# Restormel WTW

## GAC pesticide control and capital maintenance project

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The Restormel Water Treatment Works (WTW) project was South West Water's largest single capital infrastructure project during AMP5. The project was successfully delivered by H5O, South West Water's Delivery Alliance, a 'virtual company' with the five principal partners providing complementary skills to deliver the company's diverse capital programme totalling circa £100m per year. South West Water has been at the forefront of partnering for over 20 years and the Alliance model builds upon this experience, uniquely adopting a 'mixed economy' approach whereby Tier 2 suppliers (specialist local small and medium enterprises) work alongside the four Tier 1 design and construction partners. Whilst collaboration, integration, mutual trust and cooperation between Alliance partners is regarded as the norm, on the Restormel WTW project the current best practice in delivery was surpassed.

*Completed GAC gallery - Courtesy of H5O*

### Works overview on existing plant

Restormel WTW is located near Bodmin in Cornwall. The works supplies potable water to much of Cornwall's resident and visiting tourist population. The works was originally built in 1960 with a capacity of 15MLD. Various extensions between 1976 and 2009 have increased the capacity to 100MLD output. The average winter output is circa 65MLD with a typical summer output rising to 85MLD to accommodate tourist demand.

The low lift pumping station delivers raw water from the River Fowey to two main process streams. Stream 1 consists of a mixing/flocculation chamber followed by 20 (No.) hopper-bottomed clarifiers (HBC) and 9 (No.) rapid gravity filters (RGF). Stream 2 comprises a total of 4 (No.) flat-bottomed clarifiers (FBC) and 11 (No.) RGFs developed over several years. The individual RGF outlet streams flow into the chlorine contact tank (CCT) for disinfection before being delivered into the supply network.

### Project drivers

Routine water quality sampling and review of the water management plan identified potential risk from pesticides. Supported by the Drinking Water Inspectorate (DWI), it was recommended that a quality driven enhancement for control of pesticides by the addition of granular activated carbon (GAC) contactors was required.

In addition, to ensure the plant is capable of a sustainable treated water output during periods of peak demand, a site audit identified

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that a number of process improvements were also necessary. These security of supply measures included replacement of the intake screens, clarifier repairs and replacement of the obsolete raw water pump motor control centre and part of the final water dosing system.

### Partnership and collaboration

The Restormel WTW project presented the exciting opportunity for the Alliance to take integration organisationally, technically and commercially to new levels. Success in delivery was achieved by adopting the following innovative approaches:

- Cross partner Steering Group established during project evolution to provide leadership, direction and challenge.
- The main contract design and construction delivery partners were selected on the basis of presentations by the individuals proposed for the design and project manager roles. Considering what was at stake the approach taken highlights the emphasis the Alliance places on appointing the right people for the job.
- The two locally based specialist partners delivering the MEICA works contracted directly with South West Water to avoid main contractor 'fee on fee' (saving circa £400k) and 'man marking'. In addition, South West Water directly procured £1m of filter media (saving circa £80k).
- Whilst delivering around 40% of the total project turnover, the main contractor assumed overall responsibility for project, schedule and commercial management and fulfilled the principal contractor role.
- The MEICA works was allocated to the partner who demonstrated appropriate capability. During construction, the two MEICA partners cooperated to such an extent that work was redistributed between the partners and resources were shared to optimise efficiency.
- The contract partners were paid their actual costs but were linked through a Risk Sharing Deed, incentivising collective cost effective delivery. Project gain share was distributed between the partners in agreed proportions and therefore individual company turnover was incidental.
- The contract arrangements and the collaborative culture established by project leaders and embraced by the project team meant the site team was seamless with visitors not being able to discern who a particular person worked for. This prompted a visiting BMTrada auditor to comment: *"This audit was very positive - of particular note was the extensive use of Building Information Modelling (BIM) and off site fabrication and collaborative working between the partners bringing significant efficiencies, added value and a lean approach".*

### Affordability and critical sequence of construction.

The initial target cost estimate identified affordability issues with the project. The team was challenged to re-engineer the originally proposed solution to generate substantial efficiencies. The principal resulting change was the decision to convert one of the existing treated water tanks in to an inter-stage filtered water tank generating the following efficiencies:

- Removed the risk associated with forming the connection on to the existing rapid gravity filter outlets.
- Changed the location of the interstage pump station (IPS) removing this activity from the GAC critical path - this generated a 16-week time saving and a £350k cost saving.
- Removed the requirement to build a separate filtered water storage tank by combining a tank to supply filtered water for cleaning the RGFs and GAC plant.
- Reuse of the existing filtered water tank to transfer flows removed the requirement for over 200m of 1m diameter pipework within a service constrained operational site - generating a £250k saving.

*Interstage Pumping Station - Courtesy of $H_2O$*

- Combined the forward feed inter-stage pump duty requirements and GAC backwash pumps thereby removing the need for a standby pump for backwashing - saving £80k.

In addition, through a series of cross partner buildability review meetings, the following cost saving efficiencies were achieved:

- Flow path within the existing chlorine contact tank re-engineered to reduce pipe length and reconnection problems in to the valve house.
- The GAC building was raised to enable a short length of process pipe 'build over' avoiding diversion thereby saving circa £150k.
- Relocate the IPS and GAC panel within an existing disused pump house building rather than providing additional space in the new building.
- Promotion and embracement of off-site build to realise efficiencies for elements of the critical path programme.

## The scope of works

South West Water project budget approval was achieved through innovation and exceptional team working. The value engineering and risk mitigation resulted in an affordable solution being approved.

The following scope of works was implemented:

- Construction of a 6 (No.) contactor GAC plant contained within a purpose built building, with air blower, pipework, and actuated valves including all automation and control.
- Conversion of treated water reservoir to a filtered water tank.
- Construction of an interstage pumping station (IPS) and motor control centre.
- New large bore interconnecting pipework to link FWT with IPS, and link GAC to chlorine contact tank.
- Relocated pre-contact chlorine dosing and sampling points.
- Modifications of CCT for new entry, residence times and general remedial works.
- Construction of a 1,240m$^3$ dirty washwater tank and downstream pipework.
- Installation of new screens.
- Low lift raw water pumping MCC panel replacement.
- Upsizing of high lift pumping capacity for treated water - a new 20MLD pump.

## Design led innovation

To achieve a promotable project, several of the original assumptions and technical standards were challenged to achieve a promotable project that met the output requirements.

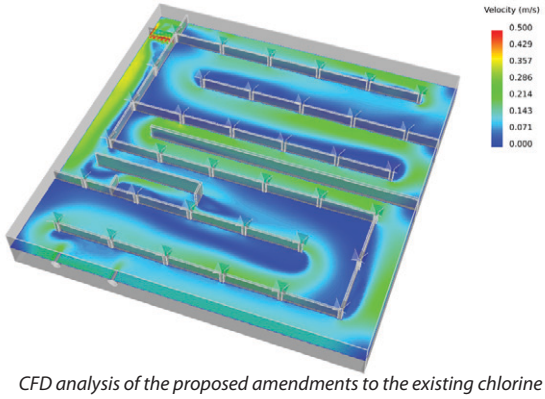
Land availability at Restormel WTW is limited; therefore the process design envelope parameters that determine the GAC footprint were reviewed and modified so that this tertiary process could be sited within the existing works boundary.

The design parameters affected were:

- Empty bed contact time (EBCT).
- GAC media bed depth.
- GAC contactor plan view area.
- Surface loading rates (SLR).

In doing so, SWW technical standard was challenged with revised parameters agreed for the basis of design. The EBCT of 18.67 minutes (all contactors in service) at maximum output was agreed for this installation with an increase in media depth from 3m to 3.75m to reduce the footprint, for the installation, for a given EBCT.

*Restormel CCT2 1m below TWL (from GAC)*




*CFD analysis of the proposed amendments to the existing chlorine contact tank - Courtesy of The Fluid Group*

*RC wall panel fabrication - Courtesy of H$_5$O*

*RC GAC structure - Courtesy of H$_5$O*

*GAC and pipework gallery installation - Courtesy of H$_5$O*

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### BIM enabled off-site manufacture and fabrication

Manufacturing off-site was established as the teams default position from the outset. The adoption of BIM provided the platform from which the project team's 'off-site manufacture' vision was exploited. Design partners contributed to the single 3D model to generate the following benefits:

- Aid to end user visualisation of the product thus ensuring operation and maintenance requirements were effectively considered and incorporated in to the design as well as avoiding the pitfalls of extensive MEICA installations within a limited physical area.
- The complex reinforced concrete GAC structure which comprised 6 (No.) cells and a gallery was manufactured in precast concrete - the units being 'stitched' together on site using in situ concrete. Impressively, the location and form of all 'cast in' items were built in to the BIM model by the various partners and were incorporated in the precast elements off site.

  The following demonstrates what was achieved:

  - 145 (No.) precast concrete elements ranging from 4 to 15 tonnes.
  - In excess of 200 (No.) items cast in off site.
  - Reinforced concrete structure built in 8 weeks saving 16 weeks on programme.

The Carlow Precast Concrete system was selected to construct the contactors. Whilst a piling rig progressed, perfect fabrication conditions were being enjoyed by Carlow Precast Ltd as they carefully positioned pipe connection flanges and fittings within the shutters in preparation for formation of the tank walls. Design integration enabled over 200 (No.) connections to be installed within the factory conditions.

Galvanised mild steel platforms walkways and stairways fully incorporated the support for pipework and cable management systems, as well as providing access, maintenance and lifting facilities whilst still fulfilling all safety and technical standards. This was designed by Kier May Gurney.

The complex GAC gallery pipework, support steelwork, access ways and cable support were fabricated off site in six modules. The civil, mechanical, and electrical designers all contributed to the BIM model to maximise the off-site element. The GAC gallery modules were installed and connected in 4 weeks saving 10 weeks of critical path time.

In addition to the time savings, significant benefits in production quality, risk reduction and reduced waste and noticeable improvements in site tidiness and housekeeping during construction were achieved.

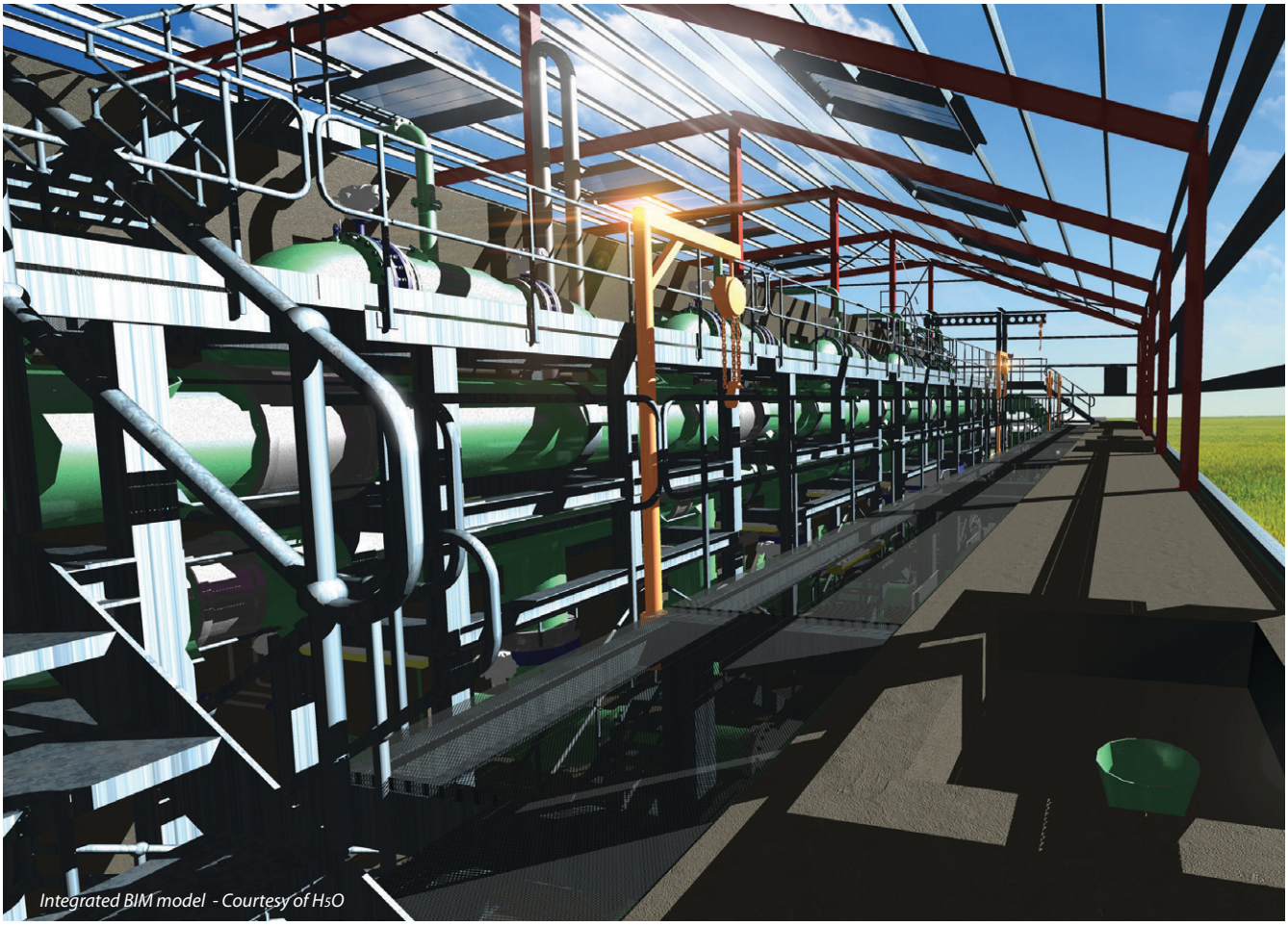
Weholite were selected to provide the off-site build prefabricated backwash chamber.

### Working within the site constraints

***Colliford Main***: One of the existing treated water lines leaving the site, the 24bar Colliford main, was located within the building footprint and thus presented an early and significant obstacle to the structure and piling design. An underground pipe 'bridge' was conceived in order to prevent any unwanted movement around this critical asset.

***Limited space***: Due to the historical variety of upgrades that have taken place the available space for the new plant was restricted.

A compact design on a sloping site resulted, and careful attention to footpaths and access roads to allow good access during and post construction was duly given.



*Integrated BIM model - Courtesy of H5O*

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***Continuity of supply***: Typical of many upgrading schemes in water treatment, continuity and quality of drinking water supply are the controlling factors to all planned and reactive works. Process risk assessments detailed out non-negotiable programming, engineering, chemistry and contingency elements.

In order to maintain water production and quality compliance at Restormel while construction work was ongoing, detailed planning and the production of a series of modelled schematics were necessary to understand the complexity of the modifications. These depicted the current and phased future works flows through the various tanks and reservoirs necessary to facilitate the construction works

### The build - Olympic pace Installation

The precast panels that form the walls of the contactors were installed on a piled foundation. The panels themselves were set out in a matter of days, and in situ concrete infills followed, reducing the overall programme for this element by over 50%. The overall time for the civil installation was 11 weeks.

The internal pipework modules comprising GMS platforms walkways and stairways also provided pipework supports and cable management integration. The first module took 1 day to install with the overall installation of the pipework modules within 3 days, with a further 3 days to connect the modules. The gallery was installed within 6 days.

### Process commissioning

Introduction of the 'new' water into supply was recognised as a key project risk not only due to the complexity of integrating the new treatment plant into the existing works but also due to the potential complaints from customers due to the possibility of water tasting different.

Existing site wash water recovery restrictions and the potential to impact on the existing works meant that GAC conditioning flows could only take place as a manual operation and thus only during manned site hours, thus significantly restricting process commissioning of the plant.

To address this risk the commissioning team comprising the best people within H5O irrespective of their employer brainstormed the problem. The following benefits ensued:

- Process commissioning plan produced during design development with appropriate provision built into the design.
- Early liaison with South West Water's operational personnel resulted in staged process commissioning and extended blending programme and zero customer contacts.
- New software written to permit 24/7 backwashing of GAC filter media to reduce overall conditioning period resulting in critical path time savings and commissioning engineer direct cost savings due to automation of what previously was a manual operation. This software also provided time and cost savings during the commissioning of the GACs.
- The experience of using the new software will form part of a new South West Water commissioning standard to ensure that this learning cycle is concluded.

The above approach allowed operational use and achievement of the DWI regulatory date, which otherwise would not have been possible.

### Summary

The South West Water Alliance Delivery team (H5O) has achieved delivery and technical excellence on the Restormel WTW project through partner collaboration, cooperation and innovation. The project highlights are summarised as follows:

- An impressive health and safety record was achieved with a project minor accident frequency rate of 0.9 against an alliance average of 1.76.
- Through early partner involvement, savings of circa £3m were achieved during option selection and outline design to arrive at a solution that was within South West Water's £11m budget.
- This extremely complex project was delivered below target cost and prior to the 31 December 2014 quality driven regulatory deadline.
- Integrated collaborative and cooperative delivery and commercial arrangements provided the ideal platform for successful BIM implementation with associated benefits including modularisation and offsite build, improved quality and reduced H&S risk and waste.
- All partners contributed to the project BIM model optimising design efficiency and facilitating off-site fabrication for the GAC reinforced concrete structure and gallery pipework/access/etc. Overall, off-site fabrication generated a 6 month time saving off an initial 20 month construction programme.
- Innovative approach to process commissioning which not only ensured introduction of the new water into supply without any taste and odour complaints but also established a new South West Water benchmark standard for media cleansing.
- Non adversarial contract and commercial arrangements meant that partners were incentivised to contribute to project success ahead of individual turnover.

*The editor and publishers would like to thank Chris Holt, H5O Design Leader (Hyder Consulting Ltd), and Simon Davis, H5O Project Manager (Interserve Construction Ltd), for providing the above article for publication.*

*Pipework modules being installed - Courtesy of H5O*

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