

1 GENERAL REQUIREMENTS

#	Function	Details
1	Landscaping	
	i.	All-weather vehicle access to the wet-well, valves, electrical and any other major equipment installed on site. Where indivisible components requiring servicing are between 20 and 200kg, design the access for a (crane mounted on a) light truck of: <ul style="list-style-type: none"> length = 5 metres, width = 2.5 metres and maximum axle loading on 7.00 x 15 single tyred axle = 2500 kg ensuring that: <ul style="list-style-type: none"> the rear axle of the truck mounted crane can be brought to within 2m of the vertical centreline of the component to be lifted, and Insure there is sufficient head room to operate the crane.
	ii.	Hard surfacing (concrete or asphalt) to all areas where sludge, raw sewage or chemicals are likely to spill, draining to the wastewater system or wet-well
	iii.	Washdown area for pump cleaning – with drain back to wet well
	iv.	Ability to locate a mobile standby generator
2	Pumps	
	i.	Duty and standby required
	ii.	Flygt submersible where (where possible Flygt N-Technology pumps)
3	Motor control	
	i.	Soft starters compatible with Flygt pumps.
4	Pipework and valves	
	i.	Knife gate valves used for isolate of each pump and non-return ball valves (both should be housed in individual valve chamber beside wet well).
	ii.	Cast ball check valve
5	Wet well and emergency storage	
	i.	Minimum of nine hours storage (ADWF). A smaller wet well with off line storage is preferred. Where the pump station is considered “large” and has a standby generator and spare pump supplied (additional to duty / standby pumps) – with the agreement with Council, emergency storage may be reduced.
	ii.	May be constructed from pre cast concrete or fibre glass.
	iii.	Venting – Where applicable use of McBerns GM375 Mixed Media Odour filters
	iv.	Automatic well washing (on hinged bracket)
	v.	Manhole adjacent to pump station with cutoff valve. Note - SS knife valve with deflector plate on inlet pipe with valve spindle to top of well. <i>Allows wet-well and associated pipework to be safely isolated from the sewer system</i>
	vi.	All pipe work, riser joint & attachments within wet well shall be stainless steel 316
	vii.	Cover lids - McBerns 4-sided safety cover lid type
	viii.	Valve chambers and pits with a 50mm minimum diameter drain hole falling into the wet-well
	ix.	Locate the covers to enhance equipment maintenance and to permit the setting up of davits or tripods for entry to confined spaces.
	x.	Drop structure on the inlet at an angle of at least 45 degrees to prevent the forming of vortices on pumping
	xi.	Any ducts (electrical / control) shall be a minimum of 100mm diameter

#	Function	Details
6	Switchboard	
	i.	Beige in colour to reduce internal heat build-up.
	ii.	Weatherproof protection hoods for any instruments exposed to sunlight. <i>To prevent degradation of liquid crystal displays by ultraviolet light or moisture ingress from heating and cooling effects.</i>
	iii.	RTU aerial: Locate the external line-of-site aerial on the furthest side of the building from the road boundary whilst maintaining line of sight. Detail securing of aerials against wind and snow loading. Mount the aerial on a 50mm diameter aluminium scaffolding tube extending two metres above the top of the electrical control cabinet or building. Ensure this pipe is easily lowered to the ground for aerial maintenance
	iv.	Remote pump starting and stopping shall also be provided from the SCADA system
	v.	All ducting from the sewer well and valve chambers to electrical cabinet shall be filled with builders foam
	vi.	UPS required for SCADA control system – to operate for a minimum of 4 hours.
7	Remote Terminal Unit (RTU)	
	i.	Developer to provide proposed method of RTU communication to Veolia for approval. The developer is responsible for all costs associated with the provision of the SCADA communication.
	ii.	Developer is required to use the maintenance contractor for all changes required for the software configuration to Council's SCADA system and includes graphical interface, pump station reports and pump station generated alarms.
8	<u>Magflow meter</u>	
	i.	Isolating valve in the same or a separate concrete chamber downstream of the meter. <i>This valve allows isolation of the pressure main if the meter has to be removed, eliminating the requirement to drain the whole pressure main</i>
12	Water supply	
	i.	RPZ - Wilkins Double Check Valve assembly (Model 350) with DekoRRa 301-BG-C2 insulated backflow enclosure
	ii.	Inlet supply – 32mm Outlet – 25mm with female camlock connection and isolating valve
13	Public Toilets	
	i.	All new public toilet facilities with a pump station or septic tank must be connected to SCADA and comply with this Electrical and SCADA Standard.
	ii.	The following parameters should be monitored for new public toilets connected to SCADA: <ul style="list-style-type: none"> Well levels Pump status High/low warnings Any faults Loss of communications
	iii.	Spare capacity in the RTU should be provided for a flow meter to be installed in the future.



ELECTRICAL & SCADA STANDARD FOR WASTEWATER PUMP STATION SWITCHBOARD DESIGN & INSTALLATION IN THE QUEENSTOWN LAKES DISTRICT

Draft for Consultation 2022

ELECTRICAL & SCADA STANDARD

WASTEWATER PUMP STATION SWITCHBOARD DESIGN

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OVERVIEW

This Electrical & SCADA Standard for Submersible WWPS has been prepared for Queenstown Lakes District Council (QLDC) to provide for a consistent approach to QLDC submersible WWPS infrastructure through the enforcement by QLDC of a uniform standard.

The specification is prepared specific for Submersible WWPS [2 pump WWPS, external (non building housed) switchboard of <30 kW].

It is intended that:

- This Electrical & SCADA Standard: Submersible WWPS apply for all submersible WWPS of <30 kW within the Queenstown-Lakes District.
- This Electrical & SCADA Standard: Submersible WWPS form the basis for the preparation of tailored individual specifications for pump stations of $\geq 30\text{kW}$ within the Queenstown-Lakes District.

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APPENDICES

- APPENDIX A – Equipment Data Sheet
- APPENDIX B – RTU Standard I/O Configuration and Tag Naming
- APPENDIX C – Operations and Maintenance Manual Example
- APPENDIX D – WWPS commissioning test and check sheets
- APPENDIX E – Standard Electrical Drawings

DRAWINGS

- QLDC_WWPS_01 QLDC Pump Station Standardisation <30kw Soft Starter
- QLDC_WWPS_01 REG Electrical Drawings Register
- QLDC_WWPS_01 STD Standard Project Information
- QLDC_WWPS_01 BOM Equipment Schedule
- QLDC_WWPS_01 GA - General Arrangements
- QLDC_WWPS_01 LDL1 - Label Schedule
- QLDC_WWPS_01 01- Wiring Schematics

The enclosed Specification for the Design and Construction of Submersible Wastewater Pumping Station Switchboards up to 30 kW contains references to the following Australian and New Zealand Standards:

AS/NZS 60947.8: Low voltage switchgear and control gear - Protection of electric motors
- Built-in thermal detectors and associated control units

AS/NZS 1100: Technical drawing

AS 1101: Graphic symbols for general engineering

AS/NZS 1102: Graphical symbols for electrotechnical documentation

AS 1307.2: Surge arresters - Metal-oxide surge arresters without gaps for a.c. systems

AS 1319: Safety signs for the occupational environment

AS/NZS 1554.6: Structural steel welding - Welding stainless steels for structural purposes

AS 1627.1: Metal finishing - Preparation and pre-treatment of surfaces - Removal of oil, grease and related contamination

AS/NZS 2053.2: Conduits and fittings for electrical installations - Rigid plain conduits and fittings of insulating material

AS/NZS CISPR 11: Industrial, scientific and medical (ISM) radio frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement

AS 2184: Low voltage switchgear and controlgear - Moulded-case circuit-breakers for rated voltages up to and including 600 V a.c. and 250 V d.c.

AS/NZS: 61000.3.6 Electromagnetic compatibility (EMC) - Limits - Assessment of emission limits for distorting loads in MV and HV power systems

AS/NZS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules)

AS/NZS 3008.1.2: Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV - Typical New Zealand installation conditions

AS 3111: Approval and test specification - Miniature overcurrent circuit-breakers

AS 3112: Approval and test specification - Plugs and socket-outlets

AS/NZS 3133: Approval and test specification - Air-break switches

AS/NZS 3190: Approval and test specification - Residual current devices (current-operated earth-leakage devices)

AS/NZS 3439.1: Low-voltage switchgear and controlgear assemblies - Type-tested and partially type-tested assemblies

AS/NZS 61000.6.1: Electromagnetic compatibility (EMC) - Generic standards - Immunity for residential, commercial and light-industrial environments

AS/NZS 4383: Preparation of documents used in electrotechnology

AS/NZS 4792: Hot-dip galvanised (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialised process

AS/NZS 5000.1: Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 (1.2) kV

AS 5000.2: Electric cables - Polymeric insulated - For working voltages up to and including 450/750 V

AS/NZS 60044.1: Instrument transformer - Current transformers

- AS 60269.1:** Low-voltage fuses - General requirements
- AS 60269.2:** Low-voltage fuses - - Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
- AS 60269.4:** Low-voltage fuses - - Supplementary requirements for fuse-links for the protection of semiconductor devices
- AS 60417:** Graphical symbols for use on equipment
- AS/NZS 60529:** Degrees of protection provided by enclosures (IP Code)
- AS 60947.2:** Low-voltage switchgear and controlgear - Circuit-breakers
- AS 60947.4.1:** Low-voltage switchgear and controlgear - Contactors and motor-starters - Electromechanical contactors and motor-starters
- AS 60947.4.2:** Low-voltage switchgear and controlgear - Contactors and motor-starters - A.C. semiconductor motor controllers and starters
- AS 60947.5.1:** Low-voltage switchgear and controlgear - Control circuit devices and switching elements - Electromechanical control circuit devices
- AS 61800.3:** Adjustable speed electrical power drive systems - EMC requirements and specific test methods
- AS/NZS CISPR 11:** Industrial scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement
- AS IEC 61131.1:** Programmable controllers - General information
- AS IEC 61131.2:** Programmable controllers - Equipment requirements and tests
- AS IEC 61131.3:** Programmable controllers - Programming languages
- IEC 60073:** Basic and safety principles for man-machine interface, marking and identification - Coding principles for indicators and actuators
- AS 60204.1:** Safety of machinery—Electrical equipment of machines
- AS 4024:** Safeguarding of Machinery
- AE-5014:** Aurora Energy Network Connection Standards

1 SCOPE OF WORKS

Installation of switchboards designed for the purpose of providing submersible pump control need to meet numerous standards for vesting as future QLDC owned and operated facilities.

1.1 Key design parameters

As a minimum, the switchboard shall be designed to achieve the following;

- House all electrical components,
- Allow for space to accommodate larger switchgear should this be required in the future,
- Be safe for network operators to use without requirement of electrical qualification,
- Be positioned away from wells and other civil structures that might detrimentally affect operation and maintenance of the facility,
- Be built to withstand local environmental conditions together with the potential harm that may result from wastewater odours.
- Conform to this Electrical and SCADA standard.
- For QLDC sites be connected to the QLDC SCADA base station for system monitoring. This station is located at the Veolia Site office.
- For the Lake Hayes Scheme be connected to the SCADA base station for system monitoring. This station is located at the Fulton Hogan controlled, Lake Hayes Estate Treatment Station.
- Consideration of Temporary Traffic Management Requirements and compliance with the Code of Practice for Temporary Traffic Management.

1.2 Conformance to standards

Any electrical contractor engaged to design and install electrical switchgear at new or upgraded wastewater pump stations needs to ensure the above, high level design parameters are met whilst conforming to the following relevant standards;

- Pump station design to meet QLDC infrastructure code requirements,
- Electrical installation to meet all relevant industry and safety standards,
- All electrical work shall be performed in accordance with AS/NZS 3000 and the requirements of the supplier of electrical energy.
- Design and functionality to meet this Electrical and SCADA standard,
- Design approval by QLDC or their approved representatives.

1.3 Expected deliverables

Equipment to be supplied and installed by the Electrical Contractor shall include but not be limited to:

- (1) Civil works for switchboard footings.
- (2) Supervision over installation of conduits and ducting.

- (3) Supply of pumping station electrical cabinet, main switchboard and motor control.
- (4) Wet well level indications, controls and associated wiring.
- (5) Installation of mounting pole and floodlight.
- (6) Installation of telemetry hardware and RTU.
- (7) Liaise with Veolia to prepare SCADA alarms and pages

1.4 Provision of documents

The provision of documents associated with the deliverable of new pump station switchboards shall be determined by the requirements of the contract. This shall include, but not be limited to, the following;

- Component list / specification / asset description. This list shall be supplied in a format determined by QLDC for the purpose of populating their Asset Management Database.
- Functional control description for the purpose of understanding pump station control logic and functionality.
- User manuals, equipment manuals and operation manuals.
- Electrical drawings.
- Declaration of Conformity Statements
- Electrical Certificates of Compliance.
- Test certificates and commissioning documents.
- Programming software and print outs of control logic files.

1.5 Commissioning

Commissioning is the most important aspect of the contract. Electrical contractors are expected to liaise closely with QLDC 3 Waters Contractors Veolia (QLDC sites) and Fulton Hogan (Lake Hayes Sites) throughout this process.

A commissioning plan shall be developed together with check sheets that aim to test every functionality of the electrical and mechanical components installed.

Commissioning shall be witnessed by the appropriate QLDC staff and Veolia or Fulton Hogan representatives and signed off by them.

Commissioning checks completed on new wastewater facilities shall include functional testing on the following components;

- Pump performance
- Primary pump control
- Secondary pump control

- Well level measurement
- Flowmeter
- RTU communications and SCADA connectivity
- SCADA I/O checks

DRAFT

2 ELECTRICAL SUPPLY

2.1 General

The power supply shall be a 400/230 V ac, 50 Hz, 3 phase, 4 wire, earthed neutral electrical supply. Where possible, the pillar / plinth which houses the connection to the supplier of electrical energy shall be at pillar / pole top or transformer.

2.2 Electricity Metering

The supplier of electrical energy meters, CT's (if required) and other equipment shall be installed in a manner acceptable to the supplier of electrical energy.

The Electrical Contractor shall arrange with the supplier of electrical energy for the reuse of the existing or replacement of electrical meters as required.

The electrical contractor shall liaise with QLDCs energy retailer to request appropriate power metering at site. Depending on the anticipated power consumption of the facility, QLDC may request a pulse output off the power metering connected through to the RTU for remote monitoring of power use.

3 SWITCHBOARD DESIGN

3.1 Structural design

3.2 Concrete Footing

A concrete footing shall be installed except where ground conditions are deemed to be unstable by either the QLDC Chief Engineer or the Electrical Contractor, in which case an engineered design by an appropriately qualified civil engineer will need to be supplied.

The concrete footing dimensions shall be sized so that is larger in area than the footprint of the switchboard enclosure.

3.3 Plinth

Where the switchboard is floor-mounted, the switchboard shall be provided with a bolt-on, hot dip galvanised rolled steel or stainless steel channel plinth. The plinth shall be approximately 200 mm high and secured to the concrete footing using grade 316 stainless steel bolts and masonry anchors.

The plinth shall not be drilled except for enclosure and securing mounting holes.

Gasket

Where a plinth is required, a rubber gasket shall be installed between the plinth and the switchboard enclosure to ensure that moisture cannot be trapped between the surfaces. The gasket shall be 3mm thick, 3-ply insertion rubber reinforced with 2-ply canvas.

Bolts and fastening equipment

- Bolts used to secure switchboards or major items of equipment shall be in accordance with AS 1252 and have a bolting category of 8.8/S.
- All other bolts, nut, washers and fasteners shall be hot dipped galvanised or grade 316 stainless steel.
- All minor fastenings, saddles, screws, washers, nuts, metal threads etc. shall be grade 316 stainless steel.
- All stainless steel shall be insulated from other metals using plastic washers and spacers to ensure that no galvanic action and/or corrosion can take place.

Conduits

- Conduits shall be supplied and installed for cables in accordance with AS/NZS 3000, this clause and the drawings.
- The Electrical Contractor shall size conduits in accordance with AS/NZS 3000 for the number and size of cables to be installed within each conduit, but shall in no case be smaller in nominal size than 20 millimetre diameter.

- Electrical conduits and conduit fittings shall be medium duty rigid UPVC conduits and fittings in accordance with AS/NZS 2053.2.
- The Electrical Contractor shall install all conduits between the pumping station switchboard and the wetwell.
- The main conduits for the pump power and level control devices between the pumping station and the wetwell shall be 1x 100mm per pump and 1x50mm for instrumentation.
- Any underground bends or elbows installed should be swept long radius bends.
-
- Cap and individually gland the ducts from the sewer well to the cabinet to eliminate any fumes entering the cabinet

3.4 Switchboard specification

Design of the switchboard shall reflect the functionality required of the wastewater pump station.

The switchboard shall be designed with separate internal panels comprising the following critical hardware;

Switchgear

- Generator changeover switch or
- auto changeover switch if there is an on-site generator.
- If there is no on-site generator, an externally mounted generator plug is required for the purpose of connecting a mobile generator.
- External generator plug to be mounted in a lockable enclosure on the side of the switchboard.
- Generator plug should be designed to use with a portable generator of suitable size and application that can be used to run the pump station without the need for on site supervision from an operator ie the front doors of the external enclosure must be able to be closed and locked when a portable generator is connected to the switchboard.
- Generator plug to be IP54 rated.
- Sizing and specification of this socket shall be determined by rating of the pump motors and switchboard.
- Single phase likely to be a 3 pin 10 Amp socket with RCD protection
- 3 phase socket C Form 63A or C Form 125A plug.

Motor Control Centre

- Internal Switchboard Form 3A comprising individual compartments for the main incomer, tariff metering, local services, DB, level duty and telemetry controls, field terminations and pump starters (1 per starter)

- Live parts within an enclosure must be arranged to provide basic protection against direct or indirect contact.
- Soft starters or VSDs to run the pumps
- Pump motor isolators
- Power factor capacitors
- Phase rotation relays
- Under current / over current
- Over voltage / under voltage

Telemetry and SCADA hardware

- RTU to communicate to the SCADA base station
- 24V DC UPS for low voltage supply to critical control gear,
- Suitable communication aerial
- Telemetry panel to be located in the upper portion of the switchboard, close to eye level.

Metering

- Network metering to conform to local Power Supply Authority Standards.

Distribution

- Circuit breakers for local distribution
- This may or may not include the pump circuit breakers

Pump control hardware and instrumentation

- Pump controller
- Primary level control

Flowmeter

- Electromagnetic flowmeter transmitter or display unit
- Pressure monitoring (if any)

3.5 Switchboard and component rating

External enclosures should be rated to IP56.

The switchboard shall be designed and manufactured in accordance with the drawings QLDC_WWPS_01 provided with this Specification and the following:

- Components installed such as motor fuses holders, isolating switches, contactors and motor plugs and sockets etc. shall be sized to suit these ratings.
- The motor starters/VSDs, motor fuses and thermal overloads used for the pumps shall be sized to suit the pump ratings.
- All switching and control devices shall be secured in the switchboard using DIN rail mounting wherever possible.

Switchboard Enclosure

Where a switchboard is to be installed externally, or when required by the project specification for internal switchboards, a custom built metal enclosure shall be in accordance with the following:

- 1) Principal switchboard enclosure requirements indicated in Appendix A, or where no Principal switchboard enclosure requirements are indicated should be 2mm thick 304 stainless steel (316 stainless steel if enclosure is specifically located in, on or immediately around sewerage and is exposed to an aggressive atmosphere) to be resistant against UV and malodours generated from wastewater or other corrosive marine environments (e.g. marine) or where required by the project specification.
- 2) Front access shall be provided by hinged lockable doors. Opening the doors shall give access to a dead front panel on which controls and indications are mounted. Locks shall be in accordance with Section 3.4.1. Gas struts shall be used to assist door opening and being restrained.
- 3) Locking of the enclosure is by means of a stainless steel swing handle and roller rod assembly able to accommodate a standard QLDC water/waste water padlock.
- 4) Exterior sheetmetal shall have a minimum thickness of 2 mm. Large doors, or doors or panels with a large number of cut-outs, shall have additional thickness or shall have stiffeners added to ensure rigidity.
- 5) The top surface shall slope to prevent accumulation of water. The slope on single sided enclosures shall be such so as to direct water away from the front of the cubicle.
- 6) With doors and covers in position, provide a degree of protection in accordance with AS 1939 of not less than:
 - (a) IP56 if any component within the enclosure has an IP rating of less than IP5X or
 - (b) IP26 if all components within the enclosure have an IP rating of IP5X or greater.
- 7) Equipment which is installed within outdoor cubicles shall be protected against the effects of excessive temperature by either:
 - (a) The equipment being de-rated to accommodate the higher ambient temperatures which are to be expected within the cubicles or
 - (b) The cubicles being ventilated to ensure that the cubicle internal temperatures do not exceed the temperature ratings of the equipment

(any ventilation shall not decrease the IP rating of the enclosure) and/or the fitting of a metal sun shield of appropriate design allowing for orientation when installed.

- 8) Ground and floor mounted cubicles shall be provided with a bolt-on, painted hot-dip galvanised (to AS/NZS 4680) rolled steel channel or stainless steel plinth 200mm high.
- 9) Seismic restraints should be used to secure the switchboard to any adjacent wall.
- 10) Provided with an interior automatic LED lamp(s) and a switched socket outlet (with RCD protection), accessible when the front door is open.
- 11) Switchboards and control panels shall be provided with thermostatically controlled anti-condensation heaters in accordance with Section 3.6.9.
- 12) Internal switchboard to be powder coated of beige colour with exact colour specification required to be 'RAL 7035 Light Grey Ripple' colour in order to ensure maximum heat dissipation from radiant and/or solar heat. This does not apply to the external enclosure.
- 13) 304 SS exteriors shall be powder coated with exact colour specification to match Dulux Coloursteel "Desert Sand" with a TSR of 58% and LRV of 51% (unless 316 SS is used, then do not powder coat), with a minimum of one zinc shield base coat and one architectural polyester top coat to a thickness of 80 + or – 20 microns.
- 14) Stainless exteriors shall be roughed surface with a minimum of one 2 pack polyester etch primer and one architectural polyester top coat.

Displays and local lamp indication

All switches, controls, instrument displays and pump and level indicators used for the operation of the pump station shall be positioned on the switchboard such that there must be no direct or indirect contact with live conductive parts.

Stainless Steel Fabrication

Metalwork required to be manufactured from stainless steel shall be constructed in accordance with the following:

- (1) Manufactured from grade 304 stainless steel, unless where the enclosure is specifically located in, on or immediately around sewerage and is exposed to an aggressive atmosphere - 316 stainless steel is required.
- (2) Welding shall be in accordance with Table 4.5.1 or Table 4.5.2 of AS/NZS 1554.6 and the surface finish of welds shall be Grade II (a) or (c) in accordance with Table 6.2.1 of AS/NZS 1554.6.
- (3) Have a uniform texture on the external surface.

3.6 Ancillary extras

Door locks

Locking of cubicle doors, except for vandal resistant cubicles, shall be 3 point for all doors of height greater than 1000mm. Locks shall be cut with barrels allowing for QLDC contractor access. It should be noted that a different key is used to access Wanaka facilities from those in Queenstown.

Allowance shall be made for all internal doors to open at an angle of 90° when installed in the switchboard.

Padlocks are an acceptable method of securing external cabinet doors on electrical switchboards.

Mounting Pole for Antenna and Floodlight

The Electrical Contractor shall install a radio antenna on a mounting pole in accordance with drawing QLDC_WWPS_01

The mounting pole height shall be determined by the Telemetry Contractor and shall not be less than the height shown on drawing QLDC_WWPS_01

Mounting poles shall be manufactured from stainless steel in accordance with AS/NZS 4792.

Station Identification Signage

A station identification sign may be provided by the QLDC Chief Engineer. Where provided this shall be affixed to the switchboard enclosure by the Electrical Contractor in such a manner as to preserve the IP rating of the switchboard.

Electrical Danger Warning Sign

The Electrical Contractor shall supply and install a danger warning sign on the outside of one of the front doors of the switchboard enclosure. The danger warning sign shall be in accordance with AS 1319 and in particular clause 2.3.4 and shall be engraved "400 VOLTS" as per NZS 3000:2007.

Protection against shock

All electrical equipment installed within the pumping station switchboard shall be shrouded to IP 2X in accordance with AS/NZS 60529 to avoid accidental contact.

Electrical control equipment with an ingress protection rating less than IP 52 shall be mounted within metal enclosure(s) with an ingress protection rating of not less than IP 52 in accordance with AS/NZS 60529.

Service conditions

The equipment supplied shall be suitable and approved for operation in the following range of ambient conditions:

Maximum internal temperature	50°C
Minimum air temperature	-10°C

Equipment which is installed within the cubicle shall be protected against the effects of excessive temperature by either the equipment being de-rated to accommodate the higher ambient temperatures which are to be expected within the cubicles or the cubicles being ventilated to ensure that the cubicle internal temperatures do not exceed the temperature ratings of the equipment. Any ventilation shall not reduce the IP rating of the enclosure.

Forced ventilation or cooling

All cabinets exposed to direct sun should be shaded where possible or have a double skinned top / side.

Forced ventilation is only required when any Motor Control Centre (MCC) inside an electrical cabinet incorporates Variable Speed Drives (VSDs). The load banks inside VSDs result in the generation of additional heat output.

Cooling fans on both the internal enclosures and external cabinet are required in all instances when VSDs are mounted.

Electrical contractors are required to calculate the additional heat output resulting from VSD installations and ensure that this additional heat is dissipated and removed through installation of forced ventilation or cooling. No such cooling mechanisms are required where soft starters rated at $\leq 30\text{kW}$ are installed.

Cubicle Heaters

Cubicle heaters shall be in accordance with the following:

- (1) Black heat strip heaters rated at approximately 20 watts per square metre of cubicle surface area and suitable for operation at 230 volts.
- (2) Shall be of such a number and shall be installed so that heat from the heaters can readily circulate throughout the cubicles and that heat energy from the heaters will not damage materials or components adjacent to the heaters.
- (3) Provided with a thermostat which will energise the heaters when the air temperature inside the cubicle is below 20°C. The thermostat can be either built-in or separate and shall preferably be adjustable. On long panels additional thermostatically controlled heaters shall be supplied and installed, if required, to ensure adequate temperature control within the switchboard or control panel.
- (4) Heater and thermostat terminals shall be shrouded to eliminate the possibility of accidental personal contact.

Switchboard Light

An interior automatic LED lamp shall be provided to provide illumination in the switchboard enclosure when the front door is open. The light shall be installed in a location as shown on the electrical drawings QLDC_WWPS_01

4 CABLE SPECIFICATION

4.1 General

- Power, instrumentation and control cables shall be installed in accordance with this clause and AS/NZS 3000.
- The Electrical Contractor shall install all cables between the pumping station switchboard and the wetwell.

4.2 Cable Routes and Methods of Installation

- Unless specified otherwise, cable shall be installed underground in conduits with pits as specified.

4.3 Cable Pits

- Unless otherwise agreed or specified cable pits shall be provided for all underground cable runs where cables change direction and at intervals in straight runs so as to allow easy pulling of the cables.
- Cable pits shall be provided with drainage facilities.
- Cable pits in footpaths or where there is no vehicle traffic shall be provided with covers equivalent to Gatic light duty category.
- Cable pits located where there is vehicle traffic (or loading) shall be provided with covers equivalent to Gatic heavy duty category.

4.4 Cable Joints

- Intermediate joints in cables shall not be permitted.

4.5 Cable Handling

- Cables shall be handled carefully from cable drums or spools.
- Kinks shall not be allowed to develop during unwinding or during installation.
- Cables shall not be subjected to bending radii of less than twelve times the outside diameter of the cables or the manufacturer's recommended minimum radius (whichever is the greater) at any stage during installation of the cables.
- Care shall be taken during installation of cables that the insulation and/or sheathing of the cables is not cut, abraded or otherwise damaged.
- Any cables which are damaged during installation shall be repaired or replaced by the Electrical Contractor to the satisfaction of the QLDC Chief Engineer at the Electrical Contractor's expense.

4.6 Cable Termination

- Cables shall be terminated at the terminals provided in the switchboards and control panels and on the various items of equipment which are supplied and/or installed by the Electrical Contractor.
- Spare cores shall be terminated.
- Cables shall be supported as necessary at all points of termination to prevent undue mechanical strain on the terminations.

4.7 Instrumentation Cable Screens

- Screens of instrumentation cables shall be individually terminated at both ends at insulated terminals.
- The screen between the cable sheath and the terminal shall be insulated with heat shrink tubing.
- The cable screens shall then be earthed at the switchboard end only by looping an earthing conductor between terminals.

4.8 Labelling

- Individual cores of control or instrumentation cables shall be labelled with printed slip on type full circle ferrules.
- The core identification shall correspond with the wiring diagrams.
- Cables shall be identified at the ends by a corrosion resistant tag printed with the cable identification used on circuit diagrams.

4.9 Field Cables

Power Cables

- Power cables shall be in accordance with AS/NZS 5000.1 or 5000.2. Sheathed cables shall have a PVC sheath unless otherwise specified and shall be suitable for use underground.
- All cables shall be of multistrand construction with copper conductors.
- The minimum cross sectional area of any cable shall be 1.5 mm².
- The Electrical Contractor shall be responsible for selecting cable sizes in accordance with AS/NZS 3008.1.2.

Control Cables

- Control cables which are required to operate at low voltages shall be stranded PVC insulated PVC sheathed conductor cables manufactured in accordance with AS/NZS 5000.1 or 5000.2 and having a minimum conductor cross sectional area of 1.5 mm².
- Control cables which are required to operate at extra low voltage shall be rated for the voltages and currents which they have to carry.
- Conductor cross sectional area shall be not less than 0.5 mm².

- For cables which connect input contacts to the switchboard the conductors shall be coloured red or white (as applicable) for single core cables and red/white for two core cables.
- Red coloured cores shall be connected to the terminal nearest the supply or active and white cores shall be used for the switched wires.
- For cables which connect output devices the conductor insulation shall be coloured red or black (as applicable) for single core cables and red/black for two core cables.
- Red coloured cores shall be connected to the terminal nearest the supply or active.

Instrumentation Cables

- Instrumentation cables shall consist of either single pairs or multiple pairs with each pair being of twisted PVC insulated stranded copper conductors in either case.
- Each instrumentation cable shall have an overall screen with a stranded copper drain wire and PVC sheath.
- The conductors of each pair shall have a minimum conductor area of 0.5 mm².
- Multicore cables shall be provided with a number of spare pairs equal to not less than 25% of the total number of installed pairs rounded to the next higher whole number.
- All spare pairs shall be terminated in terminals.

Motor Cables

- Cables should be chosen and installed in accordance with best practice
- Shielded cables are to be used in combination with VSDs, unless otherwise approved by QLDC and supported by specific engineering justification.

5 INTERNAL WIRING

5.1 Type

- The Electrical Contractor shall be responsible for selecting cable sizes, in accordance with AS/NZS 3008.1.2.
- Wiring shall be insulated stranded copper conductor in accordance with AS/NZS 5000.1 or 5000.2. Insulation material selected to suit environment.
- The wiring shall be adequately sized to carry the current and the minimum conductor size shall be 0.5mm² except in the case of current transformer wiring which shall have a minimum size of 2.5mm².
- The ends of control wiring that terminate within the switchboard shall be fitted with bootlace ferrules and identification labels.

5.2 Colour Coding

The insulation of cables and wires shall be in accordance with AS/NZS 3000 and as follows:

- (1) Low voltage ac power circuits and CT wiring to be colour coded in accordance with the phase to which they are connected, i.e. RED, WHITE, BLUE with neutrals coloured BLACK.
- (2) Low voltage ac cables to be RED or WHITE or BLUE with BLACK neutral.
***Note:** Control supplies shall be derived from the white phase unless otherwise indicated.*
- (3) Extra low voltage dc circuits to be coded GREY (+) and PINK (-).
- (4) Extra low voltage ac circuits to be coded BROWN (phase) ORANGE (Neutral)
***Note:** For two wire dc systems a black wire shall be used for the "earthy" end of the supply, and a red or blue conductor used for the other end depending if the supply is positive or negative with respect to earth.*
- (5) Instrumentation loop wiring (4-20 mA, 1-5 V) to be coded GREY where not included within screened cables. Core colours within screened cables may be to the manufacturer's standard.
- (6) Earth cable to be GREEN/YELLOW.

5.3 Wiring Installation

Wiring of size 2.5mm² or less shall be run wherever possible in side slotted PVC ducts with snap on covers. Ducts shall be adequately sized to accommodate the wiring, including field wiring where applicable. Where ducting is impractical, wiring may be loomed using proprietary looming or sleeving.

5.4 Termination

Internal wiring shall terminate at relays, contactors, switches etc.

All other outgoing wiring shall terminate at rail mounted clip-on type terminal blocks.

All terminals shall be mounted within a PVC enclosure in the cabling cubicle and be adequately shrouded to prevent accidental contact.

5.5 Junction boxes

Junction boxes to be considered where either there is significant distance between the MCC and Wet well or on sites >30kW.

Above ground junction boxes shall be secure and lockable stainless steel cabinets and conform to relevant industry standards. The location of these junction boxes shall be between the switchboard and the wet well but shall not interfere with normal operations or introduce ergonomic or trip hazards.

6 MAJOR COMPONENTS

6.1 Motor Control Panel

The motor control panel shall be installed in the pumping station switchboard. The motor control panel shall be constructed of metal and have an ingress protection rating of not less than IP 52 in accordance with AS/NZS 60529.

The motor control panel is to have a mechanism that prevents access to the electrical wiring and components by unqualified personnel. This may be in the form of lockable handles, key locks, tool or other methods approved by the QLDC Chief Engineer.

The motor control panel shall house all controls for the pumping units. Operator control and indication equipment shall be located on the front panel of the motor control panel.

6.2 Remote Telemetry Unit

An RTU shall be installed in the pumping station switchboard by the Telemetry Contractor as shown on drawing QLDC_WWPS_01

The RTU shall be enclosed in a metal enclosure with an ingress protection rating of not less than IP 32 in accordance with AS/NZS 60529.

6.3 Earthing

Pumping station switchboard earthing shall be provided in accordance with AS/NZS 3000 and in particular the multiple earthed neutral (MEN) provisions of the rules. Any external earthing cables must be protected against mechanical damage.

6.4 Labelling

Controls and Indications

Controls and indications shall be labelled with titles provided in this Specification or, where these are not specified, titles which adequately and accurately describe the function of units.

The use of the manufacturer's standard escutcheon plates is permitted.

Purpose made labels shall be manufactured from engraved, laminated plastic which results in:

- (1) white lettering on a red background for warning labels and
- (2) black lettering on a white background for other labels.

The minimum lettering height for purpose made labels shall be 4mm.

Labels, other than manufacturer's standard escutcheon plates which shall be attached in accordance with the manufacturer's directions, shall be fixed to the surface by pins, screws.

Embossing tape shall not be used.

Contactors, Relays and Other Control Equipment

Contactors, relays and other components shall be labelled with the designation or label name used in the control circuits.

Labels shall be fixed by rivets, pins or screws.

Embossing tape shall not be used.

Terminals

Terminals shall be labelled with number corresponding to the control circuits and termination schedules.

Wiring

Wiring shall be labelled by means of slip on ferrules or heat shrink numbered to correspond with the control circuits. Jumper wires of less than 50 mm length and which are visible for their entire length need only be labelled once, but other wiring shall be labelled at each end.

6.5 Controls and Indications

General

Controls, indications and alarms shall be provided as required to operate the station.

Motor Protection

Motor thermal overload protection shall be provided as a minimum. Thermal overload protection shall be provided using a thermal overload relay or the soft starter/VSD inbuilt thermal protection. Where soft starter inbuilt thermal protection is used, the circuit shall be designed to ensure that the soft starter protection continues to monitor motor current when the soft starter is bypassed.

Control Voltages

Pump control circuits shall operate at 24 V dc, with the exception of the pump contactor coil circuits which where required to, may operate at 230 V ac.

Labelling

The following controls shall be provided and labelled (labels shown in upper case, colour shown in brackets) as a minimum:

- (1) PUMP 1 MODE SELECTOR, AUTO/OFF/MANUAL
- (2) PUMP 1 START
- (3) PUMP 1 STOP
- (4) PUMP 2 MODE SELECTOR, AUTO/OFF/MANUAL
- (5) PUMP 2 START

- (6) PUMP 2 STOP
- (7) DUTY SELECTOR, 1-2/2-1/ROTATION
- (8) PUMP STATION FAULT RESET (Black)
- (9) MODE SELECTOR AUTO CONTROL / RTU CONTROL

Indications

The following indications shall be provided and labelled (labels shown in upper case, colour shown in brackets) as a minimum:

- (1) PUMP 1 RUN (Green)
- (2) PUMP 2 RUN (Green)
- (3) PUMP 1 MOTOR FAULT (Red)
- (4) PUMP 2 MOTOR FAULT (Red)
- (5) PUMP 1 REMOTE LOCKOUT (Amber)
- (6) PUMP 2 REMOTE LOCKOUT (Amber)
- (7) PUMP 1 HOURS RUN
- (8) PUMP 2 HOURS RUN
- (9) PUMP 1 MOTOR CURRENT
- (10) PUMP 2 MOTOR CURRENT
- (11) SCADA (RTU) CONTROL ACTIVE (Blue)
- (12) WETWELL HIGH LEVEL (Red)
- (13) PUMP CONTROLLER FAULT (Red)
- (14) WETWELL LEVEL (%)
- (15) AC MAINS ON (White)

6.6 Control Circuits

Control Circuits shall be designed in accordance with the requirements of AS 60204.1 and AS 4024 and with this clause unless otherwise specified in the project Specification or shown on the Specification drawings.

Control circuits shall comply with the following:

- (1) Local control circuits shall operate at 24 V dc.
- (2) The following shall operate at 24 V dc:
 - a) Indicator lights.
 - b) Pushbuttons (with the possible exception of emergency stop pushbuttons).
 - c) Control and selector switches.

- d) Other control equipment on cubicle front panels and false mounting panels.
 - e) Control relays.
 - f) Control wiring external to the switchboards or control panel.
- (3) Alarm relays shall be energised in the non-alarm condition (failsafe).
- (4) Phase Fail Relay to provide indication only where motor protection is provided by a Variable Speed Drive or Soft Starter. Where pumps are Direct Online (DOL) then the Phase Fail Relay shall ensure that the function unit is stopped and latched out if a power supply failure is detected. A delay shall be incorporated to ensure that short power “flicks” of less than 10 seconds duration are not considered as a power failure. Automatic fault reset shall be provided on power restoration for common controls and all functional units.
- (5) Controls circuits shall be designed to ensure that all latched circuits are reset automatically and that items of equipment will be available to run without the need for manual resetting following a power failure.
- (6) Control circuits and/or PLC programming shall be designed to ensure that starting of the first duty functional unit is delayed for an adjustable period of time after power is restored following a power supply failure (as detected by the phase failure and under voltage relay).
- (7) Control circuits shall be designed to ensure that all faults are reset using a local FAULT RESET pushbutton. This local reset shall operate independently of any PLC installed and continue to operate if any PLC fails.
- (8) Fault circuits shall be designed to ensure that items of equipment or functional unit alarms (once detected) remain active in the control system (following a fault sensing device reset) until the alarm is reset using the local FAULT RESET pushbutton or a remote fault reset function (when provided). This control system reset shall only be possible following resetting of the fault sensing device.
- (9) Control circuits and switchboards shall be designed to ensure that manual resetting of all fault sensing devices (e.g. thermal overload, Soft Starter, VFD etc.) shall be possible from the front panel of (and external to) the switchboard (or false mounting panels where controls and indications are installed on the false mounting panel). This requirement does not apply to short circuit protective devices (i.e. circuit breakers) that are not providing motor overload protection (i.e. TOL protection).
- (10) Control circuits for functional unit (e.g. a pump) shall be designed to ensure that RUN and FAULT (as a minimum) indicator lamps continue to operate when the functional unit has MANUAL mode selected and when any PLC installed fails. This requirement shall include functional units operated by variable speed drives (VFD's) where the functional unit has MANUAL or OFF selected and is operated directly from the VFD (or the VFD control panel).

- (11) Pump protection faults (e.g. No Flow) shall be latched and time delayed and shall continue to provide protection when the pump is operating in all modes (e.g. MANUAL mode).
- (12) All functional unit faults detected shall activate the functional unit local and remote (e.g. SCADA and telemetry) fault indication signals.

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7 INSTALLATION REQUIREMENTS OF ELECTRICAL COMPONENTS

7.1 Ratings

Where current and/or voltage ratings for components are specified and/or shown on the specification drawings, components shall have ratings not less than those specified or shown.

Where current and/or voltage ratings are not specified or shown then components shall have current and voltage ratings adequate for the duty which they are to perform.

When determining the ratings allowance shall be made for:

- (1) frequency of usage,
- (2) making and breaking currents,
- (3) power factor (where applicable),
- (4) prospective fault current and
- (5) ambient temperatures which will occur at the point of installation.

7.2 Degree of Protection

The degree of protection of components which are mounted on the outside of switchboards or control panels shall be suitable for the location and application and shall not be less than that of the switchboards or control panels.

The degree of protection for electrical equipment installed within the switchboard shall provide a degree of protection of not less than IP2X in accordance with AS/NZS 60529.

7.3 Circuit Breakers

All circuit breakers installed shall be selected to ensure that they discriminate with, and operate prior to, the supplier of electrical energy fuses upon occurrence of a fault. Circuit breakers installed to protect pump motor circuits shall be selected in accordance with the manufacturer's requirements to meet this specification.

Discrimination

Where circuit breakers are installed in series, discrimination shall be provided for tripping currents up to the maximum prospective fault current for the installation.

Moulded Case Circuit Breakers

Moulded case circuit breakers shall be in accordance with either AS 2184 or AS 60947.2 and the following:

- (1) Three pole.
- (2) Suitable for 400 volt 3 phase 50 Hz operation.
- (3) Quick make manual closing.
- (4) Quick break manual opening.
- (5) Trip free.
- (6) Automatic opening on overcurrent and short circuit.

- (7) Provided with mechanical status indication, i.e. open, closed and fault.
- (8) Lockable in the open position.
- (9) Provided with safety interlocks to prevent the compartment door from being opened with the breaker in the closed position and to prevent the breaker from being closed with the compartment door opened.
- (10) Suitable for uninterrupted duty.
- (11) Rated for the full load current of the circuit.
- (12) Have a rated short circuit making capacity not less than the prospective short circuit current of the supply.
- (13) Have a rated service short circuit breaking capacity not less than the prospective short circuit current of the supply.
- (14) Provided with instantaneous tripping.
- (15) Provided with inverse time delay tripping.

Miniature Circuit Breakers

Single pole and multi-pole miniature circuit breakers shall be in accordance with AS 3111 and the following:

- (1) Shall have a current interrupting capacity suitable for the prospective fault current and not less than 6 kA symmetrical.
- (2) 3 single-pole breakers shall be replaceable by 1 three-pole breaker and vice versa.
- (3) Any miniature circuit breaker which is used to isolate its associated electric motor shall, in addition, be provided with facilities to padlock the switch in the OPEN or OFF position.

Surge Protection

Surge Arrestors to be fitted and have discharge current of 20kVa.

7.4 Residual Current Devices

Residual current devices shall:

- (1) Be in accordance with AS 3190.
- (2) Be type II devices in accordance with AS 3190.
- (3) Be combined miniature circuit breaker/residual current devices in accordance with the requirements of the miniature circuit breaker requirements of this specification.

Residual current devices shall be tested before being placed into service to ensure that:

- (1) the tripping current is set to the appropriate value; and
- (2) the unit trips in less than 30 milliseconds at a test current of 10 mA.

7.5 Isolating Switches

Isolating switches must be provided for all electric motors. These shall be in accordance with AS/NZS 3133. Any switch which is used to directly isolate its associated electric motor by switching the phase conductors shall be a motor control switch as defined in the Standard and shall, in addition, be provided with facilities to padlock the switch in the OPEN or OFF position.

All single phase isolating switches which are rated at 20 A and above and all multiphase isolating switches shall include a positive indication, which shall include the words 'ON' and 'OFF', of the position of the switch.

7.6 Composite Fuse Switch Units

Composite Fuse Switch (CFS) units shall be in accordance with the air break switch requirement of this specification and the following:

- (1) Accommodate HRC fuses.
- (2) Triple pole units.
- (3) Individual contacts separately and fully shrouded.
- (4) Barriers included between fuse cartridges to reduce the possibility of a phase to phase or phase to earth fault occurring.
- (5) Shrouds, barriers and the complete moving contact assembly shall be removable from the CFS enclosure for maintenance purposes.
- (6) Provided with facilities to padlock the unit in the OPEN or OFF position.
- (7) Provided with safety interlocks to prevent the compartment door from being opened with the CFS unit in the closed position and to prevent the CFS unit from being closed with the compartment door opened.

7.7 Low-Voltage Fuses

Low voltage fuses shall be in accordance with the general requirements of AS 60269.1, applicable requirements of AS 60269.2 and AS 60269.4 and the following:

- (1) Suitable for use on a 400/230V 50 Hz supply.
- (2) Fuse links shall:
 - (a) have a rated breaking capacity of not less than 50 kA at 400 volts 50 Hz or the prospective fault level at the point of installation whichever is higher and
 - (b) be of the 'gG' or 'gM' type unless otherwise approved by the QLDC Chief Engineer.
- (3) Fuse holders shall:
 - (a) have a rated current and a rated power acceptance suitable for the fuse links and

- (b) have a protection rating of not less than IP2X in accordance with AS/NZS 60529 with the fuse carriers removed.
- (4) Labels shall be fitted on, or immediately adjacent to, each fuse base or each 3 phase set of bases to identify the function and designation of the fuses and to specify the current ratings of the fuse links.

7.8 Meters

General

Where amps and voltages are not displayed on VSD or soft starter display panels, ammeters and voltmeters shall be provided. They shall be square bezel pattern, nominal size 96 mm with an approximate 240° movement. A multi-function meter may be used in place of individual voltmeter, ammeter, kilowatt meter etc. to measure and display the required parameters in a single unit.

Ammeters

Ammeters shall be in accordance with the following:

- (1) Provided with a selector switch to allow selection of individual phase currents. An OFF position shall be provided.
- (2) Accuracy of $\pm 2.5\%$ or better.
- (3) Scaled to correspond to the rated primary current.
- (4) Where used for measuring motor current, be overscaled to approximately 6 times the rated current of the associated motor. Full load current shall occur between 60% and 90% of full scale.
- (5) Where used for other than measuring motor current, be overscaled to approximately two times the rated current of the circuit.

Voltmeters

Voltmeters shall be in accordance with the following:

- (1) Provided with a voltmeter selector switch and potential fuses to allow selection of individual phase to phase voltages. No OFF position shall be provided.
- (2) Accuracy of $\pm 2.5\%$ or better.
- (3) Scaled to read between 0 and 500 volts.

Multi-function Meters

Multi-function meters shall be in accordance with the following:

- (1) Measure and display voltage, current and power in a single integral unit at not less than $\pm 1\%$ accuracy.

Additional parameters (energy, power factor, individual and total harmonic distortions etc.) shall be included as required by the project specification and/or drawings. The display shall be retained during power failure where used for energy measurement.

- (2) Panel mounting.
- (3) Suitable for monitoring a 3 phase unbalanced supply and load.
- (4) Operation from a 230 V ac auxiliary supply.
- (5) Provided with the following remote interfaces where required by the project specification:
 - (a) Digital and analogue inputs/outputs programmable to represent the selected parameters.
 - (b) RS-485 serial port with industry standard Ethernet protocol.

Hours Run Meters

Hours run meters shall be synchronous motor driven units with a display capable of registering not less than 999999 hours and shall be non-resettable.

Current Transformers

Metering Current Transformers

Metering current transformers shall be in accordance with AS 60044.1 and the following:

- (1) Accuracy not lower than Class 0.2 or, where used with test sockets, kW meters, kWh meters or multi-function meters, not lower than Class 1M or higher as required by the project specification.
- (2) Rated secondary current of 5 A.
- (3) Rated burden sufficient to cover the burden imposed by the connected equipment including cables. Where a test socket is required, an additional burden of 5 VA shall be allowed for external equipment which may be plugged into the socket.

Protection Current Transformers

Protection current transformers shall be in accordance with AS 60044.1 and the following:

- (1) Designated as 10P150F20 unless otherwise specified or required to suit the protection relay.
- (2) Rated secondary current of preferably 1A.
- (3) Transformer ratio shall be determined for correct operation of the associated relay under fault condition taking into consideration the rated accuracy limit factor of the transformer and the burden of the connected circuit.
- (4) Provided with test taps where required to be used in conjunction with a test socket.

7.9 Control Relays

All control, interposing, latching and auxiliary relays shall be in accordance with AS 60947.5.1 and the following:

- (1) If there is no control circuit or the voltage is not specified, then 24 V dc shall be used unless otherwise agreed by the QLDC Chief Engineer.
- (2) Contacts shall be suitable for the type of duty required and shall have a current rating adequate for the load and, in any case, not less than 1 A.
- (3) Plug in relays shall be provided with an LED status indicator.

If relays are of the plug-in type and mixed extra-low and low voltages are used within the relays, then all relays which have mixed voltages shall have a Certificate of Suitability from a recognised Statutory Authority for mixed voltage application. Such relays shall not be physically interchangeable with other plug-in relays within the system.

7.10 Timing Relays

Timing relays shall be in accordance with the following:

- (1) Electronic type with an adjustable range.
- (2) Suitable for operation on the voltage shown on the control circuit drawings or specified in the project specification. If there is no control circuit or the voltage is not specified, then 24 V dc shall be used unless otherwise agreed by the QLDC Chief Engineer.
- (3) Contacts shall be suitable for the type of duty required and shall have a current rating adequate for the load and, in any case, not less than 1 A.
- (4) Accuracy Class 1.5 or better.

7.11 Equipment Electronic Relays

Any electronic relays that are installed to control individual items of equipment (e.g. a pump) shall comply with the following:

- (1) Have a minimum of 20% spare inputs and outputs installed.
- (2) Be of the Make and Model specified in Appendix A, unless otherwise approved by the QLDC Chief Engineer.
- (3) Operate from 24 V dc.
- (4) A copy of all manuals including a disk copy of the program shall be provided.
- (5) A copy of any programming software unless the software is the same as that used for programming the main control PLC.
- (6) All hardware connectors necessary to allow for connection of a personal or laptop computer to the relay for making program changes shall be provided.

Float Switches

Float switches shall be of the make and model specified in Appendix A and shall contain both normally open and normally closed contacts.

Undervoltage and Phase Imbalance Relays

The relay shall be a combined phase imbalance and undervoltage type with a contact opening for the following:

- (1) Voltage below 80% of nominal 400 V ac.
- (2) Phase imbalance greater than value set. This value shall be adjustable from 5-15% and initially set at 10%.

Control Switching Devices and Indicator Lights

Pushbuttons, rotary switches and indicator lights shall be in accordance with AS 60947.5.1.

Indicator lights shall be high intensity LED type.

The colours of pushbuttons and indicator lights shall be in accordance with those defined in the project specification, this specification, or if not specified, in accordance with IEC 60073.

8 PUMP MOTOR CONTROL

8.1 Motor control mode

The mode and method of pump motor control shall be determined by the contract specification.

For small wastewater pump stations where this electrical and SCADA standard applies, soft starters are the preferential method of motor control. This assumes that the pumps shall only be required to run at full speed.

8.2 Motor Starting

Direct on line (DOL) starting may be used where allowed by the supplier of electrical energy if approved by the QLDC Chief Engineer. Soft starters/VSDs of the make and model specified in Appendix A and installed to manufacture recommendations shall be used for motor starting where the direct on line starting current exceeds the limitation on starting current set by the supplier of electrical energy. The use of VSDs over soft starters shall be approved by the Principal.

8.3 Motor Contactors

Motor contactors shall be in accordance with the following:

- (1) 3-pole or where necessary 4-pole, air break, electromechanical type in accordance with AS 60947.4.1.
- (2) Provided with Type 2 co-ordination with short-circuit protective devices in accordance with AS 60947.4.1.
- (3) Utilisation category AC-3 and intermittent duty not less than Class 12 as defined in AS 60947.4.1, or a higher category and/or duty class to suit the specified operation requirements if required.
- (4) A mechanical endurance of not less than 1 million operating cycles.
- (5) Operating coils shall operate at 230 volts 50 Hz single phase.

8.4 Soft Starters

Soft starters shall be ac semiconductor type in accordance with AS 60947.4.2 and the following:

- (1) Be of the make and model specified in Appendix A.
- (2) Electronic starters are to be installed as per the manufactures recommendations.
- (3) Provided with a bypass contactor to minimize energy loss and/or heat generation during operation unless otherwise agreed by the QLDC Chief Engineer.

- (4) Be designed and constructed to operate satisfactorily with an emergency stop contactor installed between the starter and the motor. This requirement shall apply at all motor loads up to and including the full load rating of the soft starter.

8.5 Variable Speed Drives

The switchboard design, electrical drawings and line diagrams developed as part of this standard is intended to cover for electrical installations and MCC specification where submersible pump motors are controlled on soft start rather than variable speed drive.

Should the contract specification or principal to the contract identify a requirement for VSD controlled pumps, installation of VSDs should, at minimum, conform to the requirements below;

- (1) Shall be of the make and model specified in Appendix A.
- (2) Electronic starters are to be installed as per the manufactures recommendations.
- (3) C-tick compliant with harmonic and RFI filters incorporating input ac chokes if necessary to comply with the limits of electromagnetic and harmonic disturbances in accordance with AS/NZS CISPR 11, be rated and suitable for use in the first environment in accordance with AS 61800.3 and meet with the requirements of the supplier of electrical energy.
- (4) Electromagnetic immunity in accordance with AS/NZS 4252.1.
- (5) Capable of sustaining not less than 110% rated output current for a minimum of 1 minute.
- (6) Motor cables and wiring shall be in accordance with the variable frequency drive supplier's recommendations. Such requirements shall include the cable type and installation method to satisfy the radio frequency interference and other requirements specified in this Specification.
- (7) Harmonic mitigation shall be provided in accordance with network requirements.
- (8) Output filters shall be provided to ensure motor maximum voltages are not exceeded.

8.6 Motor Protection Units

Thermal Overload Units

Thermal overload units shall be in accordance with AS 60947.4.1 and the following:

- (1) Triple pole, differential action to enhance the performance of protection against phase imbalance or phase failure.
- (2) Incorporate ambient temperature compensation.
- (3) Include a provision to allow the trip setting to be adjusted.

- (4) Suitable for alternative manual or automatic reset and initially selected to automatic reset if the control circuit has a separate RESET pushbutton.

Electronic Motor Protection Relays

Electronic motor protection relays shall be provided for the protection of motors rated at 15 kW and above and a soft starter or VFD is not fitted. The protection relays shall be in accordance with the following:

- (1) Provide protection and separate indication for each of the following:
 - (a) Overload
 - (b) Winding overtemperature by means of thermistors
 - (c) Single phasing and asymmetry.
- (2) Have selectable current and trip time settings.
- (3) Have a test feature.
- (4) Suitable for operation from a 230 V ac supply.
- (5) Provide finger protection for the terminals (IP 2X) other than the main connections.
- (6) Unaffected by the passage of short circuit currents through the unit.

Directly connected units (i.e. without the need for external current transformers) are preferred.

Thermistor Control Units

Thermistor control units shall be used to monitor the operation of thermistors built into motors unless the thermistors are monitored by an electronic motor protection relay.

The control units shall be in accordance with AS 1023.1 and the following:

- (1) Suitable for a 230 V ac supply voltage.
- (2) Provide a visual indication that a trip has occurred.
- (3) Match the type of thermistor, i.e. positive or negative coefficient type.

9 PUMP CONTROL SYSTEM

9.1 Pump configuration

The configuration of the pumps shall be determined at the design stage. This can be one of two configurations;

- (1) Duty / standby. This set up will work to run only one pump at any one time. This may be as a result of constraints to power supply and / or hydraulic conditions. This set up will work to run a standby pump when the standby pump start level is reached. This will be as a result of duty pump failure and/or high inflow conditions. Under this configuration the duty pump has to stop running prior to standby start.
- (2) Duty / assist. This set up will work to run an assist pump when the assist pump start level is reached. This may be as a result of duty pump failure and/or high inflow conditions. Under this configuration the assist pump can run together with the duty pump.

9.2 Duty rotation

The pump controller shall be programmed to rotate duty pump after each pump cycle. This is to ensure all pumps are regularly run.

Where this function is not a feature of the controller, a duty selector switch shall be installed and shall be labelled 1-2, 2-1.

When 1-2 is selected, pump 1 shall be the duty pump and operate from the duty 1 start and stop levels.

When 2-1 is selected, pump 2 shall be the duty pump and operate from the duty 1 start and stop levels.

The initial setting for the duty start and stop level setpoints shall be determined by the design.

9.3 Pump mode control

A mode selector switch shall be provided for each pump. The mode selector shall have an AUTO, OFF and MANUAL position.

- When pump 1 mode selector has MANUAL selected, pump 1 shall start. irrespective of the wetwell level or SCADA control systems.
- When pump 1 mode selector has AUTO selected, pump 1 shall operate off the primary level measurement device and pump controller.
- When pump 1 mode selector has OFF selected pump 1 shall not run.
- Control for the pump 2 mode selector shall be similar to that of pump 1.

- The operation of pumps when in MANUAL mode shall be independent of any electronic device(s) or common control components other than motor protection. and shall not be connected to such device(s) (e.g. manual running shall be possible during complete failure of the primary level measurement device and pump controller or SCADA system).

9.4 Pump control systems

Pumps shall start and stop depending on the sewage level in the wetwell as determined by set points programmed in the pump controller.

The pumping station shall be controlled by two independent pump control systems as follows;

- (1) Primary pump control (operating off a pump controller and wet well level measurement device),
- (2) Secondary pump control system (operating off 2nd wet well level device and RTU.).

Remote pump starting and stopping shall also be provided from the SCADA system using Control Outputs off the RTU.

Design of wastewater pump stations in this manner allows for a good level of redundancy should one of these pump control systems fail.

Primary pump control

The primary level measurement device and pump controller shall operate when the mode selector has AUTO selected.

Pump start and stop points shall be programmed into the pump controller and labelled as follows:

- (1) START DUTY PUMP
- (2) STOP DUTY PUMP
- (3) START STANDBY PUMP
- (4) STOP STANDBY PUMP

All of the above level setpoints shall represent wetwell level and shall be adjustable between 5% and 95% of wetwell level in 1% increments. All level settings shall be programmed in the pump controller and remain operator adjustable.

- The duty pump shall start when the sewage level increases to the START DUTY level and stop when the level falls to the STOP DUTY level.
- The standby pump will start when the sewage level increases to the START STANDBY level and stop when the level falls to the STOP STANDBY level.

Secondary pump control

The secondary pump control system shall operate from a 2nd wet well measurement device via the RTU. The control circuit shall be wired completely independently from the primary control system in order to provide a fully redundant pump control function.

This secondary pump control system is required to work when any component of the primary control system fails. The functional control of this secondary pump control system is required to achieve the following;

- Automatic switch over of duty / standby and assist pump control functions without intervention of operators,
- Secondary pump start set point configured to be higher than primary control duty start setpoint,
- Pump run signals to be communicated through to the RTU from the motor starter.
- SCADA alarm output to notify operators of the failure of primary pump control system.

Design of the secondary pump control system shall align with the pump configuration when in primary control mode.

RTU Control

Basic automated control of the pumps can also be achieved through pump control programmes downloaded to the RTU at site. The use of these programmes must be agreed by the QLDC Chief Engineer. The programmes shall be supplied by QLDC's SCADA system administrators.

This method of pump control differs from the primary and secondary control systems in that it requires manual selection by the operator on site via a control switch.

It is a useful mechanism for running the pump station in automatic control when the pump controller has failed but the level measurement device remains operational.

RTU control switch

In order to facilitate this feature, a push button between Local and RTU control is required to be installed. The push button is to be wired to a Digital Input on the RTU. This switch shall be labelled Level Control / Local - RTU

Activation of this switch to RTU control enables the following;

- Disengage of primary pump control system,
- Activation of RTU control outputs.
- Automated pump running off set points programmed into RTU.
- Remote manual control of pumps via the SCADA system (this should only be possible when the local pump control mode switches are in AUTO).

The pump run signal from the SCADA system shall operate the pump when the pump mode selector for that pump is in the AUTO position but shall not operate the pump if the pump mode selector is in the MANUAL or OFF position.

9.5 Remote fault resetting

High / low level resets

High and low level fault conditions shall be able to be reset manually or via the SCADA system. Floats will be an indication of level only and not provide any control over the pumps.

A pulse signal from the SCADA system shall be initiated from the base station which when activated will reset the pump station fault. This is a useful mechanism when the high and low level faults activate as a result of a level condition which clears itself.

10 PROGRAMMABLE LOGIC CONTROLLERS

Proprietary “off the shelf” controllers are preferred. A PLC should only be used where a proprietary controller is not suitable.

10.1 Specification

- (1) Shall be of the Make and Model specified in Appendix A unless otherwise approved by the QLDC Chief Engineer.
- (2) Ethernet link shall preferably be used for inter-PLC communications and for communications with a host SCADA system where applicable. Any PLC connected to a SCADA system shall be fitted with one (1) dedicated communication port for that purpose.
- (3) An electronic copy of PLC ladder program shall be supplied unless agreed by the QLDC Chief Engineer.
- (4) A copy of PLC manuals shall be supplied unless agreed by the QLDC Chief Engineer.

10.2 PLC Programming

The Contractor shall be responsible for programming the PLC.

The contractor should ensure all key parameters and set points may be operator adjustable by the operation and maintenance contractor to allow for adjustment in operational efficiency.

The contractor is advised to communicate the control philosophy of the pump station to the operation and maintenance contractor at the earliest opportunity in order that submersible pump operation is consistent with other pump stations across the Queenstown Lakes district.

At the conclusion of the project the contractor shall supply to QLDC a licensed copy of any software packages required to modify PLC programming. QLDC have copies of the following software and as such copies of the following are not required:

- RSLogix 500 8.40.00 (CPR9)
- RSLogix 5000 20.01.00(CPR9 SR5)
- Control Expert v14.1 - Small (S)

10.3 PID control

PLC control loops employing PID control shall be designed and programmed to ensure that the analogue PLC process variable output signal (i.e. pump speed control signal) is set equal to zero % and the PID calculations cease when the controlled device is not running (i.e. pump is stopped). The process variable signal shall commence calculations using signals that are present when the controlled device commences operation (i.e. “anti-reset windup” shall be programmed into the PLC). Such programming and calculations shall ensure that the process variable does not drive to full scale 100% when the controlled device is started.

When telemetry analogue output signals are used as inputs to the control system for setpoints or control setting, PLC programming shall be designed to ensure that only valid signals are accepted by the PLC. This shall be achieved using time based validation of input signals. The validation shall check input values at regular time intervals (expected to be in the order of 2-10 seconds) and accept the most recent valid value as the control variable. Time validation shall not be used on control signals that are used as feedback in PID control loops. If an invalid setpoint or control signal (e.g. signal < 4 mA or > 20 mA) is detected by the control PLC, the previous value of that signal shall continue to be used by the control system until the next different valid control signal is detected.

If PLC programmes are protected by password, then that password shall be noted in the site documentation and be recorded at the SCADA base station.

10.4 HMI Touchscreen

Any touchscreen installed shall be in accordance with the following:

- (1) Shall be of the Make and Model specified in Appendix A unless otherwise approved by the QLDC Chief Engineer.
- (2) All parameters above shall be easily viewable and adjustable from the front of the touchscreen.
- (3) The Touchscreen shall communicate directly to the main control PLC.
- (4) The touchscreen shall be provided with two levels of security access coding to restrict access to authorised personnel only. Level one shall be for all liquid level and flow setpoints and level two shall be for PID control parameters and PLC time delay settings in addition to flow and level setpoints. No security shall be required for viewing operational parameters and status information.
- (5) The touchscreen shall be colour with a minimum screen size of 140 mm.
- (6) The Contractor shall program the touchscreen and provide an electronic copy of the final program to the Principal.
- (7) The Contractor shall design the touchscreen screen displays. All such screen displays shall be approved by the QLDC Chief Engineer.
- (8) Draft versions of HMI screens are to be sent for peer review.

Any touchscreen installed shall be mounted in the common control cubicle of the switchboard.

The following information shall be displayed on the touchscreen as a minimum:

- (1) The current duty selection status for each item of equipment.
- (2) Operational status (e.g. run/stop, open/close) for each item of equipment.
- (3) Status of all alarms installed for each item of equipment.
- (4) Other operation parameters for each item of equipment.

- (5) The duty setpoints for each item of equipment.

The touchscreen shall be used to interface and display the following PLC parameters:

- (1) All level and flow operational values.
- (2) Alarm setpoints.
- (3) Control parameters.
- (4) PID control parameters for all control systems.

Touch Screen to conform to following colours

Red – Fault

Yellow – Manual/Unavailable

White – Running

Green – Available

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11 PUMP CONTROL HARDWARE

11.1 Pump controller

Approved pump controllers presently in use across the Queenstown Lakes District include the following devices;

- Siemens MultiRanger 200 (MR200) pump controller,
- MultiTrode MultiSmart pump controller.
- PLC type as specified in Appendix A.

Secondary pump control systems are a compulsory requirement of all pump station designs.

The pump controller shall provide for a 4-20 mA DC wetwell level input signal, a relay output with changeover contacts for Duty 1 pump run, Duty 2 pump run and level transducer fault.

If the pump controller is programmable, then the Electrical Contractor shall supply a device programmer or appropriate PC software and hardware to program the device.

QLDC have copies of the following software and as such copies of the following are not required:

- RSLogix 500 8.40.00 (CPR9)
- RSLogix 5000 20.01.00(CPR9 SR5)
- Control Expert v14.1 - Small (S)

11.2 Level measurement

Level measurement at QLDC wastewater pump stations is to be undertaken through use of a hydrostatic level transducer. They shall be suitable for use in wastewater and installed to manufactures recommendations.

The transducers shall be configured into any pump control module on site and also be connected to the RTU for remote monitoring via SCADA.

Primary level measurement requires a method of returning an analogue level well level % back to the SCADA independent of the output from the pump controller. This is to ensure remote monitoring of well level can be observed where the pump controller is not operational.

11.3 Installation

The level sensor shall be mounted in accordance with the manufacturer's instructions. Hydrostatic level transducers need to be installed in stilling tubes mounted inside the pump station.

The purpose of the stilling tube is to protect the sensor. The stilling tube shall be made of PVC or stainless steel in order that it is suitable for use in wastewater. It shall be hydraulically linked to the well level in order that sensor measurement accurately reflects well level.

The stilling tube shall be attached to a side wall of the wet well and allow for easy access for operators to remove and clean the transducer inside. All mounting brackets, bolts, nuts and washers shall be manufactured from grade 316 stainless steel.

The level sensor shall be located such that the level sensor and mounting equipment shall not interfere or foul with the pumps during their removal and reinstatement in the wetwell or with the normal removal of any safety grid installed in the wetwell.

- The wetwell level sensor shall be hard wired to the pumping station switchboard.
- Power for all level sensors shall be provided from the switchboard.
- All cables shall be in accordance with this Specification.
- If the level sensor is a non contact type then the level sensor shall be located such that the beam does not detect pumps, pipes and other obstacles in the wetwell.
- Electrical installation of this instrument requires the analogue input signal to be split between RTU and pump controller.
- This is to be achieved using a signal isolator in order that each of these circuits remain separate from each other.

11.4 Level display

A local level display of well level (%) shall be mounted on the control panel of the switchboard in order that operators are able to determine the level of liquid in the pump station without the need to dial into the SCADA system.

11.5 Scaling

Configuration of the level measurement device to the pump controller is required as part of local pump control commissioning. The span of the level measurement (metres) is a critical value and allows QLDC and the maintenance contractor to correlate liquid level with volume for the purpose of engineering design and performance.

- The span of the level transducer should reflect the depth of the wet well from a point above the invert level to the emergency storage chamber to the bottom of the wet well. This is to ensure that any overflow to the emergency storage chamber is captured via the level measurement device.

- The electrical contractor shall supply this value to the maintenance contractor during the commissioning phase.

11.6 Operation

- The hydrostatic level transducer shall operate from a DC battery-backed supply so that it continues to operate and provide a wetwell level signal to the telemetry system during times of power failure.
- The level transducer shall be capable of measuring level over the whole height of the wetwell in which it is installed.
- Where the level transducer 4-20 mA signal has a fixed range, that range should be chosen to correspond as closely as possible to the actual wetwell full level.
- The 4-20 mA signal shall be calibrated such that 4 mA is the wetwell empty level and 20 mA corresponds to overflow level.
- If the level sensor is a non-contact type then the unit shall have in built temperature compensation and be suitable for the conditions inside the wetwell.
- The unit shall have an ingress protection rating of not less than IP 65 in accordance with AS/NZS 60529.

12 BACK UP FLOATS AND PROBES

Back up float switches and/or level probes have an important role to play in the signalling of critical pump station levels to the operator. These are generally set up in order that low level and high level alarms are generated when the liquid of sewage reaches certain levels in the main wet well.

Back up float signals are required to be connected through to the RTU for SCADA alarming. Any high or low level float switches installed need to be independent of the main level measurement device for the purpose of autonomous status feedback.

This standard allows for high and low level liquid detection through the use of two alternative instruments;

- Float switches as per the Make and Model specified in Appendix A unless otherwise approved by the QLDC Chief Engineer,
- Liquid level probe, as per the Make and Model specified in Appendix A unless otherwise approved by the QLDC Chief Engineer.

12.1 Float Switches

Two float switches are generally required to provide indication of pump station status. These floats are designed to operate independently of the primary level control system and are linked through to the RTU for SCADA alarming.

- High level
- Low level

Float switches shall be the type specified in Appendix A or equivalent suitable for specific gravity of 1.0 and with cable length to suit the application.

High and low level floats will manual PUSH TO RESET buttons mounted on the switchboard to allow for local reset.

Remote reset of high and low level fault conditions shall also be made available through the SCADA.

Float switches shall be mounted on a float hanger as shown in Drawing QLDC_WWPS_01 The Contractor shall supply and install a float hanger which is similar in design to QLDC_WWPS_01, with float supports to prevent movement and entanglement.

12.2 Liquid level probes

The level probes allow for a floatless level relay system to be installed with the benefit that one probe can provide a number of outputs.

The probes are available with up to 10 sensors for multi functional alarming and back up pump control. The more basic model, with three sensors, allows for standard high and low level alarming with the potential for a third set point to be configured against an overflow point or back up pump start level.

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13 FLOW AND PRESSURE MONITORING

13.1 Flowmeters

All QLDC pump station facilities are to be installed with electromagnetic (magflow) flowmeters on the discharge rising main in order to monitor pump station performance.

Magflow meters installed should be installed to the following standard;

- Make and Model specified in Appendix A unless otherwise approved by the QLDC Chief Engineer
- Be installed full bore on the common rising main,
- Be of a diameter that matches the rising main so as not to incur flow restriction or dynamic head losses,
- Mechanical installation via flange connection to the rising main,
- Be mechanically installed to manufactures recommendations conforming the requirement of 5 x dia straight line lengths upstream of the flowmeter and 2 x dia straight line lengths downstream of the flowmeter.
- Be installed inside a manhole or chamber. QLDC recommends use of 1050mm dia manholes for magflow meters of 200mm dia or less.
- Manholes to be installed with 2 x 50mm conduit running between manhole and pump station switchboard or building (one for power, one for signal cable).
- Transmitter or head units to be mounted inside pump station switchboard or building to allow for operators to determine pump flow
- Transmitter or head units to be hardwired with analogue connection through to RTU for remote flow measurement.
- Flowmeter scaling to be determined by Veolia. Veolia shall provide a scaling range (litres/sec) that shall be configured to the 4-20mA range of the magflow meter installed.
- Transmitter or head units to be hardwired with analogue connection through to RTU for remote flow measurement.
- Pulse output from magflow meter to be configured so that 1 pulse count = 1m³ pumped volume.
- Flowmeter scaling to be determined by Veolia. Veolia shall provide a scaling range (litres/sec) that shall be configured to the 4-20mA range of the magflow meter installed.

- Analogue and digital inputs for magflow connection to be pre-determined by SCADA I/O schedule issued by Veolia or 3 Waters contractor.

13.2 Pressure transducers

All QLDC pump station facilities are to be installed with pressure transducers tapped onto the discharge rising main in order to monitor pump performance and pipeline integrity.

Pressure transducers should be installed to the following standard;

- Make and Model specified in Appendix A unless otherwise approved by the QLDC Chief Engineer.
- Measuring range of transducer to be appropriate to anticipated pipeline pressures modelled for.
- Connection of transducer to be allowed for via ½' BSP female threaded tapping point above isolation valve mounted on the rising main.
- Pressure transducer to be connected through to SCADA for remote monitoring only. No local display is required.
- Pressure transducers may be hardwire connected through to RTU or through use of alternative protocols such as Modbus. This is because this measurement is considered non critical.
- Analogue inputs for pressure monitoring connection to be pre-determined by SCADA I/O schedule.

14 SCADA AND TELEMETRY

14.1 Roles and responsibilities

Electrical contractors engaged to connect submersible wastewater pump stations to the QLDC SCADA network should be aware of the contractors involved in the administration and management of the SCADA system;

- Countrynet: QLDC telemetry network provider
- Arthur D Riley : QLDC SCADA hardware and software supplier
- QLDC: SCADA system asset owners
- Veolia: QLDC 3 Waters Contractor and SCADA administration / management for QLDC sites. SCADA and SCADA software provider.
- Fulton Hogan Central: QLDC 3 Waters Contractor and SCADA administration / management for the Lake Hayes Scheme
- Switchbuild; Lake Hayes Scheme SCADA hardware and SCADA software provider

Liaison with Veolia for QLDC sites and Fulton Hogan for Lake Hayes sites at the start of this process is recommended in order to confirm all aspects of SCADA design, installation and commissioning.

14.2 SCADA

Veolia or Fulton Hogan shall be responsible for delivery of the following items associated with the installation of SCADA hardware and subsequent connection of the site to the QLDC SCADA system;

- Selection of communication protocol (RTU to SCADA base station)
- Selection of telemetry hardware required
- Development of SCADA I/O schedule
- Allocation of RTU address
- Commissioning checks on all SCADA I/O
- Allocation of SCADA alarm signals
- Configuration of the base station including datalogging, reporting and alarms.
- Development of SCADA GUI screen/s

14.3 SCADA work required of contractor

Any electrical contractors engaged to connect a remote facility to the QLDC SCADA system shall be required to complete the following;

- Supply and installation of the RTU
- Connection of control hardware to RTU
- Installation of telemetry hardware
- Connection of telemetry hardware to RTU
- Connection of local digital and analogue signals to RTU
- End to end signal testing
- Commissioning checks on all SCADA I/O

14.4 RTU supply and installation

The QLDC SCADA system uses Abbey Systems Swampfox Remote Telemetry Units (RTUs) to communicate with remote pump station facilities.

The QLDC Lake Hayes Scheme SCADA system uses Kingfisher Remote Telemetry(RTU's) to communicate with remote pump station facilities.

Installation of these RTUs shall conform to the following standards;

- Installed to manufactures recommendations
- Installed with back up 24v DC UPS
- Installed inside a dedicated telemetry panel at eye level.
- There must be a minimum of 75mm clearance around the remote telemetry unit and the radio transmitter.
- All connections to the RTU shall be via a telemetry terminal strip.
- Assignment of terminals to field I/O shall be in accordance with Appendix B.

RTU wiring

All contact signals must be voltage free (rated at not less than 24 V dc 0.5 A, 2 wires per signal).

All field wired 4-20 mA signals shall be isolated for connection to the RTU, and shall comply with the following:

- (a) Linear with the respect to the measured variable.
- (b) Capable of driving a load of 750 Ohms.
- (c) Two wire, shielded with shield earthed at the switchboard end.

Backup power supply for RTU

QLDC require all RTUs to be installed with a backup power supply in order that remote monitoring of the pump station can continue in the event of a power outage (mains fail).

This shall be achieved through the use of a DC UPS with capacity to supply the RTU and critical instruments for four hours.

14.5 Signal transmission and telemetry hardware

Signal transmission from the pump station to the SCADA base station shall involve the installation of an antenna.

The type and size of antenna to be installed shall be determined by the 3 Waters Contractor or the radio survey (see below).

The most common form of hardware installed at pump stations across the Queenstown lakes district includes;

- Microwave dish,
- Cellular antenna

Antenna installation

Installation of antenna shall be undertaken to the following conditions;

- Conformance against relevant standards
- The antenna shall be mounted on a stainless steel mounting pipe.
- All fastening and securing brackets, nuts, bolts, washers etc. shall be manufactured from grade 316 stainless steel.
- The radio antenna installation shall be designed and constructed to withstand the prevailing conditions and wind speeds of 120 km/h.
- All cabling to be glanded through the switchboard.
- IP rating of the switchboard shall not be compromised by the mounting of the antenna.
- The antenna shall not be mounted less than 3m above ground level.

Communication method

QLDC 3 Waters Contractors will advise of the preferred method of communication between pump station and SCADA base station. Method of protocol may vary depending on geographical location.

Methods of communication between RTU and SCADA base station used across Queenstown lakes district include the following;

- IP radio
- Cellular

Radio Path Survey

It should be noted that it may be necessary for the electrical contractor to conduct a radio path survey to determine the availability of an acceptable radio path from the base station to the pumping station.

The results of this survey shall be provided to the 3 Waters Contractor who will liaise with the contractor as to an agreed specification for the communication system prior to its installation.

14.6 SCADA I/O

The following signals shall be provided to the telemetry terminal strip for input to the RTU using the terminal numbers specified in Appendix B:

Digital inputs

- (1) AC POWER FAILURE (opens on fault: from under-voltage and supply failure relay)
- (2) HIGH LEVEL ALARM (opens on fault, from wetwell level device)
- (3) LOW LEVEL ALARMS
- (4) PUMP 1 RUNNING (closed when running, from motor starter)
- (5) PUMP 2 RUNNING (closed when running, from motor starter)
- (6) PUMP 1 FAULT (opens on fault)
- (7) PUMP 2 FAULT (opens on fault)
- (8) PUMP 1 AUTO SELECTED (closed when auto selected)
- (9) PUMP 2 AUTO SELECTED (closed when auto selected)
- (10) PUMP CONTROL FAULT (opens on fault)
- (11) FLOW VOLUME (totaliser pulse from flowmeter)
- (12) SCADA CONTROL (on when pulsed)
- (13) UPS Alarms

14.7 Analogue inputs

- (1) MOTOR 1 CURRENT (Amps)
- (2) MOTOR 2 CURRENT (Amps)
- (3) WETWELL LEVEL (% full)
- (4) INSTANTANEOUS FLOW (litres/sec)
- (5) DISCHARGE PRESSURE (kPa)

14.8 Digital outputs

The following signals shall be provided from the output of the RTU to the telemetry terminal strip. This allows for some remote operation and control of the site.

- (1) SCADA RUN PUMP 1 (closed when pump to run)
- (2) SCADA RUN PUMP 2 (closed when pump to run)
- (3) HIGH / LOW LEVEL RESET
- (4) RTU Control Enabled

14.9 Analogue outputs

No analogue outputs are required for wastewater pump station operation.

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15 SCADA SOFTWARE CONFIGURATION

15.1 SCADA administration

The SCADA software provider is responsible for software configuration of the pump station to the SCADA base station. Pumping station measurements and status shall be stored and archived for performance monitoring and engineering design requirements by QLDC and third parties.

Veolia shall provide the following:

- (1) A graphical user interface (GUI) at the SCADA base station for the pumping station.
- (2) The calculation, display and logging of alarms at the base station (both pump station and telemetry generated).
- (3) Configuration of all remote signals and measurements as specified in Appendix B.

15.2 Graphical User Interface (GUI)

The SCADA software provider shall produce and make operational the GUI for the pumping station. The GUI shall display all critical pump station and measurements to ensure pump station performance can be monitored remotely by network operators.

The SCADA software provider shall configure and test all alarms and indications included on the pumping station GUI. Testing of these shall be made in conjunction with the electrical contractor on site.

15.3 Pump station alarms

The SCADA software provider shall configure the SCADA base station such that the following pumping station alarms are displayed on the GUI, appear in event logs and activate the appropriate pager(s) in accordance with existing alarm classes, where appropriate, or as determined by the QLDC Chief Engineer:

- (1) High Level.
- (2) Power Fail.
- (3) Pump 1 Fault.
- (4) Pump 2 Fault.
- (5) Wetwell Level Device Fault.

16 INSPECTION AND COMMISSIONING

16.1 General

All electrical equipment manufactured under the Contract shall be tested at the manufacturer's works to ensure that the equipment complies with this Specification.

Witness tests may be carried out in the presence of and to the satisfaction of the Principal inspecting officer.

The Electrical Contractor shall give the QLDC Chief Engineer a minimum of ten (10) working days' notice of the manufacturer's intention to conduct tests.

All works testing costs, including the supply of plant, materials, gauges and instruments shall be the responsibility of the Contractor. All test instruments shall have current calibration certificates, if applicable, and all certificates shall be made available for checking by the inspecting officer.

16.2 Commissioning format

Veolia have developed a structure for testing of new pump station facilities vested to QLDC. The format of this commissioning follows a logical review of the operation and functional testing of all major mechanical and electrical components and instruments. A recommended format for facility commissioning is as follows;

- Civil works and structures
- Pipework and valving
- Switchboard construction to specification
- Pump performance
- Fault conditions
- Primary pump control
- Secondary pump control
- Local pump control
- Auto pump control
- Remote pump control
- High and low level alarming
- Instrumentation
- SCADA communication
- SCADA signals (local vs SCADA)
- SCADA measurements

16.3 Pump station functionality

Works tests shall be carried out to thoroughly test out functions of control and back up pumping systems, alarm outputs, local and remote status indication, pushbutton and reset functions.

Testing shall include, but not be limited to, the following

Pump performance

- Duty flow output vs design curve
- Discharge pressure vs design curve
- AUTO/ MANUAL / OFF mode switches

Fault conditions

- Pump RUN / pump FAULT
- High and low level faults alarm outputs and control outputs (if any)
- Primary pump control fault
- Level measurement fault

Primary pump control

- Duty pump start / stop set points
- Standby pump start / stop set points
- Assist pump start / stop set points
- Duty pump rotation (method)

Secondary pump control

- SCADA alarm outputs
- Duty pump start / stop set points
- Standby pump start / stop set points
- Assist pump start / stop set points

16.4 Switchboard inspection

At the completion of the installation or at the completion of agreed subsections of the work, the Electrical Contractor shall, in the presence of the inspecting officer conduct site acceptance tests on all equipment which has been supplied and/or installed as part of the Contract. The testing shall be in accordance with the Specification and to the satisfaction of the inspecting officer.

The Electrical Contractor shall give the inspecting officer not less than ten (10) working days' notice of his intention to undertake the tests.

The provision of all necessary equipment for testing shall be the responsibility of the Contractor. All test instruments shall have current calibration certificates, if applicable,

and all certificates shall be made available for checking by the inspecting officer before testing commences.

16.5 Switchboard testing

The Electrical Contractor shall, in the presence of the QLDC Chief Engineer inspecting officer, carry out site tests to demonstrate that the installation is in accordance with the specified requirements and that the installation operates correctly.

Equipment which has been satisfactorily performance tested or witness tested in the manufacturer's works need not be site tested except to:

- (1) check the installation and interconnections;
- (2) check for any damage or deterioration which may have occurred since the works tests; and
- (3) demonstrate that the system functions in accordance with the Specification.

Control circuits / local distribution

The tests shall be carried out in accordance with the relevant Standards and shall include the following where applicable:

- (1) insulation resistance tests
- (2) earth resistance tests
- (3) continuity tests
- (4) polarity tests
- (5) calibration checks
- (6) sequencing tests
- (7) functional tests

The series of test below are required demonstrate the integrity and correct operation of the system including protective devices and remote operations, indications and controls.

Protective units, relays etc. which allow current injection or similar to check their settings shall, during testing, have each function tested and calibrated.

Units which may be adjusted (e.g. thermal overload relays) shall be adjusted to the appropriate settings in accordance with the manufacturer's written instructions.

SCADA Testing

The Electrical Contractor shall liaise with the SCADA software provider Veolia throughout SCADA testing to ensure local pump station status is reflected through the SCADA system

The inspection and tests shall include, but not be limited to the following:

- (1) SCADA comms check to ensure strength of signal and protocol type allows for robust signalling and communication back to the SCADA base station,
- (2) Performance tests to ensure that all inputs and outputs confirm to the SCADA I/O schedule.
- (3) Instrument checks to ensure mapping and scaling ranges are accurately determined and match.
- (4) Remote control checks to ensure all control outputs installed at site map through to the correct local functionality.

Test Results

The results of all site tests shall be neatly and legibly recorded during the progress of the test on the approved test sheets. A copy of the test sheets, co-signed by the Electrical Contractor and the inspecting officer, shall be handed to the inspecting officer on completion of the tests.

Sign off on SCADA signalling, controls and alarms is required by both the maintenance contractor and electrical on-site contractor.

An example of a generic test sheet is provided in Appendix D. The test sheet shall be modified by the Contractor to include any additional tests required to demonstrate compliance with this specification and any variations approved by the QLDC Chief Engineer.

Commissioning sheets should be provided in the O & M manual in order to provide operators with a record of pump station performance results during testing and commissioning.

17 ELECTRICAL DRAWINGS

17.1 General

All drawings produced shall be in accordance with AS/NZS 1100, AS 1101, AS/NZS 1102, AS/NZS 4383 and AS/NZS 60417 as applicable.

Contractors Drawings shall be prepared using a CAD system.

Drawings shall be plotted at the same scale as they were drawn/composed (1:1) to maintain the original intended line and text attributes.

The drawing shall be A1 or A3 size in accordance with (AS/NZS 1100 Part 101).

17.2 CAD Files

- The Contractor shall provide CAD files for all electrical and instrumentation Final Contractors Drawings. CAD files shall be provided to the QLDC Chief Engineer at the same time as the Final Contractors Drawings.
- Each CAD drawing file shall contain all information used to produce the drawing including externally referenced information (e.g. AutoCAD X'refs should be bound into the drawing file).
- Drawings produced using AutoCAD shall be supplied in .DWG format. All other CAD files shall be supplied in DXF format.
- Drawings produced using AutoCAD shall, where possible, be produced using QLDC Chief Engineer drafting defaults (a copy of the Principal defaults file shall be made available to the Contractor on request). Each drawing produced using AutoCAD and not using the Principal standard defaults shall be supplied with an individual plotter setup file(s) to enable reproduction of the original drawing.
- CAD files (including .PC2, .PC3, .CTB or .STB files) shall be named with the drawing number in accordance with this clause except that the dash "-" shall be replaced with an underscore "_" (e.g. 00_4031.DWG).
- CAD files (including .PC2 files etc.) shall be named with the drawing number.

17.3 Drawing Details

Drawings produced by the Electrical Contractor shall show the following information, where applicable:

- (1) Detailed material and parts list.
- (2) Electrical power and control circuit schematic drawings which shall:
 - Give ratings of all components.
 - Show all cable types and sizes.
 - Be drawn as vertical ladders with each line numbered.
 - Show cross referencing of remote contacts etc. using line numbers and other drawing numbers if required.
 - Identify spare cores of field cables by their respective cable, core and terminal numbers where applicable.

Drawing GENERAL 09-01 has been included as a means of establishing quality standards required for electrical schematic drawings. Circuitry shown is not an indication of facilities or methods required to achieve requirements.

- (3) Layouts of the pumping station switchboard and motor control panel.

17.4 Submission of draft electrical drawings

The Electrical Contractor shall:

- (1) Submit a copy of the scaled drawings to the QLDC Chief Engineer for examination prior to manufacture or commencement of work.
- (2) Allow time in his/her program for the QLDC Chief Engineer to examine, or subsequently re-examine in accordance herewith, the drawings submitted by the Electrical Contractor. The time to be allowed to the QLDC Chief Engineer for such examination shall be not less than ten (10) working days.

Upon examining the drawings, the QLDC Chief Engineer may direct comments or queries to the Electrical Contractor on those drawings. If drawing modifications are required as a result of the examination, the Electrical Contractor shall supply revised drawings for re-examination.

- (3) Not depart from the details shown on drawings examined by the QLDC Chief Engineer in accordance with this Clause unless the Electrical Contractor has first amended the drawing accordingly, submitted it for re-examination in accordance with this Clause and had it returned by the QLDC Chief Engineer signifying approval to proceed.

If manufacture or construction commences prior to approval from the QLDC Chief Engineer, any re-work shall be at the Electrical Contractor's expense.

17.5 Submission of final electrical drawings

Prior to the date of practical completion, the Electrical Contractor shall provide two (2) sets of Final Contractors Drawings which have not been folded, punched or marked to the QLDC Chief Engineer. The QLDC Chief Engineer shall determine if copies submitted as Final Contractor Drawings are of an acceptable quality. If the drawings are deemed by the QLDC Chief Engineer to be unacceptable, the Electrical Contractor shall re-submit drawings which are of an acceptable standard.

Final Contractors Drawings shall:

- (1) Be provided for all equipment and structures included in the Contract.
- (2) Include all "As Constructed" information which shall include all changes brought about during manufacture, installation, construction, testing and commissioning.
- (3) Show signatures of authorising and/or approving personnel.
- (4) Be on white paper not less than 80 gsm thick and shall be suitable for reproduction by conforming with the requirements of AS/NZS 1100.

One copy of the Final Contractors Drawings protected by a protective sleeve shall be left in the pumping station switchboard.

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18 OPERATIONS AND MAINTENANCE MANUAL

18.1 Format

The Electrical Contractor shall supply to the Engineer's Representative three (3) copies of Operations and Maintenance Manuals ("O&M Manuals") which shall be prepared according to the content requirements provided in Appendix D.

A first draft copy shall be submitted to QLDC 3 Waters contractor, for review as part of the process to ensure all pertinent information is included.

Operations and Maintenance Manuals shall be in accordance with the following requirements:

- (1) Wholly in the English language, clear, legible and contain all pertinent information relating to the functional control, operation and maintenance of the facility and its components.
- (2) Be presented in a format that matches the example contents page in Appendix D.
- (3) Include the manufacturer's manuals for all supplied equipment. This includes but is not limited to manuals for installation, configuration, programming, maintenance and troubleshooting.
- (4) Include complete parts listing which shall include the manufacturer's name, parts catalogue number and, where applicable, the local agent's name, address and telephone number.
- (5) Include drawings of the actual equipment supplied, including detailed ladder and schematic circuit diagrams.
- (6) Include any relevant safety procedures.
- (7) Where PLCs are supplied, hard copy program listings in ladder format shall be provided. In addition, electronic copies of the PLC programs and supporting files shall be supplied on CD ROMs.
- (8) Any passwords or codes required for access.

18.2 Content

The operating component of the Operations and Maintenance Manual shall include a description of the operation of the equipment and clear and logical instructions for the operator.

The operating manual shall describe the operation of the equipment under manual and under remote and/or automatic control.

The instructions shall include:

- (1) starting, running and stopping procedures;
- (2) functional control processes;
- (3) sequencing and control logic descriptions;
- (4) measured parameters;
- (5) Fault conditions and SCADA alarms.

The maintenance component of the Operations and Maintenance Manuals shall contain all relevant information for the maintenance and repair of the equipment and shall include:

- (1) Identification of items of equipment, including model and serial numbers.
- (2) A brief description of the equipment and its operation.
- (3) All necessary setting up procedures.
- (4) All maintenance procedures including suggested preventative maintenance schedules.

18.3 Asset register

Veolia and QLDC wish for any electrical contractor installing switchgear at a submersible pump station to document the components installed for the purpose of recording within QLDCs HANSEN Asset Management System.

The list of components and instruments detailed on this list should reflect the 'big ticket items' mirrored in the switchboard specification in Section 3.2

Contractors may wish to seek additional information on this requirement from both Veolia and QLDC.

Contractors shall be required to populate an Excel spreadsheet issued by QLDC titled; Asset register template for consultants/ contractors/ project managers (Sept 2015, Version 9).

This register seeks to quantify the components installed in newly vested facilities and capture their cost (both capital and installation).

Costs of big ticket items are required for QLDC insurance purposes.

18.4 Provision of additional documentation

All relevant documentation generated as a result of testing, inspection and certification of installation shall be supplied by the electrical contractor. This shall include, but not be limited to, Declaration of Conformity Statements and Electrical Certificates of Compliance.

APPENDIX A

EQUIPMENT DATA SHEET

Note : Compatible alternatives may be considered with the approval of QLDC Chief Engineer

Component	Equipment Standard	Comment
Panel Operators	Schneider 22mm ZB5 Rockwell 800F	
MCB's and RCD's	Schneider Acti 9	
Motor Circuit Breakers	Schneider GV2 Rockwell 140m	
Signal Isolators	Weidmuller	
Interface Relays	Omron Rockwell	
Contactors and Overloads	Schneider LC1 – LRD series Rockwell 100 – 193 series	
Surge	Weidmuller	
Terminals	Weidmuller	
Complex Selector Switches	Kraus and Naimer	
RTU: QLDC Sites	Abbey Systems Swampfox SF-3	

RTU: Lake Hayes Sites	Kingfisher	
DC UPS	Phoenix Trio UPS. 5Amp minimum. With fault, mains and battery monitoring.	
Communications	Swampfox SF-3 Microwave IP – Countrynet Cellular – Veolia supplied modems.	
Pump controller	Siemens MultiRanger 200 (MR200). Panel mount MultiTrobe MultiSmart pump controller.	
Wetwell Level Device	Endress & Hauser FMX21 Hydrostatic Level Transducer (4-20mA HART)	
Soft Starter/VSD	Danfoss MCD Series Aucom EMX Danfoss VLT Aqua VSDs Schneider	
PLC	Schneider M340 Allen Bradley Micrologix Series (1100 or 1400)	
HMI	Schneider Magelis	
Floats	Flygt ENM-10	
Level probe	MultiTrobe level probe	
Magflow meter	Endress and Hauser Promag (remote)	
Pressure transducer	Endress & Hauser Cerabar T PMP131 (4-20mA)	
Generator Plug	C From 63A or 125A	Compatible alternatives may be considered
Switchboard Enclosure	Switchbuild Dunedin Ltd Phone 03 466 4281 Email sales@switchbuild.co.nz Bremca. 25 Bond St, Invercargill. Phone 03 218 8038	

Switchboard Locks	Flush mounted internal lock with QLDC tumbler pattern	
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APPENDIX B

SCADA STANDARD I/O TEMPLATE

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DIGITAL INPUTS

0	<i>kwh pulse</i>	
1	<i>P1 Run</i>	
2	<i>P2 Run</i>	
3	<i>Flow Pulse</i>	
4	<i>P1 Auto</i>	
5	<i>P2 Auto</i>	
6	<i>P1 Fault</i>	
7	<i>P2 Fault</i>	
8	<i>Hi Level Alarm</i>	
9	<i>Lo Level Alarm</i>	
10	<i>RTU Control On</i>	
11	<i>Critical High Level Alarm</i>	
12	<i>Phase Fail</i>	
13	<i>Critical Low Level Alarm</i>	
14	<i>Seal Fail Pump 1</i>	
15	<i>Seal Fail Pump 2</i>	
16	<i>Surge Alarm</i>	
17		
18		
19		
20	<i>Multiranger Fault</i>	
21	<i>UPS Fault</i>	
22	<i>UPS Online Mains Fail</i>	
23	<i>UPS Battery Low</i>	
24		
25		
26		
27		
28	<i>Gen Run</i>	
29	<i>Gen on Load</i>	
30	<i>Gen Fuel Low</i>	
31	<i>Generator Fault</i>	
32	<i>PLC Fail</i>	
33	<i>Flow Fail</i>	
34	<i>Low Pressure</i>	
35	<i>RTU Control Enabled</i>	

ANALOG INPUT SIGNALS

AI

0	Well Level (by pressure)	
1	P1 Current	
2	P2 Current	
3	Flow L/s	
4	<i>MR Level by ultrasonic</i>	
5	<i>P3 Current</i>	
6	<i>P4 Current</i>	
7	<i>P1 Speed</i>	
8	<i>P2 Speed</i>	
9	<i>P3 Speed</i>	
10	<i>P4 Speed</i>	
11	<i>Pressure</i>	

DIGITAL OUTPUTS

DO			
0	General Reset	pulse	
1	Start/Stop P1	On/Off	
2	Start/Stop P2	On/Off	
3	P1 Reset	pulse	
4	P2 Reset	pulse	
5	Standby Stop	pulse	
6	Duty 1-2 = Off, 2-1 = On		On/Off
7	RTU Control Enable		On/Off
8			
9			
10	-		
11	-		
12	-		
13	-		
14	-		

Items listed below are derived from digital inputs

Pulse			
0	kwh		
1	P1 Run Hrs		
2	P2 Run Hrs		
3	Flow		
4	-		
5	-		
6	-		
7	-		
8	-		
9	-		
10	-		
11	-		

APPENDIX C

OPERATIONS AND MAINTENANCE MANUAL REQUIRED CONTENT

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INTRODUCTION

WASTEWATER PUMP STATION OVERVIEW

- Site Location
- WWPS Criticality

PRINCIPAL COMPONENT DESCRIPTIONS

- Pump Chamber / wet well
- Submersible Pumps
- Valve Chamber
- Electrical cabinet & switchboard
- Soft starters
- Pump controller
- Hydrostatic level transducer
- Power metering
- Magflow meter
- Telemetry
- Generator
- Generator controller
- Rising Main

PUMP CONTROL & SCADA

- Pump controls
- Fault lamps
- Pump configuration
- Pump operation
- Duty / standby pump operation
- Manual / auto operation
- Remote pump operation via SCADA
- Primary pump control
- Secondary pump control
- High and low level alarms
- SCADA I/O
- Digital Inputs
- Digital Outputs
- Analogue Inputs
- Pulse counts
- SCADA Alarms and Operating Responses

ASSET REGSITER

WWPS OPERATIONS & MAINTENANCE

- Monthly Operating / Maintenance Activities
- Yearly Operating / Maintenance Activities
- Troubleshooting
- Pump chamber Level High alarm response
- Pump fault
- Soft starter fault
- Adjusting pump set points on the MultiRanger
- Adjusting pump set points on the SCADA
- Odour complaint
- Wastewater overflow response
- Unblocking a partially or fully blocked pump
- Generator fault
- Loss of SCADA signal

OPERATIONS & MAINTENANCE PROCEDURES

- Cleaning the pump chamber
- Cleaning the level sensor
- Cleaning & maintenance of pressure transducer
- Lifting a pump
- Installing a pump into the pump chamber
- Pump fault troubleshooting
- Isolating plant and equipment
- Unblocking the check (non-return) valves
- Electrical service check
- Pump maintenance & service
- Test running the generator
- Standby generator service

HEALTH & SAFETY

- Risk Assessment

As-Builts

- Electrical, Pump Station and Rising Main

APPENDIX D

WWPS COMMISSIONING TESTS AND CHECK SHEETS

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SUBMERSIBLE WASTEWATER PUMPING STATION

TESTING & COMMISSIONING PROCEDURES

TEST/COMMISSIONING PROCEDURES

The following procedures will be used as a basis of commissioning/testing the pumping stations.

Other tests considered necessary to establish the correct operation of the plant and equipment installed shall be performed during commissioning at the discretion of the Veolia commissioning officer(s) as required.

No.	PROCEDURE	PAGE
1.	SWITCHBOARD CONSTRUCTION	3
2.	SWITCHBOARD GENERAL EQUIPMENT TESTS	6
3.	SWITCHBOARD PROPRIETARY TESTS	7
4.	GENERATOR CONNECTION TESTS	8
5.	PHASE FAILURE RELAY TESTS	9
6.	PUMP OPERATION & MOTOR CURRENT TESTS	10
7.	PUMP OPERATING MODE TESTS	12
8.	PUMP POWER AND INDICATION TESTS	15
9.	PUMP SOFT STARTER & FAULT CIRCUIT TESTS	17
10.	LEVEL DEVICE TESTS	19
11.	EMERGENCY FLOAT SYSTEM TESTS	23
12.	SCADA CONTROL TESTS	25
13.	SCADA TESTS	25
14.	FLOWMETER TESTS	26

TEST EQUIPMENT REQUIRED (Supplied By Contractor)

Note : It is the responsibility of the Contractor to provide current calibration certificates for the test equipment used during commissioning.

The following test equipment will be required for the testing.

1. Insulation resistance tester (1000V).
2. Earth continuity testing instrument.
3. RCD test equipment.
4. Power factor measuring instrument.
5. Digital multimeter.
6. Low current instrumentation ammeter/calibrator (4-20 mA).
7. Clamp on ammeter (rated for full load current of pump motors).

1. SWITCHBOARD CONSTRUCTION

Objectives:

To establish general compliance with construction requirements of specification.

Test Procedure:

- Check construction of switchboard including material 316 SS construction.
- Check switchboard rating is IP rating.
- Check main switchboard including IP rating.
- Check motor control panel including IP rating.
- Check RTU including IP rating.
- Check component ratings for pump CB's, soft starters, bypass contactor are the same.
- Check switchboard constructed from stainless steel.
- Check controls and indications are provided as per design drawings.
- Check plinth hot dipped galvanised secured with 316 SS anchors.
- Check high security locks are fitted with QLDC tumbler.
- Check internal wiring PVC and minimum size & colour coding as per specification.
- Check wiring installed in PVC ducts and terminated in terminals.
- Check controls & indications are labelled as required.
- Check relays, terminals and cables are labelled as required.
- Check current transformer wiring is 2.5 mm².
- Check terminal enclosure is installed and manufactured from PVC.
- Check miniature circuit breakers are lockable in the OFF position.
- Check that an RCD was installed on the GPO circuit.
- Check Current Transformers are class 2M or better (2M or less).
- Check that Current Transducers are class 1M or better (1M or less)
- Check ammeter selector (if installed) fitted with an OFF position.
- Check hours run meter has 5 digits minimum.
- Check surge arresters have a discharge current of 20kA.
- Check indicator lamps are 22 mm dia.
- Check phase imbalance relay adjustable from 5 to 15 %.
- Check floodlight is rated at 5000 Lumens

Acceptance Criteria:

- Switchboard constructed from 316 SS.
- Switchboard exterior appears to be IP 56.

Results

<ul style="list-style-type: none"> • Main switchboard is IP 32. • Motor control panel is IP 52. • RTU is IP 32. • All components rated for (15 or 30 kW). • Switchboard constructed from stainless steel. • Controls and indications are as per design drawings. • Plinth is hot dipped galvanised secured with 316 SS anchors. • High security swing locks fitted. • Internal wiring PVC, min. 1.5 mm² (control) and 2.5 mm² (power), colour coding grey for LV & violet for instrumentation. • Wiring installed in ducts and terminated in terminals. • Controls & ind. labels to be engraved plastic 4 mm high letters. • Relays, terminals and cables are labeled as required. • Current transformer wiring is 2.5 mm². • Terminal enclosure is installed and manufactured from PVC. • Miniature circuit breakers are lockable in the OFF position. • RCD is installed on the GPO circuit. • Current Transformers are class 2M or better (2M or less). • Current Transducers are class 1M or better (1M or less) • Ammeter selector (if installed) fitted with an OFF position. • Hours run meter has 5 digits minimum. • Surge arresters have a discharge current of 20kA. • Indicator lamps are 22 mm dia. • Phase imbalance relay adjustable from 5 to 15 %. • Floodlight is rated at 150 Watts minimum. 	
Test Result Pass Fail	
Accepted by	
Passed By (Contractor) _____	Date : _____
Passed By (Veolia Water) _____	Date : _____

2. SWITCHBOARD GENERAL EQUIPMENT TESTS

Objectives:

To establish switchboard general equipment complies with specification.

Test Procedure:

- Automatic Switch on cubicle light switch in switchboard.
- Check operation of switchboard light.
- Switch on floodlight switch in switchboard.
- Check operation of floodlight.
- Check anti-condensation heater and thermostat fitted.
- Connect measuring meter, turn thermostat temperature down.
- Check that 230V is applied to anti-condensation heater.
- Reset thermostat to operating temperature.
- Test operation of 230V GPO on switchboard.
- Test operation of GPO RCD using RCD test equipment.
- Activate LAMP TEST pushbutton and check all lights operate.

Acceptance Criteria:

- Switchboard light installed and operates when door is opened.
- Floodlight operates as required.
- Anti-condensation heater fitted and operating.
- Anti-condensation heater operating.
- Switchboard GPO operates.
- RCD operates at required test current.
- LAMP TEST operates all lamps correctly.

Results

Test Result **Pass** **Fail**

Accepted by

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3. SWITCHBOARD PROPRIETARY TESTS				
Objectives: To establish that proprietary test have been conducted.				
Test Procedure: <ul style="list-style-type: none"> • Disconnect main power supply. • Check MEN earthing system used. • Perform insulation resistance test on main busbars. • Perform earth loop impedance test on main earthing system. 				
Acceptance Criteria: <ul style="list-style-type: none"> • MEN earthing used. • Insulation resistance above 1.0 MΩ. • Earth loop impedance less than 0.5 Ω. 	Results			
<table border="0"> <tr> <td>Test Result</td> <td>Pass</td> <td>Fail</td> </tr> </table>		Test Result	Pass	Fail
Test Result	Pass	Fail		
Accepted by				
Passed By (Contractor) _____	Date : _____			
Passed By (Veolia Water) _____	Date : _____			

4. GENERATOR CONNECTION TESTS

Objectives:

To establish correct connections of generator plug. Tests to be undertaken using QLDC supplied generator.

Test Procedure:

- Ensure generator is not plugged in.
- Ensure that Main Isolator is closed.
- Check that Generator Isolator can not be closed.
- Switch off Main Isolator.
- Perform conductivity test between all phases of generator plug to main busbars.
- Check that Red, Yellow and Blue phases are connected correctly.
- Close generator isolator.
- Check that Main Isolator can not be closed.
- Open Generator Isolator.
- Close Main isolator.

Acceptance Criteria:

- Generator Isolator can not be closed when Main Isolator is closed.
- Red, Yellow and Blue phases connected correctly.
- Main Isolator can not be closed when Generator Isolator is closed.

Results

Test Result Pass Fail

Accepted by

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5. PHASE FAILURE RELAY TESTS

Objectives:

To establish correct operation of phase failure relay.

Test Procedure:

- Check that AC POWER OK lamp is illuminated.
- Remove one wire from phase failure relay.
- Check that AC POWER OK lamp goes out.
- Replace wire on phase failure relay.
- Check that AC POWER OK lamp is illuminated.

Acceptance Criteria:

- AC POWER OK lamp goes out on phase failure.
- AC POWER OK lamp on when power restored.

Results

Test Result **Pass** **Fail**

Accepted by

Passed By (Contractor) _____ **Date :** _____

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6. PUMP OPERATION & MOTOR CURRENT TESTS

Objectives:

To establish correct pump and motor current instrumentation operation.

Test Procedure:

6.1 Motor Direction

- Connect main power supply.
- Start Pump 1 and check for correct operation (rotation direction).
- Start Pump 2 and check for correct operation (rotation direction).
-

6.2 Motor Current

- Connect low current ammeter (4-20 mA) to motor current transducer on Pump 1.
- Measure Pump 1 motor current using clamp on (tong) ammeter.
- Observe Pump 1 motor current on switchboard ammeter.
- Compare motor current readings for Pump 1.
- Connect low current ammeter (4-20 mA) to motor current transducer on Pump 2.
- Measure Pump 2 motor current using clamp on (tong) ammeter.
- Observe Pump 2 motor current on switchboard ammeter.
- Compare motor current readings for Pump 2.

Acceptance Criteria:

6.3 Motor Direction

- Pumps run correctly and pumps.

6.4 Motor Current

- Pump 1 panel ammeter and analogue the same.
- Pump 2 panel ammeter and analogue the same.

Results

Test Result Pass Fail

Accepted by

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7. PUMP OPERATING MODE TESTS

Objectives:

To establish correct operation of the pump mode selector switches.

Test Procedure:

7.1 Off Mode

- Select OFF on the Pump 1 and Pump 2 MODE SELECTOR switches.
- Allow sump level to increase.
- Check that pumps do not run.

7.2 Manual Operation

- Select RUN mode on Pump 1 mode selector.
- Check that Pump 1 starts.
- Select OFF mode on Pump 1 mode selector.
- Select RUN mode on Pump 2 mode selector.
- Check that Pump 2 starts.
- Run pump(s) until sump is empty (below duty 1 start level).
- Select OFF mode on Pump 2 mode selector.

7.3 Pump 1 Automatic Duty 1 Operation

- Select DUTY 1-2 on the DUTY SELECTOR switch.
- Select AUTO on Pump 1 and Pump 2 MODE SELECTOR switches.
- Allow sump level to increase.
- Check that Pump 1 starts at DUTY 1 start level.
- Check that Pump 1 stops at DUTY 1 stop level.

7.4 Pump 2 Automatic Duty 1 Operation

- Select DUTY 2-1 on the DUTY SELECTOR switch.
- Allow sump level to increase.
- Check that Pump 2 starts at DUTY 1 start level.
- Check that Pump 2 stops at DUTY 1 stop level.

7.5 Pump 1 Automatic Duty 2 Operation

- Select DUTY 2-1 on the DUTY SELECTOR switch.
- Select OFF on the Pump 2 MODE SELECTOR switch.
- Allow sump level to increase.
- Check that Pump 1 starts at DUTY 2 start level.

7. PUMP OPERATING MODE TESTS

- Check that Pump 1 stops at DUTY2 stop level.
- Select AUTO on the Pump 2 DUTY SELECTOR switch.

7.6 Pump 2 Automatic Duty 2 Operation

- Select DUTY 1-2 on the DUTY SELECTOR switch.
- Select OFF on the Pump 1 MODE SELECTOR switch.
- Allow sump level to increase.
- Check that Pump 2 starts at DUTY 2 start level.
- Check that Pump 2 stops at DUTY 2 stop level
- Select AUTO on the Pump 1 MODE SELECTOR switch.
- Allow sump to be pumped down to DUTY 1 stop level.

7.7 Rotation Operation

- Select ROTATION on duty selector switch.
- Ensure that Pump 1 & 2 have AUTO mode selected.
- Allow sump to fill.
- Observe which pump is started at DUTY 1 start level.
- Allow sump to be pumped down to DUTY 1 stop level.
- Allow sump to fill.
- Check that the duty rotation changes and the other pump now starts at DUTY 1 start level.

Acceptance Criteria:

7.8 Off Mode

- Pumps do not run start when OFF selected.

7.9 Manual Operation

- Pump 1 starts on manual start.
- Pump 2 starts on manual start.

Pump 1 Automatic Operation

- At DUTY 1 start level Pump 1 starts.
- At DUTY 1 stop level Pump 1 stops.

Pump 2 Automatic Operation

- At DUTY 1 start level Pump 2 starts.
- At DUTY 1 stop level Pump 2 stops.

Pump 1 Automatic Duty 2 Operation

Results

7. PUMP OPERATING MODE TESTS

- At DUTY 2 start level Pump 1 starts.
- At DUTY 2 stop level Pump 1 stops.

Pump 2 Automatic Duty 2 Operation

- At DUTY 2 start level Pump 2 starts.
- At DUTY 2 stop level Pump 2 stops.

Rotation Operation

- Duty rotation alternates correctly between pump starts.

Test Result	Pass	Fail
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Accepted by

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8. PUMP POWER AND INDICATION TESTS

Objectives:

To establish correct operation of the starter, contactors and run indications.

Test Procedure:

- Connect power factor measuring instrument to main supply.

8.1 Pump 1

- Select RUN mode on the Pump 1 MODE SELECTOR.
- Check Pump 1 hours run meter is operational.
- Check that PUMP 1 RUN indicator lamp is illuminated.
- Check Power Factor to ensure that it is not less than 0.95 lagging.
- Select OFF mode on the Pump 1 MODE SELECTOR.
- Check that Pump 1 is stopped using soft starter pump control.

Pump 2

- Select RUN mode on the Pump 2 MODE SELECTOR.
- Check Pump 2 Hours Run Meter is operational.
- Check that PUMP 2 RUN indicator lamp is illuminated.
- Check Power Factor to ensure that it is not less than 0.95 lagging.
- Select OFF mode on the Pump 2 MODE SELECTOR.
- Check that Pump 2 is stopped using soft starter pump control.

Acceptance Criteria:

Pump 1

- Pump 1 hours run meter is operational.
- PUMP 1 RUN indicator lamp illuminates.
- Power Factor is not lower than 0.95 lagging.
- Pump 1 is stopped using soft starter pump control.

Pump 2

- Pump 2 Hours Run Meter is operational.
- PUMP 2 RUN indicator lamp illuminates.
- Power Factor is not lower than 0.95 lagging.
- Pump 2 is stopped using soft starter pump control.

Results

Test Result Pass Fail

Accepted by

8. PUMP POWER AND INDICATION TESTS

Passed By (Contractor)

Date :

Passed By (Veolia Water)

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9. PUMP SOFT STARTER & FAULT CIRCUIT TESTS

Objectives:

To establish correct operation of the soft starters and pump fault circuits.

Test Procedure:

Pump 1

- Ensure that no faults are present.
- Check that Pump 1 alarm relay is energised.
- Select OFF on Pump 1 mode selector.
- Adjust the soft starter overload current to minimum Amperes.
- Select RUN on Pump 1 mode selector.
- Check that Pump 1 alarm relay de-energises.
- Check that Pump 1 Fault indicator is illuminated.
- Select OFF on Pump 1 mode selector.
- Press Pump 1 RESET pushbutton.
- Check that Pump 1 alarm relay re-energises.
- Check that Pump 1 Fault indicator is not illuminated.
- Adjust the soft starter overload current to motor current.
- Select AUTO on Pump 1 mode selector.

Pump 2

- Ensure that no faults are present.
- Check that Pump 2 alarm relay is energised.
- Select OFF on Pump 2 mode selector.
- Adjust the soft starter overload current to minimum Amperes.
- Select RUN on Pump 2 mode selector.
- Check that Pump 2 alarm relay de-energises.
- Check that Pump 2 Fault indicator is illuminated.
- Select OFF on Pump 2 mode selector.
- Press Pump 2 RESET pushbutton.
- Check that Pump 2 alarm relay re-energises.
- Check that Pump 2 Fault indicator is not illuminated.
- Adjust the soft starter overload current to motor current.
- Select AUTO on Pump 2 mode selector.

Acceptance Criteria:

Pump 1

- Fault relay is energised with no fault present.

Results

9. PUMP SOFT STARTER & FAULT CIRCUIT TESTS

- Fault relay de-energises on fault.
- Pump 1 Fault indicator illuminates on fault.
- Fault relay energises when RESET operated.
- Pump 1 Fault indicator not illuminated when reset.

Pump 2

- Fault relay is energised with no fault present.
- Fault relay de-energises on fault.
- Pump 2 Fault indicator illuminates on fault.
- Fault Relay energises when RESET operated.
- Pump 2 Fault indicator not illuminated when reset.

Test Result Pass Fail
Accepted by
Passed By (Contractor) _____ **Date :** _____

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10. LEVEL DEVICE TESTS

Objectives:

To establish correct operation of the level indicator/controller & associated controls.

Test Procedure:

- Ensure that power is switched on to switchboard.
- Check that sump level is displayed on the Level Device.
- Switch off power to switchboard.
- Check that level is displayed on the Level Device using battery backup power.
- Connect low current ammeter (4-20 mA) into analogue output.
- Switch pumps on and empty sump.
- Check that sump level reads 0 %.
- Check that High Level Alarm relay is energised.
- Switch pumps off and allow sump to fill.
- Check that de-energises at HLA setpoint on controller.
- Check that HIGH LEVEL ALARM light is illuminated.
- With sump level just below overflow pipe, measure distance from top of sewerage to top of sump and calculate sump level in %.
- Check that sump level is the same as level displayed on level device.
- Select RUN mode on Pump 1 and 2.
- Check that Level Device Faulty relay is energised.
- Simulate sump level device fault condition.
- Check that de-energises.
- Check that SUMP LEVEL SYSTEM FAULT light is illuminated.
- Select AUTO mode on Pump 1 and 2.

Acceptance Criteria:

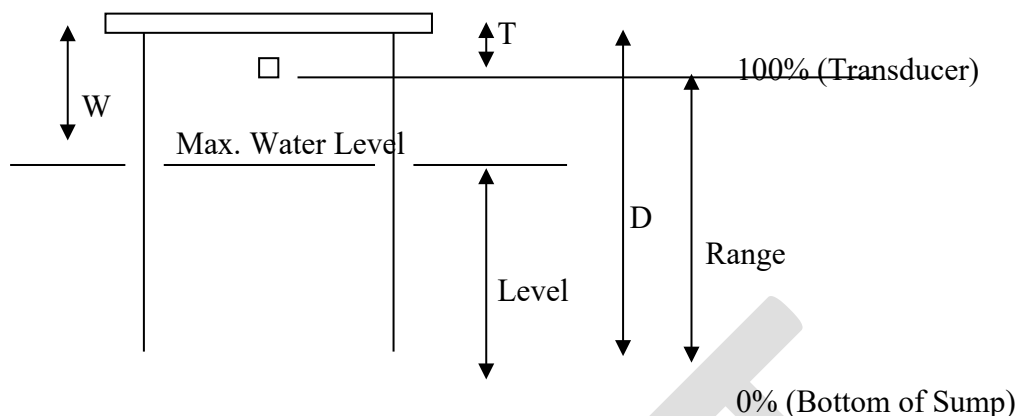
- Level displayed with power on.
- Level displayed with power off (using 12 V battery).
- Sump level reads 0 % with empty sump.
- energised below HIGH LEVEL sump level.
- de-energises above HIGH LEVEL sump level.
- HIGH LEVEL ALARM light operates.
- Actual sump level the same as displayed sump level.

Results

<ul style="list-style-type: none"> • Level device fault is energised with no fault present. • Level device fault de-energises when fault exists. • SUMP LEVEL SYSTEM FAULT light operates when level device fault exists. 	
Test Result Pass Fail	
Accepted by Passed By (Contractor) _____ Date : _____ Passed By (Veolia Water) _____ Date : _____	

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General Sump Details



Measured & Operational Site Details

LEVEL	mm	Value
DEVICE SETUP & CALIBRATION DETAILS		
Bottom Of Transducer To Top / Bot Of Sump Cover		T
Sump Depth To Top / Bot Of Sump Cover		D
Level Device Range		
Maximum Water Level Measurement (Water level to cover)		W
Level Device Reading at Maximum Water Level		
Required Current at Maximum Water Level		
Actual Current at Maximum Water Level		
SETTING DETAILS		
Overflow Level Float		
Emergency Start Float		
Emergency Stop Float		
High Level Alarm		
Start Duty 2 Pump		
Start Duty 1 Pump		
Stop Duty 2 Pump		
Stop Duty 1 Pump		

Formula

Level Device Range = D - T

Sump level = D - W

Required Current at Maximum Water Level = $\left[\frac{D - W}{\text{Range}} \times 16 \right] + 4$

11. EMERGENCY FLOAT SYSTEM TESTS

Objectives:

To establish correct operation of the emergency float system.

Test Procedure:

Emergency Level Float System

- Ensure that pump station has been operational.
- Disconnect battery power to Level Device.
- Switch power off to Level Device.
- Select AUTO on Pump 1 and Pump 2 mode selectors.
- Check that both pumps do not run.
- Check that Emergency Start Float Relay is de-energised.
- Allow sump level to increase.
-
- Replace battery power to Level Device.
- Switch power on to Level Device.

Overflow Level

- Lower Overflow Level Alarm float into sewerage.
- Check that the Overflow Alarm Relay energises and OVERFLOW ALARM is illuminated.
- Reset Overflow Float to correct level.

Acceptance Criteria:

Emergency Level Float System

- Pumps do not run when level below emergency start.
- Emergency start relay is de-energised.
- Emergency start relay energises when level reaches Emergency Start Level and Pump 1 starts.
- After a time delay and Pump 2 starts.
- Pump 1 and 2 stop when level falls below Emergency Stop Level.

Overflow Level

- Overflow alarm relay energises and OVERFLOW ALARM is illuminated.

Results

Test Result **Pass** **Fail**

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12. SCADA CONTROL TESTS

Objectives:

To establish correct operation of common control circuits.

Test Procedure:

SCADA Control

- Ensure that SCADA control is not active.
- Check SCADA Control Relay is de-energised and SCADA CONTROL ACTIVE indicator lamp is off.
- Initiate SCADA control.
- Check SCADA Control Relay is energised and SCADA CONTROL ACTIVE indicator lamp is on.

Acceptance Criteria:

- SCADA Control Relay de-energised & SCADA indicator lamp off when SCADA control is not active.
- SCADA Control Relay energised & SCADA indicator lamp on when SCADA control is active.

Results

Test Result Pass Fail

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13. SCADA TESTS

Objectives:

To establish all SCADA signals returned correctly to base.

Test Procedure:

SCADA Control

- Review historical logs / alarm logs for all the tests above.
- Check that power fail, pump run, pump fault, emergency level control active, level device fault, high level, pump currents and well level all indicate correctly.
- Check alarms generated to pager for power failure, pump fault, level device fault, emergency level control active and high level alarm.

Acceptance Criteria:

- Power fail indication and alarm paged out

Results

<ul style="list-style-type: none"> • Pump 1 and Pump 2 run indication paged out • Pump 1 and Pump 2 fault indication and alarm paged out • Emergency level control active indication and alarm paged out • Level device fault indication and alarm paged out • High Level alarm paged out • Overflow alarm paged out • Pump 1 and Pump 2 currents indicated correctly • Wet well level indicated correctly 	
Test Result Pass Fail	
Accepted by	
Passed By (Contractor) _____	Date : _____
Passed By (Veolia Water) _____	Date : _____

14. FLOWMETER TESTS	
Objectives: To establish the flowmeter is working accurately to measure and record pumped flow output from the wastewater pump station.	
Installation check procedure: Mechanical installation <ul style="list-style-type: none"> • Check that magflow meter is installed to manufactures' recommendations and observes the minimum straight line dimensions required upstream and downstream of the sensor. • Check that the magflow meter is installed with grounding disks where installation has been performed in pipelines made of plastic, concrete or those with an insulated lining or coating metal. • Check that rubber gaskets are installed on both sides of the grounding disk as per manufactures recommendations. • Check that the flowmeter is installed in a manhole or similar chamber to allow for any operation or maintenance checking required. 	
Acceptance Criteria: <ul style="list-style-type: none"> • Transmitter or head units to be hardwired with analogue connection through to RTU for remote flow measurement. 	Results

<ul style="list-style-type: none"> Transmitter or head units to be mounted inside switchboard to ensure a visible local display is available for operators to view. Scaling range (4-20Ma) is greater than the maximum flow out of the pump station by a factor of ≥ 1.2 Scaling range is communicated through to SCADA supervisor. Pulse output from magflow meter to be configured so that 1 pulse count = 1m³ pumped volume. Local display to match SCADA flow measurement. Commissioning officers and SCADA supervisor to check. Analogue and digital inputs for magflow connection to be pre-determined by SCADA I/O schedule No local alarming or control outputs are required to be configured from flow measurements from the magflow meter. Any relevant alarming or low / high (abnormal) flow conditions are to be configured against the analogue value returned to SCADA. 	
Test Result Pass Fail	
Accepted by	
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APPENDIX E

DRAWINGS

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QLDC_WWPS_	QLDC Pump Station Standardisation
QLDC_WWPS_01	REG Electrical Drawings Register
QLDC_WWPS_01	GA - General Arrangements
QLDC_WWPS_01	LDL1 - Label Schedule
QLDC_WWPS_01	01- Wiring Schematics

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