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SMEC Company Details

Approved by	Matt Box
Address	Level 6, 480 St Pauls Tce, Fortitude Valley, QLD, 4006, Australia
Phone	(07) 3029 6600
Email	Matt.box@smec.com
Website	www.smec.com
Signature	

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Contents

1. Introduction....1
1.1 Purpose of Manual....1
1.2 Staff Responsibilities....2
1.3 System Description....2
1.3.1 Pump Station and Riverine Flood Gates....2
1.3.2 Levee System and Landside Gates....4
2. Design Criteria and Equipment Control....5
2.1 Design Criteria....5
2.1.1 Saltwater Creek Pump Station....5
2.1.2 Distillery Creek Pump Station....6
2.2 Equipment Control....7
3. Pump Station and Flood Gate Operation....15
3.1 Description of System....15
3.1.1 Pump Station and Flood Gates....15
3.1.2 Wet-well....15
3.1.3 Stormwater Pumps....15
3.1.4 Instrumentation....15
3.1.5 Roller Gates....16
3.1.6 Hydraulic Actuators....16
3.1.7 Hydraulic Power Unit....16
3.2 Normal, Alternative and Emergency Operation....16
3.2.1 Normal Operation....16
Alternative....17
3.2.2 Operation....17
3.2.3 Emergency Operation....17
3.3 Routine Inspection and Adjustments....18
3.3.1 Pump Station Grounds....18
3.3.2 Pump Station Generator Room....18
3.3.3 Pump Station Sluice Gate Room and Bar Screen....19
3.4 Shutdown Considerations....19
3.4.1 Stormwater Pumps Shutdown Procedures....19
3.5 Restart Procedures....19
3.5.2 Stormwater Pumps....19
3.5.3 Local Operation (Operation from MCC-MS) Manual Control....20
3.5.4 Dewatering Pump....20
4. Levee and Landside Gate Operation....20
4.1 Description of System....20
4.2 Operation....20
4.2.1 Levee Wall....20
4.2.2 Landside Gates....20
5. Pump Station and Flood Gate Support Systems....21
5.1 Heating and Ventilation....21
5.1.1 Heating....21
5.1.2 Ventilation....21
5.1.3 Maintenance Recommendations....21

5.2 Normal and Standby Power 21
5.2.1 Normal Power Supply and Distribution 21
5.2.2 Standby Power 22
5.2.3 Operation Conditions 22
5.2.4 Lighting System 22
5.2.5 Safety Precautions 23
5.3 Security and Communication Systems 23
5.3.1 Security Alarm System 23
5.3.2 Communications System 23
5.3.3 Supervisory Control and Data Acquisition (SCADA) 23
6. Records 24
6.1 Introduction 24
6.2 Pump Station Operations Logs 24
6.3 Flood Gate Operations Logs 24
6.4 Alarm Logs 24
6.5 Accident Report 24
7. Pump Station and Flood Gates Maintenance 25
7.1 Introduction 25
7.2 Maintenance Program 25
7.2.1 Preventive Maintenance 25
7.2.2 Corrective Maintenance 25
7.2.3 Lubrication 26
7.2.4 Mechanical 26
7.2.6 Exercising the Pumps and Gates 28
7.2.7 Electrical System Maintenance 28
7.2.8 Heating and Ventilation 28
7.2.9 Housekeeping and Painting 28
7.2.10 Post-Event Monitoring and Inspections 30
7.3 Records 30
7.3.1 General 30
7.3.2 Equipment Numbering Systems 30
7.3.3 Equipment Records 30
7.3.4 Manufacturer's Service Manuals 30
7.3.5 Vendor List 31
8. Levee and Landside Gates Maintenance 32
8.1 Maintenance 32
8.1.1 Levee Wall (Earthen) 32
8.2 Inspection Types 33
8.2.1 Operational Inspections 33
8.2.2 Routine Inspections 33
8.2.3 Periodic Inspections 34
8.2.4 Emergency Inspections 34
8.3 Inspection Methodology 34
8.3.1 Typical & Notable Defects 34
9. Safety 35
9.1 General 35
9.2 Safety Program 35

Appendices

Appendix A	United States Army Corps of Engineers EM1110-2-3105 – Example O&M Manual
Appendix B	Operation and Maintenance Manual Example for Pump Stations Including Gates
Appendix C	Warranties
Appendix D	Client Training Register
Appendix E	Asset Register
Appendix F	Completion Certificates
Appendix G	Specifications
Appendix H	Maintenance Matrix

Figures

Figure 1: Project Location 1
Table 1 - Local Control Panel (LCP) 5
Table 2 - Local Control Panel (LCP) 6
Table 3 – Motor Control Centre – MCC 7
Table 4 - Local Control Panel (LCP) 8
Table 5 – Sluice Gate Local Controls 9
Table 6 – Stormwater Pump Control Panel 11
Table 7 – HVAC Control Panel 11
Table 8 – Heating and Ventilation Controls 12
Table 9 – Generator Control Panel 12
Table 10 – Battery Charger 13
Table 11 – Load Bank 14
Table 12 Mechanical Maintenance Tasks 27
Table 13 Electrical Maintenance Tasks 28

Table of Abbreviations

Abbreviations	Expansion
ARI	Average Return Interval
AHD	Australian Height Datum
HIVAC	High-Value Asset Control
HPU	Hydraulic power unit
LCD	Liquid-Crystal Display
LCP	Local Control Panel
LED	Light Emitting Diode
LEL	Lower Explosive limit
MCC	Motor Control Centre
MMS	Maintenance Management System
No.	Number of
O&M	Operations and Maintenance
OIT	Operator Interface Terminal
PLC	Programmable Logic Controller
PM	Preventative Maintenance
SCADA	Supervisory Control and Data Acquisition
SEMP	State Emergency Management Plan
SDS	Safety Data Sheets
SOJP	Standard Operating Job Procedures
TBD	To Be Determined
TDH	Total dynamic head
VDC	Volts Direct Current
ARI	Average Return Interval
AHD	Australian Height Datum
HIVAC	High-Value Asset Control
HPU	Hydraulic power unit
LCD	Liquid-Crystal Display
LCP	Local Control Panel

1. Introduction

1.1 Purpose of Manual

This Operation and Maintenance Manual presents the necessary steps for operation and maintenance of the various flood control elements of the proposed Bundaberg East Levee which include: floodwalls, flood gate structures, pump stations and associated support facilities, as shown in Figure 1.

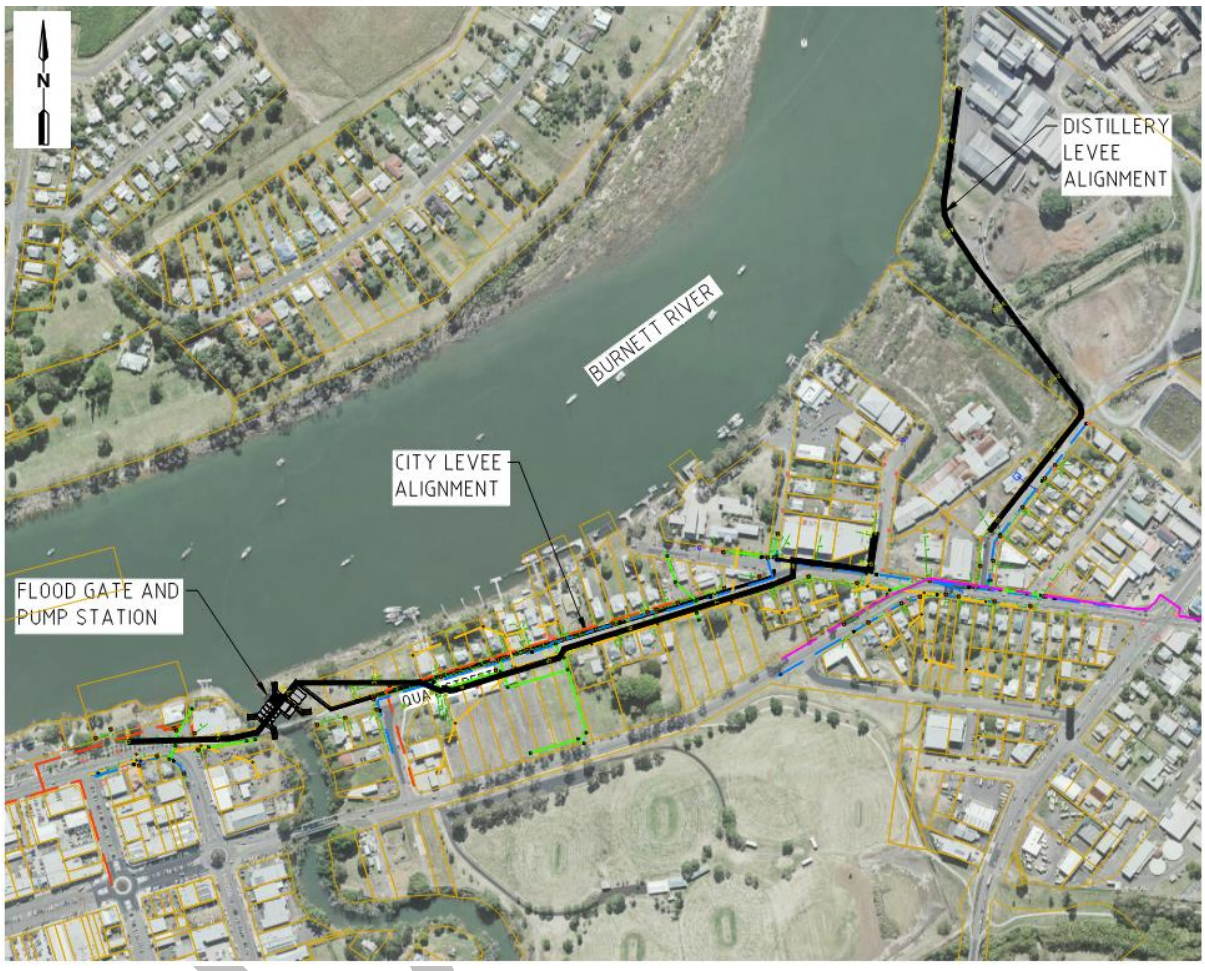

Figure 1: Project Location

Efficient operation of the Bundaberg East Levee system including gates and pump stations will result in controlled discharge of collected floodwater in the Saltwater Creek catchment to the Burnett River and will play an important part in flood protection to properties within Bundaberg East and Bundaberg South.

Correct operation of these flood control systems is important, this manual has been prepared to aid the system operating and maintenance personnel. The purpose of this manual is to provide available information in a form that will help achieve and maintain high equipment performance and efficiency levels at the pump station.

Additional information, discussed below, will be required to supplement the information and general procedures outlined in this manual.

Information such as Standard Operating Job Procedures (SOJPs), Standard Equipment Maintenance Procedures (SEMPs), Lubrication Schedule, and Troubleshooting Guides, should be prepared by the operators after start-up and initial operation of the pump station.

This manual is a live document and will be updated as modifications, changes or upgrades are made to the design or construction of the levee system.

1.2 Staff Responsibilities

The pump station operators will be responsible for the operation of the riverine gates and the pump stations. The operator and their agents are required to acquaint themselves with the safe method of operations and maintenance of this equipment. Operation and maintenance personnel should have the minimum necessary qualifications to perform the works in accordance with the Operation and Maintenance Manual (this document), related documents such as the Emergency Response Plan and comply with all relevant legislative requirements or regulations.

A multi-person team will be responsible for deploying the gates within the levee in preparation for a flood emergency, including “dry run” testing of the system. The team assigned must be adequately trained in the operation of the gates and gate equipment in accordance with this Operations and Maintenance manual.

Personnel are to be trained to be constantly on the lookout for potential emergency conditions within the flood control system. Personnel should be alert and prepared to respond to alarms, unusual noises from units within the pump station, odours, or flooding in or around the flood control system. It is recommended that the pump stations be inspected weekly during dry weather, daily during rainy season, or during the coincidence of a severe weather event *and* high tide. During this inspection, any unusual occurrences should be noted. If higher than normal storm flow is expected through the pump station gates, more-frequent inspections are recommended.

Safety of pump station personnel is of primary importance. All pump station personnel should be thoroughly familiar with the safety information contained in Section 9.

Recommended pump station, gate, and levee personnel responsibilities are given below:

1. Know the correct operational procedures for the equipment and systems.
2. Maintain efficient operation and maintenance of the entire flood control system.
3. Keep continuously informed of the best operating and maintenance practices.
4. Report problems in a timely manner.
5. Maintain accurate and concise records of system operation and maintenance.
6. Maintain awareness of potential major problems in the operation and maintenance of the system.
7. Be aware of safety hazards connected with operation of the pump station and gates.
8. Know detailed (step-by-step) SOJPs for each sub-system within the system.
9. Prepare detailed (step-by-step) SEMPs for both normal and emergency conditions for all equipment.
10. Be familiar with Bundaberg Regional Council's maintenance management system, which provides procedural information on the maintenance requirements for all Council equipment.

1.3 System Description

The Bundaberg East Levee flood control system is located on the south side of the Burnett River and consists of the City Levee Alignment which crosses Saltwater Creek and runs along Quay Street East, and the Distillery Levee Alignment that runs along Cran Street, crossing Distillery Creek as shown in Figure 1-1. The flood control system consists of floodwall sections with landside gates, and two pump stations each consisting of a cast-in-place reinforced concrete wet-well substructure, riverine flood closure gates, and an associated control and equipment building.

1.3.1 Pump Station and Flood Gates

The Pump Station structures on Saltwater Creek and Distillery Creek each consist generally of a concrete culvert superstructure, sluice gates, hydraulic actuators, pump wet-well, submersible axial flow pumps, manual trash racks and screens, and other associated elements.

The Pump Station structures are supported by a pump control building which houses the electrical systems, control panels, pump and sluice gate controls, combustible gas detection systems, standby power generator, climate control and ventilation systems.

Refer to drawings in Appendix A.

At each control station, the level control system for the wet well is an ultrasonic transponder system, with associated controls inside the Local Control Panel in the Generator Room. The system transmits a level signal to the Programmable Logic Controller (PLC) inside the Local Control Panel, which controls the automatic operation of the stormwater pumps.

For each Pump Station, backup power is provided by a diesel generator. Upon loss of the normal power source, the generator will automatically start and transfer the load to operate the pumps and associated equipment and controls.

The pump station is equipped with an instrumentation system that includes combustible gas detection, high water level detection and equipment malfunction alarms.

The Pump Station and Gate configurations are as follows:

1.3.1.1 Saltwater Creek Configuration

1.3.1.1.1 Pump Station

A permanent pump station is being designed at Saltwater Creek with the following parameters:

- Design Capacity = 7.0 m^3/s
- Three pumps (2 Duty, 1 Standby) at 3.5 m^3/s each
- Submersible, axial flow pumps, vertical arrangement
- Electric motor driven, constant speed
- Manual trash racks

1.3.1.1.2 Flood Closure Gates

The flood closure gates at Saltwater Creek consist of the following:

- Four total gates = 4.5 m wide by 4.5 m high
- Gate Type = Roller
- Invert elevation = -1.0 m AHD [TBC]
- Material = Stainless Steel
- Actuator = Hydraulic Cylinder

1.3.1.1.3 Pump Station Building

A separate building will be provided to house the emergency generator, electrical room, and control room. This pump station is for flood control and, as a result, is considered a staffed station during flood events, however there will not be a requirement for overnight stays.

1.3.1.2 Distillery Creek Configuration

1.3.1.2.1 Pump Station

A permanent pump station is being designed at Distillery Creek with the following parameters:

- Design Capacity = 1.0 m^3/s
- Two pumps (1 Duty, 1 Standby) at 1 m^3/s each
- Submersible, axial flow pumps, vertical arrangement
- Electric motor driven, constant speed
- Manual trash racks

1.3.1.2.2 Flood Closure Gates

The flood closure gates at Distillery Creek consist of the following:

- Two total gates = 2.0 m wide by 3.0 m high
- Gate Type = Roller
- Invert elevation = 0.5 m AHD [TBC]
- Material = Stainless Steel
- Actuator = Hydraulic Cylinder

1.3.1.2.3 Pump Station Building

Pump station buildings, at the Saltwater Creek and Distillery Creek locations, are required to house the electrical switchboards, hydraulic systems and equipment controls for the pumps and gates. The pump station building will have provision for a standby generator and fuel tank. Both items will be positioned within an appropriately sized bunded area to capture any fuel or lubricant leakage.

The pump station is for flood control and, as a result, is considered a staffed station during flood events, however there will not be a requirement for overnight stays.

1.3.2 Levee System and Landside Gates

The flood levee wall is currently in the early stages of design and currently generally consists of a reinforced concrete flood wall with landside gates. Alternate wall form options may be considered in future design stages, subject to a multi-criteria assessment including Safety in Design review and demonstration of benefits.

The wall height along the alignment is +9.5m AHD based on a 1% Annual Exceedance Probability (AEP) modelled flood event plus 300mm of freeboard.

The City Levee Alignment starts in Quay Street, between Walla Street and Toonburra Street, traverses Saltwater Creek continues along Quay Street East, into Scotland Street, ending in Petersen Street.

The Distillery Levee Alignment starts midway along Cran Street, enters the Bundaberg Sugar Millaquin Sugar Mill site, crosses Distillery Creek and continues adjacent the internal access road to end near existing Mill buildings.

Landside gates are currently anticipated to be stop log gates. This will be further explored in future design stages.

2. Design Criteria and Equipment Control

2.1 Design Criteria

The following tables are a listing of major equipment found in the Saltwater Creek and Distillery Creek Pump Stations and design criteria for each.

2.1.1 Saltwater Creek Pump Station

Table 1 - Local Control Panel (LCP)

Sluice Gate with Operator	
Number	4
Manufacturer	TBD
Series	TBD
Size, meters	4.5 x 4.5
Hydraulic Operator	TBD
Material	Stainless Steel
Bar Screen	
Number	4
Material	TBD
Width	TBD
Stormwater Pumps	
Number	3 (2 Duty, 1 Standby)
Type	Submersible Axial Flow
Manufacturer	TBD
Model	TBD
Capacity, m^3/s	7.0
Blade angle	TBD
RPM	595
Kilowatt (Kw)	365
Volts/Phase/Hertz	400 / 3 / 50
Flexible Tide Gate Flap	
Number	3
Manufacturer	TBD
Size, meters	1.2 DIA
Diesel Engine Driven Generator	
Number	1
Manufacturer	TBD
Model	TBD
Type-Cylinder	TBD
RPM	TBD
Fuel	Diesel
KVA	TBD
KW	TBD
Volt	TBD / TBD
Wire	TBD

Phase	TBD
Hertz	TBD
Battery Charger	
Number	1
Manufacturer	TBD
Model	TBD
Type	TBD VDC
Maximum Output, amperes	TBD
Input VAC	TBD
Generator Load Bank	
Number	1
Manufacturer	TBD
Model	TBD
Type	Resistive
KW @ 480 Volts	TBD
Phase	3
Wire	3
Hertz	TBD
P.F.	TBD

2.1.2 Distillery Creek Pump Station

Table 2 - Local Control Panel (LCP)

Sluice Gate with Operator	
Number	2
Manufacturer	TBD
Series	TBD
Size, meters	2.0 m wide x 3.0 m high
Hydraulic Operator	TBD
Material	Stainless Steel
Bar Screen	
Number	2
Material	TBD
Width, meters	2
Stormwater Pumps	
Number	2 (1 Duty, 1 Standby)
Type	Submersible Axial Flow
Manufacturer	TBD
Model	TBD
Capacity, m^3/s	1.0
Blade angle	TBD
RPM	988
Kilowatt (Kw)	100
Volts/Phase/Hertz	400 / 3 / 50
Flexible Tide Gate Flap Valve	

Number	2
Manufacturer	TBD
Size, meters	0.8 DIA
Diesel Engine Driven Generator	
Number	1
Manufacturer	TBD
Model	TBD
Type-Cylinder	TBD
RPM	TBD
Fuel	Diesel
KVA	TBD
KW	TBD
Volt	TBD / TBD
Wire	TBD
Phase	TBD
Hertz	TBD
Battery Charger	
Number	1
Manufacturer	TBD
Model	TBD
Type	TBD VDC
Maximum Output, amperes	TBD
Input VAC	TBD
Generator Load Bank	
Number	1
Manufacturer	TBD
Model	TBD
Type	Resistive
KW @ 480 Volts	TBD
Phase	3
Wire	3
Hertz	TBD
P.F.	TBD

2.2 Equipment Control

The following is a listing of the location and types of controls for the major equipment at the Saltwater Creek and Distillery Creek Pump Stations.

It should be noted that the following is generic at this Preliminary Design phase and will be updated appropriately as the detailed design progresses.

Table 3 – Motor Control Centre – MCC

Control Name	Features	Function
Disconnect Switch Pump No. 1 Pump No. 2 Pump No. 3	ON/OFF/TRIP/RESET	"ON" supplies electricity and provides overload protection to the local control panel from the electrical panel. "OFF" disconnects electricity to the local control panel from the electrical panel.

		"TRIP" disconnects electricity from the local control panel and indicates electrical circuit overload. "RESET" resets tripped breaker after circuit overload has been connected.
Pump RUN Indicator Light	Red Light	Indicates pump running when illuminated.
WATER-IN-OIL ALARM Indicator Light	Amber Light	Indicates water in oil when illuminated.
HI-TEMP ALARM Indicator Light	Amber Light	Indicates motor high temperature when illuminated.
Control Selector Switch	LOCAL/OFF/REMOTE	"LOCAL" position allows the pump to run controlled by the START/STOP pushbuttons on the MCC. "OFF" position will not allow the pump to run. "REMOTE" position allows the pump to run based on the computer control program at the LCP.
Pushbuttons	START/STOP	When the LOCAL/OFF/REMOTE selector switch is in the "LOCAL" position, pressing the "START" pushbutton starts the pump, pressing the "STOP" pushbutton stops the pump.
Reset Pushbutton	Black Pushbutton	Pressing the pushbutton resets overload trip.
Disconnect Switch Sluice Gate EUH-1, Generator Room Electric Unit Heater EUH-2, Generator Room Electric Unit Heater RF-1	ON/OFF/TRIP/RESET	"ON" supplies electricity and provides overload protection to the local control panel from the electrical panel. "OFF" disconnects electricity to the local control panel from the electrical panel. "TRIP" disconnects electricity from the local control panel and indicates electrical circuit overload. "RESET" resets tripped breaker after circuit overload has been corrected.
RF-1 Control Selector Switch	LOCAL/OFF/REMOTE	"LOCAL" position allows the fan to run "OFF" position will not allow the fan to run. "REMOTE" position allows the fan to run based on the thermostat setting.
Fan RUN Indicator Light	Red Light	Indicates fan running when illuminated.
Reset Pushbutton	Grey Pushbutton	Pressing pushbutton resets overload trip.

Table 4 - Local Control Panel (LCP)

Control Name	Features	Function
SLUICE GATE ROOM INTRUSION Alarm Indicator Light	Amber Light	Indicates Sluice Gate Room intrusion when illuminated.
SLUICE GATE ROOM HIGH COMB GAS Alarm Indicator Light	Amber Light	Indicates Sluice Gate Room high combustible gas when illuminated.
HIGH WET-WELL Level Alarm	Amber Light	Indicates wet-well level when illuminated.

STORMWATER PUMP 1 FAIL Alarm	Amber Light	Indicates stormwater pump 1 failure when illuminated.
STORMWATER PUMP 2 FAIL Alarm	Amber Light	Indicates stormwater pump 1 failure when illuminated.
STORMWATER PUMP 3 FAIL Alarm	Amber Light	Indicates stormwater pump 1 failure when illuminated.
UTILITY POWER FAIL Alarm	Amber Light	Indicates power failure when illuminated.
GENERATOR FAIL Alarm	Amber Light	Indicates generator failure when illuminated.
Wet-well Level Indicator	Bar Graph	Indication of wet-well Level, 0-4 meters.
Sluice Gate OPEN Indicator Light	Red Light	Indicates sluice gate open when illuminated.
Sluice Gate CLOSED Indicator Light	Green Light	Indicates sluice gate closed when illuminated.
Sluice Gate REMOTE Indicator Light	White Light	Indicates sluice gate in REMOTE when illuminated.
Sluice Gate Control Selector Switch	OPEN/CLOSED/AUTO	"OPEN" position opens sluice gate. "CLOSED" position closes sluice gate. "AUTO" position allows sluice gate to open/close based on a signal from the LSH float switch at the railroad manhole and the wet-well level transmitter.
Stormwater Pump 1 RUNNING Indicator Light	Red Light	Indicates stormwater pump 1 running when illuminated.
Stormwater Pump 1 REMOTE Indicator Light	White Light	Indicates stormwater pump 1 in remote when illuminated.
Stormwater Pump 2 RUNNING Indicator Light	Red Light	Indicates stormwater pump 2 running when illuminated.
Stormwater Pump 2 REMOTE Indicator Light	White Light	Indicates stormwater pump 2 in remote when illuminated.
Stormwater Pump 3 RUNNING Indicator Light	Red Light	Indicates stormwater pump 3 running when illuminated.
Stormwater Pump 3 REMOTE Indicator Light	White Light	Indicates stormwater pump 3 in remote when illuminated.
Stormwater Pumps Sequence Select Selector Switch	123/231/312/AUTO	Allows selection of stormwater pumps rotation sequence, 123; 231, 312, or automatic.
Panel Alarm Reset	Black Pushbutton	Pressing pushbutton resets alarm when condition cleared.

Table 5 – Sluice Gate Local Controls

Control Name	Features	Function
Sluice Gate Control Selector Switch	LOCAL/OFF/REMOTE	"LOCAL" position allows sluice gate operation to be controlled by local "OPEN," "CLOSE," and "STOP" pushbuttons. "OFF" position will not allow sluice gate to operate, "REMOTE" position allows sluice gate to be controlled from the LCP.

Pushbuttons	OPEN, CLOSE, and STOP	When the LOCAL/OFF/REMOTE selector switch is in the "LOCAL" position, pressing the "OPEN" pushbutton opens the sluice gate, pressing the "CLOSE" pushbutton closes the sluice gate, and pressing the "STOP" pushbutton stops the travel of the sluice gate.
Sluice Gate Position Indicator	Dial 0 - 100%	Indicates sluice gate % open position.
Declutch and Manual Wheel	Declutch and Wheel	Allows sluice gate to be operated manually.

Table 6 – Stormwater Pump Control Panel

Control Name	Features	Function
Disconnect Switch	ON/OFF/TRIP/RESET	"ON" supplies electricity and provides overload protection to the local control panel from the electrical panel. "OFF" disconnects electricity to the local control panel from the electrical panel. "TRIP" disconnects electricity from the local control panel and indicates electrical circuit overload. "RESET" resets tripped breaker after circuit overload has been corrected.
Control Selector Switch	LOCAL/OFF/REMOTE	"LOCAL" position allows the pump to run. "OFF" position will not allow the pump to run. "REMOTE" position allows pump control from the Local Control Panel.
Multitrode indicator Controller	NOT USED	NOT USED
OVER TEMP Indicator Light	Red Light	Indicates motor overtemp when illuminated.
MOISTURE Indicator Light	Red Light	Indicates moisture in motor oil when illuminated.
PUMP RUN Indicator Light	Green Light	Indicates pump is running when illuminated.
Elapsed Time Meter	5 Digits and 1/10th of Hour	Indicates total amount of time pump has run.
Mini-Cas RESET	Red Pushbutton	Resets OVERTEMP and MOISTURE alarms once condition has been corrected.
Alarm Light	Red Beacon	Flashes during alarm condition.

Table 7 – HVAC Control Panel

Control Name	Features	Function
EF-1 Control Selector Switch	HAND/OFF/AUTO Selector Switch	"HAND" position allows fan to operate continuously. "OFF" position will not allow fan to run. "AUTO" position allows fan to run based on thermostat setting.
EF-2 Control Selector Switch	HAND/OFF/AUTO Selector Switch	"HAND" position allows fan to operate continuously. "OFF" position will not allow fan to run. "AUTO" position allows fan to run based on thermostat setting.

Table 8 – Heating and Ventilation Controls

Control Name	Features	Function
EUH-1 Local Disconnect	ON/OFF/TRIP/RESET	"ON" supplies electricity to heater. "OFF" disconnects electricity from heater. "TRIP" disconnects electricity from heater and indicates electrical circuit overload. "RESET" resets tripped breaker after circuit overload has been corrected.
EUH-2 Local Disconnect	ON/OFF/TRIP/RESET	"ON" supplies electricity to heater. "OFF" disconnects electricity from heater. "TRIP" disconnects electricity from heater and indicates electrical circuit overload. "RESET" resets tripped breaker after circuit overload has been corrected.
EUH-1 Thermostat Controller on Unit	Potentiometer	Allows setting of operation temperature.
EUH-2 Thermostat Controller on Unit	Potentiometer	Allows setting of operation temperature.
EF-1 Thermostat	Potentiometer, 40-110 degrees F (5 - 43 degrees Celsius)	Allows setting of operation temperature.
RF-1 Thermostat	Potentiometer, 40-110 degrees F (5 - 43 degrees Celsius)	Allows setting of operation temperature.

Table 9 – Generator Control Panel

Control Name	Features	Function
Digital LCD Display	AC voltmeter, line to line and line to neutral AC ammeter Frequency meter KW meter KVAR meter Power factor meter %KW KWH Run time meter Lube oil pressure Coolant temperature Tachometer DC voltage	Indicates associated function value.
Combination ammeter/voltmeter phase selector	Keypad	Allows selection of ammeter/ voltmeter phase.
Programmable protective relay functions	Under voltage Over voltage Under frequency	Allows programming of protective relays.

	Over frequency Reverse power Over current	
Voltage Adjust	Potentiometer	Allows voltage to be adjusted.
Cycle Adjust	Potentiometer	Allows cycle to be adjusted.
Four position selector switch	OFF-RESET/AUTO/MANUAL-START/COOLDOWN- STOP	"OFF-RESET" position will not allow generator to run and resets trip. "AUTO" position allows generator to start up upon power failure. MANUAL-START" position will start up generator. "COOLDOWN-STOP" position stops generator after a cooldown period.
Emergency Stop	Pushbutton	Pushing button will stop generator.
Alarm Silence	Pushbutton	Pushing button silences alarm horn.
Panel Lights	Toggle Switch	Allows panel lights to be turned on/off.
Alarm horn	Horn	Horn sounds during alarm condition.
Emergency Stop	"Break Glass" switch on wall near door in Generator Room	Breaking glass and pushing button stops generator.
LED display for safety Shutdown/Alarms: Low oil pressure shutdown High water temperature Engine overspeed Overcrank Fault Shutdown Fault Alarm Emergency stop Low coolant temperature Low oil pressure High coolant temperature alarm Low battery voltage System not in automatic Low gas warning Aftercooler low coolant Low fuel level	 Red LED Red LED Red LED Red LED Red LED Amber LED Red LED Amber LED Amber LED Amber LED Red LED Red LED Amber LED Red LED Amber LED	Light illuminated indicates associated shutdown/alarm. NA

Table 10 – Battery Charger

Control Name	Features	Function
DC Voltmeter	0 - 30 DC Volts	Indicates DC volts.
DC Ammeter	0 - 20 DC Amps	Indicates DC amps.
Low Battery Voltage Alarm Indicator	Red LED	Indicates low battery voltage.
High Battery Voltage Alarm Indicator	Red LED	Indicates high battery voltage.
Equalize Indicator	Green LED	Indicates equalization.
AC on Indicator	Green LED	Indicates AC power on.

Input Protection	Pushbutton	Push to reset trip
Equalize/Float	Pushbutton	Allows selection of equalize or float

Table 11 – Load Bank

Control Name	Features	Function
Control Selector Switch	AUTO/OFF/MAN	"AUTO" position automatically puts load bank on generator during the exercise mode. "OFF" position will not allow load bank to be put on generator. "MAN" position puts load bank load on generator.
75 kW Loads (2)	ON/OFF Toggle Switch	"ON" position puts 75 kW load on generator. "OFF" position takes load off.
75 kW Load Indicator Lights (2)	Blue Lights	Indicates 75 kW load is on.
Cooling Failure Alarm Indicator	Red Light	Indicates cooling failure when illuminated.

3. Pump Station and Flood Gate Operation

3.1 Description of System

3.1.1 Pump Station and Flood Gates

The Saltwater Creek and Distillery Creek pump station and flood gate systems consist of similar infrastructure components for consistency and operational efficiency. The pump station superstructures consist of roller gates, and a pump wet-well, housing stormwater submersible axial flow pumps that receive the incoming stormwater flow.

Stormwater runoff from east Bundaberg is collected and delivered to the gated pump stations by Saltwater and Distillery Creeks, respectively. The roller flood gates will typically operate in the open position to allow for flows to discharge to the Burnett River while maintaining fish passage. During periods of high flow in the Burnett River, the flood gates will close and water from the Creeks will be discharged via the pump stations.

3.1.2 Wet-well

Upon closing of the hydraulic sluice gates, stormwater enters the pump station wet-well through a bar-screen in the diversion structure.

The wet-well water level is monitored by a level indicator/transmitter. Pump control is based on the level signal received at the Local Control Panel (LCP).

3.1.3 Stormwater Pumps

The stormwater pumps are submersible axial flow pumps designed to handle stormwater solids without clogging. Each pump at Saltwater Creek is driven by a 365 Kw motor rated at 595 rpm, with a capacity of 3.5 m^3/s at 5 m of total dynamic head (TDH). Each pump at Distillery Creek is driven by a 100 Kw motor rated at 998 rpm, with a capacity of 1 m^3/s at 5 m of total dynamic head (TDH). The Saltwater Creek pump and the Distillery Creek pump are equipped with 1200-mm flap valve and 800-mm flap valve respectively.

The pumps are in pump discharge tubes within the wet-well. Access to each pump is through an exterior hatch cover.

Each pump motor is powered from the Motor Control Centre (MCC) which is located on the upper level of the pump station in the Generator Room.

3.1.4 Instrumentation

Instrumentation at each Pump Station consists of the following:

- Local Control Panel
- Combustible Gas Monitors
- Stormwater Pump Control Panel

3.1.4.1 Local Control Panel (LCP)

The Local Control Panel is located on the upper level of the pump station, on the wall of the Generator Room.

This panel is located on the upper level of the pump station and contains the following instrumentation:

- Wet-well level indication
- Operator Interface Terminal (OIT)
- Stormwater pumps operation sequence rotation selector
- Equipment status indication lights
- Alarm indication lights

Bar graph indicators are provided to indicate the levels of the wet-wells.

The stormwater pump sequence rotation selector switch allows the operator to rotate equipment and place desired pumps in sequence mode.

Alarm indication lights illuminate to indicate station alarm conditions. When activated, a light will illuminate the alarm condition. After the alarm condition is resolved, the RESET button will extinguish the alarm light.

This panel monitors various pump station functions, alarms, and provides control of the stormwater pumps and wet-well level indicating system. Refer to Section 2.2 for detailed information regarding the controls found on this panel.

The wet well level shall be monitored with an ultrasonic level transmitter. This level shall be displayed on the LCP and also available on the OIT. This level shall be used to sequence pump starts and stops when the pumps are in automatic mode. These level setpoints shall be operator enterable from the OIT. The wet well shall also have high and stop floats backup that shall be used to start and stop the stormwater pump when it is in auto mode and the ultrasonic level transmitter fails.

3.1.4.2 Combustible Gas Monitoring

The two combustible gas monitoring systems will normally be online and operating continuously. One is in the Sluice Gate Room and the other in the Generator Room (if internally housed). During safe conditions (i.e., no combustible gas detected) the green external beacon light will activate. An alarm will go off at 25 percent of the Lower Explosive Limit (LEL). The combustible gas monitors should be calibrated at least monthly or as experience dictates. Should combustible gas be detected an alarm will be activated at the LCP and the red external beacon will flash.

3.1.4.3 Stormwater Pump Control Panel

The Stormwater Pump Control Panel is located on the west wall of the Generator Room. This panel controls the stormwater pumping. The stormwater pump disconnect switch should be in the ON position and the "LOCAL/OFF/REMOTE" pump control selector switch should be in the REMOTE position for automatic control.

3.1.5 Roller Gates

Hydraulically operated flood control stainless steel roller gates are utilized at both stations. Saltwater Creek has four (4) gates that are 4.5 m x 4.5 m square. Distillery Creek has two (2) gates that are 2 m (wide) by 3 m (high). Local controls for the gates consist of a local gate panel by each gate.

The gates can be locked in the raised position out of the waterway allowing ease of inspection and maintenance; and

The gates are operated using hydraulically actuated gate hoists installed above the design flood stage.

3.1.6 Hydraulic Actuators

The roller gates are operated using hydraulically actuated cylinders, powered by the Hydraulic Power Unit.

3.1.7 Hydraulic Power Unit

A Hydraulic power unit (HPU) will be located in the electrical building and will provide the hydraulic power to each of the roller gate's hydraulic actuators to open the roller gates. The HPU local control panel, will be located on the HPU skid.

3.2 Normal, Alternative and Emergency Operation

Both the Saltwater Creek and Distillery Creek pump stations will be configured the same to allow for operational consistency. What follows is an example configuration, to be refined as detailed design progresses.

3.2.1 Normal Operation

Under normal operating conditions the systems will be placed in automatic mode and controlled via the appropriate level and flow sensors.

To be further developed after final selection of pumps and flood gates.

3.2.2 Alternative Operation

Alternative operation of the pump station may involve one of the following:

- Manual operation of the flood gates and/or the stormwater pumps
- Shutdown of one of the flood gates and/or the stormwater pumps

The gates and pumps should be operated manually only on extremely rare conditions, such as testing and adjustment. A LOCAL-OFF-REMOTE switch and START/STOP pushbuttons are provided to control the pump manually. During manual operation, the wet-well level must be monitored very carefully to be sure that the wet-well does not overfill, or it is not drawn down excessively. Care must be taken to ensure that the pumps are not allowed to completely drain the wet-well and draw air.

Any one of the pumps may be taken offline for service while the remaining pumps maintain operation of the pump station. Refer to Section 3.4 for detailed shut down procedures.

The wet-well level system must be in continuous operation. If the level system were to fail, the operator must monitor the wet-well level for continued pump station operation.

3.2.3 Emergency Operation

Emergency situations, which may develop during operation of the flood gates and pump station, include equipment failure and loss of power. Resulting alarm conditions require the attention of an operator as soon as possible.

3.2.3.1 Equipment Failure

Breakdown of major pump station equipment requires immediate attention to maintain continuous operation of the station. Whenever possible, standby units should be placed in operation until the cause of the problem is determined and corrective action is taken.

3.2.3.2 Loss of Power

In the event of a power interruption, the standby generator will automatically start and transfer load. When normal utility power resumes, the load transfer switch will automatically transfer load back to the utility source and shut down the standby generator without manual resetting.

The automatic transfer switches on the Motor Control Centre should all be NORMAL position for automatic starting and stopping of the standby generator and load transfer upon failure of the normal source of power.

Emergency lighting is provided by 12-volt automatic emergency battery units located the pump station. Emergency power is discussed in more detail in Section 5.2, Normal and Standby Power.

Immediately following a power outage, the station operator should check the Local Control Panel, stormwater pumps, wet-well level system, and motorized sluice gate to ensure all are operating properly and set as required. All equipment set in the AUTOMATIC mode of operation will restart immediately following resumption of electrical service. If any equipment does not restart, the station operator must take the appropriate steps to restart this equipment.

3.2.3.3 Alarm Conditions

When an alarm condition develops during pump station operation, the alarm is automatically sounded and the indicator light for that condition is illuminated. A RESET pushbutton provided on the Local Control Panel is used to silence the alarm horn. The light remains illuminated until the situation causing the alarm has been corrected and the RESET pushbutton has been depressed.

Refer to Section 2.4, Equipment Control, for alarm conditions for the Pump Stations that are automatically monitored at the Local Control Panel.

3.3 Routine Inspection and Adjustments

A routine inspection of each pump station should be completed at least once per week during the dry season and daily during the wet season. The operator will be able to identify problems with equipment and possible upsets in the system before serious damage can occur. An operations log should be filled in and filed during this inspection.

The pump discharge tube drywell should be inspected for flooding by opening a hatch, and inspection from above. Do not enter this space as it is considered a confined space. See 8.4.2 "Confined Spaces". A drain incorporating a ball check is in the floor of the dry well to allow condensate and infiltrated water to drain to the wet-well.

Once a month during the flooding season, each stormwater pump should be "bumped" by momentarily starting the pump. This allows the oil in the pump to be circulated around bearings and seals. Additionally, each gate should be lowered and then raised again to confirm functionality and no blockages.

3.3.1 Pump Station Grounds

Check the station and grounds for security and signs of vandalism.

3.3.2 Pump Station Generator Room (TBC)

- Check the emergency generator for:
  - Engine control panel switch positions
  - Generator set control switch positions
  - Condition of batteries and rate of battery charge
  - Automatic Transfer Switch cabinet and Transfer Switch Disconnect cabinet for proper switch positions
  - Load bank for proper switch positions.
- Check the station for unusual temperature (high or low), unusual odours or noise, and smoke.
- Check station lights, and heating and ventilating equipment for proper operation.
- Check the Motor Control CentreCentre for tripped breakers. If a tripped breaker is found, inspect the equipment before attempting to reset the breaker. Record all tripped breakers in the operations log.
- Check that all breaker switches are in the proper position.
- At the Local Control Panel check:
  - Alarms - investigate cause, correct, if possible, record alarm and action taken in the operations log
  - Pump mode selector switch positions and record in the operations log
  - Combustible gas meter alarm conditions and record in the operations log
  - Position of pump sequence selector switch and record in the operations log.
- Check stormwater pump control panel for proper switch positions and illuminated fault indicator lights.
- Perform general housekeeping, to include:
  - Pick up all litter and debris
  - Sweep floor
  - Wipe down equipment
  - Remove trash for proper disposal.
- Check the stormwater pumps for:
  - Proper position of the local pump mode selector switch.

3.3.3 Pump Station Sluice Gate Room and Bar Screen

- Check the sluice gate operator for proper position of mode selector switch.
- Perform general housekeeping, to include:
  - Pick up all litter and debris
  - Sweep floor
  - Wipe down equipment
  - Remove trash for proper disposal.
- Check for and remove debris from the bar screen.

3.4 Shutdown Considerations

3.4.1 Stormwater Pumps Shutdown Procedures

- Confirm flood gates are in the fully raised position.
- At the MCC turn gate "LOCAL/OFF/REMOTE" Selector switch to "OFF."

Note: For extended shutdown, close, lock out and tag gate disconnect breaker.

At no time should the gates be left in the lowered position when the pumps are shutdown as this will result in elevated water levels behind the gates with no means of removal.

3.5 Restart Procedures

Restart procedures are specific to the individual equipment selected. To be further developed after final selection of pumps and flood gates.

- At MCC-MS, place each gate's disconnect switch in the "ON" position
- At MCC- MS, place each gate's "LOCAL/OFF/REMOTE" selector in the "REMOTE" position.
- Gates should engage automatically, with operation based on water levels in the Burnett River.

3.5.1.1 Local Operation (Operation from MCC-MS) Manual Control

- At MCC-MS, place each gate's disconnect switch in the "ON" position.
- At MCC-MS; place the gate "LOCAL/OFF/REMOTE" selector in the "LOCAL" mode.
- Gates should function when activated.

3.5.2 Stormwater Pumps

3.5.2.1 Remote Operation

- At MCC-MS, place each pump's disconnect switch in the "ON" position.
- At MCC- MS, place each pump's "LOCAL/OFF/REMOTE" selector in the "REMOTE" position.
- At the LCP, place the Wet-well Pumps Sequence Select Selector switch in the desired position, (123, 231, 312, or AUTO).
- Pumps should start automatically, with operation based on wet-well level.

3.5.3 Local Operation (Operation from MCC-MS) Manual Control

- At MCC-MS, place each pump's disconnect switch in the "ON" position.
- At MCC-MS; place the pump "LOCAL/OFF/REMOTE" selector in the "LOCAL" mode.
- At MCC-MS; press the pump "START" pushbutton.
- Pump should start immediately.
- Monitor wet-well level closely when operating in manual control.

Note: *Wet-well level indicating transmitter is located inside LCP.*

3.5.4 Dewatering Pump

- At MCC-MS, place the dewatering pump disconnect switch in the "ON" position.
- At the Dewatering Pump Control Panel place the "LOCAL/OFF/REMOTE" selector in the "REMOTE" position.
- At the LCP, place the drainage (dewatering) pump "HAND/OFF/AUTO" selector in the "AUTO" position.
- Pump will start automatically based on LCP software once a stormwater pumping cycle has been completed based on water level.

4. Levee and Landside Gate Operation

4.1 Description of System

The levee wall consists of a reinforced concrete flood wall with landside gates. The wall height along the alignment is designed to a 1% AEP with a 300mm freeboard, which is equivalent to +9.5m AHD.

4.2 Operation

To be further developed.

4.2.1 Levee Wall

TBC – if concrete superstructure, there will be nothing to operate.

4.2.2 Landside Gates

There are XX types of flood gates in the Bundaberg East Levee – XXX, XXX and XXX.

Stoplogs are inserted between permanent or temporary vertical tracks to form a flood gate. Multi span gates require a post to be fitted between sections. Stoplogs and tools required for installation can be stored at flood gate opening or if stored off site will require transportation to be deployed.

TBC – Refer to appendix X – Gate system operation requirements.

Annual “dry-runs” for closure of gates should be undertaken in order to ensure full functionality of all components in preparation for a flood event.

4.3 Inspection and Maintenance

To be further developed.

4.3.1 Levee Wall

TBC

Concrete levee wall sections will require routine inspection and maintenance.

Maintenance matrix to define intervals of routine inspection.

Inspection should occur in preparation for and immediately post-flood event to determine if any action is required.

4.3.2 Landside Gates

Maintenance matrix to define intervals of routine inspection of equipment.

Inspection should occur in preparation for and immediately post-flood event to determine if any action is required.

5. Pump Station and Flood Gate Support Systems

5.1 Heating and Ventilation

The following section explains the operating procedures for the heating and ventilating equipment. Reference should be made to the As-Built construction drawing (see Appendix C), shop drawings, and the equipment manufacturer's operating and maintenance instructions furnished by the heating and ventilating equipment suppliers.

5.1.1 Climate Control

To be compiled post selection of equipment.

5.1.2 Ventilation

Proper ventilation of any building is of primary importance to the heating and ventilating system. To improve circulation of air, exhaust systems allow a certain (proportionate) amount of air to be exhausted to the atmosphere. When combined, the two systems ensure heat equalization, and prevent the air from becoming stagnated and stale.

Air is supplied to the building through the intake louvers on the heating and ventilation units, is circulated and exhausted from the building by the exhaust fans and ducting.

5.1.3 Maintenance Recommendations

It is essential that station personnel become familiar with all instructions provided by the fan and unit heater manufacturers.

In addition to inspection, oiling, greasing, and cleaning, the following procedures should be considered:

Fan V-belt drives should be checked and adjusted for proper tension. Worn or cracked belts must be properly replaced. If the drive utilizes two belts, they must be replaced with a matched pair.

Inspect unit heaters for dust and/or dirt. A build up reduces the efficiency.

5.2 Normal and Standby Power

Electrical power supply for operation of the Saltwater Creek and Distillery Creek Pump Stations is either normal utility power supply from Ergon, or the standby power supply from the backup generator.

The electrical supply and distribution system has been designed and installed in strict compliance with all applicable codes having jurisdiction over this type of installation. *Only a properly trained and licensed electrician should be allowed to maintain, adjust, or repair the electrical equipment. Unauthorised personnel should not be allowed to tamper with any part of this system.*

5.2.1 Normal Power Supply and Distribution

The high voltage feeder provides electrical power for the pump station.

The high voltage feeder is routed to the pump station through underground conduit to a service transformer which steps the electrical service down to a usable voltage of XXX volts.

Additional details will be added as specific equipment is selected as the design progresses.

5.2.2 Standby Power

A generator will provide standby electrical power for the pumping station in the event of a failure of the normal power supply. The generator is rated to provide XXX volt, three phase, XX Hertz power at a capacity of XXX KW, XXX KVA.

The generator is arranged for automatic starting upon a reduction in voltage in one or more phases, or complete failure of the normal source of power, and for automatic load transfer when the generator has attained full speed, and rated voltage and frequency. A 0 to 5- minute adjustable standby power transfer delay timer allows the generator unit to reach full speed and allow operating pumps to come to a complete stop before transfer to standby power. A second 0 to 30-minute adjustable normal power transfer delay allows operating pumps to come to a complete stop before transfer back to normal power supply. A third 0 to 5-minute adjustable shutdown delay timer allows the engine-generator to operate unloaded for a period of time after transfer back to normal power before automatic shutdown.

The generator is equipped with starting batteries, battery charger, and controls to keep the unit ready for immediate automatic start-up and full load operation. The electrical controls and instruments for the unit are located on the engine and control panel mounted on the unit.

The engine-generator unit should be monitored whenever it is in operation. The operator should routinely check the instrument panel to ensure that the unit is operating properly and is not overloaded.

The generator unit should only be utilised during emergencies and for periods not to exceed one (1) hour per week for routine maintenance and testing. Testing should be conducted under simulated "power supply outage" conditions. It is recommended that the generator set be exercised under load once a week for one hour.

All persons during generator operation should wear hearing protection.

5.2.3 Operation Conditions

When inspecting, repairing, and performing maintenance in the main power distribution panel or a motor control centre, keep in mind that dangerous voltages may exist, and precautions must be taken to ensure that no person encounters a "live" high voltage part.

Emergencies in the electrical system are usually the result of excess electrical current flowing in circuits. Circuit breakers throughout the system serve to isolate such emergency conditions by automatically removing such circuits from the electrical system. Some circuit breakers protect against both large and small current overloads, preventing any damage to the distribution system and to minimize possible injuries that could result from faulty circuits.

If a circuit breaker has automatically opened or is tripped, as indicated by the position of the control lever, qualified personnel should test the circuit for short circuits before attempting to close the breaker. The situation must be corrected before the circuit may be used.

In control circuits and instrument panels, fuses perform essentially the same function as circuit breakers. When automatically opened (blown), the circuit must be checked before the fuse is replaced.

NEVER work on mechanical or electrical equipment without first LOCKING OUT AND TAGGING its local disconnect and the circuit breaker at its power source.

5.2.4 Lighting System

The types of lighting fixtures installed at this facility are high efficiency LED lights.

Consideration to be given to Marine Warning Lighting, levee wall lighting and lighting within and around the pump station buildings in future design stages.

5.2.5 Safety Precautions

Emergencies in the electrical system are usually the result of excess electrical current flowing in a circuit or circuits. Circuit breakers throughout the system serve to isolate such emergency conditions by automatically removing such circuits from the electrical system. In addition, there is redundant protection inherent in the electrical system.

Only qualified personnel are to work on electrical equipment. If a fuse or circuit breaker has automatically opened, as indicated by the position of the control lever, the circuit should be tested for short circuits before replacing the fuse or attempting to close the breaker.

When inspecting, repairing, and performing maintenance on metal clad switchgear, the fact that dangerous voltages may exist must be kept in mind and precautions taken to ensure that no personnel encounter a "live" voltage part. Common general precautions for high voltage work are:

- All connections should be considered "live" until the crew expecting to work on them is assured that the circuits are "dead", and until every possible precaution has been taken to see that there is no chance of a circuit being energized while the crew is working.
- Switches which have been opened to de-energize a circuit to permit work on equipment must be locked out and tagged following the City of Bundaberg's Lock-out Tag-out procedures.
- Do not work on parts normally carrying current at high voltage until their parts have been disconnected from the system and connected to the ground bus. Provisions should, therefore, be made for connecting adequate flexible ground leads to reach every part of the switching equipment.
- A good and reliable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to take care of any abnormal condition that might occur on the system and should be independent of the ground used for any other apparatus.

5.3 Security and Communication Systems

5.3.1 Security Alarm System

An electronically operated and electrically supervised security alarm system has been provided. All outside entry doors and the hatches at the pump tubes are monitored.

5.3.2 Communications System

It is anticipated that a combination of mobile phone and UHF radio communication will be utilised when personnel are actively working the pump stations. This will be further considered in future design stages.

5.3.3 Supervisory Control and Data Acquisition (SCADA)

To be developed as the system is specified.

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6. Records

6.1 Introduction

Conscientious record keeping is an essential part of good pump station operation. Well-kept records will facilitate planning for future needs and meeting typical operating situations.

Equipment in a pump station requires periodic maintenance, and good maintenance records, which note when service was last performed and when it is due again. These records are discussed in Chapter 7.

Detailed records of day-to-day operation can be useful in identifying trends in equipment condition, designing changes or expansion of existing facilities.

It is also important to maintain records of any registrable plant and ensure that the registrations are current.

Only pertinent information should be recorded. Care must be taken to avoid accumulating excess or unimportant data.

The most-efficient way to keep records is to plan what data is essential and useful and then prepare forms to record this information. Forms indicate the data to be obtained and provide ease in recording it with a minimum possibility of error or omission. Prepared forms can be used for station operations, and maintenance records. Keeping records without utilizing well designed forms increase labour, time involved and promotes inaccuracies.

Records should be catalogued at the time the data is obtained, by the person making the measurement, reading or calculation. Entries should be made directly on the appropriate form. This will greatly reduce the chances of losing or miscopying information. Responsibility for proper filing, care and use of records should rest with the operator.

Consideration will be given in future design stages to the record keeping and asset maintenance systems utilised by Bundaberg Regional Council and how these apply to the operation and maintenance of the levee system.

6.2 Pump Station Operations Logs

The Operations Log should give equipment status and provide space to record any abnormal operating conditions. Electric and gas consumption, and any other information deemed necessary to the efficient operation of the pumping station should also be recorded.

6.3 Flood Gate Operations Logs

The Operations Log should give equipment status and provide space to record any abnormal operating conditions. The number and range of operations should be recorded, along with any operational concerns observed.

6.4 Alarm Logs

Every time an alarm goes off, the cause of the alarm, even if accidental, should be recorded in an Alarm Log. Over a long period of time, alarm records may indicate problems, which could be reduced or eliminated.

6.5 Incident Reports

An Incident Report should be completed for every incident, no matter how minor, on the day on which the incident occurs. These records are important for insurance purposes and ongoing maintenance, operation and design of the system. Care should be taken to analyse the cause of the incident and provide mitigation measures to avoid the incident occurring again.

The Operator must comply with relevant Workplace Health and Safety Act 2011, Workplace Health and Safety Regulation 2011 and other codes of practice provisions regarding any incidents that have the potential to or cause harm to personnel.

7. Pump Station and Flood Gates Maintenance

7.1 Introduction

A sound Maintenance Management System (MMS) is necessary to attain efficient, economical station operation and continuous acceptable performance. A good Maintenance Management System (MMS) includes extensive detail and covers all factors of a maintenance program, including the preventive maintenance (PM) program, lubrication routines, response to emergency maintenance situations and troubleshooting suggestions all supported by a spare parts and inventory system.

7.2 Maintenance Program

The maintenance program is a plan of things to do which is supported by the MMS that takes all the parts of the program and assembles them into an orderly system. As a result, many of the parts are viewed as separate elements that support each other so that the system can properly function and achieve the program plan of assuring reliable equipment. As an example, in the Maintenance Management System (MMS), preventive maintenance is separated from the performance of corrective maintenance. Under an established MMS, corrective maintenance is the completion of emergency repairs when these situations arise, and preventive maintenance maintains equipment reliability by preventing unnecessary failure that would prompt corrective maintenance responses.

In the event emergency or corrective repairs must be made, the MMS will provide maintenance personnel with a maintenance history and other information on the equipment, an adequate stock of tools, parts, and supplies, so that the equipment can be repaired and placed in service with a minimum of downtime. This will assure operating personnel available equipment to maintain efficient levels of process control.

From senior O&M Specialist: Specifications should stipulate the equipment vendors/contractor provide the asset information and lubrication/maintenance summary

7.2.1 Preventive Maintenance

The preventive maintenance and lubrication schedule summarizes necessary inspection action and frequency for major equipment throughout the station. It is recommended that schedules be used to prepare maintenance requests so that both PM and lubrication tasks can be performed at the same time.

The Maintenance Supervisor (or an assigned employee) should carefully plan and schedule all maintenance and materials so that station operations can be maintained at highest efficiency with minimum expense. The size of the total maintenance force should be kept to a minimum and every effort should be made to avoid idle time and to minimize overtime work through proper implementation of the program.

Maintenance personnel should become familiar with the equipment troubleshooting information and procedures provided in the manufacturer's service manuals so that equipment outage time is minimized.

7.2.2 Corrective Maintenance

Corrective maintenance procedures are separate and different from the preventive maintenance program. Under an established Maintenance Management System (MMS), corrective maintenance is completing emergency repairs when these situations arise. Preventive maintenance is an ongoing procedure that improves equipment reliability by preventing unnecessary failure, thus extending equipment life.

In the event of an emergency where corrective repairs must be made, the MMS works in the same way (with the use of the maintenance request forms). The system then provides maintenance personnel an adequate stock of tools, parts and supplies, and repair manuals so that the equipment can be repaired and placed in service with a minimum of downtime. This quick response to emergency repairs will enable operating personnel to maintain efficient levels of process control. To repeat the statement made previously, the maintenance personnel must realize that their purpose is to serve as a service department for the operations department so that continued efficient operation of the pumping station is always maintained.

7.2.3 Lubrication

Establishing a lubrication program is a very important part of any preventive maintenance program. It is an important art of the Maintenance Management System. Therefore, the maintenance person assigned the responsibility of lubrication must be properly trained in its application and the use of the program.

Development of a lubrication program begins with a thorough analysis of the equipment, lubricants, and lubrication procedures recommended by the equipment supplier/manufacturer. A survey of all station equipment should be performed using station personnel. Each lubrication point should be noted at this time and the correct lubricant and frequency of lubrication established.

Based on this information, a simple assignment and report form should be set up fixing responsibility, frequency, type and providing feedback to indicate that the lubrication work has been accomplished as scheduled.

The manufacturers' service manuals should provide direction in compiling the station lubrication program. The lubrication schedule and service manuals should include the equipment name, recommended lubricant, frequency of application, inspection intervals, equipment inspection instructions and comparable and inter-changeable lubricants as per the manufacturers service manual recommendations. Many suppliers of lubricants will perform this service for you. Care should be taken in selecting a company that has people skilled in lubrication and are not just salespersons.

7.2.4 Mechanical

All station personnel should be continually on the alert for unusual conditions, equipment malfunctions, and early warning signs of impending failure, such as noise, vibrations, surging, leaks, smoke, odor, heat, etc. These should be reported to the maintenance personnel as quickly as possible. The request should be investigated immediately so that, if necessary, the equipment or other reported problems can be taken out of service, or a standby unit started before damage occurs.

7.2.4.1 Routine Maintenance Tasks

- Inspections: Maintenance personnel should inspect all operating equipment at regular intervals (usually during PM task performance) to see that all bolts and nuts are kept tight and that correct adjustments and alignments of couplings, V-belts and drives are maintained. Belt drive tensions should also be checked and adjusted, as required.
  - Equipment and surrounding areas should be kept clean and free of dirt. Machined surfaces should be cleaned free of rust spots and protected with paint or heavy grease preservative.
  - The operating personnel should also inspect equipment during their normal operating rounds and report any malfunctions, noise, leaks, etc. before they become serious.
- Adjustments: Normally, attempts should not be made to adjust moving equipment. Either the breaker at the motor control centre or the stop/start pushbutton at the machine should be locked out before work is begun on a piece of equipment. Simple bearing lubrication, packing adjustments, however, can be done while the machine is operating depending on the manufacturer's recommendations. All couplings and chain/belt drives should have adequate protective guards or shields. Before leaving the work site, the maintenance personnel must replace any guards that were removed during maintenance.
- Drive Belts: Where belt drives are used, maintaining proper tension and alignment of the belts and the belt drives ensures long life for belts and sheaves. Keep belts and sheaves clean and free of oil because oil causes belts to deteriorate. Before installing belts, replace worn or damaged sheaves. Never force a belt into position. Never replace one V-belt on a multiple drive; always replace complete sets. Store spare belts in a cool, dark place and tag all stored belts with the name of the equipment on which they are used.
- Electric Motors: Keep all electric motors free from dirt, dust, and moisture. Ensure that operating spaces are free from articles that may obstruct air circulation. Check for excessive grease and oil leakage from bearings. Lubricate as recommended in the specific motor manufacturers' service manuals.
- Drive Units: Careful attention should be given to the manufacturer's lubrication and maintenance instructions on drive units and gear reducers to ensure proper lubrication and operation. The speed changer should be exercised frequently through the full speed range so that lubricant will be distributed, and parts will not become frozen in one position. The speed of the units should not be changed unless the drive motor is in operation. Gear reducer

oil fill connections must have a breather cap or plug with a venthole to allow the unit to breathe to prevent damaging seals or loss of oil. The breather cap filter should be cleaned when the oil is changed, and the vent plug should be checked to make sure the hole is not plugged by dirt or paint.

- Bearings: Over greasing causes most ball bearing troubles. In order to protect against this and to provide proper lubrication, the following is recommended as a lubrication procedure: (1) clean exterior of bearing housing and grease fittings; (2) remove drain plug; with equipment running and the bearing at operating temperature, apply; (3) grease with a grease gun until all of the old grease is forced out the drain (plug hole); and (4) operate equipment about 30 to 60 min. to allow excess grease to work out before replacing the drain plug.
- Pumps: Pumps should not be operated for extended periods of time against a closed discharge valve (zero flow) because the water in the volute of the pump will get hot and heat will be transferred to the pump parts and may cause seizure and damage to the pump or motor. Pumps also should never operate with the suction restricted or with excessive suction lift (beyond pump design) or be allowed to suck air. These conditions can cause the pump to cavitate (sharp metallic pounding, sounding as if pumping rocks) that will cause rapid metal erosion resulting in destruction of the pump impellers. Operating personnel should be aware of and recognize cavitation noise, so they can be reported and corrected. A honeycombed or pitted condition on the underside of the impeller vanes is one indication of damage caused by cavitation.
- Valves and Gates: All valves and gates throughout the pump station, particularly those seldom used, should be exercised by fully closing and opening the valve on a regularly scheduled basis. The assigned worker's initials and the date should be recorded for each inspection and preventive maintenance action on the appropriate maintenance request form so it can be fed back to the equipment record system.
- Housekeeping Tasks: A major problem at pump stations is odour caused by accumulations of slime, or other putrefiable organic matter. Every maintenance or operation procedure must be followed by proper clean-up to ensure that the equipment and the entire area, including the walls and floors, are left clean. Removing dirt and slime while it is fresh is much easier than doing so after it has dried or become odorous.
- Outside Services: Some maintenance tasks, such as building repairs, roofing, painting, etc., may be handled more economically by outside contractors. Also, other jobs such as major electrical failures (substations, etc.), instrumentation repairs, major equipment overhauls, etc., require special technical skills, knowledge, or assistance, and may be beyond the capabilities of station personnel. The maintenance personnel should develop a list of available repair services they can call on when the need arises.

Table 12 lists basic maintenance tasks for mechanical equipment.

Table 12 Mechanical Maintenance Tasks

Item	Tasks	Frequency
Sluice Gate	Exercise gate	Monthly
	Lubricate operating stem	Every 6 months
Emergency Generator	Change oil, replace oil filter	Yearly
	Change air filter	Yearly
	Run generator with load	Weekly

7.2.6 Exercising the Pumps and Gates

To maintain the functionality of the system it must be regularly exercised to confirm that it is operating properly. Once a month during the flooding season, each stormwater pump should be "bumped" by momentarily starting the pump. This allows the oil in the pump to be circulated around bearings and seals. Additionally, each gate should be lowered and then raised again to confirm functionality and no blockages. Lastly, at an interval to be specified by the pump manufacturer the gates should be closed and each pump be engaged to circulate water through the system.

7.2.7 Electrical System Maintenance

It is recommended that an electrical maintenance schedule be prepared and included in the MMS for power distribution equipment, controls, instrumentation, and emergency power equipment.

Some equipment may require periodic tests with specialized test equipment such as on switchgear and motor control centres. These readings should be charted to allow observation of progressive weakening of insulation. (Predictive maintenance).

The PM schedule should provide for lubrication, adjustment, and tightening of various equipment. Considerations for abnormal local conditions, such as salt-laden atmosphere and corrosive gases, should be given. Proper stocking of spare parts in the inventory system should be required. For specific maintenance procedures on individual equipment, manufacturer's literature should be consulted.

Draw out and stab-on electrical equipment has been provided wherever practical so that equipment may be moved to a clean, dry area for servicing. The maintenance personnel should make sure before performing assigned tasks that all high voltage connections are adequately protected, and all possible hazards are marked with proper caution signs. All personnel should be carefully trained on all potential electrical hazards and correct procedures in case of electrical trouble. All personnel should be cautioned to disconnect and tag circuit breakers before working on equipment and, to ensure that all parts of electrical equipment have been de-energized before commencing repair work. When personnel must work close to energized electrical equipment, the equipment should be covered with an insulating blanket to prevent accidental contact with an energized part. Table 13 lists items to be checked.

Table 13 Electrical Maintenance Tasks

Item	Tasks	Frequency
Motor Control Centre	Clean and check connections	Yearly
Automatic Transfer Switch	Inspect case, contracts and terminals	Yearly
Panel boards	Inspect for moisture, cracks and clean	Yearly
Lighting	Replace bulbs, dust fixtures	As needed

7.2.8 Heating and Ventilation

Efficient operation of all equipment covered under this section of the manual will be dependent upon an adequate maintenance program through inclusion in the MMS. The basis for the program will be the equipment manufacturer's recommended practices and those obtained by the operating personnel from actual operating conditions.

7.2.9 Housekeeping and Painting

The necessity for good housekeeping cannot be overemphasized; however, in some areas the station personnel must also exercise good judgment. Careless hosing, for example, can wet down machinery that water can harm, to include

the potential of electric shock, and pools of water left on the floor after hosing can become a safety hazard for anyone in the area including the person using the hose.

An essential element of good housekeeping requires that grease on walls, floors or equipment be wiped up immediately. Less effort is required to keep the building clean if it is cleaned before these substances harden or are tracked throughout the building. A good housekeeping habit would be that station personnel carry a rag in their pockets for wiping up spills, dusting or drying equipment, walls, railings, etc. immediately. However, do not attempt to wipe moving machinery- this is not good judgment, and highly dangerous.

It is important to the maintenance of the station that the paint on the metal surfaces and equipment is always in good condition. The stormwater pumping station will experience many fumes and humid conditions, which are corrosive to metal and may cause deterioration to concrete.

Corrosion to both metal and concrete surfaces may be caused by several conditions. Corrosion prevention is much easier and less expensive than repairing the damage of unheeded and unnoticed corrosion. Corrosion prevention may be accomplished by choosing corrosion resistant materials for conveying and storing the fluids used in the stormwater treatment process. Corrosion resistant materials may range from noncorrosive metals to non-metallic materials.

Where it is impractical to use corrosion resistant materials in the stormwater pumping process, the rate of corrosion may be greatly reduced by controlling the environment in and around the facilities containing the stormwater. Environmental control may include such items as:

- Ventilation and heat.
- Cathodic protection.
- Galvanic or bimetallic corrosion resistant materials.
- Use of coatings.
- Preventing formation of hydrogen sulfide or other corrosion, causing gases.

Normally, stormwater pumping station corrosion is controlled by (1) ventilation and heat and (2) the use of a coatings. Coating a surface to prevent or retard corrosion and/or deterioration primarily refers to protective coatings, such as, sealants and paints.

For any paint to provide the protection required of it, the surface to which it is to be applied must be properly prepared. Proper preparation of the surface is the most important phase in applying the proper coating. Those surfaces which may require different methods of surface preparation are:

- Steel surfaces.
- Concrete surfaces.
- Galvanized iron surfaces.
- Wood surfaces.
- Masonry surfaces.

Each of these surfaces requires special preparation depending on its use and type of coating to be applied. The coating manufacturer or supplier can provide information necessary for preparing the surfaces to be coated.

A continuous recoating program is necessary to ensure long life to the facilities and equipment. A well-maintained facility is also a good public relations tool and ensures the public that their investment is being well taken care of.

Coatings may be rolled on, brushed on, or sprayed. Whatever method of application is used, care must be exercised to avoid spilling, dripping, or spraying on other surfaces.

The manufacturer's recommendations should be followed regarding such conditions as temperature, drying time, thinning, number of coats, ventilation, safety precautions, and atmospheric conditions.

When successive coats are to be applied, every effort must be made to apply a coating that has the same type of base or is compatible. This will provide a better bond between the new and old surfaces.

7.2.10 Post-Event Monitoring and Inspections

Following any activation of the flood control components or any high flow event in either Saltwater Creek, Distillery Creek or the Burnett River the facilities need to be fully inspected to confirm that there was no damage incurred. Debris should be removed from the trash racks and sills, along with any other areas where vegetation or foreign objects may have accumulated. After thoroughly cleaning the entire pump station the pumps should be engaged, and the gates should be exercised to confirm full functionality. Any damage or issues observed should be addressed immediately.

7.3 Records

7.3.1 General

Complete, accurate and easily accessible equipment and maintenance records will enhance and prolong the useful life of mechanical equipment throughout the station. These records will assist in identifying day-to-day maintenance tasks that must be completed, as well as providing information on past maintenance practices such as machinery adjustments and repairs so that required repair or replace decisions can be made. Detailed records provide quick access to information such as model numbers, parts lists, service representative, etc. Review of adequate records may indicate needed changes in maintenance procedures and provide accurate information for maintenance costs and budget estimates.

7.3.2 Equipment Numbering Systems

An equipment numbering system used for establishing the location and identification of all equipment should be included. All new equipment as well as the old equipment should be numbered (using the same numbering system) when they are added or replaced over time. This becomes necessary to avoid the potential for confusion in the daily operation and maintenance of affected units. The numbering system should be established and continued through the life of the facility.

Engagement with Bundaberg Regional Council will be required to ensure that all levee equipment is incorporated within any existing asset registers to avoid confusion.

7.3.3 Equipment Records

Complete detail of each item of equipment (as an example, motor, drive, and pump) should be included in the equipment records, preferably in one file location. Each file should have an equipment maintenance record form that lists the history of repairs and any other useful information for the subject equipment. Actual performance data, which is helpful in checking the condition of equipment, the need for adjustment, and/or signs of impending problems must also be included.

The file prepared as noted above, provides a complete source of information for each item of equipment and should be readily available for use to assist in locating drawings, instructions, and parts lists; ordering parts and obtaining service; recording repair operations and adjustments; etc. Files should be kept both as hard copies and electronically.

Engagement with Bundaberg Regional Council will be required to ensure that all levee equipment is incorporated within any existing asset registers.

7.3.4 Manufacturer’s Service Manuals

Manufacturers' service manuals will be provided with each major piece of equipment installed during the pumping station construction. The service manuals contain information particular to the specific equipment that will become invaluable for the performance of maintenance tasks or ordering parts or supplies. The manuals should be filed in the equipment file included as part of the maintenance record system on a server. Any additional paper copies of manuals should be indexed, listed, and stored. If for any reason the paper copies of manuals are lost or destroyed, immediate steps should be taken to reprint or replace them, by either contacting the consulting engineers or the manufacturer directly.

Generally, the service manuals provided will contain the following items:

- Equipment description
- Nameplate data
- General O&M procedures
- Startup and shutdown instructions
- Storage instructions
- Special operating instructions
- Routine and specific maintenance instructions
- Illustrations and diagrams
- Maintenance and lubrication schedules
- Spare parts listings
- Troubleshooting guides

Another source of information that is included in the record system is:

- Construction plans (as built) and
- Construction photographs.

These items should be indexed, listed, and filed.

From Senior O&M Specialist: The Specifications should stipulate that the equipment manuals be bookmarked searchable .pdf format along with additional hard copies to house onsite and in Engineer's or Maintenance Department office.

7.3.5 Vendor List

This list will be developed and populated as the design progresses.

8. Levee and Landside Gates Maintenance

8.1 Maintenance

Overall maintenance of the levee walls and landside gates are to ensure that the levee is functional and ready for a large-scale flood event to the region. Different sections of the levee will have different practices maintain the overall structure and to identify potential faults that could compromise the section.

8.1.1 Levee Wall (Earthen) – remove if not used

Earthen levee walls are at risk of failure from a multitude of different factors listed below.

8.1.1.1 Settlement

Earthen levees are at risk of failing if the soil they are constructed on is not prepared prior to construction. The soil should be compacted and reinforced in necessary to hold the weight of the levee. (Require more information on settlement techniques used at the Bundaberg Site)

8.1.1.2 Surface Protection

To ensure the longevity of the Bundaberg Levee, surface protection measures should be implemented to protect from erosion. These techniques could include geotextile fabrics, grass platting gauze matting or use multiple techniques. These will limit the effects of erosion taking chunks out of the levee over time which weaken the integrity and could compromise the structure. Maintaining the surface protection of the levee is integral to its long-term serviceability.

8.1.1.3 Erosion

Erosion will be the biggest risk to the levee integrity. Surface Protection techniques that were listed above will help minimise effects such as rainfall runoff, embankment overtopping, human interaction (walking, cycling) and dry cracks forming during dry periods of the year. High amounts of erosion is expected should there be a large scale flood event that the levee diverts, the river flow would cause large scale undercutting and scouring along the base of the levee compromising it and causing it to fail by toppling inwards due to the lack of support.

8.1.1.4 Slope Stability

(Require more information of the Levee Material)

The overall slope stability must be monitored to ensure the overall integrity of the Bundaberg Levee wall. The slope stability depends on the material the levee wall is constructed from with all materials having different material properties. The overall slope stability is at risk in times of high rainfall or flooding the levee material becomes saturated which heightens the risk of slumping or slope failure to occur. Slope failure can also occur due to the growth of vegetation promoting the growth of seepage paths through the levee wall. In times of heavy rainfall or flooding this will cause a slope failure. Monitoring the vegetation on the levee walls will mitigate the risk of this occurring.

8.1.1.5 Tension Cracks

(Require more information of the Levee Material)

Tension cracks can occur due to the material properties of the levee surface. As the surface of the levee dries cracks will occur due to the surface shrinking and expanding in dry and wet periods. The cracking is normally minimal and very shallow along the surface of the levee however without proper maintenance they can cut deep into the levee compromising the integrity by promoting seepage paths.

Surface protection techniques will combat the effects of tension cracks, but the walls must be inspected and maintained especially during dry periods of the year.

8.1.1.6 Seepage

Seepage is a major concern to the overall integrity of the Levee wall. Seepage is water that has travelled through the levee and is seeping out of the landward side often undermining the levee itself which will eventually cause a failure to occur. Seepage can occur due to high vegetation growth, tension cracks and eroded areas.

8.1.1.7 Animal Control

The presence of wildlife in the environment that the levee will be constructed in can lead to the creation of erosion or seepage paths on the surface and through the levee. Burrowing animals especially can cause significant damage to the levee walls. Ensuring that burrowing animals are identified in the area and any damage done to the levee walls is remedied immediately is essential to the longevity of the levee.

8.1.1.8 Unauthorised Usage

Unauthorised usage can be many different activities with many being well-meaning. Unauthorised usage can include tree planting, group activities, services installations, excavations, and human usage (directly effecting the levee such as using it as a ramp for bikes).

Maintaining and protecting the levee from these factors will ensure the longevity of the earthen wall section of the Bundaberg Levee Project.

8.2 Levee Wall – Concrete

Add any relevant maintenance requirements here.

8.3 Levee Wall – Other – TBC

Add any relevant maintenance requirements here.

8.4 Inspection Types

Inspections are to be undertaken at specific times with observations of differing requirements dependent upon the type of inspection. A tiered approach should be adopted where initial observations are recorded and matters requiring further investigation are referred to appropriate experts. All inspections need to be recorded. Inspections that need to be undertaken are:

Operational inspections – Bi-Annually.

Routine inspections – Annually.

Periodic inspections - at five-year intervals.

Emergency inspections (in-flood and post-flood) or at other times of heightened risk (eg. earthquake).

8.4.1 Operational Inspections

Operational Inspections are performed by the levee manager's staff or contractors during routine operational levee visits where deficiencies discovered are corrected as soon as possible or scheduled for corrective action. Deficiencies beyond the levee manager's or contractor's understanding require additional inspection. Operational inspections should be undertaken whenever a staff person is present on the levee or at least every six months. Generally, if repairs are being undertaken an operational inspection report should be completed.

8.4.2 Routine Inspections

Routine inspections are a formal inspection that document the levee condition and ensures the levee meets the minimum acceptable standards. Routine inspections are generally performed without the need of specialist equipment and should be performed bi-annually by a competent person with knowledge of the levee system and its components.

8.4.3 Periodic Inspections

Periodic inspections are generally performed by experts with a high understanding of the levee design principles and may include various engineering disciplines such as hydrologists, geotechnical, structural, and mechanical, as deemed necessary by the levee type and components. Specialist equipment may be required. Periodic Inspections should be undertaken at least every 5 years and be certified by a suitably experienced and qualified engineer.

8.4.4 Emergency Inspections

In-flood inspections are carried out while the levee system is loaded and are important to identify weaknesses and potential future failure points in order to plan and implement emergency repairs or emergency evacuations. Post-flood inspections are crucial to observe and record any damage that may have occurred during a flood event and to evaluate the ability of the levee to withstand another flood. This inspection is used to program repair works following a flood.

8.5 Inspection Methodology

8.5.1 Typical & Notable Defects

8.5.1.1 Levee Wall (Earthen)

Key items/defects for earthen levee walls that should be considered during inspections include:

- Settlement
- Surface Protection
- Erosion
- Slope Stability
- Tension Cracks
- Animal Control
- Seepage/Sand Boils
- Unauthorised Activities

8.5.1.2 Levee Wall (Concrete)

Surfaces

Visible cracking, scaling, or spalling are signs of concrete movement and stresses with the concrete.

Cracks in concrete walls are subject to moisture penetration which could cause corrosion of reinforcing steel, leading to further spalling or in severe cases a reduction of reinforcing's capacity to perform adequately.

Tilting, Sliding and Settlement

BEL constructed with the use of piling under all structures.

Movement is indicative of structural failure.

Vegetation

Vegetation should not be permitted to establish near concrete structures. Intrusive tree roots can penetrate small cracks and develop significant pressure within the structure which can trigger further failure.

Leakage in Concrete Structure Joints

8.5.1.3 Landside Gate

From Senior O&M Specialist: Typically we have been deferring to the safety program and procedures of the Utility or Entity that operates the facility.

A principal responsibility of all pump station personnel should be to prevent injury from hazards, which may exist at the pump station. A prime objective should be the total elimination of accidents because any lesser objective tends to tolerate accidents rather than prevent them. Injuries are not only indicative of improper operational procedures at the pump station, but also, they can seriously affect the efficiency and cost of operation.

All operations and maintenance activities must conform with the following:

- Queensland Work Health and Safety Act 2011
- Queensland Work Health and Safety Regulation 2011
- Queensland codes of practice
- Queensland Water Act 2000

All other applicable local and state regulations.

References

Appendix A

Appendix B

Operation and Maintenance Manual Example for Pump Stations Including Gates

Appendix C

Warranties

Appendix D

Client Training Register

Appendix E

Asset Register

Appendix F

Completion Certificates

Appendix G

Specifications

Appendix H

Maintenance Matrix

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