Wastewater Pump Station Guidelines

Sewers and Drainage Design Branch

v. 5.0

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TITLE: Wastewater Pump Station Guidelines			

Rev. No.	DCR #	Description	Date Created/ Revised
0.1		Issued for Glen PS RFP and NEFC Specifications consolidation initiative	June 2016
0.2		Updates to electrical section to incorporate Gruja Blagojevic's comments, pump control philosophy, Master Input/Output (I/O) list.	September 2017
1.0		Initial release. Updates to control philosophy, PLC screenshots, control panel layout, and other miscellaneous minor changes.	May 2018
2.0		Refer to Change Log in Appendix E.	October 2019
2.1		Added Change Log entries missed in Revision 2.0. Refer to Change Log in Appendix E.	January 2020
3.0		Added Relay Table in Appendix E. Added Master Tool List in Appendix F. Moved Change Log to Appendix G. Refer to Change Log in Appendix G for other changes.	March 2021
4.0		Added Design Submission Checklist and Project Equipment and I/O Assignment List. Moved Change Log to Appendix I. Refer to Change Log in Appendix I for other changes.	July 2021
5.0		Added new sections: Unit Heaters; Labelling, Tagging and Stencilling; Radio Antennae Cable; Lighting; Commissioning Terminology; and Continuity of Sewage Service. Refer to Change Log in Appendix I for other changes.	April 2023

APPROVAL			
Name	Position	Signature	Date Approved
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GENERAL

1.1. Guidelines Intent

1.1.1. The requirements of this document are a general guideline only. Detailed criteria and specific requirements should be obtained from, and reviewed with the Engineer. Good engineering design practice shall be used in the design of the sanitary sewage pumping stations.

1.1.2. This guideline is intended to give a general description of the pump station requirements and does not purport to describe all details of the equipment to be furnished.

1.1.3. This guideline is intended to improve the reliability of the pump station, to establish some level of uniformity between stations, maximize safety and efficiency of operations crews, reduce life cycle cost, and to preserve the quality of water bodies around the City of Vancouver by preventing sewage overflow from the sewage collection system.

1.1.4. All references to Engineer shall mean the City Engineer.

1.2. Business Case

1.2.1. A business case shall be performed for all proposed new pump stations. The business case shall include a life cycle cost analysis (“LCA”) that shall compare the construction, operation, and maintenance costs, over the life cycle of the pump station and a reasonable gravity sewer alternative. At a minimum, the following operational and maintenance costs shall be included in the LCA: labour, power consumption, equipment replacement, and routine maintenance. Pump stations will only be considered a viable option if the cost analysis clearly shows that the gravity sewers are not economically feasible.

1.3. General Requirements

1.3.1. Sanitary sewage pumping stations for the City of Vancouver may be wet pit stations with submersible pumps, wet/dry pit stations with vertical centrifugal pumps, or self-priming suction lift pumps. The chosen configuration shall be the one that has an acceptable life cycle cost and is demonstrated to be an appropriate configuration for the site conditions.

1.3.2. At least two pumps shall be provided. If only two units are provided, they should have the same capacity. Each shall be capable of handling the expected maximum flow. Where three or more units are provided, they must be of such capacity that with any one unit out of service, the remaining units will have capacity to handle maximum sewage flows. The station should be designed to operate at optimal efficiency for the typical flow conditions.

1.3.3. Velocity in the discharge piping shall be:

i) Minimum 0.6 m/s

ii) Maximum 2.5 m/s

1.3.4. All building materials, paints, mechanical, and electrical components shall be free of lead, asbestos, and other hazardous materials.

1.3.5. The station shall be designed and built to the appropriate codes as a post-disaster building. Following an earthquake the building structure shall be immediately occupiable and all systems critical to station function shall be immediately operable.

1.3.6. The station shall be designed and built for immediate operation following a flooding event. Consult the Vancouver Building Bylaw for minimum Flood Construction Level (FCL).

1.3.7. Provisions for installing a temporary pumping system to allow isolation of the station from the upstream sewers to facilitate station wet well works shall be provided. Provisions shall include the following:

i) An oversized maintenance chamber located upstream that can allow for temporary bypass pumps (complete with oversized frame and lid).

ii) Isolation between the wet well and the oversized maintenance chamber in accordance with WorkSafeBC regulations and to the satisfaction of the City.

1.3.8. Provisions shall be considered to physically delineate a safe working space around maintenance areas (e.g. wet well hatches) from public areas.

1.4. Capacity

1.4.1. The station shall be designed to meet the maximum flow conditions as per the City of Vancouver Sewer Design Standards.

1.4.2. The station shall be designed to efficiently handle both existing and future flow conditions.

1.5. Odour Control

1.5.1. Where required, a suitable odour control system shall be provided to the satisfaction of the Engineer.

1.5.2. Where odour control is not required, provisions shall be provided to facilitate easy installation of a future odour control system.

1.5.3. At minimum, the Odour Control System shall utilize a Camfil Farr Model 3 Glide/Pack with a least 2 sets of rechargeable carbon filter panels and one disposable pre-filter panel. The system shall include a magnehelic differential pressure gauge, stainless steel ducting, airflow fans, and louvers to suit.

1.6. Station Facilities

1.6.1. On a case-by-case basis, pump station building structures may be required by the Engineer to incorporate the following:

i) Enameled cast iron service sink, c/w 2-handle service sink faucet with top brace and integrated vacuum breaker, paper towel holder, soap dispenser, and metal waste bin with swivel top.

ii) Enclosed water closet c/w toilet paper holder.

iii) Emergency drench hose or eyewash station and shower.

iv) Storage closet.

1.7. Water Service

1.7.1. A 50 mm or larger water connection with approved backflow preventer shall be provided.

1.7.2. All buried water service pipes shall be Type K soft copper, and shall be sleeved with polyethylene.

1.7.3. Water connection requires a City of Vancouver water meter, which should be installed in a utility box outside the station in accordance with the City's standard construction specifications and detail drawings.

1.7.4. All interior potable water piping shall be Type L hard drawn copper, insulated, and labelled.

1.8. Landscaping

1.8.1. Sites shall be landscaped to blend with the surrounding environment to render a pleasing overall appearance. Consideration shall be made to minimize groundskeeping maintenance.

1.8.2. Landscaping must be appropriate to facilitate the necessary pump station maintenance activities.

1.8.3. Where feasible, green infrastructure shall be incorporated to mitigate the effects of all impervious surfaces. Refer to the City's Green Infrastructure Design Manual for design targets.

1.9. Architectural and Building Envelope

1.9.1. The pump station shall be designed for a minimum 75 year service life for structural and architectural systems.

1.9.2. Sanitary sewage pumping stations shall be designed to be in harmony with surrounding development.

1.9.3. Consideration should be made to incorporate windows for natural interior illumination. Windows shall be sufficiently high to minimize the likelihood of breakage or vandalism.

1.9.4. Consideration shall be made to minimize maintenance requirements.

1.9.5. Exposed timber elements shall be well protected against rain (including wind-driven rain) and UV.

1.9.6. The following shall apply to any buildings or structures that form part of the pump station facility:

i) Maintenance Access

a) All mechanical and electrical rooms shall contain double doors for maintenance purposes.

b) Thresholds at maintenance doors shall be flush.

ii) Buildings should have sloping roofs. Roof overhangs shall be discussed on a case by case basis. Roof runoff shall be directed to a gutter or otherwise controlled to prevent direct runoff.

iii) Exterior doors shall be commercial quality steel, manufactured from paintable 18ga. galvanneal sheet steel. Exterior doors shall have continuously welded seams, be vertically steel stiffened, filled with polystyrene and equipped with a welded steel top cap.

iv) Pressed steel door frames shall be of commercial quality, fully welded, 16ga. galvanneal steel supplied with appropriate anchors to rigidly secure frames to the building structure.

v) All door hardware to be of commercial grade and manufactured from stainless steel. At a minimum the following hardware shall be provided.

a) Heavy-duty mortise lock conforming to ANSI/BHMA A156.13, Series 1000, Grade 1

b) Standard lever handle with non-locking latchbolt

c) Deadbolt on exterior doors with interchangeable core (compatible with Corbin Russwin)

d) Provide security astragals on all exterior doors. Interlocking type or minimum 4.8mm thick plate type

e) Door closer

f) Kick plate

g) Interior doors shall include windows

h) Door stop

i) Low-profile door thresholds, filled with silicone caulking

j) Standard weight full mortise hinges

1.10. Unit Heaters

1.10.1. Unit heaters shall be controlled by a wall-mount thermostat. Integrated thermostats are only acceptable where accessible without a ladder.

2. EMERGENCY OPERATION

2.1. Section Objective

2.1.1. The objective of this section is to provide provisions to protect public health by preventing back up of wastewater and subsequent wastewater discharge to basements, streets, and other public and private property and to prevent the discharge of wastewater into the environment in the event of a power failure, mechanical failure, forcemain failure or other mechanism that might cause the station to not operate at full capacity.

2.2. By-Pass Pumping Provisions

2.2.1. Pumping stations shall be designed with provisions to allow temporary by-pass pumping around the station.

2.2.2. The design shall enable the isolation of the forcemain and the pumping station by means of isolation valves.

2.2.3. By-pass pumping discharge shall be to a quick coupling of the “Camlock” type (150mm) located in a buried chamber with hatch, located outside of traffic areas where possible

2.2.4. Camlock & isolation valves shall be operable from ground level without the need for confined space entry equipment or special procedures.

2.2.5. Specific details for the by-passing arrangement shall be confirmed with the Engineer.

2.3. Emergency Power

2.3.1. Provisions shall be made for supply of emergency power to the pump station in the event of a power failure. Emergency power shall be provided via either of the following methods:

i) An on-site standby generator, capable of running the station systems and maintaining the design flow capacity, shall be provided and connected to an automatic transfer switch. Generator requirements shall be reviewed with the Engineer.

ii) Provisions to connect to existing City mobile generators, including a manual or automatic transfer switch, appropriate male gen-set plug and cable compatible with

existing City mobile generators, and small lockable stainless steel pass-through door for the power cable and plug.

2.3.2. See Section 5.9 of these guidelines for additional requirements.

2.4. Storage

2.4.1. If the station does not contain an on-site generator, provisions shall be made for a minimum of 2 hours of storage during peak flow conditions (or as otherwise determined by the Engineer).

2.4.2. If the station has an on-site generator, there is no requirement to provide storage unless otherwise determined by the City Engineer.

2.5. Overflow

2.5.1. An overflow shall be provided at the highest elevation possible by connecting an upstream sanitary maintenance hole to a maintenance hole of an adjacent sanitary system or, if this is not possible, to a storm maintenance hole. The overflow shall have a submerged inlet to limit the escape of solids, floatables and scum into the storm maintenance hole. The overflow elevation shall be confirmed by the Engineer.

2.5.2. An overflow connection made directly from the wet well is not acceptable.

2.5.3. An adjustable visual marker shall be placed in the wet well to indicate the overflow elevation.

2.6. Seismic Performance

2.6.1. The ‘design earthquake’ used for performance evaluation and design shall be in accordance with applicable building code for post-disaster performance.

2.6.2. The seismic design of new stations shall follow a performance based approach. Performance target shall be equivalent to ‘Operational A-1’ per ASCE 41. Following the design earthquake, the facility’s structural elements shall allow for immediate occupancy and the facility’s non-structural components and systems shall be immediately operable (possibly with minor repairs).

2.6.3. For retrofits of existing stations, the expected seismic performance of the building shall be evaluated in accordance with ASCE 41, ACI 350M, and other applicable guidelines/codes. Post-earthquake performance targets for refurbishment work will be determined on a project specific basis.

2.6.4. The geotechnical assessment shall identify any expected ground motion (slope stability, lateral spread, settlement, buoyant uplift, etc.), seismically induced or otherwise, which could affect the station and recommend potential mitigation options. This shall include an estimate of the differential settlement/movement between the pump station and any connected piping, maintenance holes, and chambers.

2.6.5. The building and foundation shall be designed to ensure compatibility with anticipated settlement of the structure, which may require incorporation of ground improvement techniques and/or piles.

2.6.6. Limit differential settlement between structures or between structures and adjacent fittings/pipework and/or provide flexible connections to accommodate anticipated movement.

2.6.7. Restraints shall meet the requirements of the Vancouver Building Bylaw.

2.6.8. A Professional Engineer who specializes in the restraint of building elements (herein referred to as Seismic Engineer) shall provide all required engineering services related to seismic restraints of equipment, ductwork and piping.

2.6.9. The Seismic Engineer shall inspect the completed seismic installation and shall submit a statutory declaration stating that the complete seismic installation is installed in accordance with his requirements and it complies with the regulatory requirements.

2.6.10. Prior to substantial performance, the Seismic Engineer shall provide letters of assurance for all Mechanical, Electrical, Plumbing and Fire Protection systems (if applicable).

2.6.11. The back-up power system, power distribution system, and other critical equipment should be seismically qualified for the given design earthquake and site-specific ground conditions. When available, other station mechanical and electrical equipment should be similarly qualified. Equipment installations shall satisfy all requirements for restraint and support. Equipment seismic qualification shall be in accordance with the International Building Code or a similar qualification system subject to approval by the Engineer.

2.6.12. EBAA FLEX-TEND flexible expansion joints, or approved alternative, shall be provided at all gravity sewer and forcemain connections to the Pump Station. Ensure each end of the expansion joint is adequately restrained to prevent extension upon system pressurization. Expansion joints must allow for angular deflection and axial expansion and compression.

2.6.13. Where possible, oversteepen the incoming gravity sewer such that differential settlement between the pump station and gravity sewer does not result in reverse pipe grade.

2.7. Flood Performance

2.7.1. A flood risk assessment shall be completed for the station and included in the design report(s). The assessment shall identify flood risks, flood mitigation features incorporated into the design, and any flood risks that were impractical to mitigate. For each unmitigated flood risk, explain why the risk could not be mitigated, provide a list of any equipment that could be damaged by the flood, and provide a cost estimate of any remediation that would be required. Sources of flooding should include but not limited to:

i) Failure of the pumping system resulting in flooding of the wet well to the overflow relief elevation;

ii) Failure of the pumping system and overflow relief system resulting in surcharging of the sewer and wet well to ground elevation;

iii) Coastal flooding to the City's Flood Construction Level (FCL); and

iv) Any other potential flooding scenarios identified by the Consultant or the City.

2.7.2. Unless specifically designed to prevent flooding, spaces below grade or below the FCL shall be designed to flood without resulting in significant remediation works and ensuring the station shall be immediately operable after the flooding event is over.

2.7.3. Dry wells should be designed to protect from ingress of sewage and other flood waters from the wet well. The flood risk assessment in the design report(s) (as applicable) shall include a diagram indicating the size and invert elevation of all penetrations between the wet well and dry well, the station overflow size and invert elevation, and the worst-case wet well flood level. Any penetration below the flood level shall indicate design features to prevent flooding the dry well.

2.7.4. All equipment which could be damaged by full or partial submergence (such as electrical equipment) shall be located above all expected flood levels. A waterproof enclosure or

other means may be considered where it is impractical to locate the equipment above the expected flood level.

2.7.5. All section and elevation drawings shall show flood levels to clearly depict all station areas and equipment that will be below flood levels.

3. MECHANICAL

3.1. Sewage Pumps

3.1.1. Pumps shall be designed to handle raw sewage. All passages and openings shall be large enough to pass a sphere 75 mm in diameter. For very small pump applications, the sphere diameter may be reduced to 50 mm, subject to approval by the City Engineer.

3.1.2. The horsepower rating of the pump motors shall be such that they will carry continuously the maximum load between shutoff and runout conditions without exceeding the name plate rating.

3.1.3. Each pump shall have a factory applied data plate that shall contain at a minimum the following information:

i) Manufacturer's information.

ii) Capacity and standard operating head of the pump.

iii) Pump identification number as per scheduling practice of the record drawings.

iv) Submersible pumps shall be supplied with a second, loose name plate for reference (to be stored in the electrical room).

3.1.4. Wet Well Installations

i) The pumps shall be the submersible type. Provisions shall be made for removal and reinstallation of the pumps without entry into the wet well.

ii) Power cables shall be factory sealed into the motor, and be of sufficient length to be connected to a junction box located above grade and outside the wet well.

iii) Each pump shall be supplied complete with an anchor frame, self-seating discharge connection, stainless steel upper and lower guide rail holders, stainless steel guide rails and stainless steel lifting chain or cable so that the pump can be removed without personnel entering the wet well. The lifting chain or cable shall be mechanically fastened to the pump and supported at the upper end by a stainless steel chain hook or clip located close to the guide rails.

iv) Anchor frames shall be epoxy coated ductile iron and supplied with stainless steel bolts, nuts, and washers.

v) Pipe supports shall be stainless steel.

3.1.5. Dry Well Installations

i) Pumps and motors shall be submersible type if there is risk of dry well flooding.

ii) Pump bases, whether employing a corrosion resistant pan or hand trowelled grout, shall allow complete and unobstructed draining of all liquids to the floor.

3.1.6. Pumps and motors shall be dynamically balanced with couplers installed. In-situ testing shall be done on the installed units to confirm acceptable vibration levels. Testing to be

performed by industry professionals. Vibration analysis to be included in the maintenance manual.

3.1.7. Pump seal flushing systems using potable water shall not be used.

3.2. Sewage Piping Systems

3.2.1. 75mm and smaller piping shall be:

i) 316 SCH. 80S stainless steel with threaded joints.

ii) SCH. 80 PVC only where approved by the Engineer

3.2.2. 100mm and larger piping shall be:

i) Carbon steel piping

a) 100mm to 250mm diameter to be minimum SCH. 40.

b) 300mm to 600mm diameter to be minimum SCH. STD. (0.375 inch minimum wall thickness).

c) Externally coated and internally lined to the satisfaction of the Engineer. Top coat colour shall be RAL 6019 (Pastel Green)

d) Joints shall be made using full-penetration butt-weld, slip on flanges, or weld-neck flanges. Grooved joints shall not be used.

ii) Stainless Steel piping

a) 100mm and larger shall be 316L SCH. 40S.

b) Joints shall be made using full-penetration butt-weld, slip on flanges, or weld-neck flanges. Grooved joints and Vanstone flanges shall not be used.

iii) All bolts, nuts, and washers to be corrosion resistant. Bolts, nuts, and washers shall not be painted unless approved by the Engineer. If corrosion is a concern, options should be reviewed with the Engineer.

iv) Field cuts in steel pipe shall be dressed with I.T.W. Devcon brushable ceramic or approved equal and allowed curing time prior to assembly.

3.2.3. A bell mouth shall be installed on the pump intake.

3.2.4. Piping to be hydraulically and seismically restrained.

3.2.5. The main discharge header piping shall be equipped with a 50mm threadolet complete with a drain valve. Where the header is greater than or equal to 400 mm diameter in size or there are more than three pumps, provide a second redundant 50mm drain.

3.2.6. One spare 50mm weldolet c/w isolation valve shall be provided on the top side of the discharge header.

3.2.7. A 50mm thredolet, complete with a ball valve, shall be provided on the discharge of each pump between the check valve and isolation valve.

3.2.8. Suction-side piping for each pump installed in a dry pit shall include a 2” thredolet complete with a drain valve and a 25mm thredolet complete with isolation ball valve (for a pressure transmitter).

3.2.9. Any branches on the main header pipe for future expansion shall be fitted with isolating discharge valve and blanking plate or blind flange.

3.2.10. Drain valve shall be taken to mean a full-port ball valve c/w male-camlock end and camlock cap. All parts shall be stainless steel.

3.3. Valves, Fittings, Appurtuences

3.3.1. Isolating valves, check valves and pump control valves shall be located in a separate valve chamber(s) or valve room(s), away from the raw sewage wet well chamber to minimize the risks associated with WorkSafeBC confined space entry procedures, for easily accessible operation and maintenance procedures, and to eliminate excessive corrosion of the components.

3.3.2. Check Valves

i) Check valves shall be provided on the discharge side of each pump and shall be placed in the horizontal position.

ii) Check valves shall be outside lever and weight type. Resilient seat check valves with a mechanical post indicator and manual opening operator may be considered with the approval of the Engineer.

iii) Check valves shall be flanged and of ductile iron body material.

iv) Check valves must be able to be opened manually.

v) Where damaging effects of water hammer are anticipated, valves with controlled rate of closure shall be considered.

3.3.3. Isolating (shut-off) Valves

i) Isolating valves shall be located on both suction and discharge sides of each pump.

ii) Isolation valves shall be flanged, ductile iron body material, eccentric plug valves (full port for suction side valves) unless otherwise approved by the Engineer.

iii) Isolation valves shall be complete with:

a) Gear actuator, handwheel and position indicator.

b) Chain actuated handwheel or electronic actuators where valve is located 1.8m or more above the operational floor surface.

3.3.4. Ball Valves – 50mm and smaller (for instrument isolation or other service)

i) 316 stainless steel construction

ii) Threaded ends (N.P.T. Standard)

iii) Full port

iv) Minimum 6900 kPa (1000 PSI) rated

v) Lever actuator with lock

vi) Blow-out proof stem

3.3.5. Indicating Pressure Sensors and Gauges:

i) Shall be provided on the suction side and discharge side of each pump, and on the main header pipe.

ii) Gauges shall be located practically so that they function properly and can be easily seen by operation staff performing maintenance work. Tappings into the piping for all gauges and transmitters shall be to the side of the pipe (3 or 9 o'clock position).

iii) Isolation valves and stainless steel diaphragm seals or inline ring seals shall be provided at gauges and pressure transmitters, complete with air bleeder device.

iv) Analog Pressure Gauges:

a) Shall be liquid filled process gauges.

b) Indication shall be psi (in max 2 psi) increments, with secondary kPa indication.

c) Indication range shall be from -13 psi to +125 psi, or as determined by the City Engineer.

d) Shall have a 4.5” diameter face.

v) Pressure Transmitter:

a) Shall be provided on the main header discharge pipe.

b) Shall be hardwired to the RTU and PLC.

c) Shall include local indication

d) Shall be rated for submersion (IP68 / NEMA 6P) unless otherwise approved by the City Engineer

3.3.6. Air Release Valves:

i) Discharge piping shall be designed where possible to avoid localized high points. Where unavoidable, automatic air relief valves shall be installed at high points in sewage piping to prevent air locking.

ii) Air release valves shall be Vent-O-Mat RGXb series, or alternative approved by the Engineer.

iii) The air release valves shall be exhausted to the wet well.

iv) Air release valves shall be installed c/w isolation valves and downstream unions to facilitate removal and service.

v) Air release valves shall be supplied with all components required for backflushing.

3.4. Labelling, Tagging and Stencilling

3.4.1. All piping excluding sewage piping shall be labelled with pipe contents and direction of flow. In some instances, sewage instrumentation may require labelling at the discretion of the City Engineer. Labelling requirements to be discussed with the City Engineer.

3.4.2. All valves and sump pumps shall be tagged. Tag requirements shall be reviewed with the City Engineer.

i) Naming convention for valve and sump pump naming shall adhere to the following (# denotes number):

a) IIV-# (inlet isolation valve)

b) DIV-# (discharge isolation valve)

c) CV-# (check valve)

d) FMIV-# (forcemain isolation valve)

e) RPBA-# (reduced pressure backflow assembly)

f) PRV-# (pressure reducing valve)

g) ARV-# (air release valve)

h) SUMP-# (sump pump)

ii) Where applicable, valve numbering shall correspond to its associated pump number and pump bay position.

3.4.3. All interior and exterior hatches shall be engraved with tag label for any equipment accessed through that hatch

3.4.4. Where applicable, suction piping, discharge piping, and pumps in dry wells shall be field labelled with black stencil markings.

i) Black spray paint using stencil.

ii) Letter height shall be 100 to 150mm

iii) Hatch and pump naming conventions (x denotes number):

iv) P-# (sewage pump)

v) MX-# (mixer pump)

vi) Hatch and pump numbering shall correspond to its associated pump number and pump bay position.

vii) Stencil(s) used during construction shall be given to the City at station handover.

3.4.5. Proposed valve, pump and hatch naming and numbering configurations and letter orientation shall be clearly shown on the design drawings and confirmed during shop drawing review.

4. GENERAL FACILITY REQUIREMENTS

4.1. General Chamber Requirements

4.1.1. Chamber roofs:

i) Shall be designed to withstand full HS-20 loading in roadways and full traffic areas and incidental H-20 in non-traffic areas.

ii) Shall be flush or below grade and not present a trip hazard where practical. Design shall consider surrounding landscaping.

iii) Shall be outfitted with support for davit cranes, lifting eyes, or other hoisting mechanism as appropriate for equipment contained within the chamber or personnel that may enter the chamber (see Section 4.4 for information on lifting davits).

4.1.2. Access hatches (where applicable):

i) Shall be appropriately sized for removal of equipment and entry and exit of personnel.

ii) Ensure there is at least 50 mm clearance between any part of the equipment being lifted through hatch and the hatch's 'clear opening' limits in any orientation using the equipment's lifting points. Unless otherwise approved by the City, lateral adjustments (manhandling) shall not be required to pass the equipment through the hatch opening.

iii) Shall be designed to withstand full HS-20 loading in roadways and full traffic areas and incidental H-20 in non-traffic areas. In addition, hatches for pump access shall be rated to support the full weight of the pump.

iv) Shall be mounted flush and not present a tripping hazard.

v) Shall be equipped with a locking mechanism. On exterior access hatches this shall consist of a watertight slam-lock mechanism and an oversized recessed padlock hasp with a flush hinged cover plate which does not present a tripping hazard. Interior hatches may only require a slam-lock mechanism.

vi) Shall have appropriate slip protection surface.

vii) Shall have gas spring assisted lids which lock in the open position.

viii) Chambers containing motors or other electrically sensitive equipment shall have gutters in the hatch that collects and prevents water from dripping onto equipment. The water from the gutter shall be piped to a drain or sump pump.

ix) Telescoping ladder extension safety posts shall be installed at all man entry points to underground chambers.

x) Shall contain double-leaf fall protection grids (fall protection meshing is not acceptable) with adequate clearance between leafs to allow the hoist chain to be lowered through while closed. Account for reduction in hatch clear opening due to fall protection grid.

xi) Exterior hatches shall be fitted with a zone rated momentary contact switch (wired to intruder alarm).

xii) Hatches to be etched with “City of Vancouver” and equipment tag labels.

4.1.3. Lighting requirements shall be reviewed with the City Engineer on a case-by-case basis.

4.1.4. Ventilation requirements shall be reviewed with the City Engineer on a case-by-case basis.

4.1.5. Ladder/platform requirements shall be reviewed with the City Engineer on a case-by-case basis.

4.1.6. Chamber floors shall be slightly graded to a sump, complete with sump pump or gravity drain to prevent accumulation of water in the chamber. The sump discharge should be equipped with a check valve and be directed to the station’s wet well or a nearby sanitary sewer. Sump shall be sized to prevent excessive pump cycling.

4.1.7. Chambers should be designed such that if they are flooded, they can be flooded to the chamber lid elevation (or higher on a flood plain) without any adverse effects to the chamber or equipment.

4.1.8. Chambers shall be equipped with a float switch located just above floor level to indicate if the chamber has flooded.

4.2. Wet Well Requirements

4.2.1. If constant speed pumps are used, storage volume of the wet well shall be adequate to prevent the short cycling of the pumps (i.e. frequent starting and stopping).

4.2.2. The wet well shall be designed under the assumption that it will flood multiple times throughout its service life. Flooding of the wet well shall not result in damaged equipment, flooding of adjacent chambers, service interruptions, or extensive clean-up work. The design flood level shall be confirmed during design, but it shall not be lower than the City’s

Flood Construction Level (FCL) or the expected water level during a station overflow event (peak wet-weather flow with no pumps running).

4.2.3. All electrical equipment in the wet well shall be explosion proof and rated for submergence.

4.2.4. Where four or more pumps are to be installed the wet well shall be divided into at least two sections so that any section maybe taken out of service for inspection, cleaning, or repairs. Each section of the wet well shall have an individual inlet equipped with a sluice gate designed to divert flow from the section that has been removed from service. Each of the set wet well sections shall be interconnected with a sluice gate that will be open during normal station operation. Access shall be provided for each section.

4.2.5. Platforms shall be removable if required to access or remove equipment.

4.2.6. Provisions shall be provided for removal of pumps and mixers through the use of overhead cranes or removable lifting davits without the need for wet well entry.

4.2.7. Ladders shall be constructed of non-corrosive material, and platforms and handrails shall be constructed of fibreglass where possible and anchored using stainless steel fasteners.

4.2.8. Where wet well walls are concrete, the concrete shall be epoxy coated or otherwise designed to minimize concrete and rebar degradation.

4.2.9. Wet wells shall be designed in accordance with Hydraulic Institute standards. Sloping sump bottoms and filleted corners (benching) shall be provided in the wet well as appropriate to direct sewage flow to the pump suction inlets and to minimize solids deposition on the bottom.

4.2.10. Ventilation requirements to be reviewed with the Engineer. Fresh air shall be brought in to the lowest practicable point in the wet well. Exhaust air intake shall be from the highest point in the wet well. Where the wet well contains multiple ‘cells’, multiple ducts will be required to ensure the entire wet well is ventilated.

4.2.11. Where used, inlet baffles shall be 316 stainless steel.

4.2.12. A sluice gate shall be installed at the inlet to the wet well. Sluice gate shall be designed and be of appropriate material for a wet well application. Mounting shall be as per the manufacturer’s instructions.

4.2.13. Mixer Pumps

i) A submersible mixer pump suitable for operation in sewage pump station wet well shall be installed, except in specially designed self-cleaning wet wells.

ii) The mixer shall have 316 stainless steel construction throughout for all mounting hardware including lifting cable, support cable, lift cable holding clamp, mast, supports and related installation/operating hardware.

iii) Where appropriate, the mixer shall be Flygt SR-4630. Other mixers may only be used with the approval of the Engineer.

iv) The mixer pump shall be mounted in a manner that will allow removal and installation without personnel entering the wet well.

v) MiniCAS unit shall be used when using Flygt mixers.

4.2.14. Wet well shall not leak. Cracking shall be limited to “Tightness Class 1” (Eurocode 2, Part 3) or equivalent standard acceptable to the City.

4.2.15. Where inlet drop tees are used on the incoming sewer, they shall be designed in such a way to eliminate the possibility of air entrainment leading to air-locking of any pumps.

4.2.16. Refer to section 4.1.2 for Access Hatch requirements

4.3. Dry Well Requirements

4.3.1. The dry well shall be ventilated by a mechanical air exhaust system in accordance with the CEC Part 18 (supplemented by NFPA 820). Supply air shall be filtered (MERV 8 or better) using standard sized filters. Ventilation requirements shall be discussed with Engineer.

4.3.2. Drainage

i) Dry well floors shall be constructed to drain by gravity into trench drains channelled to a sump. Minimum slope shall be 1%.

ii) Trench drains shall be covered with corrosion resistant gratings.

iii) A sump pump shall be installed in the sump, and discharge above the higher of either the highest possible water level in the wet well, or 0.3 meters above the 100 year flood level.

iv) The sump pump shall be controlled by an integral float switch or external float control system depending on sump design.

v) Dry well shall be equipped with float switch set at an elevation just above floor level to indicate if the dry well has flooded.

vi) The sump pump shall use 120V power and the electrical plug shall be replaced with a turnlok style plug and matching wall receptacle or zone rated plug in classified spaces. In some cases a waterproof junction box may be required in lieu of a turnlock style plug at the discretion of the Engineer.

vii) The sump pump shall be equipped with a current transducer and a run contact to the PLC.

viii) Sump pump piping shall be installed in accordance with the plumbing code. There shall be a union, check valve, and isolation valve (stainless steel process ball valve preferred) installed sequentially in the direction of flow on the pump discharge line.

ix) Where the total weight of the sump pump assembly exceeds 50 lbs (or is otherwise arranged in a way making it awkward to lift), a lifting point shall be installed above the pump to facilitate removal with a hand winch. The lifting point shall be in accordance with WorkSafeBC requirements and be positioned approximately 2.1m above floor level.

4.3.3. All lift stations shall be sized to conform with the following clearances unless otherwise approved:

i) A minimum of 0.6m between the pump/motor assembly's projections and the inside station wall surface.

ii) A minimum of 0.9m clear floor space between adjacent pump/motor assemblies.

iii) Adequate horizontal and vertical clearance shall be provided for removal of all equipment that requires disassembling and/or lifting for removal or for other maintenance purposes.

iv) Pumps and motor assembly shall be accessible for maintenance on three sides without having to climb over piping or other pieces of equipment.

v) Detailed analysis and review of the working clearance shall be reviewed for all equipment installations.

4.3.4. Dry well walls shall be painted to the owner's preference prior to installation of any equipment or appurtenances.

4.4. Lifting Davits

4.4.1. Where portable lifting davits are required, the lifting davit shall:

i) Have a minimum lifting capacity of 250 kg.

ii) Have adjustable boom length and height.

iii) Break down for easy storage.

iv) Rotate 360 degrees.

v) Have a spur gear hand winch that is self-breaking in forward and reverse direction.

vi) Have a stainless steel rope affixed to a swivelling catch type hook.

vii) Have a lifting height suitable for intended use including considering size of equipment that may need to be lifted out of the chamber.

viii) The City's preference is a Thurn 5PF5 series with M1 winch. Crane shall be stainless steel or carbon steel with galvanized or epoxy finish.

ix) Provisions for storage (mounted to wall) shall be provided for the davit crane.

4.4.2. The lifting davit receiver shall:

i) Have a flush mounted base (for installation through cored hole in concrete slab) so as to not pose a tripping hazard.

ii) Have a cover plate or plug that shall be anchored down when davit not in use. Plate and anchoring components shall be countersunk so as to not pose a tripping hazard.

iii) Include a drain to prevent accumulation of water in the receiver socket.

4.5. Cranes

4.5.1. Design and installation shall be in accordance with all applicable regulatory requirements, including WorkSafeBC and the Vancouver building bylaws.

4.5.2. The station structural design engineer shall provide a signed and sealed letter of verification that the supporting structure as installed, including the connection interface(s) between the structure and crane, is capable of handling the maximum load as rated as per CSA standard B167 or any superseding standards, regulation or guidelines to this standard. This verification will be included in the station Crane Logbook as per the referenced guideline.

4.5.3. The crane installer shall provide:

i) Initial inspection as per CSA standard B167

ii) a Crane Logbook containing all documents required as per CSA Standard B167.

4.5.4. Either the station structural design engineer or the crane supplier shall provide sealed engineering documentation verifying that the crane beam(s) and other components as installed is capable of handling the maximum load as rated per CSA standard B167 or any superseding standards, regulation, or guidelines to this standard. This verification shall be included in the station Crane Logbook as per the referenced guideline. If the station structural designer chooses to delegate this to the crane supplier, it shall be clearly outlined in the contract requirements.

4.5.5. The crane shall be labelled with the appropriate Load Rating Decal (in Tonne and KG).

4.6. Flow Measurement

4.6.1. Flow measurement devices are required for all pumping stations.

4.6.2. Flow measuring devices shall be properly located for accurate readings.

4.6.3. Flow monitoring equipment shall be able to determine and record rate of flow, duration, volumetric sum, and frequency for each pump and each bypass, and interface with City SCADA requirements.

4.6.4. The approved flow meter is the Siemens Sitrans FM Magflow MAG 5100 W electromagnetic flowmeter tube and MAG 6000 remote mounted transmitter. Other flow measuring devices may only be used with the approval of the Engineer.

5. ELECTRICAL

5.1. General

5.1.1. The installation shall comply with requirements of the current edition of the Canadian Electrical Code as amended by the province of British Columbia and the local authority having jurisdiction.

5.1.2. All materials shall be new, and all electrical work shall comply with the latest revisions of CSA standards and codes, and satisfy regulatory requirements of authorities having jurisdiction. Where equipment or materials are specified by technical description only, they shall be of the best commercial quality obtainable for the purpose. All work shall be executed in a neat and professional workmanlike manner by qualified tradespeople.

5.1.3. The Electrical Contractor shall obtain all required electrical permits, and arrange for all necessary electrical inspections, including final inspection, and provide copies of all permits and inspections to the Engineer.

5.1.4. Record Drawings

i) The Electrical Contractor shall accurately record daily, all conduit, fixtures, and equipment as actually installed on the project. Any changes to the contract work shall be similarly recorded on the redline drawings.

ii) As-built drawings shall be provided for all control panels, motor control centre, and all new and modified connections to the existing RTU panel. All wiring and components such as relays, contacts, terminal blocks, devices and instruments shall be labelled and identified in the field and on the as-built drawings. As-built drawings shall include a complete bill of materials for each MCC section, equipment layout diagrams, and detailed motor control wiring diagrams for each individual load including all PLC and RTU signal terminations and wire tags.

iii) Wires with terminations in different enclosures shall be labelled with heat shrink labels identifying the starting and landing terminal on each end of the wire. Discuss labelling convention with City.

iv) Electrical drawings shall include:

a) a relay list c/w relay name, location, description, and relay number and voltage. An example relay list can be found in Appendix E.

b) a fuse list c/w fuse size, description, voltage, and location.

5.1.5. House Power

i) A separate house panelboard, 42cct type, 225A rated, 3-phase, 4wire, copper bus, fully rated shall be provided for the station.

ii) All lights and power receptacles shall be fed from the house panel.

iii) The receptacles shall be arranged to be suitable for use by operations and maintenance personnel.

5.1.6. The following wires shall be separated from each other by use of separate conduits or cables:

i) 120/240 VAC power.

ii) 24 VDC power and control.

iii) Analog and data.

5.1.7. The uniformity of manufacture shall be maintained for any particular item throughout the project.

5.1.8. The engineer reserves the right to modify the location of any equipment to within 3m of points indicated within the plans without extra charges providing the Contractor is advised prior to installation.

5.1.9. An arc flash hazard assessment shall be completed as per the latest revision of CSA Z462. The arc flash hazard assessment shall be signed and sealed by a Professional Engineer.

5.1.10. Spare wires shall be labelled as ‘spare’ and shall be terminated to spare terminal blocks. Wires with terminations in different enclosures shall be labelled with heat shrink labels identifying the starting and landing terminal on each end of the wire. Contractor to review labelling convention with the City prior to start of work.

5.1.11. Any transformer used to power more than one piece of equipment or process shall be terminated on an appropriate panel board as close to the source as possible

5.2. Labelling of Conduits, Cables, and Enclosures

5.2.1. All conduits, cables, junction boxes, electrical receptacles and switches shall be labelled.

5.2.2. Labelling shall reflect the drawings and City naming convention.

5.2.3. All name plates shall be white lamacoid face with black engraved letters. The use of “Dymo” type tape markers will not be permitted.

5.2.4. Name Plates shall reflect naming convention on the record drawings.

5.2.5. Arc Flash warning labels shall be installed as per CSA Z462

5.2.6. Field labelling shall match the design drawing labelling. Labelling methodology shall be confirmed with the City at the 50% design stage, prior to implementation.

5.3. Control Systems

5.3.1. The basic operation and control philosophy for City sewage pump stations is described in Appendix B.

5.3.2. The control panel door layout shall be based on the drawing shown in Appendix C.

5.3.3. The City has developed standardized wire labelling, termination, and circuitry drawings. The Designer shall incorporate the City’s standardized EIC drawings into their design. No

modifications to the City's standards are allowed without written approval by the City Engineer.

5.3.4. Programmable Logic Controller (PLC)

i) There shall be redundant PLC's, with the secondary PLC set in a cold standby configuration.

a) Failure of the primary system shall automatically cause a switch to the secondary system utilizing timer relays.

b) The secondary switch shall not automatically switch back to the primary system. Switch back to the primary system shall be done manually through a hardwire switch.

c) PLC cabinetry shall show status of which system is active.

d) A manual switching option shall also be provided.

ii) The PLC shall be an Allen Bradley CompactLogix System or similar approved by the City Engineer.

iii) The following PLC modules are approved for use:

a) 1769-L33ER COMPACTLOGIX 5370 L3 CONTROLLER, DUAL ETHERNET W/ DLR, 2MB MEMORY

b) 1769-PA4 1769 POWER SUPPLY 120V/220V AC

c) 1769-IQ32 32 POINT 24V DC INPUT MODULE

d) 1769-OW16 16 POINT AC/DC RELAY OUTPUT MODULE

e) 1769-IF8 8 CHANNEL, VOLTAGE/CURRENT I/P, ANALOG INPUT MODULE

f) 1769-OF4CI 4 CHANNEL, CURRENT ISOLATED, ANALOG OUTPUT MODULE

g) 1769-ECR RIGHT END CAP TERMINATOR

h) MVI69-MNET PROSOFT MODBUS TCP/IP COMM MODULE

i) 1769-IA16 16 POINT 120 VAC INPUT MODULE

j) Other modules may only be used with the approval of the City Engineer.

iv) Interface of all alarms between PLC and RTU shall be hardwired with the exception of some Modbus registers to be approved by the City Engineer.

v) A list of typical physical inputs and outputs to the PLC's for sewage pump stations has been included in Appendix A. This list may change from time to time and the most up to date list should be obtained from the City. The I/O will vary depending on the type and number of equipment used in the station. All tag names and descriptors used in the PLC programming must be consistent with City I/O requirements, and should be consistent between the PLC and the RTU. A formal list of all tags to be used in the PLC programming (including tag name, function, and descriptor) shall be submitted for review and approval by the City)

vi) For redundancy purposes, the I/O for pumps shall be split across multiple cards. If any one card fails, there should be at least 1 pump that can still be operated.

vii) The DC power supply shall be redundant OMRON 240W, 10A, 24VDC, S8VS-24024AP units, with either a primary/secondary, or parallel configuration as approved by the City Engineer.

5.3.5. Operator Interface (HMI)

i) The local operator interface shall consist of a twin Allen-Bradley Panelview HMI screens. The acceptable part number is: 15" screen: 2711P-T15C22D9P. Units require 24VDC for power, and run a Windows CE operating system.

ii) This setup shall be in a redundant (cold standby) configuration. The redundant configuration shall be as per Section 5.3.4 i).

iii) The operator interface (touchscreens) shall be located on the face of the control panel (control panel layout in Appendix C).

iv) Pumps that are located out of visual sight from the MCC shall be provided with two start/stop controls.

5.3.6. Switches

i) Rotary switches

a) Rotary switches shall be included on the control panel cabinet door for the following:
- HOA (Hand-Off-Auto) pump control for each discharge pump
- HOA (Hand-Off-Auto) pump control for each mixer pump (if station equipped)
- Level transmitter primary/secondary selection
- PLC primary/secondary selection
- Control Power primary/secondary selection

b) Rotary switches shall be 30mm diameter, NEMA 4X, with contact blocks

c) Switches shall be IDEC or Allen Bradley with the approval of the Engineer. Other switches may only be used with the approval of the City Engineer.

ii) Push button switches

a) Push button switches shall be included on the control panel cabinet door for the following:
- Pump Sequence Selector
- Alarm Reset/Lamp Test

b) Push button switches shall be 30mm diameter, NEMA 4X, oil-tight, with contact blocks

c) Permitted switch manufacturers include: Allen Bradley, and IDEC. Other switches may only be used with the approval of the City Engineer.

iii) E-stops

a) E-stops generally shall not be used. Inclusion of E-stops shall be discussed during station design. Where E-stops are included, please incorporate the following guidelines:
- Sewage pump E-stops shall be provided near the location of the pump starter device (VFD, soft start, etc.).
- Each E-stop shall have:
  - red illuminated mushroom operator illuminated while depressed

- push-pull/twist action
- switch shroud to prevent accidental stops

- E-stops shall be set up such that control equipment cannot bypass a depressed E-stop to operate machinery (e.g. VFD operator interfaces shall not be able to start pumps while the E-stop is depressed).
- After an E-stop has been deactivated (pulled out), the associated equipment shall automatically go back into service without requiring additional acknowledgement.
- Toggle switches are not permitted.

5.3.7. Indication Lights

i) The following indication lights shall be included on the control panel cabinet door:

a) HOA (Hand-Off-Auto) Pump Status Indication

- Pump Status Indication shall be illuminated with the following colour scheme:

HAND:	Amber or Orange
OFF:	Red
AUTO:	Green
RUN Status:	Yellow

- Permitted indication device is IDEC SLC30N-0202-DD2F. Other indication devices may only be used with the approval of the City Engineer.

b) Primary/Secondary Indicators

- All Primary/Secondary Indicators shall be illuminated with the following colour scheme:

PRIMARY:	Yellow
SECONDARY:	Blue

- Permitted indication device is IDEC SLC30N-0201-DD2H. Other indication devices may only be used with the approval of the City Engineer.

ii) The following indication lights shall be included on the motor control cabinet doors:

a)	Running:	Amber or Orange
b)	Fault:	Red
c)	Power/Ready:	Green

5.3.8. Convenience Connections

i) A 120V power receptacle shall be provided inside the control panel. This receptacle shall not be connected to the uninterruptable power source if station equipped.

ii) An ethernet port shall be provided inside the control panel for laptop connectivity.

5.3.9. Wiring

i) 600 volt wiring shall be copper TECK90 or RW90, with 1000 volt insulation and bearing CSA labelling.

ii) 600 volt wiring colour coding:

a)	Phase A	red
b)	Phase B	black
c)	Phase C	blue
d)	Neutral	white
e)	Ground	green

iii) 120/240 volt wiring shall be copperTECK90 or RW90, with 600 volt insulation and bearing CSA labelling.

iv) No conductor smaller than #12 AWG shall be used for branch circuit wiring.

v) Approved TECK90 connectors are to be utilized. XP type TECK connectors are required for classified area.

vi) All cables shall be identified with aluminum cable markers on both ends of the conductor.

vii) Control wiring to be #16 type TEW, colour coding:

a)	Neutral AC	white
b)	Hot AC	blue
c)	Positive 24 VDC	red
d)	Negative 24 VDC	black
e)	120 VAC Earth Ground	green
f)	PLC-1 Discrete Input	orange
g)	PLC-1 Discrete Output	brown
h)	PLC-2 Discrete Input	yellow
i)	PLC-2 Discrete Output	purple

viii) Analog signal wiring shall be Belden #8760, #18 2 wire shielded or equivalent as appropriate as approved by the City Engineer. Colour coding:

a)	Analog Positive Signal	white or clear
b)	Instrumentation (Sensors)	black

ix) Instrumentation cables shall be #18 stranded conductors, individual shielded pairs with shields grounded at one end only (opposite instrument). Shielding shall be continuous through terminal blocks where applicable. Shielding to be isolated at the instrument end of the wire by wrapping with heat shrink.

x) Spare wires shall be labelled as ‘spare’ and shall be terminated to spare terminal blocks.

xi) Provide adequate grounding and bonding of all components including wire raceways, pumps, metal hatch covers and instruments.

xii) Panduits are not to be greater than 70% full to allow additional changes and future additions.

xiii) Wiring shall be cut to an appropriate length for service, with some allowance for ‘slack’. Excess wiring shall not be coiled up in junction boxes or similar locations.

5.3.10. Control Terminals

i) Discrete inputs shall have tubular screw with pressure plate suitable for two #14 wires per terminal or front entry cage clamp type with jumpers and suitable for one #14 wire per terminal.

ii) Analog inputs shall have three connections per side, each suitable for #22-12 wire.

iii) All exposed conductors shall be covered, even where not required by code.

5.3.11. Relays

i) Timing relays shall be OMRON H3CR-H8L, plug in type with track mounted 8-pin socket, or acceptable equivalent product.

ii) Control relays shall be OMRON LY4N-D2 or MY4N-D2, 4 pole double-throw plug-in type with track mounted sockets (minimum 6 amps), or acceptable equivalent product.

5.3.12. Control power conditioning transformers to be manufactured by Sola/Hevi Duty. The electrical designer to specify appropriate model. Other power conditioning transformers may be used with the approval of the Engineer.

5.4. Cabinetry Requirements

5.4.1. If an external free standing kiosk is to be used to house the electrical equipment, the following shall apply:

i) All electrical and control equipment shall be housed in CSA Type 3R enclosures.

ii) The kiosk shall be fabricated from 12 gauge stainless steel plate. The kiosk shall be painted on the inside and outside with an epoxy primer and an epoxy finish coating of 6 mil in lamp post green.

iii) Ventilation openings shall be screened from the inside to prevent entry of foreign materials (i.e. insects, leaves, etc.)

iv) Space shall be made available inside the kiosk for mounting of all electrical components.

v) Doors shall have concealed stainless steel hinges and locking device suitable for a padlock. Arrangements of the doors shall provide unobstructed access to the electrical equipment.

vi) The main disconnect switch and adequate space acceptable to B.C. Hydro for the billing meter shall be provided in a separate compartment of the kiosk, complete with door closing mechanism and separate provision for padlocking.

vii) A separate conduit from the wet well to the inside of the kiosk is required for each pump cable. Splices are not allowed on the pump cables. Pump cable connections must be made in a separate compartment of the kiosk. A provision shall be made to prevent sewer gases from entering all other compartments of the kiosk, in accordance with the latest revision of Section 18 of the Canadian Electrical Code. Sealed junction boxes, if used for this purpose, shall not be smaller than 100 x 100 x 75 mm deep (or larger as appropriate for the application) and must be suitable for Class I Div II service.

viii) The kiosk and doors shall be properly bonded and grounded.

ix) All kiosks shall be outfitted with:

a) An internal light to illuminate the enclosure automatically controlled by door activated switches.

b) A venting fan controlled by a reverse acting thermostatic switch.

c) A thermostatically controlled baseboard heater.

d) Two convenience duplex outlets with ground fault protection shall be provided for operation of 120 VAC devices. One outlet shall be installed inside each compartment of the kiosk.

e) A WP lock type L5-15R receptacle outlet located on the control panel side of the Kiosk.

x) A recessed vandal proof padlock box shall be provided, but should allow operations crews to cut lock with bolt cutters in emergency.

xi) The concrete slab for the kiosk shall be designed to withstand seismic conditions, shall be raised 100 mm above ground level, and extended 50 mm around the base plate.

5.4.2. If the MCC is housed within a building, it shall meet the following specifications:

i) The control equipment shall be mounted in metal enclosed sections joined to form a ridged, free standing, dead front, CSA Type 1 enclosure, designed to operate at the designed pump station service voltage. Vertical sections shall have top and bottom horizontal wiring spaces and a full length barrier to isolate bus sections from unit modules. A full length ground bus shall be provided outfitted with screws and clamp washers in each section.

ii) Motor starter compartment doors shall have mechanical interlocks so door cannot be opened with unit energized, however a defeat mechanism shall allow intentional access.

5.4.3. Where conduit stubs come into control cabinet from bottom, provide false floor or shelf above stub-ups

5.5. SCADA

5.5.1. Adequate space and provisions shall be provided for the installation of the City's SCADA panel and associated appurtenances.

5.5.2. Remote Terminal Unit (RTU)

i) The Remote Terminal Unit (RTU) shall be a Motorola ACE 3600 Series.

ii) The following RTU modules are approved for use. Modules other than those listed below will not be permitted unless approval is granted by the City Engineer:

a)	V107	7 I/O Slot Frame
b)	V056	48 X 48 cm Metal Chassis
c)	V261	AC PS 100-240 V with Battery Charger
d)	V328	10 ah Backup Battery
e)	V446	ACE CPU3640
f)	V212	Plug-in Ethernet 10/100 M Port
g)	V379	32 DI Fast 24V DC

h) V463 16 AI, +/- 20mA

i) V616 16 DO EE relay 2A

iii) Interposing relays shall be required for all I/O (DIs and DOs) to the RTU (including those that are not currently assigned (reserved) – see I/O commentary below.) DIs to be Phoenix Contacts, DOs to be Omron.

iv) Input/Output (I/O)

a) Please see Appendix A for a list that contains the tag name and descriptors of physical inputs/outputs (I/O) to the SCADA panel that are used for the sewage pump stations. Tag I/O addressing shall be obtained from the City.

b) This list may change from time to time and the most up to date Tag List should be obtained from the City.

c) All tag names, descriptors, and addressing must be consistent with City I/O requirements, and tag names and descriptors should be consistent between the PLC and the RTU.

d) Tags have been assigned particular addresses consistent across the City's stations. I/O addresses for tags that are not used for a particular station shall remain unused (reserved) to maintain consistency with I/O addressing across stations.

e) If an additional tag(s) is to be used that does not have an I/O address assigned within the City's I/O standards, then the addressing, tag name, and descriptor must be verified with the City Engineer.

f) A formal I/O list shall be submitted for approval by the City. This I/O list shall include the RTU addressing, Program addressing, HMI Tag name, and tag descriptor.

v) The HMI screen shall be Allan Bradley Panelview (15" screen: 2711P-T15C22D9P).

vi) Spare wires shall be labelled as 'spare' and shall be terminated to spare terminal blocks.

vii) Implement a Modbus network to the RTU and integrate any Modbus enabled equipment.

5.5.3. Radio Antennae Cable

i) The location of the RTU (SCADA) cabinet and radio antennae should be reviewed with the City during the design phase. A radio path study will be required to determine the location of the radio antennae for new stations or where the antennae otherwise needs to be relocated.

ii) For new stations or refurbishment projects where the antennae cable cannot be re-used, the cable shall be completely replaced with one solid, continuous run from the antenna to the lightning protector in the RTU. Intermediate connections and splicing is not permitted.

iii) Review the existing antennae cable conduit condition, size, and routing with the City to determine if the conduit can be re-used or should be replaced.

a) Conduit shall be PVC routed all the way to the RTU cabinet. Metal conduits shall not be used.

b) Conduit shall be sized sufficiently so that the antennae cable (including end connectors) can easily be pulled through. Bend radii shall not be less than two times the minimum cable bend radius without prior approval.

iv) The antennae cable shall be Times Microwave Systems Low Loss Flexible LMR-###-UF coax cable. No substitutions are allowed without approval of the City. Model number for the cable shall be:

a) LMR-400-UF where the total cable length is 30.5m (100 ft) or less

b) LMR-600-UF where the total cable length exceeds 30.5 m (100 ft)

v) Antennae cable installation shall be in strict accordance with the Manufacturer's written installation instructions. Special attention shall be paid to the minimum bend radius and connection details.

vi) The installation of the cable shall be by a qualified company as approved by the City Engineer.

vii) After installation, a qualified company, as approved by the City Engineer, shall sweep test the antennae system to determine the inductive and capacitive reactance, impedance and resonance, and losses on the feedline and antenna.

viii) A report on the installation from the qualified testing company shall be submitted to the City with the following information:

a) Signal/noise ratio

b) Received signal strength indication (RSSI), in dbm

c) Standing wave ratio (SWR)

d) Resonance (identify the resonant frequency and verify that it matches the specifications)

e) Resistance, in ohms

f) Inductance

g) Reactance, both XL and XC capacitive and inductive

h) Total loss, in the cable and connectors

5.6. Wetwell Level Measurement

5.6.1. The level control shall use an ultrasonic system for monitoring of sewage levels. An alternate level control system shall only be used if ultrasonic system not appropriate for the application and with the approval of the City Engineer

The following equipment shall be used:

i) Siemens MultiRanger 200 HMI with 6 relays. Panel mount design shall be used if cabinet has double doors, otherwise the Wall mounts design shall be used.

ii) Siemens Echomax XPS-15 transducers.

5.6.2. There shall be redundant level controllers and transducers with the secondary system on cold stand-by.

5.6.3. Transducers to be cord suspended with the cord continuous to a junction box accessible outside the wet well. Transducer wiring shall not be run in rigid conduit.

5.6.4. Transducers shall be hung as low as possible but above the overflow spill elevation so they do not become submerged. All transducers shall be equipped with submergence shields.

5.6.5. Controller shall be placed in the control cabinet if space permits. If it is not possible to place the controller in the control cabinet, it shall be mounted on wall in a practical location as approved by the Engineer.

5.6.6. The wet well shall be equipped with a Flygt ENM-10 float switch. This float switch shall be set just below the overflow elevation for the exclusive purpose of triggering the "WETWELL EMERGENCY HI" alarm. Adequate provisions shall be provided such that there is no chance of the float switch getting tangled on other equipment while still retaining the ability to remove the switch or adjust the elevation without requiring wetwell entry.

5.6.7. Pressure and level remote readouts when used shall be: "**Siemens Sitrans RD200**" readouts.

5.7. Pump Controls

5.7.1. Some stations, particularly those stations with dry well mounted pumps in a separate room from the electrical control equipment, shall have a local H-O-A control for each pump mounted as close as practical to the pump, local annunciation showing the status of the pump, and one E-STOP on the pump room floor. The location and arrangement of the H-O-A switches, annunciation, and E-STOP shall be reviewed with the Engineer.

5.7.2. A remote HMI panel may be used in lieu of local H-O-A switches and local annunciation provided the HMI is programmed for digital H-O-A functionality.

5.7.3. General pump control philosophy and functionality is provided in Appendix B and shall be reviewed with the Engineer prior to detailed design of the control systems.

5.7.4. The control system shall have the capability of remotely starting or stopping any pump through the City's SCADA network.

i) The RTU will send a REMOTE START/STOP signal to the PLC for one or more of the pumps.

ii) The PLC will remove the pump(s) from sequence and start or stop the pump(s) as appropriate.

iii) The Control Narrative in Appendix B describes the logic for dealing with conflicting control signals and/or loss of communication.

iv) There shall be no other remote control functionalities at the station.

5.7.5. Where MAS units are used in concert with Flygt pumps, cabling shall be run independently between each MAS unit and each pump. Cabling shall not use common junction or pull boxes.

5.7.6. MAS "no-go" signal shall go to PLC, not VFD. It should be a permissive through the PLC.

5.7.7. H-O-A signals shall go to the PLC, the PLC then sends 'start/stop' signal to the pump starter. H-O-A shall not be hard-wired to pump starter unless approved by the City Engineer.

5.8. Circuit Breakers and Disconnects

5.8.1. Provide a main breaker with an integral solid state type protective relay. Relay shall have adjustable long time pickup, long time delay, short time pickup, short time delay, instantaneous ground fault pickup and ground fault delay. The relay shall be complete with one L.E.D. indicator for overload, and one L.E.D indicator short circuit and ground fault.

Provide C.T.s, P.T.s and zero sequence C.T. as required. The main circuit breaker shall have an auxiliary contact(s).

5.8.2. All breakers in the MCC shall have auxiliary contacts.

5.8.3. Motor circuit breakers shall be provided for branch disconnect service and over-current protection of all motor, control and auxiliary circuits. Provide current overload protection for the motors and complete phase protection to protect the pump motors against single phasing.

5.8.4. All circuit breakers, motor starter reset buttons and pump control switches shall be mounted so that they are operable without opening the high voltage cabinet.

5.8.5. All disconnects shall have auxiliary contacts wired back to the PLC to be monitored.

5.8.6. Motor disconnect switches:

i) Shall be located as close as practical to the pump motors and as per the Canadian Electrical Code.

ii) Shall have facilities to padlock the switches in "OFF" position.

5.8.7. Circuit breakers shall be provided on the secondary side of all transformers, even where not required by code. In some instances, the City may accept fuses in lieu of circuit breakers.

5.8.8. Surge protection devices shall be protected by a circuit breaker unless otherwise approved by the City.

5.9. Stand-By Power Requirements

5.9.1. Generators

i) Shall run on diesel fuel.

ii) Shall be sized for the firm capacity of the pump station (one pump out of service) plus house loads, mixers, and other critical equipment.

iii) Provide fuel storage for continuous 24 hr operation at full load.

iv) Shall be supplied with a load bank sized appropriately to ensure the generator can be exercised as recommended by the Manufacturer. A load bank integrated into the genset unit is generally preferred, but the City is open to separate units where advantageous.

v) Sound attenuation requirements shall be discussed with the City Engineer.

vi) Shall be located in a dedicated enclosure, a dedicated room separate from other critical systems (MCC, control panel, SCADA panel, pumps, etc.), or in an external kiosk.

vii) Where the generator is constructed within the pump station facility, it shall be fuelled from and vented to the exterior of the building. The generator room shall be designed to control sound, vibration, and other deleterious effects.

viii) Under no circumstance shall biodiesel be supplied in lieu of diesel.

ix) Generator controller shall send all relevant information to the RTU.

5.9.2. Transfer Switch

i) Automatic Transfer Switch (ATS)

a) Shall be CSA approved and approved by the City Engineer.

b) Shall be ASCO 7000 series unless otherwise approved by the City Engineer.

ii) Manual Transfer Switch (MTS)

a) Shall be CSA approved and approved by the City Engineer.

b) Shall have auxiliary contacts.

c) Shall have mechanical interlocks so door cannot be opened with unit energized, however a defeat mechanism shall allow intentional access.

d) Shall be outfitted with a gen-set plug compatible with existing City generators as appropriate for station loading requirements (see section 5.9.4 for plug types).

e) Written procedures shall be provided for connecting the generator to the manual transfer switch. These procedures shall also be posted in the station.

iii) Provide green indicator light upstream of transfer switch to provide visual indication of whether BC Hydro power is on.

5.9.3. Uninterrupted Power Supply (UPS)

i) Provisions shall be made to provide an uninterrupted power supply hardwired into the control system.

ii) UPS shall not be installed in the control cabinet. Preferred location of installation shall be on top of the PLC cabinet.

iii) The UPS shall have sufficient battery capacity for a minimum of 2 hours run time to power all control, monitoring, and telemetry systems. Smaller battery capacity may be considered where there is an on-site generator with the approval of the Engineer.

iv) UPS shall have form 'C' contacts for alarming/status feedback to RTU: low battery and fault.

v) If the UPS fails, it shall send a UPS Failure alarm to the RTU and shall automatically go into bypass mode and allow 120V through the UPS for continual operation of the control system.

5.9.4. Plug Types

i) For installations without an on-site generator, the station shall be outfitted with a plug to match the voltage and current ratings for the subject pump station.

ii) Plugs shall be a pin and sleeve device, singly rated with a non-interchangeable pin configuration, of one of the following descriptions:

Type 1 100A, 125/250 VAC, 1 phase, 3 pole, 4 wire grounding plug. Plug housing shall be yellow nylon. Hubbell Cat. #4100P12W.

Type 2 60A, 250 VAC, 3 phase, 3 pole, 4 wire grounding plug. Plug housing shall be blue nylon. Hubbell Cat. # 460P9W

Type 3 60A, 120/208 VAC, 3 phase, 4 pole, 5 wire grounding plug. Plug housing shall be blue nylon. Hubbell Cat. #560P9W.

Type 4 — 100A, 120/208 VAC, 3 phase, 4 pole, 5 wire grounding plug. Plug housing shall be blue nylon. Hubbell Cat. #5100P9W.

Type 5 — 60A, 480 VAC, 3 pole, 4 wire grounding plug. Plug housing shall be red nylon. Hubbell Cat. #460P7W.

Type 6 — 100A, 480 VAC, 3 pole, 4 wire grounding plug. Plug housing shall be red nylon. Hubbell Cat. #4100P7W.

Type 7 — 200A, 600 VAC, (for use on 480 volt system), 3 wire, 4 pole, grounding plug. The plug housing shall be painted red. Crouse Hinds Cat. #AP40467-S4.

Type 8 — Not Used

Type 9 — 60A, 600 VAC, 3 phase, 3 pole, 4 wire grounding plug. Plug housing shall be black nylon. Hubbell Cat. #460P5W.

Type 10 — 100A, 600 VAC, 3 phase, 3 pole, 4 wire grounding plug. Plug housing shall be black nylon. Hubbell Cat. #4100P5W.

Type 11 — 200A, 600 VAC, 3 wire, 4 pole grounding plug. The plug housing shall be painted black. Crouse-Hinds Cat. #AP20467.

Type 12 — 400A, 600 VAC, 3 wire, 4 pole grounding plug. The plug housing shall be painted black. Crouse-Hinds Cat. #AP40468.

iii) Plug shall be mounted in station with an accompanying dedicated pass through hatch/door. Plug shall not be located in a box mounted external to the station unless approved by the Engineer.

iv) Cable length and size to be as appropriate for the specific pump station requirements.

5.10. Hour Meters

5.10.1. A resettable hour meter shall be supplied for all pumps, displaying accumulated time in 1/10 hour increments.

5.10.2. The hour meter shall be Omron H7ET unless alternate approved by the Engineer.

5.10.3. The hour meters shall be located on the face of the control panel as per the Standard Panel Layout (See Appendix C for Standard Panel Layout).

5.11. Power Monitoring

5.11.1. In the incoming section of the MCC install a programmable panel mount type DPM (Digital Power Meter) for monitoring the incoming feeder electrical characteristics, wired on the line side (Hydro side) of the transfer switch, by means of 3 current transformers and line voltage by means of 3 direct fused inputs. Metering capability shall be; voltage, current, voltage imbalance, current underbalance, kW, kVAR, kVA, kWh, kVARh, power factor, frequency, kW demand, amps demand, amps THD, volts THD, and crest factor.

5.11.2. An alphanumeric display shall show actual value monitoring and diagnostic messages.

5.11.3. A Hydro failure monitoring device (relay) shall be installed on the Hydro line side of the transfer switch (not the load side). Refer to I/O list for Hydro failure PLC and RTU inputs.

5.11.4. Provide filtered fans on cabinet.

5.12. Mixer Starter

5.12.1. To be non-reversing with motor circuit protector and adjustable trip current.

5.12.2. Where across-the-line starters are used for the mixer, the Designer shall evaluate and design the system to avoid power factor issues arising during low-demand periods.

5.13. Emergency Lighting & Signage

5.13.1. Emergency Lighting shall be provided throughout the station.

5.13.2. Emergency Lighting requirements shall be discussed with the Engineer.

5.13.3. Emergency light packs shall use rechargeable gel-cell batteries.

5.13.4. Emergency exit signage shall be provided at all exits. Provide additional exit signage to ensure an exit sign is visible while standing at any location within the facility.

5.14. Variable Frequency Drives (VFD)

5.14.1. Requirements to be reviewed with the Engineer on a case-by-case basis.

5.14.2. Where deemed desirable for pump control, VFD's shall have output amperage rating minimum 20% in excess of full load current rating on the driven motor.

5.14.3. VFD control shall have an operator interface with a display indicating operating speed in percent and current.

5.14.4. The pump HAND-OFF-AUTO (HOA) selector switch SHALL NOT be placed on the VFD enclosure, but shall remain on the main station control panel.

5.14.5. Maximum drive sound level shall not exceed 75 dbA at one meter under all operating conditions.

5.14.6. Drives shall have selectable V/F patterns including Constant Torque, Variable Torque, Voltage Torque Boost, and Flux Vector Control.

5.14.7. Drives shall be capable of communicating directly as a network node on Modbus-RTU protocol over RS-485.

5.14.8. The Drives shall have a minimum input power factor of 0.92 under all operating conditions, including no-drives-on

5.14.9. The enclosure door shall be equipped with a potentiometer to allow for adjustment of VFD speed reference when in HAND or directly controlled from the VFD interface.

5.15. Lighting

5.15.1. All lights shall be controllable with a toggle switch or dimmer switches such that they can be turned off. Lights shall not be "always on" unless expressly approved by the City in writing.

5.15.2. Exterior lights shall have a photocell or time of day controls to deactivate the light during the day.

5.15.3. Access for bulb replacement shall be considered for all lighting. At most, a 10 ft ladder can be required for access. Requirement for scaffolding or a scissor lift is not acceptable.

5.15.4. Exterior lighting shall be mounted sufficiently high to deter vandalism.

5.15.5. Lighting to be LED unless otherwise approved.

6. RESERVED FOR FUTURE

7. COMMISSIONING

7.1. Terminology

7.1.1. The following terminology shall be used exclusively when referring to the commissioning process

i) *FUNCTIONAL TESTING* – refers to the stage of testing where the Contractor and Sub-contractors provide end-to-end testing and documentation of all pump station elements to ensure correct operation and consistency with the design (lamacoids, labels, settings, etc.)

ii) *PLC/HMI/RTU CONFIGURATION AND PROGRAMMING* – refers to the stage of testing where the City (or its agent) provides PLC, HMI, and RTU configuration and programming. The Contractor is required to assist the City as required to address field device and wiring issues.

iii) *COMMISSIONING* – refers to the stage of testing where the Contractor demonstrates complete system functionality.

iv) *PERFORMANCE TESTING* – refers to the stage of testing after successful commissioning where the Contractor will remain on site and demonstrate complete trouble-free system functionality for a period of two (2) weeks.

v) *VERIFICATION* – refers to the stage of testing where the City will perform quality control verifications (checking accuracy of record drawings, labels, wire tracing, I/O, alarms, etc.). The Verification process typically takes 2 months. The Contractor will be expected to address any deficiencies found during the Verification process.

7.2. General Requirements

7.2.1. All parties involved in commissioning activities, including the Design Engineers, General Contractor, sub-trades, manufacturer representatives, and PLC programmer shall be present on-site at the time of commissioning.

7.2.2. A minimum notice of three weeks shall be provided to the Engineer to facilitate scheduling.

7.2.3. The total time to be allotted for commissioning will depend on each project.

7.2.4. Commissioning will not be considered completed until all components are functioning as a system as per the design and specifications.

7.2.5. Prior to commissioning, all cabinets, enclosures, cabling, wireways, instrumentation, motors, lighting, and the balance of the electrical installation shall be left clean and free of debris.

7.3. Continuity of Sewage Service

7.3.1. From the time the Contractor mobilizes to site until they demobilize, the Contractor shall have overall contractual responsibility for maintaining sewage service to the pump station catchment. The City cannot take overall responsibility due to it being a Contractor controlled site. Contractor responsibilities include daily inspections of the sewage pumping systems and any operation or maintenance issues that arise while it is a Contractor controlled site. All inspections and maintenance work shall be logged.

7.3.2. The City can provide Operation and Maintenance service of the existing pump station facility prior to commissioning of the bypass system if the Contractor is able to provide safe access to the facility and does not otherwise restrict the City's ability to conduct O&M work (keys to locks, space to park, clean work space, regular updates on scheduled work/hazards, etc.)

7.3.3. The Contractor is solely responsible for operating and maintaining their bypass system.

7.3.4. The City can provide Operation and Maintenance service for the newly constructed (or refurbished) pump station prior to demobilization if the following conditions are satisfied

i) Successful completion of Performance Testing.

ii) Submission and acceptance of O&M Manuals (hard copy version shall be provided at the station).

iii) Provide safe access to the facility and does not otherwise restrict the City's ability to conduct O&M work (keys to locks, space to park, clean/tidy work space, regular updates on scheduled work/hazards, etc.)

7.3.5. The City providing O&M services does not negate the Contractor's role as Prime Contractor nor modify the terms of the Agreement between the City and Contractor.

8. DOCUMENTATION

8.1. Design Submission Checklist

8.1.1. The Design Submission Checklist, included in Appendix G, outlines the general submission expectations through the course of the project.

8.1.2. The intent of this document is ensure that, for each stage of the design phase, an adequate amount of information is captured in the design package submissions and that this information is located in the appropriate documents (e.g. drawings, specifications or a report).

8.2. Pre-Design Report

8.2.1. Prior to construction, the Design Engineer shall provide a pre-design report for approval by the City. The pre-design report shall contain at a minimum:

i) Design flows and various stages of development and catchment area map(s).

ii) System head curves for different friction coefficients and static conditions.

iii) Pump curves including modified pump curves.

iv) Wet well volume and pump unit cycle time

v) Hydraulic assumptions, C value, forcemain plan and profile on reduced drawings (11 x 17).

vi) Pump start and stop elevations and corresponding wet well volumes

vii) Descriptions of major mechanical, hydraulic, ventilation, electrical power and electrical control systems

viii) A description of the station type and explanation detailing why the proposed station type is the most appropriate configuration for the site.

ix) Description of seismic resiliency features and expected post-disaster performance.

x) Assessment of station flood risks, flood mitigation features, and unmitigated flood risks including reasoning, potential damage, and expected remediation costs.

xi) Drawing showing a general layout and configuration of the station layout.

xii) Station storage and standby power requirements.

xiii) Cost estimates, including capital, operating, and maintenance costs.

8.3. Control Narrative

8.3.1. A draft written control narrative shall be provided with the 50% design submission, and final control narrative shall be provided with the 100% design submission. A sample control narrative shall be provided by the City for the consultant to make project specific updates

8.3.2. The consultant shall detail and provide a rationale for all changes made to the sample control narrative or previous submitted versions.

8.3.3. The Control Narrative shall provide at a minimum the following:

i) Equipment and Instrumentation List(s)

ii) Alarm list

iii) P&ID Diagram

8.4. Project Equipment and I/O Assignment List

8.4.1. The Project Equipment and I/O Assignment List shall be developed by the Consultant and reviewed by the City at specific stages in the design process.

8.4.2. A Generic version of the list is provided in Appendix H. The Consultant shall update the City-provided Generic version of the list for the specific project. The Consultant shall maintain an updated list.

8.4.3. The Consultant shall provide the following information on the list:

i) Provide a list of all project equipment. For equipment tied into PLC and/or RTU, include on the IO List. For all equipment not tied into PLC and/or RTU, include on the "List (NO I/O Assignment) sheet.

ii) Update Equipment Name/Tag ID, Equipment Spec, Operation Description as applicable, highlighting any changes

iii) Propose PLC I/O and tag descriptors. The I/O provided in this document serve as suggestions based on previous pump station installations. The Consultant is expected to modify these as needed to suit the equipment and desired station operation. Any deviations from the suggested I/O should be highlighted, and rational for deviation shall be provided. All deviations shall be approved by the City.

iv) RTU I/O provided in this document is mandatory and is based on COV's Master RTU I/O List.

8.5. Commissioning Report

8.5.1. Immediately following commissioning of the pumping facility, the Designer shall submit a commissioning report.

8.5.2. The commission report shall contain at a minimum:

i) Written control narrative for the operation of the station (including ventilation, heating, etc.);

ii) Written pump control logic narrative for the operation of the station;

iii) TDH and flow values for the station (both design values and actual values as determined through commissioning);

iv) All station setting, set-points (including important notes for these set-points), alarm list (including a complete list of all alarms, set points, associated instruments, adjustment range), calibration parameters, and other key operational data that is not otherwise contained in the O&M manuals; and

v) Include verification that all applicable equipment, systems, and components are started up, calibrated, operationally tested, adjusted and balanced, and functionally tested for acceptance by the City.

8.6. Project Wrap-Up Report

8.6.1. Once construction of the Project has been completed with all deficiencies rectified and all payments made to Contractors (including any holdbacks), the Consultant shall provide a project wrap-up report.

8.6.2. The Project Wrap-Up Report shall at a minimum include:

i) Signed and sealed letter certifying that the construction has been completed in accordance with the design drawings and specifications;

ii) A detailed written summary of the Project;

iii) A detailed photographic log of the Project;

iv) Project timeline showing key project milestones dates (including all Phase I-V project stages);

v) A summary explanation of all Project expenditures compared to the budget;

vi) Appendices that shall include Project meeting notes, inspection reports, permit copies, etc.; and

vii) Summary of lessons learned, including notes from a post project lessons learned meeting.

8.7. Operating and Maintenance Manual

8.7.1. Before acceptance of the completed pumping station by the City, three copies of an Operating and Maintenance Manual, and three copies of the electrical drawings showing all installation modifications shall be provided to the City. This manual shall cover the operation, maintenance and servicing procedures of the station.

8.7.2. Manuals shall be prepared by qualified and experienced personnel.

8.7.3. Provide 215 x 280mm three hole extension type piano hinged binders, bound with heavy weight fabric, hot stamped in silver lettering front and spine. Three ring binders, Acropress, Cerlox or similar light weight or special hole binders are not acceptable.

8.7.4. Letter each binder as follows:

Front Face:

- Pump Station Name (e.g. Kent & Kinross Pump Station)
- "City of Vancouver"
- Project Name and Year (e.g. Pump Station Upgrade 2013)
- "Operation and Maintenance Manual"
- Volume number (e.g. Volume 2 of 3)
- Set number (e.g. Set 2 of 3)

Spine:

- Pump Station Name (e.g. Kent & Kinross Pump Station)
- "City of Vancouver"
- Project Name and Year (e.g. Pump Station Upgrade 2013)
- "Operation and Maintenance Manual"
- Volume number (e.g. Volume 2 of 3)
- Set number (e.g. Set 2 of 3)

8.7.5. Arrange each binder as follows, using divider tabs of laminated Mylar plastic:

1.0 Title Page
1.1 List of Drawings
1.2 Project Info (Including name of project and list of all consultants and contractors)
1.3 Description of Systems
1.4 Operation of Systems
1.5 Maintenance & Lubrication
1.6 List and Addresses of Suppliers
Tab 2.0, 2.1, etc. – Certifications
Tab 3.0, 3.1, etc. – Manufacturer's Data, Shop Drawings, Bulletins

8.7.6. Provide preventative maintenance program in applicable sections. Provide maintenance data for finished surfaces, copies of hardware schedules, guarantees, warranties and bonds including commencement and expiry dates, instrument lists, types, services, locations, calibration info, and certificates of inspections and inspection reports.

8.7.7. Up-to-date electrical drawings of installed or changed equipment must be included in this manual.

8.8. Record Drawings

8.8.1. Before acceptance of the completed pumping station by the City, editable AutoCAD and three (3) sets of hard copies of all as-built information shall be provided to the City.

8.8.2. The Electrical Contractor shall accurately record on the plans daily, all conduit, fixtures and equipment as actually installed on the project. Any changes to the contract work shall be similarly recorded. As-built drawings shall be provided for all electrical, mechanical, structural, architectural, and equipment components and systems.

8.8.3. Updated as-built drawings shall accurately record on plans all piping, appurtuences, conduits, fixtures, equipment as actually installed.

8.8.4. As-built drawings shall be provided for all control panels, and shall include a complete bill of materials, equipment layout diagram, detailed wiring diagrams identifying wires and

location of wire terminations, and termination diagrams. This includes all new and/or modified connections to the existing facility RTU panel.

8.8.5. As-built drawings shall be provided for the Motor Control Center, and shall include a complete bill of materials for each MCC section, equipment layout diagram, detailed motor starter wiring diagrams for each individual load; this includes all PLC and RTU signal termination terminal block references.

8.8.6. A Process and Instrumentation Diagram (P&ID) shall be included in the drawing set. Tag names shall be consistent with the pump station naming convention.

9. WARRANTY

9.1. Warranty Requirements

9.1.1. A one year warranty that the facility including all equipment and components will be free of defects in design, material, installation, and workmanship is required.

9.1.2. Warranty period shall start upon acceptance of the pump station by the City.

10. ACCEPTANCE

10.1. Station Acceptance Requirements

10.1.1. The developer or contractor shall request in writing to the City an inspection of the pump station works.

10.1.2. Upon completion of the inspection, the City Engineer or delegate shall develop a list of deficiencies.

10.1.3. The City shall retain a deficiency holdback in an amount which is double the estimated cost to repair the deficiencies and work to complete items.

10.1.4. Following an inspection to the satisfaction of the Engineer, there shall be a minimum of 2 weeks trouble free operation of all the pumping station systems before the City will accept the pump station.

10.1.5. Following a successful 2 week trouble free operation of the pump station, the City shall accept control of the pump station operations.

10.1.6. Before acceptance of the pump station, the contractor shall provide maintenance manuals and record drawings.

10.1.7. After the acceptance of the pump station by the City, the contractor shall coordinate completion of remaining deficiencies and work to complete with the Engineer.

10.1.8. The City shall retain the deficiency holdback until the deficiencies and work to complete items have been rectified to the satisfaction of the Engineer.

10.1.9. Acceptance of the pump station does not constitute completion or have any implications with respect to the Builders Lien Act.

END OF SECTION

APPENDIX A

Master RTU Input/Output (I/O) List for Sewage Pumping Stations

The latest version of the Master RTU I/O list shall be obtained from the City.

This is a master list that governs the general RTU I/O requirements for the City of Vancouver sewage pumping stations. This list contains tag names and descriptors of physical inputs/outputs to the SCADA panel that are used for the sewage pump stations. This list also contains all logic (memory) tags and alarms that are generated within the RTU.

Using this master list as a template, a station specific RTU I/O list shall be submitted for approval by the City. This I/O list shall include the RTU addressing, HMI Tag name, and tag descriptor. All tag names, descriptors, and addressing must be consistent with City I/O requirements. Tag name descriptors should be consistent between the PLC, RTU, and the electrical record drawings. RTU tags have been assigned particular addresses consistent across the City's stations. I/O addresses for tags that are not used for a particular station shall remain unused (reserved) to maintain consistency with I/O addressing across stations. If an additional tag(s) is to be used that does not have an I/O address assigned within the City's I/O standards, then the addressing, tag name, and descriptor must be verified with the City Engineer.

APPENDIX B

COV Sewage Pump Station
Pump Control Philosophy
Aug 23, 2017

The controls of each station shall be designed so that the failure of a single component will not prevent the operation of more than one 'pumping unit'. Therefore devices that may cause a total station shutdown are required to be made redundant and "Secondary" automated control shall be provided. Generally speaking, redundant components shall be in a 'cold' standby configuration with transfer to the standby component by way of automation and a manual operator controlled transfer mechanism (switch). The standby component shall not be powered until it has been automatically switched or manually selected and then the component shall be capable of operating entirely on its own while the failed component is repaired or replaced. The failure of primary systems should alarm to the PLC HMI and SCADA system accordingly.

For clarity, the following terminology is used throughout this document:

1. "HMI" – Shall be used to reference GE Fanuc iFix which is the City's SCADA software
2. "PLC HMI" – Refers to the control system PLC display interface (i.e. touch screen)
3. "RTU" – Refers to the remote telemetry unit for the SCADA system (Motorola ACE 3600 series)
4. "MMI" – Refers to the SCADA RTU display interface (i.e. touch screen)
5. "EMERGENCY HI LEVEL" Alarm – is the spill point elevation (elevation to be determined based on station design) and is triggered by a float switch
6. "WET WELL HI LEVEL" Alarm – Shall be set just above the last LAG pump call, indicating the inflow to the station is greater than the station capacity.
7. "Low Level" Alarm – shall be set below the LEAD OFF but above the pumps' minimum design operating level.
8. Alarm – Is an event that require immediate notification to the Pump Mechanics
9. Warning – Is an event that is logged and provides notification through the PLC and/or SCADA but does not require the immediate notification to the Pump Mechanic.

A. Control and Monitoring Equipment Configuration.

1. PLC Configuration

Sanitary pump stations shall have two PLCs, each with its own dedicated HMI, and the PLC's shall have identical module and logic configurations (note that IP addresses are to be different). (The City's standard PLC and PLC HMI's shall be used.) During regular operation, the secondary PLC and its HMI will be powered down (i.e. cold stand-by). The primary PLC will pulse an output connected to a timer relay. In the event of a primary PLC fault or power failure, the timer relay time (10 seconds suggested but adjustable) will lapse and the relay contact will close enabling power to the secondary PLC and HMI. Consideration shall be provided to allow the pumps, motors, forcemain, and valves and the like to attain a normally stopped condition while the transfer to the standby component is occurring. No provision shall be made for the secondary system to switch back to the primary system automatically, switching back to the primary system shall only be done manually accompanied with a "reset" button to clear any latched alarms. Each PLC shall be wired to receive signals from either the primary or secondary level controller, whichever is the active unit and should be displayed to the corresponding PLC HMI screen and RTU MMI screen accordingly.

2. Level Controller Operation

The station shall have at least two ultrasonic level transducers and two level controllers, one primary and one secondary for which the operator shall have the ability to select the secondary controller via a selector switch on the control panel. (A two controller and 4 transducer configuration should be used in a two wet well station).

Siemens Controllers have an internal relay assignment for two separate alarms: 'Controller Failure' and 'Loss of Echo'. Both of these alarms shall be monitored out separately on each of the controllers.

The controllers shall be selected, operated, and monitored in accordance with the following logic:

a) There shall be two level controllers. The secondary (back-up) level controller is normally in cold stand-by (OFF) and powers ON only upon automatic PLC command due to a primary controller failure, or the manually operated selector switch.
b) If the primary level controller fails:
    i. The primary level controller shall send a 'Primary Level Controller Failure' alarm to the PLC and SCADA RTU.
    ii. The PLC shall make the secondary Level Controller the active/operational controller.
    iii. This secondary (now the active/operational controller) shall send 'Secondary Level Controller Failure' and 'Secondary Level Transducer Loss of Echo' alarms if and when those conditions exist.
    iv. The failed primary level controller (inactive controller) shall not send any further alarms while in the failed state
    v. Upon the manual re-selection of the Primary Level controller as the active/operational controller and clearing of latched alarms with the reset button:
        1) The Primary level controller shall send 'Primary Level Controller Failure' and 'Primary Level Transducer Loss of Echo' alarms if and when those conditions exist.
        2) The secondary level controller (inactive controller) shall not send alarms.
c) If the secondary level controller is manually selected with the sector switch:
    i. The primary level controller (inactive level controller) should not alarm at all.
    ii. There should be a description on the PLC HMI, RTU MMI, and the RTU HMI screens that displays: "Secondary Level Controller selected"
    iii. The secondary controller (active controller) shall send 'Secondary Level Controller Failure' and 'Secondary Transducer Loss of Echo' alarms if and when those conditions exist.

When the pumps are in ‘AUTO’ mode, they are started and stopped based on PLC set points and the wet well level analog signal from the level controller in service. The output of the controllers will be a 4-20 mA scaled signal proportional to the wet well level and calibrated values determined during the wet well design. Level set points shall be adjustable on the PLC HMI screen, and are relative to the wet well floor in distance.

3. Emergency High Float

In addition to the level controllers, there is also an Emergency High Level Float located at the Emergency High Level elevation (spill point) in the wet well. This Emergency High Float shall NOT trigger a pump start. The Emergency High Level Float shall use the normally closed contact and should fail on an open (Failsafe) condition (float tipped) and send the “EMERGENCY HI LEVEL” alarm.

4. SCADA Monitoring and Alarming

   A SCADA RTU shall monitor all discrete and analog I/O related to each pump station and transmit the data to the City of Vancouver's SCADA system using radio transmission and SCADA communications protocols. The RTU and PLC shall not be directly connected, and there shall be relays and signal splitters in place to present each signal to the RTU and both PLCs simultaneously. The RTU should not have a direct connection. With the exception of the "Remote Start/Stop" functions, the RTU shall not have any means to control or program the station PLCs.

   All alarms to SCADA shall be latching at the RTU, requiring operator acknowledgement to dismiss. Alarms at the PLC may be latching or non-latching depending on the nature of the alarm. Consult City Engineer for more guidance.

5. Flow Indication

   Pump stations shall be equipped with one magnetic flowmeter either on the main header discharge pipe or on the forcemain in a chamber outside the station (if the station contains multiple discharge header pipes or forcemains, each shall be equipped with a flow meter). The output of the transmitter shall be 4-20mA and scaled to the amount of flow present. Reverse flow will not be measured. The flow meter shall provide a normally closed held open relay output which will indicate a flowmeter fault. The flowmeter shall also have a totalizer pulse output that will be monitored where one pulse will be equal to one cubic meter. The PLC HMI, RTU MMI, and the RTU HMI displays, should show flow rates in litres per second and gallons per minute simultaneously, and totalized flows in cu. meters.

   Flow alarms and warnings shall be provided as shown in the table below. Low Flow warnings & High flow alarms will only be enabled while there are one or more pumps running. The flow alarm set-points shall be adjustable via the PLC HMI. The "Flowmeter Fault" alarm shall be generated as required weather pumps are running or not.

   Flow Alarms:

Event	lps (gpm) / State	Activation Condition
"Low Flow/ No Flow" Warning	• One pump running: xxx lps (xxx usgpm) • Pumps running: xxx lps (xxx usgpm)	Warning shall be activated when the low flow conditions occurs for greater than 30 seconds
High Discharge Flow Alarm	Not currently used. Discuss applicability for station with City.	Logic to be discussed with the City.
"Flowmeter Fault" Alarm	Discrete (Open signal)	Should be activated immediately upon flowmeter alarm contact change of state (or after a 5 second d-bounce).

6. Station Flooded Float

   There is a Station Flooded Float located in the station's dry well just above the floor level. This Station Flooded Float shall NOT trigger a sump pump start as its only purpose is to notify operators that the dry well has flooded. The Station Flooded Float shall use the normally closed contact and should fail on an open (Failsafe) condition (float tipped) and send the "Station Flooded" alarm.

7. Sump Pump

   A contactor in the sump pump's MCC bucket (or approved alternative method) shall send a run status signal which will be split to both the PLC and RTU. Based on the run status signal, two alarms shall be generated

   a) "Sump Pump Extended Run" Alarm – sends alarm if sump pump has been running continuously for more than 5 minutes
   b) "Sump Pump Frequent Starts" Alarm – sends alarm if sump pump starts more than 3 times in 5 minutes

8. Pump Control Valves
   a) If Pump Control Valves (PCV's) are used, each pump shall be started and stopped against a closed valve. Each PCV automatic operator shall be equipped with an open and closed limit switch and "Control Valve failure to open/close" alarm. A fault shall stop the pump, indicate the cause at the PLC HMI, RTU MMI, and the RTU HMI displays and require a manual reset before a re-start could occur. The alarms should be generated if the end of travel limit switches are not reached within 60 seconds of being called to open or closed.
   b) Pump Control Valves are required to operate whether the pumps are in automatic or hand mode and must be equipped with a manual override on the solenoid pilot for air operated type valve or a declutchable hand wheel for an electric motor type valve.
   c) Pump control valves should also be equipped with a "Pilot Operating valve" to manually adjust valve opening and closing speeds to control transients in the discharge piping.

B. Process Control:

Each pump shall be controlled through a 'Hand-Off-Auto' 3-position selector switch (including a corresponding status light). Control function requirements are further defined below.

1. Position commands:
   a) OFF – in this position the applicable pump will not run automatically and will be removed from the alternator sequence. Note: The pump will run in "local mode" if a start is initiated directly from the VFD (manual operator initiated) or a key switch if contactors are used.
   b) HAND – in this position the applicable pump shall run without regard for the level sensing commands and will rely on an operator to start and stop.
   c) AUTO – in this position the pump shall be automatically controlled by the station PLC.

2. In pump station Automatic Mode of operation (AUTO);
   a) The pumps shall be individually started upon a rise in the wet well to pre-set level set-points and individually stopped upon lowering to pre-set level set-points. Under all conditions, multiple pumps are not to be started or stopped at the same time (to prevent hydro demand charges and hydraulic transients). (10 second delay on additional (lag) pump starts)
   b) All the following permissive must be met for a pump to be ready to be called for service;
      i. Emergency Stop not activated
      ii. station power available
      iii. no pump faults

iv. pump temperature not high
v. pump seal not failed (this signal determined by MAS units or seal failure relays)
vi. SCADA remote start/stop not activated
vii. pump circuit breaker not open
viii. pump selector switch not in OFF or AUTO.

c) Pumping stations that utilize Variable Frequency Drives (VFD's) shall be controlled by the PLC and when required on PID control. Individual pump acceleration-deceleration rates and spans shall be set at the VFD. VFD drives shall be capable of communicating directly as a network node on Modbus-RTU protocol over RS-485 to the PLCs.
d) An automatic alternator programmed within the PLC shall be provided to change the sequence of operation of the pumps on the completion of each pumping cycle. Provision must be made for the pumps to run in parallel in a lead/lag configuration should the effluent level in the wet well continue to rise above the starting level for the lead pump. There shall be a push button to alternate pumps and status indicators on the control panel doors to allow the operator to manually step to any sequence. Alternator indicators should all flash when no pumps are in sequence or available to run.
e) A pump alternation timer shall be included in the station control and shall be adjustable through the PLC HMI with an adjustable set-point and disabling feature with initial settings at 1hr (i.e. the pumps shall alternate during pumping operation to avoid excessive continual pump run duration). This logic should only be negated if a Jockey pump is in operation.
f) Generally, all pumps shall be permitted to operate concurrently in automatic mode (although provisions for staggered start-up will be required (10 second delay)). Note - in emergency operation, it may be necessary to limit the number of pumps operating based on the capacity of an emergency generator. Other exceptions to permitting all pumps to operate in automatic mode should be discussed on a case by case basis.
g) Provisions shall be made to allow for all in-service pumps to be in automatic alternating mode while other pump(s) are out of service. Out of service pumps shall be removed from the alternator sequence and not selected for operation and the alternator shall automatically select the next sequence.
h) Protection against simultaneous start-up of the pumps is to be provided through internal timers in the PLC logic (staggered start). (10 second delay)
i) In the event of a SCADA Remote Start or Stop, the pump is removed from sequence. Any local change in operation (HOA switch in HAND or OFF) will override the SCADA Remote Start/Stop as will loss of communication between the station RTU and the SCADA CFIU.
j) Consideration shall be given to ensure the station is operating at the most energy efficient manner possible.
k) If no pumps are available to operate the alternator sequence indicators shall flash and shall also be indicated on the PLC HMI, RTU MMI, and the RTU HMI displays. These displays should also indicate the reason each or all pumps are out of service.

3. In pump station Manual Mode of operation (HAND);
   a) When a pump is operated in the 'hand' position, only the normal start/stop levels shall be bypassed to permit pumping the wet well lower than normal. The operator shall be responsible for starting and stopping the pump. All permissive shall remain functional for protection of personnel and equipment.
   b) "Low Flow/ No Flow" interlocks and alarms shall not interfere with any pump operating in HAND mode.

4. Fault, Warning, and Alarm Conditions
   a) All Faults, warnings, and alarms shall be indicated on the PLC HMI, RTU MMI, and the RTU HMI displays as per the City's Master RTU I/O List (which provides specific descriptors and colour codes for enunciation).

b) A pump fault or alarm condition shall cause the control system to remove the subject pump from duty, and the fault or alarm shall be displayed on the PLC HMI, RTU MMI, and the RTU HMI displays. A manual reset (or acknowledgment) of the alarm or fault shall be required to return the pump to duty.
c) A pumping unit shall be removed from duty for the following faults and alarms:
   i. Motor overload.
   ii. Ground fault.
   iii. Loss of phase.
   iv. Motor high temperature.
   v. Pump volute high temperature (self-priming pumps).
   vi. Bearing high temperature (when monitored).
   vii. Pump control valve failure to open or close.
   viii. Excessive vibration (vertical mount dry pit motors).
   ix. Drive fault (solid state soft start of variable speed controllers).
   x. Stator housing leak
   xi. Pump Protection relay (e.g. MAS unit)
   xii. Circuit Breaker Open.
   xiii. Disconnect Open
   xiv. Oil housing seal failure (water in oil)

C. Mixer Logic

For stations with a mixer pump(s) installed in the wet well, the mixer(s) is to have three (3) selectable modes of operation, as described below. Note that this description is for a typical pump station arrangement and shall be modified as required by the Engineer on a case by case basis.

1. **Day of Week and Time-of-Day**: In this mode of operation, the operator will be able to set a mixer START time and a mixer STOP time on specific days of the week; the mixer will operate continuously between these two set points.

   Example: START time is set to 8:00am and STOP time is set to 5:00pm on Mon, Wed, and Fri at the PLC HMI. The mixer will run continuously between 8:00am and 5:00pm on Mondays, Wednesdays, and Fridays.

2. **Time-Cycle**: In this mode of operation, the operator will be able to set a duty cycle timer for the mixer at the PLC HMI. The operator will be able to set an adjustable “ON CYCLE TIME” and “OFF CYCLE TIME”. When the mixer is placed into AUTO mode, the PLC will automatically start the mixer and being counting down the “ON CYCLE” timer. The mixer will run continuously until the “ON CYCLE” timer lapses, at which point the PLC will turn off the mixer and begin counting down the “OFF CYCLE” timer. When the “OFF CYCLE” timer lapses, the PLC will restart the mixer, and the process will repeat. When the mixer is put into HAND and then switched back to AUTO, the timer should be restarted.

   Example: ON CYCLE time is set to 15 minutes and OFF CYCLE time is set to 10 minutes at the PLC HMI. The operator places the mixer into AUTO mode, and the PLC starts the mixer. The mixer runs continuously for 15 minutes. The PLC stops the mixer. The mixer is off for 10 minutes. The PLC restarts the mixer, which will run continuously for another 15 minutes. This process will repeat.

3. **Level Mode**: (Primary mode of operation): In this mode of operation, the operator will be able to set a single, adjustable MIXER LEVEL at the PLC HMI. When the level in the wet well rises (or is above) to the set-point, the PLC will start the mixer. The mixer will run continuously until the level in the wet well drops below the set-point, at which point the PLC will stop the mixer. The programmer shall allow a small dead-band such that the mixer will not cycle itself on and off around the set-point.

Example: Mixer LEVEL is set to 1.0m. The level in the wet well rises until the ultrasonic level controller reads 1.0m. The PLC starts the mixer. The mixer runs continuously as the level in the well continues to rise. The lead duty pump level is reached, and the lead pump is started. The level begins to drop. The level reaches 1.0m (minus dead-band) and the PLC stops the mixer. The lead duty pump continues operating until the level reaches the “Lead off” level set point.

APPENDIX C

Control Panel Door Layout

The control panel door layout will depend on the number and size of the control panel doors, and the station equipment to be accommodated. The latest control panel door layout is to be obtained from the City. The consultant shall submit a control panel door layout for review at the 50% stage, and highlight all deviations from the City's typical control panel layout. Any modifications to the City's standard must be approved by the City.

APPENDIX D

PLC Programming

Sewage pump station PLC programming requirements shall be discussed with the City on a case by case basis. The layout and content to be provided on the PLC screens shall be based on the screenshots provided here in this Appendix for reference. The basic programming principle is to obtain consistency among the stations, in particular for the HMI screens (functionality and layout) and tag name descriptors. Tag name descriptors shall be consistent with the City's convention and shall be consistent between the PLC, RTU, and electrical record drawings. See Appendix A for a list of Tags and descriptors used in the City's SCADA system. A formal list of all tags to be used in the PLC programming (including tag name, function, and descriptor) shall be submitted for review and approved by the City.

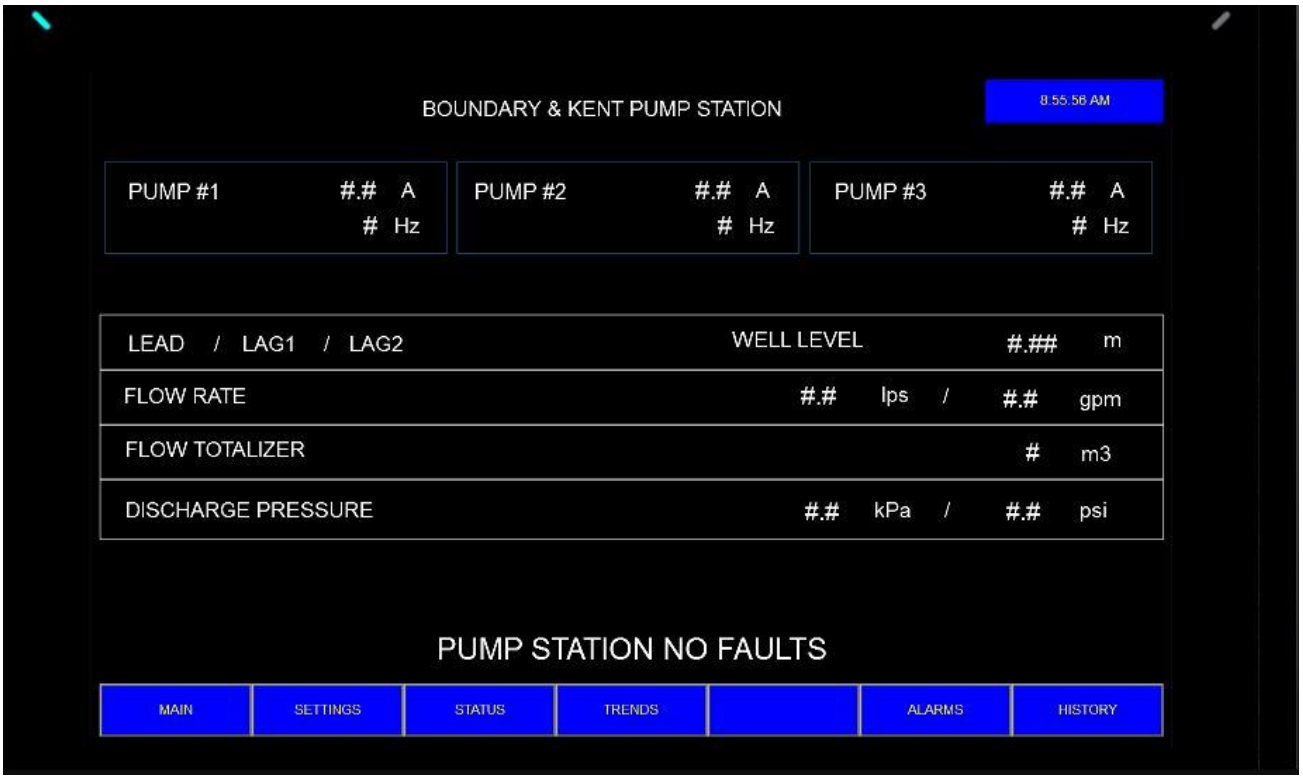

Figure 1: PLC HMI Screen #1 (Typical)

Figure 2: PLC HMI Screen #2 (Typical)

Figure 3: PLC HMI Screen #3 (Typical)

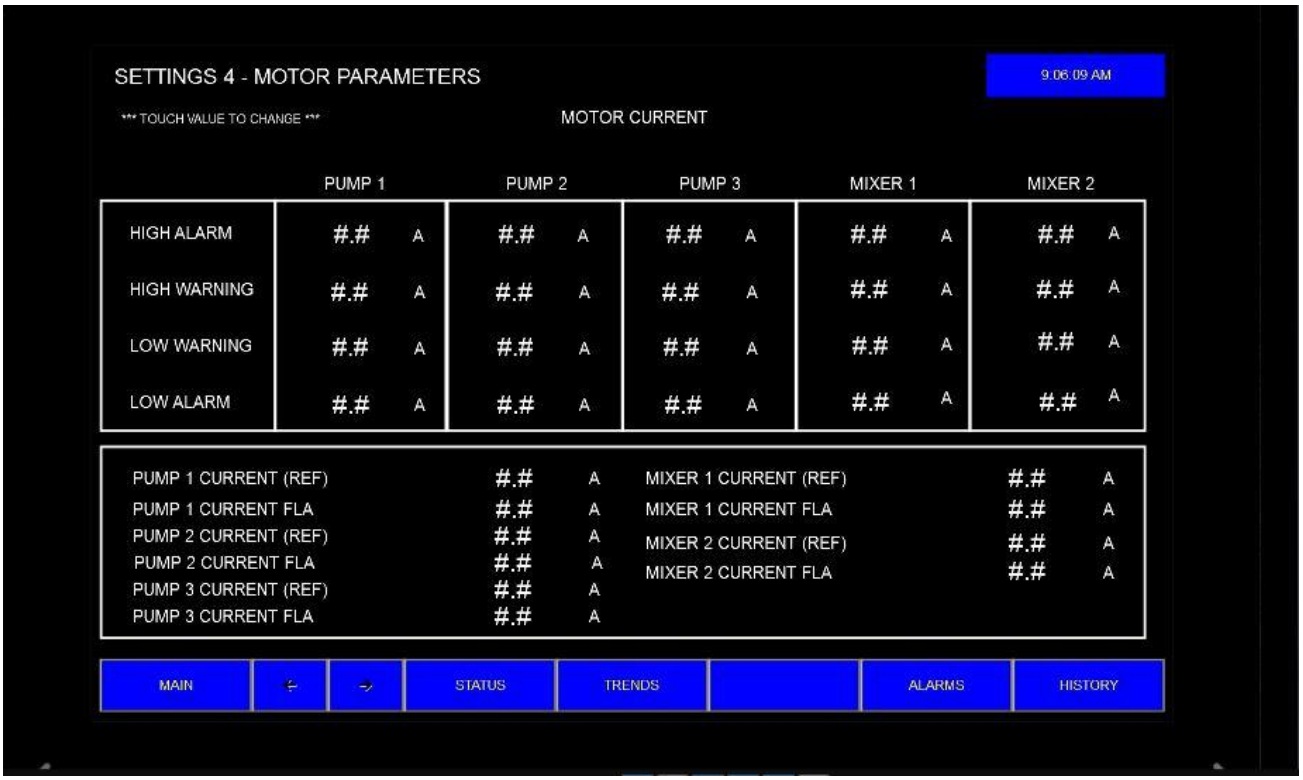

Figure 4: PLC HMI Screen #4 (Typical)

Figure 5: PLC HMI Screen #5 (Typical)

Figure 6: PLC HMI Screen #6 (Typical)

Figure 7: PLC HMI Screen #7 (Typical)

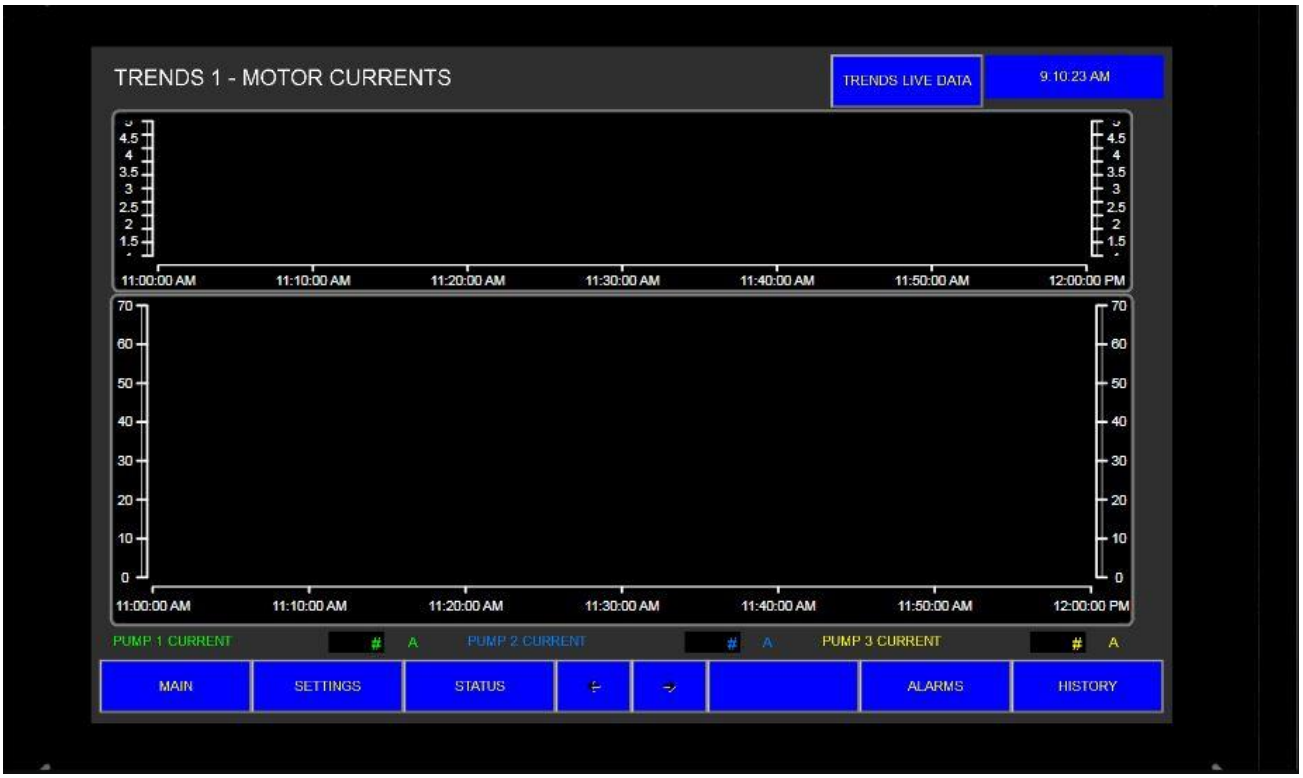

Figure 8: PLC HMI Screen #8 (Typical)

APPENDIX E

Relay Table

RELAY	LOCATION	DESCRIPTION	RELAY # AND VOLTAGE
CPF	CONTROL PANEL	CONTROL PANEL FAILURE	OMRON G2R-2-SN(S) 120 VAC
PPS	CONTROL PANEL	PRIMARY PLC SELECT	OMRON G2R-2-SN(S) 120 VAC
PLS	CONTROL PANEL	PRIMARY LEVEL CONTROLLER SELECT	OMRON G2R-2-SN(S) 120 VAC
TMR-5	CONTROL PANEL		OMRON H3CR 120 VAC
ISB-1	CONTROL PANEL	SPARE	PEPPERL+FUCHS KFD2-SR2-Ex1.W.LB 24 VDC
ISB-2	CONTROL PANEL	WW EMERGENCY HIGH LEVEL FLOAT SW	PEPPERL+FUCHS KFD2-SR2-Ex1.W.LB 24 VDC
TMR-1	CONTROL PANEL	ON DELAY TIMER	OMRON H3JA 120 VAC
TMR-2	CONTROL PANEL	ON DELAY TIMER	OMRON H3JA 120 VAC
TMR-3 (NOT USED)	CONTROL PANEL	ON DELAY TIMER	OMRON H3JA 120 VAC
TMR-4	CONTROL PANEL	ON DELAY TIMER	OMRON H3JA 120 VAC
ESR-1	CONTROL PANEL	EMERGENCY STOP PUMP 1	PHOENIX CONTACTOR 24VDC
ESR-2	CONTROL PANEL	EMERGENCY STOP PUMP 2	PHOENIX CONTACTOR 24VDC
ESR-3	CONTROL PANEL	EMERGENCY STOP PUMP 3	PHOENIX CONTACTOR 24VDC
VFD 1 AUX 1	VFD 1 MCC	POWER FACTOR CAPACITOR	EATON D7PF2AT1 24 VAC
VFD 1 AUX 2	VFD 1 MCC	MAS UNIT #1 RUN INPUT	WACO 857-152 24 VAC
VFD 2 AUX 1	VFD 2 MCC	POWER FACTOR CAPACITOR	EATON D7PF2AT1 24 VAC
VFD 2 AUX 2	VFD 2 MCC	MAS UNIT #2 RUN INPUT	WACO 857-152 24 VAC
VFD 3 AUX 1	VFD 3 MCC	POWER FACTOR CAPACITOR	EATON D7PF2AT1 24 VAC
VFD 3 AUX 2	VFD 3 MCC	MAS UNIT #3 RUN INPUT	WACO 857-152 24 VAC
CT-1	CONTROL PANEL	SUMP PUMP RUNNING	VERIS HAWKEYE 608 (175A ADJUSTABLE)
CT-2	CONTROL PANEL	SF-2 RUNNING	VERIS HAWKEYE 608 (175A ADJUSTABLE)
CT-3	LIGHTING PANEL WIREWAY	EF-2 RUNNING	VERIS HAWKEYE 608 (175A ADJUSTABLE)
CT-4	MIXER #1 MCC	MIXER #1 CURRENT FEEDBACK	EATON EAC14205C 120 VAC
CT-5	MIXER #2 MCC	MIXER #2 CURRENT FEEDBACK	EATON EAC14205C 120 VAC
NAR-1	TRANSFER SWITCH	BC HYDRO FAILURE	PHOENIX CONTACTOR 24VDC
LIT-01	CONTROL PANEL	LOSS OF ECHO, TXR FAULT	
LIT-02	CONTROL PANEL	LOSS OF ECHO, TXR FAULT	

RELAY	LOCATION	DESCRIPTION	RELAY # AND VOLTAGE
SSR-1	CONTROL PANEL	FLOWMETER PULSE	OMRON G3NA-D210B 24 VDC
R1A	CONTROL PANEL	P1 HOA IN AUTO	OMRON G2R-2-SN(S) 24 VDC
R1H	CONTROL PANEL	P1 HOA IN HAND	OMRON G2R-2-SN(S) 24 VDC
R2A	CONTROL PANEL	P2 HOA IN AUTO	OMRON G2R-2-SN(S) 24 VDC
R2H	CONTROL PANEL	P2 HOA IN HAND	OMRON G2R-2-SN(S) 24 VDC
R3A	CONTROL PANEL	P3 HOA IN AUTO	OMRON G2R-2-SN(S) 24 VDC
R3H	CONTROL PANEL	P3 HOA IN HAND	OMRON G2R-2-SN(S) 24 VDC
CR-1000	CONTROL PANEL	ENABLE VFD 1	OMRON G2R-2-SN(S) 24 VDC
CR-1001	CONTROL PANEL	ENABLE VFD 2	OMRON G2R-2-SN(S) 24 VDC
CR-1002	CONTROL PANEL	ENABLE VFD 3	OMRON G2R-2-SN(S) 24 VDC
CR-1003	CONTROL PANEL	SPARE	OMRON G2R-2-SN(S) 24 VDC
CR-1004	CONTROL PANEL	P1 RUN COMMAMD TO RTU	OMRON G2R-2-SN(S) 24 VDC
CR-1005	CONTROL PANEL	P2 RUN COMMAMD TO RTU	OMRON G2R-2-SN(S) 24 VDC
CR-1006	CONTROL PANEL	P3 RUN COMMAMD TO RTU	OMRON G2R-2-SN(S) 24 VDC
CR-1007	CONTROL PANEL	PUMP LOW FLOW WARNING	OMRON G2R-2-SN(S) 24 VDC
RX	CONTROL PANEL	PRIMARY PLC FAILURE	OMRON LY4N 24 VDC
CR-1008	CONTROL PANEL	PLC 1 OPERATING	OMRON G2R-2-SN(S) 24 VDC
CR-1009	CONTROL PANEL	ENERGIZED RELAY RU	OMRON G2R-2-SN(S) 24 VDC
CR-RU	CONTROL PANEL	ENABLE SECONDARY ULTRASONIC	OMRON G2R-2-SN(S) 24 VDC
CR-1010	CONTROL PANEL	ENABLE MIXER #1	OMRON G2R-2-SN(S) 24 VDC
CR-1011	CONTROL PANEL	ENABLE MIXER #2	OMRON G2R-2-SN(S) 24 VDC
CR-1012	CONTROL PANEL	MIXER #1 RUN	OMRON G2R-2-SN(S) 24 VDC
CR-1013	CONTROL PANEL	MIXER #2 RUN	OMRON G2R-2-SN(S) 24 VDC
CR-1014	CONTROL PANEL	LIT-01 FAULT	OMRON G2R-2-SN(S) 24 VDC
CR-1015	CONTROL PANEL	LIT-02 FAULT	OMRON G2R-2-SN(S) 24 VDC

APPENDIX F

This table provides a list of tools to be supplied by the Contractor at turnover of the pump station to the City.

Master Tool List
1 of 4

QTY.	MAKE	SUPPLIER	PART NO.	SIZE	DESCRIPTION
TOOL STORAGE CHEST					
1	Rubbermaid	Acklands	FG773488BLA	5 Drawer	Mobile Work Center (Blk/Red)
SOCKET SETS					
1	JET	Weber Supply	600125	1/4" Drive	SAE / Metric (42 Pc) Socket Set - 6 Point
1	JET	Weber Supply	672903	1/2"	Flex (Johnson) Bar 15" (Model SA1202)
1	JET	Weber Supply	600241	3/8" drive	SAE / Metric Shallow & Deep 6pt 45pc
1	JET	Weber Supply	600341	1/2" Drive	SAE / Metric Shallow & Deep 6pt 55Pc
1	Grey	Weber Supply	3G2281T1	1/8" - 3/8"	SAE 3/8 Drive 7pc Long Hex Bit Set
1	Grey	Weber Supply	3G2281T3	4mm - 10mm	Metric 3/8 Drive 7pc Long Hex Bit Set
COMBINATION WRENCH SETS					
1	Dynamic	Weber Supply	D074221	1/4" - 1 1/4"	16pc SAE Combination Wrench Set
1	Dynamic	Weber Supply	D074203	6mm - 21mm	19pc Metric Combination Wrench Set
2	JET	Weber Supply	701109	3/4"	SAE Ratchet Wrenches (non-reversing)
2	JET	Weber Supply	701112	15/16"	SAE Ratchet Wrenches (non-reversing)
ADJUSTABLE (CRESCENT) WRENCHS					
1	JET	Weber Supply	711102	8" 10" 12"	Adjustable Wrench Set (AW-35)
1	JET	Weber Supply	711112	6"	Adjustable Wrench (AW-6)
1	JET	Weber Supply	711117	18"	Adjustable Wrench (AW-18)

Master Tool List
2 of 4

QTY.	MAKE	SUPPLIER	PART NO.	SIZE	DESCRIPTION
HEX (ALLEN) KEYS WRENCHES					
1	JET	Weber Supply	775164	1/16" - 3/8"	SAE / METRIC (25 Pc) Hex Key Wrench Set (JBHK-22SM)
SCREWDRIVERS TORX & NUT DRIVERS					
1	JET	Weber Supply	720524	3/16" - 3/8"	Ergonomic (14 Pc) Screwdriver Set (JSTD - 14S)
1	JET	Weber Supply	720527	T10 - T40	Ergonomic (7 Pc) TORX Driver Set (JSTD - 7TS)
1	JET	Weber Supply	721105	3/16" - 1/2"	Hollow Shaft (7 Pc) Nut Driver Set (NDS-07)
PLIERS & VISE GRIPS					
1	JET	Weber Supply	730355	10"	Snap Ring Pliers Set
1	JET	Weber Supply	730306		(5 Pc) Plier Set (Chrome Nickel)(JPHD-5S)
1	JET	Weber Supply	730428	11"	Long Needle Nose Pliers
1	JET	Weber Supply	730488	11"	Long Needle Nose Pliers Curved Nose
KNIVES - BLADES - SHEARS & SAWS					
1	JET	Weber Supply	840441	18mm	Auto Load Snap Off Utility Knife (JALK-18)
1	JET	Weber Supply	735301	10"	Aviation Snips (JAS-1S)
1	JET	Weber Supply	775306	12"	Hacksaw Frame (525-A)
2	JET	Weber Supply	566231	12" - 18 TPI	Bi Metal Hacksaw Blade 18 TPI
2	JET	Weber Supply	566232	12" - 24 TPI	Bi Metal Hacksaw Blade 24 TPI
PIPE WRENCHES					
2	RIDGID	Ridgid	RDG47057	12"	Aluminum Handle Straight Pipe Wrench
2	RIDGID	Ridgid	RDG31100	18"	Aluminum Handle Straight Pipe Wrench

Master Tool List
3 of 4

QTY.	MAKE	SUPPLIER	PART NO.	SIZE	DESCRIPTION
HAMMERS					
1	JET	Weber Supply	740165	32oz - 15"	Ball Pein Hammer (BP-32F)
1	JET	Weber Supply	740191	2 1/2lb - 10 3/4"	Club Hammer (JSCH-25)
1	STANLEY	Weber Supply	57-534	52oz	Composite Mallet Hammer
PUNCHES - CHISELS & PRY BARS					
1	JET	Weber Supply	775509	3/32" - 5/16"	Pin Punch (6 Pc) Set (PP-6S)
1	JET	Weber Supply	775526	3/32" - 5/16"	Roll Pin Punch (6pc) Set
1	JET	Weber Supply	775531	1/4" - 3/4"	Cold Chisel (6 Pc) SET
1	JET	Weber Supply	779220	8" - 24"	Cushion Grip Pry-Bar Set (JMPB-4S)
SCRAPERS & SEAL PICK HOOKS					
1	JET	Weber Supply	859341	3/4" - 2"	Chisel Point Scraper Set (JCS-4S)
1	JET	Weber Supply	859301	6"	Heavy Duty Hook Set (JPHS-604)
GREASE GUNS					
1	JET	Weber Supply	350155		Pistol Grip Grease Gun HD
DRILL BITS - FILES & Brushes					
1	JET	Weber Supply	570147	1/16" - 1/2"	Premium (29 Pc) Drill Bit Set (BG29RS)
1	JET	Weber Supply	532929		File Handle
1	JET	Weber Supply	532926		File Handle
1	JET	Weber Supply	532811	6" - 8" - 10"	Premium (5 Pc) File Set (JFS-5V)
1	JET	Weber Supply	531630	10"	Premium Round File Second Cut
1	APEX	Weber Supply	7F0706Y5	10"	File Card
1	JET	Weber Supply	551111	13 3/4"	Wire Brush (3X19)
1	JET	Weber Supply	720761	1/8" - 5/16"	Screw Extractor Kit (5pc)

Master Tool List
4 of 4

QTY.	MAKE	SUPPLIER	PART NO.	SIZE	DESCRIPTION
SAFETY					
6	Honeywell / UVEX	Acklands	UVXS4400	NA	Safety Glasses
1	Grainger	Acklands	GGS4GMR6	9"X6 3/4"X4 5/8	Safety Glasses Case PTEG Dispenser (Holds 6 Pairs)
1	Brady	Acklands	BDY74630	14" X 20"	Safety Glasses Required Sign
3	Dynamic	Acklands	NP115	NRR 25DB	Over The Head Ear Muffs Yellow/Black
2	AMEREX		B456	10LB - 4.54KG	Fire Extinguisher (W/Mounting Hardware)
1	Cederoth	Acklands	REF 7251A	1litre	Eyewash Bottle W/Wall mount
1	Brady	Acklands	BDY45021	10" x 7"	Eyewash Station Sign
1	Dynamic	Acklands	DSIFAKBCBASBP	N/A	First Aid Kit BC Basic (Plastic)
1	Brady	Acklands	BDY22647	14" X 10"	First Aid Station Sign
HOUSEKEEPING & MISCELLANEOUS					
1	Rubbermaid	Home Depot	8620-20	20 Lb	Rubbermaid Brute Garbage Container W/Lid
1	Greenline	Greenline Hose	G1331-075	50Ft - 3/4"	Greenline Blue Aqua Hose 300 PSI
1	Greenline	Greenline Hose	G97-GHT	3/4"	Garden Hose Fog Nozzle (Green)
1	Quartet	Staples	3413871017	3' x 4'	Dry Erase Whiteboard
1	Expo	Staples	SHP84074	4 Set	Dry Erase (Fine)Markers Set W/Eraser
1	Greenline	Greenline Hose	PSP-700-020	BC Forestry	Fuel / Oil Spill Kit
1	Featherlight	Home Depot	FL-2210-08	8'	Featherlight Aluminum Step Ladder (Green Top)

APPENDIX G

Design Submission Checklist (Generic)

Engineering Services	STANDARD PROJECT LIST	Rev. No.: 0	Record No.: DOC/2021/016512
Branch: Sewer and Drainage Design		Process Owner: Callem McDougall	
TITLE: Design Submission Checklist Summary Table			

REVISION HISTORY			
Rev. No.	Description	Date Created/Revised	Created/Revised By
1.0	Initial release. Issued for PSRP.	6/28/2021	Callem McDougall

INSTRUCTIONS TO THE CONSULTANT
The document is provided a Consultant in the early stages of a pump station design project as a reference design submission requirements for the project. The intent of this document is ensure that, for each stage of the design phase, an adequate amount of information is captured in the design package and that this information is located in the appropriate documents (e.g. drawings, specifications or a report).

CATEGORY	ITEM	SUBMITTAL																														
			DWGs? Specs? Report?				DWGs? Specs? Report?				DWGs? Specs? Report?				DWGs? Specs? Report?				DWGs? Specs? Report?				DWGs? Specs? Report?				DWGs? Specs? Report?			
		Conceptual (25%)	D	S	R	Intermediate Submission	50%	D	S	R	75%	D	S	R	90%	D	S	R	100%	D	S	R	IFT	D	S	R	IFC	D	S	R
GENERAL	Station Configuration	• Propose configuration of wet-well, dry-well, electrical room (building vs. kiosk, submersible pump, suction lift, etc.). • Provide site plan, station/wetwell floor plans, and section views.	✓		✓		• Confirm configuration	✓		✓	Updated as necessary																			
	Architecture	• Discussion of how to integrate building with its environment • Architectural concept provided • Renderings	✓		✓		• Options for building finishes • Sections	✓		✓	• Building elevations • Soft & hard landscaping details, grading	✓	✓		Updated as necessary															
	Flood Performance	• Expected flood levels in relation to proposed conceptual designs	✓		✓		• Draft Flood Risk Assessment • Section drawing(s) should show flood levels, including in any external chambers.	✓		✓	• Final Flood Risk Assessment			✓	Updated as necessary															
	Seismic Resiliency	• Confirm seismic performance target			✓		• Magnitude of expected seismic ground movements (see Geotechnical Report) and how they will be accomodated • Identify building code seismic criteria that will be used			✓	Incorporate seismic requirements into design.																			
	Confined Space Identification	• Consideration to minimizing confined spaces			✓		• Identify confined spaces in the station	✓		✓	Updated as necessary																			
	Access and Maintenance	• Conceptual provisions for general station access (e.g. parking areas, walkways, crane/hydrovac truck set-up locations as necessary) • Crane type(s) and alignment proposed (monorail, gantry, etc.)	✓		✓		• Confirmed provisions for general station access (e.g. parking areas, walkways, crane/hydrovac truck set-up locations as necessary) • Crane types and alignment confirmed, lifting capacities confirmed • Access hatch and leaf layout and orientations (hatch & grating)	✓		✓	• Crane components identified and detailed • Access hatch and leaf size, layout, dimensions, etc. Drawings should show outline of pump to ensure hatches align properly. • Specifications for cranes, including all installation, testing, documentation and commissioning requirements.	✓	✓		Updated as necessary															
	Stormwater Management						• Concept of how site stormwater will be managed in accordance with the City's Integrated Rainwater Management Plan	✓		✓	Updated as necessary																			
	Cost Estimate	• Class D Cost Estimate (for each proposed option)			✓		• Class C Cost Estimate			✓	• Class B Cost Estimate			✓	• Class A Cost Estimate • Include brief			✓	Updated as necessary									
	Construction Schedules						• Preliminary Construction Schedule			✓	Updated as necessary																			
	Naming Convention	• Submit equipment & tag naming convention for approval by COV • Submit wiring and conduit naming convention for approval by COV					• Submitted I/O naming convention for approval by COV (included in Project Equipment and I/O Assignment List)				Updated as necessary																			
CIVIL	Incoming Sewers	• Site plan showing proposed gravity sewers and tie-in point	✓				• Plan/profile of incoming sewers • Proposed wet-well isolation valves • Proposed flexible connection details	✓		✓	• Sewer details (MH benching, construction details, trench detail, etc.)	✓	✓		Updated as necessary															
	Forcemain	• Provide recommendation of re-use of existing forcemain or new • Site plan showing proposed forcemain tie-in point • Estimate flow velocity based on proposed capacity and pipe size	✓		✓		• Proposed forcemain plan/profile (if applicable) • Forcemain tie-in details • Location and arrangement of forcemain bypass port and chambers	✓			• Forcemain details (termination MH/connection, restraints) • Bypass port and chamber details	✓	✓		Updated as necessary															
	Overflow						• Overflow location, elevation and capacity confirmed • Modifications to overflow proposed (if necessary). Proposed location, elevation, capacity	✓		✓	Overflow details provided.	✓			Updated as necessary															
STRUCTURAL	Structural	• Discuss foundation concept • General arrangement of structure • Options for building structural systems and materials	✓		✓		• Confirm foundation design • Confirm main structural systems and materials	✓		✓	• Details of structural systems	✓	✓		Updated as necessary															
	Guardrails, Platforms, Etc.						• General arrangement • *Note: should consider Operator Access and Maintainability*	✓			Updated as necessary																			

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PROCESS MECHANICAL	Inflows	• Confirm design flows that will be used for detailed design (PWWF, PDWF). • Design flows should be based on planning information (population estimates, I&I estimates, etc.)			✓		Updated as necessary																									
	Pumps	• Propose number of pumps • Propose model of pump • Preliminary station capacity and TDH • Include performance data for proposed pump in all operating conditions (i.e. one pump, two… etc)	✓		✓		• Pump selection and configuration confirmed • Station capacity and TDH confirmed • Complete pump performance data • Pump layout and mounting details proposed	✓		✓	• Pump layout and mounting details confirmed	✓	✓		Updated as necessary																	
	Piping	• Propose wet-well and dry-well piping materials • Preliminary piping layout	✓		✓		• Confirm wet-well and dry-well piping materials • Updated wet-well and dry-well piping configuration	✓		✓	Updated as necessary																					
	Wet Well & Dry Well	• Propose wet-well and dry-well configurations	✓		✓		• Wet-well and dry-well configuration confirmed • Wet-well and dry-well elevations • Structural material and coating	✓		✓	• Detailed dimensions for wet-well and dry-well	✓	✓		Updated as necessary																	
	Valving & Fittings	• Propose valving arrangement for suction/discharge piping	✓				• Show provisions and location for instrumentation, air-release valves (if necessary) all valves and fittings (e.g. drain down valves, spare valve ports, pressure guages, etc. • Confirm valving arrangement for suction/discharge piping	✓			Updated as necessary																					
	Transient Analysis	• Conduct a preliminary transient assessment			✓						• Submit a detailed transient assessment (if applicable)			✓	Updated as necessary																	
ELECTRICAL	Single Line Diagram						• Submitted to COV for review	✓			Updated as necessary																					
	Schematic and Wiring Diagrams										• Submitted to COV for review	✓			Updated as necessary																	
	Genset/Standby Power	• Propose on-site genset location OR other standby power options	✓		✓		• Genset enclosure and arrangement • Generator sizing calculations	✓		✓	• Confirm location of load banks (if applicable)	✓		✓	Updated as necessary																	
	Instrumentation						• Instrumentation configuration in dry-well (i.e. pressure transmitters, flowmeter) • Instrumentation configuration in wet-well (i.e. transducers, floats, etc.)	✓		✓	• Confirm elevations of instrumentation in wet-well • Instrumentation details (mounting, readout locations, etc.)	✓			Updated as necessary																	
	SCADA						• SCADA antenna location • RTU panel location	✓			Updated as necessary																					
	Incoming Power	• Confirm suitability of existing BC Hydro service			✓		• BC Hydro service connection	✓			• Suggested temporary construction power arrangement	✓		✓	Updated as necessary																	
	Motor Control Centre	• Approximate sizing, location, and arrangement of MCC	✓				• Dimensions of MCC • Detailed arrangement of MCC	✓			Updated as necessary																					
	Electrical Analysis														• Short Circuit Study • Load Calculations			✓	Updated as necessary											
	Arc Flash														• Draft Arc Flash Hazard Study/Analysis			✓	Updated as necessary				• Finalized after submission of shop drawings				✓			
	Lighting						• Propose lighting configuration (flood lights, etc.)	✓			Updated as necessary																					
	Electrical Classifications	• Discussion on room classification			✓		• Confirm room classification (explanation provided in report for each classified zone/room, locations shown on drawings)	✓		✓	Updated as necessary																					

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PROCESS CONTROL	Control Narrative					▪ Draft written Control Narrative based on chosen general station arrangement	▪ Updated with each new submittal.												▪ Final written Control Narrative			✓	Updated as necessary							
	P&ID	▪ Basic P&ID diagram for proposed options	✓				Updated with each new submittal.																							
	Control Panel Door Layout										▪ Propose control panle door layout. Any deviations from standard door layout in Pump Station Guidelines to be highlighted for City acceptance.	✓			Updated as necessary														
	Project Equipment and I/O Assignment List						▪ Draft Project Equipment and I/O Assignment List				Updated with each new submittal.								▪ Final Project Equipment and I/O Assignment List				Updated as necessary						
	PLC Drawings										▪ PLC drawings drafted in accordance with Project Equipment and I/O Assignment List	✓			Updated as necessary														
	Control	▪ Propose control method for major systems (PLCs, VFDs, across-the-line starters)			✓		▪ Show control elevations in wet-well (LEAD, LAG 1, LAG 2, etc) ▪ Include Control Diagram(s) for station systems	✓		✓	Updated as necessary																			
BUILDING MECHANICAL	HVAC	▪ HVAC location proposed	✓		✓		▪ HVAC system type proposed ▪ General HVAC equipment arrangement ▪ Confirm HVAC control method ▪ Identify energy-saving opportunities (i.e. heat recovery systems, etc.)	✓		✓	▪ HVAC ducting ▪ Detailed HVAC equipment arrangement to meet ACH requirements.	✓	✓	✓	Updated as necessary														
	Wet Well Ventilation & Odour Control	▪ Propose odour control room location ▪ Propose odour control options	✓		✓		▪ **If in scope** - discuss chosen option ▪ **If not in scope** - show provisions for future installation	✓		✓	Updated as necessary																			
	Sump Pumps						▪ Sump/trench location ▪ Discharge alignment	✓			▪ Detailed sump pump configuration (mounting of float switches, discharge piping configuration, pump and sump size)	✓	✓		Updated as necessary														
CONSTRUCTION CONSIDERATIONS	Construction Sequencing						▪ Propose suggested construction sequencing	✓		✓	Updated as necessary																			
	Decommissioning Plan						▪ Demolition plan and elevation ▪ Discussion on hazardous building materials and abatement	✓		✓	Updated as necessary																			
	Bypass System						▪ Provide options and recommentation to maintain sewage service during construction (i.e. implementing by-pass, keeping existing PS in service)	✓		✓	▪ Submit by-pass requirements and suggested plan to COV for review (if applicable)	✓	✓	✓	Updated as necessary														
	Construction Access/Staging	▪ Identification of potential access restrictions			✓		▪ Identify construction access/staging area for necessary construction sequencing and bypass operations	✓		✓	▪ Incorporate site access requirements and coordination between COV and Contractor		✓	✓	Updated as necessary														

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		Conceptual (25%)	D	S	R	Intermediate Submission	50%	D	S	R	75%	D	S	R	90%	D	S	R	100%	D	S	R	IFT	D	S	R	IFC	D	S	R
SITE ASSESSMENTS	Geotechnical	▪ Geotechnical investigations, including drilling and soil corrosivity test results (if applicable) ▪ Geotechnical Report outlining expected sub-surface geotechnical conditions, expected post-construction and post-seismic ground movements, relevant design paramenters, and recommendations for construction methodology ▪ Account for study findings in conceptual design and cost estimates			✓		Additional investigations as necessary																							
	Environmental	▪ Environmental Site Assessment Lvl.2 if required ▪ Design should account for requirements determined by initial environmental assessment completed by COV			✓		Additional investigations as necessary				▪ Requirements/restrictions (if any) to be defined	✓	✓		Additional investigations as necessary														
	Archeological	▪ Archeological Overview Assessment and/or Archaeological Impact Assessment if required. ▪ Design should account for archeological requirements & additional assessments as determined by COV.			✓		Additional investigations as necessary				▪ Requirements/restrictions (if any) to be defined	✓	✓		Additional investigations as necessary														

APPENDIX H

Project Equipment and I/O Assignment List (Generic)

The latest Project Equipment and I/O Assignment List is to be obtained from the City.

APPENDIX I

Document Change Log

Rev. No.	Section	Description	Date Created/ Revised
5.0	Various	Revision 2.0 changes removed from Change Log for brevity	April 2023
5.0	Various	Revision 2.1 changes removed from Change Log for brevity	April 2023
5.0	Various	Revision 3.0 changes removed from Change Log for brevity	April 2023
5.0	Various	Revision 4.0 changes removed from Change Log for brevity	April 2023
5.0	General	Added Table of Contents	April 2023
5.0	General	Revised formatting	April 2023
5.0	1.3.8	Safe working space provisions	April 2023
5.0	1.6.1 i)	Service sink and related items	April 2023
5.0	1.6.1 iii)	Emergency drench hose or eyewash station and shower	April 2023
5.0	1.6.1 iv)	Storage closet	April 2023
5.0	1.7.2	Water service piping	April 2023
5.0	1.7.3	Water meter	April 2023
5.0	1.7.4	Interior potable water piping	April 2023
5.0	1.8.3	Green infrastructure	April 2023
5.0	1.9.1	Service life of structural and architectural systems	April 2023
5.0	1.9.3	Windows	April 2023
5.0	1.9.5	Exposed timber elements	April 2023
5.0	1.9.6 ii)	Roofs	April 2023
5.0	1.9.6 v)	Door hardware	April 2023
5.0	1.10	Unit heaters	April 2023
5.0	2.2.3	Bypass chamber location	April 2023
5.0	3.1.7	Pump seal flushing systems	April 2023
5.0	3.2.1 ii)	Sch. 80 PVC only where approved by the Engineer	April 2023
5.0	3.2.2 i) c)	Carbon steel piping top coat colour	April 2023
5.0	3.2.2 i) d)	Carbon steel piping joints	April 2023
5.0	3.2.2 ii) b)	Stainless steel piping joints	April 2023
5.0	3.2.5	Threadolet; redundant 50mm drain	April 2023
5.0	3.2.8	Drain valve on suction-side piping in dry pit	April 2023
5.0	3.2.10	Drain valve requirements	April 2023
5.0	3.3.5 iv) b)	Max. 2 psi increments on analog pressure gauges	April 2023
5.0	3.3.5 v) d)	Pressure transmitter submersion rating	April 2023
5.0	3.3.6 iv)	Isolation valves and unions for air release valves	April 2023
5.0	3.3.6 v)	Backflushing components for air release valves	April 2023
5.0	3.4	Labelling, tagging and stencilling	April 2023
5.0	4.1.1 iii)	Added lifting eyes	April 2023
5.0	4.1.2 iii)	Hatches rated to support full pump weight	April 2023
5.0	4.1.2 xii)	Hatch etching	April 2023
5.0	4.1.8	Chamber flood float switch	April 2023
5.0	4.2.8	Wet well wall concrete requirements	April 2023
5.0	4.2.9	Wet well design requirements	April 2023
5.0	4.2.14	Wet well cracking limitations	April 2023
5.0	4.2.15	Inlet drop tee design	April 2023
5.0	4.2.16	Reference to access hatch requirements	April 2023

Rev. No.	Section	Description	Date Created/ Revised
5.0	4.3.2 v)	Dry well flood float switch	April 2023
5.0	4.3.2 vi)	Waterproof junction box in lieu of turnlock style plug	April 2023
5.0	4.3.2 ix)	Sump pump lifting point	April 2023
5.0	4.4.1 viii)	Added carbon steel and epoxy	April 2023
5.0	4.4.1 ix)	Storage provisions	April 2023
5.0	4.4.2 iii)	Lifting davit receiver drain	April 2023
5.0	4.5.4	Sealed engineering documentation for cranes	April 2023
5.0	5.1.11	Transformer requirements	April 2023
5.0	5.2.1	Added electrical receptacles and switches	April 2023
5.0	5.2.3	Specified colours	April 2023
5.0	5.3.3	Standard wire labelling, terminations & circuitry drawings	April 2023
5.0	5.3.4 vi)	I/O for pumps to be split across multiple cards	April 2023
5.0	5.3.6 iii) a)	E-stops	April 2023
5.0	5.4.3	False floor or shelf in control cabinet	April 2023
5.0	5.5.3	Radio antennae cable	April 2023
5.0	5.6	Added wetwell and measurement to heading	April 2023
5.0	5.6.4	Transducer submergence shields	April 2023
5.0	5.6.6	Wet well float switch	April 2023
5.0	5.6.7	Pressure and level remote readouts	April 2023
5.0	5.7.6	MAS “no-go” signal routing	April 2023
5.0	5.7.7	H-O-A signal routing	April 2023
5.0	5.8.7	Circuit breakers on secondary side of transformers	April 2023
5.0	5.8.8	Circuit breakers for surge protection devices	April 2023
5.0	5.9.1 ii)	Generator sizing	April 2023
5.0	5.9.1 iv)	Load bank	April 2023
5.0	5.9.1 vi)	Generator location	April 2023
5.0	5.9.1 vii)	Generator room requirements	April 2023
5.0	5.9.1 viii)	Generator fuel requirements	April 2023
5.0	5.9.1 ix)	Generator controller to send relevant information to RTU	April 2023
5.0	5.9.2 i) a)	Approved by CSA and City Engineer	April 2023
5.0	5.9.2 i) b)	ASCO 7000 Series	April 2023
5.0	5.9.2 iii)	Indicator light upstream of transfer switch	April 2023
5.0	5.11.4	Filtered fans	April 2023
5.0	5.12.2	Design system to avoid power factor issues	April 2023
5.0	5.13.3	Rechargeable gel-cell batteries	April 2023
5.0	5.13.4	Emergency exit signage	April 2023
5.0	5.14.9	Speed adjustment when in HAND or directly controlled	April 2023
5.0	5.15	Lighting	April 2023
5.0	7.1	Commissioning terminology	April 2023
5.0	7.3	Continuity of sewage service	April 2023

END OF SECTION