GIPPSLAND WATER

SEWAGE PUMP STATION DESIGN REQUIREMENTS

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Abbreviations

Abbreviation	Description
ADWF	Average Dry Weather Flow
BEP	Best Efficiency Point
DACS	Data Acquisition and Control System
DI	Ductile Iron
DICL	Ductile Iron Cement Lined
DOL	Direct on Line
EPA	Environmental Protection Authority
ERS	Emergency Relief Structure
ES	Emergency Storage
FAT	Factory Acceptance Testing
H2S	Hydrogen Sulphide
ID	Identification
MH	Maintenance Hole
NPSH	Net Pressure Suction Head
PDWF	Peak Dry Weather Flow
PWWF	Peak Wet Weather Flow
RTU	Remote Telemetry Unit
SAT	Site Acceptance Testing
SCADA	Supervisor Control and Data Acquisition
SPS	Sewage Pump Station
VSD	Variable Speed Drive
WSAA	Water Services Association Australia

1 Chapter Introduction

This manual describes Gippsland Water's requirements, arrangements and layout for small and intermediate sewage pumping stations (SPS). All new SPS must comply with Gippsland Water's standard design and be compatible with other SPS in Gippsland Water's system in layout, electronics, operation, maintenance and Gippsland Water's standard remote telemetry unit (RTU) program. To ensure this occurs new SPS must comply with these design requirements.

For the purpose of these design requirements, a SPS extends from the upstream connection point of the pump well incoming sewer to the downstream connection point of the rising main.

These design guidelines are to be read in conjunction with the following code:

- Water Services Association of Australia (WSA), Sewage Pumping Station Code of Australia WSA 04-2001

For additional information refer to the following:

- Water Services Association of Australia (WSA), WSA 01-2004 Polyethylene Pipeline Code Version 3.1
- Water Services Association of Australia (WSA), Gravity Sewerage Code of Australia WSA 02-2014-3.1 MRWA Edition and Gippsland Water Supplement.
- Water Services Association of Australia (WSA), Water Supply Code of Australia WSA 03-2011-3.1 MRWA Edition and Gippsland Water Supplement.

Additional Gippsland Water documents to comply with:

- Sewage Pump Station Standard Drawings
- Standard Electrical Specification
- Standard SPS Commissioning (FAT & SAT)
- Wastewater systems Design Criteria COR/10/27706

1.1 Clarification If Required

Gippsland Water will be the sole source if clarification is needed on any issue arising from this document.

1.2 The Contents Of This Manual

Chapter 1. Overview and Introduction
Chapter 2. Requirements for Small and Intermediate Pumping Stations.
Chapter 3. Pumping Station Sizing
Chapter 4. Mechanical
Chapter 5. Electrical
Chapter 6. Civil Design

1.3 Small Pumping Stations

Small SPS shall have:

- Two pump sets rated up to 5.5kW each.
- A wet well minimum ID of 2250 mm or a maximum ID of 3200mm
- Minimum wet well size may be reviewed if physical constraints of site do not allow for a 2250 mm wet well, however, pump manufacturers' recommendations for positioning and clearances must be satisfied.

- Configuration of DOL control.
- A flow meter, installed in appropriate pit, on the discharge pipe work.
- Control and monitoring equipment as outlined in section 5.2

1.4 Intermediate Pumping Stations

Intermediate SPS shall have:

- Two pump sets rated between 7.5 kW and 22 kW each.
- Wet wells minimum ID of 2250 mm or a maximum ID of 3200mm.
- Variable speed drives and overall screened pump cables.
- A flow meter, installed in appropriate pit, on the discharge pipe work.
- Control and monitoring equipment as outlined in section 5.2

1.5 Large Pumping Stations

Gippsland Water SPS's are generally no bigger than 22kW. In the event that a pump station larger than stated above is required then the designer shall refer to Gippsland Water's Responsible Officer who will consult with internal stakeholders for direction. This specification and associated standard drawings will be used as a basis for design but other relevant design standards will be taken from relevant MRWA codes or as directed by Gippsland Water's Responsible Officer.

1.6 Labelling of Site & Equipment

Refer to Identification and Labelling of Gippsland Water's Assets (COR/07/41914) which is available from Gippsland Water.

Pump Numbers are to be fixed at the top of wet well adjacent to the guide rails.

Site label to be installed on the front of the right hand side electrical cubicle door in the centre of the door.

Refer to Gippsland Water standard drawings.

2 General Design Requirements

This chapter describes the essential features and requirements for small and intermediate SPS.

2.1 General

Small and intermediate SPS must be designed to:

- Conform to current environmental state and federal requirements;
- Effectively pump unscreened raw sewage;
- Provide a standard SPS arrangement requiring minimum maintenance;
- Operate automatically and unattended;
- Provide a below ground structure to house the pump sets;
- Provide a below ground structure to store sewage until the volume is sufficient to transport;
- Minimise the retention of solids and rags within the wet well;
- Reduce detention times in the wet well and reticulation system;
- Minimise storage volumes;

- Provide an unobtrusive design without a superstructure;
- Minimise the need to purchase land by utilising road reserves where possible;
- Facilitate routine cleaning and removal of equipment without the need to enter the wet well;
- Facilitate easy removal of equipment from the SPS for off-site maintenance and repair;
- Be designed in conjunction with inlet sewers and rising mains so the whole system minimises initial and future sulphide build up;
- Be cost effective;
- Contain odours within the well and gravity pipe system;
- Minimise noise pollution;
- Permanent civil works must be designed to last at least 50 years;
- Mechanical and electrical works to last 20 years; and
- Allow storage volume of 2 hours Peak Dry Weather Flow is to be provided within the wet well between the high level alarm and overflow inclusive of the reticulation storage.

Note: Depending on downstream network limitations, Gippsland Water may assess reduction of pump rate, in lieu of increased storage capacity, on a case by case basis.

2.2 Timing

At such time that a developer identifies the requirement for a sewage pump station with regards to a proposed development, the developer must make Gippsland Water aware of their intentions. This notification is initiated by the developer and must be supplied to Gippsland Water in writing or e-mail.

Once identified, the consultant shall submit a design report which outlines the SPS details and specifications and sets out the preferred design approach. If required, the specifications will be internally reviewed by Infrastructure Planning and Field Services prior to acceptance.

The application process and timeframes will be in accordance with Gippsland Water's negotiating framework (COR/13/32213). A Developer Works Deed will indicate agreement between the parties.

2.2.1 Larger SPS – Sewage Pump Station Preliminary Design Meeting

Upon receipt of the initial notification in writing from the developer to Gippsland Water of the requirement of a sewage pump station for the development Gippsland Water will request a Sewage Pump Station Preliminary Design Meeting which will include as a minimum Gippsland Waters representatives from Land Development, Field Services and Asset Planning / Asset Management. This Sewage Pump Station Preliminary Design Meeting establishes the fundamental requirements of the sewage pump station. At this point Gippsland Water will issue to the developer a set of the current Sewage Design Guidelines, and current Sewage Pump Station Standard Design Drawings including electrical standard drawings, of which are utilised to develop a sewage pump station design.

2.3 Pumping Station Design Process

The SPS design process includes the following:

- Establish levels and positions of the inlet, outlet and emergency relief structure overflow from existing or designed sewer information.

- Establish the capacity of the SPS for whole of catchment flows from existing or designed sewer information. Design rates are specified in Wastewater systems Design Criteria COR/10/27706
- Select the size of pump discharge pipe work connecting into the rising main.
  - System duty point is to be within -30% and +15% of selected pumps best efficiency point (BEP).
- Calculate the system curve(s) for the SPS and rising main, & select most efficient pump for immediate, intermediate and whole of catchment growth stages.
- Select the pump well diameter based on the cut-in/out volume and required layout. Refer Gippsland Water Drawing A1 - 70486.
- Calculate the control levels.
  - Check detention times using the total volume of the pump well and rising main, based on immediate (10% of catchment growth), intermediate (50% of catchment growth) and whole of catchment growth stages
  - If detention times in SPS and rising main then the consultant shall incorporate mitigation measures to limit odour generated from the SPS.
- Perform detailed design of civil, mechanical & electrical works using the selected parameters.
- Gippsland Water to confirm the need for epoxy lining in wet well and incoming maintenance structure to avoid corrosion. Material type to be proposed by designer.

2.4 Design Interaction

During the design of the SPS, the Consultant must:

- Obtain asset information from other authorities;
- Liaise with property owners;
- Obtain permits, supply agreements, etc. from other authorities;
- Liaise with Gippsland Water as required; and
- Calculate the impact on the existing receiving sewage systems.

Gippsland Water may request that pump station design calculations and drawings including geotechnical information have an independent check carried out by a qualified Engineer.

Proof of current professional indemnity insurance must be submitted with the design information.

2.5 Site Selection

Where the site is not specified by Gippsland Water, the site selected must:

- Minimise the length of the rising main;
- Where possible be continuously rising. If not, the designer is to consider least impact location for air valves and/or odour mitigation of these air valves in sensitive locations.
- Be suitable for the hydraulic capacity requirements;
- Be located in a reserve. Alternatively, land must be owned by Gippsland Water, or leased to Gippsland Water (Only applies to crown land and will be considered on a case by case basis);
- Meet all environmental requirements;
- Have suitable soil conditions;
- Have an underground electricity supply (cable and substation capable of handling the load and installed as per the design);

- Have access for maintenance and vehicles;
- Have a water supply;
- Be clear of overhead electric power lines to allow safe crane operation;
- Have a hard standing area adjacent to the well for mobile crane access to pump sets;
- Be above the 1 in 100 year flood level, with the cubicle 300 mm higher than this;
- Be not in the path of vehicles or pedestrians; and
- Have minimal aesthetic impacts on adjacent properties.

2.6 Pump Well Arrangement

The arrangement of the wet well must incorporate the following features:

- The SPS must be an underground structure with a separate valve pit;
- The wet well must house two identical submersible pump sets each facing the same direction and each capable of 100% duty of peak wet weather flow (PWWF) as determined by Wastewater systems Design Criteria COR/10/27706;
- The wet well diameter must be determined from the control volumes with consideration of the wet well layout. Wet well diameters are between 2250 mm and 3200 mm;
- Each discharge pipe must have an isolating valve, non-return valve and a pressure gauge stainless steel tapping point with quarter turn Stainless Steel ball valve all located in a separate valve pit;
- Scour pipe to extend from rising main to wet well controlled via a sluice valve;
- Emergency pumping point to be provided in valve pit;
- Air release valves as necessary;
- An incoming sewer isolating valve must have a standard mounting flange and extension spindle arrangements to enable operation from ground level;
- Incoming sewer must not enter the wet well within the quadrant facing the back of the pumps;
- Motor cables supported by appropriate stainless steel cable socks;
- The termination of motor cables will be via a junction box mounted outside the wet well in a separate compartment on the side of the electrical cubicle. The connections between this junction box and the electrical cubicle will be sealed with 50mm gas resistant sealing material (to allow for cable management in future) to stop wet well gases entering the cubicle;
- A freestanding electrical control cabinet must be provided;
- A wet well washer with suitable length to ensure a full wet well spray zone and be able to be maintained from the surface via a lifting chain, where possible. Larger wet wells may require two wet well washers;
- Pump manufacturers recommendations for positioning and clearances must be observed;
- Access to the wet well and valve pit must be provided using covers as described by the Gippsland Water Standard Drawings Nos. A1-33340 – Wet Well and A1-33348 – Valve Pit.
- Access to wet well, fall protection, pumps, control cubicle and controls must be safe and easy and must comply with the Victorian Occupational Health and Safety Act 2004 and any relevant codes of practice.
- Ladders are not to be provided within the wet well unless noted otherwise.

2.7 Selection of Pump Sets

Selection of the pump sets must be based on:

- Sphere clearance;

- System head for immediate, intermediate and whole of catchment as per Wastewater systems Design Criteria COR/10/27706;
- Required submergence of pump set, at manufacturers recommendation;
- Wet well net positive suction head (NPSH) requirements;
- Pump set efficiency within the normal duty range;
- The size of the wet well access opening;
- Availability of spare parts;
- Adequate manufacturer/agent service backup;
- Consistency with existing plant and other Gippsland Water equipment;
- Best efficiency point – within -30% to +15% of duty point for immediate, intermediate, and whole of catchment growth stages/design flows;
- Pumps to operate in all hydraulic conditions as designed by the system curves;
- Proven performance history; and
- Gippsland Water's preference is Flygt pumps, and where possible N-type pumps with hard iron impellers.

2.8 Control and Alarm Levels

All pumping units shall be automatically controlled from level sensing equipment in the wet well. Two back-up float switches plus an overflow float switch for the level sensing/control system shall be provided so that the station can continue to function in the event of a failure of a single component of the primary system. Refer Gippsland Water Drawing A1-70486.

The electrical controls shall allow sequential or alternate operation of pumps so that running times are equalised. The stand-by pump shall automatically cut-in should the duty-pump fail. The duty-pump shall start when the level in the wet well rises to the cut-in point.

If the duty-pump fails to run at cut-in level or if the level continues to rise past the high level float, the stand-by pump shall start. Pumps shall stop when the level in the wet-well falls to the cut-out point. If a pump continues to run for an excessive period of time a pump over-run alarm shall be initiated.

Cut-in and cut-out levels must be set to minimise retention times without exceeding the manufacturer's recommended maximum number of starts per hour for one pump.

The following levels must be included in the control system:

Control level	Description
Cut – Out Level	100mm above pump bowl or as specified by manufacturer
Duty Cut – In Level	Distance such that V=90×Q minimum where V = differential volume in litres & Q = pump duty flow rate L/s
Standby Cut – In Level	200 mm above the duty cut-in level
High level alarm - Emergency Cut	Float switch 200 mm above the Standby cut-in level
High High Level Critical Alarm	Float switch 200 mm above the Emergency Cut In located at invert level of the lowest incoming sewer
Wet Well Overflow Level	Float switch 100 mm below ERS overflow level

2.9 Control Cabinet

The control cabinet houses the switchgear, control circuits, telemetry unit and electrical supply for the pumping station. It is a self-contained freestanding weatherproof cabinet constructed from marine grade aluminium alloy or stainless steel. Control cabinet details

can be found in the Electrical Specification for Small SPS. Refer Gippsland Water Drawing A1-47731 or A1-47775.

All outdoor control cabinets shall be powder coated “Wilderness Green”. Reference Bluescope Steel colour charts.

2.10 Emergency Relief Structure (ERS)

An ERS must be provided to prevent spillage upstream of and at the SPS during facility failure or a storm event above 1:5 ARI via a controlled spill outlet. The outlet is to be designed in such a way, that the discharge invert level of the ERS is above the 1:100 ARI flood level and below the lowest manhole level in the catchment. The capacity of the ERS must be designed to accommodate PWWF.

The design of the ERS must be in line with WSA 04 – 2001 with these additional GW conditions:

- A non-metallic approved flap gate must be installed at the inlet to the ERS to prevent flow back into the sewer. All ERS’s must be self-draining.
- Adequate facilities to prevent gross solids entering the watercourse and to enable collection and removal from the structure.
- Overflow discharge from the inlet sewer MH, shall be from a point not less than 150 mm below the surcharged level of water. This will minimise the discharge of fats to the watercourse,
- An alarm device linked to the SCADA to alert when an overflow occurs.

At the design stage, Gippsland Water must be provided of the following:

- Capacity,
- Location of the outlet works (spill location),
- Controls to minimise spills.

Gippsland Water will consult with the EPA and advise the consultant, if the ERS details are compliant.

2.11 Emergency Storage

An external to well emergency storage (ES) must be provided when the 2 hours of PDWF cannot be contained within the wet well and the reticulation during shutdown or facility failure.

The design of the ES must be compliant with WSA 04 – 2001.

Refer to drawing A1-70482.

2.12 Telemetry

Telemetry equipment is issued by Gippsland Water SCADA Group as per ‘for Construction” drawings to suit the requirements of the Gippsland Water telemetry system. The telemetry unit must be capable of operation from the supply provided in the control cabinet.

A radio path survey is to be conducted by an approved Gippsland Water contractor to determine the type and size of aerial required providing acceptable telemetry coverage of the site. Gippsland Water will arrange aerial installation.

The design shall include items such as fixing details, minimum heights, maintenance, location, materials, signal strength etc. Refer standard COR/14/1040 Gippsland Water Standard Electrical Specification.

3 Pumping Station Sizing

This chapter describes the size requirements for design of small and intermediate SPS.

3.1 Pumping Station Capacity

SPS capacity is calculated at 6 times the Average Dry Weather Flow (ADWF). The selected pump set must be able to accommodate changes to impeller sizes to cater for immediate, intermediate and whole of catchment flows.

3.2 System Hydraulics

3.2.1 General

Where practical, the rising main shall be continuously rising from the pump station wet well to discharge location. Where the above is not possible, ensure the discharge location is at the highest elevation of the rising main.

The system hydraulics are determined using the following parameters:

- Invert level of the incoming sewer,
- SPS capacity for (immediate, intermediate and whole of catchment) inflows,
- Internal diameter, length, route and materials of the rising main,
- Level of the pumping discharge point,
- High points to account for possible characteristics controlled by intermediate high points along the rising main,
- A minimum seating pressure of 2 metres must be achieved at the highest air valve elevation, during static/pump off conditions. The minimum seating pressure is to be calculated from the top of air valve assembly, as per Gippsland Water Standard Air Valve Drawing – refer to A3-53024.

3.2.2 Discharge Pipe Work Diameter

The design criterion for sizing the pump discharge pipe work is as follows:

- Pipe work and fittings diameter must be equal to or larger than the sphere clearance of the pump. The minimum diameter is 50 mm.
- Pipe work diameter must be large enough to cater for the whole of catchment capacity of the pump station, with consideration of self cleansing and rising main detention times at immediate and intermediate and whole of catchment growth stages. This may include (dependent on growth in catchment) the periodic upsize of pump sets or rising main.
- Pipe work velocities for immediate, intermediate and whole of catchment flows must be within the range 1 m/s to 3 m/s.
- Where possible, there must be no reduction in pipe work diameter, from valve pit to discharge location.
- Pipe work to be of Stainless Steel (316L) and to have flanged joints. Refer Gippsland Water Drawings A1-70478 and A1-70480.

3.2.3 System Curves

Pipe work friction losses are dependent on the pipe work material and must be calculated using the Colebrook White, Hazen Williams Formula, or the Manning Formula. Values used are k, C and n respectively.

Losses through fittings, valves, junctions, etc. must be calculated with the following:

$$H_f = k_f \frac{v^2}{2g}$$

Where:

H_f	=	head loss through fitting (m)
K_f	=	sum of fittings valve head loss coefficients
V	=	velocity of liquid (m/s)
G	=	gravitational constant (m/s^2)

Fitting loss coefficients, k values, shall be determined from references such as AS 2200, International Flow Systems (DS Miller), Hydraulic Institute Standards, and the Australian Pump Manufacturers Technical Handbook.

To calculate the system curve, the static head must be calculated by setting the duty cut-in level at 150 mm below the invert of the incoming sewer.

3.2.4 Pump Set Selection

Submersible pump set selection must be based on the calculated system curve and the number of available impeller changes and/or pump set changes. The pump set operation must also be checked against calculated system curves at snort and overflow levels.

Ninety percent of the maximum continuous motor rating must not be exceeded for all duty conditions.

3.3 Wet Well Sizing

3.3.1 General

Pump wells must be designed as small as is practicable to minimise the detention of sewage and reduce the formation of H2S and other odours.

In small SPS, the minimum area required to install the selected pump sets usually determines the wet well size. The distance between pump sets must be at least equivalent to the manufacturer's specifications, with a minimum spacing of 200mm between pumps and 100mm between pump set and wet well wall. This clearance is based on the operation of one pump at a time, that is, duty/standby/assist mode of operation.

Where pumps operate in unison, the clearances specified by the pump manufacturer must be used. The depth of the wet well must be determined by the levels dictated in Gippsland Water Drawing A1-70486

3.3.2 Cut-in/cut-out volume

The cut-in/cut-out volume determines the level of the pump sets in the wet well and must be based on the number of pump starts per hour and the pumping flow rate. The volume is calculated as follows:

$$V = \frac{0.9Q}{S}$$

Where: *V* = cut-in/cut-out volume (m^3)
Q = final pump capacity (L/s)
S = allowable number of starts per hour (maximum of 10 or 90% of the manufacturers recommended number of starts per hour, whichever is the lower)

3.3.3 Control Levels

The parameters for setting the control levels (Wet Well Level Sensor & Float Switches) refer Gippsland Water Drawing A1-70486.

3.4 Rising Main Detention Time

Detention times must be calculated for initial and whole of catchment flows and are based on:

- Average dry weather flow (ADWF)
- Storage volume of the rising main
- Storage volume of the well

Detention times are calculated as follows:

$$T = \frac{0.025Qp + 0.218LD^2}{ADWF}$$

Where: *T* = detention time (hours)
Qp = pump rate (L/s)
L = rising main length (m)
D = internal diameter of rising main (m)
ADWF = mean dry weather flow (L/s)

The volume of sewage stored should be reviewed after the wet well dimensions are initially determined. Sewage must be detained in the SPS and rising main for the minimum time. Generally, up to two hours is acceptable for the detention of fresh sewage. Stale sewage, sewage with low oxygen content, or sewage at elevated temperatures may become a problem with detention times of one hour or less. In these cases, provision must be made for treating the sewage in the rising main and or treatment of odour at discharge location or sensitive receptors along rising main alignment.

3.5 Valve Pit

Valve pits must allow sufficient space for the access of maintenance personnel to work on valves and flexible joints.

Valve pits shall be adequately drained into the wet well and be controlled via a sealed flap valve located above the high level float switch.

Valve pits are to contain the valves, scour pipe, emergency by-pass connection and discharge pipe tappings. Tappings are to be located on the discharge pipes for the installation of a pressure transmitter to monitor discharge pressure. Valves are to be arranged so they can be operated at ground level. Refer Gippsland Water Drawing A1-

70479.

The valve pit must contain thrust type dismantling joints fitted to pipework for maintenance works, refer drawing A1-70479.

Covers are as per Standard Drawings Nos. A1-33340 to A1-33348.

4 Mechanical Design

This chapter describes the mechanical design requirements for small and intermediate SPS. It includes:

- Pump sets
- Discharge pipe work
- Valves

4.1 Pump Sets

4.1.1 Pump Set Construction

Standard submersible vertical centrifugal pump sets with an integrated submersible motor fitted with a non-clog impeller must be used. The impeller must have openings large enough to pass spheres of 50 mm diameter or larger depending on the size of the pump. Two vane or single vane impellers are preferred.

The pump set must be of a type that facilitates installation and removal via guide rails. The pump set must also have standard discharge bend fittings. Suitable materials for the pump are shown in Table 3-1.

Table 3-1 Pump Material

Description	Material
Casing and discharge head	Cast iron or ductile iron
Impeller	Hard iron
Mechanical seal sealing faces	Tungsten carbide to tungsten carbide
Shaft	Stainless steel, Grade 316 or better
Guide rails and lifting chain	Galvanised carbon steel or stainless steel
Wear rings	Bronze or stainless steel, Grade 316 or better

4.1.2 Selection of Submersible Pump Set

The selection of the pump set is determined by flow, head and retention time calculations. The pump set must pump raw unscreened sewage and be a standard unit able to be obtained from local suppliers.

The Consultant must provide the following information to the pump manufacturer:

- Fluid description and temperature
- pH value & Specific gravity
- Sphere clearance required in the impeller (minimum 75 mm closed impellor)
- (Minimum 50 mm with open impellor with cutter)
- Capacity (immediate, intermediate and ultimate)
- Service (intermittent or continuous)
- Wet well conditions
- Limitations on size or weight
- Maximum operating speed (1500rpm), unless approved by Gippsland Water

- Range of ambient temperature
- Special requirements such as preferred materials of construction and features to be included in the design of the pump
- Maximum number of starts per hour
- The majority of sewage pumps in Gippsland Water are Flygt pumps.

The pumps must conform to the requirements of this specification and the Sewage Pumping Station Code of Australia WSA 04-2001.

4.1.3 Pump Set Installation

The pump set installation must be in accordance with the manufacturer's requirements. A typical installation is shown in drawing A1-70490.

4.1.3.1 Pump Set Guide Rails and Retaining Bars

When Flygt pumps are used then the preferred connection is the Flygt "Quick Connect" complete with guide rails. Size of guide rail to be determined by pump manufacture. Guide rails and brackets are to be of 316 stainless steel

Where the wet well is of a depth such that the a 10 meter long or longer guide rail is required, the pump set guide rails must be supported from the wet well walls using supports as shown on Standard drawing A1-70495.

Labelling of the pumps [i.e. PUMP #1, PUMP #2] shall be placed at the top of the guide rails for ease of identification.

4.1.3.2 Lifting Attachments

A stainless steel 316L securing line and a stainless steel chain holding bracket must be installed as close as possible to the top of the wet well on the edge of the access opening. The upper end of the securing line and the lifting chain must be secured with stainless steel D shackles to the lifting chain holding bracket.

4.1.3.3 Pump Set Motors

The pump set motors must be suitable for continuous operation on a 415 V, 3 Phase, 50 HZ power supply.

4.2 Pump Discharge Pipe work

4.2.1 General

Pump discharge pipe work diameters are described in Chapter 2, Pumping Station Sizing.

The pump discharge pipe work comprises the following three sections:

- Vertical pipe work in wet well
- Horizontal pipe work up to the non-return valve
- Pipe branch joining the non-return valve to the rising main
- Stainless steel pipe work must be Grade 316, (316L if welded) in accordance with AS 2837.

4.2.2 Vertical Pipe Work in Pump Well

The vertical pipe work in the wet well must be stainless steel [316L].

Pipe work must be supported at maximum intervals of 3 metres. The pipe support brackets, bolts, nuts and washers must be stainless steel. A typical arrangement is shown in drawing

A1-70479.

4.2.3 Horizontal Pipe Work to the Non-Return Valve

The horizontal section of the pipe work from the wet well to the non-return valve in the valve pit must be stainless steel.

4.2.4 Pipe Branch – Non-Return Valve to Rising Main

The pipe branch joining the non-return valve to the rising main must be stainless steel.

Stainless steel pipe work must be Grade 316, (316L if welded) in accordance with AS 2837.

4.2.5 Pipe Work Joints

All joints must be flanged and provided with 3 mm thick full-face neoprene gaskets and a hardness of Durometer Shore 'A' 50 +/- 5 to prevent joint leakage.

All flanges and gaskets must be drilled in accordance with AS 4087. The table used for the drilling dimensions depends on the design pressure. PN16 flanges to be the minimum standard.

All bolts, nuts and washers must be stainless steel, Grade 316.

4.2.6 By-Pass Pumping Arrangements

Gippsland Water requires emergency by-pass pumping connections to be located in the valve pit. The facilities shall include a branch line from the rising main (pressure main) incorporating a sluice valve, a non-return valve, a 90º bend and a quick-connector coupling hose adaptor (male fitting).

Refer to Gippsland Water Drawing A1-70478 for the position of the sluice valves and non-return valves. Ground level operation of the sluice valves is required.

The quick-connector coupling hose adaptor shall be positioned vertically so that temporary hose connections can come from any direction, but must be accessible at ground level.

The by-pass line pipe work and fittings shall always be DN150. All other by-pass line fittings and valves shall be flanged.

4.3 Valves

4.3.1 General

The SPS must be isolated from the incoming sewer using an isolating valve equal in size to the sewer. Where space in the wet well is limited, or the sewer entry conditions are awkward, the incoming sewer isolating valve must be located in the first manhole upstream of the SPS. If there is more than one incoming sewer, all inlets must have an isolation valve.

Each pump set discharge pipe must have a non-return valve and an isolating valve located in a separate or integrated valve pit.

All valves must be anti-clockwise closing, resilient seated, and their bodies must be coated externally with a fusion bonded epoxy. All valves must be arranged so they can be operated from ground level.

4.3.2 Incoming Sewer Isolating Valve

A knife gate isolating valve must be used. This isolating valve must have a non-rising spindle, a mounting flange, an extension spindle and a valve key that allows the operation of the valve from ground level. An example arrangement of the incoming sewer isolating valve is shown in drawing A1-70479. The knife gate valve must have a Grade 316 stainless steel body with Grade 316 stainless steel blade and a resilient seat.

A valve spindle of 25 mm must be used for valves of DN150. A valve spindle of 38mm must be used for valves of DN200 to DN300. If the spindle length is greater than 6 metres, an intermediate spindle must also be used. The spindle must extend to within 50mm to 100mm of the top of the wet well slab.

The extension spindle must be adequately supported from the wet well wall. Bolts or anchors of Grade 316 stainless steel must be used for securing the spindle guide assembly to the wet well wall.

4.3.3 Discharge Pipe Work Non-Return Valves

Each discharge pipe must have a non-return valve. The non-return valves must be located in the valve pit upstream of the isolating valve. The non-return valves must be either the swing-check type with cast iron body and a bronze disc, or the rubber ball type.

Each non-return valve must be fitted with a 15NS gate valve with copper bleed piping to release air during maintenance.

4.3.4 Discharge Pipe Work Isolating Valves

Each discharge pipe must have a gate valve. The gate valves must be located in the valve pit and positioned downstream of the non-return valve. The gate valves must have a non-rising stem, cast iron body and bronze wedge.

4.3.5 Scour Valves

Where applicable scour valves shall be placed:

- To drain rising main into the wet well
- At low points in the rising main
- Refer Gippsland Water standard drawing A3-53024.

4.3.6 Air Release Valves

Gippsland Water requires the Consultant/Contractor to include in the design and construction air release valves on the Rising Main at locations needed. Refer Gippsland Water standard drawing A3-53024.

4.4 Odour Control

The proposed sewerage system must be designed such that the potential for odour generation is kept to a minimum level acceptable to Gippsland Water.

The potential for odour generation and control must be investigated and reported to Gippsland Water at the design stage. This report must identify and recommend options to control or minimise the odour problem.

The pump station is to be effectively sealed to ensure offensive odours are not discharged to the environment while operating normally. Ease of access and opening of the covers shall also be ensured.

4.5 Wash Down Operation

A 25 mm diameter water supply connection with a ball valve and an industrial backflow prevention valve, must be installed adjacent to the pump well. The configuration, placement and protection of the water supply connection is to be approved by Gippsland Water.

A wet well washing system is to be installed to wash down the walls at appropriate times so that the walls are kept reasonably free of fatty deposits.

4.5.1 Specifications

4.5.1.1 Materials

All materials used shall be of non-corrosive type.

4.5.1.2 Stainless Steel

All stainless steel materials shall be stainless steel grade 316.

4.5.1.3 Copper

Where required, water main connections shall be made in 25 mm copper piping.

4.5.1.4 Galvanised Steel

The water tap assembly shall be enclosed in a heavy duty galvanised powder coated (green) cage complying with AS2423 – Galvanised Wire for Fencing Products. The cage shall be lockable and opened from above.

4.5.1.5 Gunmetal

All water supply fittings shall be gunmetal complying with AS3688-1994 – Copper and copper alloy body compression and capillary fittings and threaded end connectors.

4.5.1.6 Spray device

Self rotating “Wobbler” type wet well washer.

4.5.2 Parts required outside of well

- 1 No. RPZ backflow preventer valve 25 mm diameter full flow to AS2845 – 1991
- 1 No. 20mm Elster/Honeywell PSM Dual Check Valve flowmeter and angle ball valve
- 2 No. shut off ball valves (one for washing down)
- 1 No. Inlet strainer 25 mm kit
- Water meter – Gippsland Water to install
- 1 No. Tee
- Solenoid Control Valve 25 mm full flow with coil to control (24V AC) – BURKERT
- Connectors – Unions and Nipples 25 mm (to enable dismantling when required)
- Copper piping
- Lockable heavy duty galvanised iron cage (green powder coated) on concrete slab. Refer Gippsland Water standard drawing A1-47766 or A1-47816.

4.5.3 Parts required inside of well

- 20 mm reinforced flexible pressure Hose (poly hoses not acceptable)
- 1 No Self rotating “Wobbler” type wet well washer
- Stainless steel bracket and retractable arm. Refer Gippsland Water standard drawing.

5 Electrical Design

5.1 Standard Electrical Designs

The pumps shall operate as a duty/standby pair with the exception that the standby may cut in as a result of a high well level rather than as a result of a failure of the duty drive.

Gippsland Water have standard electrical designs which shall be used as templates for sewage pump station design.

- Sewer Pump Station up to 5.5kW DOL (A1-47731)
  - Document location: ADC-1 and alternatively within 09/02/01/02/01/01
- Sewer Pump Station 7.5 to 22kW VSD (A1-47775)
  - Document location: ADC-1 and alternatively within 09/02/01/02/02/01
- Sewer Pump Station 30 to 160kW VSD (A1-52770)
  - Document location: ADC-1

In addition to these documents designers should refer to the Gippsland Water – Standard Electrical Specification document.

5.1.1 Power Supply

The incoming power supply from the local supply company must be 400 V, 3 phases at 50 Hz. Maximum demand should be calculated as the full nameplate rating of both pumps plus 10Amps for control equipment.

An underground consumer main must be run between the point of supply and the control cabinet. Voltage drop in the consumer mains should be a maximum of 3% at maximum demand. The supply meters must be housed in the control cabinet.

The Consultant must:

- Apply to the electricity supply company for the supply of electricity, with adequate capacity to enable both pumps to operate together.
- Estimate Total Harmonic Distortion (THD) requirements and compliance.
- Determine the terms and conditions of that supply.
- Arrange for the signing of the final electricity supply agreement in conjunction with Gippsland Water.
- Consult with Gippsland Water if the electrical supply authority, transformer and cable details will vary to those listed on the Power & Control Single Line Diagram drawing

5.1.2 Control Cabinet

The control cabinet houses the switchgear, control circuit, telemetry unit and electricity supply metering for the SPS. It is a self-contained, free standing, weatherproof cabinet constructed from marine grade aluminium, and will be powder coated “Wilderness Green or similar colour”. (Reference Bluescope Steel colour charts.)

The recommended maximum height of the control cabinet roof is 1550 mm. The control cabinet must enable easy access to all internal components via side entry doors.

The cabinet must be located between 1.5 and 3 metres from the perimeter of the well to

facilitate the monitoring of the pump operation and the control circuit. The door of the cabinet must open towards the well; however the door in an open position must not obstruct access around the perimeter of the well. The cabinet must be mounted on a concrete plinth with a 1.2 metre apron for service access. The top of the plinth must be at least 150mm above the surrounding ground level and the top of the apron for safe service access must be 50 mm above surrounding ground level. A twin 10A GPO must be provided inside the cubicle for maintenance purposes.

Separate compartments must be provided for:

- Electricity supply metering
- Power distribution/Pump set starting equipment/Control
- Telemetry equipment
- Other equipment (blowers, sprinkler control valves etc.)

Refer Gippsland Water Drawing standard drawings.

5.2 Control and Monitoring Equipment

5.2.1 General

Labelling is required for all components in Cubicle and external e.g. Wet Well Floats (locate on cables in well near support) and individual pump sets numbered (locate adjacent guide rails). Refer standard COR/07/41914 Identification and Labelling of Gippsland Water's Assets which is available from Gippsland Water.

5.2.2 Power Failure Monitoring

The power fail monitoring shall be provided by a dedicated phase failure relay selected from the Gippsland Water Preferred Electrical Equipment List. The power failure recovery shall be wired directly to the RTU terminals and shall be configured in the fail-safe mode.

5.2.3 Wet Well Level Sensor

The wet well level sensor must supply a 4 to 20 mA signal to the RTU that represents the full range of the instrument from wet well floor to invert of overflow. The wet well level sensor shall be battery backed by a suitable power supply to allow continuous monitoring to occur in the advent of power failure.

The wet well sensor shall be an approved ultrasonic level transmitter powered by a 2-wire, 4-20mA DC loop. The 4-20mA loop is also an industry standard control line to the RTU (preferred ultrasonic level transmitter suppliers are MJK or Vega Measurement Systems Pty Ltd).

5.2.4 External Storage Level Sensor

A level sensor must be placed for each external storage that fills either independently to the wet well or adjoining emergency storage vessels. The level sensor must supply a 4 to 20 mA signal to the RTU that represents the full range of the instrument from emergency strorage floor to invert of overflow. The emergency storage level sensor (s) shall be battery backed by a suitable power supply to allow continuous monitoring to occur in the advent of power failure.

The emergency storage level sensor shall be an approved ultrasonic level transmitter powered by a 2-wire, 4-20mA DC loop. The 4-20mA loop is also an industry standard control

line to the RTU (preferred ultrasonic level transmitter suppliers are MJK or Vega Measurement Systems Pty Ltd).

5.2.5 High Cut In Level (Float Switch)

There shall be a dedicated float switch installed to indicate that a high level exists in the wet well. The float switch shall activate the emergency control system via the RTU and initiate an alarm. The float switch shall be located 200mm above the maximum setting allowable for the starting of the standby pump. The float switch shall be configured to be fail-safe in that a closed circuit shall represent the not high or healthy condition.

5.2.6 High High Level Critical Alarm (Float Switch)

There shall be a dedicated float switch installed to indicate that a very high level exists in the wet well. The very high float switch shall be used to activate a critical alarm. The float switch shall be located 200mm above the High Cut In Level. The float switch shall be configured to be fail-safe in that a closed circuit shall represent the not high or healthy condition.

5.2.7 Wet Well Overflow Level (Float Switch)

There shall be a dedicated float switch that is directly connected to the RTU input terminals and shall be configured such that the input is applied when the well is below the alarm limit. The float switch shall be located at 100 mm below the level at which the well discharges to an emergency relief structure. Where external emergency storages exist, the emergency relief level is to be set above the overflow pipeline obvert level, I,e the level at which the SPS wet well overflows to emergency storage(s).

The float switch shall be wired directly to the RTU terminals and shall be configured in the fail-safe mode.

5.2.8 Operation of the Emergency Control System.

Should the Primary Control System fail the Emergency Control System shall function as follows:

When the wet well level reaches the High Cut in Level the Back Up Control system will attempt to start any pumps that are not running. It is necessary to ensure that pump starts are staggered so as to not overload the power supply. As wet well level drops it will reset the High Cut In float switch and the running pump &/or pumps shall run for a predetermined time before stopping (set during commissioning ensuring pumps do not run dry).

5.2.9 Motor Starters

Pumps less than 7.5kW may be started DOL. Starters for pumps 7.5kW and larger shall be of the variable speed type (VSD). The preferred manufacturer is Danfoss. The use of other drives shall not be allowed without written permission from Gippsland water.

5.2.10 Motor Protection

The VSD unit chosen shall have full thermal overload protection (I^2T), with at least 4 individual configurable thermal image curves. The VSD unit shall also have the facility to accept a thermistor input directly at the VSD terminals to provide thermistor protection for the motor if required. Danfoss VSD drives meet both these criteria.

5.3 Control and Monitoring Requirements.

5.3.1 General Considerations – Standard Design

Gippsland water has developed a standard electrical design and software package for

"standard" sewer pump stations. This package consists of a set of engineering drawings (see section 5.1).

The RTU programing is performed by Gippsland Water on Request.

5.3.2 Local Controller and Interface

A local control scheme shall be installed that provides for the following:

- Local indication of pump availability
- Local indication of local and remote status.
- The ability to select local or remote status via pushbuttons.
- Local indication of fault conditions.
- Local reset facility. (Local and Remote Faults.)
- Local indication of the Wet Well level
- The facility to switch each pump to the On, Auto or Off status.
- An indication that the pump station is "locked out" due to system requirements.

NB: Switching any pump to the "Off" state shall prevent the Back Up Control system from starting the pump in an emergency situation, however, isolation of the power source shall be performed if it is to be ensured that a pump motor does not start.

An analogue output of the level signal shall be retransmitted to the RTU. The Primary Control System must be battery backed so that its status can be monitored by the SCADA system via the RTU unit. The battery backup installed shall supply the RTU, Primary Control System & Level Sensor for at least 6 hours in the advent of power failure.

System wide supervisory control systems may require that the local system be "locked out" to prevent or limit adverse consequences at other sites. The RTU shall be capable of "locking out" a SPS such that both the Primary and Back Up controls are made inoperative. The lock out must be configured to lock out a SPS if and only if the RTU is healthy. A switch shall also be provided on the local control panel that enables an operator to turn the pump on or off or place it under automatic operation. Remote lockout or start will be overridden in the on or off position. The status of this switch shall also be an RTU input.

For the RTU to be healthy the following shall be true:

1. The RTU shall be functional.
2. The RTU shall be capable of communicating with the control station requesting the lock out. The control station requesting the lock out shall be interrogated by the RTU at the pump station and if a reply is not received the lock out shall be disabled. It is still possible that the remote control system will operate the plant via the RTU if the RTU is healthy, however the lock out of the SPS shall always be disabled if communication is lost. The detection of the communication failure shall be performed in the on site RTU.

5.3.3 Function of the Remote Controller

The RTU shall supply the following:

- The facility to remotely stop and start the pumps in manual via the SCADA system.
- The facility to "lock out" the Primary control due to overall system requirements.
- The facility to select the local or remote mode of operation.
- To provide an emergency control system should the analogue measuring system fail via the High Level float switch back up system.

- To monitor the “health” of the Primary control.
- The retransmission of ALL alarms to the SCADA host system

5.4 SCADA System Requirements

This section details the requirements of the SCADA system for SPS.
The following alarms shall be created for each SPS:

5.4.1 Critical Alarms

- High Level
- High High Level
- Wet Well Overflow Level
- Pump Station Failure (all pumps failed)
- RTU failure (detected by SCADA system)

5.4.2 Non Critical Alarms

- Power Failure
- Emergency Cut In Level
- Standby Pump Running.
- Lock out disabled.
- RTU battery low
- Pump Starts Excessive (greater than 8 station starts per hour)

5.4.3 Pump Specific Alarms (repeated for each pump)

- Pump Run Time Excessive (pump running for greater than 20 minutes.)
- Pump Thermal Overload Operated
- Pump Fail To Start
- VSD fault (if a variable speed drive is used.)
- Pump No Load fault (pump running but load is low, indicating possible blockage)

5.4.4 Measured and Derived Values

The following derived value shall be measured or derived in the RTU and be available to the SCADA system:

- Wet Well Level
- Discharge flow
- Pump running times for each pump
- Pump Start counters for each pump installed

5.4.5 Junction Boxes

All pump cables and float from the wet well will terminate in a junction box on the side of the cubicle. These cables will be extended into the main cubicle which houses the starting, control, telemetry & metering via glands to ensure corrosive gases cannot enter. All instrument cables will still go via the junction box and include glands, but will not be terminated in the junction box. Refer Gippsland Water Drawings A1-30679 to A1-30693 for reference purposes only.

5.4.6 Cables

The cables connected to the submersible pumps must be suitable for immersion in raw sewage. A minimum length of 10 metres must be used to facilitate the change over of the pump sets.

All cables connected to pump motors, instruments and float switches shall be long enough (without joints) to enable complete retraction from the wet well of the instrument and or switch to enable sufficient length for maintenance to occur e.g. including slack allowance for operating-level adjustments & termination of pump motor cables.

All pumps fitted with VSD's are to be installed with overall screened cables.

5.4.7 Conduits

Conduits shall be used for cables running between the control cabinets, the cable pit the pump well and the ERS (if installed). The layout and routes should be co-ordinated with the civil design to enable the inclusion of conduits at the works construction stage. Heavy-duty UPVC conduits shall be used to avoid corrosion.

The cable entries into the bottom of the cabinet and on the cabinet side shall be sealed with fire retardant expanding foam.

Conduits must take the shortest route available and be arranged in straight runs with long radius bends for changes in direction.

There shall be two conduits at 50 mm for the control and instrumentation.
There shall be one conduit of 80 mm for pump cables.

The minimum size for conduits is 50 mm. Conduits shall be sized such that when all cables are installed, no more than 30% of the cross sectional area of the conduit is taken up by the cables. At least one draw wire shall be left in each conduit that is of sufficient strength and is accessible to allow future cabling to take place. Refer GW Gippsland Water drawing A1-70478.

5.5 The RTU

5.5.1 Application

The RTU is the programmable device that sends information via the Gippsland water telemetry network. The RTU is programed by the Gippsland Water SCADA team or an approved SCADA contractor. Each RTU that is connected to the network shall have the following functionality.

5.5.2 Functional Requirements

5.5.2.1 Control

The SCADA system shall be capable of initiating, via a screen-based pushbutton, a poll on any selected RTU. The poll will commence on receipt of the manually initiated command and will be carried out independently of any predefined time based polling regime in place.

The SCADA system shall have the facilities to alter the RTU polling rates. It shall be possible to alter polling parameters for each RTU individually.

5.5.2.2 Calculations

The plant RTU shall perform totalising and other integrating type operations. The total value shall be read by the SCADA and or data acquisition and control systems (DACS).

Calculations necessary for the operation of the plant shall be performed in the RTU and all the necessary data shall be presented to the RTU. The calculations shall not rely on the

availability of the DACS and or the SCADA system.

Calculations shall only be performed in the DACS and or SCADA system when the data from several distinct RTU units is required for the calculations, and provided that the result of the calculation is not to be used to control the plants involved.

5.5.2.3 Behaviour at Power Failure

The RTU shall be installed with a battery backed up supply, which will allow at least 6 hours of operation under mains power failure. All critical inputs shall be backed up from the battery supply, including critical analogue devices. Non-critical inputs are not required to be backed up.

5.5.2.4 Automatic Battery Test – Functional Description

The RTU is wired directly to the battery and every Tuesday the RTU shall preform a test. If a battery voltage of less than 11.8 volts is detected during a 30 minute test period, the test will be stopped, the AC power will be restored to the charger and a “battery fail” alarm shall be generated. Reset of this alarm will only be possible by the use of programming software.

5.5.2.5 SCADA Interface.

The SCADA system shall be capable of monitoring the following variables from the RTU:

Battery voltage	
AC power status	Normal or failed
Communication link status.	Okay or failed
Module status	Okay or failed
Communication status (to external intelligent devices)	Okay or failed.

5.5.2.6 Critical Alarms

Communication link failed. (Determined by SCADA)

5.5.2.7 Non Critical Alarms

- Battery fail from an automated battery test.
- Module fault.

6 Civil Works

This chapter describes the requirements for civil works. It includes:

- Pumping station civil components
- Ground investigation
- Basic design considerations
- Access
- Water supply
- Alternative design consideration

6.1 Pumping Station Civil Components

The drawings in A1-70471 provides guidance on the civil components for a typical wet well installation.

Wet wells may be fabricated out of precast reinforced concrete pipe sections. The concrete used for precasting must be sulphide resistant. Care must be taken that the seal between precast sections is installed properly to prevent leakage.

The depth of the wet well may be varied to suit the level of the incoming sewer. The diameter of the wet well may be varied to suit the dimensions of the equipment to be installed.

Excavation must be performed using open cut methods, except where noted in alternative design considerations. The base must be over-excavated by at least 200 mm.

Reinforced concrete walls must be provided for the valve pit where an integral valve pit is incorporated into the wet well structure.

A heavy-duty reinforced top slab at ground level must be at least 250 mm thick. Access must be provided using the aluminium covers. Access holes must be sized to ensure adequate clearance for pump installation and removal.

6.2 Ground Investigation

Where there are no suitable records of sub-surface conditions, at least one borehole must be drilled to 2 metres below excavation level, or to bedrock if higher. Soil samples must be tested to determine soil properties.

Testing must include:

- Soil classification
- E values
- Ko values
- Shear strength
- Bulk density

The soil characteristics must be considered when the Consultant is determining the method of construction of the wet well.

The level of ground water must be considered when determining if uplift pressures will be a factor in the design and construction of the pump well.

6.3 Basic Design Considerations

6.3.1 General

Concrete structures shall be designed in accordance with AS 3600 for strength and AS 3735 for serviceability. The pump well must be designed with a concrete strength, Fc = 32 Mpa. This will provide improved durability and flexural strength. Type SR cement must be used.

6.3.2 Base Slab

The pump well base slab provides the bulk of the mass to resist buoyancy so the thickness should be about 600 mm, but it may need to be greater in areas of high groundwater levels.

Soil pressure acting on the bottom face of the base slab must be considered in the design of the wet well base.

Friction between the ground and the pump well wall must not be considered when determining the thickness of the base slab.

6.3.3 Pump Well Walls

Concrete walls to be reinforced, local thickening and splays must be provided around openings. Sloped second stage concrete may be necessary at the junction of the walls and the base slab to facilitate cleaning of the wet wells, depending on the wet well size and configuration.
With a circular cross section, the walls are designed to resist the stresses induced by the external active earth pressure and hydrostatic internal or external pressures. For this case, the wall is analysed as a cylindrical shell taking into account the appropriate end condition at the junction of the wall and base slab.

Bending stresses must be taken into account by applying ground loads and the hydrostatic groundwater load at the normal groundwater level, then applying an additional 20 percent of the applied load to two opposing quadrants of the ring being analysed. Ground loads used for structural design must include an additional overburden of one metre of soil and the highest recorded groundwater level, plus an adequate margin.

6.3.4 Caisson Construction

In some ground conditions, conventional open cut excavation could be difficult or even hazardous, for example sands, soft clays or high water tables.

In these conditions, caisson construction may be necessary. Caisson construction involves sinking a circular, progressively cast concrete caisson, which has a cutting edge at its base. The caisson should have sufficient mass to sink. Techniques for caisson construction require specialised considerations, which are outside the scope of this manual.

6.3.5 Pump Well Top Slab

The pumping station location will determine the design of the top slab. If the location is in a trafficked area with heavy loadings, the top slab must be designed to W7 or T44 Standard Vehicle Loadings, whichever is the greater. This will generally result in a top slab of up to 400 mm thick with double reinforcement, depending on diameter.

Reinforcement used must be Grade 400 deformed bars or Grade 450 steel fabric. Minimum cover to reinforcement must be 75 mm against soil and 65 mm on the internal face.

In non-trafficked areas, a lighter form of construction may be suitable.

The top slab must have a rectangular opening of sufficient size to permit installation and removal of the mechanical components. It must also allow access for maintenance purposes.

The top surface of the top slab must be flush with the ground surface when the station is built in a nature strip. Otherwise the top surface can be 100 mm above ground surface.

The top slab must be of sufficient area to allow for removal and storage of covers during maintenance and cleaning operations.

6.3.6 Cover Selection

Adequately designed covers must be used in trafficked areas or where the noise from pumps must be minimised.

The Gippsland Water Standard access covers [Drawing Nos. A1-33340 to A1-33348] along with bollards for protection from traffic must be used in all other areas.

Access holes must be sized to ensure adequate clearance for pump installation and removal. In the pump well the first cover opened shall allow access to the level sensor.

A protective grid shall be installed under the covers to prevent personnel from falling into the pump well as detailed on the standard drawings. Refer Gippsland Water drawing Nos. A1-33340 to A1-33348.

6.3.7 Valve Pit

A shallow dry valve pit must be provided on the discharge side of the pumps for a non-return valve and isolating gate valve and a pressure gauge tapping point on each pump discharge line. A by-pass pumping point is also to be provided. The pit may be included as part of the wet well or a short distance downstream depending on the ground conditions.

The minimum internal size of the valve pit is to be 2000x1200mm and accommodate all appropriate valving and piping. Refer to Gippsland Water standard drawings A1-70481.

Where there is a risk of differential settlement between the two structures, the valve pit must be included as part of the wet well. Where ground conditions are stable, a separate valve pit may be suitable. A separate valve pit must include at least two gibault or flexible joints for any movement in each pump discharge line.

Ground loads for the valve pit must be the same as those for the wet well.

Drainage must be provided from the valve pit back into the wet well. The drain must have a flap valve at the wet well end.

Non-Trafficable aluminium access covers to be installed as per standard drawing. Refer drawing A1-33344.

Step irons shall not be provided in valve pits unless valve pit depth exceeds 1.2 meters.

6.3.8 Flow Meter Pit

A shallow dry flow meter pit must be provided on the discharge pipework.

A 1200mm maintenance hole with trafficable cover is sufficient. Pit to drain to valve pit of wet well with flap valve.

The flow meter is to sit on a pedestal on a concrete base. Drainage must be provided to either the valve pit or the wet well with a flap valve.

6.3.9 Access

Where there is no existing road access. A crushed rock access road must be constructed. The road must be a minimum width of 3 metres, 150-200 mm thick, with a concrete edging or gravel shoulder. The longitudinal grade must not exceed 1 in 10 with adequate cross slope for drainage.

Where there is no road or suitable space, a hard standing area adjacent to the wet well must be provided for pump installation or removal using a truck-mounted or mobile crane. This area must be sealed with compacted crushed rock or a reinforced concrete slab, depending on the site requirements.

The area must be large enough to manoeuvre the truck or crane into position. Typical site

plan and layouts are shown in WSA 04 - 2001 Standard Drawing No SPS-020.

7 Commissioning and Acceptance of the Pump Station

7.1.1 Final Acceptance (FAT & SAT)

It is a requirement that the pump station be commissioned to the satisfaction of Gippsland Water. A signed document that reflects that the requirements have been met is to be supplied by the contractor before Gippsland Water will accept a pump station for operation.

A checklist for the commissioning and practical acceptance of sewage pump stations is available from Gippsland Water upon request (COR/05/3480).

7.1.2 Commissioning Procedure

A commissioning procedure is available from Gippsland Water that is suitable for the commissioning of a standard pump station. The documents that cover the commissioning of the instruments, variable speed drives and the telemetry and control equipment are available from Gippsland Water and are suitable for commissioning of a standard pump station. Refer to COR/11/34257 Standard VSD SPS - Electrical and SCADA - SAT Site Acceptance Testing or COR/11/34266 Standard DOL SPS (2 Pumps) - Electrical and SCADA - SAT Site Acceptance Testing.

8 Operational Procedures and Maintenance Manuals

The Contractor shall submit two separate types of manuals (in separate folders), an Operational Procedures Manual (OPM) and a separate Maintenance Manual (MM). These two manuals shall be prepared as per Gippsland Water's Operational Procedures and Maintenance Manuals Specification as shown below. The Contractor shall provide two draft copies of the OPM and the MM to the Superintendent at the final design stage for review and comment.

The draft Operational Procedures and Maintenance Manuals shall be:

- Project specific,
- Complete, including all drawings, diagrams, sketches, and photographs (as appropriate),
- Accurately internally cross referenced,
- Inclusive of all design and operating parameters/ranges,
- Provide the Performance test data
- Include all calibration and testing data,
- Updated System Curve for the SPS, detailing designed duty point versus actual duty point.
- Checked for accuracy under Contractor's Q/A system, and
- Adequate for operation of the sewage pump stations during the commissioning period, and
- Provide step by step instruction for the operation and troubleshooting, suitable such that an operator unfamiliar with the specific work or equipment can by using the manual successfully operate the system.

The Contractor shall provide one hard copy and one electronic copy (consolidated PDF format) of the updated final Operational Procedures Manual and the Maintenance Manuals prior to the awarding of a Certificate of Practical Completion or Practical Acceptance certificate. The changes that will be required to the draft or final manuals as a result of

changes to the process or equipment during the commissioning periods, or to comply with this Clause shall be made promptly at the contractor's cost.

8.1 Sewage Pump Station Operations Manuals

8.1.1 Contents

The Operational Procedures Manual shall contain the following sections:

Section 1. General
Section 2. Safety
Section 3. Operational Procedures
Section 4. KEY DRAWINGS

- The Operational Procedures Manual shall be formatted in a 'user friendly' manner.
- The Operational Procedures Manual shall be provided with a complete index and a complete Table of Content. The Operational Procedures Manuals shall cross reference to the Maintenance Manual were appropriate.
- Any appendices should be tab indexed and referenced in the Table of Contents.
- This manual shall be provided in both hard copy and electronic copy. The hard copy shall be submitted in a loose-leaf format bound in a 4-ring A4 folder.

8.1.2 Section 1 - General

This section shall contain as a minimum:

- Description of facility location;
- Map pinpointing location of facility (Vic Roads Country Directory Ref);
- Adequate description of facility function.

8.1.3 Section 2 - OH&S Requirements

This section shall contain as a minimum:

- Operator safety procedures and warnings required during operation of the system,
- Reference to current relevant Gippsland Water safety procedures (e.g. lockout procedure, confined space access, etc.).
- This shall be provided in addition to the safety manifest and/or Dangerous Goods
- Storage and Handling assessment where such forms part of the pump station design.

8.1.4 Section 3 - Operational Procedures

The Operational Procedures section is required to provide a complete step by step guide to the operation of the system. As a guide the contractor should assume that the system is to be operated by a person well versed in an outfall system operation. It may and indeed someone who may have operated an outfall system but not the system for which the manual is written. The hypothetical operator should be imagined arriving on site and asking what next. The manual should be set out in a logical progression in terms of operating the outfall system.

Recommended control set points or operational parameters shall be justified and based on the results of optimisation testing carried out during the commissioning period. Details of these shall be added after the commissioning/optimisation phase to complete the final draft.

An extensive trouble shooting guide including specific events, shall be provided.

The text shall be well supported with fully labelled photographs and references to relevant drawing numbers. The photographs shall be selected to provide visual identification of all key structures and features associated with the operation of the system.

This section shall contain as a minimum:

- Process description by sub-system including normal operational parameters;
- Process specific operating, control, alarm and monitoring requirements;
- Guidelines for operation of the facility under non-standard operating conditions such as low flow or power failure/restoration conditions;
- Operational procedures for individual plant items.

8.1.5 Section 4 - Key Drawings

This section shall contain key drawings in relation to the operation of the system, as well as:

- Pipe work schematics of the site and system
- Site and system layouts drawings
- Other key drawings as deemed necessary

8.2 Maintenance Manual

8.2.1 Contents

The Maintenance Manual shall contain the following tabbed sections and shall be formatted in a 'user friendly' manner;

Section 1. General
Section 2. OH&S Requirements
Section 3. Maintenance Procedures
Section 4. Mechanical
Section 5. Instrumentation
Section 6. Control
Section 7. Electrical
Section 8. Civil, Drawings and Photographs

Each section is required to provide a complete step by step guide to the maintenance of plant and equipment. The manual should be set out in a logical progression both in terms of maintenance, the operating limitations and precautions of the plant/system during maintenance.

An extensive trouble shooting guide shall be provided.

The text shall be generally supported with labelled photographs and references to relevant drawing numbers. The photographs shall be selected to provide visual identification of key structures and features associated with the maintenance of plant items.

The Maintenance Manual shall be provided with a complete index and a complete Table of Contents and shall include a collection of all manufacturer product guides and service manuals within the relevant sections of the manual.

All appendices should be tab indexed and referenced in the Table of Contents.

The Contractor shall provide one hard copy and one electronic copy (consolidated PDF format).

8.2.2 Section 1 - General

This section shall contain as a minimum:

- Description of facility location;
- Map pinpointing location of facility (Vic Road Country Directory Ref);

- Adequate description of facility function.

8.2.3 Section 2 - OH&S Requirements

This section shall contain as a minimum:

- Safety data sheet for all chemicals stored;
- Operator safety procedures and warnings required during maintenance of the Works.
- Reference to relevant Gippsland Water safety procedures (e.g. lockout procedure, confined space access, etc.).

This shall be provided in addition to the safety manifest and/or Dangerous Goods Storage and Handling assessment where such forms part of the Contract.

8.2.4 Section 3 - Maintenance Requirements

This section shall contain as a minimum a table that summarises all the Mechanical, Instrumentation, Control System, Electrical and Civil schedules suitable for importing into the AMIS system. The table shall include:

- Manufacturer's recommendations for maintenance of individual components.
- Contractor's recommendations for maintenance of the whole system.

8.2.5 Section 4 - Mechanical

This section shall be divided into two parts.

PART 1: INSPECTIONS, ROUTINE AND SCHEDULED MAINTENANCE

Part 1 shall contain as a minimum:
Site location plan for all mechanical plant items;

- A complete tabular listing of all mechanical plant items (e.g. pumps, valves, pipes etc.) as per template COR/21/89427 - Gippsland Water - Electronic Asset Register and Maintenance Protocols which is available from Gippsland Water. This is to include model numbers, serial numbers, mechanical plant description using the standard Gippsland Water tag names. It should include time based maintenance tasks for all mechanical plant items for inspections, routine and scheduled maintenance (I.e. weekly, monthly or hours run). Also included should be performance parameters and parts list including stock numbers and supplier details.
- Instructions for all inspection tasks, routine and scheduled maintenance including checklists and relevant OH&S precautions.
- Required grades of lubricants including brand names.

PART 2: DETAILED MECHANICAL MAINTENANCE

Part 2 shall be presented in sections for mechanical plant item and include the following as a minimum:

- Detailed mechanical maintenance instructions for mechanical plant items and relevant OH&S precautions - (reference can be made to the relevant pages of the manufacturers manuals only if the instructions clearly provide detailed maintenance instructions. If reference is made to the manufacturer's manuals it does not negate the requirement for relevant OH&S instructions).
- Completion of template COR/21/89427 - Gippsland Water - Electronic Asset Register and Maintenance Protocols which is available from Gippsland Water.
- Complete drawings for all mechanical plant items:
- Manufacturer's documentation for all mechanical plant items

8.2.6 Section 5 - Instrumentation

This section shall contain as a minimum:

- Site location plan for all instrumentation items
- A complete tabular listing of all instrumentation items (e.g. level sensors, pH meters, no flow devices etc.) as per template COR/21/89427 - Gippsland Water - Electronic Asset Register and Maintenance Protocols which is available from Gippsland Water. This is to include model numbers, serial numbers, instrumentation description using the standard Gippsland Water tag names. It should include time based maintenance and calibration tasks for all instrumentation items (i.e. weekly, monthly or hours run), performance parameters and parts list including stock numbers and supplier details.
- Detailed instructions for all routine maintenance and calibration tasks including checklists and relevant OH&S precautions - (reference can be made to the relevant pages of the manufacturers manuals only if the instructions clearly provide detailed maintenance and calibration instructions. If reference is made to the manufacturers manuals it does not negate the requirement for relevant OH&S instructions).
- Calibration, commissioning and set point data for all instrumentation items:
- Manufacturer's documentation for all instrumentation items;

8.2.7 Section 6 - Control System

This section shall contain as a minimum:

- RTU Manual;
- RTU Program disks;
- RTU Software disks;
- Flowchart/Design Structure Diagram for RTU
- RTU logic and printed ladder diagrams;
- Operational description for each unit process;
- Specifications of all control system equipment;
- Complete documentation of control loops and control system configuration;
- As built process and instrumentation diagram;
- Manufacturer's documentation for all items within the control system;
- Recommended stock list of spare components;
- Complete documentation of alarms;
- Telemetry network protocols;
- Any I/O that is received or sent to other sites must be documented along with an explanation of why and how it fits into the network.

8.2.8 Section 7 - Electrical

This section shall be divided into two parts.

Part 1: Routine and Scheduled Maintenance and Inspection

Part 1 shall contain as a minimum:

- Site location plan for major electrical component items
- A complete tabular listing of all major electrical item components (e.g. VSD's, switchboards, etc.) as per template COR/21/89427 - Gippsland Water - Electronic Asset Register and Maintenance Protocols which is available from Gippsland Water. This is to include model numbers, serial numbers, and instrumentation description using the standard Gippsland Water tag names.
- It should include time based maintenance tasks for all major electrical component items for inspections, routine and scheduled maintenance (i.e. weekly, monthly or

hours run), and performance parameters and parts list including stock numbers and supplier details.
- Instructions for all inspection tasks, routine and scheduled maintenance including checklists and relevant OH&S precautions.

Part 2: Detailed Electrical

Part 2 shall be presented in sections for each major electrical component item and include the following as a minimum:

- Detailed electrical maintenance instructions for major electrical component items and relevant OH&S precautions - (reference can be made to the relevant pages of the manufacturers manuals only if the instructions clearly provide detailed maintenance instructions. If reference is made to the manufacturer's manuals it does not negate the requirement for relevant OH&S instructions).
- Completion of template COR/21/89427 - Gippsland Water - Electronic Asset Register and Maintenance Protocols which is available from Gippsland Water.
- As built electrical schematic diagrams/drawings.
- Manufacturer's documentation for all major electrical component items

8.2.9 Section 8 - Civil, Drawings and Photographs

This section shall be divided into two parts.

Part 1: As Constructed Drawings, this shall contain the following as a minimum:
- As constructed drawings of the facility, including all facility items and site layouts;
- All P&I Diagrams of the facility.

Part 2: Photographs of the facility:
- Annotated photographs of all major plant items;
- Annotated photographs of all hidden items (such as buried valves);
- Annotated photographs of all control displays.

8.2.10 Pre-commissioning Checklist

The Design engineer or consultant shall ensure all checks are done so that the plant can be operated to perform its commissioning requirements and be safely placed into operation.

Specific pre-commissioning plans including ITPs shall be submitted to Gippsland Water for approval.

As a minimum the scope will incorporate:
- end-to-end testing of all cabling and instrumentation;
- direction check of motors;
- verification that the wiring schedule, P and ID's and all electrical drawings reflect what is actually installed;
- provision of a complete marked up set of 'pre-commissioned drawings', prior to putting plant into service;
- the plan shall include a staged approach to demonstrate each part of the works ready to be placed into service;
- site testing of VSD installations to demonstrate Total Harmonic Distortion (THD) is in compliance with the requirements of AS 2064 and GW requirements. A test certificate to be supplied to Gippsland Water.
- factory acceptance test (FAT) of all RTY/SCADA programming to validate all

operator screens (Citect).

- site acceptance test (SAT) of all RTU/SCADA programming to validate functionality of each main control loop. The functionality of each loop must be verified individually to Gippsland Water satisfaction.

8.2.11 Commissioning

Gippsland Water and the design engineer or consultant have a shared responsibility for the commissioning of the sewage pump station. Commissioning is conducted, as per Chapter 4, to identify defects associated with the installation that will need to be rectified prior to issue of Practical Completion or Practical Acceptance.

8.2.12 Practical Completion Date

Practical completion or Practical Acceptance is deemed to be the point at which commissioning has taken place on the installed sewage pump station and the commissioning has proven the performance requirements of the pump station with no major non-conformances identified. Major non-conformances are items that could affect the operation of the SPS or are deemed an OH&S risk by Gippsland Water

8.2.13 Warranties

The manufacturers of plant and equipment supplied for use under this contract or developer works deed of agreement shall give a warranty to Gippsland Water as to the quality of the materials and workmanship used in the manufacture of plant, equipment and accessories under the specified conditions.

The design engineer or consultant shall obtain from the manufacturers a written warranty, to be provided to Gippsland Water prior to any plant, equipment or accessories being used in the works.

The warranty shall refer to and cover all aspects of the specification. In no case will the warranty be less than the Defects Liability Period.

The warranty provisions applying to the manufacturers of valves and equipment shall apply for a minimum period of twelve months commencing from the issue date of practical completion.

8.2.14 Defects Liability Period

The Defects Liability Period shall commence at the time of issue the Certificate of Practical Completion or Certificate of Practical Acceptance. The Defects Liability Period shall have a duration of 12 months unless otherwise noted by Gippsland Water.