CENTURION
WATER & WASTEWATER SOLUTIONS

SEQUENCING BATCH REACTOR (SBR) WASTEWATER TREATMENT PLANT

CONTROL PHILOSOPHY

GENERAL	
Client:	Silverlake Resouces
Project:	50m³/day SBR Wastewater Treatment Plant Deflector Gold Mine, WA
Tristar Doc No:	TWS14920-CP-101
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1. Introduction

An SBR wastewater treatment plant (WWTP) shall be used to service the 200 (50m3/day) person camp. The WWTP shall be designed to produce Low Risk/class C effluent for disposal to an existing storage pond. The wastewater treatment process selected is based on Sequence Batch Reactor (SBR) technology. All treated effluent is stored in the irrigation tank prior to discharge. The SBR process train shall be equipped with a control panel.

The main process units and systems that make up the wastewater treatment plant are as follows:

- 2mm Inlet bar screen (S-101) – Removal of in-organics from camp influent.
- Balance tanks (TK-101) – Buffer for peak inflows.
- Balance pump (PU-101) – Transfer of wastewater to SBR tank.
- Sucrose dosing pump (PU-102) – External carbon for TN reduction.
- Poly Aluminum Chloride (PAC) dosing pump (PU-103) – Phosphorus removal.
- SBR tank (TK-102) – BOD removal, complete nitrification, de-nitrification (i.e., Nitrogen removal) and clarification (i.e., TSS removal).
- Submersible Aerator/Mixer (PU-104A/B) – Oxygen supply to SBR tank for biological treatment, mixing and suspension of solids during anoxic phase.
- Decant Pump (PU-105) – Decanting of clear effluent from top of SBR tank after settle period.
- Sludge Pump (PU-106) – Transfer of waste sludge from the SBR tank to the sludge tank.
- Irrigation Pump (PU-107) - Transfer of disinfected treated effluent to spray field.
- Recirculation Pump (PU-108) – Recirculation of treated effluent stored in the irrigation tank.
- Sodium hypochlorite dosing pump (PU-109) – Sterilization of treated effluent prior to storage.
- Irrigation Tank (TK-103) – Storage of treated effluent prior to disposal.
- Sludge Tank (TK-104) – Sludge tanks for waste sludge storage prior to removal by tanker truck.

2. Control Philosophy

2.1 Inlet Screen

The Inlet screen receives raw wastewater from the main camp sewage pump station. A 2mm automatic bar screen is installed to remove the inorganic material from the wastewater and dispose of it to the waste bin at ground level.

The screening unit is equipped with the following main features:

- Automatic main screen rake
- Inlet for raw wastewater
- Overflow
- Outlet to balance tank
- Conductivity level switch – x2 digital relay outputs

Table 2.1: *Inlet Screen Operations & Level Settings*

Instrument Tag No	Description	Action	Set point from sensor (m)
LS-101	High Level (H)	Start screen for set time (1 minutes). Stop screen after set time period if level is lower than set-point. If level is higher than set-point restart 1 minute screen on period.	<0.45
LS-101	High High Level (HH)	Alarm and start screen.	<0.3

The operator can select either Manual/Off/Auto mode to control the operation of the inlet screen.

Automatic mode:

- The screen rake shall stop and start based on liquid level in the screen channel (refer table 2.1). On activation at high level the screen rake rotates to removal debris from the plate screen area for a period of 1 minute, if the liquid level is below the start set point at the end of the 1 minute period the screen shall stop. If the liquid level is still above the high set point the screen shall remain operating for another 1 minutes.

- At high high level the alarm shall be activated. Overflow from the screen is directed to the balance tank.
- Screen to run for 1 minutes if high level has not been detected in the previous 12 hours.

Manual mode:

- The screen rake will operate continuously.

Off mode:

- The inlet screen rake shall stop.

2.2 Balance Tank

The balance tank receives screened wastewater from the inlet screen. The balance tank is installed to buffer the wastewater treatment plant against peak inflows.

The level transmitter fitted to the balance tank provide the following operations:

Table 2.2: *Balance Tank Operations & Level Settings*

Instrument Tag No	Description	Action	Set point from base (m)
LT-101	Low Level (L)	Stop Balance pump	0.4
LT-101	High Level (H)	Start Balance pump	0.6
LT-101	High High Level (HH)	Alarm (indication on panel and activate sounder/beacon)	2.0

Note: Balance pump shall start/stop based on level in Balance tank and SBR process train.

2.3 Balance Pump

The balance pump draw wastewater from the balance tank and discharges to the SBR tank based on time and back to the balance tank for mixing. The balance pump shall operate based on a time sequence and level in the balance tank and SBR tank. Refer to the process timeline.

Automatic mode:

- Balance pump shall start/stop based on time, liquid level in the balance tank (Refer table 2.2 for level set-points) and level in the SBR tank.
- Balance pump shall start for 0.5hr during the anoxic fill period in SBR tank. Refer process timeline.

- Balance pump shall stop at high level in SBR tank.
- Balance pump shall stop at low level in the balance tank.
- If the duty balance pump faults, activate alarm.

Manual mode:

- The balance pump shall run continuously.
- The balance pump shall start if the liquid level in the balance tank is higher than the low-level set-point in table 2.2.

OFF mode:

- The balance pump shall stop.

2.4 Poly Aluminium Chloride Dosing System

A Poly Aluminium Chloride (PAC) dosing system is installed to chemically precipitate phosphorus in the wastewater. PAC is dosed at a pre-determined fixed rate set during commissioning into the balance discharge line prior to entering the SBR tank. The PAC dose rate is variably controlled (manual stroke control) from the dosing pump.

Automatic mode:

- The PAC pump is activated by the operation of the balance pump.
- The PAC dosing pump shall stop on deactivation of the balance pump.

Manual mode:

- In Manual mode the PAC dosing pump shall operate continuously.

Off mode:

- The PAC dosing pump shall stop.

2.5 Sucrose

A sucrose dosing system is installed to provide an external carbon source. Sucrose is dosed at a pre-determined fixed rate set during commissioning into the balance discharge line prior to entering the SBR tank. The sucrose dose rate is variably controlled (manual stroke control) from the dosing pump.

Automatic mode:

- The sucrose pump is activated by the operation of the balance pump.
- The sucrose dosing pump shall stop on deactivation of the balance pump.

Manual mode:

- In Manual mode the sucrose dosing pump shall operate continuously.

Off mode:

- The sucrose dosing pump shall stop.

2.6 SBR Tank

The SBR tank receives screened wastewater from the balance tank. The SBR tank cycles through 6 x 4 hr cycles per day. Each cycle includes a fill period, pre-anoxic period, aerobic period, settle period and decant period. The combined fill/anoxic periods provide de-nitrification (nitrogen removal). The Aerobic period provides the biological oxidation of the organic matter (BOD removal and nitrification). The design MLSS in the SBR tank is 4,000mg/L. The design dissolved oxygen (DO) in the SBR tank is 2mg/L. The design SRT is 20 days. The settle period allows for a quiestant time where all solids settle to the base of the SBR tank. The decant period is where clear liquor is decanted from the top of the SBR tank and discharged to the Buffer tank. Sludge is wasted from the SBR tank at the start of the decant cycle for a set time period. The sludge wastage time period shall be adjustable.

The SBR tank is equipped with the following main features:

- Submersible Aerator/Mixer
- Sludge Pump
- Level transmitter
- Floating decant weir.

The SBR tank level transmitter provide the following control:

Table 2.3: *SBR Tank Operations & Level Settings*

Instrument Tag No	Description	Action	Set point from base (m)
LT-102	SBR Low Level (L)	Stop decant pump	1.9
LT-102	SBR High Level (H)	Stop balance pump	2.30
LT-102	SBR High High Level (HH)	Alarm - Start force settle/decant period, and stop balance pump	2.35

2.7 Submersible Aerator

The biological aerators provide the oxygen required for biological oxidation of the wastewater. The aerator is equipped with a variable speed drive to control the speed of the aerator during the aerobic phase and the anoxic phase.

Automatic mode:

- Aerobic period: the biological aerator shall operate at 100% speed. Aerobic phase speed to be adjustable from HMI.

- Fill/Anoxic period: The biological aerator shall operate at 30% of full speed *(adjustable from HMI)* to engage mixing of the tank's contents with zero oxygen input. Due to the low aerator speed no air will be drawn through the venturi.
- Settle/Decant period: The biological aerator shall be off.
- If biological aerator faults, alarm and sounder shall be activated.

Manual mode:

- The biological aerator shall run at 100% speed.

2.8 Decant Pump and Decant Flush Valve

The decant pump draws supernatant from the top of the SBR tank and discharges to the irrigation tank for storage. The decant pump is controlled based on time and low level in the SBR tank. Prior to the decant pump starting the decant flush valve (3 way) shall open for a set time period to remove any sludge from the decant weir back to the balance tank. Refer to process timeline for sequence details and table 2.3 for level control details.

Automatic mode:

- Decant period: The decant pump and decant flush valve shall operate as per the process control timeline.

  SBR Tank:

  - At the start of the decant period close MV-101 for 30 seconds after the closed limit has been reached, then start the decant pump. After the 30 second period open the decant flush valve MV-101 to allow effluent to enter the irrigation tank.
  - At the end of the decant period based on time or on activation of the low level (LT-101) in the SBR tank; (1) stop the decant pump, (2) close the decant flush valve (MV-101), (3) Start anoxic/fill period.
  - The decant valve shall be closed during the fill/anoxic period, aerobic period, settle period and 30 seconds into the start of the decant period.
  - If decant valve fails to open or close alarm and indication on panel.
  - If the decant pump faults, alarm.

Force Settle/Decant Period:

- Stop balance pump.
- Aerator off for 40min.
- Start Decant: Flush decant weir for 30 secs then open MV-101. Decant pump on. Stop decant at low level in SBR tank.

- Return back to normal timed cycle position.

Manual mode:

- The decant pump shall be on. The decant pump shall be interlocked on low level in the SBR tank.
- The decant flush valve shall be opened and closed from the HMI.

2.9 Sludge Tank & Sludge Pump

Excess sludge is wasted from the system to maintain MLSS in SBR tank. The waste sludge is stored in the sludge storage tank for removal off site by tanker truck. The sludge pump shall start end of settle period in the associated SBR Tank (Refer process timeline) and operate for a set time period (Sludge timer period adjustable from HMI). The operator can select either Man/Off/Auto for operation of the sludge pump.

2.10 Recirc Pump & Hypochlorite Dosing System

The sodium hypochlorite 80L tank shall store sodium hypochlorite (12.5%) ready for transfer to the process. The Irrigation tank uses a recirculation pump to provide mixing in the irrigation tank and to provide a stream that can be analysed for chlorine levels. An online chlorine analyser measures the chlorine level and pH in the irrigation tank.

Automatic mode:

- The recirculation pump runs continuously.
- The hypo dosing pump shall start on activation of the recirculation pump and stops based on deactivation of the recirculation pump.
- The sodium hypochlorite dosing pump shall ramp up and down to maintain a free chlorine residual of 1mg/L. Chlorine set-point shall be adjustable from the HMI.

Manual mode:

- The sodium hypochlorite dosing pump shall run continuously.

2.11 Irrigation Tank and Irrigation Pump

The Irrigation Tank stores treated effluent before disposal to the existing pond. The operator can select either Manual/Off/Auto mode to control the operation of the irrigation pump. In AUTO mode, irrigation pump shall start 30 minutes after the end of the decant cycle and based on level in the irrigation tank. An emergency overflow is fitted to the irrigation tank to discharge to ground.

Should the irrigation pump fault, alarm and indication on panel. A magnetic flow meter is fitted to the discharge line to record instantaneous and totalise flow. 4-20mA feedback to PLC for instantaneous and total flow.

The irrigation tank is equipped with the following main features:

- Inlet nozzle
- Outlet nozzle to irrigation pump, recirculation pump
- Drain
- Emergency Overflow to ground
- Level transmitter

The irrigation tank level transmitter provides the following control:

Table 2.4: *Irrigation Tank Operations & Level Settings*

Instrument	Description	Action	Set point from base (m)
LT-103	High/Low level	Start/Stop irrigation pump	0.8/0.6
LT-103	High High level	Alarm	2.4

3. Process Timeline

Refer to attached process timeline chart.

4. Reference Drawings/Documents

- R1082-P-101- P&ID
- TWS14920-SCH-101 – Load Schedule
- TWS14920-SCH-102 – Instrument Schedule
- TWS14920-SCH-103 – Equipment Schedule
- TWS14920-SCH-104 – Valve Schedule

TWS14920 - SBR WWTP

Pre-Denitrification SBR WWTP Process Timeline

Time	Hour	SBR Process Mode	Balance Pump (PU-101)	Aerators (PU-102A/B)	Decant Pump (PU-105)	Sludge Pump (PU-106)
4:00	0	SETTLE (45MIN)	OFF	OFF	OFF	OFF
4:15	0.25					
4:30	0.5					
4:45	0.75	DECANT (15MIN)			ON FOR 15MIN	
5:00	1	ANOXIC (60MIN), 5am to 6pm	ON FOR 30MIN	ON @ 30% FOR MIXING	OFF	
	1.25		OFF			
	1.5					
	1.75					
6:00	2	AEROBIC (120MIN)		ON 100%		
	2.25					
	2.5					
	2.75					
7:00	3					
	3.25					
	3.5					
	3.75					ON FOR SET TIME
8:00	4	SETTLE (45MIN)		OFF		OFF
	4.25					
	4.5					
	4.75	DECANT (15MIN)			ON FOR 15MIN	
9:00	5	ANOXIC (60MIN)	ON FOR 30MIN	ON @ 30% FOR MIXING	OFF	
	5.25		OFF			
	5.5					
	5.75					
10:00	6	AEROBIC (120MIN)		ON 100%		
	6.25					
	6.5					
	6.75					
11:00	7					
	7.25					
	7.5					
	7.75					ON FOR SET TIME
12:00	8	SETTLE (45MIN)		OFF		OFF
	8.25					
	8.5					
	8.75	DECANT (15MIN)			ON FOR 15MIN	
13:00	9	ANOXIC (60MIN)	ON FOR 30MIN	ON @ 30% FOR MIXING	OFF	
	9.25		OFF			
	9.5					
	9.75					
14:00	10	AEROBIC (120MIN)		ON 100%		
	10.25					
	10.5					
	10.75					
15:00	11					
	11.25					

	11.5					
	11.75					ON FOR SET TIME
16:00	12	SETTLE (45MIN)		OFF		
	12.25					
	12.5					
	12.75	DECANT (15MIN)			ON FOR 15MIN	
17:00	13	ANOXIC (60MIN)	ON FOR 30MIN	ON @ 30% FOR MIXING		
	13.25					
	13.5					OFF
	13.75					
18:00	14	AEROBIC (120MIN)	OFF	ON 100%	OFF	
	14.25					
	14.5					
	14.75					
19:00	15					ON FOR SET TIME
	15.25					
	15.5					
	15.75					
20:00	16	SETTLE (45MIN)		OFF		
	16.25					
	16.5					
	16.75	DECANT (15MIN)			ON FOR 15MIN	
21:00	17	ANOXIC (60MIN)	ON FOR 30MIN	ON @ 30% FOR MIXING		
	17.25					
	17.5					OFF
	17.75					
22:00	18	AEROBIC (120MIN)	OFF	ON 100%	OFF	
	18.25					
	18.5					
	18.75					
23:00	19					ON FOR SET TIME
	19.25					
	19.5					
	19.75					
0:00	20	SETTLE (45MIN)		OFF		
	20.25					
	20.5					
1:00	20.75	DECANT (15MIN)			ON FOR 15MIN	
	21	ANOXIC (60MIN)	ON FOR 30MIN	ON @ 30% FOR MIXING		
	21.25					
	21.5					OFF
	21.75					
2:00	22	AEROBIC (120MIN)	OFF	ON 100%	OFF	
	22.25					
	22.5					
	22.75					
3:00	23					ON FOR SET TIME
	23.25					
	23.5					
	23.75					