

Capel Dewi WTW

treatment works extension and existing works improvements

by Malcolm Bamsey BSc Hons CEng MIMechE

Capel Dewi Water Treatment Works (WTW) is located 5km east of Carmarthen and supplies drinking water to 28,000 customers in the Carmarthen area. Dŵr Cymru Welsh Water, as part of the AMP 5 Investment Plan, has upgraded the works to meet the requirements of the Drinking Water Inspectorate (DWI) to improve water quality. The scheme addresses the treated water quality iron driver and also included major additional capital maintenance that would make the works more robust and significantly reduce any risk of failure. The works extension includes a new granular activated carbon (GAC) stage to address taste and odour, a new contact tank to address disinfection and a new final water pumping station for the design capacity of 12Mld. The work included a new chlorine gas dosing system, refurbishment of the existing sand filters, upgraded waste water treatment plant, new generator and modifications to the lime plant. The combination of a second stage GAC filter, new single purpose contact tank and other improvements will provide a plant capable of producing high quality water well into the future.



View looking inside the pumping station showing three pairs of high lift pumps - Courtesy of Dŵr Cymru Welsh Water

Existing works

The original process incorporated clarifiers and rapid gravity filters (RGF), with chemical dosing for coagulation and disinfection in a combined contact tank/high lift pump sump. The treated water was pumped to three service reservoirs above Carmarthen and from there by gravity into the local supply network.

Historical data indicated elevated concentrations of iron in the raw and treated water. In 2001 elevated geosmin levels in the river Tywi generated customer complaints for taste and odour. Temporary

PAC dosing was relatively successful but increased solids loading on the clarifiers. During spate conditions elevated turbidity, colour, iron and manganese values are also present in the raw water.

As well as problems with coagulant dosing under varying conditions causing poor dosing control there was some evidence to show, following filter backwashes, there were spikes in turbidity values of filtered water. As there is only one filtration stage this resulted, on occasions, in water which is higher than 1 NTU being presented for disinfection.

Chlorine contact tank

The existing chlorine contact tank had been designed for four purposes:

1. Disinfection contact, lime and final pH adjustment.
2. Hydraulic balance between plant input and output.
3. Filter backwash water pumping and wash water storage.
4. Each half of the contact tank also contained 3 (No.) high-lift service water pumps, to Penlanffos, Pellain and Llangunmor reservoirs, and 2 (No.) filter backwash pumps.

The unusual configuration and multifunctional use of the existing contact tank was impacting on chemical dosing control and there were a number of issues with inadequate disinfection under fluctuating flow conditions leading to both quiet zones and streaming when different combinations of pumps were operating.

Other risks at the site included the potential for the off site waste water lagoons to cause pollution incidents in the river Tywi.

The preferred option

Black & Veatch, Welsh Water's Process Partners for AMP5, investigated a number of options for the main treatment process which included new RGFs and conversion of the RGFs to GAC adsorbers and modifications to the contact tank. Also considered were the same combination, but with new clarifiers upstream of the new RGFs.

The feasibility assessment led to the decision to implement a solution that would include new GAC adsorbers, new contact tank and a new, separate, downstream high lift pumping station.

The advantages of this preferred option was that it provided for a correctly designed contact tank for improved disinfection efficiency and a high lift pumping station that did not interfere with flows through the treatment processes.

The solution also left the existing contact tank free as a dedicated interstage contact tank for the removal of soluble iron and manganese. The new configuration of the plant would lead to improved chemical dosing control at each stage:

- **GAC:** The use of GAC would also provide a safeguard against the potential for the pollution incidents in the river or taste and odour issues that arose on the river in 2001.

Both stages of RGF and GAC would be fitted with rinse to waste to minimise the risk of turbidity breakthrough after back washing and with this a reduced cryptosporidium risk. In addition, both the existing RGFs and the new stainless steel GAC adsorbers have been fitted with Leopold floors.

- **Relift pumping station:** A new relift pumping station was provided to lift the flows from the existing contact tank to the new GAC adsorbers, from where it gravitates through the new contact tank, lime reaction tank and into the new high lift pumping station.
- **Chlorine gas installation:** In addition to the main works process, a new chlorine gas installation was provided (in advance of the main works) to replace the sodium hypochlorite storage and dosing system.
- **Wastewater treatment:** The waste water treatment process was enhanced by the addition of a new sludge thickener, sludge storage tank, supernatant storage.
- **Control system:** The MCC and PLC control system for the existing works was replaced in a phased manner, ensuring that the water treatment works was kept operational at all times.

Construction challenges

The biggest challenge facing any water treatment works extension is to proceed with the work without any disruption to supply. In this case, because of the amount of work required to be carried out on the existing works there were many interfaces between the existing plant and new construction activities.

This required a significant degree of planning through day to day coordination with the works operators. The storage limitations within the distribution network meant that shutdowns needed to be of short duration. There were also three major tie-ins to the existing rising mains operating at 10 to 15 bar.

Two of the existing surge vessels on the high lift mains were renewed and also a new lime storage silo was installed to replace the existing unit.

The restricted site also presented a challenge for the construction team. New structures downstream of the existing treatment building were required. Although there was room for the new structures, there was very little room for the excavation activity. A field opposite the plant was rented so that spoil could be temporarily stockpiled and transferred back to the site following



View of main new structures including the GAC building, disinfection contact tank and high lift pumping station behind - Courtesy of Dŵr Cymru Welsh Water

completion of the main structures. The excess spoil was used in the landscaping of the works with a great deal of the spoil being used to shield the works when viewed from the road.

Most challenges can be planned for but occasionally they are less predictable. The detailed design of the works had progressed and the planning application was initiated with the aim of starting the advanced works on the chlorine system in March 2009. However, a problem came to light.

As part of the site investigation work, a bat roost was discovered and was present on site in one of the existing outbuildings, close to the proposed advanced chlorine system construction area. A consultant ecologist was commissioned immediately to advise, and the Countryside Council for Wales (CCW) was informed.

Working closely with CCW and Carmarthen County Council, a phased construction method was agreed, so that work within a 30m radius of the roost location was avoided during the May to August breeding period. The work on the chlorine system proceeded but the main build was delayed. As the proposal satisfied all stakeholders, this then allowed the planning application to be approved and work to commence.

Innovative methods used during design & construction

The chlorine gas disinfection system was designed using latest Welsh Water specification and in compliance with HSG 40. The location of the chlorine level 4 security kiosks were necessarily located greater than 25m from the nearest occupied room, and incorporates a Chlorguard safety shutdown and other safety features.

Included in the specification is a new feature whereby the gas release from the vacuum regulators is discharged through chlorine gas vent exhaust gas arrestor and then redirected out of the building. At the point of discharge a chlorine gas detector is located to warn of any residual gas. It is possible that a faulty gas regulator could discharge chlorine gas and the system, therefore, provides a first stage absorption of the gas and early warning.

This improvement is being installed on other sites in Wales. Capel Dewi WTW was the first installation to incorporate this feature.

The existing and new contact tanks have been modelled using computational fluid dynamics (CFD) by Black & Veatch Hydraulics Group. The aim of the model is to demonstrate that the new plant configuration meets the new Welsh Water Disinfection Strategy for compliance with Regulation 26. The new strategy for raw waters such as Capel Dewi requires a Ct10 of 30 based on hypochlorous acid concentration.



Inside the chlorine cylinder room showing vacuum regulators and vent exhaust gas arrestors to the right. - Courtesy of Dŵr Cymru Welsh Water

In order to strictly achieve the requirements of the strategy for disinfection on water treatment works, a number of works flow scenarios must be considered and compliance demonstrated. This included operation at full works flow and at a typical treatment flow of 8MLD and maximum flow of 12MLD, against various operational scenarios where halves of the new and existing contact tanks are out of service. The model produced by the Black & Veatch modelling team demonstrated that the new design complies with the strategy.

In addition to the above, Welsh Water also chose this project to install and trial an innovative control system (PVSS) which will lead to simpler but more robust control of all treatment works.

Teamwork

The input from Welsh Water operators at the design, construction and commissioning stages was instrumental in delivering this challenging project on time and within budget.

All installation contractors involved were Alliance Tier 1 partners and had worked previously with Black & Veatch on other clean water projects. The good communication and regular site meetings ensured work was carried out in a collaborative manner and any potential problems were dealt with to keep to the programme.

The Welsh Water operator involvement at all stages ensured that operators experience and opinions were taken onboard throughout the design stage, to build a user friendly works which the operators became familiar with as the work progressed.

Commissioning

During commissioning, a broadband link was set up between the control system software provider and the new works SCADA system, so that any fine tuning of the control system could be made remotely without having to re-visit the site.

In addition, the commissioning of the GAC stage was phased in over an extended period to avoid taste and odour complaints associated with a step change in water quality which can occur when GAC is introduced into the treatment process.

Work was originally scheduled to be complete by 31st March 2010, but due to the delayed start, as a result of the discovery of the bat roost, it was not until early November 2010 that the new pumping station was delivering water into supply. The GAC adsorber stage was fully treating the water by early February 2011.

The editor & publishers would like to thank Malcolm Bamsey, Chief Mechanical Engineer with Black & Veatch Ltd, for providing the above article for publication.



View of level 4 security chlorine kiosks with the sludge and supernatant tanks behind - Courtesy of Dŵr Cymru Welsh Water

ChlorGuard[®]

IT'S YOUR SAFEGUARD

...the natural choice for toxic gas auto shutdown systems

As legislative pressures increase on toxic and other gas users, ChlorGuard[®] offers a very flexible safeguard to prevent leaks and increase site safety.

A gas leak triggers immediate secure shutdown, protecting personnel, equipment and the environment from toxic gases and ensures compliance with Health & Safety standards.

Remote, rapid shutdown

Designed for drum and cylinder systems

Safe operation by compressed air

Low running and maintenance costs

Adaptable and compatible system

Advanced safety and diagnostic features including telemetry feedback

ISO 9001 - Module H approved

World class customer support



“ChlorGuard[®] is a simple, but highly effective automatic shutdown system and has, over many years, proven itself to be an excellent fail-safe mechanism for emergency control of toxic gas systems.”

ChlorAid, the Chlorine Emergency Service for the UK and Ireland, highly recommend the use of the ChlorGuard system for the safe operation of any Chlorine container (cylinder or drum) installation.”

Stephen Roberts,

SRST Ltd, Operations & Emergency Response Training Consultancy to the Chlorine Industry and ex-ChlorAid Emergency Team Leader, ICI ChlorChemicals

www.chlorguard.com

Water Care Division of PSI[®] Global Limited