Llyn Gwynant Campsite Wastewater Treatment Plant Management Plan

Quality Control Sheet

TITLE	Llyn Gwynant Campsite Wastewater Treatment and Disposal Management Plan
CLIENT	Gwynant Ltd
VERSION	V2
ISSUE DATE	18/5/23

Revision History

REV	Date	Status/Purpose	Prepared By	Approved
1	12/01/23	Discussion	Dan Garden	Peter Garden
2	18/05/23	Update	Peter Garden	Peter Garden

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1.0 Introduction

This document provides a summary of the onsite wastewater treatment and disposal system installed at Llyn Gwynant Campsite and outlines the requirements for the ongoing operation, maintenance and monitoring.

2.0 Wastewater Treatment Plant Description

The Wastewater Treatment Plant (WWTP) treats domestic wastewater from Llyn Gwynant Campsite.

The Sequencing Batch Reactor (SBR) activated sludge based WWTP was selected over other technologies and process configurations to:

- Facilitate biological nutrient removal (BNR) (i.e. total nitrogen removal) rather than nitrification only, to minimise adverse effects on the receiving environment (i.e. area around Llyn Gwynant).
- Cater for the highly variable (seasonal) influent loading experienced at the campsite.
- Provide operational flexibility, to allow operating parameters to be adjusted as required to further optimise and enhance treatment performance (particularly nutrient removal), energy efficiency and greenhouse gas emissions.

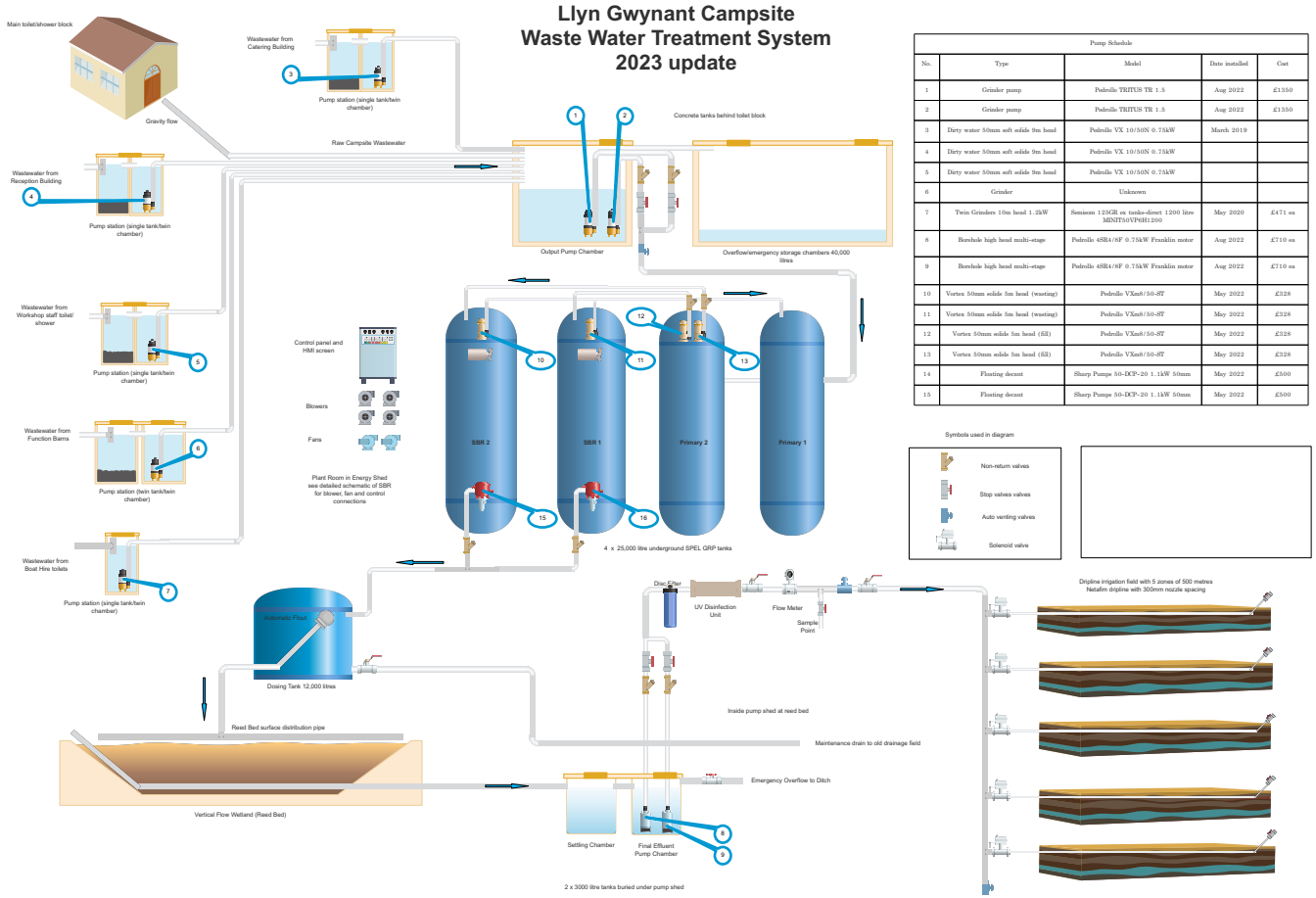
Sizing of unit processes has been based on an assessment of actual influent flows and loads as opposed to generic per capita loading data.

2.1 Summary

Key WWTP design parameters are summarised in Table 1 and a simplified process flow diagram of the overall campsite wastewater collection, treatment and disposal system is shown in Figure 1.

Table 1: WWTP Design Summary	
Type - Specific Engineering Design	Primary Sedimentation followed by Sequencing Batch Reactor (SBR) activated sludge treatment, reedbed polishing and UV disinfection prior to discharge to subsurface irrigation comprising of a network of below ground pressure compensating drip emitter pipes
Primary Treatment	2 No. 25 m^3 primary sedimentation tanks in series (SPEL 300 Series Tankstor Underground fibreglass storage tanks)

Secondary Treatment	2 No. 25 m^3 SBR tanks in parallel (SPEL 300 Series Tankstor Underground fibreglass storage tanks) each fitted with 34 No. 200 mm dia Sanitaire fine bubble diffusers with aeration provided by 2 No. 1.5 kW Airtech RT-1900 side channel blowers. SBRs also fitted with 0.9 kW Flygt 4610 submersible mixers
Tertiary Treatment	1 no. 200 m^2 vertical flow reedbed up-stream of 130 micron cartridge filter and 1 L/s UV reactor
Odour Management	Foul air extraction via extract fans to a bark-bed biofilter for odour treatment
Irrigation Field	0.5 ha, comprising of 5 No. zones, each consisting of 5 parallel 100 m long Netafim 0.6 GPH Bioline with drippers at 0.3 m spacing
Commissioning Date	August 2022
Treatment Capacity	50 m^3/d (peak daily flow)
Emergency Storage Tank Volume	48 m^3 at raw wastewater Pump Station and main ablution block



Pump Schedule				
No.	Type	Model	Date installed	Cost
1	Grinder pump	Pedrollo TRITUS TR 1.5	Aug 2022	£1350
2	Grinder pump	Pedrollo TRITUS TR 1.5	Aug 2022	£1350
3	Dirty water 50mm soft solids 9m head	Pedrollo VX 10/50N 0.75kW	March 2019	
4	Dirty water 50mm soft solids 9m head	Pedrollo VX 10/50N 0.75kW		
5	Dirty water 50mm soft solids 9m head	Pedrollo VX 10/50N 0.75kW		
6	Grinder	Unknown		
7	Twin Grinders 10m head 1.2kW	Semicem 125GR ex tanks-direct 1200 litre MINIT50VP6H1200	May 2020	£471 ea
8	Borehole high head multi-stage	Pedrollo 4SR4/8F 0.75kW Franklin motor	Aug 2022	£710 ea
9	Borehole high head multi-stage	Pedrollo 4SR4/8F 0.75kW Franklin motor	Aug 2022	£710 ea
10	Vortex 50mm solids 5m head (wasting)	Pedrollo VXm8/50-ST	May 2022	£328
11	Vortex 50mm solids 5m head (wasting)	Pedrollo VXm8/50-ST	May 2022	£328
12	Vortex 50mm solids 5m head (fill)	Pedrollo VXm8/50-ST	May 2022	£328
13	Vortex 50mm solids 5m head (fill)	Pedrollo VXm8/50-ST	May 2022	£328
14	Floating decant	Sharp Pumps 50-DCP-20 1.1kW 50mm	May 2022	£500
15	Floating decant	Sharp Pumps 50-DCP-20 1.1kW 50mm	May 2022	£500

Figure 1: Process Flow Diagram of Overall Wastewater Collection, Treatment and Disposal System

2.2 Process Control

While more complex than typical proprietary WWTP systems targeting nitrification only, the SBR system has been selected to optimise Biological Nutrient Removal (BNR) treatment performance over a range of loading/occupancy scenarios encountered at the campsite. The control system includes automated adjustment of fill/anoxic/aerate/settle/decant sequences of the batch treatment processes based on the measured daily incoming flows.

The WWTP includes online instrumentation and automated control via a Programmable Logic Controller (PLC) and Human Machine Interface (HMI) system which is located inside the main plant switchboard designed and constructed by TT Pumps Ltd. The control philosophy of the WWTP is outlined in the Llyn Gwynant Campsite WWTP Functional Description attached as Appendix A. Programming of the PLC and HMI system was undertaken by Bubble Automation Ltd. Remote monitoring and process adjustment can be undertaken by the web-enabled HMI system.

A Piping and Instrumentation Diagram (P&ID) of the WWTP is shown in Figure 2 and a screenshots of the HMI screens are shown in Figures 3 and 4.

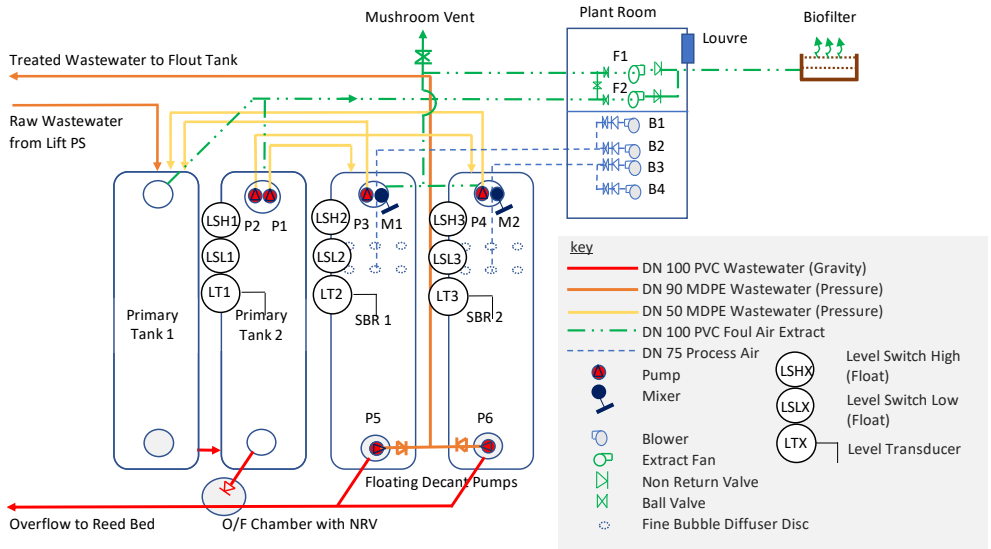


Figure 2: WWTP Piping and Instrumentation Diagram

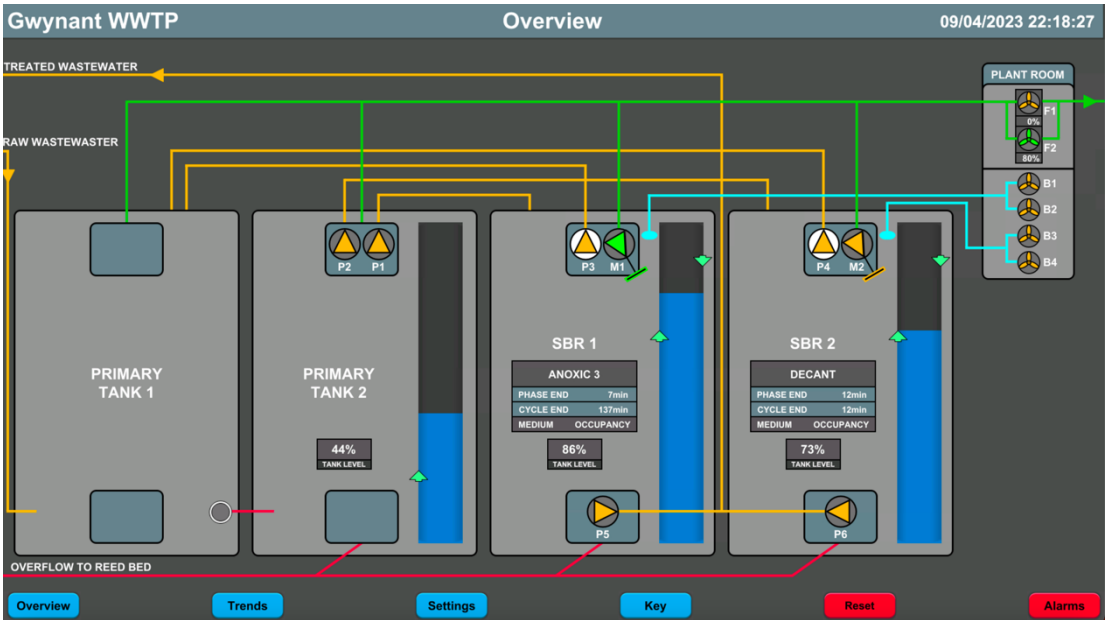


Figure 3: Sample HMI screen for remote monitoring

Date	Time	P1	P2	P3	P4	P5	P6	TOTAL INLET	DAILY
07/08/2022	00:00:23	91.1	131.9	0.0	2.7	201.2	197.7	222.9	31.8
14/08/2022	00:00:22	124.3	150.7	0.0	0.0	185.9	188.0	275.0	39.3
21/08/2022	00:00:24	115.6	122.4	0.0	0.0	130.8	109.0	238.0	34.0
28/08/2022	00:00:24	122.6	114.8	0.0	0.0	132.8	98.3	237.4	33.9
04/09/2022	00:00:24	125.5	122.1	1.9	2.0	114.5	99.0	247.6	35.4
11/09/2022	00:00:29	74.3	80.0	5.3	5.6	67.8	59.6	154.2	22.0
18/09/2022	00:00:43	63.3	61.5	0.0	0.0	59.3	48.0	124.8	17.8
25/09/2022	00:01:20	60.4	69.0	0.0	0.0	52.2	52.6	129.4	18.5
02/10/2022	00:01:36	34.2	50.8	0.0	0.0	34.5	43.0	85.0	12.1
09/10/2022	00:00:21	22.0	93.9	5.2	0.0	23.0	72.7	115.9	16.6
16/10/2022	00:00:22	19.8	31.2	0.0	0.1	24.7	24.5	51.0	7.3
23/10/2022	00:00:22	24.7	28.8	0.0	0.0	23.1	20.8	53.6	7.7
30/10/2022	00:00:23	0.0	71.1	0.0	7.1	0.0	52.4	71.1	10.2

Figure 4: Sample data recorded by HMI (m^3 flows)

2.3 Photographs

Key WWTP equipment is shown in the photos below:

Figure 5: Installation of the 4 25,000 litre underground treatment tanks

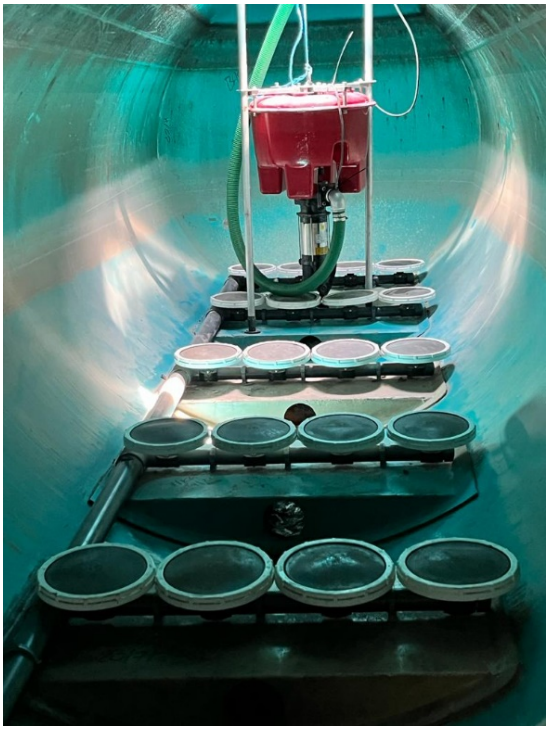


Figure 6: SBR 1 showing diffuser discs and guiderail mounted floating decant pump

Figure 7: SBR 2 Manhole 1 showing access ladder, submersible mixer mounting bar, guiderail for wasting pump and radar level transducer

Figure 8: SBR2 Mixer and wasting pump in SBR tank

Figure 9: Side Channel Blowers (1 duty and 1 assist per SBR) and extract fans

Figure 10: View of floating decant pump from access manhole

Figure 11: HMI screen showing WWTP status. Also allows manual control of the process when required.

Figure 12: Switchboard with HMI display

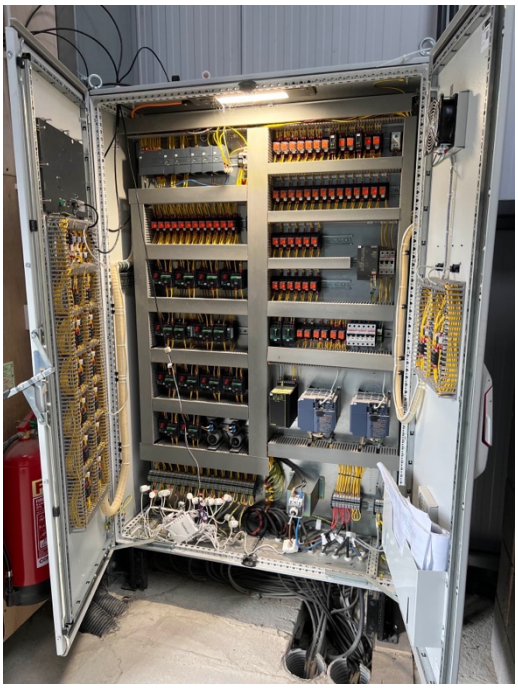


Figure 13: Switchboard showing relays, UPS, PLC and controls.

Figure 14: Lab area with instruments and reagents for on-site monitoring and tests

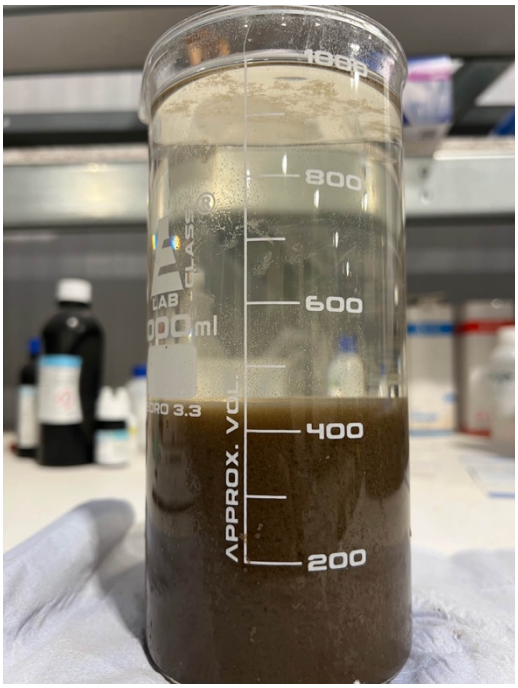


Figure 15: SBR2 Settling test (60 minutes) performed on-site (11/11/22)

Figure 16: Vertical flow reed bed for final effluent polishing, 30 April 2023. Reeds cut back over winter regenerate in spring.

Figure 17: Reed bed 10 days later than above photo, 9 May 2023 showing spring growth.

3.0 Site Infrastructure Plan

A plan showing the Llyn Gwynant Campsite wastewater infrastructure is provided as Appendix B and an excerpt is shown in Figure 18.

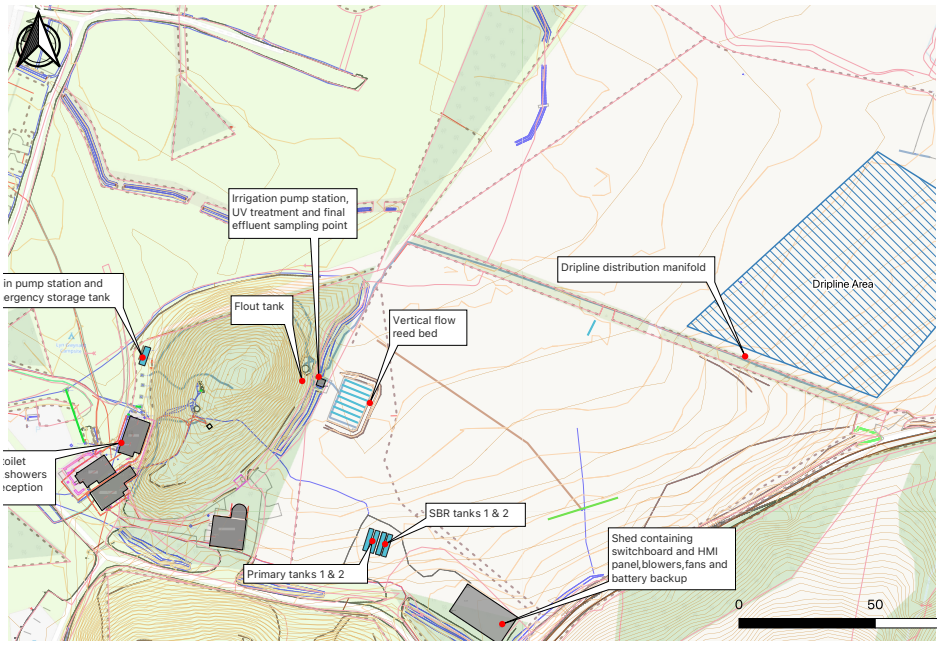


Figure 18: Excerpt of Wastewater Infrastructure Site Plan

This plan has used topographical survey undertaken by NRG Engineering Services Ltd in January 2022. All underground and overground pipework, invert levels, valves and levels are mapped and kept updated in a GIS package maintained at the campsite.

4.0 Maintenance Plan

The operation and maintenance of the WWTP shall be carried out by the WWTP Operator, with input from contractors and equipment suppliers as required.

A maintenance schedule is provided as Appendix C, which list all planned preventative maintenance to the ongoing management of the WWTP.

Maintenance is largely limited to annual inspections and maintenance tasks, with the exception of the following tasks:

Weekly

- Collect a sample of Mixed Liquor Suspended Solids (MLSS) from SBR1 and SBR2 and do a settling test. Adjust sludge wasting rates via the HMI system as required to maintain sludge volume between 400 and 600 mL/L.
- Measure the pH of the MLSS sample taken for the settling test
- Measure the DO (Dissolved oxygen) level of SBR liquor during aeration phase

Fortnightly

- Collect a sample of MLSS from SBR1 and SBR2 and send a sample to ALS Laboratories for testing (mg/L) to confirm the solids inventory. Adjust sludge wasting rates as required to maintain the MLSS concentration between 2,500 and 3,500 mg/L.
- Check pressure upstream of 100 micron screen filter in UV shed and clean/replace cartridge as required.

Monthly

- Check depth of sludge in Primary Tank 1 and schedule sludge collection from septage tanker truck (sucker truck) company GEWS Ltd when required. Sludge removal is anticipated every 2 months during the May to August period.

- Check that no excessive ponding is taking place on surface of reedbed. Rake media as required and remove weeds.
- Remove and clean UV lamps with chlorine and then acid solution

Supplier manuals for key equipment are provided as Appendix D.

5.0 Monitoring Plan and Records

Monitoring shall confirm that the discharge from the WWTP complies with the conditions of the discharge permit from Natural Resources Wales (NRW) and that the discharge is not having an adverse impact on the surrounding environment.

5.1 Routine Monitoring

Routine monitoring shall be carried out by the WWTP Operator, which shall include:

- Checking to see if the WWTP appears to be operating effectively, for example no unusual noises and odours are observed.
- Carrying out all weekly, fortnightly and monthly monitoring/maintenance as outlined in Section 4 above.
- Ensuring that the treated effluent sample point (in UV shed) is accessible at all times.
- Walk-over the irrigation/disposal field and check for any adverse effects such as ponding of water on the ground surface or pipe breaks.
- Reporting any WWTP faults or adverse effects to the Campsite General Manager and/or Director.

5.2 Wastewater Volumes and Effluent Quality

Treated wastewater volumes are measured by a flowmeter downstream of reedbed and prior to the UV and irrigation field. Daily, weekly, monthly and annual flow volumes are recorded via the SCADA system. This data shall be downloaded at the end of each year and saved in a master spreadsheet to record the wastewater volumes.

The treated effluent shall be sampled from the final sampling point in the UV shed on a quarterly basis. Samples shall be sent to ALS Laboratories for analytical chemical analysis, and tested for the following parameters:

- Biochemical Oxygen Demand (BOD_5) (mg/L),
- Total Suspended Solids (TSS) (mg/L),
- Ammoniacal-Nitrogen (NH_4-N) (mg/L),

- Total-Nitrogen (TN) (mg/L),
- Total Phosphorus (TP) (mg/L), and
- Escherichia Coli (E. coli) (cfu/100mL).

Treated wastewater contaminant concentrations shall be recorded in the record sheet attached as Appendix E.

6.0 Roles, Responsibilities and Training

The **Directors** of Gwynant Ltd shall be responsible for:

- Ensuring that the WWTP is performing as expected and within the limits and conditions of the discharge permit issued by NRW;
- Ensuring all relevant staff and sub-contractors are trained on the WWTP operation, maintenance and monitoring requirements;
- Identifying the need for any future amendments to the control or management systems;

The **Campsite General Manager** shall be responsible for:

- Ensuring that a Campsite Infrastructure Manager/Operator or other staff member is available and sufficiently resourced to undertake routine maintenance and monitoring duties
- Being the central point of contact regarding any complaints and ensuring all complaints are dealt with fairly and resolved in a timely manner;
- Responding to any email-alerts from the WWTP SCADA system with regard to faults or problems, in the event that the Campsite Infrastructure Manager/Operator is not available.

The **WWTP Operator** shall be responsible for:

- Undertaking all routine WWTP maintenance and monitoring duties as outlined in this plan;
- Responding to any email-alerts from the WWTP SCADA system with regard to WWTP faults or problems.

Training shall ensure that all relevant staff and sub-contractors are:

- Vaccinated for Hepatitis A and B, Tetanus and Typhoid
- Aware of the provisions and requirements of this plan;
- Aware of the requirements under the NRW discharge permit;
- Competent to carry out the provisions within this plan;

- Understand their individual responsibilities and contributions towards the overall goal of effective wastewater management and control.

7.0 Complaints Records

If a complaint is received in relation to the Llyn Gwynant Campsite WWTP then the Campsite General Manager shall record it immediately and the following information shall be recorded:

- The date, time and nature of the complaint
- The name, phone number and address of the complainant
- An assessment of weather conditions at the time (wind direction and approx. speed, temperature precipitation and cloud conditions)
- The likely cause of any incident and any remedial actions undertaken.

8.0 Contingency/Accident Management Plan

Table 2 below identifies potential incidents that could impact on the performance of the WWTP together with an assessment of:

- likelihood of the incident happening;
- consequences of the incident happening;
- mitigation measures taken to avoid the incident happening;
- measures taken to minimise the impact if the accident does happen.

All incidents shall be recorded, investigated and responded to by the Infrastructure Manager/Operator.

The Contingency/Accident Management plan will be reviewed annually by all parties listed in Section 6.

Emergency contacts details are as follows:

- WWTP Operator – Nolan Webb nolan@gwynant.com,
  mobile 07717 756553
- Campsite Assistant Manager – Sam Nunn – samn@gwynant.com,
  mobile 07891012146
- Campsite General Manager – Mark Wallis – markw@gwynant.com,
  mobile, 07487228017
- Campsite Director – Peter Garden – peterg@gwynant.com,
  mobile 07487 571072

Table 2: Contingency/Accident Management Plan				
Incident	**Likelihood**	**Consequence**	**Measures to Avoid**	**Measures to Minimise Impact**
Power failure	Medium	Overflow of raw or partially treated wastewater, odour	Solar PV and backup battery system in-place to power the WWTP in the event of a power failure	48 m^3 of emergency storage provided at main toilet block pump station
Pump failure	Low	Overflow of raw or partially treated wastewater, odour	Standby pumps provided for critical plant Regular inspections and maintenance	48 m^3 of emergency storage provided at main toilet block pump station Overflow from primary and SBR tanks directed to reedbed which will provide some treatment SCADA will raise alarms to alert operator of pump fault and high levels in tanks
Blower failure	Low	Loss of process aeration to SBR tanks – reduced treatment performance, odour	Regular inspections and maintenance	2 blowers for each SBR tank provides redundancy SCADA will raise alarms to alert operator of blower fault
Mixer failure	Low	Reduced nitrogen removal performance (BOD, TSS and NH_4-N performance not impacted)	Regular inspections and maintenance	SCADA will raise alarms to alert operator of mixer fault

Excess Inflows beyond WWTP capacity	Low	Overflow of raw or partially treated wastewater	WWTP sizing has been based on many years of historical flow data.	Overflow from primary and SBR tanks directed to reedbed which will provide some treatment SCADA will raise alarms to alert operator of pump fault and HL in tanks
Process upset in SBR tanks	Low	Reduced treatment performance	Process design has considered a range of flows/loads scenarios and BioWin software simulations have been used to confirm sizing and operating parameters.	Process engineering support available to WWTP operator and campsite management to diagnose problems and restore treatment performance
Flooding of site resulting in excess stormwater inflows to WWTP system	Low	Overflow of raw or partially treated wastewater	Pipework and tank manholes constructed to avoid stormwater inflows.	All pumps have been conservatively sized based on anticipated flow inputs. SCADA will raise alarms to alert operator of high level in tanks
Fire in plant building	Low	Loss of blowers and electrical equipment	Fire alarms located in plant room	
Vandalism of WWTP equipment	Low	Damage to plant equipment	WWTP is located some distance from public areas of the campsite. All process tanks and plant room to include locks to prevent access	SCADA will raise alarms to alert operator of equipment faults and high levels in tanks

Appendix A: Functional Description

Note that appendices of detailed electrical information have been omitted but are available on request.

Llyn Gwynant Campsite Wastewater Treatment Plant Management Plan

- Prepared for

Gwynant Ltd

- July 2022

Quality Control Sheet

TITLE	**Functional Description for Llyn Gwynant WWTP Upgrade**
CLIENT	Gwynant Ltd
VERSION HISTORY	V5 – Commissioning Updates [29/7/22] V5.2 – Post commissioning changes (22/8/22)
DATE	22 August 2022

Prepared by

Dan Garden

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Appendices:

9.0 Introduction

The Llyn Gwynant Wastewater Treatment Plant (WWTP) upgrade will service the wastewater discharges from Llyn Gwynant Campsite.

9.1 Purpose

The purpose of this "Level 1" Functional Description (FD) document is to describe the control requirements for the WWTP and provide equipment control/status summary tables as programmed by Bubble Automation Ltd in July 2022.

9.2 Supporting Documents

This document shall be read in conjunction with the following:

- Motor Schedule – provided as Appendix A
- IO Schedule – provided as Appendix B
- Electrical Single-line Diagram and Motor Control Centre (MCC) Layout Sketch Drawings – provided as Appendix C.

9.3 Overview

All process tanks and plant described in this document replace existing campsite WWTP infrastructure which will be removed.

The PLC includes spare IOs for future planned upgrades to the WWTP.

9.4 Abbreviations

The following abbreviations are used in this document:

Table 3: Abbreviations

Term	Definition and Commentary
DB	Distribution Board
DO	Dissolved Oxygen
FD	Functional Description
FT	Flow Transducer
FS	Flow Switch
LAL	Level Alarm – Low
LAH	Level Alarm – High
LSH	Level Switch – High
LSL	Level Switch – Low
LT	Level Transducer

LI	Level Indicator
HMI	Human Machine Interface
MCC	Motor Control Centre
MLSS	Mixed Liquor Suspended Solids in SBR
P&ID	Piping & Instrumentation Diagram
PLC	Programmable Logic Controller
PS	Pump Station
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition System
SP	Set Point
TWL	Top Water Level
VSD	Variable Speed Drive
UPS	Uninterrupted power Supply
WAS	Waste Activated Sludge

10.0 General Site Control Information

The Llyn Gwynant WWTP upgrade shall incorporate a new Motor Control Centre (MCC) which shall include a PLC, SCADA and MHI system. In general terms, the WWTP shall be fully automated.

An operator will attend site weekly for inspections and monitoring, however, the plant will generally operate unmanned.

Alarms shall be transmitted to the Web portal and operator personnel of a specific need to attend to the plant.

10.1 PLC Hardware and Software Selection

The PLC shall be a Siemens SIMATIC S7-1200. The following PLC modules are installed to provide the required digital and analogue inputs and output, and to allow for future expansion.

S7-1200	Main CPU
SM1221	8 digital inputs
SM1223	8 digital outs, 8 digital inputs
SM1222	8 digital outputs
SM1231	8 analogue inputs
SM1231	8 analogue inputs

SM1232 4 analogue outputs

Remote web-based SCADA access shall be provided for.

The PLC will be supported by a UPS to maintain PLC data and cycle timing, and the HMI display. A separate external UPS will be used to provide backup power for pumps, blowers and fans.

10.2 Plant Operating Modes

From the MCC, the Direct Online (DOL) and Variable Speed Drive (VSD) WWTP equipment motors shall run on MANUAL-OFF-AUTO selector key switches, as follows:

'Manual'	Control is no longer automatic and the pump/motor can be run manually from the push button START/STOP switches on the MCC panel.
'OFF'	The item is turned OFF and will not be available for automatic control
'Auto'	Control is automatic by the PLC programme

10.3 Valves

All valves are manually operated valves with no actuators or limit switch functionality (i.e., no PLC programming required).

10.4 VSDs

Variable Speed Drives (VSDs) will be mounted in the MCC cabinet.

VSDs will be adjusted during commissioning and subsequent adjustment via the HMI is not required.

Remote monitoring of motor speeds shall be provided via the SCADA system.

10.5 Equipment and Instrumentation References

Equipment and instrumentation relevant to the WWTP system are listed as follows:

P1 – SBR1 Feed Pump

P2 – SBR2 Feed Pump

P3 – SBR1 Sludge Waste Pump

P4 – SBR2 Sludge Waste Pump

M1 – SBR1 Mixer

M2 – SBR2 Mixer

P5 – SBR1 Decant Pump

P6 – SBR2 Decant Pump

B1 – SBR1 Blower 1

B2 – SBR1 Blower 2

B3 – SBR2 Blower 1

B4 – SBR2 Blower 2

F1 – Fan 1 (VSD Drive)

F2 – Fan 2 (VSD Drive)

LT1 – Level Transducer Primary Tank 2

LT2 – Level Transducer Primary SBR1

LT3 – Level Transducer Primary SBR2

LSL1 – Level Switch Low (Float) Primary Tank 2

LSH1 – Level Switch High (Float) Primary Tank 2

LSL2 – Level Switch Low (Float) SBR1

LSH2 – Level Switch High (Float) SBR1

LSL3 – Level Switch Low (Float) SBR2

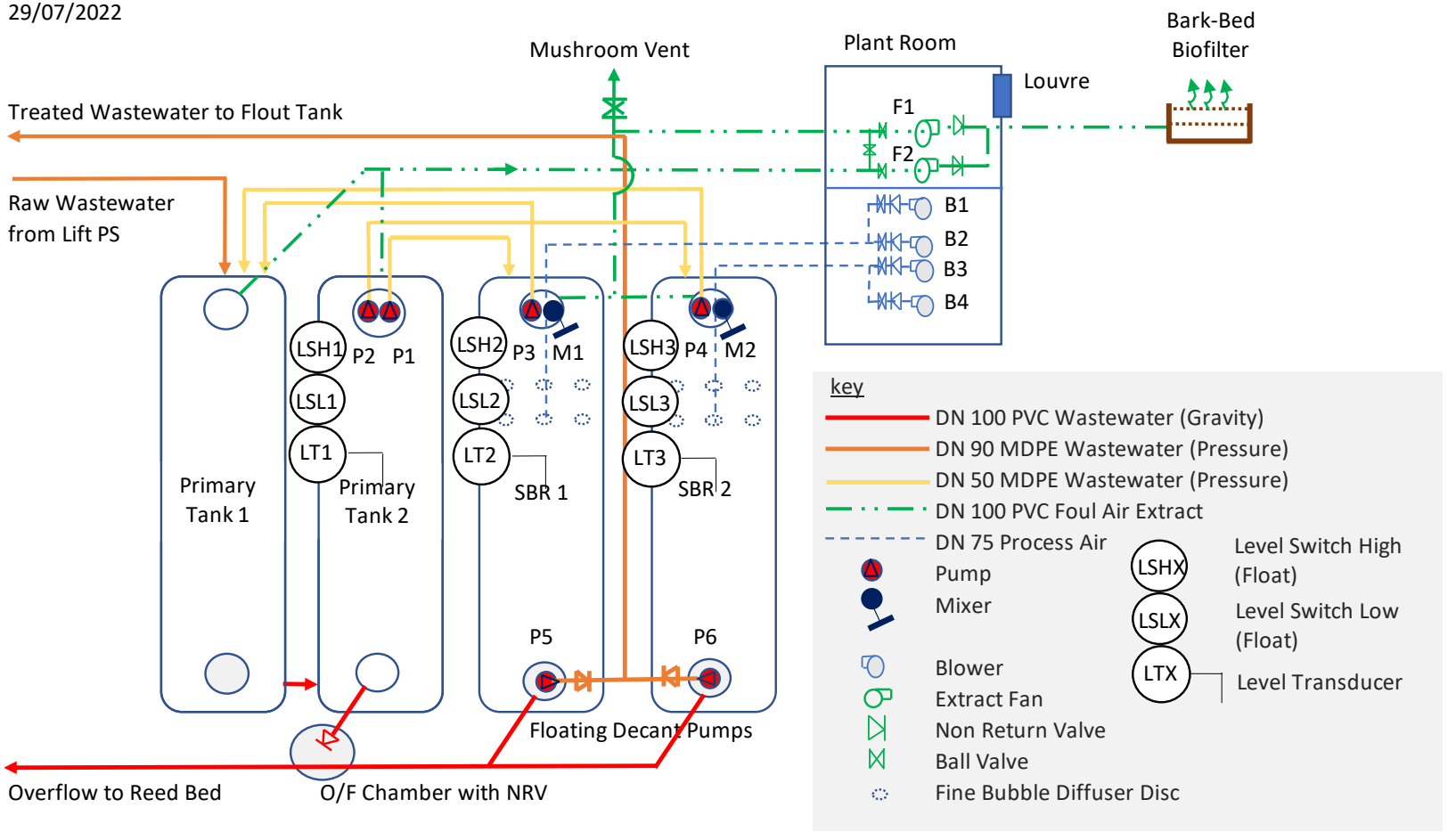
LSH3 – Level Switch High (Float) SBR2

Piping and instrumentation for the WWTP is shown on the following P&ID

Llyn Gwynant Campsite WWTP

Piping and Instrumentation Diagram (P&ID)

29/07/2022



Campsite Access Track

10.6 Duty Changeover Roster

Where duty and standby motors are provided the duty motor shall changeover automatically each time the motor is called to START.

If a duty motor fails to START (current overload) then a fault alarm shall be raised and the STANDBY motor shall be automatically switched to DUTY.

10.7 Plant Flow Reporting

Cumulative WWTP flows (m3/day) shall be calculated and displayed on HMI screens based on pump run-time logging (for 24 hour period each day from 00:00:00) and pumping rate (m3/hour) as per the inputs provided in Table 2.

Table 4: Pumping Rates

Pump		**Pumping Rate (m3/hour)[1]**
SBR Feed Pumps	P1 and P2	18
SBR Sludge Wasting Pumps	P3 and P4	20
SBR Decant Pumps	P5 and P6	23

Notes:

1. *The pumping rates will be measured by the operator and updated by the Automation Contractor during onsite commissioning/acceptance testing.*

Daily, weekly and monthly flows shall be reported for each pump, and the 'Total Inflow" as the sum of P1 and P2, which shall be shown graphically on time series plots and in data tables. This data shall be stored for a 12-month period and shall be downloadable as a .CSV file from the SCADA system.

10.8 Alarms

A dedicated alarm log page shall be provided. All alarms shall be displayed on this page while they remain active. Within this screen the operator shall be able to open a pop-up window with a complete alarm history.

All alarms shall be recorded in the history, even if the alarm condition corrects itself. The alarms shall be recorded with the time/date of alarm and time/date corrected.

The following alarms shall be provided:

- Motor Fault
- High Level Alarm in process tanks (LAH):
  - Primary Tank 2 LAH
  - SBR1 and SBR2 LAH
- Low Level Alarm in process tanks (LAL):

- Primary Tank 2 LAL
- SBR1 and SBR2 LAH

All pumps called to STOP due to a LAH being triggered shall automatically restart if that Alarm has been cleared (i.e. when the level in a tank drops back down below the high level alarm setpoint the pump shall automatically re-start).

10.9 HMI and SCADA Communications Summary

An HMI touch screen panel shall be installed in the MCC to allow the operation and monitoring of all plant. The HMI screens shall also be visible and operable from web portal. The requirements shall include:

- Graphical User Interface consistent with the P&ID
- The colour of the equipment icons on the SCADA screens shall indicate the status of that piece of equipment in both Manual and Auto Modes, as per the following convention:
  - AMBER - Pump/motor is STOPPED
  - GREEN - Pump/motor is RUNNING
  - RED – Pump/motor FAULT
- All Operator adjustable Set Points
- All indications and visualisation related to each unit process, including data logging and trend data
- History of all faults and alarms triggered
- Flow monitoring and reporting
- Cumulative run-time history of all pump and motors (run hours)

The summary of the HMI displays, indications and alarms for the various processes and equipment is given in Table 3.

Table 5: Summary of HMI and SCADA Communications Display

Unit Process	Description	Information Displayed
SBR	Occupancy Mode Status	"Low Occupancy Mode" / "Medium Occupancy Mode" / "High Occupancy Mode"
	SBR Cycle Duration	Calculated Value (hours = sum of set point phase durations)
	SBR Process Phase duration each SBR	"FILL/REACT" / "REACT" / "SETTLE" / "DECANT" (minutes)
	SBR Phase Timer each SBR	Measured Value (minutes elapsed)
	Operating Water Level in Primary Tank 2	Measured Level (%)

	Operating Water Level in each SBR Tank	Measured Level (%)
	Primary Tank 2 High Level Alarm (LAH)	Alarm – "HIGH LEVEL"
	Primary Tank 2 Low Level Alarm (LAL)	Alarm – "LOW LEVEL"
	SBR Tank High Level Alarm (LAH)	Alarm – "HIGH LEVEL"
	SBR Tank Low Level Alarm (LAL)	Alarm – "LOW LEVEL"
	SBR Feed Pump Operation State	ON/OFF/FAULT
	Blower Operation	ON/OFF/FAULT
	Mixer Operation	ON/OFF/FAULT
	Decant Pump Operation	ON/OFF/FAULT
	Sludge Wasting Pump Operation	ON/OFF/FAULT
	Foul Air Extract Fan Operation	ON/OFF/FAULT
	Foul Air Extract Fan Speed	% Full Speed (50 Hz)
	Sludge Wasting Duration (Per SBR Cycle)	Set Point Time (Seconds)

11.0 Sequencing Batch Reactors (SBRs)

11.1 Process Description

The SBRs will operate as variable volume activated sludge plants. The treatment process is characterised by a repeated treatment cycle consisting of a series of sequential process phases: FILL/REACT, REACT, SETTLE and DECANT. The inter-phase cycle process is described as follows:

i. **FILL/REACT** – Each SBR tank is filled with wastewater from Primary Tank 2 up to the high-water setpoint level or when the phase cycle time is completed, whichever comes first. The FILL/REACT PHASE will have distinct ANOXIC and AERATE sub-phases.
ii. **REACT** – When REACT/FILL ends, REACT phase begins. The REACT PHASE will have distinct ANOXIC and AERATE sub-phases.
iii. **SETTLE** – When the REACT phase ends, SETTLE begins. All the mixing and aeration is turned OFF and the MLSS settle, allowing a clear supernatant to form in the upper part of the SBR tank. Sludge wasting will take place from each SBR for a short operator adjustable run time.

iv. **DECANT** – When SETTLE ends, DECANT begins. Clarified treated wastewater is drawn from the SBR tank and discharged to the Flout Tank via the floating decant pump.

A summary of the operating regime of the SBR phases and sub-phases is shown in Table 4.

Table 6: Dual Tank SBR Process Cycle Regime

SBR Tank	Cycle Phase					
1	FILL/REACT	REACT			SETTLE	DECANT
2	REACT	SETTLE	DECANT	FILL/REACT	REACT	

Notes:

2. *AERATE = aeration and mixing.*
3. *ANOXIC = Anoxic mixing with no aeration.*
4. *Sludge Wasting coinciding with start of SETTLE.*

11.2 Control Description

The SBR consists of two reactor tanks (SBR1 and SBR2), each filled via a dedicated feed pump transferring wastewater from Primary Tank 2.

The total cycle length for each reactor is adjustable via the HMI.

The SBR system is operated with two distinct control strategies:

i. Cycle Time Control – Fixed duration cycle times; and
ii. Level Control – Bottom up fill strategy where the normal Low Level Set Point is fixed.

11.2.1 SBR Occupancy Mode

The SBR operating mode shall be selectable from the HMI based on the operator selected Occupancy Mode setpoint, which shall compromise of three options:

- Sleep Occupancy Mode
- Low Occupancy Mode
- Median Occupancy Mode
- High Occupancy Mode

The operator shall also have the option to select “AUTO Occupancy Mode”, which shall select the Occupancy Mode based on the previous days cumulative

SBR Feed Pump flow rate as per Table 5 (i.e. sum of SBR1 Feed Pump and SBR2 Feed Pump flows from the previous 24-hour period as per Section 2.7).

Table 7: AUTO Occupancy Mode	
Occupancy Mode	**Previous 24 Hour Period Cumulative SBR Feed Pump Flow Rate (Q) (m3/d)**
Sleep	Q < 3
Low	3 < Q < 20
Median	20 <= Q <= 40
High	Q > 40

11.2.2 SBR Cycle Configuration

SBR cycles shall be identical for each SBR and configurations shall be adjustable from the HMI by clicking the 'Configuration' icon.

For each mode the operator can select and enter the following inputs:

- Fill time (sum of FILL / ANOXIC-1 and FILL / AERATE-1 phases)
- Anoxic phase durations for each cycle
- Aeration phase durations for each cycle
- Settle phase duration
- Decant Phase duration

The SBR Cycle Time Control shall use the PLC timer function.

Each reactor will operate on a cycle offset from the other reactor by 50% of the total cycle time.

The configuration setpoint menu shown in Table 6 shall be accessed by clicking on "Configuration".

Table 8: SBR Cycle Configuration Window – Adjustable Setpoints					
SP-001	**OCCUPANCY MODE**	**Sleep**	**Low**	**Median**	**High**
SP-002	FILL / ANOXIC-1	15 min	20 min	30 min	30 min
SP-003	FILL / AERATE-1	15 min	20 min	30 min	30 min
SP-004	ANOXIC-2	15 min	20 min	30 min	30 min

SP-005	AERATE-2	15 min	20 min	30 min	30 min
SP-006	ANOXIC-3	0 min	20 min	30 min	30 min
SP-007	AERATE-3	0 min	20 min	30 min	30 min
SP-008	SETTLE	90 min	90 min	60 min	60 min
SP-009	DECANT	180 min	120 min	30 min	40 min
TOTAL CYCLE TIME		**330 min (5.5 hr)**	**330 min (5.5 hr)**	**270 min (4.5 hr)**	**280 min (4.7 hr)**

11.2.3 Level Control

Once the FILL phase is called for, then the water level in Primary Tank 2 and SBR tanks will be managed by level control. A level transducer in Primary Tank 2 (LT1) and in each SBR tank (LT2 and LT3) shall provide analogue level outputs with normal low level and normal high level setpoints.

FILL shall stop when Primary Tank 2 reaches the normal low level setpoint (SP-010), or the SBR reaches the normal high level setpoint (SP-014).

The SBR Feed pumps shall be interlocked such that they STOP once the SETTLE phase is triggered and remains STOPPED until the DECANT phase is complete.

Each tank will also have an independent high-level alarm float switches (LSH) and low-level alarm float switches (LSL) which shall also raise high-level and low-level alarms in the event that the level transducer has failed to raise the alarm. The high-level float switches shall be physically positioned 100 mm above the transducer triggered normal high level setpoint SP-014 and the low-level float stiches 100 mm below the transducer triggered normal low level setpoint SP-013.

The SBR Level Control shall enable all measurements set from zero (0.00 m) at SBR Tank floor to the tank invert level (1.8 m), which shall be displayed as % full.

SBR and Primary Tank 2 operator adjustable setpoints are summarised in Table 7.

Table 9: Level Set Points		
SP-010	Primary Tank 2 Normal Low Level Set Point (LSL)	20%
SP-011	Primary Tank 2 Low Level Alarm (LAL1)	15%
SP-012	Primary Tank 2 High Level Alarm (LAH1)	110%
SP-013	SBR Normal Low Level Set Point (LSL)	65%

SP-014	SBR Normal High Level Set Point (LSH)	100%
SP-015	SBR Low Level Alarm (LAL)	50%
SP-016	SBR High Level Alarm (LAH)	110%

11.2.4 Decant Pumps Dry Run Protection

SBR Decant pumps P5 and P6 shall be provided with dry run protection such that a pump shall be called to STOP if the pump runs for an adjustable setpoint time period before the level in the drop has dropped by an adjustable setpoint % level drop.

11.2.5 SBR Feed Pumps Delay Restart Timer for Hysteresis Control

The SBR feed pumps (P1 and P2) shall have a delay timer such that when a pump is called to STOP it shall remain stopped for a period of time specified in the Settings /Cycles screen as "Inlet pump restart delay" with a default value of 5 minutes.

11.2.6 Blower Control

Blowers shall be called to operate during AERATE phases as follows:

- **Sleep, Low and Median** Occupancy Modes – 1 blower shall operate per SBR when Blower ON is triggered. The two blowers per SBR tank shall operate on a duty/standby basis, as per the duty changeover roster.
- **High** Occupancy Mode – 2 blowers shall operate per SBR when Blower ON is triggered (duty/duty basis).

11.2.7 Mixer Control

The Mixers run at fixed speed. The Mixers shall run during axonic phases.

Mixer run indication shall be shown on the HMI.

11.2.8 Sludge Wasting

During the start of SETTLE phase, sludge wasting from each SBR back to Primary Tank 1 via sludge wasting pump (P3 for SBR1 and P4 for SBR2) will START and run for a set period of time. The sludge wasting time shall be an operator adjustable setpoint for each Occupancy Mode, as per Table 8.

The sludge wasting pumps are interlocked with normal LSL (i.e. no sludge wasting shall occur if the level in the SBR tanks drops below the normal low level set point (SP-013).

Table 10: Sludge Wasting Set Points					
OCCUPANCY MODE		**Sleep**	**Low**	**Median**	**High**
SP-017	Sludge Wasting Time Period per Cycle	0 Seconds	5 Seconds	20 Seconds	60 Seconds

11.2.9 Summary of SBR Control

A summary of the SBR control is given in Table 9.

Table 11: SBR Tanks Operation Control Summary		
Phase	**Process Condition**	**Plant Function**
FILL/ANOXIC	▪ SBR Feed Pump ON until LSL triggered in Primary Tank 2 or LSH triggered in SBR	▪ SBR Feed Pump ON/OFF ▪ Blower OFF ▪ Mixer ON ▪ Decant Pump OFF ▪ Sludge Wasting Pump OFF
FILL/AERATE	▪ SBR Feed Pump ON until LSL triggered in Primary Tank 2 or LSH triggered in SBR	▪ SBR Feed Pump ON/OFF ▪ Blower ON ▪ Mixer OFF ▪ Decant Pump OFF ▪ Sludge Wasting Pump OFF
AERATE		▪ SBR Feed Pump OFF ▪ Blower ON ▪ Mixer OFF ▪ Decant Pump OFF ▪ Sludge Wasting Pump OFF
ANOXIC		▪ SBR Feed Pump OFF ▪ Blower OFF ▪ Mixer ON ▪ Decant Pump OFF ▪ Sludge Wasting Pump OFF
SETTLE	▪ Sludge Pump START to discharge set point TIME	▪ SBR Feed Pump OFF ▪ Blower OFF ▪ Mixer OFF ▪ Decant Pump OFF

		▪ Sludge Wasting Pump ON/OFF
DECANT	▪ Decant Pump ON for time period or until LSL is reached in SBR	▪ SBR Feed Pump OFF ▪ Blower OFF ▪ Mixer OFF ▪ Decant Pump ON/OFF ▪ Sludge Wasting Pump OFF

11.3 HMI Displays

The HMI Displays will be shown for each SBR tank as follows:

SBR Cycle Duration	-	Calculated Value (hours = sum of set point phase durations – i.e. sum of SP002 through SP-0009)
SBR Process Phase	-	“FILL/REACT” / “REACT” / “SETTLE” / “DECANT”
SBR Phase Timer	-	Measured Value (minutes elapsed)
SBR Feed Pump Status	-	“RUNNING” / “STOPPED” / “FAULT”
Mixer Status	-	“RUNNING” / “STOPPED” / “FAULT”
Blower Status	-	“RUNNING” / “STOPPED” / “FAULT”
Decant Pump Status	-	“RUNNING” / “STOPPED” / “FAULT”
Sludge Wasting Pump Status	-	“RUNNING” / “STOPPED” / “FAULT”
Level Depth (Primary Tank 2 and SBRs)	-	Measured Value (%)

11.4 Set Interlocks & Permissions

The inter-dependencies for all unit operations within the SBR are interlocked.

Each unit operation must follow a sequence until completion before another starts unless specific processes are allowed to happen independent of each other.

The blowers and mixers in the SBR Tanks shall STOP if the LAL is triggered in the active SBR Tank and the SBR feed pumps shall divert incoming flows to the alternate reactor.

11.5 Power and Communications Failure Response

The PLC shall remember the PHASE and all equipment status and actions at the time of communications failure and continue with the PHASE as if no communications has failed (i.e. the timer/clock continues regardless).

12.0 Foul Air Extract Fans

12.1 Process Description

The foul air extract fans will remove foul air from Primary Tanks 1&2 and SBR1&2 and discharge to a bark-bed biofilter for odour treatment.

The pipework and valves are configured to allow foul air extraction from all tanks to the biofilter, or alternatively extraction from the Primary Tanks only, and direct venting of the SBR tanks to atmosphere. Under normal operation, to reduce the risk of objectionable odour, continuous extraction to the biofilter from all tanks is proposed, with the fans operating on a DUTY/STANDBY basis.

The fan speed will be adjusted during commissioning via the VSDs then run at this speed thereafter. The fan speed can be adjusted via the local VSD if required as fouling and degradation of the biofilter media occurs.

No adjustment of the fan speed is required via the SCADA system.

12.2 Control Description

The duty foul air extract fan will operate continuously at all times. The duty fan shall changeover as described in Section 2.6.

The fan speed shall be adjustable at the local VSD.

12.3 HMI Displays

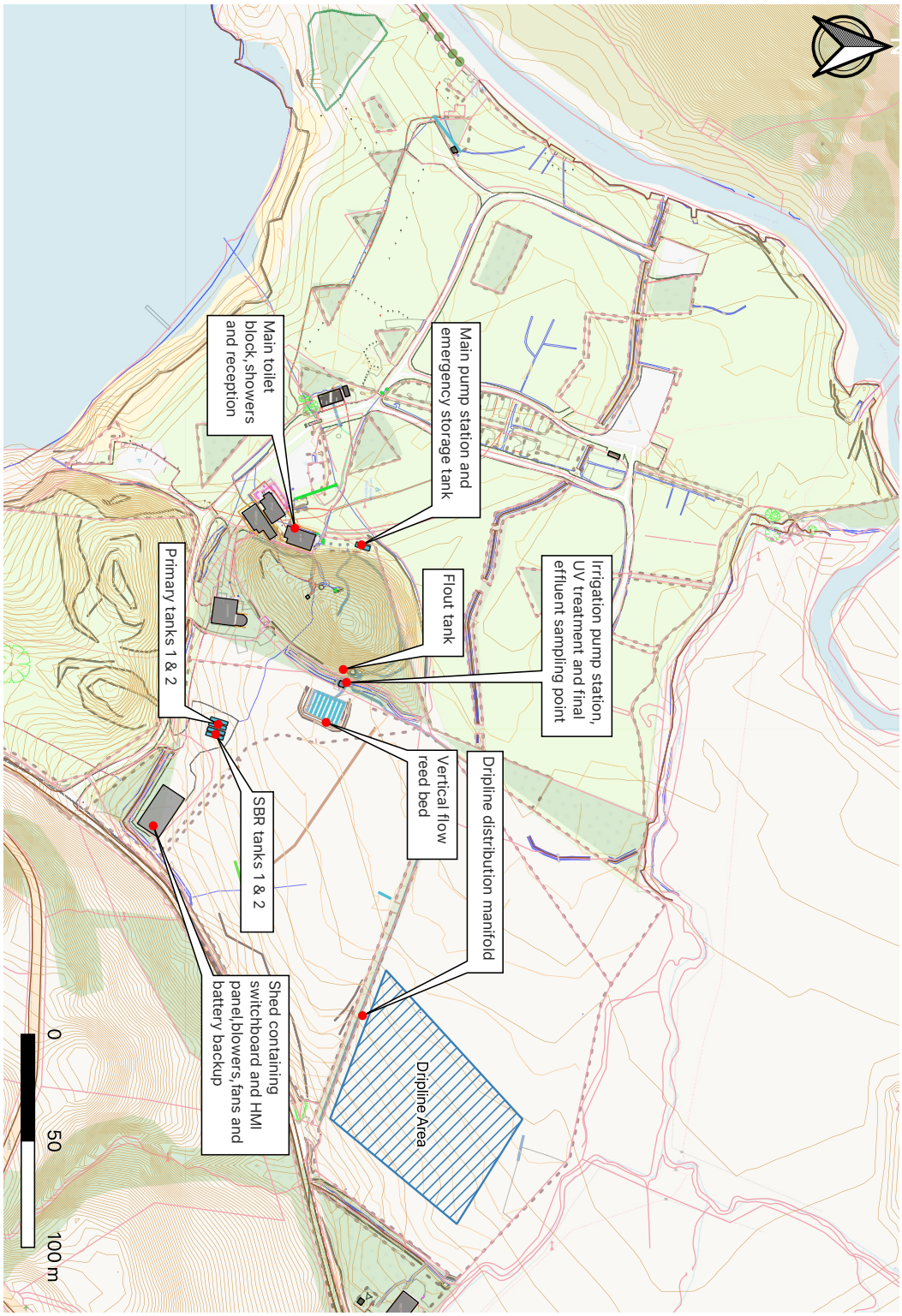
Extract Fan Status	-	“RUNNING” / “STOPPED” / “FAULT”
Extract Fan 1 Speed	-	Value %
Extract Fan 2 Speed	-	Value %

Appendix A: Motor Schedule

Appendix B: IO Schedule

Appendix C: Single Line Diagram & MCC Layout Drawings

Appendix B: Site Wastewater Infrastructure Plan



Appendix C: Maintenance Schedule

Llyn Gwynant WWTP Campsite Maintenance Schedule

Process Area	Item	Task	Frequency				Notes
			Weekly	Fortnightly	Monthly	Annually	
Toilet Block Pump Station	Pumps 1&2	annual inspection				x	refer note 1
	Level Transducer	annual inspection				x	refer note 2
	Float Switches	annual inspection				x	refer note 3
	Magflo Meter	annual inspection				x	
Primary Tank 1	Sludge Depth	check sludge depth and call sucker truck to empty if >75% full			x		sludge depth checking can be less frequent outside of May-Oct season
Primary Tank 2	SBR Feed Pumps 1&2	annual inspection				x	refer note 1
	Level Transducer	annual inspection				x	refer note 2
	Level Switches	annual inspection				x	refer note 3
SBRs 1&2	Settling Test	collect MLSS sample during "aerate 3" phase and 60min settle test in 1L beaker and record sludge volume	x				operator to record photographs of settling test and adjust wasting rates accordingly
	MLSS Test	collect MLSS sample during "aerate 3" phase and send sample to the lab for MLSS test (TSS in mg/L)		x			target MLSS concentration is 2500 to 3500 mg/L
	Level Transducer	annual inspection				x	refer note 2
	Level Switches	annual inspection				x	refer note 3
	Decant Pumps	annual inspection				x	refer note 1
	Wasting Pumps	annual inspection				x	refer note 1
	Mixers	Turn mixer On in manual and check for any abnormal sounds/vibrations, then lift unit, hose down then and check for any loose screw connections, damage to cable.				x	Every 2 years remove to workshop and check quantity and condition of oil. Every 5 years send to Xylem for full workshop service.
	Diffusers	turn blower ON in manual and observe diffuser pattern and check for any excessive air bubbles for signs of leaky pipework or damaged diffusers				x	Check discharge pressure at blowers and compare with value at commissioning. If increasing then some diffuser fouling taking place.
	Blowers	turn blowers ON in manual and check for any abnormal sounds/vibrations. Remove air filter and clean with compressed air and/or replace.				x	
	Extract Fans	turn fans ON in manual and check for any abnormal sounds/vibrations.				x	
Flout Tank	Flout	visual inspection of flout flexible pipe and joints inside tank				x	
Reed Bed	Sand substrate/reeds	Check that no excessive ponding taking place on surface of reedbed which indicates reduced infiltration performance. Inspect substrate, and rake media as required and remove weeds			x		
Irrigation Pump Station & UV	Irrigation pumps 1&2	annual inspection				x	refer note 1
	flow meter	annual inspection				x	
	Cartridge Filter	check pressure on manual gauge upstream of filter and remove and clean if >3 bar		x			remove filter cartridge every 2/3 years or as required
	UV reactor	remove and clean lamps with chlorine and then acid solution.		x			replace lamps every 5 years minimum
Irrigation Field	Solenoid valves	Check field mounted valves for lose parts and signs of corrosion, clean and remove vegetation as required				x	
	Flushing Valves	turn irrigation pump ON in manual and OPEN flushing valve at each of 100m long drip line to flush each line.				x	repeat for each irrigation line.
Biofilter	Substrate	check differential pressure across fan and compare with value at commissioning. Remove weeds from bark-bed and apply 1 handful of hydrated lime per m2 of bark-bed.				x	replace media every 5 years

Notes:

1. Annual pump inspection involves observing pump running in manual mode and listen for abnormal noises, then lift pump, hose-down and check for loose screws etc
2. Annual level transducer inspection involves manual clean and checking for visible damage
3. Annual level switch (float switch) inspection involves checking that cabling isn't tangled and hosing down

Appendix D: Equipment Maintenance Manuals

The following equipment installation, operating and maintenance manuals are held on site and in the Gwynant Microsoft Teams WWTP repository. The links below will access the document from Teams.

SPEL-Fibreglass-Tank-Installation-Guide.pdf

SEP Final as-built signed drawings.pdf

Flygt 4620 Operating and Maintenance Manual.pdf

Pedrollo VX-ST feed and waste pumps.pdf

VEGAPULS-C11-EN-Operating-instructions.pdf

TT-Pumps Control Panel A4E9973 REV A (SHT 1-20).pdf

Appendix E: Treated Effluent Monitoring Record Sheets

The following result sheet is used to record settlement test results and DO and pH results performed weekly by the operator on SBR1 and SBR2

SBR Settlement Tests Year: Sheet No.

ml of sludge per 1000ml of MLSS extracted by dip sample at end of aerate 3 phase and allowed to settle for 1 hour
pH measured on initial sludge sample, DO measured in middle of aerate and anoxic phases

Date	SBR # 1	ml sludge	pH	DO / aerate	DO / anoxic	Comments (note events that may affect sample result such as maintenance, bank holiday etc)

This sheet is used to summarise the results from the ALS tests

C 2360807 Gwynant Ltd: Gwynant LTD
Sampling Location: Treated Effluent - UV Shed (Post SBRs, Reed Bed, cartridge filter and UV)

Sample Date/Time	BOD mg/L	TSS mg/L	NH_4-N mg/L	NO_3-N mg/L	TN mg/L	ORP mg/L	TPO_4^{3-} mg/L	TP mg/L	Alk mg/L as CaCO	pH pH units	Temp degC	E. Coli cfu/100mL	Notes