TRISTAR WATER SOLUTIONS
A CENTURION COMPANY

KALLIUM LAKES 35KL/DAY WASTEWATER TREATMENT PLANT

INSTALLATION, OPERATION & MAINTENANCE MANUAL

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1. General

1.1 Introduction

A 35KL/DAY wastewater treatment plant (WWTP) is installed at the Kallium Lakes, WA to service the accommodation camp.

The WWTP is approved by the Department of Health (DOH) to treat 35,000 litres per day to produce Class C (low risk) effluent for disposal to the irrigation spray field of 10,000m2.

The wastewater treatment scheme is comprised of:-

- Sewage pump station which transfers sewage from the camp to the balance tank.
- Inlet bar screen which screens the sewage before it enters the balance tanks.
- A single process train which is comprised of a sequence batch reactor (SBR) tank and irrigation tank.
- Irrigation spray field.
- Associated pumps, aerators and dosing equipment.

The sewage is treated in batches. The treatment process follows a number of sequences. The treatment process itself is therefore described as an SBR process.

The treated effluent is then stored in irrigation tanks where it is disinfected prior to disposal to the irrigation spray field.

Sludge from the treatment process is transferred to a sludge tank where it is periodically pumped out by an approved transporter for disposal off Site at an approved disposal facility.

Table 1: Influent - Wastewater Specification

Parameter	Maximum	Unit
No of persons	140	EP
Hydraulic Load	250	LPD
Total Daily Flow	35	m^3/day
TSS	350	mg/l
BOD	350	mg/l
Total Nitrogen	60	mg/l
Total Phosphorus	14	mg/l
pH	6.5-8.5	pH units

1.2 Preliminary Notes

1.2.1 Waste Water Composition

The influent entering the wastewater treatment plant will reflect the characteristics of its source. For mine camp wastewater, the principal producers are showers, wash basins, toilet facilities, laundries and kitchens. Each of these facilities produces a characteristic effluent which combines together to be the raw sewage feeding to the wastewater treatment plant via the sewage pump stations.

Soluble Biodegradable Substances: Wastewater from the toilet facilities and kitchen contain large amounts of solids and organic matter, which together make up a large proportion of the biological and biochemical oxygen demand (BOD) and suspended solids (SS) load on the wastewater treatment plant.

Fresh wastewater also contains an amount of ammonia (NH_3) and this contributes to part of the total nitrogen (TN) content of the wastewater. Another nitrogen source is from the reduction of ammonia, nitrate or protein from food sources and faecal matter. Phosphorus (P) within wastewater is mainly due to detergent used within the laundries or from dish washers.

Non-Biodegradable Solids: Inorganic materials such as plastics, fabrics, contraceptives and sanitary items may also be experienced in large quantities. As these materials can cause blockages and major wear to pumps, Site management must implement procedures to prevent these materials from entering the system.

The camp community also includes kitchens and laundries. The wastewater from kitchens and laundries will contain a high amount of solids, detergents, cleaners, small amounts of oil and grease as well as organic matter. Kitchen waste can be extremely variable and very strong depending on the amount discharged to the sewer.

The composition and volume of the wastewater will vary, depending on the number of people present in the camp and the usage of facilities there. This means that considerable variability that should be expected in both the strength and volume of the raw wastewater entering the plant.

This wastewater treatment plant is an aerated system that provides integral nitrification, de-nitrification and phosphorous removal. The nitrification and de-nitrification process is achieved within the SBR tank.

This plant has been designed to treat a wastewater with characteristics as listed in Table 1. Wastewater characteristics and/or hydraulic loading outside of range specified in Table 1 are to be avoided and Tristar Water Solutions should be informed immediately should this occur.

1.3 Catchment Management

1.3.1 Management

Management of the sewage catchment systems is usually the responsibility of designated staff in charge of the routine operation and maintenance of the wastewater treatment plant. The performance of the wastewater treatment plant also relies on good housekeeping practices. There is a duty of care to ensure that a minimum number of undesirable chemicals and material are allowed into the system.

1.3.2 Chemicals

There are a number of chemicals that should NOT be allowed into the wastewater system under any circumstances:

- Pesticides/Herbicides/Insecticides.

- Petrol/Diesel/Oil.
- Organic solvents (e.g. Turpentine/Kerosene).
- Large quantities of chlorine (e.g. pool chlorine).
- Large quantities of acids or caustic material.
- Heavy metals, copper, lead, silver, mercury, cadmium, barium, arsenic.
- Chemicals of toxic nature to the protozoa and/or bacteria within the wastewater treatment plant.

Many disinfectants and cleaners in common use (as listed below) contain compounds, which may be harmful to the bacteria responsible for the biological wastewater treatment process employed in this plant. Provided these are used sparingly and in recommended concentrations, there should be little effect on the performance of the plant.

- Disinfectants (e.g. Pine O'Clean)
- Washing powders/detergents
- Bleach (e.g. Snow White)
- Surface cleaners (e.g. Spray "N" Wipe, Exit Mould).
- VHD Degreaser (caustic).
- Automatic dishwasher detergents (eg. Complete).
- Fabric softeners (Cationic surfactants).
- Sanitizers (eg. Napisan).

The key factors involved with many of the active ingredients in these products are concentration and exposure time. Low concentrations over an extended period of time can have similar toxic effects on the treatment plant as a shock load of high concentration. It is generally accepted that the lower concentration is preferable. Sensible practices in the use and disposal of these products and the effective management of cleaning routines should minimize the impact of these products on the performance of the plant.

1.3.3 Recommended Chemical Use

The market for environmentally friendly products has grown considerably in the last few years and these products should be considered for housekeeping. However, as there are no true standards as yet, these products should be carefully observed and assessed. In general, products should be low in (or completely free of) toxicity, heavy metals, phosphates, nitrates, chlorine, organic solvents and/or surfactants …etc. In general, products derived from renewable natural sources can be considered.

The method for assessing their suitability should be as follows:

- Low environmental impact due to high bio-degradability
- Low eco-toxicity
- Low oral, ocular and dermal toxicity
- Impact on wastewater treatment facilities
- Cost of product reference similar products
- Impact on receiving waters or disposal areas

1.3.4 Solids

The management of solids loading on the domestic wastewater system is essential if maintenance costs are to be minimized and the effective operational life of the plant is to be maintained or extended.

Log sheets should be carefully maintained detailing loading rates, and these, along with plant performance logs, will provide important information on plant loading.

Biodegradable solids loading on the plant can be effectively reduced with suitable kitchen practices. e.g.:

- Disposal of meal scraps and food preparation scraps into scrap containers for disposal at a local landfill site or incineration plant or another treatment process for the recovery of renewable energy such as Bio-diesel.
- Fats from cooking should be allowed to solidify and then be disposed of into scrap containers.
- Large amounts of hot water should not be allowed into the gathering reticulation system as this will greatly reduce the effectiveness of any grease traps.
- Garbage should be disposed of and not allowed to enter the wastewater treatment plant.

Non-biodegradable solids usually take the form of dirt and grit, which if introduced into the gathering system can cause reduction in the effective volume of the SBR tank. So

- Floor areas such as the toilet facilities should be thoroughly swept before hosing down.
- Suitable facilities should be provided for the disposal of sanitary napkins etc.
- Public showers should have water mats to pre-wash patron's feet.

Most, if not all of the above, are beyond the direct control of the plant Operator but abuse of the system does directly affect him. It is therefore very important that the Operator and the community administration have good relations and that there is an atmosphere of positive co-operation. Site management must encourage proper disposal of inorganic materials and not allow these materials to enter the system.

1.3.5 Sewers

The sewers generally need little maintenance provided proper care (as listed below) is taken to ensure a minimal amount of undesirable matter is allowed into them, such as:

- The lavatory blocks should be swept and dirt, papers and other debris removed before hosing down the floors.
- When blockage occurs, the nearest inspection eyes or manholes should be opened to clear the obstruction. Hosing the obstruction by medium pressure water jet will usually suffice to clear the obstruction. Other methods such as an improvised piston using a mop handle with a rubber or leather end, or even bagging can be used to force water under pressure into the sewer main and so

attempt to dislodge the obstruction. A pulsating motion can be effective. In some extreme cases, a pipe may have to be taken up and replaced. During the clearing of a blockage, to protect the personnel and equipment, piping safety will be carefully observed.

- Any leakages observed in sewer lines must be repaired. This can be either replacing or repairing cracked pipes, broken/leaking joints, and/or encasing the leaking section in concrete as circumstances may dictate.
- When any sewer pipes are exposed because of the cover over the pipes being removed or washed off, this cover must be replaced to provide a minimum depth of at least 400mm or else the pipes covered with 100mm of concrete.
- Any leakage of gases observed must be stopped. Such gases are both explosive and dangerous to health.
- At any time when manholes are exposed, the beaches should be washed clean and ensure the sewers is well flushed.
- After closing a manhole, the cover must be properly fitted by making sure the lid has properly seated.

1.3.6 Grease Trap

Where a grease trap is installed in the system, its purpose is to prevent blockages in the sewers due to accumulation of grease which may occur if not removed, and in preventing excess grease being conveyed to the treatment plant where it would interfere with the treatment processes. To prevent blockages the following actions should be taken:

- Large quantities of hot greasy water should not be discharged into the grease trap. Wherever possible, such hot water, except in small quantities, should be cooled before discharging into the grease trap.
- The grease on the tank should be skimmed off daily by kitchen staff and disposed of as a solid waste.
- The sludge that accumulates on the bottom should be drawn off as soon as it becomes more than a few inches thick.
- Grease and sludge should be disposed of with the general garbage. It <u>MUST NOT</u> be placed in the sewers.

1.4 General Principals for Treatment

The raw wastewater, once collected by the gravity sewer system, is pumped to the wastewater treatment plant via a duty/standby sewerage lift pump system. The sewerage lift pumps help to remove large solids so that they do not cause blockages in the rising main or Wastewater Treatment Plant.

Raw wastewater from the sewage pump station is screened by a bar screen to remove larger solids and discharged into the balance tank.

From the balance tank the screened wastewater is transferred to the SBR tank by a balance/mixer pump at the beginning of the next treatment cycle or batch. An aerobic and an anaerobic process occur in the SBR tank where micro-organisms such as zoogloea, protozoas and rotifers are used to treat the wastewater.

The micro-organisms consume the carbonaceous pollutants in the screened wastewater, producing flocculent particles which are then separated from the water in the SBR tank during the settling period. This leaves a clear effluent, low in oxygen demand and suspended solids which is decanted from the SBR tank at the end of the settle period. This effluent is then acceptable for discharge to the environment after disinfection.

Micro-organisms require a continuous source of oxygen to perform their function which is provided by aerators in the SBR tank.

The SBR tank provides a space in which the bacterial mass is contained for a considerable period of time. This allows for the maximum utilization of nutrients. The activated sludge treatment relies on converting organic matter in the wastewater to living matter in the form of bacterial growth or sludge. Wasting sludge from the system to achieve a predetermined sludge age controls the quality and quantity of the sludge in the plant. This is the reason behind the need to waste activated sludge on a 2 monthly basis. The amount wasted depends on the mixed liquor suspended solids (MLSS) level and treatment efficiency of the plant. Refer to the Trouble Shooting Guide in section 9. As a rule of thumb, we estimate the amount of wasted sludge (bacterial cell) is 0.1-0.3 kg/kg of BOD_5 removed (Dry solid).

Ammonia nitrogen in sewage is fully oxidized to nitrate and eliminated by the de-nitrification action. The nitrification takes place only in the oxidation process and de-nitrification happens within the anoxic environment (dissolved oxygen level around 0.5 mg/l). Within this plant the SBR tank provides such functions and the aeration and non-aeration timing is carefully controlled as this affects the desired nitrification and de-nitrification process within the plant.

Extended aeration facilities normally have a sludge age in the range of 20 to 30 days. The sludge age affects the plant's demand for oxygen and usually has consequences with regard to the type of bacteria present and the settling characteristics of the sludge. The preferred ageing time is between 20 and 30 days. We usually prefer to keep it at 20 days.

Sludge is wasted two monthly from the SBR tank. Sludge is removed off site for further treatment if drying beds are not installed.

1.5 Effluent Quality Requirements

The DOH effluent standards require that discharge from the wastewater treatment plant is within pre-set limits. The effluent quality for the plant is listed in Table 2.

Table 2: Treated Effluent Specification- Low Risk (Class C)

Parameter	Maximum	Unit
BOD_5	<20	mg/l
TSS	<30	mg/l
pH	6.5-8.5	pH units
Chorine Residual	0.2-2	mg/l
E.Coli	<1,000	cfu/100mL

2. Plant Process and Control Philosophy

2.1 Plant Process

A 35KL wastewater treatment plant (WWTP) shall be used to service the Kallium Lakes accommodation camp, WA. The WWTP shall be designed to produce Low Risk/class C effluent for disposal to a spray field. 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 main process units and systems that make up the waste water treatment plant are as follows:

- 2mm Inlet bar screen (BS-201) – Removal of in-organics from camp influent.
- Balance tank (TK-201) – Buffer for peak inflows.
- Balance/Mixer pump (PU-201) – Transfer of waste water to SBR tank.
- Poly Aluminium Chloride (PAC) dosing pump (PU-208) – Phosphorus removal.
- Sucrose dosing pump (PU-207) – External carbon.
- SBR tank (TK-202) – BOD removal, complete nitrification, de-nitrification (ie Nitrogen removal) and clarification (ie TSS removal).
- Submersible Aerator/Mixer (PU-202A/B) – Oxygen supply to SBR tank for biological treatment, mixing and suspension of solids during anoxic phase.
- Decant Pump (PU-203) – Decanting of clear effluent from top of SBR tank after settle period.
- Sludge Pump (PU-204) – Transfer of waste sludge from the SBR tank to the sludge tank.
- Sodium hypochlorite dosing pump (PU-209) – Sterilization of treated effluent prior to storage.
- Irrigation Tank (TK-203) – Storage of treated effluent prior to disposal.
- Sludge Tank (TK-204) – Storage of sludge prior to removal by tanker truck

2.2 Control Philosophy

2.2.1 Inlet Screen (BS-201)

The Inlet screen (BS-101) receives raw wastewater from the mine camp pump station. A 2.5mm 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 (LS-201) – x2 digital relay outputs

Table 2.1: *Inlet Screen Operations & Level Settings*

Instrument Tag No	Description	Action	Set point from sensor (m)
LS-201	High Level (H)	Start screen (BS-201) for set time (5 minutes). Stop screen after set time period if level is lower than set-point. If level is higher than set-point restart 5 minute screen on period.	<0.45
LS-201	High High Level (HH)	Alarm and start screen (BS-201). Activate red indicator on the front of the panel.	<0.3

The operator can select either Manual/Off/Auto mode to control the operation of the inlet screen BS-201).

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 5 minutes, if the liquid level is below the start set point at the end of the 5 minutes period the screen shall stop. If the liquid level is still above the high set point the screen shall remain operating for another 5 minutes time period.

- At high high level the alarm shall be activated. Overflow from the screen is directed to the balance tank.
- Screen to run for 5 minutes if High level has not been detected in the previous 12 hours.

Manual mode:

- The screen rake (BS-201) will operate continuously.

Off mode:

- The inlet screen rake (BS-201) shall stop.

2.2.2 Balance Tank (TK-201)

The balance tank (TK-201) receives screened wastewater from the inlet screen. The balance tank is installed to buffer the wastewater treatment plant against peak inflows.

The level float switches 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)
LS-202	High/Low Level (H/L)	Start/Stop Balance pump	0.6/0.4
LS-203	High High Level (HH)	Alarm (indication on panel and activate sounder/beacon)	2.25

2.2.3 Balance/Mixer Pump (PU-201)

The balance/mixer pump (PU-201) draw wastewater from the balance tank and discharges to the SBR tanks 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 (PU-201) shall run continuously.
- The balance pump (PU-201) 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 (PU-201) shall stop.

2.2.4 Poly Aluminium Chloride Dosing System (PU-208)

A Poly Aluminium Chloride (PAC) dosing system is installed to chemically precipitate phosphorus in the waste water. 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.

2.2.5 Sucrose Dosing System (PU-207)

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.

2.2.6 SBR Tank (TK-202)

The SBR tank (TK-202) 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 float switches
- Floating decant weir.

The SBR tank level switches provide the following control:

Table 2.3: *SBR Tank Operations & Level Settings*

Instrument Tag No	Description	Action	Set point from base (m)
LS-204	SBR Low Level (L)	Stop decant pump (PU-203)	1.8
LS-205	SBR High Level (H)	Stop balance pump (PU-201)	2.35
LS-206	SBR High High Level (HH)	Alarm - Start force settle/decant period, and stop balance pump (PU-201)	2.45

2.2.7 Submersible Aerator (PU-202A/B)

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 VSD.
- Fill/Anoxic period: The biological aerator shall operate at 30% of full speed *(adjustable from VSD)* 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.

2.2.8 Decant Pump and Decant Flush Valve (MV-201)

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 pumps and decant flush valves shall operate as per the process control timeline.

  SBR Tank:

    - At the start of the decant period close MV-201 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-201 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 (LS-204) in the SBR tank; (1) stop the decant pump, (2) close the decant flush valve (MV-201), (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 MV201. 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.

2.2.9 Sludge Tank & Sludge Wastage 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.

2.2.10 Recirc Pump (PU-206) & Hypochlorite Dosing System (PU-209)

The sodium hypochlorite 20L tank shall store sodium hypochlorite (12.5%) ready for transfer to the process. The Irrigation tank (TK-203) uses a recirculation pump (P-206) to provide mixing in the irrigation tank and to provide a stream that can be analysed for chlorine levels. An online chlorine analyser (CT-201) measures the chlorine level and pH in the irrigation tank. This chlorine analyser sends the reading directly to a chlorine dosing pump (PU-209).

Automatic mode:

- The recirculation pump runs continuously.
- The hypo dosing pump shall start on activation of the recirculation (PU-206) 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.

Manual mode:

- The sodium hypochlorite dosing pump (PU-209) shall run continuously.

2.2.11 Irrigation Tank (TK-203) and Irrigation Pump (PU-205)

The Irrigation Tank stores treated effluent before disposal to the spray area. The operator can select either Manual/Off/Auto mode to control the operation of the irrigation pump (PU-205). In AUTO mode, irrigation pump shall start 10 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 turbine flow meter is fitted to the discharge line to record instantaneous and totalise flow. No feedback to the PLC is required.

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 switches

The irrigation tank level switches provide the following control:

Table 2.4: *Irrigation Tank Operations & Level Settings*

Instrument	Description	Action	Set point from base (m)
LS-207	High/Low level	Start/Stop irrigation pump	0.8/0.5
LS-208	High High level	Alarm	2.3

3. Process Plant Design

3.1 Design Parameters

The mass of BOD_5 entering per day was estimated based on the design raw wastewater strengths listed in Table 1. More oxygen will be required during peak load periods when the camp population is high and/or the raw wastewater strength is greater than average.

The hydraulic detention time is a measure of the volume of wastewater passing through the plant and the plant's capacity to treat it. This value is set at the design stage and the Operator has little control over this parameter. Generally, it is preferable to have a longer hydraulic retention time. This allows the micro-organisms the maximum time to complete their task. The balance that needs to be struck is highly energetic micro-organisms with the time they need to complete their task.

In addition to the biological reduction of the raw wastewater we are also oxidizing the ammonia that comes into the plant. Later in this manual there is a description of this process known as nitrification. During the quiescent (Settle) period certain bacteria later described can make use of the oxygen combined with the ammonia and so nitrogen is then released as a gas. This process is known as de-nitrification and is also described in detail later in the manual.

As we are required to reduce nitrogen in our treated effluent we must establish an efficient nitrification/de-nitrification program with the plant. We must provide sufficient oxygen to oxidize the ammonia while the plant is aerating and then provide sufficient time for "free" oxygen to be used up and then the "combined" oxygen to be used by the appropriate bacteria and so allow the nitrogen to be released as a gas to the atmosphere.

The mixed liquor dissolved oxygen concentrations should be between 1.0 and 2.5 during the aeration period. This may take about 5 minutes to achieve, and therefore aeration periods should not normally be less than 15 minutes.

During quiescent (Anoxic) periods the dissolved oxygen concentration should fall to less than 0.5 mg/L and preferably to <0.1 mg/L. This may take up to 10 to 15 minutes to occur and hence this anoxic period should not be less than 30 minutes. As we require de-nitrification to occur we would be looking to extend the time when the oxygen levels are <0.1 as this is when de-nitrification will occur.

When these control parameter values cannot be achieved or if problems occur with the treatment process, then remedial action must be taken

3.2 Food to Micro-Organism Ratio

The Food to Micro-organism (F:M) ratio is a measure of the organic loading of the plant. It is calculated by considering the mixed liquor suspended solids concentration and the raw feed to the plant by the equation given below:

F = (Qr *Sr)/1000

M = (V*Xm* P)/1000

F:M ratio = F/M

Where:

F = Food entering the plant (kg/day)
Qr = Raw wastewater flow rate (m^3)
Sr = Influent BOD_5 concentration (mg/L)
V = Aeration chamber volume (m^3)
Xm = Mixed liquor suspended solids concentration (mg/L)
P = Volatile solids fraction
M = Mass of bacteria in system (kg)

For example, consider a plant receiving 500 m^3/day of wastewater with a BOD_5 concentration of 250 mg/L. Assume the MLSS concentration is 3000 mg/L with an 80% volatile component and the aeration chamber has a volume of 500 m^3.

F = (500 x 250)/1000 = 125 kg/day
M = (500 x 3000 x 0.8)/1000 = 1250 kg/day
F:M ratio = 125 / 1250 = 0.1

4. Biological Nitrogen Removal

4.1 Introduction

In the past, the principal objective of biological wastewater treatment was to remove organic contaminants, which were characterized by the Biological Oxygen Demand (BOD_5), and the concentration of suspended solids. In recent years, environmental concerns have resulted in a re-appraisal of these objectives.

For some time it has been known that the discharge of nitrogen and phosphorus containing substances has contributed to the eutrophication (excessive plant/algae growth as a result of high nutrient concentrations) of waterways and dams. In addition, certain compounds are present in the wastewater effluent, such as ammonia (NH_3) and are toxic to animal and marine life. For these reasons, many authorities are looking for ways to reduce the discharge of nutrients to the environment.

4.2 Nitrogen Removal in the Activated Sludge Process

The majority of nitrogen is received at a wastewater treatment plant in the form of ammonia. There are two basic processes that must take place for nitrogen removal to occur. These processes are called nitrification and de-nitrification

4.2.1 Nitrification

This term refers to the process in which ammonia is converted (oxidized) to nitrite and nitrate.

There are two genera of bacteria responsible for the oxidation of ammonia. These are Nitrosomonas which convert ammonia to nitrite and Nitrobacter which convert nitrite to nitrate.

Chemically, these two reactions may be described:

$$NH_4 + 3/2\ O_2 + \text{Nitrosomonas} \rightarrow NO_2 + H_2O + 2H^+$$
$$NO_2 + 1/2\ O_2 + \text{Nitrobacter} \rightarrow NO_3^-$$

Approximately 4.6mg O_2 is required to convert 1.0 mg of ammonia to nitrate. 2 moles of hydrogen ions are given off for each mole of ammonia converted. This means there will be an increase in the oxygen demand when nitrification occurs and there is potential for the pH value to decrease, particularly in areas where the alkalinity is low.

<u>Rates of Nitrification Reaction</u>

The rate of production of nitrite by Nitrosomonas is much slower than the conversion of nitrite to nitrate. This means any nitrite formed will be used almost immediately for the production of nitrate and consequently little nitrite is normally detected in the effluent from wastewater treatment plants. As a consequence of this, it is often difficult to completely remove ammonia except in plants that are lightly loaded organically.

Factors Influencing Nitrification

Each bacteria species present in the activated sludge process has a specific growth rate. This rate is dependent on several factors including temperature, the bacterial species, the sludge age and the presence of inhibiting substances. Organisms with low growth rates are difficult to establish in treatment plants as they tend to get flushed out by wasting. This means there is a minimum sludge age at which a particular species can be present. The growth rate of Nitrosomonas determines the sludge age, which is suitable for the plant. A sludge age of at least 15 days is required for constant nitrification at 20°C and slightly less at higher temperatures.

The growth of bacterial species is very dependent on temperature. A 6°C drop in temperature can halve the specific growth rate of the nitrification organisms. For this reason, longer sludge ages are required during winter to ensure nitrification occurs, however 20-30 days is sufficient for "winter" temperatures in Australian Conditions. The growth rate of nitrifying bacteria is dependent on the pH value of the activated sludge. Optimal growth is experienced at pH values of between 7 and 8.5 with sharp declines outside this range.

During the production of nitrite, hydrogen ions are produced which lower the pH of the sludge, i.e. alkalinity is consumed. Approximately 7.2 mg alkalinity as $CaCO_3$ is destroyed for every mg of ammonia that is nitrified. A reduction in pH is likely if the alkalinity of the mixed liquor falls below about 40 mg/L as $CaCO_3$. This means that for typical wastewater, pH reduction is likely if the alkalinity of the wastewater is below about 250mg/L as $CaCO_3$ (if de-nitrification is occurring, some alkalinity recovery will occur).

Nitrifying bacteria are obligate aerobes, i.e. there must be dissolved oxygen present for them to survive. The organisms will become inactive if the dissolved oxygen falls to less than about 0.5 mg/L. The dissolved oxygen concentrations should be held above 1.5 mg/l to ensure completely unimpeded nitrification.

4.2.2 De-nitrification

The term de-nitrification refers to the process by which nitrate is reduced to nitrogen gas. In effect, for respiration the bacteria use the oxygen in the nitrate molecule. This can only occur in the absence of free oxygen.

There are four main requirements for de-nitrification to occur:

- Presence of a nitrate source.
- Absence of dissolved oxygen.
- A facultative bacteria mass.
- The presence of an energy source.

The presence of nitrate is a pre-requisite for de-nitrification to occur, and therefore it is essential that nitrification occur. If nitrogen removal is to occur in a single activated sludge system, then all the requirements for both nitrification and de-nitrification must be met, although not necessarily simultaneously.

Bacteria will prefer to use free oxygen for their respiration needs rather than bound oxygen. In other words, any free dissolved oxygen present will strongly inhibit the de-nitrification process. Dissolved oxygen concentrations as low as 0.2 mg/l have been shown to significantly inhibit de-nitrification.

In intermittently aerated systems, a non-aerated period of at least 20 minutes is required to ensure the dissolved oxygen remains low enough for de-nitrification to occur. It may require 5 to 10 minutes for the dissolved oxygen to fall to <0.2 mg/l after the end of the aeration period.

Many bacteria, including floc forming, filamentous and actinomycetes have been shown to be capable of de-nitrification. The bulk of the bacteria in an activated sludge environment are facultative (i.e. are active in aerobic and anoxic environments) and changing the conditions alters the role of each species allowing de-nitrification to occur.

During de-nitrification, hydrogen ions are consumed. This will result in a partial recovery of the alkalinity lost during the nitrification process. This stabilizes the pH and lime addition, which is sometimes required in nitrifying plants, is no longer needed to maintain pH values above 7.0.

4.3 Practical Aspects

At the design stage it is possible to specify several parameters such as tank volumes and aerator performance etc., but the designer and plant Operator have little control over other aspects such as operational temperature, variations in influent and flow and the presence of inhibitory substances. These parameters should be taken into account during the design phase and the Operator has little opportunity to alter their values. There is however, considerable scope for operational changes in other aspects.

The two most important aspects with regard to nitrogen removal are:

- Selection of an appropriate sludge age.
- Careful control of the oxygen input.

4.3.1 Sludge Age

The selection of the sludge age is critical to ensure nitrification occurs reliably. Based on experience with other wastewater treatment plants, a sludge age of at least 15 days is sufficient to ensure complete reliable nitrification. Lower sludge ages are in use in certain plants, but high mixed liquor suspended solids concentrations in the order of 3,500 to 4,500 mg/L are required for consistent nitrification. The design sludge age of this wastewater treatment plant is 20 to 30 days which is sufficient to ensure consistent nitrification all year round.

4.3.2 Oxygen Input

When considering the theory it is apparent that more oxygen is required to run a plant in a nitrifying mode (rather than carbonaceous removal only) and that low dissolved oxygen concentrations are required to ensure de-nitrification occurs. This is achieved by intermittent aeration, in which the air supply is stopped at regular intervals throughout the day. To be successful the non-aerated period must be at least 20 minutes.

Given that we have a sufficient sludge age, aeration volume, aerobic and anoxic periods etc., it is essential to know how much air to supply to ensure complete nitrification while not supplying too much air to inhibit de-nitrification. Monitoring the final effluent may do this. If conditions are ideal for nitrogen removal, then monitoring ammonia, nitrate and nitrite nitrogen concentrations in the final effluent provides a sensitive measure as to the required oxygen input.

Three possible scenarios are given below:

- High ammonia (>5 mg/L) and low nitrate-nitrite nitrogen concentrations (<1.0 mg/l). In this case, under-aeration is indicated; i.e. insufficient oxygen is available to completely oxidize the ammonia.
- Low ammonia (<2 mg/L) and high nitrate-nitrite nitrogen concentrations (>5mg/l). This suggests over-aeration is occurring and an insufficient anoxic zone is available to denitrify.
- High ammonia (>5mg/L) and high nitrate-nitrite nitrogen concentrations (>5mg/l). This situation is a little more complex, but generally indicates either the sludge age is too short or the mixed liquor suspended solids concentration is too low, i.e. there is insufficient biomass of the right type to completely remove the nitrogen.

4.3.3 Other Factors

Mixed Liquor

Biological activity is very pH dependent. Nitrification in particular is strongly inhibited outside the pH range of 7.0 - 8.5. If only nitrification is occurring, the pH may fall and lime addition will become essential to maintain the nitrification. Alternatively operation in a denitrifying mode tends to stabilize the pH, negating the need to supply lime.

Dissolved Oxygen Concentration

In the aerobic zone the dissolved oxygen concentration in the aeration cells should be maintained between 1.5 and 2.5 mg/L. This will help to ensure complete nitrification, complete carbonaceous oxidation and will help to prevent the growth of filamentous bacteria.

In the anoxic zone, the dissolved oxygen should fall to zero and remain there for a period of at least 20 minutes. Long anoxic periods (>60 minutes) are undesirable as this can lead to a growth of large quantities of filamentous bacteria.

5. Sludge Management

5.1 30 Minute Settled Sludge Volume (SSV)

The mixed liquor sample should be taken during the aeration cycle, after the aerators have been operating for at least 15 minutes.

Settling of mixed liquor and return sludge is determined by allowing 1,000 ml of well-mixed samples of each to settle in 1,000 ml graduated cylinders. At the end of 30 minutes, record the volume occupied by the sludge to the nearest 5 ml. Occasionally, it is helpful to measure the settling rate by recording the volume occupied by the sludge at various intervals of time, for example, every 5, 10, 30 and 60 minutes. The reading at the end of 30 minutes generally is used for plant control.

SSV = ml of sludge in 1,000ml cylinder after 30 minutes settling.

Typical values for the sludge settling are between 300 and 700 ml/l. Settling of less than 300 ml/l may indicate a low mixed liquor suspended solids concentration, while SSV's of greater than 800 ml/l often indicates a bulking sludge if the mixed liquor suspended solids concentration is in the normal range (2,000 – 4,000 mg/L).

5.2 Sludge Volume Index (SVI)

The sludge volume index provides a further measure of the settling characteristics of the sludge. It is defined as the volume in ml occupied by 1.0 gram of sludge, dry weight, after settling for 30 minutes in a 1,000 ml graduated flask. It may be calculated from the following expression:

$$SVI = \frac{\text{30 minute settled sludge volume (ml) x 1000}}{\text{suspended solids concentration (mg/L)}}$$

Values of the SVI of less than 100 are generally regarded as good, while values greater than 200 often indicate a bulking sludge. The direct correlation of the Jar Test to MLSS approximations are predicated on an SVI of 100. If SVI is higher or lower, the figures given above for SSV MUST be adjusted.

The SVI can only be calculated when the mixed liquor suspended solids concentration has been performed by a laboratory and may be found in the analytical results section of the report provided.

5.3 Dissolved Oxygen

In wastewater treatment applications, the dissolved oxygen concentration is typically measured using a dissolved oxygen meter and probe. Most probes can be easily calibrated in air and give an output in mg/l and percent saturation. Either output is acceptable, however if percentage saturation is to be used, a simultaneous temperature recording should also be made.

The probe contains a semi-permeable membrane, which allows the transfer of oxygen from the test sample into the probe. This membrane should never be allowed to dry out and the probe should be capped when not in use. The probe and membrane should be cleaned in fresh water after use.

Dissolved oxygen readings should be taken at various points throughout the plant. When monitoring the SBR tank it is important to obtain readings in different regions of the tank and at various depths. This will help to determine if stagnant zones are developing. Readings should also be taken when the aerators are not operating. The probe should be gently and continuously moved when monitoring quiescent water so the membrane is subjected to a continual flow of fresh water over the probe.

Occasionally, a small air bubble may develop under the membrane, particularly if it is allowed to dry out. This will cause the meter reading to become unstable and the membrane will need to be replaced. This is a relatively simple, but delicate procedure, and should be performed indoors. Comprehensive instruction manuals are usually provided with dissolved oxygen meters, which explain all aspects of their operation, including membrane replacement. The meter should normally require daily calibration to ensure accurate results.

5.4 pH Value

The pH is a numerical expression of the intensity of acidity and alkalinity, the numbers 0 to 14 being used to express the pH. A pH of 7.0 is neutral, less than 7.0 is acidic, and greater than 7.0 is alkaline. Domestic waste waters usually have pH values between 6.0 and 9.0. The pH value is dimensionless in that it is not a linear scale and any number is not an indicator of relative strength.

pH is of critical importance to biological systems and small variations can cause significant disruption. Activated sludge systems work best in the pH range 7 to 8, and must remain in the range 6.5 to 8.5. Lime or soda ash should be added if the pH falls below 6.6. Hydrochloric acid may be added if the pH rises above 8.5. Typically however, the pH is fairly stable and problems with lower pH (acidic conditions) are more frequent than those of high pH.

The pH may be measured using a probe and meter in a similar manner to the dissolved oxygen concentration. Care needs to be exercised when using the probe, as it is delicate and easily damaged. Before using the meters it is important to decide which range (i.e. acidic or alkaline) to calibrate the meter for. Two pH calibration buffers are required to calibrate the meter. One has a pH value of 7.0, is usually green and is used first to determine the fixed point (pH 7.0) and the other is usually yellow (pH 9.0) or red (pH 4.0) and is used to determine the slope once the fixed point has been determined.

Calibration is achieved by placing the probe in the fixed point buffer (pH 7.0) and adjusting the fixed-point calibration dial until the meter reads pH 7.0. The probe should then be removed, cleaned and dried on an absorbent cloth before immersing in the second buffer. The slope calibration dial should now be adjusted until the correct value is obtained on the meter. The fixed-point calibration should now be rechecked after cleaning and drying the probe.

Extreme care should be exercised not to cross-contaminate the pH buffers as this will lead to erroneous results. Further, the meter should be calibrated only for the range indicated by the buffer. If a value outside the calibrated range is obtained, the meter should be re-calibrated to include the new value.

Usually, a safety factor of 1 pH unit may be applied, i.e. if a meter has been calibrated in the range pH 7.0 to 9.0, and a reading between 6.0 and 7.0 or 9.0 and 10.0 is obtained. This may be considered accurate however, pH values below 6.0 and above 10.0 will require the appropriate re-calibration. It is not possible to perform a dilution to obtain a value in the correct range for pH.

Comprehensive instruction manuals are usually provided with pH meters and these should be referred to.

5.5 Sludge Age (Mean Cell Residence Time)

The sludge age or mean cell residence time is a measure of how long the sludge has been held in the wastewater treatment plant. It is calculated from knowledge of the wasting rate and mixed liquor suspended solids concentration as indicated below:

$$Rs = \frac{VXm}{Qw\ Xw + Qe\ Xe}$$

Where:

Rs	=	Sludge age (days)
V	=	Aeration tank volume (m^3)
Xm	=	Mixed Liquor Suspended Solids concentration (mg/L)
Xe	=	Final effluent suspended solids concentration (mg/L)
Qw	=	Waste Sludge Flow Rate (m^3/day)
Qe	=	Raw Influent Wastewater Flow Rate (m^3/day)
Xw	=	Waste Sludge Suspended solids concentration (mg/L)

6. Plant Start Up

6.1 System Balance

Wastewater treatment plant start-up is simply the balancing of the plants variable capacities, such as mixing, aeration, and running time, against the load of the facility it serves. The most important is to maintain a steady state of MLSS within the treatment process. Since no two plant loads are ever exactly alike, it is impossible, at the time a plant is installed, to pre-set it to do the best job it is capable of. At first, all you can do is analyse the load, choose the correct plant size, and make some initial equipment settings. From here on it is a matter of observing the plant's performance closely for up to 10 to 14 weeks, and making adjustments based on these observations. This fine-tuning of a plant to its load is called plant "start-up".

Plant start up must be successfully completed before any plant will do the job it is intended to do.

The incoming wastewater contains dormant bacteria that are quickly stimulated to activity by the abundant supply of oxygen in the plants SBR tank. These bacteria are able to quickly absorb and digest the organic material in wastewater and are the primary element in activated sludge. Since the SBR tank provides an ideal environment for the bacteria they multiply rapidly and are soon plentiful enough to oxidize or "burn up" all wastewater that enters the plant.

Activated sludge draws the very fine suspended particles in solution to it, just as a magnet draws iron particles. Often this suspended material is so small that it would not normally settle out by gravity. However, because of this magnetic characteristic, as the sludge settles to the bottom it takes the fine suspended matter with it, just as if a filter were being passed down through the liquid. Naturally this is a great improvement over ordinary gravity settling.

A great deal of the time taken in plant start-up is spent developing a good activated sludge culture, "Seeding" the plant, which is accomplished by taking sludge from a plant already in operation and adding it to the new plant, can accelerate the start up process. Although seeding can speed up a start up program it should be remembered that even a seeded plant cannot work properly if it does not receive the necessary start up adjustments.

6.2 Air, Mixing & Cycle Adjustments

Both the level of dissolved oxygen and the degree of mixing within the SBR Tank is governed by the amount of air being input by the aerators. For this reason adjusting the aeration rate by ramping up the VSD is the principal technique in plant start-up.

The type of aerator provided is a submersible type. The basic concept is

- Higher water level within the tank will allow more DO in the wastewater due to static pressure.

- Increased speed will produce a higher oxygen output from the aerator

The individual aerator can be used to regulate the airflow to provide even mixing. Even mixing simply means that more flow should move the tank contents so that they are rolling evenly all along the tank wall. The valves should never be "throttled down" but if the aeration rate (DO) needs to be reduced or increased it should be done primarily by regulating the anoxic/aerobic period on the PLC. By using the adjustable timer on the PLC to regulate the aeration cycle rather than throttling down the valves it is possible to maintain high mixing velocities in the SBR tank and still control and maintain a desired level of dissolved oxygen.

Any increase or reduction in the time cycle should equal 10% of the total running time. After a change is made the plant should always be permitted to run at least forty-eight (48) hours before any further adjustment. If the adjustment has been sufficient, improvement should be evident in the plant effluent within 48 hours.

6.3 Commissioning and Testing Checklist

Item	Description	Completed By
1	Check all piping and valves for leaks.	
2	Check operation of all valves.	
3	Fill tanks with water and check for tank leaks.	
4	Operate Aerators to ensure that evenly distributed fine air bubbles are produced.	
5	Check overflows.	
6	Ensure the irrigation tank outlet valve is 100% open.	
7	Prime Balance Pump by loosening the air release screw on the pump casting.	
8	Turn Balance Pump on and check that the pump operates correctly. Confirm the flow rate and pressure is as per the design specifications.	
9	Prime Decant Pump by loosening the air release screw on the pump casting.	
10	Turn Decant Pump on and check that the pump operates correctly. Confirm the flow rate and pressure is as per the design specifications.	

Item	Description	Completed By
11	Prime Sludge Pump by loosening the air release screw on the pump casting.	
12	Turn Sludge Pump on and check that the pump operates correctly. Confirm the flow rate and pressure is as per the design specifications.	
13	Prime Recirculation Pump by loosening the air release screw on the pump casting.	
14	Turn Recirculation Pump on and check that the pump operates correctly. Confirm the flow rate and pressure is as per the design specifications.	
15	Prime Sodium Hypo Dosing Pump by loosening the air release screw on the pump casting.	
16	Turn Sodium Hypo Dosing Pump on and check that the pump operates correctly. Confirm the flow rate is as per the design specifications.	
17	Prime Irrigation Pump by loosening the air release screw on the pump casting.	
18	Turn Irrigation Pump on and check that the pump operates correctly and the water meter records flow of the water. Confirm the flow rate and pressure is as per the design specifications.	
19	Place PAC carboy in bund.	
20	Turn PAC Dosing Pump on and check that the pump operates correctly. Confirm the flow rate is as per the design specifications.	
21	Place sucrose carboy in bund.	
22	Turn Sucrose Dosing Pump on and check that the pump operates correctly. Confirm the flow rate is as per the design specifications	
23	Place sodium hypochlorite carboy in bund.	
24	Turn Sodium Hypo Dosing Pump on, set ORP and inspect dosing line.	

Item	Description	Completed By
25	Inspect all tank float switches and check pump start/stop and High Level Alarm operates.	
26	Check operation of sprinklers, i.e. spray diameter and rotation.	
27	Eyewash Station – Ensure backflow prevention device has been fitted. Purge potable line by opening hose tap located next to safety shower, run for 30 seconds. Operate safety shower and eyewash together so as to visually check the cross flow on the eyewash is sufficient. Green light above eyewash must be operational.	
28	Instruct and train all personnel involved with maintaining plant. MSDS sheets for use of PAC, Sucrose and Sodium Hypochlorite to be in a position for visual inspection at any time. Train in testing procedures to keep the plant at satisfactory levels.	
29	Provide personnel with operations manual for all components of the Wastewater Treatment Plant.	
30	Visual inspection of all surrounding areas of the plant that includes: - All exposed material is painted - No water leaks - No damage to any of components and shed - Earthworks are clean with no trip hazards - All labels are in correct places including hazard signs for chlorine and confined space entry. - Site rubbish has been removed	

Tristar Representative

Name:

Signature:

Date:

Client Representative

Name:

Signature:

Date:

7. General Plant Maintenance

7.1 Introduction

To continue operating at peak efficiency, after start up is completed, all wastewater treatment plants should receive daily maintenance. Performance of plants that are not cleaned and adjusted daily will always be poorer than plants that are well maintained. Daily maintenance may seem like a little extra work but it is well worth it because a well-cared for plant will provide better treatment results, will have fewer mechanical problems and will actually require less overall maintenance.

7.2 Clean Weir

During every plant maintenance inspection check the weir to see that it is skimming evenly over its entire surface, and clean it to keep it free of sludge build-up. The weir should be brushed down and thoroughly cleaned to prevent algae build-up.

7.3 Clean SBR Tank Surface

Any particle that is on the surface should be skimmed off and deposited in a receptacle for disposal.

7.4 Power Isolation

Always shut the electrical power off before inspecting any mechanical or electrical equipment. Remember the motors and pumps are automatically controlled and can turn on at any time. Keep your hands and all objects away from the equipment until you have shut off the main circuit breaker on the control panel or the isolators to the individual item of equipment. Follow all safety requirements as apply to your particular operation.

7.5 Check Electrical Controls

Check the correct operation of all of the float switches once a week. Once a year completely check over the electrical panel. Replace any worn or frayed leads and securely tighten all conduit fittings and connectors.

7.6 Service Bar Screen

During every plant maintenance inspection check ensure that the bar screen is free of obstructions and debris.

For bar screen maintenance refer to the bar screen operations and maintenance manual in the Appendices

7.7 Sample Effluent

Inspect the plant effluent daily to ensure that it is clear and odour free. Weekly, the effluent should be sampled and suspended solids tests carried out. Three monthly sampling should also include BOD_5 tests. The results of these tests will confirm visual assessment of the effluent. All test data to be recorded on the Log sheets provided.

7.8 Sludge Management

The level of sludge in the plant will dictate the efficiency at which the plant will operate. To this end it is important to maintain a good balance in the plant. A simple test is the 30 minute settling test. To do this take a sample from the SBR tank in a calibrated column beaker and pour off the liquor until it is level at the 1000 ml graduation. Place the beaker in a quiet, vibration free area and let settle for 30 minutes. At the end of this time read off the level to which the sludge has settled. For the best working conditions this level should be between 200 and 400. If it is over 400 it will be necessary to bleed off sludge.

7.9 Repaint

Check, clean and spot paint all metal surfaces, including the grating at least once a year.

7.10 Clean-up

The plant and surrounding area should be cleaned daily. Wash down the piping and inside walls of the plant. Grass and weeds should be kept at least 8 0mm away from the edge of the plant.

7.11 Maintenance Schedule

The Operator should conduct daily, weekly and monthly maintenance on the WWTP as per the following schedule.

Operational and Preventative Maintenance	**Frequency**				
	Daily	**Weekly**	**Monthly**	**Yearly**	**As Required**
Perform necessary operational and control tests (Settleability, pH, Chlorine Residual)		X			
Perform tests as required by the Health Department of WA			X		
<u>Bar Screen</u>					
Inspect and clean mechanical bar screen	X				
Check operation of bar screen	X				
Inspect waste bin and empty	X				
Remove and dispose of rags and accumulations from bar screen	X				
<u>SBR Tank</u>					
Observe odour, colour and foam	X				
Check mixing	X				
Visually check aeration system for even air distribution, even roll across tank, no dead spots or septic areas	X				
Check operation of Aerators	X				
Check for leaks around valves and fittings	X				
Check valves for leaks	X				
Check air filters	X				

Operational and Preventative Maintenance	Frequency				
	Daily	Weekly	Monthly	Yearly	As Required
Remove any floating solids	X				
Waste sludge per results every settle period			X		
Inspect & paint any damaged/exposed surface to prevent rusting				X	
Check Operation of level switch.	X				
Irrigation Tank					
Observe quality of final effluent	X				
Check for leaks around valves and fittings	X				
Check valves for leaks	X				
Remove any floating solids	X				
Check scum accumulation level at inlet baffle		X			
Inspect & paint any damaged/exposed surface to prevent rusting				X	
Check operation of level switches	X				
Check operation of visual alarm	X				
Pumps					
Check operation of Balance Pump	X				
Check operation of PAC Dosing Pump	X				
Check operation of Sucrose Dosing Pump	X				
Check operation of Decant Pumps	X				
Check operation of Sludge Pumps	X				
Check operation of Recirculation Pump	X				
Check operation of Sodium Hypochlorite Dosing Pump	X				
Check operation of Irrigation Pump	X				
Check PAC carboy level	X				
Check PAC dosing lines	X				
Check Sucrose carboy level	X				
Check Sucrose dosing lines	X				
Check Hypochlorite carboy level	X				
Check Hypochlorite dosing lines	X				
Check operation pump suction and discharge isolation valves	X				
Check for blockages in suction lines	X				
Check pumps for clogging or near clogging condition	X				
Clean suction piping of pumps					X
Lubricate pump bearings as per manufacturers recommendations					X
Check pump motors for overheating	X				
Motors					
Check electrical leads			X		
Inspect circuit breakers, fuses and resets			X		

Operational and Preventative Maintenance	**Frequency**				
	Daily	**Weekly**	**Monthly**	**Yearly**	**As Required**
Check control panel indicators			X		
Sprayfield					
Check system functionality		X			
Mow sprayfield					X
Dripper line system flushing					Every 3 months

8. Operational Problems

8.1 Scum Growth

Surface scum may accumulate in the SBR tanks. Scum may be odorous and create slippery, dangerous and unpleasant working conditions. The scum is usually the result of Nocardia, but does not generally affect the plant performance unless exceptionally heavy scum has formed.

The exact cause of the scum is unknown but possible initiators are certain substrates in the feed or in the plant environment (i.e. dissolved oxygen levels, temperatures etc.). High mixed liquor suspended solids concentrations often encourage scum growth.

Methods of control include:

- Inspect and clean scum removal weir and piping.
- Spraying the surface with heavily chlorinated water.
- Mixing the scum into the mixed liquor by surface spraying with effluent or mixed liquor.
- Changes in aeration
- Drastic decrease in sludge age.

A combination of any of the above suggestions may be more effective. Any scum removed should not be recycled into the system, as this will re-seed the system. The last two (2) are the favoured solutions, as "kill" of useful bacteria will occur when substances like chlorine are used.

As such the first action recommended is to reduce the oxygen level in the plant. This can cause odour but this should be tolerated to more quickly control the problem. There should then be rapid desludging of the plant so that the MLSS drops to approximately 2,500 mg/l. This will represent 250 ml on the 1,000ml scale of the settling tube.

This condition must be maintained until it is effective and then gradually increase both oxygen and sludge volume until normal operating conditions are achieved. In most instances problems occur when over aeration is allowed to be present for extended periods. If 2.0 mg/l is maintained there is much less chance of problems occurring.

8.2 Filamentous Growth

Large quantities of filamentous growth may cause poor settling and in extreme cases, loss of sludge from the SBR tank. Experience has shown that long anoxic periods favour the growth of filamentous bacteria.

8.2.1 Methods of Control

Dissolved oxygen concentrations of between 1.5 and 2.5 mg/l in the aerobic section/periods should be maintained. If the dissolved oxygen concentrations fall below 0.5 mg/l, filamentous growths will be encouraged.

In general, anoxic periods should be kept as short as possible without adversely affecting de-nitrification.

The plant's operating parameters i.e. sludge age, F:M ratio and Mixed Liquor Suspended Solids (MLSS) should be kept within the required ranges. This will help to control the growth of filamentous bacteria.

Chlorine doses of between 2 and 15 kg Cl_2/1000 kg SS/day have been used successfully in the past. Typically a low value is used initially (4 to 5 kg Cl_2 /1000 kg SS/day) with chlorination occurring for one week only. Further chlorination at higher doses may be initiated if no effect on sludge settling is noticed. Chlorine doses of greater than 9 to 10 kg Cl_2/1000 kg SS/day indicate a serious problem exists and the cause of the problem should be sought. Note that the application is in terms of the mass of suspended solids and not the liquid volume. Chlorination should be stopped as soon as the sludge settling improves.

9. Troubleshooting

Generally, extended aeration plants are operationally trouble free. However, situations do arise that are beyond the Operator's control. In this section, basic guidelines will be laid out to assist in coping with some of the problems that may be experienced with the plant.

If operational problems cannot be resolved, assistance may be obtained from [redacted]

[redacted]

9.1 Trouble Shooting Guide

1.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Very stable dark tan foam on aeration basin which hosing cannot break up.	1 . Sludge age is too old.	1. If sludge age greater than 40 days, this is probable cause.	1. Increase sludge wasting in order to reduce sludge age.
	2. Plant loading <25% of plant capacity		
2.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Thick billows of white sudsy foam on the SBR tank.	1. MLSS too low	1. Check MLSS	1. Reduce hydraulic inflow if possible.
	2. Hydraulic wash out of biomass (solids).	2. Confirm MLSS with lab.	
	3. Sludge wasting to high.		1. Decrease sludge wasting rate.
	4. Plant start up.		1. Start up supplementary feeding if required, otherwise do nothing.
	5. Surfactant agent incoming	1. Check chemical incoming	1. Spray foam with water.
3.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Aeration basin contents turn grey to black - sludge blanket lost in SBR Tank during settle period.	1. Inadequate aeration	1. Aeration basin dissolved oxygen.	1. Increase aeration by increasing run times.
			2. Decrease mixed liquor suspended solids. If above 400/1000.
			3. Clean any plugged diffusers.
			4. Check aeration system for efficient operation.

4.0 OBSERVATIONS	POSSIBLE CAUSE	CHECK OR MONITOR	SOLUTION
Blocked Pipes.	1. High solids loading Inadequate pumping	1. Check operation of mechanical screen	1. Rake and wash inlet screen.
			2. Reduce rubbish intake to plant.
5.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
SBR tank smells	1. Low aeration	1. Dissolved oxygen level. Setpoint 2.5mg/L during aerobic period	1. Increase aeration to maintain 2.5 mg/L during aerobic period
		2. SSV.	2. Increase WAS if SSV (jar test) above 600 ml/L.
	1. Low pH	1. pH	1. If pH below 6. 5 add lime until 7.0.
6.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
pH of mixed liquor decreases to 6.7 or lower. Sludge becomes less dense.	1. Nitrification occurring without De-Nitrification and waste water alkalinity is too low.	1. Effluent NH3, influent and effluent alkalinity.	1. Alter aeration time to give minimum 30 min. off to allow De - Nitrification.
		2. Nitrification / De -Nitrification cycles.	2. Add source of alkalinity - lime or sodium bicarbonate.
	1. Acid waste water entering.	1. Influent pH.	1. Determine source of acid waste water and stop flow into system
7.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Dead spots in SBR tank	1. Aerator malfunctioning.	1. Visual inspection.	1. Clean or repair aerators
	2. Under aeration resulting in low DO.	2. Check DO.	2. Increase rate of aeration to bring DO. concentration up to 2.5 mg/L

8.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Sludge blanket excessively high in SBR tank during decanting period	1. MLSS (SSV) too high because of inadequate wasting.	1. Check SSV to see if above 600/1000.	1. Increase wasting if SSV > 600ml/L.
	2. Peak flows are overloading plant.		2. Expand plant if daily flow greater than 120% of plant capacity ongoing.

9.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Sludge floating to surface of SBR Tank duriung settle period.	1. Filamentous organisms pre - dominating in mixed liquor (bulking sludge).	1. SSV-If less than 800, 1 is not likely cause. If surface sludge oily, actinomycete bacteria likely.	1. Increase DO in aeration basin if < 1 mg/L.
	2. Actinomycete organisms pre - dominating in mixed liquor.	2. Nitrate concentration in SBR Tank too high.	2. Increase pH to 7.
	3. De-nitrification occurring in tank; nitrogen gas bubbles attaching to sludge particles; sludge rises in clumps.	3. Frequency and speed of sludge collection. (Sludge black with septic odour)	3. If SSV is > 600/1000, increase sludge by 10% per day until SSV 400/1000 or less, but no lower than 250/1000.
	4. Sludge collectors operating too slowly, (septic sludge producing H2S gas)	4. Mixed liquor dissolved oxygen should be 2.5 mg/L	4. Keep sludge age between 20 to 25 days.
	5. Over-aerated sludge.	5. Effluent nitrogen concentration.	6. Decrease sludge return rate.
			7. Increase DO in aeration chamber. If DO. < 1.0 mg/L during aeration make sure De-nitrification off time > 30min.
			8. Reduce sludge age.
			9. Increase frequency of sludge solids.
			10. Install skimming baffles to keep sludge from entering effluent weir.
			11. Reduce aeration times in aeration chamber if above 4 mg/L

			12. Increase de- nitrification time but not exceeding 1.0 hr.
10.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Pin floc in effluent overflow SSV (400 to 600) is good but effluent is turbid (cloudy).	1. Excessive aeration in aeration basin.	1. DO. in aeration chamber.	1. Reduce air input to plant.
	2. Sludge age > 40 days.	2. Sludge appearance, very dark and dense.	2. Increase sludge wasting to decrease sludge age.
	3. Anaerobic conditions in aeration chamber.	3. Microscopically examine sludge for inactive protozoa.	3. Increase DO. in aeration chamber.
	4. Toxic shock load.	4. Inlet baffles for leaks.	4. Re-seed sludge with sludge from another plant if possible. Enforce toxic inclusion particles. If toxic loads still likely, neutralise as fast as possible.
	5. Short - circuiting of flow allowing solids to pass into effluent.		5. Repair leaks/fractures to inlet baffles.
			6. Identify and correct sources of anaerobic conditions
11.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Plugging of sludge outlet	1. High content of rubbish and debris.	1. Visual inspection.	1. Clean rubbish and debris from sludge pipe work.
	2. Low velocity in withdrawal lines.	2. Sludge withdrawal rate and resulting velocity.	2. Back flush clogged line.
			3. Check and keep inlet screens clear to reduce input of rubbish into plant.

12.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
De flocculation in SBR Tank.	1. Toxic or acid wastes.	1. Supernatant above settled sludge is uniform in turbidity.	1. Remove source of toxic discharge or ensure adequate dilution when toxic spillages occur.
	2. Anaerobic conditions in aeration basin.		2. Increase DO. in aeration basin.
	3. Aeration basin overloaded.		3. Ensure loading of pump stations 1% of aeration volume. If plant loaded 120% above design, plant augmentation needed.
	4. Inadequate nitrogen or phosphorus supply.		4. Supplement deficiency in nutrients by chemical addition.
	5. Excessive shear caused by turbulence.		5. Reduce agitation, ie. Aeration if DO. Allows. Otherwise step down aeration headers inlet to outlet.
13.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Billowing sludge	1. Hydraulic surges.	1. Visual inspection of sludge conditions.	1. Ensure loading of pump stations 1% of aeration volume. If plant loaded 120% above design, plant augmentation needed.
	2. Density currents, ie. Hot sun on one side of plant.		2. Keep sludge depth as low as possible.
14.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Dissolved oxygen low in aeration chamber.	1. Under-aeration.	1. Aeration times	1. Maintain DO at 2.5mg/L during aeration period by increasing aeration rate.
		2. Shorten anoxic period	2. Shorten anoxic period to maximum of 30min. Intersperse anoxic and anaerobic periods.
15.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Dissolved oxygen concentration low in final effluent.	1. Anoxic conditions in SBR Tank	1. DO. in aeration if below 1.0mg/L increase.	1. Aeration decreased to 2 to 4 mg/L.
16.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**

Dissolved oxygen concentration high in SBR Tank.	1. Over-aeration.	1. Aeration times.	1. Decrease aeration to achieve between 1.5 and 2.5 mg/L.
17.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Final effluent chlorine concentration low.	1. Under-chlorination.	1. Free and total chlorine residuals.	1. Adjust chlorine dose so as to provide free chlorine residual of between 0.3 and 0.7 mg/L after 30 minutes detention.
	2. Effluent quality poor.	2. Visual inspection.	2. If final effluent is of poor quality, particularly with respect to suspended solids, chlorine concentration will be low due to high CL2 demand. Recheck CL2 concentrations once effluent quality improves.
	3. Sludge in base of Irrigation tank.		3. Empty and clean out Irrigation tank. Should be done monthly as preventative maintenance
18.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Final effluent chlorine concentration high.	1. Over-chlorination.	1. Free and total chlorine residual.	1. Adjust chlorine dose so as to provide free chlorine. Residual of between 0.3 and 0.7 mg/L after 30 minutes detention.
19.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Mixed liquor pH <7.	1. Low pH influent(<7.)	1. Influent pH.	1. Neutralise all inflows to sewer with soda ash or lime.
		2. Nitrification occurring without de-nitrification	2. Dose soda ash or lime to SBR Tank to increase pH to between 7 and 8.
			3. If final influent has low ammonia, and high nitrate concentrations then Item 2 is probably the cause.
			4. Set aeration 1 Hr on, 1 Hr off and adjust for DO. levels of 30 min. to allow de-nitrification.
20.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Mixed liquor pH >8.5.	1. High pH influent >8.5.	1. Influent pH.	1. Neutralise all inflow to sewer with diluted hydrochloric acid.

			2. Allow longer Nitrification periods of up to 2 Hrs with only 30 min. De-nitrification
21.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Sludge dark in colour. (grey or black)	1. Septic Sludge. Inadequate aeration	1. Oxygen input.	1. Increase aeration maintaining dissolved oxygen concentration between 2.0 to 2.5 mg/L during aeration period.
			2. Increase by WAS removal.
			3. Clean any plugged aerators
			4. Check aeration system piping for leaks.
22.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Large free floc percentage >15% (Turbid effluent).	1. Over agitation of mixed liquor	1. Visual inspection	1. Reduced turbulence in aeration chamber (If possible).
	2. Over aeration	2. Oxygen input.	2. Maintain oxygen concentration at 2.5 during aeration period.
		3. Effluent nitrogen concentrations	3. Create anoxic periods to reduced air input and turbulence, set plant 1 Hr on, 1 Hr off and adjust for DO. with minimum off time of 30 minutes.

23.0 OBSERVATIONS	POSSIBLE CAUSE	CHECK OR MONITOR	SOLUTION
Dominance of filamentous bacteria (poor settlability).	1. Plant operating outside optimal performance criteria.	1. Dissolved oxygen concentrations in mixed liquor.	1. Reduce the length of anoxic periods (not less than 30 min.).
		2. 30 minute SSV	2. Maintain DO. in aeration basin at 2.5 mg/L
			3. Increase pH to 7
			4. Increase WAS removal until SSV 250/ 1000 and maintain for 14 days.
			5. Adjust F:M ratio to between 0.05 and 0.15.
			6. Adjust F:M ratio to between 0.05 and 0.15.
24.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Large quantity of actinomycete bacteria (scum forming).	1. Infection from area ie. compost or leaf litter in rain forestry.	1. Microscopic Identification.	1. Reduce DO. in plant to 1.0 mg/L and hold for up to 21 days. There will be some odour on start of each cycle.
			2. Alter sludge age drastically by WAS removal from SBR Tank
25.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Floc weak and poorly formed.	1. Numerous.	1. Microscopic identification. Check pH to see if low.	1. Maintain sludge age at 25 days.
			2. Maintain F:M ratio between 0.05 and 0.15.
			3. Reduce turbulence in aeration chamber.
			4. Maintain DO concentration between 1.5 and 2.5 mg/L in aeration chamber.

			5. Add lime if pH<7.
26.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
Dominance of amoeba and flagellates.	1. Plant in recovery stage	1. Microscopic identification.	1. Maintain sludge age between 25 days.
		2. Plant performance parameters.	2. Maintain F:M ratio between 0.05 and 0.15.
			3. Maintain aeration chamber DO. to between 1.5 and 2.5 mg/L.
			4. Stabilise plant operation with respect to influent and aeration.
			5. Prevent entry to sewer system of toxic compounds.
			6. Limit anoxic periods to 30 minutes.
27.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
SSV test above 700 ml/L. High turbidity and sludge levels in final effluent.	1. Too much sludge.	1. Check DO.	1. Waste sludge at twice daily requirement for 2 days until SSV below 400ml/L.
	2. Sludge bulking.		2. Maintain DO. in range 1.0-2.5mg/L.
28.0 OBSERVATIONS	**POSSIBLE CAUSE**	**CHECK OR MONITOR**	**SOLUTION**
SSV test below 300 ml/L.	1. Too high waste rate. Too little sludge.	1. Check SSV & Check DO.	1. Increase AS if possible. Maintain DO. between 1.0 and 2.5 mg/L.

10. Plant Safety and Personal Hygiene

The following section will discuss plant safety and personal hygiene. This will ensure a safe working environment and safeguard Operator health.

10.1 Safety Equipment

The following safety equipment should be held at the wastewater treatment plant for daily use.

1. One pair of cloth-lined rubber gloves for sample collection.
2. One pair of safety glasses for protection of eyes against splashing.
3. Shower rose connected to water supply to allow the Operator to be doused with water in the event of a chemical spill or splash or falling into the sewage treatment plant.

The following safety equipment should be available when working on the wastewater treatment plant or within the tanks:

1. Safety harness and safety rope to be used whenever working inside the tanks.
2. A relief Operator to raise the alarm and to assist in the recovery of personnel in the event of an accident within the tanks or while working motor pulley.
3. Rubber knee-high boots for working in pump wells and half-empty tanks.

10.2 Safety Procedures

When working at the wastewater treatment plant and carrying out repairs it is imperative that the Operators do not work alone. REMEMBER! - THIS IS A TWO -MAN JOB.

A second person must be present to assist in ensuring a safe working environment.

When working inside the tanks (or pump-wells), there is the possibility that the Operator may be overcome by odours lingering in the tank. It will be important to ensure that the tank is of course, relatively empty and that if any liquid is remaining in the tank, that the Operator wears impervious rubber boots.

A safety harness and rope should be attached to the Operator inside the tank and this should be connected to (preferably) a tripod mounted outside the tank, so that the Operator can be quickly and easily lifted out if he does collapse inside the tank.

Under no circumstances is the relief Operator to enter the tank if the Operator collapses. The relief Operator is to raise the alarm and try and lift the Operator out of the tank.

When working on equipment it is important to ensure that the equipment is de-energized until repairs have been carried out. Normal electrical codes should be observed at all times to avoid electrocution.

10.3 Operator Hygiene

It has been well documented that raw wastewater from various stages of wastewater treatment prior to disinfection, can contain human pathogenic organisms. Disinfected final effluent can also harbor viable human pathogens if disinfection processes are not functioning effectively.

It is therefore essential that Operators and others coming into contact with wastewater from any stage of the treatment process, take precautions to prevent exposure to any human pathogenic organisms which are present in the wastewater.

The following precautions should be taken by Operators and other people likely to come in contact with wastewater, and should be enforced by supervisors and managers.

Inform all people likely to be in intimate contact with wastewater that there are potential health risks associated with ingestion of, skin contact with, or inhalation of wastewater from any stage of treatment.

Instruct persons in contact with wastewater to ALWAYS:

- Wash hands thoroughly with disinfectant soap, after handling wastewater, before drinking, eating OR SMOKING.
- Wear long-sleeved shirts and trousers to prevent wastewater contact with skin.
- Always avoid immersing hands, feet and other parts of the body in wastewater without protection, e.g. use sampling scoops to collect samples or use protective waterproof gloves or boots if contact with wastewater is unavoidable.
- In the event that a person becomes immersed in wastewater, immediately proceed to a shower, remove all affected clothing, wash thoroughly using disinfectant soap and replace affected clothing with clean clothing.
- Where splashing of wastewater into face and eyes is likely to occur (e.g. while servicing pumps and aerators) a facemask with eye protection should be worn.
- Never store or consume food or drink in close proximity to wastewater or wastewater samples, e.g. never store wastewater samples in the same fridge as foodstuffs or drinks.
- If clothing is splashed or wet with wastewater, remove and exchange for clean article of clothing at the first opportunity and certainly before eating, drinking or smoking. Wash affected clothing with disinfected soap at the first opportunity.
- Ensure that cuts/abrasions are always covered with a suitable dressing and treated with a suitable antiseptic.

Many local authorities are recommending that their employees, who are likely to have contact with wastewater, be vaccinated against Hepatitis B. This is being done in spite of the fact that studies of the occupational risks associated with wastewater treatment plant operation indicate that it is not necessary to enhance normal immunization of wastewater treatment plant Operators.

There is currently no evidence to suggest that A.I.D.S. can be contracted through contact with wastewater.

While it is the responsibility of management to provide the equipment and facilities necessary for employees to take the precautions above, it is also the responsibility of employees to carry them out. Use of safety/protective equipment such as gloves, boots, clothing etc., as well as adherence to the precautions listed above, should be strictly enforced, if necessary through disciplinary action.

11. Sample Collection

Collection of samples for on-site and laboratory testing is extremely important. Samples must be collected in the correct manner to ensure that results are accurate and are not misleading. The following section will describe the sampling instructions and requirements when sampling water and wastewater from the sewage treatment plant, as well the final effluent.

11.1 Collection of Waste Water Samples

1. Sterilize tap with blowtorch. Do not overheat the tap or the washer inside will be destroyed. Alternatively, douse the tap with 10% Sodium Hypochlorite solution.

2. After adequate sterilization of the tap, allow the water to run to waste for approximately 1 minute.

3. Remove the lid of sample bottle and fill bottle almost full. Leave an air gap of approximately 1 cm in the top of the bottle. Replace the lid and screw down firmly. Do not over tighten. Place the bottle in an esky and chill with either ice or freezer bricks for the return trip.

4. Chill with ice or freezer brick and return to the laboratory. Ensure the laboratory receives the samples within 24 hours of sample collect