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

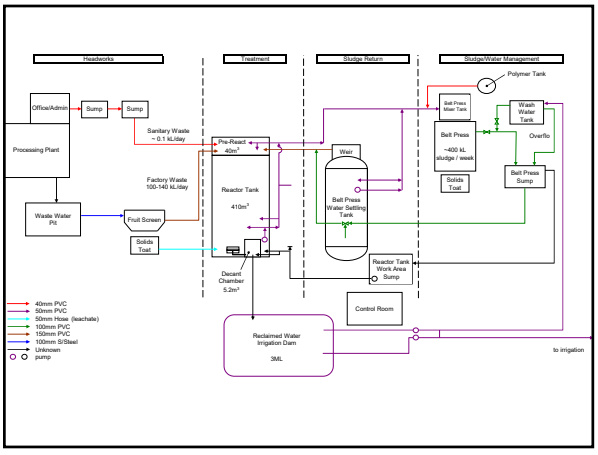
- An Operation and Maintenance (O&M) plan outlines the necessary procedures required to correctly manage an operational treatment plant and also provides a scheduled inspection regime to ensure the plant runs effectively in the future
- The O&M plan should be sufficiently detailed such that any authorised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

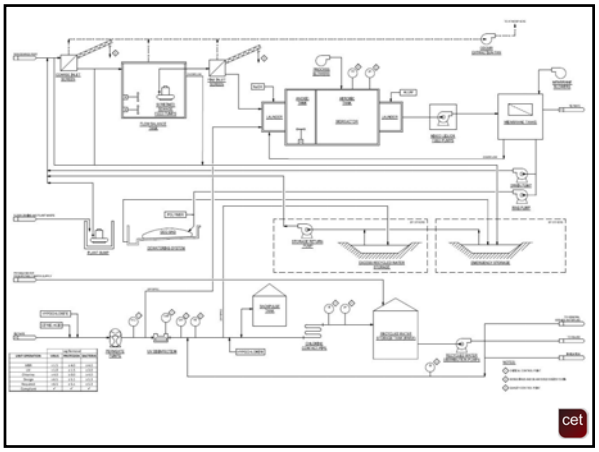
Operation and Maintenance Plans

- 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





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

Meteorological
Date and Time
Weather, Temperature

Primary Treatment
Sludge/Scum development, screens

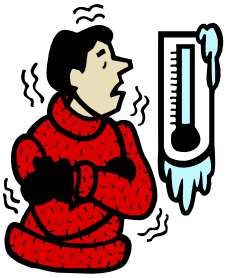
Reactor Vessel
Colour, Odour, Foaming, pH, Settleability

Clarification Vessel
Scum
Effluent Clarity

Control Tests
Dissolved Oxygen
BOD/COD (effluent)
TSS (effluent)
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 10ºC 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 O_2
  - Light Brown – hydraulic overloading, solids carryover, insufficient aeration timing
  - Black – septicity, low oxygen conditions, anaerobic, gas formation

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

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

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

System Performance Monitoring
Control Tests

- Suggest undertaken quarterly for the following parameters:

Dissolved Oxygen (reactor)
Oxygen Uptake Rate (reactor)
BOD_5 / COD (effluent)
TSS (effluent)
Faecal Coliforms (effluent)
Total ammonia (effluent)
Mixed Liquor Volatile Suspended Solids (reactor)

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

Maintenance

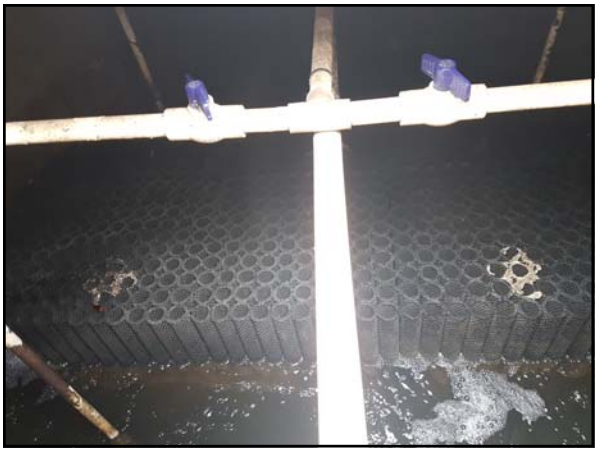
- ✓ Performing routine housekeeping duties, including hosing down, particularly in splash, spray and access areas; removing debris; checking access condition to ensure safe access to the plant; and general grounds keeping around the plant
- ✓ Inspecting and maintaining disinfection units as required (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)

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

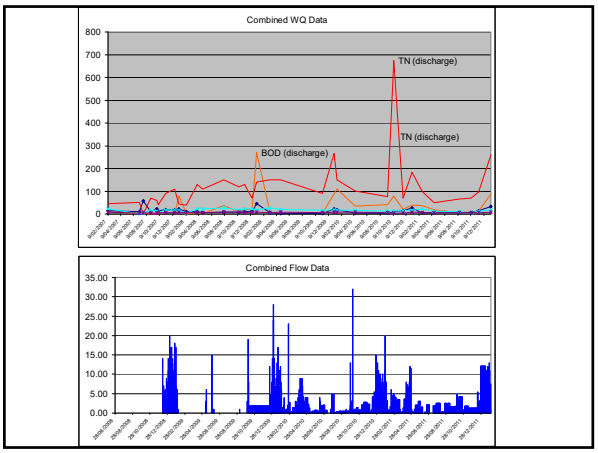
- Suggest retaining or engaging specialist advice and assistance for maintaining electrical components
- A wide variety of designs and configurations used and available (switches, electric/mechanical timers, audible/visual alarms, floats, PLC's)
- Exchange electronic boards, do not try to repair
- Best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

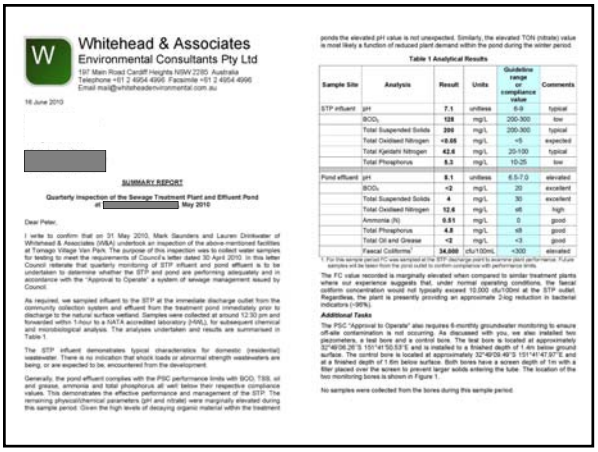
System Reporting

- 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 pro-active 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						
				Aeration Compartment				Settling Compartment		Effluent		Aeration Compartment			Effluent			
	Date	Time	Weather (routine visit)	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 (cfu/100mL)	Initials
Wk1																		
Wk2																		
Wk3																		
Wk4																		
Wk5																		
Wk6																		
Wk7																		
Wk8																		
Wk9																		
Wk10																		
Wk11																		
Wk12																		
Wk13																		
Quarter																		


Whitehead & Associates
Environmental Consultants Pty Ltd

SUMMARY REPORT

Table 1 Analytical Results