

WESTERNPORT WATER COWES WASTEWATER TREATMENT PLANT UPGRADE PROJECT

A REVIEW OF CWWTP'S MASTER PLAN AND PROJECT DEVELOPMENT PHASE

C Jayasena, J Anderson

INTRODUCTION

Located within the Bass Coast Shire 100km southeast of Melbourne (Figure 1), Westernport Water (WPW) is one of 19 Victorian water corporations providing water and wastewater services. Servicing an area of 300km² and 19,240 permanent customers, Westernport Water provides services to more than 100,000 people during major events and peak holiday periods.

The Cowes Wastewater Treatment Plant (CWWTP) is the major plant in WPW's wastewater treatment system, servicing Phillip Island and the township of San Remo. The facility was commissioned in 1982 with a hydraulic capacity of 3.5 ML/day (~14,000 persons). The plant consisted of an extended aeration-activated sludge plant with secondary clarification and effluent disinfection before discharge to Bass Strait at Pyramid Rock, and effluent reuse in summer.

There has been a significant increase in wastewater flows and loads over recent years due to growth in the area (Figure 2). The CWWTP has generally achieved good performance for most of the year. However, the performance of the biological process has been quite variable at times, resulting in varying pH and nitrogen levels during summer.

Hydraulic capacity of the plant is also challenged during storm events, due to increased inflow/infiltration



Figure 1. Westernport Water service area and key facilities.

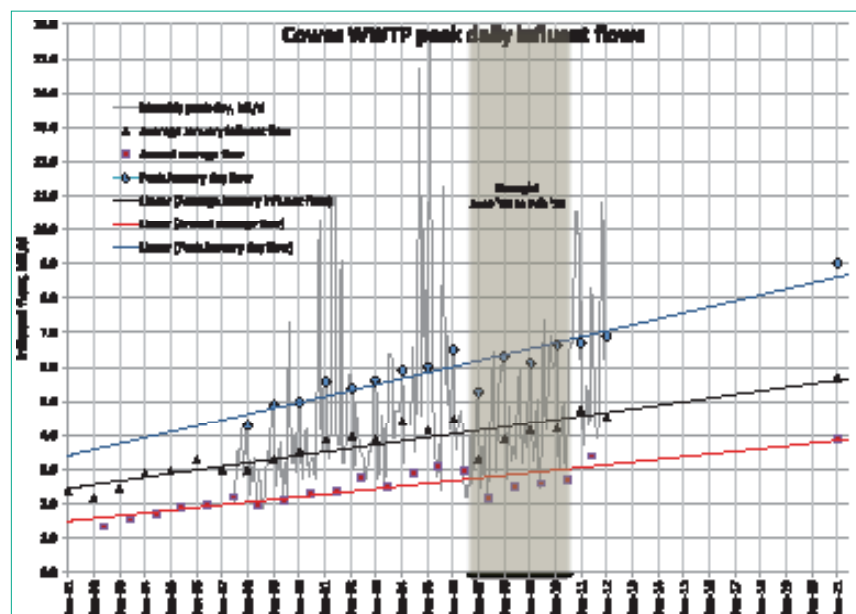


Figure 2. Monthly wastewater flows – treated and predicted flows to Cowes WWTP.

from the sewers, most of which are below the groundwater table.

Westernport Water identified CWWTP upgrade as a key component of its capital works program in Water Plan 3 (2013–2018) to address both Environmental Protection Agency (EPA) licence compliance conditions and increasing inflow from the sewerage catchment.

THE PROJECT DEVELOPMENT PHASE

The CWWTP Master Plan developed in 2012 identified the strategy for upgrading the plant in years two and three of Water Plan 3. Initial investigations were carried out to assess the recommended treatment process (Figure 3) and upgrade options for the existing plant.

The Master Plan recommended modifying the existing plant to biological nutrient removal (BNR) as the most effective means to upgrade to achieve stable and optimum performance compared to an all-new BNR plant.

Project phases included:

- EPA works approval granted March 2013;
- Functional design to detail the process design and technical specifications of the works (2013);
- Westernport Water requested tenders to design and construct (D&C) the upgrade works (April 2014);
- Design and construction phase commenced August 2014 and was completed September 2015;
- Full commissioning of the new works – October 2015.

The existing treatment plant consisted of the following facilities:

Inlet screen and grit removal facility: Influent screening with 300 L/s mechanical step screen with 3mm apertures, associated with a screening, washing and dewatering system and bypass channel with coarse bar screen, and a grit removal system consisting of a vortex grit removal chamber and grit classifier.

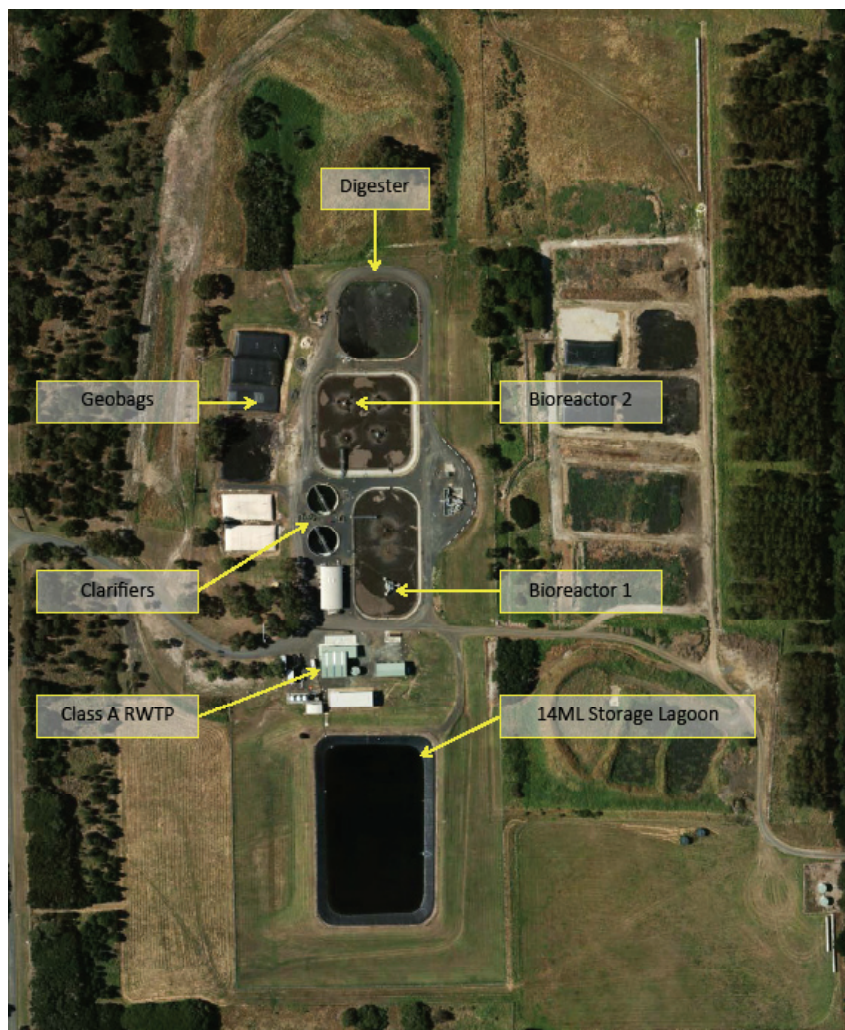


Figure 3. Aerial photo of the CWWTP before the upgrade.

Bioreactors: Activated sludge process in two lined biological reactor basins with total volume up to 12 ML and seven surface aerators with total capacity of 287 kW; mixed liquor pumping to clarifiers and return-activated sludge (RAS) pumping system.

Secondary clarification: Two 14m-diameter secondary clarifiers for solid/liquid separation.

Effluent pumping and storage facility: Effluent pump station with three pumps with transfer rate of 120 L/s, 16 ML effluent storage lagoon, two ocean outfall pumps and a 4.5km long, 375mm diameter outfall pipe into Bass Strait near Pyramid Rock.

Solids handling: Anaerobic sludge stabilisation and thickening of waste-activated sludge digester in 3.4 ML capacity lined basin. Sludge

dewatering and further stabilisation in geotextile bags without polymer addition, and subsequent solar drying of sludge on earthen pans.

In normal operation, the wastewater was pumped from four different influent pumping stations to the plant. The pumping stations operated intermittently on level control to pump an instantaneous flow of up to 330 L/s.

KEY FEATURES OF THE UPGRADE

The scope of the Stage One upgrade works consisted of process upgrade, hydraulic capacity increase and improvements to the sludge treatment and handling facilities. The CWWTP upgrade project involved an increase in the plant capacity to handle the projected influent loads up to 2021, storm flow by-pass system, inlet

works upgrade and converting the extended aeration-activated sludge process to a BNR plant.

Capacity increase: Optimisation of the capacity of the biological secondary treatment process to handle peak dry weather flow up to 8.6 ML/day and increase the average annual flow capacity up to 4 ML/day.

Converting to BNR: Process upgrade by modifying the extended activated sludge treatment plant to a BNR operation, incorporating a well-mixed anoxic (unaerated) zone for biological denitrification and an internal mixed liquor recycle of up to twice the average daily flow.

Wet weather flow handling: Construction of a storm bypass system to temporarily divert peak wet weather flows around the plant's biological process to the effluent storage during severe storm events, and increasing the plant's treatment and storage capacity up to 24 ML during a peak 24-hour storm event (i.e. six times average flow). This will also provide protection to the biological process and associated clarification from solids washout, and maintain process stability.

MAJOR CONSTRUCTION COMPONENTS

Inlet works upgrade: The capacity of the inlet works was doubled by adding a third channel, new 300 L/s step screen and a new washwater press. The channel configuration was modified so that a single channel and screen can be operated while the second screen is isolated, providing flexibility to operate as duty/standby screens during low flow periods and operate both during peak flows.

Storm bypass pipeline and control system: A 700mm diameter storm bypass pipeline was provided to enable transfer of up to 500 L/s to the effluent storage during very wet weather. An automated flow control valve regulates the inflow to Bioreactor 1 during storm events, to minimise biomass washout from the biological process and to ensure process stability. The storm bypass system has been designed to minimise the wastewater flow bypassed to the



Figure 4. Inlet structure with new channel and new screen.



Figure 5. Bioreactor 1 anoxic zone.

storage lagoon and to maximise the buffer storage of the plant.

Modification to Bioreactor 1: The activated sludge process tank was converted to a BNR reactor by dividing the tank into anoxic and aerobic zones using an HDPE curtain. Four submerged mixers are provided in the anoxic zone to maintain solids in suspension and floating surface aerators to maintain the aerobic zone contents in suspension.

Mixed liquor pumping station: The mixed liquor pump station consists of three identical pumps, each with 200 L/s capacity, providing internal recirculation of twice maximum dry weather flow to the anoxic tank and pumping mixed liquor to the two clarifiers.

Increasing capacity of the aerobic sludge digester: The capacity of the digester was increased by 50 per cent to 5.5 ML by constructing a 1.5m-high perimeter wall. An improved supernatant withdrawal structure was



Figure 6. New mixed liquor (ML) pump station.

provided to optimise solids retention in the digester.

Walkways to surface aerators:

Boat access to surface aerators for maintenance has been a critical operational safety concern. Articulated floating walkways were constructed to all aerators. This has provided easy

and safe access to the mechanical components of the aerators. Also, the new arrangement has eliminated floating electrical cables, mooring and anchors. Each aerator is attached to the articulated walkway, which is connected to a concrete block at the reactor bank.

Sludge treatment by geotextile bags and drying pans:

The digested sludge is dewatered on-site using geotextile bags and sludge drying beds. Four concrete sludge beds were constructed in the upgrade and each slab provides a solid and impermeable base to the 1 ML geotextile bags. Digested sludge at 2.5% solids is pumped periodically to the duty geotextile bags and left for at least 12 months to dewater up to about 15% solids (i.e. spadable consistency) until the following summer. This is achieved without the addition of polymer. The geotextile bag is then split open and the dewatered sludge is spread out on the sludge drying pan area for solar drying.

PROJECT CHALLENGES

A number of significant challenges and demands were successfully managed during the construction of the project, including:

Continuous operation of the plant:

The key challenge of this project was to maintain the plant operation without exceeding the licence limits during construction. During upgrade of the bioreactors, the plant was operated with a single aeration tank. The

Table 1. Plant effluent quality – July 2014 to September 2015.

Item	EPA effluent discharge licence		Plant effluent (median)	
	Compliance period	Licence limit	2014/15 Pre-anoxic tank	2015/16 (Jul-Sep) Post-anoxic tank
Mean daily flow, ML	Yr (mean)	2.5	2.7	3.2
Maximum daily flow, ML	(Maximum)	8.6	8.5	8.4
BOD, mg/L	Yr (median)	5	5	3
SS, mg/L	Yr (median)	10	4	5
Ammonia as N, mg/L	Yr (median)	5	0.4	0.2
Total N, mg/L	Yr (median)	45	28	14
Total P, mg/L	Yr (median)	15	8.9	7.1
E. coli, org/100 mL	Yr (median)	200	0	1
pH (units)	(Range)	6 -9	6.5	7.4
Anionic surfactants, mg/L	(Maximum)	1.0	0.09	0.08
Total residual chlorine, mg/L	(Maximum)	1.0	0.78	0.75



Figure 7. Surface aerator with new walkway.

construction schedules were prepared to select the best timing and duration for individual work components, so that the construction activities had no or minimal impact on the plant performance. The plant SCADA control system was closely monitored and trended to predict any increase in flows, loads or changes in the treated water quality before it reached the limits. During critical construction activities, 24-hour onsite operation was implemented.

Working in a brownfield site:

Careful construction planning and machinery selection were required, as most of the activities were within the existing services area. Underground services and process pipes needed to be surveyed before design and construction. The modification to the detailed design was done to avoid interaction with existing underground services and structures.

SUCCESS

The CWWTP Upgrade Project was a complex and challenging venture successfully delivered on time, within budget, and there were no breaches of the EPA effluent water quality

licence limits (Table 1). There has been a significant improvement in plant effluent quality since commissioning of the anoxic tank in April 2015. The plant effluent total nitrogen concentration has halved from 28 mg/L to 14 mg/L; the pH increased with the improved denitrification; and effluent turbidity reduced.

The project challenges demanded a high level of ingenuity; a focus on safe design; well developed work method statements and risk assessment to ensure that all project risks and concerns were addressed.

A major reason for the success of the project has been the excellent working relationship of the project team and the contributions each member has made at various times to improving the design and operation of the plant.

The successful completion of the infrastructure has provided major benefits and value for money to Westernport Water's customers and environment, through increased wastewater treatment capacity and effluent quality.

ACKNOWLEDGEMENTS

The Authors wish to thank CWWTP upgrade design and construct contractor, Simpson Construction Company; initial master plan concept design consultant, KBR; plant optimisation consultant, AWT; master plan strategy and functional design consultant CEE – Environmental Engineers and Scientists; and CWWTP Plant Operators and Project Team.

THE AUTHORS



Chaminda Jayasena

(email: cjayasena@westernportwater.com.au) is the Project Manager for Cowes WWTP upgrade. He

has over 15 years of project management experience in water and wastewater.



John Anderson is Principal Process Engineer with CEE – Consulting Environmental Engineers and Scientists.

He has over 40 years'

experience in wastewater and air quality management. He has carried out investigations and options assessments at over 100 wastewater facilities, involving most of the major wastewater treatment plants in Australia.