all systems operating continuously without fault and all process, mechanical, control and electrical equipment free of vibration, overloading or overheating and functioning in accordance with specified rates, methods and performance.

.2 The City Engineer will establish the operating conditions for the performance test that must be maintained. The commissioning operator must record the data daily or submit trending reports. This may include:

a) Chemical or Bacteriological Effluent/Distribution/Discharge conditions.
b) Operational readings: Flow, temperature, pressure, chemical dosing rates.
c) Pump, VFD or Motor readings.
d) Analyzer or instrumentation readings.
e) Any other pertinent data.

.3 Performance Acceptance can begin when the facility operates under steady controlled conditions where all temperatures, pressures, flows, pH levels, bacteriological conditions, chemical conditions and analyses are constant and within operational parameters. All required regulatory water quality specifications must also be consistently achieved as per codes, standards and approvals.

.4 Failure of any part of Work during the period of performance acceptance will require restart of that portion or system of Work, following rectification of the fault or failure.

.5 Implement detailed training plan.

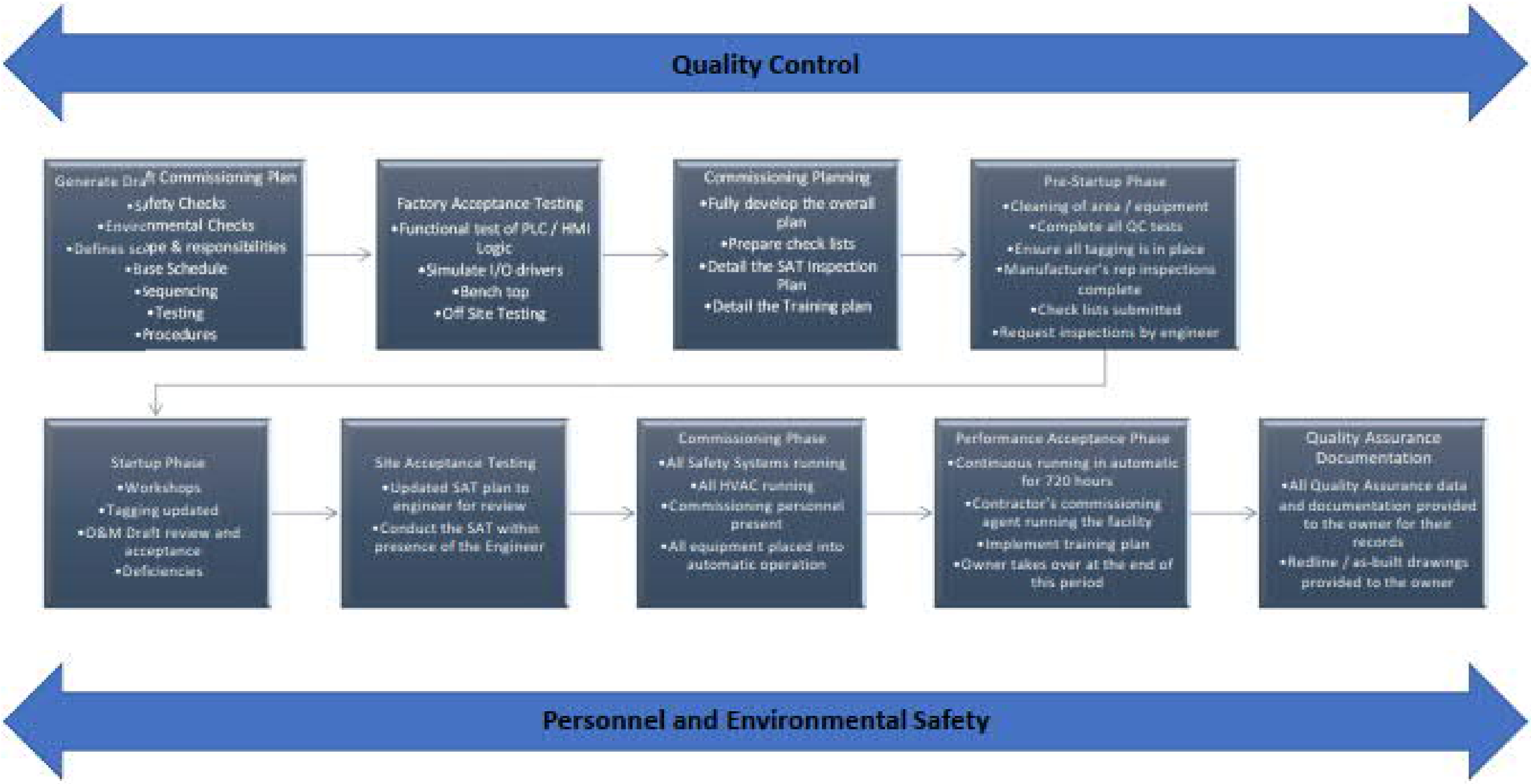
.6 Training must be held with a minimum 360 hours remaining in the performance acceptance in order for the Owner's Operator to effectively observe the daily routine of the Commissioning Operator.

.7 The facility will be handed over to the Owner's operations after:

a) The performance acceptance phase been completed and accepted by the Owner and Engineer.
b) All major deficiencies have been corrected.
c) The Facility has met design and operational intent.

Adherence to Substantial Performance as defined in the Builders' Lien Act.

7.10 FACILITY COMMISSIONING PLAN PROCESS FLOW



8 Submissions

The following typical electrical and instrumentation submissions are expected from new stations. Where stations are modified, the relevant drawings and/or documents are expected to be red-lined.

.1 As-built drawings in AutoCAD and PDF format.

.2 Operations and Maintenance Manuals (O&M Manuals).

.3 Network block diagram indicating all IP and radio hardware including IP addresses, physical port numbers, serial port assignments, and radio addresses.

.4 Card drawings for PLC.

.5 Cabinet layout drawing, including bill of materials detailing all equipment.

.6 Detailed Control Philosophy.

.7 Site layout

.8 Electrical layout

.9 Single line diagram

APPENDIX E

City of St. Albert

Duty/Standby Lift Stations
Control Philosophy

May 2019

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1 Introduction

The purpose of the Control Philosophy is to clearly define the detailed functionality of 2-pump Duty/Standby and 3-pump Lead/Lag/Standby Lift Stations. The Control Philosophy must be read in conjunction with the corresponding standards and specifications.

Note that all tags used in this document are general. Refer to the City Standards for tagging convention.

1.1 DEFINITIONS

In these Standards, unless the context otherwise indicates, the following definitions will apply:

.1 "City" will refer to the City of St. Albert.

.2 "City Engineer" will refer to the professional engineer, or designated representative, authorized by the City to authorize changes to these Standards.

.3 "Contractor" will mean the person, firm, or corporation that undertakes the installation of municipal infrastructure on behalf of the Developer or the City.

.4 "Design" will mean the designs, reports, studies, engineering drawings, technical specifications, and associated documents, including the execution and implementation of such, pertaining to a Development, Subdivision, or other municipal improvement within the City of St. Albert.

.5 "Designer" or "Consultant" will mean the professional engineer responsible for the Design. Where applicable throughout these Standards, this term may refer to or include the Landscape Architect.

.6 "ERIO" will mean the Ethernet Remote I/O modules are RIO modules that communicate to the PLC via IP over Ethernet hardware.

.7 "Ethernet" will mean a physical implementation of IP hardware. This includes ethernet switches, ethernet cables, fibre ethernet, etc.

.8 "EDIO" will mean the Ethernet Distributed I/O are Ethernet-enabled devices that provide industrial automation communications. These allow a PLC to request data from the device using ethernet communications.

.9 "Engineering Drawings" will mean the detailed engineering drawings and specifications prepared by the Consultant for a Subdivision that form part of a development agreement.

.10 "HART" will mean the Highway Addressable Remote Transducer. A protocol used to transmit additional signals superimposed on a 4-20 mA analog signal.

.11 "HMI" will mean the Human Machine Interface. This is an appliance or software program that provides a graphical interface to an operator allowing the operator to steer the process control system.

.12 "HOA" will mean Hand/Off/Auto. A three-position selector switch that chooses between local-on (Hand), Local-off (Off), or Remote (Auto) operation.

.13 "IP" will mean the Internet protocol. The basic protocol used for all internet communications.

.14 "MODBUS RTU" will mean an industrial automation serial communications protocol.

.15 "MODBUS TCP" will mean the Modbus protocol wrapped in TCP. This allows industrial automation devices to communicate over IP network infrastructure.

.16 "PCS" will mean the Process Control System. This is the system of controllers, networks, instruments, computers, software, etc. that are used in the control of a process.

.17 "PLC" will mean the Programmable Logic Controller.

.18 "Prime Contractor" is as defined by the Occupational Health and Safety Act – Alberta.

.19 "RIO" will mean the Remote Input/Output modules that provide I/O in locations distant from the main PLC. These do not have any local processing power and require communications to a PLC to control a system.

.20 "SCADA" will mean the Supervisory Control and Data Acquisition. The system that acquires data from geographically separate locations and provides some control or visibility to an operator or manager.

.21 "Standards" refers to the latest version of these municipal engineering standards in their entire scope, as further defined in Article 1.3.

.22 "Strong Password" will mean that a strong password is at least 8 characters and must be checked prior to use against a blacklist of compromised passwords.

.23 "TCP" will mean the Transmission Control Protocol. A sub-protocol of IP. It includes checksums to ensure that all data is successfully delivered and uncorrupted before processing the data.

.24 "UPS" will mean the Uninterrupted Power Supply. A backup power system that provides emergency power in the event of a power failure. A UPS seamlessly takes over in the event of a power failure and is intended to outlast brief power interruptions.

.25 Facilities:

a) "DRLS" means the Deer Ridge Lift Station.

b) "ERLS" means the Erin Ridge Lift Station.

c) "FHLS" means the Fire Hall Lift Station.

d) "GALS" means the Gate Avenue Lift Station.

e) "GPSF" means the Glacier Park Storm Facility.

f) "HBS" means the Henday Booster Station.

g) "JKPW" means the Jack Kraft Public Works Facility.

h) "KWDP" means the Kingswood Day Park Sanitary Lift Station.

i) "LLP" means the Lacombe Lake Park Facility (Lift Station).

j) "LPS" means the Lacombe Pup Station and Reservoir.

k) "MHG" means the Mission Hill Grinder Sanitary Installation.

l) "OLS" means the Oakmont Lift Station.

m) "OPS" means the Oakmont Pump Station and Reservoir.

n) "RCLS" means the Rivercrest Lift Station.

o) "RPALS" means the Riel Park Amenities Lift Station.

p) "RPRVLS" means the Riel Park RV Lift Station.

q) "RRLS" means the Riel Road Lift Station.

r) "RSLS" means the Riverside Lift Station.

s) “SPS” means the Sturgeon Pumphouse and Reservoir.

t) “TLS” means the Twilight Sanitary Lift Station.

u) “WLS” means the Walmart Storm Water Lift Station. This site will be decommissioned by the City, so there is not any scope of work included.

1.2 MAJOR COMPONENTS

The following are the major components within the Lift Station:

v) Two to three sanitary pumps;

w) Lift Station level transmitter;

x) Lift Station discharge flow meter;

y) Lift Station discharge pressure transmitter; and

z) Lift Station control cabinet and PLC.

1.3 SCADA INTEGRATION

A PLC capable of communicating via Modbus TCP and serial Modbus RTU will be installed in the Lift Station’s control panel, along with an Ethernet-enabled HMI and a managed Ethernet network switch. The Lift Station will be integrated into the Master PLC and HMI located at the Jack Kraft Public Works Facility.

Each remote site PLC will be programmed to collate all information that will be displayed at the JKPW into two blocks of contiguous registers, numerically separated from the registers used in the local station operations. One set of registers will be used for “read-only” information, such as values and statuses. The second set of registers will be used for “write” information, such as setpoint and command entries. The Master PLC in JKPW will query the remote site PLC for this data. Provide at least 20% spare registers in these ranges for potential expansion of read and write information.

The Local PLC must be programmed such that if values are modified from the local HMI, they are accepted and retained. The Local PLC must also be programmed such that if values are modified from the SCADA HMI by way of the Master PLC, they are accepted and retained. If communications between the Master PLC and Local PLC are interrupted, the local PLC will continue to operate as normal.

All monitored stations will use “heartbeat” signals and timers to indicate communication integrity between the Master PLC and the remote PLCs. The Master site will activate a Level 2 Alarm if communications are lost to the Lift Station.

Lift Station setpoints and all equipment controls are adjustable from both the Local HMI and the Master HMI screens. Access is controlled by the access level logged into either HMI.

1.4 REPORTING

The local PLC should track the current 24-hour discharge flow total. It will retain the last seven days' discharge flow and display both current and seven-day values. Every 24-hours, the current total resets in the PLC and the held data shifts into the seven day holding registers. The non-resetting total, read directly from the flow meter via HART if available, is also displayed on screen.

The local PLC should track motor run times. It will retain the previous day's motor run times and displays both current and previous-day values. Every 24-hours, the daily runtime values are shifted into the previous-day value and the daily runtime is reset. The cumulative non-resetting total is also displayed on the screen.

1.5 COMMUNICATIONS

The Lift Station will operate in one of two modes based on heartbeat signals between remote site and Master PLCs:

Online Mode: SCADA communications are valid, and the Master HMI has access to all process data and status signals. Both the Master HMI and Local HMI may be used to coordinate signals and equipment operations to ensure continuous operation. The local PLC controls operations, such as when to start and stop the pumps and Alarm activations. The local PLC may receive operational requests and setpoints from either the local HMI or from the Master HMI via the Master PLC.

Stand-Alone: SCADA communications are interrupted and/or invalid. Each location has a PLC that will determine if communications have been interrupted to the Master PLC using a heartbeat signal and a timer. Upon determination of a communications loss, the station will revert to stand alone operating parameters. Stand-alone mode means all required equipment, if in Remote-Manual (see below), will revert to Remote-Automatic and pumps will operate based on the last known level setpoints. When the heartbeat is re-established, the system will revert to online mode. The Operator will need to place any equipment required to be in Remote-Manual back into that mode when returning from Stand Alone to Online mode. No OOS motors will be changed in Stand-Alone mode.

1.6 ALARMS

All Alarms are functional whether the process is in Auto or Manual mode. There are three distinct Alarm levels:

Level 1 **Critical:** Immediate action is required! This level of Alarm should be considered before any **Level 2** or **Level 3** Alarm. Acknowledgement is required to silence the Alarm. Once the condition is cleared, a reset is required to remove the Alarm from the Alarm summary and thus remove any interlocks associated with the Alarm.

Level 2	**Normal:** Important, but non-critical, fix abnormality when time allows. Acknowledgement is required to silence the Alarm. The Alarm will automatically clear when condition itself has cleared and the Alarm has been acknowledged.
Level 3	**Event:** Important but not critical; intended for Operator notification only. Acknowledgement is not required. **Level 3** Alarms are typically used to log setpoint changes, motor starts, or other non-critical events.

Alarms and events will be displayed with the following classifications:

ACK	-	Alarm was acknowledged (White)
UNACK	-	Alarm has not been acknowledged
ALM	-	Alarm has occurred (Red)
EVT	-	Event has occurred (Yellow)
RTN	-	Return from an alarm state to a normal state (Green)
SYS	-	A system event has occurred
USER	-	The Operator login has changed

All Alarms for the Lift Station will be displayed on the local HMI screen and Master HMI screens at the Jack Kraft Public Works Facility. Alarm call-outs are handled by the Master HMI and no local alarm dialler will be installed at the Lift Station. Each Alarm will have de-bounce time delays in the local PLC to prevent nuisance Alarms. All Alarms must be able to be individually or collectively acknowledged by the Master HMI and have that acknowledgement pass onto the local HMI.

2 Lift Station

2.1 LIFT STATION DISCHARGE PUMPS

Sanitary waste will flow by gravity into the Lift Station wet well, where it will then be pumped by either two or three lift station pumps. Discrete outputs from the PLC will send a signal to each pump to start. The pumps operate as either Duty/Standby or Lead/Lag/Standby, and the status of each is displayed on the local HMI, using the remote Running, Fault, Ready, and Watchdog Alarm. The pumps can be controlled manually in the field using the HOA switch on the pump control panel, or remote-manually from the local HMI using the Remote Start command. Motor runtime hours (today's twenty-four-hour total, yesterday's twenty-four-hour total, and cumulative total) are displayed on the HMI using the pumps' running signals.

A push button will be available on the HMI motor control pop up screen allowing the Operator to select which pump is selected as Duty, or in the case of a Lead/Lag setup, which pumps are selected as Lead and Lag. When a pump is selected as the Duty, or a set of pumps are selected as the Lead and Lag, the remaining pump will automatically be designated as the Standby pump. On first scan of PLC logic, a pump will automatically be set as Duty, or in the case of a Lead/Lag setup, a set of pumps will automatically be set as Lead and Lag. This will ensure the Lift Station continues to operate without Operator intervention if the PLC resets. A pressure transmitter will be installed on the common discharge piping of the pumps for discharge pressure indication, an Operator-adjustable High-Pressure Alarm will be derived from this device.

When placed in Automatic mode, the pumps operate as Duty/Standby or Lead/Lag/Standby and can also be placed in "Out of Service" mode. If all pumps at the facility are placed in "Out of Service" mode, an Alarm is issued to warn the Operator of the situation. Pump designation status is determined on the HMI screen. Should the Duty, Lead or Lag pump fail to Start or trip when called to Start, the Standby pump will automatically be promoted to the failed pumps designation and an Alarm issued to the Operator.

The Lift Station discharge flow rate is monitored and trended via the discharge flow transmitter. The flow rate will be totalized and displayed on the local and Master HMI, as a daily resettable 24-hour total (current and previous seven days) and as a non-resettable running total, as measured by the flow transmitter (read via HART if available). If the duty pump is running for an Operator adjustable timer (nominally 30 seconds) and no flow is registered on the flow meter, an Alarm will be issued to the Operator, indicating a potential blockage or pump issue.

Table 2-1
Discharge Pump Devices

Device	Item	Alarm Level	Action
Pumps 1 & 2	Run Status	**Level 3**	
	Fault Alarm	**Level 1**	Duty Pump Set to OOS; Standby Pump Designated as Duty; Alarm Callout
	Ready & Remote-Auto Status	**Level 3**	
	Both Pumps OOS	**Level 2**	Alarm Callout
	Fail-to-Start Alarm	**Level 1**	Duty Pump Set to OOS; Standby Pump Designated as Duty; Alarm Callout
Discharge Flow Transmitter	Pump Running & No Flow Alarm	**Level 2**	Alarm Callout

2.2 DUTY/STANDBY DISCHARGE PUMP LEVEL CONTROL LOGIC

The wet well level is monitored by an ultrasonic transducer, which will be used for pump start/stop logic and Alarming purposes. The HMI will display and trend the level from Empty to Full, as measured in meters. This instrument provides Low and High Supervisor-adjustable HMI Alarm setpoints, as well as Operator-adjustable start-pump and stop-pump setpoints.

The wet well is also equipped with High High and Low Low level switches, which are set higher and lower than the level transmitter High and Low Alarm setpoints. These devices are used for backup flood and pump protection and will be hardwired directly to the pumps. When on generator and the PLC is active, as detected by the transfer switch status, the PLC will only attempt to run the Duty pump (Depending on generator power availability, if the generator is sized to accommodate running both pumps, then both can run).

If a Low or Low-Low Level Alarm is received, the PLC will automatically stop any running pumps. If a High or High-High Level Alarm is received, the PLC will automatically start the Duty pump.

Under normal operation, the level will move between the start and stop setpoints. When the level in the wet well rises past the start setpoint, the PLC will start the Duty pump. The pump will operate until the stop setpoint has been reached.

After the duty pump stops in remote-automatic, or if the duty-pump should fail to start, the Duty/Standby designation will automatically switch, assuming the other pump is ready, not out of service and not in Manual Mode. This will help distribute the runtime hours between the pumps.

Table 2-2
Discharge Pump Level Control Logic Devices

Device	PLC Tag	Alarm Level	Action
Level Transmitter	High Level Alarm	**Level 2**	Start Duty Pump; Alarm Callout
	Level Above Start Level	**Level 3**	Start Duty Pump
	Level Below Stop Level	**Level 3**	Stop Duty Pump; Swap Designation
	Low Level Alarm	**Level 2**	Stop All Pumps
High-High Level Bulb	High-High Level Alarm	**Level 2**	Alarm Callout; See Hardwired Level Control Logic
Low-Low Level Bulb	Low-Low Level Alarm	**Level 2**	Alarm Callout; See Hardwired Level Control Logic

2.3 LEAD/LAG/STANDBY DISCHARGE PUMP LEVEL CONTROL LOGIC

The wet well level is monitored by an ultrasonic transducer, which will be used for pump start/stop logic and Alarming purposes. The HMI will display and trend the level from Empty to Full as measured in meters. This instrument provides Low and High Supervisor-adjustable HMI Alarm setpoints, as well as Operator-adjustable start-pump and stop-pump setpoints.

The wet well is also equipped with High High and Low Low level switches, which are set higher and lower than the level transmitter High and Low Alarm setpoints. These devices are used for backup flood and pump protection and are hardwired directly to the pumps. When on generator and the PLC is active, as detected by the transfer switch status, the PLC will only attempt to run the Lead pump (Depending on generator power availability, if the generator is sized to accommodate running both pumps, then both can run).

During automatic operation, the PLC will control the Lead and Lag pumps, based on Operator-adjustable LEAD_START, LAG_START, and LSP_STOP setpoints, derived from the ultrasonic level transmitter. They are to be entered on the local HMI screens. When the level in the wet well rises past the LEAD_START setpoint, the PLC will Start the Lead pump and begin discharging sewage. If the level continues to rise to the LAG_START level, then the Lag pump will start, and both pumps will continue to run, until the level has dropped below the LSP_STOP setpoint.

When the Lead pump stops while in auto, or should fail to start, and if the Lag pump is in Remote and Remote-Auto, and not out-of-service the Lead/Lag designation will automatically switch. This will distribute the runtime hours between the pumps.

Table 2-3
Discharge Pump Level Control Logic Devices

Device	PLC Tag	Alarm Level	Action
Level Transmitter	High Level Alarm	**Level 2**	Start both Lead and Lag Pumps; Alarm Callout
	Level Above LEAD_Start Level	**Level 3**	Start Lead Pump
	Level Above LAG_Start Level	**Level 3**	Start Lag Pump
	Level Below LSP_Stop Level	**Level 3**	Stop both Lead and Lag Pumps
	Low Level Alarm	**Level 2**	Stop all Pumps
High-High Level Bulb	High-High Level Alarm	**Level 2**	Alarm Callout; See Hardwired Level Control Logic
Low-Low Level Bulb	Low-Low Level Alarm	**Level 2**	Alarm Callout; See Hardwired Level Control Logic

2.4 HARDWIRED LEVEL CONTROL LOGIC

The following hardwired logic applies to both a duty/standby and lead/lag/standby lift station configuration. This operation is intended for new installations. Existing installations have their own relay logic built-in and this should not be modified.

The High-High and Low-Low level switches described above are also wired to the PLC for status information and to a secondary relay-based control system for back-up control.

The below description is for the Relay-Based Control System (RBCS). This should be implemented using hard-wired relays. Wiring is the responsibility of the contractor.

The RBCS accepts the following inputs:

1. High High Level Bulb Active (Tipped)
2. Low Low Level Bulb Active (Not Tipped)
3. Pump 1 Run Status
4. Pump 2 Run Status (If exists)
5. Pump 3 Run Status (If exists)
6. PLC Run Status (normally closed contact from PLC, closed while running, opens if PLC stops or loses power).

The RBCS provides the following outputs:

1. Run Pump 1
2. Run Pump 2 (if exists)
3. Run Pump 3 (if exists)

The RBCS logical function in a station where the electrical system is sized such that all pumps can run whether on normal or backup power is described below:

1. The PLC will maintain a normally closed contact to disable the secondary control system. If this is opened, the remainder of the RBCS is enabled.
    a. If the high high level bulb is tipped while the low low level bulb is also tipped:
        i. Send a run command to all pumps.
        ii. When neither the high high level bulb or the low low level bulb are tipped (i.e. the level has dropped below the low low level bulb), or the PLC run Status re-activates, release the run command from all pumps.
    b. If the high high level bulb is tipped while the low low level bulb is not tipped:
        i. Send a run command to all pumps.
        ii. If, after a time delay (nominally 60 seconds) no pump run statuses are returned, activate “RBCS attempted all pumps alarm”.
        iii. After a time-delay (field-set to the amount of time it takes to run from high-level to low-level), or the PLC run Status re-activates, release the run command from all pumps.

The RBCS logical function in a station where either the normal or backup electrical systems are not sufficient for all pumps to run is described below:

1. The PLC will maintain a normally closed contact to disable the secondary control system. If this is opened, the remainder of the RBCS is enabled.
    a. If the high high level bulb is tipped while the low low level bulb is also tipped:
        i. Send a run command to one pump (Pump #1).
        ii. If after a time delay, nominally 60 seconds, this pump run status is not activated:
            1. Release the run command from Pump #1.
            2. Apply run command to Pump #2 (if exists)
                a. If after a time delay, nominally 60 seconds, this pump run status is not activated:
                    i. Release the run command from Pump #2
                    ii. Apply run command to Pump #3 (if exists)
        iii. If after a time delay, nominally 60 seconds after the last available pump has been attempted, try Pump #1 again, cycling through pumps continuously.
        iv. When neither the high high level bulb or the low low level bulb are tipped (i.e. the level has dropped below the low low level bulb), or the PLC run Status re-activates, release the run command from all pumps.
    b. If the high high level bulb is tipped while the low low level bulb is not tipped:

i. Send a run command to one pump (Pump #1).
ii. If after a time delay, nominally 60 seconds, this pump run status is not activated:
    1. Release the run command from Pump #1.
    2. Apply run command to Pump #2 (if exists)
        a. If after a time delay, nominally 60 seconds, this pump run status is not activated:
            i. Release the run command from Pump #2
            ii. Apply run command to Pump #3 (if exists)
iii. If after a time delay, nominally 60 seconds after the last available pump has been attempted try Pump #1 again, cycling through pumps continuously.
iv. If, after a time delay (nominally 60 seconds) no pump run statuses are returned, activate “RBCS attempted all pumps alarm”.
v. After a time-delay (field-set to the amount of time it takes to run from high high level to low low level), release the run command from all pumps.

2.5 STAND-ALONE MODE

Stand-alone mode applies to both pumping configurations and is entered when a heartbeat timer expires, indicating communications are not occurring to the site from the Master HMI. Any equipment in Remote-Manual Operation mode is switched to Full Automatic mode and the last known setpoint values for all level control logic are used for operation. The site will continue functioning in this manner until communications have been restored and the PLC returns to Online mode.

When communications are restored, devices shall not automatically change to remote-manual. They will remain in automatic mode until instructed otherwise by an operator.

2.6 BUILDING CONTROLS

A low temperature switch will be available for low building temperature indications. A **Level 2** Alarm will activate, when the low-temperature switch activates.

A security system will be installed at the Lift Station, which uses a key pad and associated door/hatch contact switches; it will provide a **Level 2** General Intruder Alarm to the local PLC, if the armed security system is triggered. An Alarm will activate, when the security keypad is armed, and a door/hatch contact switch has been opened.

For a lift station with a building, a building smoke detector will be wired back to the PLC. The contact will remain closed, while no smoke is detected. A **Level 2** Alarm will activate, if the smoke detector detects smoke and opens the contact.

The local PLC will be equipped with dual redundant 24 V_{DC} power supplies, each of which will provide a contact back to the PLC if either has failed. A **Level 2** Alarm will be sent to the Operator, if a power supply fails. The 120 V_{AC} UPS also provides a normally-closed contact to the PLC that opens, if a power failure has occurred and the UPS is running on battery. A **Level 2** Alarm will be activated when this contact opens. For a lift station with a building, a Hydrogen Sulfide gas detector will provide a normally-closed contact to the PLC. A **Level 2** Alarm will activate, if the gas detector detects gas and opens the contact. A red-green pair of indicator lights will be installed outside the building. While the Alarm is active, the red indicator light will be lit. While the Alarm is inactive, the green indicator light will be lit. A test button will be made available on the HMI to test both lights.

Table 2-4
Building Devices

Device	PLC Tag	Alarm Level	Action
Temperature Switch	Low Temperature	**Level 2**	Alarm Callout
Security	Intruder Alarm	**Level 2**	Alarm Callout
Smoke Detector	Smoke Alarm	**Level 2**	Alarm Callout
Power Supplies	Power Supply Failure	**Level 2**	Alarm Callout
Gas Detector	Gas Alarm	**Level 2**	Alarm Callout, Activate Red Light
UPS	On Battery Power	**Level 2**	Alarm Callout

2.7 GENERATOR

The Lift Station may be equipped with an independent, backup generator system. The following description applies where a generator system is provided.

The local PLC will monitor the generator running, generator fault, generator ready, and fuel low level signals. All of these signals will be displayed on the HMI for indication and alarming. The transfer switch position (normal/backup) and transfer switch fault signals will be monitored and displayed on the HMI.

Table 2-5
Generator Devices

Device	PLC Tag	Alarm Level	Action
Backup Generator	Run Status	**Level 3**	
	Fault Alarm	**Level 1**	Alarm Callout
	Fuel Low-Level Alarm	**Level 2**	Alarm Callout
	Ready and in Auto Status	**Level 3**	
Transfer Switch	On Normal Power	**Level 3**	
	On Backup Power	**Level 2**	Alarm Callout
	Fault	**Level 1**	Alarm Callout

3 HMI Programming Standards

3.1 OVERVIEW

All HMI's (current and future) will use the same graphical screens, including the following features:

Security	Operator must login successfully before accessing the system; this function is provided by the Login screen.
Menus	One main menu at the top of the screen gives access to system functions, such as login, options, utilities, alarm summary, operational history, etc. The menu also includes a status bar to indicate status of important process information at a glance. A second menu at the bottom of the screen provides screen selection. Both menus are visible from all screens.
Process Screens	Process screens will display a process and instrument diagram showing equipment and process flow between devices. Additional screens can be added in the future. Local touch screens will only display local information.
Real Time Trending	Multiple real time trending of process analog values, accessed from the relevant process screen. It is not Operator configurable. This trending is time based, usually on a 12 or 24-hour period.
Alarm Summary	All active alarms are shown on one screen. Alarms are acknowledged and reset only from this screen.
Operation History	All alarms and event occurrences are appended to this screen, it is meant to give the Operator a tool for tracking the time of occurrence of alarms and events. Events include: system events, changes in state of equipment, and logical states in the process.

3.2 SCREENS, GRAPHICS AND OPERATOR CONTROL

The term "Selecting", as used in the following description, means selecting an object on the touchscreen by touching its respective area on the GUI screen. Any items that are selectable are highlighted by the HMI software when pressed.

3.3 GRAPHICAL STANDARDS

3.3.1 Screens

The graphic screens consist of one login screen for security, a main overview graphic, sub-overview screens (summary), as well as process graphic screens.

The main overview displays all the critical plant data, the summary screens display all the important data for that specific process area, and the process graphic screens display the information similar to the P&IDs to aid the Operator's understanding of the process relationships. The screens also include an alarm summary screen, historical trend screen, and a setpoint screen for each of the main process areas.

3.3.2 Graphic Colors

Graphical colours are broken down into two groups: Operational Colours and Process Schematic Line Colours, following Alberta Environmental Protection Guidelines, as shown in the following:

3.3.2.1 Operational Colours

On/Open	-	Green
Off/Closed	-	Red
Alarm	-	Flashing Red

3.3.2.2 Process Colours

Raw Water	-	Dark Green
Potable Water	-	Blue
Gas	-	Orange
Oil	-	Burgundy
Steam	-	Purple
Air	-	White
Chemical Line	-	TBD by Engineer
Fire Protection	-	Red
Sewage	-	Brown

Graphical line weights will be used to indicate major process verses minor processes. The thicker line will highlight the major process flow.

3.4 SECURITY

The user login ID defines the user's security level. Three system access levels will exist: Operator, Supervisor, and Developer. The Operator level has rights to view (not modify) process values/setpoints, acknowledge alarms and control various process equipment. The Supervisor has all these access rights, plus the ability to modify all setpoints and reset flow totalizers. The Developer user has unrestricted access rights and is only used for screen maintenance and development purposes. The screens contain process graphics showing status, alarms, values, and real and historical trend graphs. Process trends are grouped by site. All reporting requirements will be handled at the master HMI.

3.5 MOTOR OPERATION

All motors that can be controlled by the PLC are selected from the applicable process graphic. By selecting the motor on the screen, a pop-up window is displayed. The pop-up window displays all the specific details for that motor, as well as any buttons to control that piece of equipment. Each pop-up will contain the following information:

- Motor Running Status: Auto/Manual Status
- Auto/Manual Push Selector: Start/Stop Push Buttons
- Ready to Run Status: Fail-to-Start Alarm Status
- Run Timer Values: Fail-to-Stop Alarm Status
- OOS Push Selector: OOS Status
- Motor Fault Status: Motor Interlock Status

Even though each motor is different, they all share the same pop-up control window. If the motor does not contain a specific indication, then the item will be blacked out.

Each motor will have the ability to be placed into three modes of control as controlled by the local selector switch.

Remote: The device will be able to accept automated PLC commands as determined by PLC logic. When the motor is in this mode, it enables the HMI Auto/Manual controls.

Local-Hand: The device will run, regardless of PLC logic. This bypasses all interlocks. When the motor is in this mode, it disables the HMI Auto/Manual controls.

Local-Off: The device will not run, regardless of PLC logic. This bypasses all PLC start control logic. When the motor is in this mode, it disables the HMI Auto/Manual control.

While in remote, the ready-to-run status will be provided to the PLC and HMI Auto/Manual controls are activated. Each motor will have the ability to be placed in one of three modes of control as controlled by the HMI.

Remote-Auto: The device will accept automated PLC commands as determined by PLC logic.

Remote-Manual: The device will accept PLC commands as determined by the start/stop HMI commands. The motor will retain its Duty or Standby Status, which will be able to be changed in this mode, but it will not affect how the motor operates in Remote-Manual. If the site enters Stand-Alone mode, all motors in Remote-Manual are switched to Remote-Auto. Remote-Manual bypasses all PLC interlocks and the motor may be started or stopped immediately by pressing the appropriate button on the HMI.

Remote-OOS: The device will not run regardless of any PLC logic. The motor will be automatically set to Standby and will not be able to be made a Duty pump while OOS. If the site enters Stand-Alone mode, the device will remain OOS. If the PLC loses power, this status will be retentive, and upon power restoration, an OOS motor will not be allowed to be set to Duty.

Each motor has a fail-to-start and fail-to-stop alarm. The fail-to-start alarm is activated when the PLC requests a Start but does not receive the "Motor Run Status". The fail-to-start alarm will remove the PLC request to Start. This will prevent equipment from unexpectedly restarting. The fail-to-stop alarm is activated when the PLC removes a start request, the motor is in Remote, and the "Motor Run Status" is still active after a supervisor-adjustable delay.