Five Fords WwTW

new anaerobic digestion plant and habitat quality upgrade

by Lee Simpson, Simon Cady, John Salisbury and Paul Hunter

Dŵr Cymru Welsh Water has invested £23 million at its Five Fords Wastewater Treatment Works (WwTW), near Wrexham, Clwyd in North Wales. The project includes improvements to wastewater treatment, as part of the Habitat quality improvement programme and a new anaerobic digestion plant, which is part of Welsh Water's AMP5 Sludge Strategy. This paper explains the work undertaken from late 2010 through to March 2012 in upgrading the facility and providing improved sustainable sludge treatment in North Wales.

Complete sludge digestion and CHP plant - Courtesy of Dŵr Cymru Welsh Water

The existing works

Five Fords WwTW is required to achieve a new treated effluent consent under the Habitats Directive, with the implementation of new Ammonia and Phosphorus consents.

The original and new consents are shown in the table on the right.

The site has two treatment streams. Stream A is an activated sludge plant with surface aeration, and Stream F is a percolating biofilter plant. The works receives a mixed domestic and trade effluent flow, with a future design horizon load requiring treatment of:

BOD: 13,902 kg/d NH_4-N: 1,164 kg/d TP: 376 kg/d

The site also includes a sludge treatment centre where indigenous and imported sludges are disinfected with lime and dewatered before storage and recycling to local farmland.

The original consent was:		
BOD: 50 mg/l	SS: 60 mg/l	NH_3-N: 16 mg/l
With UWWTD composite sampling consent requirements of:		
BOD: 25 mg/l	COD: 125 mg/l	
The new consent is		
BOD: 50 mg/l	SS: 60 mg/l	NH_3-N: 10 mg/l
P: 1 mg/l	Along with the existing UWWTD requirements	
The required flow consent conditions have remained the same:		
DWF: 27,720 m^3/d = 321 l/s	FFT: 69,607 m^3/d = 806 l/s	

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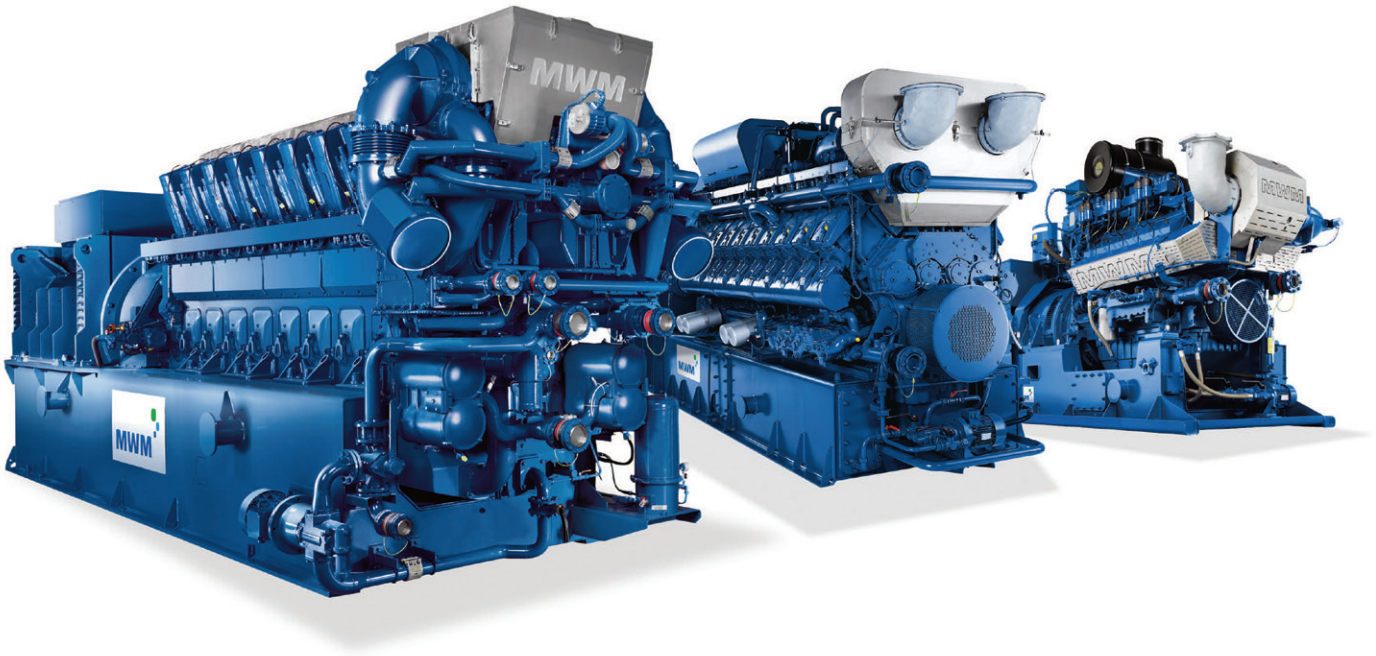

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Diver inspection of existing aeration basins
Courtesy of Dŵr Cymru Welsh Water

Raw sludge screening and buffer storage tank and anaerobic digesters
Courtesy of Dŵr Cymru Welsh Water

This plant did not have enough capacity to treat the increased sludge produced resulting from the new Habitat Directive. It was therefore agreed that the sludge centre was upgraded to provide a new sustainable sludge treatment plant with renewable power generation, including thickening, anaerobic digestion, biogas collection, and high efficiency CHP. This plant will allow the site to move towards power self-sufficient waste water service with export of surplus renewable power to grid.

The design throughput for the new sludge plant is 10,000 tonnes of dry solids per year (tDS/y). This will increase the strength of return liquors, which will be treated through the upgrading of the wastewater treatment works. The new project also addresses any potential odour issues arising from both existing and new equipment.

Description of improvements

Activated sludge plant: To achieve the new ammonia discharge consent, a series of improvements have been included to overcome hydraulic constraints and increase the capacity and efficiency of the existing ASP. A new anoxic tank has been constructed upstream of the existing ASP in order to improve denitrification and improve process stability and efficiency.

This comprises a new concrete tank approximately 1,700m^3 in volume, complete with flow baffles and submersible mixers. Hydraulic limitations have been overcome by installing a new 800mm transfer pipeline alongside the existing settled sewage flow channel. Improvements to the existing ASP has included the refurbishment of 9 (No.) existing surface aerators and associated baffles. Additional aeration capacity has been provided, consisting of a series of fine bubble diffusers mounted on special lift out frames, complete with new variable-speed blowers and interconnecting pipework. Submersible flow inducers have been fitted to improve flow within the aeration lanes.

New outlet weirs have been fitted to the aeration lanes to overcome hydraulic constraints, provide equal flow distribution to the existing four final settlement tanks (FSTs), and provide continuous MLSS monitoring and automatic control.

RAS system: The original RAS system which consisted of a combination of submersible pump and screw pumps has been uprated with new variable speed submersible RAS pumps and a flow meter to allow automatic real time control.

F works: Improvements to the F works included refurbishment of the biofilter distributors and installation of new variable speed recirculation pumps, and flow meter to allow optimium reciculation during periods of low flow. Improved lifting arrangements were included for safe maintenance of the new pump installation.

Inlet works: Improvements to the inlet works included uprated screenings handling equipment, refurbishment of the de-gritting installation, improved storm water separation and flow distribution.

Phosphorus discharge consent: In order to achieve the new phosphorus discharge consent of 1mg/l, ferric dosing has been installed together with improvements to the primary tanks, and continuous phosphorous monitoring. Primary tank modifications have include new scraper bridges and automated desludging with covers fitted over the desludge wells no minimise odour nuisance. A new pump station allows transfer of primary sludge direct to the new sludge treatment plant.

Ferric dosing plant: The ferric dosing plant includes bunded bulk storage of ferric sulphate (96m^3 for 14 days storage) complete with a tanker unloading area and safety equipment. Automatically adjustable dosing pumps allow optimum four-point dosing of ferric into the screened sewage flow and secondary treatment.

SAS: Further improvements included suspending co-settlement of SAS in the A Works primary tanks. New submersible SAS pumps replaced the original SAS draw-off and a new rising main was installed to transfer SAS direct to the new sludge treatment plant.

Sludge treatment plant: The new sludge treatment plant provides improved sustainable sludge treatment in North Wales and has been sized to treat the additional sludge arising from phosphate removal.

The new plant includes imported sludge reception, sludge thickening, and 2 (No.) 4,000m^3 anaerobic digesters, which have been designed to process up to 12,000 tDS/y.

Digester gas is collected and used by 2 (No.) high efficiency 600kWe CHP units, to provide all process heating requirements and sufficient renewable power – to move the whole works toward power self-sufficient service, with savings in operational carbon footprint and operating costs. Treated sludge will be dewatered and recycled to local farmland, as a high-value fertiliser.

The new sludge treatment plant includes 3 (No.) sludge tanker reception bays to safely receive thickened raw sludge imports. Each of these unloading bays is fitted with data logger in order to accurately monitor the source, volume and DS of the sludge received.

The indigenous primary sludge and raw sludge imports are combined in a reception sump and pumped through a series of 4 (No.) strain presses mounted on an elevated platform and the screened sludge is transferred to the screened sludge buffer. Similarly, SAS is pumped direct from the works to a SAS buffer tank.

All sludges are pre-thickened by a series of 4 (No.) gravity belt thickeners. The belt thickeners are provided with dedicated sludge transfer and polymer dosing pumps. In normal operation 2 (No.) units are used to thicken raw indigenous and imported sludges, 1 (No.) unit is used for thickening SAS, with 1 (No.) unit available as a common standby.

Sludge digestion plant: All thickened sludge is transferred by dedicated pumps direct to the thickened sludge storage tank and is mixed to maintain consistent characteristics. The sludge digestion plant includes 3 (No.) thickened sludge digester feed pumps (duty, duty, standby) feeding 2 (No.) anaerobic digesters, each with a working volume of approximately 4,000m^3, and fitted with jet mixing and pumped recirculation through dedicated heat exchangers.

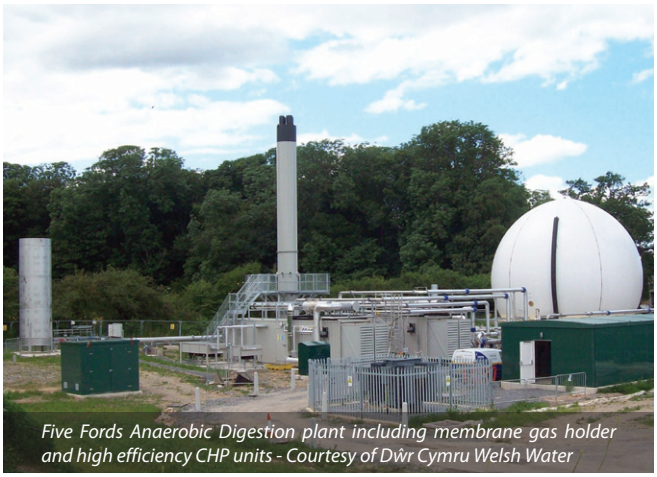
Sludge is displaced from the digesters via overflow bellmouths and flows by gravity to 2 (No.) existing tanks, providing post digestion buffer storage before conditioning and dewatering using the existing centrifuge dewatering plant. Digested sludge cake is then stored before recycling to local farm land.

Biogas: Biogas flows from the digesters to a membrane type gas holder through oversized stainless steel pipework with automatic condensate traps installed at the low points to automatically remove condensate as the biogas cools.

Under normal operation, all of the biogas is cleaned to remove siloxane and used in the high efficiency CHP units in order to produce renewable power and hot water for process heating. Also, a dual fuel hot water boiler has been installed in order to produce hot water using either biogas or natural gas during periods when the CHP units are being maintained. Surplus biogas can be transferred to a waste gas burner.

Odour control: In order to minimise odour nuisance all raw sludge tanks and equipment are covered and potentially odourous air is extracted and transferred to a dedicated odour control plant.

Complete sludge digestion plant
Courtesy of Dŵr Cymru Welsh Water



Five Fords Anaerobic Digestion plant including membrane gas holder and high efficiency CHP units - Courtesy of Dŵr Cymru Welsh Water

New sludge digestion plant including raw sludge storage, thickening, thickened sludge buffer tank, anaerobic digesters, odour control, and main control building - Courtesy of Dŵr Cymru Welsh Water

Biogas utilisation plant including membrane gas holder, siloxhane removal, high efficiency CHP units, standby hot water boiler and emergency flare - Courtesy of Dŵr Cymru Welsh Water

Liquid lime slurry: There is also the facility to dose liquid lime slurry to the digested sludge in order to produce enhanced quality sludge cake for recycling to local farm land.

Sludge strategy

Dwr Cymru Welsh Water's sludge strategy is to maximise resource recovery and move towards the most sustainable, efficient, environmentally beneficial, economical, and customer supported service. Further improvements are being planned at Five Fords including Advanced Digestion and biomethane injection into the grid or use as vehicle fuel.

Conclusions

This improvement project has provided the following benefits:

- Compliance with new Habitats Directive including improved levels of nitrification and phosphate removal.
- Improved process reliability and resilience of North Wales largest wastewater treatment works.
- Improved efficiency of wastewater treatment including denitrification, increased aeration efficiency and optimum process control.
- Improved resource recovery including renewable power generation that helps move the works to power self-sufficient wastewater service.
- Operational savings which will support reducing customer bills.

The delivery team is working closely with Welsh Water to further optimise the economic, environmental and society benefit of wastewater service at Five Fords WwTW.

Delivery partners

The project was delivered through close involvement with Welsh Water's operational and strategy team, and in partnership with Imtech Process (process, mechanical and electrical design, construction, testing, commissioning and performance testing, Costain (civil design and construction) and EC Harris. Key supply chain partners who contributed to the successful delivery of this project included William Hughes Civil Engineering Ltd, Lloyd Morris Electrical, Mectec Engineering, JB Fabrications and Siemens.

Timeline

Following outline design and agreement of target cost, work commenced in late 2010, and the project has been successfully delivered.

The improvement programme for this wastewater treatment plant included improved screening, grit removal, storm water management, new settlement tank scrapers, improved flow control, ferric dosing, new anoxic tank, improved aeration and control. This work allows treatment of the full flow, and compliance with the new effluent consent, which required improved levels of nitrification and phosphate removal.

Construction was completed in March 2012 and the plant is now fully commissioned, generating renewable power and undergoing a period of extended performance testing before final handover in September.

The Editor & Publishers would like to thank the following for providing the above article for publication:

Lee Simpson (Project Manager) & Simon Cady (Lead Engineer) with Imtech Process, and John Salisbury (Construction Manager) & Paul Hunter (Project Manager) with Costain.

The authors wish to thank Welsh Water for its support, as well as all the companies and their employees who contributed to the successful delivery of this project.

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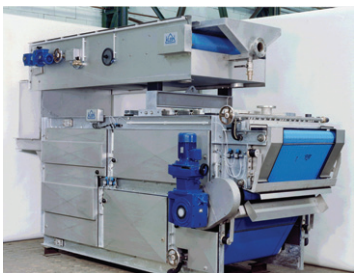

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