Pennington WwTW

delivering environmental improvements through enhanced final effluent quality and increasing capacity to meet population growth

by Andrew Martin MAPM

Built in the late 1990s, Southern Water's Pennington Wastewater Treatment Works in Hampshire was designed to treat the wastewater from Lymington and the surrounding New Forest area. It currently serves a population equivalent (PE) of 54,000 with a current full flow to treatment of 375l/s. The Pennington works discharges into Avon Water which feeds into the Solent. The Environment Agency (EA) has designated the Solent and local watercourses feeding into it, as sensitive waters under the Urban Wastewater Treatment Directive. This £7m project has been driven by recent changes in environmental legislation and local population growth (anticipated to rise to 56,000 by 2020), resulting in the need to enhance final effluent quality and increase overall process capacity.

ASP2 - Courtesy of 4Delivery

Project need

High nitrate levels in the water can lead to eutrophication, a process whereby water bodies receive excess nutrients stimulating excessive plant growth. This in turn causes depletion in oxygen levels in the water, leading to a reduction in fish and animal populations. As a result new Total Nitrogen and copper consents have been introduced for Pennington (see table on the next page).

The Solent

The Solent is also covered by the EC Shellfish Waters Directive. This Directive aims to protect and improve the aquatic habitat of bivalve and gastropod molluscs, including oysters, mussels, cockles, scallops and clams. As a result any final effluent from Pennington is now required to receive UV disinfection to improve & protect shellfish life and growth across the Solent region.

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The solution

The site is located within the New Forest National Park, Hampshire and is surrounded by land covered by a number of local and national designations, including a Site of Importance for Nature Conservation (SINC), a Special Area of Conservation (SAC), a Site of Special Scientific Interest (SSSI), a National Nature Reserve (NNR) and Ancient Woodland. To secure consents to work in these areas would have required a considerable amount of time and effort, without any guarantee of success.

To negate any associated risk and ensure the project remained on programme, it was therefore decided to contain all construction activity within the existing operational site. This was a significant challenge due to the limited space available and the need to maintain operational compliance while undertaking the works.

In arriving at a TOTEX solution, the condition and performance of existing assets on the site were assessed. Following that assessment the assets below were retained as part of the final solution:

- Inlet works and storm facilities.
- Intermediate lift pumping station.
- Activated sludge plant (ASP1) – *modifications are required for new consent.*
- 3 (No.) Primary settlement tanks.
- 3 (No.) Final settlement tanks.
- Outfall.
- Sludge treatment and odour control.

The requirement for the following new assets within the overall solution was also identified:

- Activated sludge plant (ASP2).
- Ultraviolet disinfection plant.

Activated sludge plant

To achieve the new 9.5mg/l Total N consent, a Modified Ludzak Ettinger (MLE) activated sludge process has been utilised at Pennington; a two–stage biological process with internal recirculation. This process is shown in Figure 1 (top right).

Suspended growth nitrogen removal processes consist of an aerobic zone (in which nitrification occurs) and an anoxic zone (in which denitrification occurs). Low oxygen levels within the anoxic zone will denitrify the influent, providing the nitrified flow is fed back.

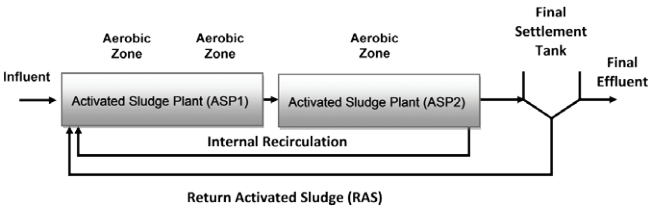

Fig. 1 Pennington WTW - MLE Process

Two types of bacteria are responsible for nitrification, *Nitrosomonas* and *Nitrobacter*. *Nitrosomonas* oxidise ammonia to nitrite, and *Nitrobacter* convert the nitrite to nitrate.

Denitrification is the removal of nitrogen in the form of nitrate, by conversion to nitrogen gas, in the absence of oxygen. Conversion of nitrate is accomplished by several types of bacteria. These bacteria are heterotrophs and reduce nitrate to nitrogen gas.

ASP construction

Due to the limited space available on operational site and the configuration of existing activated sludge plant it was not possible to extend the existing plant. The team therefore opted to construct the new ASP running at right angles to the existing ASP. This new 86m ASP was constructed within a cantilevered sheet piled cofferdam, enabling the concrete structure to be safely constructed 4m below ground level to maximise the use of gravity and avoid pumping where possible, and in doing so, minimise operational and whole life costs.

The combination of the existing ASP1 and the new ASP2 provides the required increase in process capacity. ASP1 provides the anoxic process and 25% of the aerobic zone and ASP2 provides the remaining 75% of the aerobic zone. The two structures are connected by a 1,200mm diameter pipeline.

ASP2 was designed with 3 (No.) separate process lanes. This enables the operational team the flexibility to isolate a single lane during periods of dry weather flow enabling the reduction of operational costs, or during routine maintenance periods.

Existing consents New consents Not applicable		WATER RESOURCE ACT				UWWTD		
		Proposed Consent (Winter)		Proposed Consent (Summer)		Percentile Limits		Upper Tier
		Look-up Table	Upper Tier	Look-up Table	Upper Tier	95%ile	% Reduction	
DWF	m^3/d	16,362						
FFT	l/s	375						
SS	mg/l	49	125	49	125			
BOD	mg/l	31	65	31	65	25	70	50
COD	mg/l					125	75	250
NH_4-N	mg/l							
Cu	mg/l	45		45				
P (Ann Av)	mg/l							
N (Ann Av)	mg/l	9.5				15		
Fe	mg/l							
UV	mJ/cm	Y						
Storm capacity	m^3	3,500						
Storm screen		6mm 2D						
FFT screen		6mm 2D						

Final connections between the existing plant and the new ASP2 were achieved using a combination of over pumping between ASP1 and the final settlement tanks and under-pressure connections into live pipelines or chambers, ensuring that there was no interruption to service.

UV treatment

UV treatment was installed to substantially reduce the number of micro-organisms being discharged back into the environment that could potentially cause harm to shellfish. UV disinfection was chosen instead of chlorine, iodine, or other chemicals, to avoid the potential adverse effects those chemicals could have on the wider environment.

The new Pennington UV consent requires an uninterrupted dose of 30mJ/cm^2. The consent only permits 1% maintenance downtime per annum.

The main disadvantage of UV disinfection is the need for frequent lamp maintenance. With this in mind, a robust solution was developed to provide the plant with duty and standby channels, each channel having dual power distribution centres (PDCs) capable of providing the required UV dose. This means that a channel can be taken out of operation for routine maintenance and cleaning periods while still maintaining the level of treatment required under the consent.

Flow control through the UV plant proved to be a major challenge, due to the high variance in flows arriving at the inlet works from the multiple pumping stations serving it. Actuated penstocks were required to react quickly to the rapid change in flow.

The positioning of the new UV process plant was also a challenge to negate the introduction of lengthy pipelines and challenging connections into existing pipelines. After careful consideration, it was positioned between the final settlements tanks and the works outfall. This in itself was a challenge due to existing pipelines, structures and existing underground services.

Health, safety and the environment

The following summarises the team's achievements at Pennington during the construction phase:

- Zero reportable accidents or environmental incidents during 150,000 man hours worked over 18 months, while working within a congested, operational wastewater treatment works.
- Zero compliance issues throughout construction and commissioning.
- Over 90% of waste materials either reused on site or recycled off site.

Conclusion

The project has been delivered on behalf of Southern Water by 4Delivery; a joint venture between Veolia Water, Costain Ltd and MWH. Over the last seven years throughout AMP4 and AMP5, 4D has delivered over £1billion of environmental improvement works across Kent, Sussex, Hampshire and the Isle of Wight, through turnkey solutions involving responsibility for project management, design and delivery.

Working together, the Southern Water and 4Delivery teams have carefully applied their professional expertise, knowledge and skills to deliver this technically challenging scheme at Pennington WwTW safely, within budget and three months ahead of consent compliance. A magnificent achievement by all parties involved.

The Editor & Publishers would like to thank Andrew Martin, Construction Manager with 4Delivery, for providing the above article for publication.

UV plant - Courtesy of 4Delivery

Excavation for ASP2 - Courtesy of 4Delivery

Aerial photo of Pennington WwTW before the works commenced Courtesy of Southern Water