BRISBANE
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Urban Utilities

GIBSON ISLAND, WATER RECLAMATION PLANT
FINAL SETTLING TANK CAPACITY UPGRADE

OPERATION
&
MAINTENANCE
MANUAL

VOLUME 1

INTRODUCTION, SYSTEM OVERVIEW, FUNCTIONAL SPEC & DESIGN

thomas &coffey

Thomas & Coffey Limited
Water Group
Unit 3/41 Paringa Rd
Murarrie, QLD 4172
Phone : (07) 3908 8059
Fax : (07) 3908 8099

Contract No. BW80207-07/08

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Volume 1 Introduction, System Overview, Functional Spec, Design

1.1 Introduction and System Overview

Gibson Island Water Reclamation Plant (WRP) commissioned in 1989 has a hydraulic capacity of 45 ML/day ADWF (average dry weather flow) and a biological capacity of 11.2 $tBOD_5$/day. The plant, prior to installation of FST 7&8 is treating up to 45 ML/d ADWF with a biological load (80^{th} percentile) of 10.8 $tBOD_5$/day.

Separate hydraulic and biological models have been developed to determine 'bottlenecks' to the plant's operation during both wet and dry weather conditions. The modelling outputs suggested Gibson Island WRP can treat between 90 to 120 ML/d of wet weather flow depending on the settleability of the sludge, which is far below, the target of 135 ML/d of wet weather flow.

The key outcome from the modelling was the identification of Final Settling Tanks (FSTs) as the major wet weather 'bottleneck' and the need to have the FST capacity upgraded.

The plant has also suffered process control problems due to inaccurate flow metering in mixed liquor lines to existing Distribution Chambers No. 1 & 2 due to air entrapment. The installation of de-aeration chambers, one on each mixed liquor line before the flow meters was the solution to this problem.

The Gibson Island Reclamation Project comprised the installation of two new fully functional FSTs with the capacity to treat an additional 50 ML/d (as the Peak Value including allowance for wet weather conditions) of raw sewage into the plant (existing FSTs have a capacity of 120 ML/d during wet weather).

The installation also included associated mechanical and electrical infrastructure as well as provision for future flows and connections also made to accommodate future plant upgrades.

Gibson Island Water Reclamation Plant -

CAPACITY UPGRADE PROJECT

FINAL SETTLING TANK 7 & 8

Control System Functional Specification

Document Approval

Name	Section	Signature
PAUL FISHER	**Projects**	
JIM STARK	**Project Engineer**	

CONTROL SHEET

Prepared By:	Andrew Cao	**Date:**	27/1/2010
Checked By:	Phil Bennington	**Date:**	27/1/2010
Authorised For Issue By:	Gary Ellis	**Date:**	27/1/2010

REVISION SHEET

REV.	DATE	COMMENT	APP.
A	15/10/2009	Initial	
B	23/10/2009	DRAFT 1	
C	08/12/2009	DRAFT 2	
D	18/1/2010	For Construction	
E	27/1/2010	Revised according to feedback from AIT	
F			
G			

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Glossary

Term	Description
CITECT	The SCADA software package used to control the equipment.
DOL	Direct On Line electrical motor starter
LOI	Local Operator Interface
OWS	Operator Work Station
NIC	Network Interface Card.
PLC	Programmable Logic Controller.
PCS	Plant Control System
SCADA	Supervisory Control And Data Acquisition.
TCP/IP	Transmission Control Protocol / Internet Protocol.
VSD	Variable Speed Drive
AI	Analogue Input
AO	Analogue Output
DI	Digital Input
DO	Digital Output
EWS	Engineering Work Station
FST	Final Settling Tank
IO	Input Output
Nm^3/hr	Normal m^3/hr
P&ID	Process and Instrumentation Diagram
RAS	Return Activated Sludge
WRP	Water Reclamation Plant
EDI	Energy Dissipating Inlet
FOBOT	Fibre Optic Break Out Termination

1. INTRODUCTION

1.1 Overview

Gibson Island Wastewater Reclamation Plant (WRP) capacity upgrade involves design and construction of two new Final Settling Tanks (FST), FST 7 and FST 8, to increase the process capacity by reducing the bottleneck of the existing 6 FSTs.

As part of the FST upgrade electrical package, a new switchboard including GE Fanuc RX3i PLC (PLC 15) is installed for FST 7&8. The PLC is programmed to provide data monitoring and control function to the following process and is linked to the existing SCADA system via high speed fibre connection.

Initially, mixed liquor from Bioreactor 1 and 2 flows into the Final Settling Tank distribution chamber 3, where it is transferred to FST 7 and FST 8. Mixed liquor enters the FST through the centre column into the energy dissipating inlet and is contained by the flocculation skirt. FST performs gravity separation providing appropriate flow rate. The settlement layer from the top to bottom can be described as scum, effluent and sludge.

Solids heavier than water settle to the bottom of the tank (commonly called activated sludge) due to bacteria contained to facilitate the wastewater treatment process, and are recycled back to the Bioreactors to maintain its biological production. In FST 7&8, RAS flow meters are coupled with actuated control valves to perform automatic flow rate adjustment.

The scum scraper guides the scum to the FST extremities where the hinged scum skimmer blade pushes the scum up the submerged scum box. Scum is drawn off via the scum box outlet pumps, which are located external to the settling tanks. A flow meter positioned on the combined scum pipeline continuously monitors the flow rate.

Effluent overflows out of the FST to the effluent outlet. An electromagnetic flow meter located in Flow Meter Pit No2 continually monitors the out flow rate.

The essential electrical components of the FST includes two scum pumps, a bridge drive, an EDI spray pump, a sludge blanket level monitoring system and various control and safety devices. Details of each are provided in separate sections of the functional specification.

1.2 P&IDs

This document should be read in conjunction with Gibson Island WRP Final Settling Tank Capacity Upgrade PLC network diagram, drawing number 486/5/5-0046-526 and process and instrumentation diagram, drawing number 486/5/5-0046-300, 486/5/5-0046-304, 486/5/5-0046-305 and 486/5/5-0046-306.

1.3 Switchboard

FST 7&8 Switchboard is positioned nearby, which provides motor control, power distribution and PLC control for the devices that are involved with the FST 7&8 upgrade.

A power meter provides continuous monitoring of the power consumption. Power parameters are monitored continually and are logged by the SCADA.

The design and structure of the MCC complies with Form 3B. Each motor (except for the EDI spray pump) has its own set of selector switches, push buttons and indicators mounted on the switchboard escutcheon panel. The mode of operation is selectable from a three way selector switch (local/off/remote). The electronic overload modules for the main drives include an auto reset function without the involvement of the PLC.

A 24V DC power supply (fed from a UPS) provides power to the PLC, control circuit, I/O and instrumentation. The control circuit operates on 24V DC. Fuses are used to provide protection to control circuits and IOs. The PLC and its IO modules are integrated into the switchboard. All PLC modules are Conformal coated (parylene polymer) for harsh environments.

Also within the MCC is a distribution board which supplies general Lighting and Power circuits.

1.4 Functional Specification Guideline

This document should be consistent with, and read in conjunction with the following documents:

- 'Software Guidelines - PLC Control Logic' dated August 04

- Citect Operators Manual v0.9
- Citect HMI Standards v2.5.doc
- Gibson Island Return Active Sludge Control System – PLC 5 Functional Specification
- SWAN v1.05+Audit Details.xls
- GibsonIslandPLC-PLCComms.xls

The existing PLC software should be used as a guide for how the system operates.

1.5 PLC Communication Link

The fibre optic link in FST 7&8 is connected to the RAS fibre optic break out termination block (FOBOT), where it joins the Gibson Island WRP fibre-optic ring.

All PLC's communicate via the existing 1 GB fibre optic ring network. All CITECT Servers are connected via 1 GB copper ports to the fibre-switches. All PLC's connect to the 1 GB/s Network via 100Mb/s to 1 GB/s switches.

2. MIXED LIQUOR FEED, SLIDE GATE VALVES

2.1 Process Overview

Mixed liquor is transferred from Bioreactor 1 and Bioreactor 2 into distribution chamber No.3, via flow meters located in flow meter pit No1, from where it is distributed to FST 7 and FST 8. Each outlet from the Bioreactors to the distribution chamber is fitted with an actuated slide gate valve for flow control purposes.

2.2 Equipment

Equipment	Tag	Process Media	Location
Slide gate Valve – Bioreactor 1	SG_0511-001	Mixed Liquor	Bioreactor Weir Chamber No1
Slide gate Valve – Bioreactor 2	SG_0512-001	Mixed Liquor	Bioreactor Weir Chamber No2

Table 1: Mixed Liquor Inlet Slide gate Valve

2.3 Control System Overview

The slide gate valves are electrically driven via a local control station and the PLC provides continuous monitoring of their status. The slide gate valve actuators are Rotork Model IQ10. Selectors are provided on the actuator's electrical control cover for local Open/Close Control.

2.4 Operation

2.4.1 Interlocks

There are no interlocks with any other equipment in any mode of operation.

2.4.2 Operating Modes

The valves operate in local mode only, which can be manually adjusted, with respect to the valves position and flow rate (span 0 and 100%).

There are no automatic control functions required. However, the PLC continually monitors the valves position. The 'Valve Position Indication" inputs from the actuator are analogue outputs (4-20mA), which provide valve position values anywhere from fully open to fully close.

2.5 SCADA Information

2.5.1 SCADA Display

The SCADA display shows the slide gate valves on the SCADA page and the following indication for each Valve: (2 OFF)

- Valve Position (0 to 100%)
- Valve Open/Close Limit Reached

Alarms:

- Valve Unavailable
- Position signal invalid (not within 4-20mA range)

2.5.2 Tags

Tag	R / W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
BY AIT	R	BY AIT	Valve OPEN	DIG				

LEGEND:

RW – Read or Write IO Device – R = Read, W = Write

PLC Address – address in associated PLC unless otherwise noted.

Type (Citect Tag Data Type) – DIG = Digital, INT = Integer

Ctl (Control – is the tag used for control – i.e. data written to the PLC) Y = Yes, N = No, O = On / Off, P = Pulse (0 1 0), S =Setpoint

Alm (Alarm – is the tag used in a Citect Alarm?) Y = Yes, blank =No, I = used inverted i.e NOT <Tag> in Alarm Expression

Trn (Trend – is the tag used in a Citect Trend Tag?) Y = Yes, blank = No, E = used in a Trend Tag Expression – common for digital tags.

Table 2: List of Citect Tags Associated with Mixed Liquor Inlet Slide gate Valve

2.5.3 SCADA Control

Local manual control only, no remote control required.

2.6 PLC information

2.6.1 Related IO

PLC Address	Description	P&ID Equipment No.
%AI013	Valve Position (4 - 20mA)	SG_0511-001
%AI015	Valve Position (4 - 20mA)	SG_0512-001

%I049	Valve Fully Open	SG_0511-001
%I050	Valve Fully Close	SG_0511-001
%I051	Valve Fully Open	SG_0512-001
%I052	Valve Fully Close	SG_0512-001

Table 3: List of I/Os Associated with Mixed Liquor Slide gate Valves

3. Flow Meter Pit No. 1

3.1 Process Overview

Flow Meter Pit No.1 is positioned downstream of the new additional outlet weirs of the Bioreactors. Its purpose is to monitor the mixed liquor intake of distribution chamber No.3. Two electromagnetic flow meters are installed within this pit, one for each of the mixed liquor lines. These flow meters provide flow rate information to the operator via PLC/SCADA.

A sump pump is installed in the flow meter pit to discharge any collected rain water or accidental spillage at the flow meter connection. It is controlled by integrated float switches, and the level is indicated on SCADA via a multi-trode level controller.

3.2 Equipment

Equipment	Tag	Process Media	Location
Flow Meter 1	FE_0511-001	Mixed Liquor	Flow Meter Chamber No1
Flow Meter 2	FE_0512-001	Mixed Liquor	Flow Meter Chamber No1
Flow Chamber No1 Sump Pump	PU_0512-001	Storm Water	Flow Meter Chamber No1

Multi-trode Level Probe	LT_0512-001	Storm Water	Flow Meter Chamber No1

Table 4: Flow Pit No.1 Equipment List

3.3 Control System Overview

No control is required for the flow meters, indication only.

The 240V sump pump is designed to operate specifically via the integrated float switches.

3.4 Operation

3.4.1 Interlocks

There are no interlocks with any other equipment in any mode of operation.

3.4.2 Flow Meter Control

The PLC monitors the flow rate data continually via an analogue input 4-20mA proportional to the flow rate. Flow data is alarmed when the effluent flow set points are reached. The set points are Low/Low, Low, High, High/High and are adjustable in SCADA. The alarm is indicative only.

3.4.3 Sump Pump Control

The 240V sump pump is designed to specifically operate via the float switches.

Level indication/monitoring will be provided on SCADA via a multi-trode level controller.

3.4.4 Alarms

3.4.4.1 Flow Meter Alarms

An alarm is activated when flow meter reading is not available.

An alarm is activated when flow meter reading is invalid (outside of the 4 – 20mA range).

An alarm is activated when flow meter detects a reverse flow.

Flow alarms are activated when the flow rate reaches any one of the four operator adjustable set points, (low/low, low, high and high/high alarms).

3.4.4.2 Water Level Alarms

Water level alarm (high and high high) in the flow meter pit is monitored by a multi-trode level controller. These levels are set higher than the sump pump run/stop level.

3.5 SCADA Information

3.5.1 SCADA Display

- Mixed Liquor Inlet Flow Rate from Bioreactor 1 to Distribution Chamber 3
- Mixed Liquor Inlet Flow Rate from Bioreactor 2 to Distribution Chamber 3
- Total Mixed Liquor Inlet Flow Rate from Bioreactor 1 and 2 to Distribution Chamber 3
- High Level - when water in pit reaches high level.
- High high Level - when water in pit reaches high high level.

3.5.2 Tags

	R/W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
BY AIT	R	BY AIT	FLOW CHAMBER WATER LEVEL HIGH	DIG				
BY AIT	R	BY AIT	FLOW CHAMBER WATER LEVEL EXTRA HIGH	DIG				
LEGEND: see section 2.5.2.								

Table 5: List of SCADA Tags Associated with Flow Chamber 1

3.5.3 SCADA Control

Flow meter alarm set points (4 off) adjustable by the operator (low/low, low, high and high/high alarms).

3.6 PLC information

3.6.1 Related IO

PLC Address	Description	P&ID Equipement No.
%I025	LEVEL HIGH	Multi-trode Controller
%I026	LEVEL HIGH/HIGH	Multi-trode Controller
%AI001	FLOW (4-20mA)	FIT 0511-001
%AI003	FLOW (4-20mA)	FIT 0512-001
%I113	FLOW METER Forward	FIT 0511-001
%I114	FLOW METER Reverse	FIT 0511-001
%I115	FLOW METER Forward	FIT 0512-001
%I116	FLOW METER Reverse	FIT 0512-001

Table 6: List of I/Os Associated with Flow Meter Pit 1

4. FST 7&8 BRIDGE DRIVE AND EDI SPRAY PUMP

4.1 Process Overview

Mixed Liquor enters FST's 7&8 via a pipeline from distribution chamber 3, that runs underneath the FST's and then rises through the centre column into the energy dissipating inlet (EDI) and is contained by the flocculation skirt.

Solids flocculate and settle to the bottom of the tank. The level of solid settlement is monitored by the sludge blanket monitoring system. Scum floating on top of the effluent layer is scraped and drawn off by the scum pump. Effluent overflows a 'V' notched weir into a launder that runs the circumference of the FST. Functions of the scum pump and sludge blanket level monitor are documented in separate sections of this functional specification.

To ensure safety and provide protection for bridge drives, each FST has two limit switches for track wipers, one located at each end of the bridge (which will stop

the bridge if there is a foreign object left on the track or if a launder cover is left open), also two limit switches are provided on the access ladder plough arms, one at each end of the bridge, (this will stop the bridge if there is a foreign object left on the pathway in front of the bridge access ladder). There is also a torque element limit switch to prevent overloading of the bridge drive. When activated, bridge drive will be stopped.

In addition, there are three safety relays, for dedicated for FST7, FST8 and MCC Emergency Stop, are installed to monitor the safety status of the bridge. Details are explained in Section 4.3.

A proximity sensor is installed on the bridge, which functions as a rotation timer to verify that the bridge is rotating at a constant speed.

EDI Spray Pumps are provided on the bridges and use effluent water from the FSTs to control the scum during wind events etc. They are controlled via timer relay and pushbuttons on the MCC.

4.2 Equipment

Equipment	Tag	Process Media	Location
BRIDGE 7 DRIVE MV71	MV71	Mixed Liquor	FST 7
BRIDGE 8 DRIVE MV81	MV81	Mixed Liquor	FST 8
BRIDGE 7 SPRAY PUMP MF73	MF73	Effluent Water	FST 7
BRIDGE 8 SPRAY PUMP MF83	MF83	Effluent Water	FST 8
Emergency Stop Push Buttons (2 OFF Each FST)			FST 7 & 8
Limit Switch (4 OFF Each FST)			FST 7 & 8
Torque Element (1 OFF Each FST)			FST 7 & 8
Proximity Switch - Rotation			FST 7 & 8

Timer (1 OFF Each FST)			

Table 7: Bridge Drive & Spray Pump Equipment List

4.3 Control System Overview

For FST's 7&8, the Bridge drive is able to be locally manual activated or remotely started by the control system. However, the bridge drives rotational speed can only be set at the VSD keypad on the MCC by the operator.

Emergency stops are installed at both ends of each bridge. If either of the emergency stops is activated, a dedicated safety relay will be energised and will shut down the relevant FST bridge drive. The SCADA will indicate the status and alarm if emergency stops are activated.

An additional safety relay is installed to monitor the Emergency Stop mounted on the MCC. This emergency stop will drop out both FST7 and FST8 bridge drives, if activated. The operation of this E-stop will be monitored by the SCADA.

All three safety relays are required to be reset manually via a single reset pushbutton mounted on the MCC.

The PLC is constantly monitoring the status of the torque element for torque overload on each bridge drive as well as all of the limit switches on the bridge (Refer to Section 4.1 for their functions). The limit switches are hardwired to the control circuit, so that when any of these switches are activated, the bridge drive will stop operating immediately, and the PLC input is indicative only.

Each FST bridge drive rotation is monitored by the PLC which receives a pulse input from a proximity sensor mounted of one end of the bridge. The pulse signal is activated at each 90° rotation of the bridge.

The EDI Spray pump is designed to operate in Local/manual mode only. The decision to activate the spray pump is to be decided by the plant operators and run time is controlled by a timer.

4.4 Operation

4.4.1 Operating Requirements

Emergency stop circuit has to be complete, ie: no stops activated

Limit switches in normal position and not activated.

Torque element (Over torque) must not be activated.

Rotation Timer is within the time limit. (In remote mode only).

4.4.2 Interlocks

The bridge drive affects the operation of the scum pumps. See scum pump section (Section 7) for details.

4.4.3 Operating Modes

The Bridge Drives can be operated in any one of the three modes – Local/Manual, Remote/Manual or Remote/Auto.

The spray pumps have only local control, and their control status is not displayed on the SCADA. A local timer provides adjustable run time, should the spray pump be inadvertently left on.

4.4.3.1 Bridge Drive Operating Modes

Local/Manual Mode

Local/Manual operation is achieved by setting the Local/Remote selector to Local. The selector switch and push buttons are located on the FST 7&8 switchboard.
The drive can now be started and stopped independently of the PLC via the local pushbuttons. However activation of any of the bridge limit switches or overload function will still stop the drive.

Remote / Manual Mode

When the selector is in Local, the Manual/Auto toggle on the SCADA screen will be "greyed-out". When the Control Mode Selector is set to "Remote", the operator can set the remote control mode to either Manual or Auto. Note: the previous setting, either Manual or Auto, must be remembered by the system when it is returned to Remote after having been set to Local Manual.

In Remote/Manual mode, the drives can be started and stopped via buttons on the SCADA screen. The bridge drive speed is not monitored and cannot be adjusted on the SCADA.

All fault protection will be available in Remote/Manual Mode to stop a drive that develops a fault. The drive will not start automatically after a power outage.

Remote / Auto Operation

Remote/Auto mode is normally used to operate the Bridge Drives. When Remote/Auto mode is selected, and the drive is "healthy", the Bridge Drive will start as per start sequence. When the power returns after a power outage, the drives will start automatically, (the PLC will provide timed re-starting of drives, to avoid all drives starting at the same time upon power resumption).

Alarms per Bridge Drive (1 off each FST)

	Alarm Description	Source	Latched	Action	Alarm Category
1.	Over-Torque Alarm	"Torque Element" input turns on	Latched	Inhibit drive operation	?
2.	Failed to Start	"Running" signal not received within 5 sec of request to start	Latched	Inhibit drive operation	?
3.	Control Power Unavailable	"Control Power Available" input turns off	Not latched	Inhibit drive operation	?
4.	VSD Not Ready	"VSD Ready/Auto" input turns off	Not latched	Inhibit drive operation	?
5.	Field Circuit Fault	"Field Circuit Isolator Healthy" input turns off	Not Latched	Inhibit drive operation	?
6.	Bridge Stopped	For Any Reason (This alarm is used to generate a dial out alarm for the Bridge)	N/A	Information Only	1

7.	Failed to Stop	Running" signal still on 5 secs after Run Signal removed (Only in Remote Mode)	Latched	Inhibit drive operation	?
8.	Rotation Failure	Bridge Running but Rotation Input not activated	Latched	Information Only	1
9.	ESTOP	Emergency Stop Signal turns off	Latched	Inhibit drive operation	1
10.	Arm or Track Limit	Input turns off	Latched	Inhibit drive operation	?

Table 8: Bridge Drive Alarm Table

4.4.3.1 Spray Pump Operating Modes

The spray pumps have only Local control with "running" indication to the SCADA. In addition, they are usually controlled by a timer relay, but can be started and stopped via the local pushbuttons on the MCC. The timer circuit incorporates a bypass switch to enable the Spray pumps to run continually.

4.5 SCADA Information

4.5.1 SCADA Display

For each FST: (2 OFF)

- Bridge Drive control mode: Local/Manual, Remote/Manual, Remote/Auto
- Bridge Drive Status: Healthy/Fault
- Rotation Time / Rotation Time Setpoint
- Spray Pumps: Running /Off

4.5.2 Tags

Tag	R/W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
BY AIT	R	BY AIT						

LEGEND: see section 2.5.2.								

Table 9: FST Bridge Drive & Spray Pump Tag List

4.5.3 SCADA Control

For each FST Bridge Drive:

- When the selector switch is set to Remote: Auto/Manual select
- When the bridge drive is in Remote/Manual mode: Start/Stop select
- FST Fault Reset
- Rotation time set point

4.6 PLC information

4.6.1 Related IO

PLC Address	Description	Notes
%I081	Remote Selected	MV71
%I082	VSD Running	MV71
%I083	VSD Ready/Auto	MV71
%I084	Enable	MV71
%I085	Isolator Healthy	MV71
%I086	Control Supply	MV71
%I089	Remote Selected	MV81
%I090	VSD Running	MV81
%I091	VSD Ready/Auto	MV81
%I092	Enable	MV81
%I093	Isolator Healthy	MV81

%I094	Control Supply	MV81
%Q001	Run Enable	MV71
%Q002	Reset	MV71
%Q003	Fault Indicator	MV71
%Q005	Run Enable	MV81
%Q006	Reset	MV81
%Q007	Fault Indicator	MV81
%I029	Spray Pump Running Indicator	MF73
%I030	Spray Pump Running Indicator	MF83
%I033	Bridge 7 E-stop	FST 7
%I034	Bridge 7 Plough Arm & Track Wiper Limit Switches	FST 7
%I035	Bridge 7 Torque Element	FST 7
%I036	Bridge 7 Rotation Proximity Switch	FST 7
%I041	Bridge 8 E-stop	FST 8
%I042	Bridge 8 Plough Arm & Track Wiper Limit Switches	FST 8
%I043	Bridge 8 Torque Element	FST 8
%I044	Bridge 8 Rotation Proximity Switch	FST 8

Table 10: List of I/Os Associated with FST 7&8 Bridge Drive & Spray Pumps

5. FST Sludge Blanket level Monitoring

5.1 Process Overview

Solids flocculate and settle to the bottom of each FST. Settled solids are forced out via the RAS pipe by water pressure. Each tank has one level monitor to provide the height of the sludge in the tank comprising a Royce series ultrasonic level transmitter and detector. The detector is mounted under the bridge and the

transmitter is mounted at the middle of the bridge. Sludge blanket level is not used for control purposes, but indication only on the SCADA.

5.2 Equipment

Equipment	Tag	Process Media	Location
Sludge Level Transmitter	LT_0617-001	Sludge Level	FST 7
Sludge Level Sensor	LE_0617-001	Sludge Level	FST 7
Sludge Level Transmitter	LT_0618-001	Sludge Level	FST 8
Sludge Level Sensor	LE_0618-001	Sludge Level	FST 8

Table 11: Sludge Blanket Level Monitoring Equipment List

5.3 Control System Overview

Sludge Blanket Level monitor installed in each FST provides the Operator with information to optimise RAS flow rates, particularly during high flow periods.

5.4 Operation

The control system monitors the values received from the sensors and provides an alarm on high blanket level. The blanket levels are also recorded for trending, but there are no control functions provided by the Sludge Blanket Level monitor.

The Sludge Blanket Level analogue inputs are evaluated against a set point in the PLC. If the level input is higher than the set point for 30mins. The sludge high level alarm will be activated.

5.4.1 Interlocks

There are no interlocks with any other equipment in any mode of operation.

5.4.2 Required Set Points

FST Sludge Blanket Hi Level Alarm Set point = TBAmm (range 0 - 3000mm)

5.4.3 Alarms

High level alarm should be activated if sludge level signal is above High Level alarm set point for 30mins. Alarm is for indication only.

Invalid alarm should be activated when analogue signal is out of 4-20mA range.

5.5 SCADA Information

5.5.1 Display

For Each FST (1 off):

- Sludge Blanket Level (m) one value per FST

5.5.2 Tags

Tag	R/W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
BY AIT	R	BY AIT						
LEGEND: see section 2.5.2.								

Table 12: FST Sludge Blanket Tag List

5.5.3 Control

The Operator can input the following control function:

For each FST

- Sludge Blanket High Level Alarm Setpoint (mm)

5.6 PLC information

5.6.1 Related IO

PLC Address	Description	Notes
%AI025	SLUDGE LEVEL	Sludge Level FST 7
%AI027	SLUDGE LEVEL	Sludge Level FST 8

Table 13: Sludge Blanket I/O List

6. RAS FLOW CONTROL

6.1 Process Overview

The Return Activated Sludge (RAS) flow control arrangement for FST 7&8 consists of 2 flow control valves, and 2 flow meters. The 2 RAS valves are actuated modulating valves that display their current position (0-100 %). The valves allow RAS from the FST's, to flow into the existing RAS Wet Well. Each valve is modulated to regulate its flow to a set point (entered on the SCADA) using a flow signal from its associated flow meter.

6.2 Equipment

Equipment	Tag	Process Media	Location
Flow Meter FST 7 RAS	FE_0617-001	RAS	FST 7 RAS
Flow Meter FST 8 RAS	FE_0618-001	RAS	FST 8 RAS
Sludge Flow Control Valve FST 7	FCV_0617-001	RAS	FST 7 RAS
Sludge Flow Control Valve FST 8	FCV_0618-001	RAS	FST 8 RAS

Table 14: RAS Flow Control Equipment

6.3 Control System Overview (Subject to review)

6.3.1 RAS flow control valves

The valve actuators are Rotork Model IQ12F10A. Each Rotork actuator is fitted with a proportional control unit which allows the actuator to control the position of the valve in proportion to a continuous 4-20mA analogue input current signal.

Selectors are provided on the actuator's electrical control cover, one for Local/Stop/Remote selection, pad-lockable in each position and the other for Open/Close Control. This latter switch is for local manual control of the valve i.e. manual control from the actuator itself. The Valve Monitor Indicator digital input from the actuator is active when the valve is available for remote control i.e. control via the PLC.

This signal is inactive when any of the following conditions is true:

- Loss of one or more of the power supply phases
- There has been a motor thermostat trip
- The actuator mounted local stop selected
- The actuator mounted local control selected
- Loss of control circuit supply

The valve position analogue input from the actuator and the valve operation analogue output to the actuator are both linear signals i.e. 4-20 mA DC proportional to valve position.

6.3.2 RAS Flow Meters

These are magnetic flow meters which produce a 4-20 mA DC signal proportional to the RAS flow rate. Flow Meter range TBA.

6.4 Operation

The RAS flow control valves regulate the flow of RAS from the FST's to the RAS Wet Well. The flow is regulated to a set point entered via the SCADA.

The flow is set at a rate to keep the sludge blanket in the FST's to an acceptable level. The sludge blanket level monitor is for indication only and offers no control.

In addition, RAS flow control valve will close completely if reverse flow is detected by RAS flow meter.

6.4.1 Operating Requirements

Both valves must be available for operation in the selected mode.

6.4.2 Interlocks

RAS flow control valves will close if 'RAS wet well high signal is received from existing PLC05,

RAS flow control valves will close if a Reverse Flow alarm is activated.

RAS flow control valves will close if a RAS Pumps fail signal is received from existing PLC05.

6.4.3 Failure responses

6.4.3.1 Valve Unavailable

If a valve becomes unavailable, due to any of the basic operating requirements are acceptable, the valve will maintain its current position. Once all the operating requirements become met again, the valve is ready for operation and will operate according to the description for the mode that it is in.

The *Valve Monitoring Indicator* input to the PLC indicates the actuators availability for Remote control. When switched to Local, and the valve is ready for operation, it can be opened and closed using the local controls on the actuator. However, when switched to Local, the Actuator Available input goes off, raising an alarm on SCADA, but the valve can still be available for local operation. The *Valve Monitoring Indicator* input can also go off if a fault occurs, or there is no power to the valve.

In addition, PLC monitors the open limit and close limit of the valves position. SCADA will indicate when either open/close limit is reached.

6.4.3.2 PLC Failure

PLC failure results in the loss of the monitoring and alarming functionality that is provided by the PLC and SCADA. The PLC's ability to control the valve is also lost, and the valve will stay in the position that it was in before the failure.

6.4.4 Operating Modes

There are three main operating modes;

- Remote Auto

- Remote Manual
- Local Manual

6.4.4.1 Operating Mode Selection

The operating mode is able to be set to either "Remote Auto" or "Remote Manual" via the SCADA. "Local" mode is selectable from a switch on the actuator. If "Local" is selected, remote modes are unavailable and the PLC has no control over the valve.

6.4.4.2 Remote Auto

In Remote Auto the PLC modulates the RAS valves via PID Control loops to achieve the desired flow set points. The flow set points can be determined in one of three ways as described below.

1. "Flow Paced RAS Control" where the overall RAS flow rate is adjusted so as to be a ratio of the overall plant inflow rate and the RAS flow Setpoint is proportioned as per the respective weir lengths on the bioreactors that feed the FSTs. (Calculations done in PLC05)
2. "Fixed Plant RAS Control" where the overall RAS flow rate is fixed by the Operator and would be proportioned as per Option 1. (Calculations done in PLC05)
3. "Fixed FST RAS Flowrate Control" where the flow rates from sources Distribution chambers 1 & 2 and FSTs 7&8, can be entered separately. Generally, this mode would be used when short term tank maintenance such as cleaning weirs and launder channels is required. The RAS flow rate would be entered by the Operator/Process Engineer. Due care to enter appropriate RAS flows would be required as this mode is likely to be a higher risk than the other modes. There is one Setpoint per tank in this mode.

For options 1 and 2, the flow rate set points are determined in the existing RAS PLC (PLC05). They are transmitted via Ethernet Communications from the RAS PLC (PLC05) to the Final Settling Tank 7&8 PLC (PLC15). There is one setpoint per tank. In effect PLC15 will either be in Fixed FST RAS flow rate control, or it will be getting a set point from PLC05. NOTE: The calculations and description for these modes are contained in the Functional Specification for PLC05 (To be updated by QUU).

The PID Control Loop is to be slow acting so as not to cause large disturbances in the level of the RAS well.

The RAS well level is typically below the level of FST7&8 so as to allow hydraulic flow from FST7&8 through to the RAS Well. However, under certain circumstances, such as RAS Pump failure or Power Failure the RAS well can build up to a level that is higher than FST 7 and 8, and backflow would be possible to FST 7 & 8. Non-return valves are to be fitted to reduce this possibility.

In the event of a RAS Backflow Alarm the RAS Valves are to close. A Category 1 alarm will contact the operator immediately.

If the RAS Well reaches a High Level then the RAS Valves are to close. A signal will be sent from PLC05 to enable RAS Valve Operation.

If the RAS Pumps Fail then the RAS Valves are to close. A signal will be sent from PLC05 to enable RAS Valve Operation.

In the event of Flow meter Failure the valve will remain in its current position. The operator can switch the control to Remote-Manual to further control the valve. A Category 1 alarm will contact the operator immediately.

In the event of Communications failure to PLC05 the RAS valves are to remain in their current position, unless the backflow condition above is detected. A Category 1 alarm will contact the operator immediately.

In Auto Control the RAS Valves are to modulate between Minimum and Maximum Position Set points. The Set points for each valve are to be adjustable on the SCADA screen.

6.4.4.3 Remote Manual Operation

When Remote/Manual is selected, the operator can enter the desired valve position into the SCADA, and the valve is then driven to that position. The automatic RAS flow control function is turned off in this mode.

6.4.4.4 Local Operation

In this mode the operator must switch the actuator to 'Local' using the selector switch on the local controls on the actuator and set the desired position by using the local (Open/Close) control switches.

6.5 SCADA Information

6.5.1 SCADA Display

Total for FSTs (2 off):

- RAS Flow 24 hour Average. (This is a rolling average of the previous 24hrs flow rate, displayed as "ML/day" and updated once every 15 minutes)

Total for FSTs (2 off):

- FST Total RAS flow rate (L/s and also ML/day), which is the sum of the flow rates measured by the two individual FST RAS flow meters.

For Each FST (2 off):

- FST RAS flow (L/s) (Note: when the flow rate drops below 5 L/s, the displayed value is to be automatically zeroed, ie; displayed as 0 L/s)
- FST RAS required flow rate Set point (L/s)
- RAS control valve actual position (%)
- RAS open/close Limit reached

Alarms displayed on the Alarm Page (2 off):

- RAS flow valve failed.
- RAS HiHi, Hi, Lo and LoLo Alarms
- RAS flow invalid (outside of 4 – 20mA range)
- RAS reverse flow alarm

6.5.2 Tags

Tag	R/W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
	R	BY AIT		DIG				
	R	BY AIT		DIG				
LEGEND: see section 2.5.2.								

Table 15: RAS Flow Control Tags

6.5.3 SCADA Control

The Operator can input the following control functions:

Global Set points for FST 7&8:

- Maximum RAS Flow rate Set point for each FST (L/s)
- Minimum RAS Flow rate Set point for each FST (L/s)

For each FST (2 off):

- RAS Control Valve Remote/Manual and Remote/Auto selection
- In Remote/Manual: RAS Control Valve Position (%)
- In Remote/Auto: Required Flow rate Control Set point (0 - ???L/s)
- FST RAS Flow Set Points (Low/low, Low, High and High/High).
- In Remote/Auto RAS Valve Min Position (0..100%)
- In Remote/Auto RAS Valve Max Position (0..100%)

6.6 PLC information

6.6.1 Related IO

PLC Address	Description	Notes
%AI005	RAS Flow Meter	FIT 0617-001
%I117	RAS Flow Meter Forward	FIT 0617-001
%I118	RAS Flow Meter Reverse	FIT 0617-001
%AI007	RAS Flow Meter	FIT 0618-001
%I119	RAS Flow Meter Forward	FIT 0618-001
%I120	RAS Flow Meter Reverse	FIT 0618-001
%AI017	VALVE Position Input	FCV 0617-001
%AI019	VALVE Position Input	FCV 0618-001
%AQ001	VALVE Position output	FCV 0617-001

%AQ002	VALVE Position output	FCV 0618-001
%I097	VALVE Monitor Indicator	FCV 0617-001
%I098	VALVE Remote Selected	FCV 0617-001
%I099	VALVE Fully Open	FCV 0617-001
%I100	VALVE Fully Close	FCV 0617-001
%I101	VALVE Monitor Indicator	FCV 0618-001
%I102	VALVE Remote Selected	FCV 0618-001
%I103	VALVE Fully Open	FCV 0618-001
%I104	VALVE Fully Close	FCV 0618-001

Table 16: List of I/Os Associated with RAS Flow Control

7. FST SCUM PUMPS & SCUM FLOW METER

7.1 Process Overview

Mixed liquor enters the FST through the centre column into the energy dissipating inlet and is contained by the flocculation skirt. The flocculation skirt is submerged approximately 50mm below the water line. This allows scum to float over the flocculation skirt. The scum scraper guides the scum to the FST extremities where the hinged scum skimmer blade pushes the scum up the submerged scum box beach where the scum is extracted from the FST.

Under normal Auto operation, the Scum Pumps are activated via 2 limit switches mounted at the drive end of the FST Bridge. One limit switch is dedicated to one scum pump. The limit switch is mechanically activated by striking a metal arc while the bridge travels through a set distance to be determined. The scum pumps will stay activated during this period until the limit switch is de-energised.

All delivery of scum is combined to a single rising main and monitored by an electromagnetic flow meter.

7.2 Equipment

Equipment	Tag	Process Media	Location
FST Scum pump	MF71	Scum	FST 7 Scum
FST Scum Pump	MF72	Scum	FST 7 Scum
FST Scum pump	MF81	Scum	FST 8 Scum
FST Scum Pump	MF82	Scum	FST 8 Scum
Sump Pump	PU_0617-001	Sump Water	For Scum Pump 71
Sump Pump	PU_0617-002	Sump Water	For Scum Pump 72
Sump Pump	PU_0618-001	Sump Water	For Scum Pump 81
Sump Pump	PU_0618-002	Sump Water	For Scum Pump 82
Scum Pump Activation Switch 71			FST 7
Scum Pump Activation Switch 72			FST 7
Scum Pump Activation Switch 81			FST 8
Scum Pump Activation Switch 82			FST 8
Flow Meter	FE-0617--006	Scum	Scum Transfer

Table 17: Scum Pump Equipment List

7.3 Control System Overview

In normal operations (Remote/Auto) the scum pumps operate without input from the Operator, however the Scum Pumps can be operated in Local/Manual or Remote/Manual if required.

In Remote/Auto mode, the Scum Pumps are activated via 2 limit switches. There are 4 limit switch activation arc on each tank (2 per limit switch) on each tank mounted 180° apart on the external wall of the FST, each activation will run the relevant scum pump while the limit switch is on the activator. For each full revolution of the bridge, both scum pumps will run twice, due to their locations only a single pump will run at any time.

The flow meter which is positioned on the combined scum line measures scum transfer from FST 7 and FST 8 continually. To prevent over pressurisation, the scum flow rate is checked while any of the scum pumps are running, if any of the pump are running and no flow is detected, an alarm is to be activated and the scum pumps are to be stopped immediately.

No control is required for the sump pumps located in the scum pump pits.

7.4 Operation

7.4.1 Operating Requirements in Remote/Auto Mode

Bridge Drive is running.

Scum Pump available & no fault.

The Scum pump Limit switch is activated

No emergency stop activated.

No flow alarm is not activated.

Flow meter reading is valid

7.4.2 Interlocks

In auto mode, the scum pumps are indirectly linked to the bridge's operation. The scum pumps are activated due to bridges rotation.

7.4.3 Failure responses

Drive Unavailable

If a Scum Pump becomes unavailable, due to any of the basic operating requirements not being met, the Scum Pump will stop. Once all the operating requirements are met again, the Scum Pump is ready for operation and will operate according to the description for the mode that it is in.

PLC Failure

PLC failure results in the loss of the monitoring and alarming functionality that is provided by the PLC and SCADA. The Scum Pumps will remain operational while the bridge is rotating.

7.4.4 Operating Modes

The Scum Pump can be operated in one of three modes – Local/Manual, Remote/Manual, or Remote/Auto.

7.4.4.1 Local/Manual Mode

Local/Manual operation is achieved by setting the Local/Remote selector to Local.
The pump can now be started and stopped via the local pushbuttons without any PLC control. When the selector is in Local/Manual mode, the Manual/Auto toggle on the SCADA screen will be "greyed-out".

7.4.4.2 Remote / Manual Mode

When the Control Mode Selector is set to "Remote", the operator can set the remote control mode to either Manual or Auto. Note: the previous setting, either Manual, or Auto, must be remembered by the system when it is returned to Remote after having been set to Local/Manual.

In Remote/Manual mode, the pumps can be started and stopped via buttons on the SCADA screen.

All fault protection will be available in Remote/Manual Mode to stop the pump should it develop a fault, however the pump will not start after a power outage.

7.4.4.3 Remote / Auto Operation

Remote/Auto mode is the normal operating mode for the scum pumps, when Remote/Auto mode is selected, and the drive is "healthy", the Scum pump will run whenever the relevant limit switches are activated, with each full rotation

triggering the pump's operation twice. When power returns after a power outage, the pumps will start automatically. (Refer to the section 9.8)

7.4.5 Alarms per pump (4 off)

	Alarm Description	Source	Latched	Action	Alarm Catagory
1.	Pump Fault Alarm	"Overload" input turns on	Latched	Inhibit pump operation	?
2.	Failed to Start	"Running" signal not received within 5 sec of request to start	Latched	Inhibit pump operation	?
3.	Control Power Unavailable	"Control Power Available" input turns off	Not latched	Inhibit pump operation	?
4.	Excessive run time	Excessive run time	Not Latched	Inhibit pump operation	?
5.	No Run	No activation detected after one full bridge rotation			?
6.	Failed to Stop	"Running" signal still on after run request removed	Latched	Inhibit pump operation	?

Table 18: Scum Pump Alarms

7.4.6 Flow Meter alarm

Low flow alarm, when flow rate is less than TBA L/s and pump is running.

One alarm for each pump. (2 off per FST)

7.5 SCADA Information

7.5.1 SCADA Display

For Each Scum Pump: (2 off per FST)

Scum pump operating mode: Local/Manual, Remote/Manual or Remote/Auto

Scum pump status: Running / Fault

Scum pump operating time

For Scum Flow meter:

Scum flow rate (L/s)

Scum Flow total KL today

Scum Flow total KL yesterday

7.5.2 Tags

Tag	R/W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
BY AIT	R	BY AIT						
LEGEND: see section 2.5.2.								

Table 19: Scum pump & Scum flow meter Tag List

7.5.3 SCADA Control

For each scum pump (4 OFF) :

- Auto / Manual select
- If Remote manual mode is selected: Start / Stop
- Fault Reset

7.6 PLC information

7.6.1 Related IO

PLC Address	Description	Notes
%I009	Scum pump Control Power	MF71

	Available	
%I010	Scum pump Overload	MF71
%I011	Scum pump Reset	MF71
%I012	Scum pump Running	MF71
%I013	Scum pump Remote Selected	MF71
%I014	Scum pump Isolator Healthy	MF71
%I017	Scum pump Control Power Available	MF72
%I018	Scum pump Overload	MF72
%I019	Scum pump Reset	MF72
%I020	Scum pump Running	MF72
%I021	Scum pump Remote Selected	MF72
%I022	Scum pump Isolator Healthy	MF72
%I065	Scum pump Control Power Available	MF81
%I066	Scum pump Overload	MF81
%I067	Scum pump Reset	MF81
%I068	Scum pump Running	MF81
%I069	Scum pump Remote Selected	MF81
%I070	Scum pump Isolator Healthy	MF81
%I073	Scum pump Control Power Available	MF82
%I074	Scum pump Overload	MF82
%I075	Scum pump Reset	MF82
%I076	Scum pump Running	MF82
%I077	Scum pump Remote Selected	MF82

%I078	Scum pump Local Selected	MF82
%I037	Limit Switch Input for MF71	FST 7
%I038	Limit Switch Input for MF72	FST 7
%I045	Limit Switch Input for MF81	FST 8
%I046	Limit Switch Input for MF82	FST 8
%Q009	Scum Pump Run Command	MF71
%Q010	Scum Pump Fault Reset	MF71
%Q011	Scum Pump Run Command	MF72
%Q012	Scum Pump Fault Reset	MF72
%Q013	Scum Pump Run Command	MF81
%Q014	Scum Pump Fault Reset	MF81
%Q015	Scum Pump Run Command	MF82
%Q016	Scum Pump Fault Reset	MF82
%AI009	Scum Flow Meter (4-20mA)	FIT_0617-006
%I121	Scum Flow Meter Forward	FIT_0617-006
%I122	Scum Flow Meter Reverse	FIT_0617-006

Table 20: List of I/Os Associated with Scum Pumps & Scum Flow Meter

8. FLOW METER PIT NO. 2

8.1 Process Overview

Effluent overflow from FST's 7&8 flows to meter pit No.2, where the flow rate is measured via an electromagnetic flow meter. There is no PLC control required.

A sump pump is installed in the flow meter pit to discharge any collected rain water or accidental spillage at the flow meter connection. It is controlled by

integrated float switches, and the level is indicated on SCADA via a multi-trode level controller.

8.2 Equipment

Equipment	Tag	Process Media	Location
Flow Transmitter	FIT_0610-003	Effluent	Flow Meter Pit No2
Flow Chamber No 2 Sump Pump	PU_0610-001	Sump Water	Flow Meter Pit No2
Multi-trode Probe	LT_0610-001	Sump Water	Flow Meter Pit No2

Table 21: Flow Meter Pit No.2 Equipment List

8.3 Control System Overview

PLC Monitors the effluent flow rate only.

The 240V sump pump is designed to operate specifically via the float switches.

8.4 Operation

8.4.1 Interlocks

There are no interlocks with any other equipment in any mode of operation.

8.4.2 Flow Meter Control

The PLC monitors the flow rate data continually via an analogue input 4-20mA DC proportional to the flow rate. Flow data is alarmed when the effluent flow set points are reached. The set points are Low/Low, Low, High, High/High and are adjustable in SCADA. The alarm is indicative only.

8.4.3 Sump Pump Control

The 240V sump pump is designed to specifically operate via the float switches.

Level indication/monitoring will be provided via a multi-trode level controller which would also provide indication on SCADA.

8.4.4 Alarms

8.4.4.1 Flow Meter Alarms

An alarm is active when flow meter reading is not available.

Flow meter reading is invalid (outside of the 4 – 20mA range)

Flow alarms are active when the flow rate reaches four operator adjustable setpoints, (low/low, low, high and high/high alarms)..

Flow meter detects a reverse flow.

8.4.4.2 Sump Pump Alarms

Level indication/monitoring will be provided via a multi-trode level controller which would also provide indication on SCADA. (High & high/high alarms)

8.5 SCADA Information

8.5.1 SCADA Display

- Effluent Flow Rate (l/s)
- Effluent Flow Total Today (kL)
- Effluent Flow Total Yesterday (kL)
- High Level - when sump water in pit reaches high level.
- High high Level - when sump water in pit reaches high high level.

8.5.2 Tags

Tag	R/W	PLC Address	Description	Type	Ctl	Alm	Trn	NOTES
BY AIT	R	BY AIT						
LEGEND: see section 2.5.2.								

Table 22: Flow Meter Pit No 2 Tag List

8.5.3 SCADA Control

No control via SCADA

8.6 PLC information

8.6.1 Related IO

PLC Address	Description	Notes
%I027	LEVEL High	Multi-Trode
%I028	LEVEL High/High	Multi-Trode
%AI011	Effluent FLOW Meter (4-20mA)	FIT 0610-003
%I123	Flow Meter Forward Counter	FIT 0610-003
%I124	Flow Meter Reverse Counter	FIT 0610-003

Table 23: List of I/Os Associated with Flow Meter Pit No 2

9. PLC MISCELLANEOUS UTILITIES

9.1 Total Drive Run Hours

Drive Run and Valve open/close Hours totalisation is carried out in the PLC for each of the following devices:

- Mixed Liquor Slide gate Valve SG_0511-001 (open/closed)
- Mixed Liquor Slide gate Valve SG_0512-001 (open/closed)
- Scum Pump MF71
- Scum Pump MF72
- Scum Pump MF81
- Scum Pump MF82
- FST Bridge Drive 7 MV71
- FST Bridge Drive 8 MV81
- RAS Flow Control Valve 1 FCV_0617-001 (open/closed)
- RAS Flow Control Valve 2 FCV_0618-001 (open/closed)

All values are to be retentive in the SCADA when power failure occurs.

9.1.1 Daily Run Hours

The Daily Drive Run Hours are to be incremented while the drive is running, and stored retentively via the PLC to a resolution of 1 second. Values to be available for reading by the SCADA are:

- Current Day Run Hours (INT 0 to 24)
- Current Day Run Minutes (INT 0 to 59)
- Previous Day Run Hours (INT 0 to 24)
- Previous Day Run Minutes (INT 0 to 59)

At midnight a pulse will be auto generated by the SCADA, the PLC will copy the Current Day values to the Previous Day values, and then clear the Current Day values to zero.

9.2 Total Operations Counter

Equipment Operations (Number of Starts) totalisation is carried out in the PLC for each of the devices listed in section 9.1Drive Run Hours Totalisation.

All values are retentive in the SCADA when power failure occurs.

9.2.1 Daily Total Operations Counter

At each start of a drive, its Daily Total Operations Counter is to be incremented by 1. Values to be available for reading by the SCADA are:

- Current Day Total Operations (INT 0 to 1,000)
- Previous Day Total Operations (INT 0 to 1,000)

At midnight a pulse will be auto generated by the SCADA, the PLC will copy the Current Day values to the Previous Day values, and then clear the Current Day values to zero.

(Flow totalisation will be carried out in the PLC by integrating the Analogue Flow signal)

9.3 Flow Totalisation

Flow totalisation is carried out in the PLC for each of the following flow meters:

- Mixed Liquor Bioreactor 1
- Mixed Liquor Bioreactor 2
- RAS Flow Meter 1
- RAS Flow Meter 2
- Scum Flow Meter
- Effluent Flow Meter

All values are to be retentive in the SCADA when power is cycled.

- Current Day Total Flow (REAL 0 to XXXX kL)
- Previous Day Total Flow (REAL 0 to XXXX kL)

At midnight a pulse will be auto generated by the SCADA, the PLC will copy the Current Day values to the Previous Day values, and then clear the Current Day values to zero.

9.4 Power Monitoring

Siemens SENTRON PAC3200 power monitoring device indicates the power consumption for the FST 7 & 8 MCC and performs important measurements such as voltage, current, power, power factor and other power parameters.

Via an Ethernet communication interface, FST 7&8 MCC power data is transferred to the PLC. Power data is to be retentive in SCADA.

The Ethernet Address is 192.168.151.085

SCADA is to display and trend the following:

- KW
- KVA
- KVAR
- PF
- KW max
- KWH
- V per phase
- I per phase
- Total daily KWH

Values for kW, KVar, and kVA are to be totalised each day.

At midnight a pulse will be auto generated by the SCADA, the PLC will copy the Current Day values to the Previous Day values, and then clear the Current Day values to zero.

The under voltage relay installed on the incomer also monitors the phase voltage, it has a normally closed contact input to the PLC, which is for indication only.

9.5 Lighting Control

Dusk till Dawn information is provided from existing PLC 3. (PE cell)

SCADA Display:

- Lighting: On/Off/Auto

SCADA Control:

- Auto / Manual
- In Manual Mode: On/Off Switch

9.6 Standard PLC alarms

PLC automatically generates 27 standard alarms such as: Lo Battery, Failed Battery and CPU Hardware Fault etc. These are to be displayed on the SCADA.

9.7Alarm Discrimination

The PLC is to detect a Power Failure to the switchboard by monitoring the 24VDC Power Supply and the Phase Failure Relay. If a power failure is detected, then all drives are to be stopped, and all alarms from the PLC inhibited. A single alarm will be sent to the Operator indicating a Power Failure.

In addition alarm discrimination is to be included in all PLC logic, so that multiple alarms are not generated from a single fault. For example if the Main Circuit Breaker for a drive is tripped, then only a single alarm for the drive will be generated – "Control Power Unavailable". All other alarms are masked on a time delay.

Details of the alarm category refer to QUU document "Citect HMI Standards v2.5.doc".

9.8 Drive start sequence

On power restoration the system is to generate a RESET to all drives and PLC logic after a time delay of 30 seconds to enable all devices to power up.

When system restart after a power failure event, PLC to resume the drive operation following the sequence table below:

Drive Tag	Drive Description	Time-delay
MV71	FST Bridge 7 Drive	65 s
MV81	FST Bridge 8 Drive	70 s
FCV_0617	RAS Flow Control Valve 1	75 s
FCV_0618	RAS Flow Control Valve 2	80 s
MF71	FST 7 Scum Pump 1	85 s
MF72	FST 7 Scum Pump 2	90 s
MF81	FST 7 Scum Pump 1	95 s
MF82	FST 7 Scum Pump 2	100 s

Table 24: Drive start sequence table

9.9 PLC Standard Blocks

QUU requires the standard PLC blocks which have been developed for the Rx3i PLC to be used for all motors, valves and analogue devices.

All drives are to use the BWDRIVE block

All analogs are to use the BWANALOG BLOCK

All valves are to use either the BWCVALVE, BWPVALVE or BWBiVALVE BLOCKs.

All PID's are to use the bwPID block

All alarms are to use the BWALARM block

A copy of the blocks is available from QUU.

9.9.1 Tag Naming Convention

The standard tag naming conventions shall be as follows.

DddddEeeeeTtXxxxx

Where Ddddd = Device/Area Identification (ID) (eg. BR001 = Bioreactor 1, BR2Z4 = Bio 2 Zone 4 etc)

Eeeee= Equipment Indentification (ID) (eg PU001 for pump No.1, MX001 for Mixer No.1 etc)

tt= Tag Type (eg. 'ds' for status, 'dq' for digital output, 'as' for analog status etc)

Xxxxx = Tag Name (eg ThermalOLoad etc up to 15 characters)

Tag naming Rules

- Total tag name cannot exceed 27 characters. (5 characters representing the site ID are prefixed when the Citect Tags are generated to give a total of 32 characters).
- For the newer sides (e.g. BWEA/New BW Ellipse Naming conventions) the Equipment number must match the P&ID's/Ellipse number. In this case the DeviceId (Ddddd) can be dropped and just the equipment number used in the PLC program. The Device/PLC must be reinstated when developing the Citect tags. (E.g. Fairfield Inlet PLC tag would be FV0520005.dsOpen, Citect Tag becomes ST002INL01 FV0520005dsOpen)
- The use of upper and lower case to split up the tag name is allowed. Eg. ST032Tnk01Vlv01dsFault

- Devices and Equipment can be split up to include more information if required (eg. BR3Z4 = Bioreactor 3 Zone 4, or AEREQ = Aeration Equipment etc).
- Tag name and description of digital Variable tags shall relate to the tag in the 'ON' (1) state (eg ...VLV01dsOpen)
- All variable tags must have an appropriate comment included.
- Under no circumstance are raw inputs on the PLC to be mapped directly to SCADA. All inputs are to be mapped to 'ds' registers for use in SCADA. This is required to code for consequential alarming.

Some examples are:

(ST034) HYP01PU002dsRunning = Karana Hypo System No.1 Pump No.2 Running status

(ST012) SCN01FLW03asVolume = Wynnum Screen No.1 Flow meter No.3 Volume

(ST002BIO01) FV0520005dsOpen = Fairfield Bioreactor 1 Valve FV0520005 Open Status

The Citect screen is to be approved by Queensland Urban Utilities, who use standard **genies** for flow direction, pipe sizes, colour, and popup boxes. The existing Citect pages on site are to be used as a guide.

All analog displays are to use the "BW AI Test Right + Super Genie Popup"

All motors are to use the "BW Motor 2 Genie + Super Genie Popup"

The SCADA tags are to be the same as the PLC Tags, except with the addition of the site number "ST032" at the front of each tag.

9.10 PLC Time Update

The PLC time and date is to be displayed on the SCADA. The SCADA system will send a pulse each day at 12:30PM to synchronise the PLC times.

9.11 PLC Fault Tables

The Rx3i PLC has a controller fault table and an IO Fault Table. The fault tables are able to be reset from SCADA in the event of a fault.

9.12 Emergency Stops

There are a total of nine emergency stops installed either on the FSTs or around the FST 7&8 Area. All emergency stops are hardwired to the allocated drive/panel, if activated it will stop the drive without the involvement from the PLC.
However, the PLC monitors the status of each emergency stop, and will generate an alarm when any of the emergency stops are activated. In particular, the switchboard emergency stop will stop all operations on FST 7&8, which will be a category 1 alarm.

9.12.1 Related IO

PLC Address	Description	Alarms
%I057	Emergency Stop Switchboard	1
%I058	Emergency Stop Scum Pump 71	?
%I059	Emergency Stop Scum Pump 72	?
%I060	Emergency Stop Scum Pump 81	?
%I061	Emergency Stop Scum Pump 82	?
%I062	FST 7 Emergency Stop 1 & 2	?
%I063	FST 8 Emergency Stop 1 & 2	?

Table 25: List of I/Os Associated with Emergency Stops

10. PLC COMMUNICATIONS (PLC 15)

10.1 Overview

All PLC Peer to Peer is done via the GE Ethernet COMM_REQ Protocol. Messages are produced and received between peer PLCs via a 1GB fibre optic network.

10.2 Inter-PLC Communications

The PLC's communicate with each other via the 1Gigabit Fibre network. The network itself consists of a fibre ring topology with Moxa ethernet switches stationed at each PLC. Each Moxa switch has eight copper ethernet ports, one of which is at 1 gigabit. Each main PLC rack contains one or more Ethernet cards, each with two ports. The Ethernet card for FST 7&8 PLC is configured with the following address:

PLC 15 IP address	192.168.151.065
MOXA IP address	192.168.151.045
SIEMENS POWER METER	192.168.151.085

Full network allocation table see Appendix A.

These addresses are available to the whole Queensland Urban Utilities Network and are connected to the OWS located in the control room.

10.2.1 SCADA standard data blocks

Each PLC does not transmit data to other PLCs. Instead, each PLC packages specific data into a block of 100 registers. It is then up to the other PLCs on the network to retrieve the block of data and extract what they require from it locally. The retrieving of data is performed using COMM_REQ blocks.

Each PLC has address ranges reserves for each data type and is consistent throughout all PLCs, the allocated address refers to address allocation spreadsheet attached to this document.

10.2.2 Inter-PLC Communications Alarm

The first integer in the Integer Array is the watchdog counter. The counter is incremented every second and reset to 0 when it reaches 32767. All PLC's that retrieve data from another PLC check to see that the PLC's watchdog is changing. If the watchdog does not change within 5 seconds a communications alarm is raised.

10.3 Peer to Peer Communications

10.3.1 Data Produced for other PLC's

Each PLC parcels the data for communications to other PLC's into a group of 100 registers. Details refer to QUU document "GibsonIslandPLC-PLCComms.xls". PLC 15 flow data is packaged for PLC05.

10.3.2 Data Retrieved from other PLC's

Each PLC then reads what information it requires from each PLC as necessary. Details refer to QUU document "GibsonIslandPLC-PLCComms.xls". PLC 15 retrieved PE-Cell info from PLC03 for lighting control.

11. Replacement of the existing Mixed Liquor Flow meters

11.1 Overview

The entrapped air in mixed liquor to the existing FST train is currently causing problems at the flow meters that result in process control problems at the plant. Two de-aeration chambers, one on each mixed liquor line shall be designed and constructed to facilitate removal of entrapped air in mixed liquor.

The construction of the de-aeration chambers requires removal of the two existing flow meters. The replacement flow meters are positioned downstream of the de-aeration chamber.

11.2 Equipment

Equipment	Tag	Process Media	Location

Flow Meter	FIT_0511-002	Mix Liquor	De-aeration
Flow Meter	FIT_0512-002	Mix Liquor	De-aeration

Table 26: Replacement Mixed Liquor Equipment List

11.3 Control

The replaced flow meter is to resume link to the existing RAS PLC (PLC05).

.....End of the Document .....

1.2 Location Details and Map

The Gibson Island Water Reclamation Project is located at 188 Paringa Road Murarrie, adjacent to the Brisbane river estuary on Gibson Island (refer to figure 1 and 2 below).

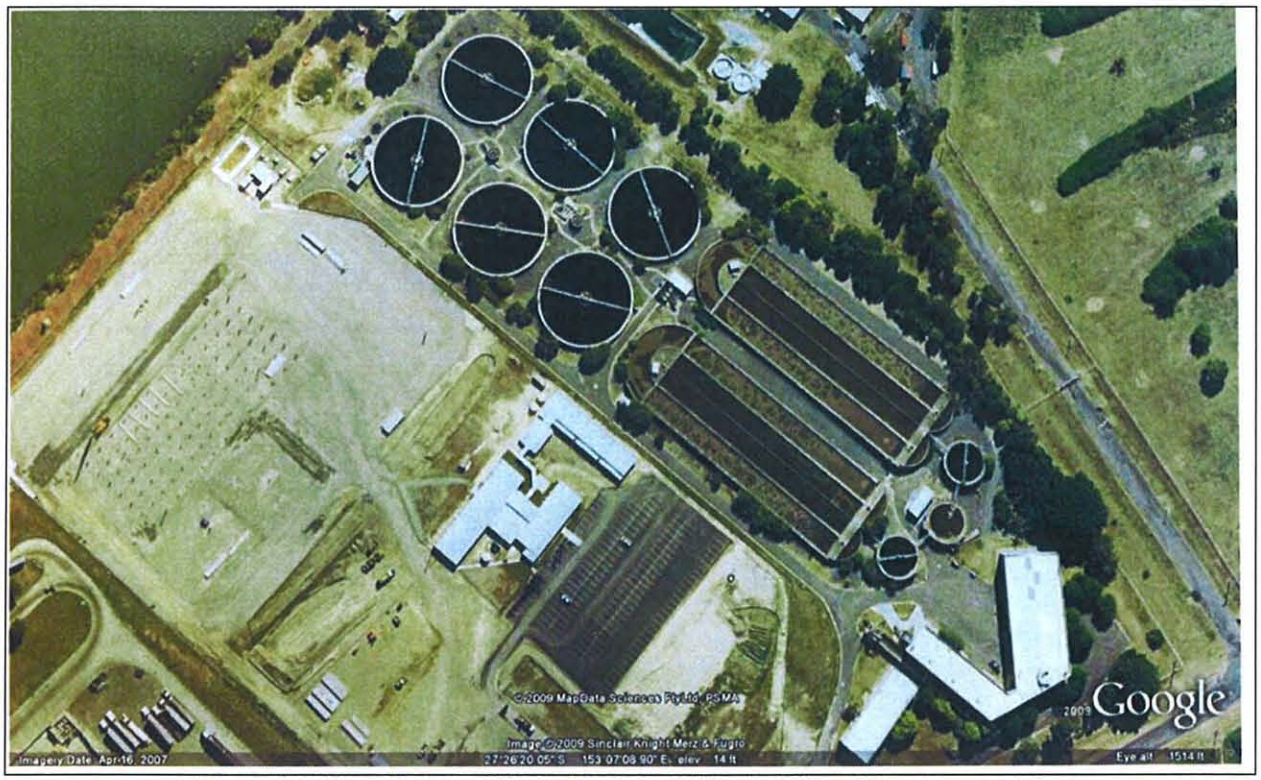

Figure 1 – Site Map - Gibson Island Waste Water Treatment Plant

Filename	Issue	Rev Status	23 Nov '10	
GIO&M Manual 1.doc	1	Final		

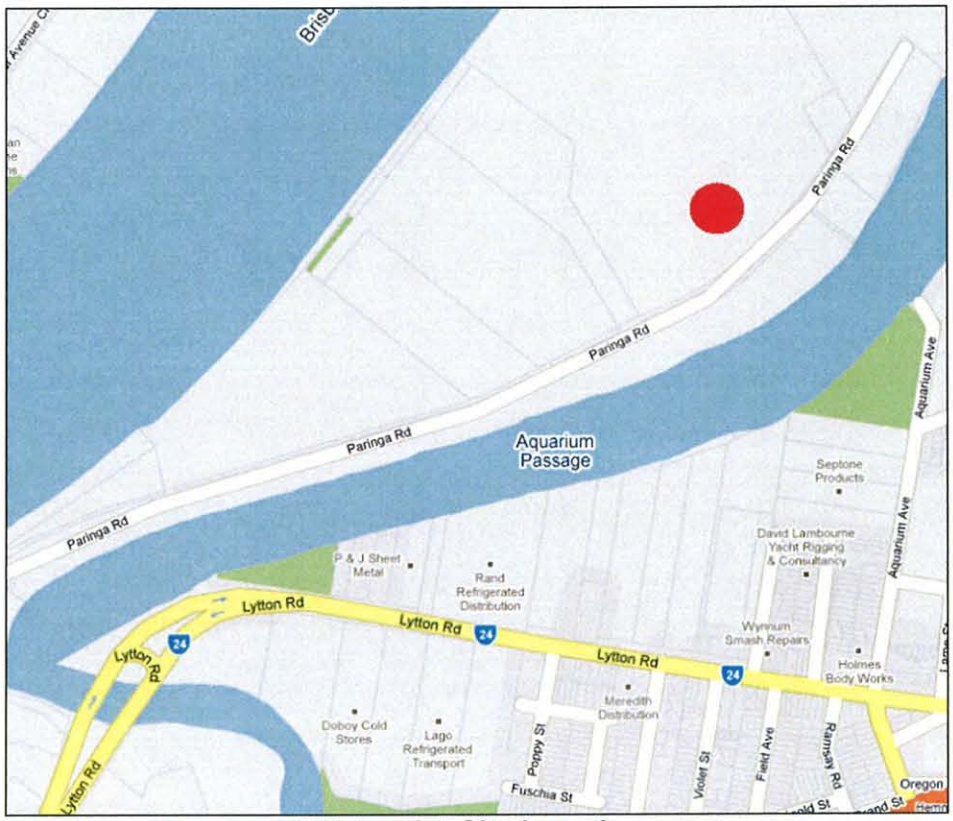

Figure 2 – Site Location

1.3 Description of Equipment and Process

The new plant consists of the following equipment;

- New Weirs and Outlet Weir Chamber on existing Bioreactors No. 1&2.
- Distribution Chamber No. 3.
- Two new FSTs No. 7 & 8.
- Mixed Liquor Line from Outlet Weir Chambers through Flow Distribution Chamber No. 3 to FST No 7 & 8.
- RAS lines from FST No. 7& 8 to existing RAS pump station wet well.
- Four Scum Pump Stations No 71,72,81 & 82.
- Scum line from FST No. 7 & 8 to the head of the existing plant.
- Effluent Line from FST No. 7 & 8 to the existing outfall main.
- Carport type facility to accommodate a new FSTs switchboard.
- Power supply from the existing Plant Main Switchboard to a new FSTs switchboard.
- All associated mechanical and electrical works including flow meters required for operational performance and all instrumentation.
- A PLC based control system for the above, programming and linking to SCADA system.
- De-aeration chambers, one on each Mixed Liquor Line to existing Distribution Chambers No. 1 & 2.
- Install flow meters and link to existing plant PLC system.

Mixed liquor will leave the existing bioreactors via the new weirs. Flow control is achieved through the side winder gates.

The mixed liquor enters DC3 by way of the 960 MSCL pipe line from the weir chambers. The distribution chamber distributes the mixed liquor to FST 7&8 equally via fixed internal weirs. The mixed liquor goes out through the energy dissipation inlet out into the settling tank. The RAS settles to the bottom and the effluent water overflows the "v" notch weir and leaves the tanks via the out fall drop boxes.

The scum is removed by way of skimmers and pumped back to the head of the plant.

The RAS leaves the FST and goes through a flow meter and eccentric plug valve to the existing RAS station.

1.4 Operational Modes

All electrical equipment has control push buttons and status indication lights on their starter panel front door, located inside the MCC cabinet.
All electrical equipment shall have three modes of operation selectable from a three position (Local/Off/Remote) mode selector switch mounted on the starter panel front door, located inside the MCC cabinet.

Local Mode

This mode is active when the mode selector switch is selected in local mode. In local mode, the drive can be controlled using the switchboard start, stop and reset push buttons. The operator can start the drive via the start push button if the start and run interlocks are healthy. The drive will stop if the operator presses the stop push button or if any of the run interlocks become faulty.

Remote Manual Mode

This mode is active when the mode selector switch is selected in remote mode and the operator has selected manual from the auto/manual selection on the Citect SCADA system. In remote manual mode, the operator can start and stop the pump from the Citect SCADA system using the control popup screen (start/stop/reset buttons), if run and start conditions are healthy. The drive will also stop if any of the run interlocks become faulty.

Remote Auto Mode

This mode is active when the mode selector switch is selected in remote mode and the operator has selected auto from the auto/manual selection on the Citect SCADA system. In remote auto mode, the drive is controlled by either, run request input from the PLC as part of automatic control logic. The drive will stop once stop command is issued by the PLC.