

# Liverpool WwTW

## AMP5 main works upgrade sequencing batch reactor design and construction

by John Appleton

**D**ing, ding...full speed ahead. Mounted in the main lobby of Liverpool Wastewater Treatment Works, the ship's bell of The Corinthian has been resoundingly rung by the granting of planning permission by Liverpool City Council for a £200m extension to the works. The extended WwTW will not only meet the standards set by the regulators, but will also have sufficient capacity to serve the growing population by being capable of handling 11,000 litres of waste per second. The extension is part of the £3.6bn being invested by United Utilities across the North West to improve water quality and the environment by 2015. By upgrading the existing works and constructing a sequential batch reactor (SBR), the treated water leaving the new plant will be cleaner and greener, helping the continuing rejuvenation of the River Mersey and ensuring it meets strict European standards for water quality.



Liverpool WwTW - Courtesy United Utilities

### Existing works

In the 1980s, the Mersey was one of the most polluted rivers in the UK. In 1991 the existing treatment works at Sandon Dock became operational and was upgraded to its current form in 2000. Using cutting-edge technology, the state-of-the-art works met all the required standards, and as a result the Mersey now sustains a wide range of fish including salmon, trout, lamprey and dace. The works has made a valuable contribution to the Mersey clean-up campaign but it is now in need of replacement.

### Programme of works

In addition to the engineering activities of the main works upgrade and the sequencing batch reactor secondary treatment project, there are a number of other individual projects which will make up the programme of works:

- *X maintenance works*: Addressing problem areas of the existing works.
- *Habitats directive*: Providing a new outfall pipe out into the Mersey estuary.
- *Environmental permitting regulations (EPR)*: Updating the pollution prevention aspects of the existing works.
- *BAFF refurbishment works*: Optimising the poorly performing BAFF plant with the intention to improve the hydraulic and process performance of the works.
- *Dock closure and infill*: Sand fill and enabling works to provide the foundation of the SBR structure.

### Third party issues

Third party issues have played a major role in the development of the project and management of stakeholders, which is upwards of 50 organisations, has been undertaken. Reclaiming the dock has been a particularly sensitive issue. The Environmental Impact Assessment (EIA) had to address a number of environmental issues and solicit the views, and get buy-in from a number of interested organisations:

- **World Heritage**: Of all the areas reviewed by the EIA the singularly most provocative item of third party interest was the effect of building in a World Heritage buffer zone. This prompted the requirement to provide 'Exceptional Justification' in defence of constructing what was viewed as just a wastewater treatment works in an area of 'Outstanding Universal Value'. The team rose to the



# JACOBS®

Client focused solutions based on practical experience and innovation.

Working in partnership with our clients to deliver real and continuous improvements in the water market.

[www.jacobs.com](http://www.jacobs.com)



# M&J DRILLING

M&J Drilling Services has established a reputation of delivering outstanding service to its broad client base over the past 30 years. Operating a fleet of modern geotechnical drilling rigs throughout the United Kingdom.

- Sonic Rotary Core Drilling
- Stabilisation of Mine Workings
- Location & Treatment of Mine Shafts
- Ground Anchors & Soil Nails
- Ground Source Heating Boreholes
- Rotary Core Drilling Investigations
- Sewer Abandonment Grouting
- Utility Pipeline Annulus Grouting

**APPLYING REALISTIC SOLUTIONS TO COMPLEX PROBLEMS**

[enquiry@mandjdrilling.com](mailto:enquiry@mandjdrilling.com)

Tel: +44 (0)1902 885241

[www.mandjdrilling.com](http://www.mandjdrilling.com)



Reg. No. 1650049. Reg. Office: Unit 44,  
Coneygree Industrial Estate, Tipton, West Midlands DY4 8XP  
V.A.T. Reg. No. 369 6295 96





Granite Wellington Dock sign from 1848 - Courtesy United Utilities



Heritage dock furniture - Courtesy United Utilities



Dock Gates at Wellington Dock - Courtesy United Utilities



Bell from The Corinthian - Courtesy United Utilities

challenge by ensuring that wherever possible all current heritage items are retained or protected. The structure of the listed perimeter dock wall and the wet dock walls were found to be of special historical significance, due to their 'Cyclopean' granite construction as designed by Jessie Hartley in the early 1800s. Wellington Dock was commissioned in 1848.

- **Archaeology:** Local archaeology, specifically underground artefacts and heritage surfaces, including old dockland railway tracks are items which will receive continued archaeological investigation and observation as the construction progresses.
- **Conservation Management Plan:** The plan defines the items which United Utilities has agreed to protect with respect to the heritage aspects of the dock infrastructure. Items such as all dock furniture (mooring posts, bollards, capstan engines and old gas lamp standards etc) will be refurbished and painted. The cyclopean granite wet dock walls and perimeter dock walls will be re-pointed, as appropriate, to prolong their longevity. The perimeter in-dock area around the SBR structure will have a finished surface at a similar level to the existing water level, with green slate proposed as the finished surface to emulate water in the dock.

The perimeter dock wall is a listed structure and as such one of the agreements in the Conservation Management Plan is to provide two sets of replacement gates manufactured to the original heritage design.

#### Operations and maintenance staff become one team

Early on it was recognised the only way the project would be successful was to deliver it as one team. A member of the operations staff was appointed to the project team as the interface and contact point with operations and maintenance staff. Throughout the whole design process close liaison has been maintained to ensure the thoughts and suggestions of O&M staff were incorporated into the overall designs. Weekly project design meetings welcomed the lively interaction and positive input into the design, resulting in a project scheme that O&M staff bought into. HAZOP and ALM and Fire risk assessments all benefitted from a multi-team input from both the O&M and construction partner staff. This interaction will be maintained throughout the implementation phase, specifically during the detail design and commissioning activities.

#### Project background

The initial events and engineering challenges included:

##### January 2011 - Environmental Impact Assessment (EIA)

The requirement to locate the new SBR process in Wellington Dock necessitated the need to provide an EIA to accompany the planning submission documentation. The production of the EIA was undertaken by one of our PECs (Jacobs Engineering), under the guidance of our Environmental and Sustainability department. This weighty document took over four months to compile and included the following topics:

- Landscape and visual aspects.
- Architectural and cultural heritage.
- Ecology, aquatic and terrestrial.
- Noise and vibration.
- Transportation.
- Air quality and odours.
- Hydrology and flood risk.
- Soils, geology and water quality.

##### January 2011 - Site and borehole investigations

In November 2010, prior to planned site investigation (SI) activities, Wellington Dock underwent magnetometer surveys to search for metallic underwater objects, typically UXBs, cars and so on. However



nothing of 'interest' was found other than small nondescript items. In January, a jack-up drilling rig was floated into the dock to undertake the drilling of 10 (No.) boreholes within the wet dock to determine geotechnical conditions. A further 19 (No.) boreholes were also drilled on the quayside together with a number of trial trenches to determine any major underground obstructions.

#### **April 2011 - Pilot plant trials**

In order to provide enhanced process data to support the SBR design, two pilot plant trials have been undertaken. In August 2010, a twin stream activated sludge plant (ASP) trial unit was brought in from Ellesmere Port WwTW. The main focus for this unit was to determine the treatability of the Sandon influent with the determination of ammonia and COD removal being the target parameters. The second unit is a bespoke designed SBR pilot plant which was constructed in April 2011. Circular in design, 6m high x 3m diameter, this unit is targeted at understanding effluent settleability, sludge age and aeration parameters, with the added advantage of being able to observe transient treatment shocks from high salinity, toxic substances and the effects of low alkalinity. The ASP and SBR pilot plants have also provided data which has been used in odour modelling.

#### **May 2011 - Power supply**

The determination of the size of power supply has been a challenge. The dock area of Liverpool has very limited opportunity to extend the current power infrastructure and the need to upsize the current authorised supply capacity (ASC) from 10MVA to 15MVA has been a challenge. This challenge came from both the determination of actual project design power requirements, which have been subject to the constraints of a very tight project scope book delivery schedule and negotiations with the DNO to respond to our requirements. An order has now been placed with the DNO for an ASC of 15MVA.

#### **June 2011 - Dock clearance**

In preparation for dredging activities the dock was raked by MV Norma. This vessel was equipped with a back hoe and the exercise involved a systematic rake pattern bringing all submerged debris from the floor of the dock into a corner location suitable for grab recovery and disposal. Detritus was made up of old tyres, railway sleepers and wire hawsers.

#### **July 2011 - Planning submission**

Throughout the duration of design development and planning submission production, the team worked closely with Liverpool City Council (LCC) planning department and their World Heritage Officer. It was recognised that stakeholder management was essential to the success of planning approval of such a large development within the sensitive World Heritage Buffer Zone. An architect, from our main partner, was engaged to give guidance on the architectural style of the structure.

The challenge here was to manage expectations of the LCC vision of the best looking wastewater treatment works in Liverpool and an award-winning architectural design. However, the design direction focussed on a design sympathetic to the vernacular architecture. It can be seen from the approved plan that a grey concrete box was the result. However, a number of constraints have been incorporated into the design; these will include two architectural stair towers with a creative lighting installation to the south elevation. Another important heritage consideration is the retention of the perimeter wet dock wall, except for vehicle access points and surrounding SBR perimeter area which will be filled with green slate to a finished surface equivalent to the old water level.

To enhance the cultural influence within the local community and to present a more aesthetic view of the plant from a seaport traffic viewpoint, it is planned to provide an artistic mural on the plant elevation facing the river.



Jack-up drilling rig - Courtesy United Utilities



SBR pilot plant - Courtesy United Utilities



Dredger W.D. Mersey - Courtesy United Utilities



MV Norma - Backhoe rake - Courtesy United Utilities



### August 2011 - Odour control

From the outset of the project it was expected that a new secondary treatment process would have to be provided with an odour control plant. This need was based on public perception and historical odour complaints, including litigation against UU. This led to the installation in 2002 of odour control covers over the whole of the primary treatment plant and underperforming BAFF plant. Three large OCU plants accompanied this to service the odour need. These three units are scheduled for refurbishment under the X Maintenance project.

Selection of the SBR process introduced a high element of doubt as to the need for this type of aeration process to have any form of odour control whatsoever. The overall design progressed with the inclusion of this major requirement in the project scope. However, following extensive odour modelling based on surrogate data from other plants, evidence from visits to other SBR plants in the UK and Ireland, and additional data from on-site SBR and ASP pilot plant trials, it was proven that the SBR would not contribute to any additional odours emanating from the works. Therefore the decision to de-scope the odour control system was agreed at UU board level, however, the SBR structure will still be designed to retrofit odour control if eventually it is found to be needed.

### September 2011 - SBR solution scope book

The development of the overall SBR solution scope book for Liverpool WwTW has focussed the design team to deliver an SSB within a very tight programme schedule, one that has been firmly driven by UU's commitment to provide a solution to satisfy the Environment Agency.

Although the SBR process and attendant systems are reasonably simplistic, the actual design development has been firmly guided by third party issues. Major challenges being, heritage integration, SBR overall architectural design, SBR vendor selection, constructability

requirements, access, lifting and maintenance requirements and operational needs.

### September 2011 - Dredging and silt issues

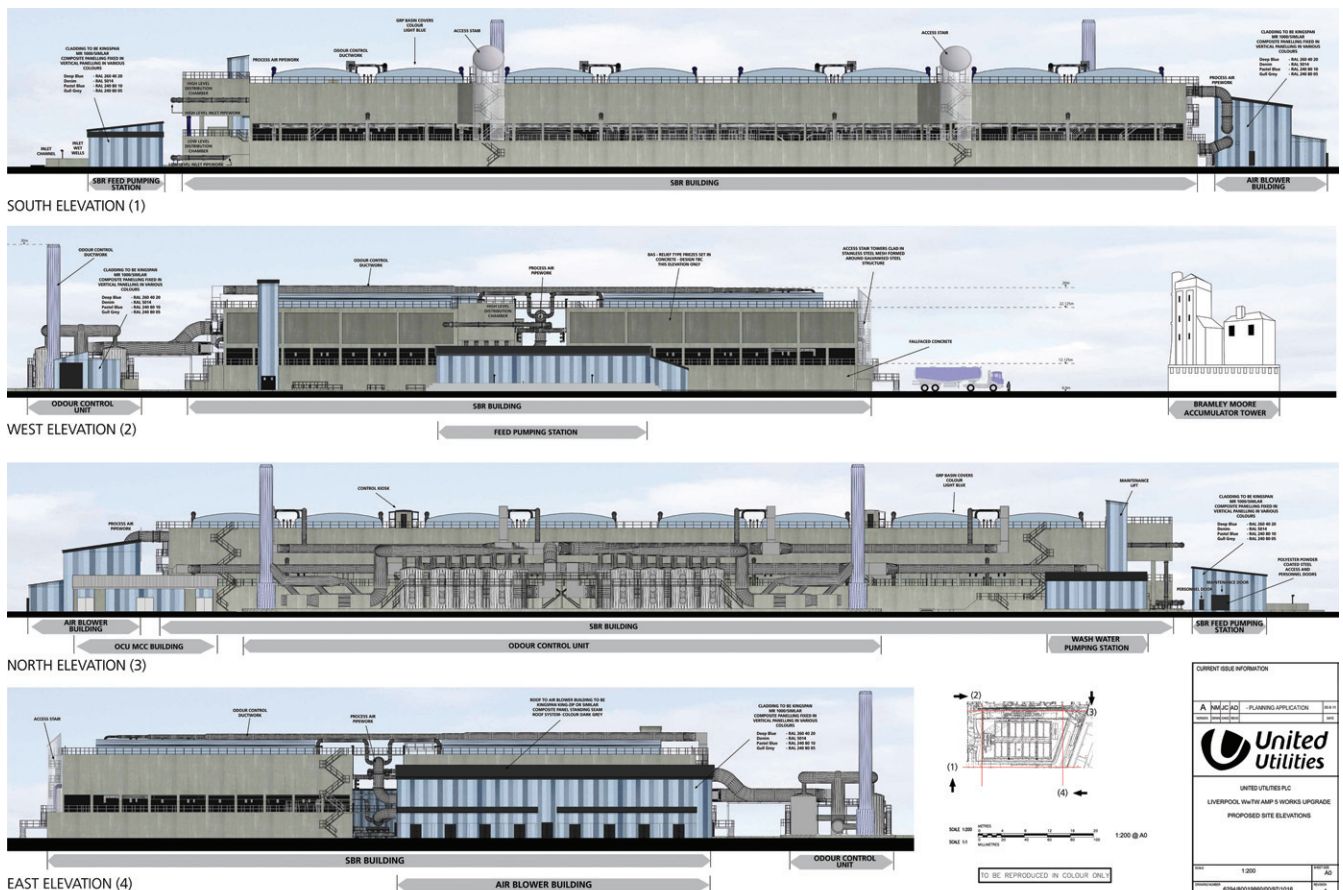
Silt removal has been a very complicated exercise involving many third parties. Concerns as to levels of contamination, extraction licences, disposal routes and the method of removal required close coordination. Following testing, the silt was found to be suitable for disposal to a local licensed site. In September 2011 dredging commenced and was undertaken by 'W.D. Mersey', a trailing suction hopper dredger operated by Westminster Dredging. Fish rescue was another survey undertaken prior to silt removal, whereby the local fish stock was caught and relocated to the Sandon Half Tide Dock. This exercise involved the installation of a bubble curtain to deter fish migration back into Wellington Dock, while still allowing the dredger unhindered access.

### December 2011 - Value Engineering

Engineering challenge was raised in the form of the Value Engineering exercise. The complete team, comprising Engineering, O&M and Partner staff held a series of brainstorm evaluations of the preferred SSB solution. These lively discussions ranged from small order detail to 'out of the box' suggestions. Over 40 individual topics were identified, some were very sensible and easy to implement, others gave great challenge to the established overall design. The most valuable requirement in this whole exercise is the need to be flexible yet focussed on potential whole life cost improvements.

### January 2012 - Planning approval

On January 10th, three members of the project team attended the LCC Planning Committee meeting in the grand and hallowed halls of Liverpool's Victorian Town Hall. After sitting through a list of planning applications, some seemingly taking an inordinately long time, the time to present the WwTW case arrived. The application sailed through the review process and at 15.30 the application was



SBR Elevations for Planning - Courtesy of United Utilities

approved, with no objections and very few planning constraints; a major achievement given the scale and location of the project.

### February 2012 - Dock gates and caisson closure

The dock gates are over 100 years old and have not been used since the 1960s. They have been a point of interest from a World Heritage viewpoint and the project team has been aware of their significant heritage value. There has been a strong requirement by LCC World Heritage officers to retain the gates as an item of historical significance and as such a team of divers were engaged to survey them with the view to gate closure and retention. The dock closure caisson was originally planned on the outer edge of the dock entrance, thus the gates would have been encased in sand infill. This was not favoured and the dock gates have now been closed, with no detriment to the gates' structural integrity. They remain retained in water to prolong their longevity and the caisson is to be constructed within the gate recesses.

### March 2012 and the forthcoming year

The ongoing detail design and construction schedule will be a challenge to the whole project team to ensure a timely completion to meet the agreed EA compliance date of April 2016. The following activities are planned for the immediate future:

#### Sand infill

Wellington Dock will be filled with approximately 200,000m<sup>3</sup> of a specific grade of sand dredged from the Irish Sea. A feed pipe system has been installed under the Sandon Half Tide Dock, which is still an operational dock, through to a pipework distribution system in Wellington Dock. This will allow a 24-hour dredging operation for the dredger to moor up to a temporary discharge terminal located within the River Mersey and pump sand into the dock. Excess and displaced water will be pumped back into the half tide dock. Completion of sand fill will be followed by a period of compaction and further dewatering.

### Foundation construction

The SBR structure and associated sub-structures will be constructed on piled foundations comprising approximately 1,000 continuous flight augured (CFA) piles. Piling mats will be laid in the required areas to facilitate piling.

The SBR feed pumping station will require a deeper excavation requiring the installation of a coffer dam prior to piling. Foundation preparation will complete by the end of the year.

### Maintenance works

There are a number of different areas on the existing WwTW which are programmed for refurbishment within the project timescales, all of which will ultimately benefit the robustness of the SBR solution. They are briefly as follows:

- Refurbishment of the primary settlement tanks.
- Up-rated PST scum collection systems.
- Replacement of storm tank scrapers.
- SCADA system upgrade.
- Inlet works upgrade.

### Conclusion

Further articles will appear in future editions of UK Water Projects as the project develops. The following aspects may be featured in the next edition:

- SBR feed pumping station construction.
- SBR construction.
- Sludge thickening improvements.
- River outfall extension.

*The Editor & Publishers would like to thank John Appleton, Senior Design Manager with United Utilities Group PLC for preparing the above article for publication.*



View of Wellington Dock as currently is (top) and with artist's impression of the SBR superimposed (bottom) - Courtesy United Utilities