

# Llyn Conwy WTW

new treatment works in the *Go to Green* programme using a single filtration stage with sand and Polarite media to reduce manganese levels

Llyn Conwy WTW is located at around 390m AOD in the Snowdonia National Park in the remote Migneint moorland area between Ysbyty Ifan and Ffestiniog. The works has an average output of approximately 2.4MI/d and supplements treated water from the larger Bryn Cowlyd WTW (46MI/d) to supply customers in the south west area of the Cowlyd distribution system. The works is supplied under gravity from Llyn Conwy, approximately 2.5 miles to the west of the treatment works. The Llyn Conwy WTW forms part of the £106m Go to Green Guaranteed Maximum Price programme to deliver upgrades and new works at 12 sites.



External view of the new works - Courtesy of Dŵr Cymru Welsh Water

## Existing works

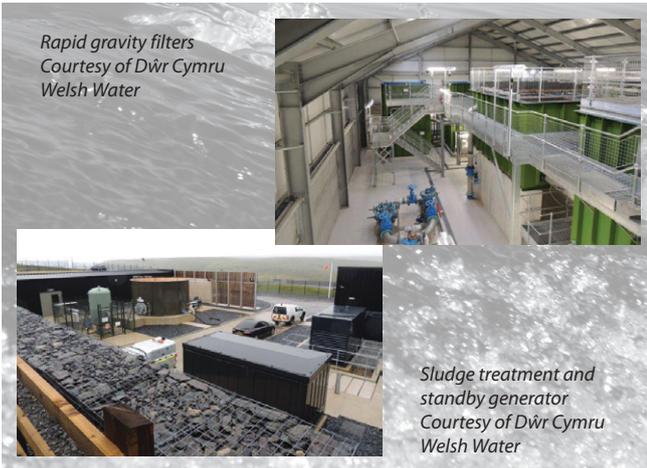
The current works was constructed in 1963 and consisted of ferric chloride, lime and polyelectrolyte dosing upstream of 3 (No.) hopper bottomed clarifiers, pH elevation with lime and CO<sub>2</sub> for alkalinity adjustment and filtration via 4 (No.) rapid gravity filters for turbidity and manganese removal. Filtered water is dosed with chlorine for disinfection and orthophosphoric acid for plumbosolvency control in distribution. Limited chlorine contact is provided in the filter outlet channel upstream of a 0.65MI treated water reservoir, where disinfection is completed. The existing works was limited to treating approximately half its abstraction license at 2.2MLD.

## Pilot trials

Llyn Conwy WTW was an ageing asset that required excessive operator input and had a treatment capacity below that of the available abstraction licence. Bacteriological failures at the works had resulted in a decision by Dŵr Cymru Welsh Water (DCWW) to build a new treatment works to replace the existing asset. Black & Veatch (B&V) is the AMP5 water process partner for DCWW delivering quality and base maintenance schemes at water treatment works and associated assets, with responsibility for programme planning, feasibility, design and project delivery.

B&V had identified a two-stage treatment process comprising coagulation and dissolved air flotation followed by a single-stage of rapid gravity sand filtration as the most appropriate treatment process to meet the project objectives. This was subject to confirmation that manganese dioxide catalytic media (Polarite) in the filters could achieve satisfactory manganese removal. B&V designed and undertook pilot trials designed to assess manganese removal at various pH values and filtration rates, with and without Polarite media.

Traditionally soluble manganese, in Mn (II) oxidation state, is oxidised to an insoluble form, Mn (IV) state, by dosing chlorine and raising the water pH upstream of conventional sand filters in which the oxidised material is removed. Alternatively, Polarite, a proprietary manganese dioxide media derived from naturally occurring ores, which acts as a catalyst can also be used for this oxidation reaction. It allows the reaction to take place without the use of an external oxidising agent such as chlorine. This reduces the risk of trihalomethane formation associated with dosing chlorine to such waters. These trials were conducted to assess effective manganese removal using sand and Polarite, in a single treatment stage.



Rapid gravity filters  
Courtesy of Dŵr Cymru  
Welsh Water

Sludge treatment and  
standby generator  
Courtesy of Dŵr Cymru  
Welsh Water

Raw water quality throughout the trials was consistent with a mean pH of 5.3 and turbidity around 1.0 NTU. Manganese levels in raw water were also consistent between 7-15 µg/l. The addition of ferric chloride for coagulation increased manganese levels in the clarified water to between 21-42 µg/l.

Initial trials with sand and Polarite, conducted with water from the clarifiers at the prevailing pH (6.8-7.1), reduced manganese levels in the filtrate but not to the required target levels. Subsequent trials with sodium carbonate dosing to raise the pH of water reaching the filters to 8.0-8.5 were much more effective and consistently removed manganese to trace levels.

Manganese removal in the pH range 8.0-8.5 remained consistent at raised filtration rates (9m/h), reducing manganese to trace levels (< 1 µg/l) consistently, much below the DCWW target level 10 µg/l.

The trials demonstrated that a single filtration stage with sand and Polarite media was able to reduce manganese levels to well below target values and confirmed that a secondary filtration stage was not necessary.

### Design

Design was carried out both in Wales and by one of B&V's design teams in Mumbai, India. The plant layout adopted at Llyn Conwy is based on previous successful B&V plants in Wales. Great attention to detail was made to consider the operational requirements with resultant well laid out and spacious process areas. Requirements for commissioning were included in the detailed design from onset.

A key success of the scheme was the regular consultation with DCWW operations throughout the design process and formal sign off of the solution at Gateway 1, design freeze point.

The new treatment process comprises the following main process elements:

- Gravity supply from Llyn Conwy.
- pH correction using kalic.
- Ferric sulphate coagulant addition.
- Clarification by conventional DAF.
- pH elevation using kalic.
- Sand filtration in rapid gravity filters, with sand/Polarite media.
- Chlorine dosing for disinfection.
- Orthophosphoric acid dosing for plumbosolvency control.
- Disinfection in chlorine contact tank.
- Carbon dioxide dosing.
- pH correction using kalic.
- Gravity flow into treated water reservoir.
- Washwater and sludge handling system comprising 2 (No.) used washwater holding tanks, 2 (No.) sludge thickeners, 1 (No.) thickened sludge holding tank and supernatant recovery plant.

In addition the old works will be demolished and landscaped.

### Third party consultations

The existing works is located within the Snowdonia National Park on property owned by the National Trust. The team consulted closely with Snowdonia National Park Authority (SNPA), the National Trust and local councils to ensure that the proposed design for the new WTW was acceptable and blended in with the local landscape. Planning permission was granted by SNPA.

### Procurement

As part of the Go to Green programme a central approach was taken for procurement of main mechanical equipment, valves and instruments. In particular, the stainless steel DAF saturator vessels were procured from India and B&V was able to use in-country



Treated water reservoir base construction  
Courtesy of Dŵr Cymru Welsh Water



Process tank being lifted into place  
Courtesy of Dŵr Cymru Welsh Water

20/01



The original works - Courtesy of Dŵr Cymru Welsh Water

professionals from the Pune office to inspect the quality control during manufacture. Considerable savings were made from the central procurement approach.

**Construction**

Work commenced on site with the enabling works on the 3rd June 2013. The main civil works were carried out by Mulcair Ltd, who had to cope with severe weather conditions due to the site's exposed, elevated position. The stepped building slabs and retaining walls were constructed first to enable the fabricated steel rapid gravity filters to be installed prior to the steel frame being erected. This led to the shortest possible programme to a water tight building.

Mechanical installation and process pipework was carried out by Whitland Ltd and other specialist contractors, electrical installation was undertaken by Lloyd Morris Electrical and MCC and software was designed and installed by General Panel Systems Ltd.

**Commissioning/summary**

Commissioning planning started at the onset of the project once the initial scope freeze was achieved. Regular commissioning planning meetings were held with the DCWW project manager and operations liaison manager as construction progressed. Commissioning commenced on 4 August 2014 allowing the team time to commission the new works whilst running to waste. This enabled process engineers to achieve the desired water quality outputs of the new works before switching flows. Water into supply was achieved on 14 April 2015 with all design parameters being met.

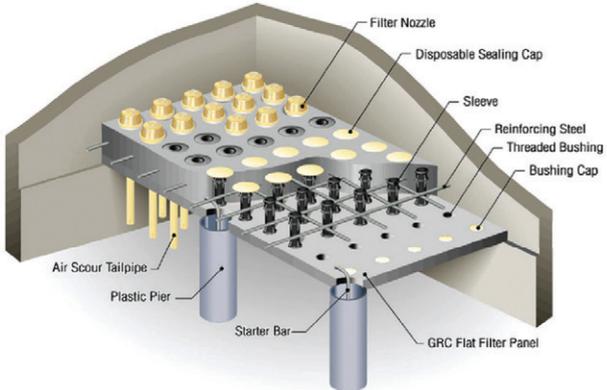
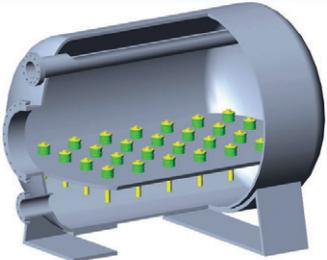
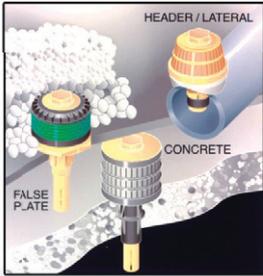
Working closely as a team, Dŵr Cymru Welsh Water, Black & Veatch and the supply chain have delivered a reliable works under budget.

*The editor and publishers would like to thank Dŵr Cymru Welsh Water for providing the above article for publication.*



## Monolithic Filter Floor

- Becomes a permanent part of the civil structure with little or no long term maintenance
- Totally flexible to accommodate variable nozzle densities and nozzle types
- No seals to fail or degrade
- Designed to optimise specific flow rates
- Suitable for separate or combined air/waterwash regimes (collapse pulse)
- Stronger than other filter floor systems, allowing high rate pressure testing
- Flexible plenum height dimension from 250mm-1250mm
- Compatible with any filter dimensions and adjustable on site
- Pier or Dwarf Wall design
- Low cost, simple installation
- Long term savings on maintenance costs and media loss prevention
- Ideal for new or retrofit
- Proven worldwide



3 the Point Business Park  
 Rockingham Rd, Market Harborough  
 Leicestershire LE16 7QU  
 Tel: (01858) 410101 Fax: (01858) 433934  
 Email: sales@cadar.ltd.uk  
 Website: www.cadar.ltd.uk