

Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021

Package Treatment Plant Operation and Management

System Monitoring and Reporting



Mark Saunders



Introduction

In this session we will cover:

- Developing Operation & Maintenance Plans for Wastewater Treatment Systems incorporating Package Treatment Plants
- Monitoring the Ongoing Performance of Package Treatment Plants
- Reporting for Package Treatment Plants



Operation and Maintenance Plans

- An Operation and Maintenance (O&M) plan outlines the necessary procedures required to correctly manage an operational treatment plant and also provides a scheduled inspection regime to ensure the plant runs effectively in the future
- The O&M plan should be sufficiently detailed such that any authorised person should be able to manage the day-to-day operation of the plant with minimal support



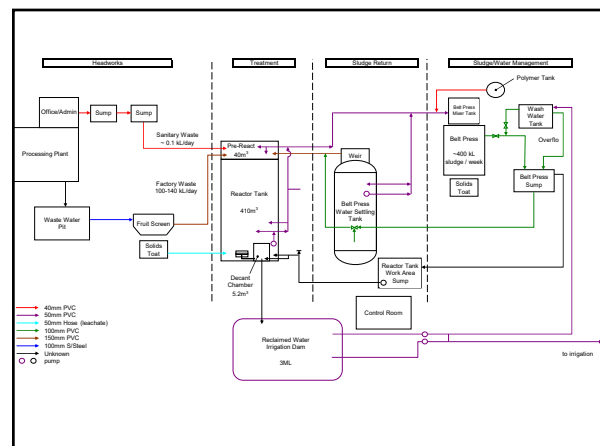
Operation and Maintenance Plans

- As a minimum, the O&M plan should include the following:
 - ✓ Plan and section drawings of the plant so that the operator has a full understanding of the system layout and design
 - ✓ A Site Plan showing the entire wastewater management system for the development, including:
 - the PTP location
 - additional (pre) treatment facilities (grease traps?)
 - buried pipe work, effluent irrigation lines, pumps, wells and electrical equipment



Operation and Maintenance Plans

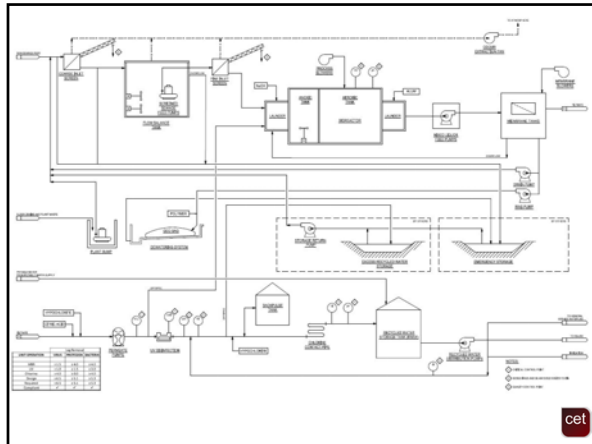
- ✓ A process diagram or schematic outlining the treatment sequencing for the plant, including wastage and recirculation (if included)
- ✓ A copy of any calculations used to determine the expected effluent volumes to be treated by the package treatment plant (hydraulic loading)
- ✓ A copy of any calculations used to determine expected organic or nutrient loadings



Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021



Operation and Maintenance Plans

- ✓ A copy or outline of the regulatory approval or license requirements for both the package plant and (if applicable) the entire wastewater management system
- ✓ Effluent quality performance ranges and maximum acceptable values (limits)
- ✓ A copy of the water balance calculations used to determine the appropriate irrigation or re-use area sizing for the expected effluent loads

Operation and Maintenance Plans

- ✓ A detailed description of the monitoring schedule for the PTP
- ✓ A detailed description of the maintenance schedule for the plant
- ✓ Contact details for a nominated professional who can assist the operator should any situation arise that they are not capable of dealing with alone

Operation

- To ensure that a package plant operates in a satisfactory manner at all times and that any problems are identified and rectified quickly it is important to undertake routine monitoring of wastewater treatment and effluent quality
- With a majority of plants, the routine performance of simple on-site tests can provide invaluable information for the successful operation of a package treatment plant

Operation

- The level of operator attention or automated control required by a PTP is highly dependent upon the nature of the treatment process being utilised and the level of complexity associated with the plant itself

e.g. Extended Air / Pasveer Ditch	Low
IDEA / SBR / RBC	Moderate
Integrated BNR or MBR plant	High

Operation


- As a general guide a typical performance monitoring program will require operator attention for (on average):

– **One to four** hours per day for larger size or high complexity package plants (IDEA, BNR, MBR, high strength/trade waste)

– **One to two** hours per week for smaller / less complex or more robust package plants (EA, IDEA/SBR, RBC)


System Performance Monitoring

- The monitoring program described here involves performing a series of on-site tests, observing the physical characteristics of the plant and wastewater and completing a routine monitoring checklist
- During periods of plant upset or as part of a license requirement / review, more detailed monitoring and analysis of the wastewater treatment stages and effluent would most likely be provided by the nominated professional advisor for the plant



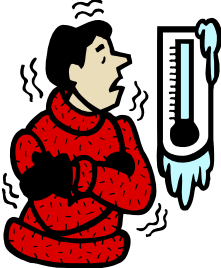

System Performance Monitoring Observation and Testing

<u>Meteorological</u>	<u>Clarification Vessel</u>
Date and Time	Scum
Weather, Temperature	Effluent Clarity
<u>Primary Treatment</u>	<u>Control Tests</u>
Sludge/Scum development, screens	Dissolved Oxygen
	BOD/COD (effluent)
<u>Reactor Vessel</u>	TSS (effluent)
Colour, Odour, Foaming, pH, Settleability	Faecal Coliforms (effluent)
	Sludge Depth




System Performance Monitoring Temperature


- Not normally a problem with PTP in NSW coastal areas
- Domestic wastewater typically occurs within a restricted range (bathing, washing)
- Quickly moderated in treatment plant (dilution)
- If seasonal temp variation exceeds 10°C process management may be required
 - Winter – less aeration
 - Summer – high micro-organism growth rates

System Performance Monitoring Sludge and Scum





- Scum formation important in primary treatment (anaerobic)
- Scum health indication of retention capacity and influent quality (primary)
- Scum return from secondary clarification
- Sludge Depth measured to manage effective volume of treatment vessels




System Performance Monitoring Colour

- Colour is a good indication of plant performance
 - Dark Brown – solids retained, aerobic activity, sufficient O₂
 - Light Brown – hydraulic overloading, solids carryover, insufficient aeration timing
 - Black – septicity, low oxygen conditions, anaerobic, gas formation

Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021



System Performance Monitoring

Odour

- Odour is a good indicator of plant performance
- When a plant is performing satisfactorily it will generally have no odour or a sweet earthy smell
- When problems occur the odour will quickly change from earthy to a strong smell of rotten eggs, caused by an increase in anaerobic activity

System Performance Monitoring

Foaming

- Foaming can be an indicator of plant instability caused by:
 - Influent wastewater (surfactants, detergents etc.)
 - Polymer overdosing
- But most often:
 - Filamentous micro-organisms causing floating flocs and foams
 - Can be problematic to effective treatment



System Performance Monitoring

pH

- pH is a measure of the acidity (H^+ concentration) of wastewater
- Domestic wastewater will typically have a pH that is close to neutral (7.0)
- Wide or frequent fluctuation in pH is detrimental to plant performance as it may reduce the settleability of solids and decrease beneficial microbiological function
- Biological function 6.0 – 9.0 (6.5 to 7.5 optimum)

System Performance Monitoring

pH buffering

- Alkalinity is a measure of hydroxides (OH^-), carbonates (CO_3) and bicarbonates (HCO_3) in wastewater
- Alkalinity helps wastewater resist changes in pH by 'buffering' the effects of acid inputs
- Nitrification is a major consumer of alkalinity in aerobic reactors
- ~7g $CaCO_3$ is required for every gram of ammonia oxidised
- Residual alkalinity of 70-80mg/L (measured as $CaCO_3$) is normally required to maintain a balanced pH around 7
- Additions of carbonate/bicarbonate (soda ash) will assist

Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021

System Performance Monitoring Settleability

- Important physical test to determine the efficiency of solid/liquid separation in the final clarifier
- A well performing plant will have a densely granulated, dark brown sludge, which after 30 minutes settles to a relatively small volume
- Liquid above the settled sludge will contain a few suspended particles but will otherwise be clear



cet

System Performance Monitoring Effluent Clarity

- A clear effluent sample indicates that the plant is operating well and the majority of solids are being retained within the plant
- A cloudy effluent sample indicates that the plant may be hydraulically overloaded or that some other portion of the treatment process is not working correctly



cet

System Performance Monitoring Control Tests

- Suggest undertaken quarterly for the following parameters:
 - Dissolved Oxygen (reactor)
 - Oxygen Uptake Rate (reactor)
 - BOD₅ / COD (effluent)
 - TSS (effluent)
 - Faecal Coliforms (effluent)
 - Total ammonia (effluent)
 - Mixed Liquor Volatile Suspended Solids (reactor)

cet



Maintenance

- Proper operation and maintenance of a package wastewater treatment plant is the responsibility of the owner or designated operator
- The plant should be inspected at least once per week by the owner or designated operator.
- The maintenance inspection should include:
 - ✓ Determining that motor / blower / pump assemblies are operating correctly. Where fitted, the operational assembly (the one currently in use) should be alternated from time to time to ensure that the work hours on duplicate units are approximately equivalent

cet

Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021

Maintenance

- ✓ Performing routine housekeeping duties, including hosing down, particularly in splash, spray and access areas; removing debris; checking access condition to ensure safe access to the plant; and general grounds keeping around the plant
- ✓ Inspecting and maintaining disinfection units as required (additional chlorine, clean UV tubes etc.)
- ✓ Examining pumps, pipes, air release/vacuum valves for damage or wear
- ✓ Cleaning or clearing inline filters or other apparatus from the effluent irrigation systems



Common Maintenance Items *Tanks*

- Concrete tanks can be affected by pH, fats and oils, ammonia, and caustic products
- Should be sealed at the main lid with a semi permanent compound
- When de-sludging primary tanks, always refill
- Take care with baffled tanks during pump-out
- Polymer tanks need additional care when installed above ground



Common Maintenance Items *Air Delivery Systems*

- Surface aerators – lubrication, loose fittings, cracked impeller blades, moisture damage to motor
- Air Filters – cleaning and regular replacement
- Blowers – header blockages, control malfunction, oil levels, bearings/lubrication, motor ventilation
- Air distribution – leaks or fractures, seals and gaskets, corrosion, loose fittings
- Diffusers – clogging, biological films, solids accumulation



Common Maintenance Items *Effluent Filters*

- Filters should be checked and cleaned at each maintenance interval
- Most commercial filters will operate up to ~50% blockage
- Further blockage can result in considerable back-pressure to treatment plant
- Clean filters back into aerobic reactor or primary tank (if fitted)



Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021

Common Maintenance Items *Pumps*

- Centrifugal (submerged transfer):
 - Used for relatively clean water
 - Close tolerances
 - Impeller works directly on the water it moves
- Multi-stage (submerged):
 - Multiple impellers to increase pressure
 - Finer inlets, usually with strainer to protect closer tolerances of impellers
 - Generally have a lower volume delivery



Common Maintenance Items *Pumps*

- Vortex (submerged transfer):
 - Used to transfer dirty water during processing, aerating, batching and de-sludge
 - Water and matter moved by creating a vortex which acts on the substance being moved
 - Usually high volume with low head (pressure) able to move particle sizes 25% of the intake
- Grinder/Macerator (submerged):
 - Typically for raw wastewater transfer
 - Cutter or grinder gears shred solid materials



Common Maintenance Items *Air Lifts*

- Air feed rate will slide between maintenance intervals
- Adjust accordingly to maintain desired flow rates, run bucket (volume) test if necessary to ensure appropriate values
- Avoid oversupply (spluttering)
- Check for blockages (particularly skimmers and sludge pick ups)



Common Maintenance Items *Timers/Alarms/Boards*

- Suggest retaining or engaging specialist advice and assistance for maintaining electrical components
- A wide variety of designs and configurations used and available (switches, electric/mechanical timers, audible/visual alarms, floats, PLC's)
- Exchange electronic boards, do not try to repair
- Best to consult an electrician with experience in wastewater servicing systems



Common Maintenance Items *Disinfection Systems*

- Chlorination – effective delivery imperative
 - Liquid delivery – check seals and containment, dosing timers, safety controls (oxidiser)
 - Tablet delivery – feed blockages, swollen cakes, full refills at every service
 - Check contact chambers for sludge deposits
- UV – effective treatment requires high quality effluent and good transmission
 - Keep vial and tubes clean (some auto), check flow management if fitted, keep spare tubes on site, emergency backup may be required (chlorine?)



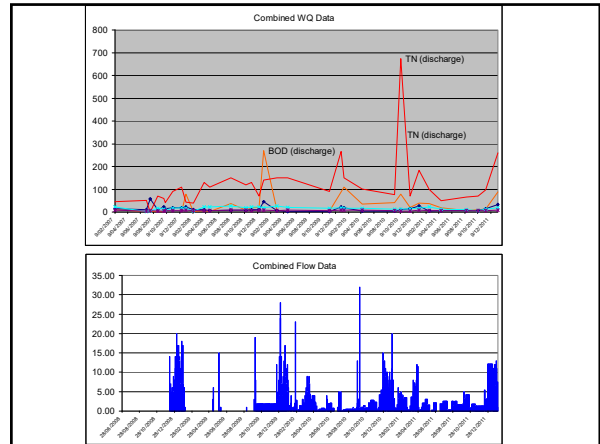
Package Treatment Plant Operation and Management

Cessnock, NSW

8-9 June 2021

System Reporting

- System monitoring data should be recorded in an appropriate form for presentation to regulatory staff as required/requested
- Maintenance of an accurate and up-to-date monitoring log (record) will demonstrate a proactive management regime for the plant and other treatment system components
- Also allows for the identification of long-term trends in performance and promotes an adaptive approach to system management



Package Wastewater Treatment Plant Monitoring Results																		
Sample Period	PHYSICAL			VISUAL OBSERVATIONS				CONTROL TEST										
	Date	Time	Weather	Aeration Compartment		Settling Compartment		Effluent		Aeration Compartment		Effluent		Inlets				
				Colour	Odour	Foaming	pH	Heavy Scum	Light or No Scum	Clear	Cloudy	Settleability (30min)	Dissolved Oxygen		Sludge Depth (cm)	BOD ₅ (mg/L)	TSS (mg/L)	FC (col/100mL)
Wk1																		
Wk2																		
Wk3																		
Wk4																		
Wk5																		
Wk6																		
Wk7																		
Wk8																		
Wk9																		
Wk10																		
Wk11																		
Wk12																		
Wk13																		
Quarter																		

Whitehead & Associates
Environmental Consultants Pty Ltd
101 Main Road Cardiff Heights NSW 2256 Australia
Telephone +61 2 4564 4000 Facsimile +61 2 4564 4006
Email mail@whiteheadenvironmental.com.au

18 June 2010

SUMMARY REPORT
Quarterly Inspection of the Sewage Treatment Plant and Effluent Pond
May 2010

Dear Panel,

I write to confirm that on 31 May 2010, Mark Saunders and Lauren Chrobater of Whitehead & Associates (W&A) conducted an inspection of the above-mentioned facilities at Torrago Village Van Park. The purpose of this inspection was to collect water samples for testing to meet the requirements of Council's letter dated 20 April 2010 to the local Council regarding the quarterly monitoring of STP effluent and pond effluent. It is understood that quarterly monitoring of STP and pond are performing adequately and in accordance with the 'Approval to Operate' a system of sewage management issued by Council.

As required, we sampled effluent to the STP at the immediate discharge outlet from the domestic reticulation system and effluent from the treatment pond immediately prior to discharge to the natural surface water. Samples were collected at around 12:30 pm and transported within 1 hour to a 2014 accredited laboratory (SHEL) for subsequent chemical and microbiological analysis. The analysis undertaken and results are summarised in Table 1.

The STP effluent demonstrates typical characteristics for domestic (residential) wastewater. There is no indication that shock loads or abnormal strength wastewaters are being, or are expected to be, introduced from the development.

Generally, the pond effluent complies with the FSC performance limits with BOD₅, TSS, oil and grease, ammonia and total phosphorus all well below their respective compliance values. This demonstrates the effective performance and management of the STP. The opening physicochemical parameters (pH and nitrite) were marginally elevated during the sample period. Given the high levels of decaying organic material within the treated

ponds the elevated pH value is not unexpected. Similarly, the elevated TON probably value is most likely a function of reduced plant demand within the pond during the sample period.

Table 1 Analytical Results

Sample Site	Analysis	Result	Units	Guideline Range or Compliance Value	Comments
STP Effluent	pH	7.1	unitless	6-9	typical
	BOD ₅	158	mg/L	200-300	low
	Total Suspended Solids	289	mg/L	200-300	typical
	Total Dissolved Nitrogen	-8.88	mg/L	<5	expected
	Total Kjeldahl Nitrogen	43.8	mg/L	20-100	typical
	Total Phosphorus	8.3	mg/L	10-20	low
Pond Effluent	pH	8.1	unitless	6.5-7.5	elevated
	BOD ₅	<2	mg/L	20	excellent
	Total Suspended Solids	4	mg/L	30	excellent
	Total Dissolved Nitrogen	12.8	mg/L	<8	high
	Ammonia (N)	6.81	mg/L	0	good
	Total Phosphorus	4.8	mg/L	<8	good
	Total Oil and Grease	<2	mg/L	<5	good
	Final Chlorine	34.889	ctd/100mL	>300	elevated

Additional Tests

The FSC 'Approval to Operate' also requires 6 monthly groundwater monitoring to ensure off-site contamination is not occurring. As discussed with you, we also installed two groundwater monitoring points (GW1 and GW2) and installed a Rocked depth of 1.8m below ground surface. The Rocked GW1 and GW2 are installed at 20m and 25m from the STP and at a Rocked depth of 1.8m below surface. Both bore have a screen depth of 1m with a filter above the screen to prevent larger solids entering the bore. The location of the two monitoring bores is shown in Figure 1.

No samples were collected from the bores during this sample period.

