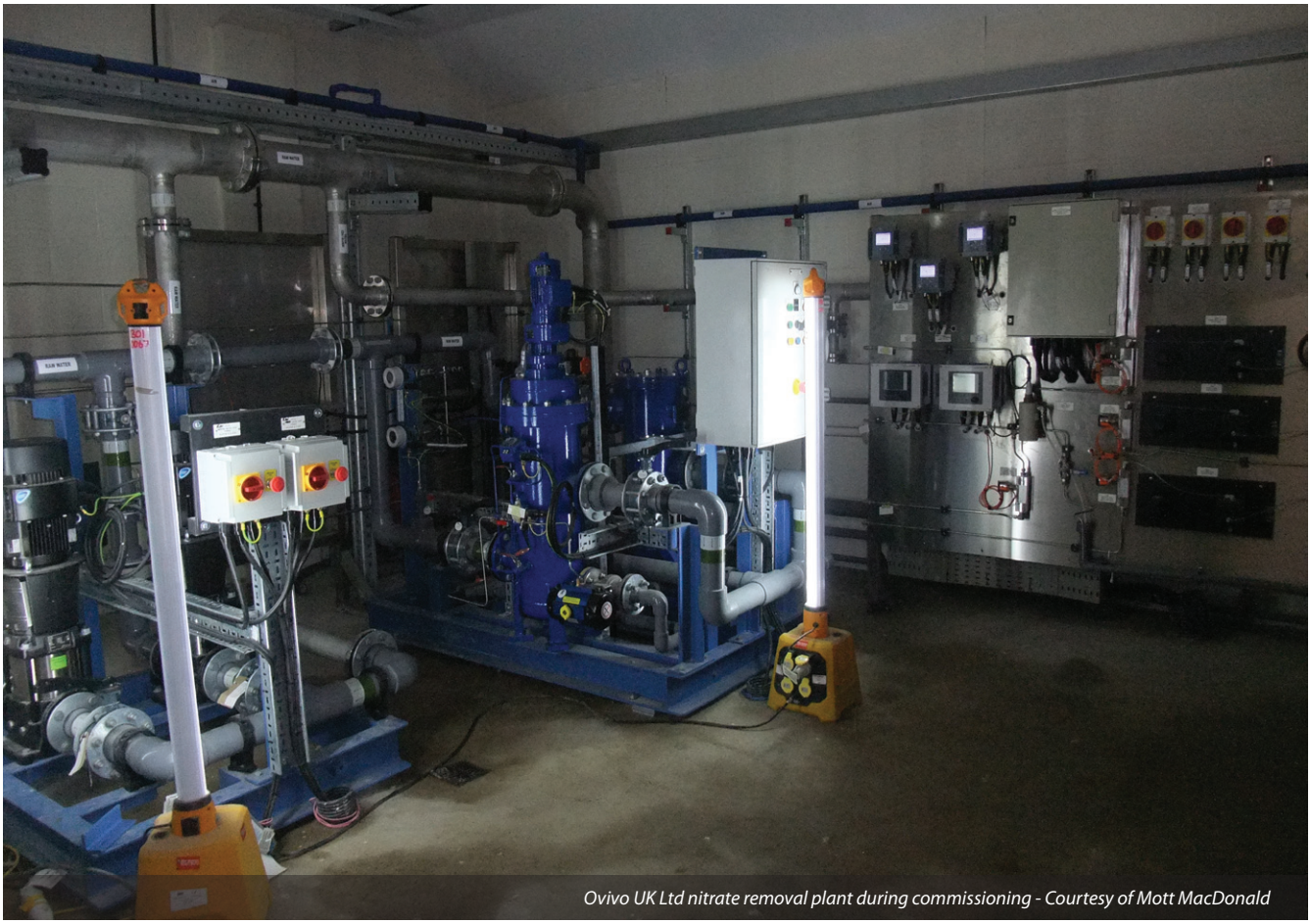
Overton WSW - Nitrate Removal Plant

integration of ion exchange technology into existing works to counteract increasing nitrate concentration in source aquifer

by Alice Clarke MEng

Overton Water Supply Works (WSW) is a small groundwater supply works within the village of Overton, west of Basingstoke. The Overton distribution zone is relatively isolated and essential to the maintenance of supply to the local populace. The works serves a population of approximately 4,500 including domestic and industrial customers. A trend of increasing concentrations of nitrate in the raw water aquifer over many years has reached a level where the works is now at risk of failing UK water quality requirements.



Ovivo UK Ltd nitrate removal plant during commissioning - Courtesy of Mott MacDonald

Current facility

The current operation of the site involves the extraction of water through boreholes from the underlying chalk aquifer followed by filtration through granulated activated carbon media, disinfection by UV, chlorination by dosing sodium hypochlorite and dosing of orthosphophoric acid for plumbosolvency. The water then enters supply via Overton treated water reservoir approximately 2km away. The average daily flow from the works is 0.8ML/d but the abstraction licence allows up to 1.6ML/d to be extracted at peak times.

Phase A option study

In 2010, Southern Water commissioned Mott MacDonald to undertake a Phase A option study to review potential nitrate removal systems for integration into the existing Overton WSW.

The study established that, based on historical trends in nitrate concentrations and the projection lines to 2050, there would be the risk of longer and more frequent periods of non-compliance. If no action was to be taken the works could exceed the legal limit of nitrate concentration between 2015 and 2020. This is based upon the works being required to maintain levels of nitrate entering supply to below 9.04mg/l.

A number of treatment processes available for the removal and, or, reduction of nitrate in the water were reviewed, including blending of water sources, ion exchange, reverse osmosis and electrodialysis reversal.

The site constraints ruled out the blending option since there is insufficient source of low nitrate blend water. Electrodialysis reversal was rejected based upon results of a reliability assessment since at that time the technology was less well proven compared with other options.

The review and accompanying site investigation identified a number of constraints that significantly affected the treatment solution for the site, including:

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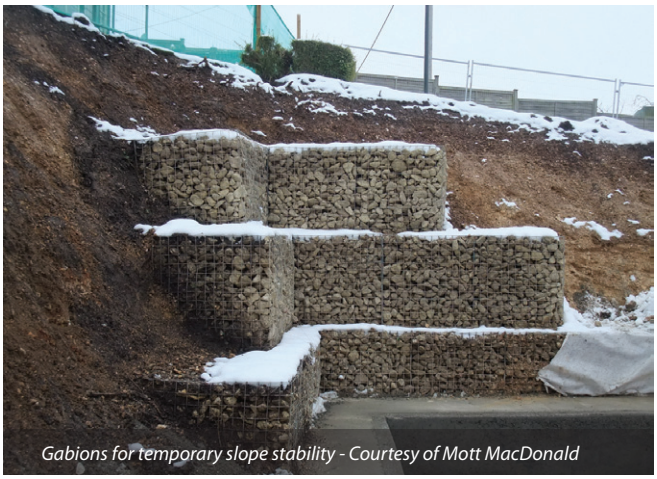
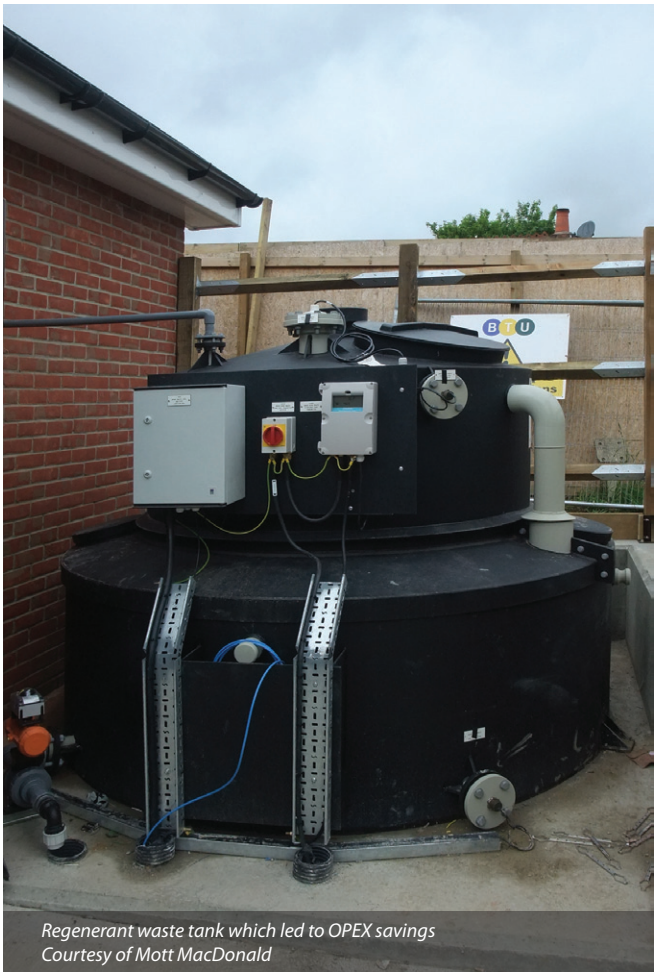
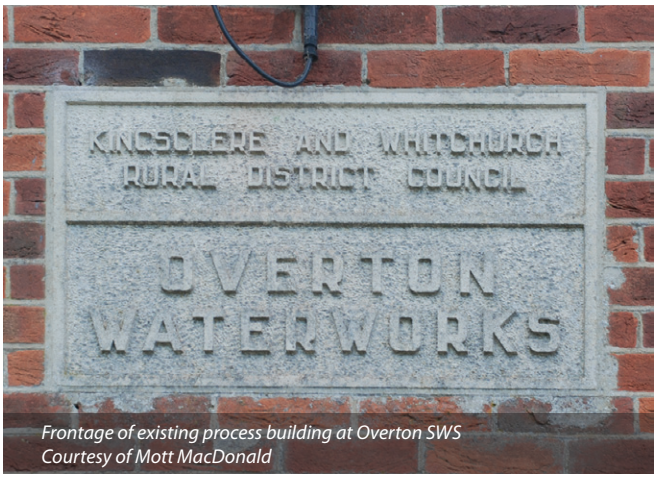


Gabions for temporary slope stability - Courtesy of Mott MacDonald



Regenerant waste tank which led to OPEX savings Courtesy of Mott MacDonald



Frontage of existing process building at Overton SWS Courtesy of Mott MacDonald

- Wastewater discharge constraints due to hydraulic restrictions in the existing combined sewerage system, most notably during wet weather periods, when there is no spare capacity available during storm conditions.
- Land availability on the small and congested site was limited to the open grassed area to the south and west boundary of the existing site. Although this area is limited in size a new process could be accommodated.
- Environmental constraints since there are residential properties located adjacent to the site boundaries and the nearby Overton Conservation Area.

The technical, financial and risk evaluation culminated in ion exchange being the preferred technology and treatment option as it demonstrated a significant benefit in terms of CAPEX, OPEX and NPV compared to reverse osmosis. The proven technology also has a small footprint, which is a considerable benefit since the site is constrained on all sides by residential properties.

Outline design stage

In 2012 Mott MacDonald completed the outline design phase of the Overton WSW project for Southern Water.

There were two main challenges during the outline design stage. Firstly, Southern Water specified that any system being employed should not have a single point of failure, for which Mott MacDonald developed a tightly worded specification, to ensure that the selected plant would be robust. Secondly, significant work was required to enable all the required equipment and associated structures to be located within the existing site boundary and to ensure the proposed works suited the local topography.

Once these were overcome, a full planning application was able to be submitted, with the significant aspects of the works including:

- New building to house the ion exchange plant and associated motor control centre.
- New salt saturator.
- Replacement of borehole pumps.
- Amended access route.
- Surface and foul water drainage arrangements for the site.
- Relocation of existing services, including overhead power line and BT telephone connections.
- New security fencing and gates.
- Landscaping and planting works.

The location of the proposed development within the existing works and in close proximity to several residential properties presented various challenges from a planning perspective. Mott MacDonald acted as the agent for the applicant, Southern Water, throughout the process.

Prior to the submission of the formal planning application, pre-application discussions were held with Basingstoke and Deane Borough Council to ensure all parties were aware of the intricate nature of the work and potential impacts on the surrounding environment. In addition, pre-application consultation was also undertaken with Natural England, the Environment Agency, Overton Parish Council and members of neighbouring residential properties and local businesses.

The outcome of the pre-application discussions fed into the final planning application submission, where some of the key mitigation areas were:

- The inclusion of extensive site landscaping and planting to mitigate the loss of several trees due to the development and to ensure the ongoing enhancement of biodiversity within Overton village. The landscaping has also been designed to minimise the visual impact of the new

structures to the surrounding residential area and the lowering of the existing site levels.

- Since the development is relatively close to the Overton Conservation Area, consultation with local interest groups led to the re-orientation of the Ion Exchange building and ensuring the style matched existing structures so that there was no adverse impact on the local character. The height of the building was also restricted to minimise visual impact on local residents who overlook the works.
- Since the construction works had the potential to be the most significant disturbance to local residents and businesses, the planning application included requirement for the principal contractor to produce a detailed and sensitive Construction Environmental Management Plan (CEMP) outlining construction best practice. In particular the CEMP would ensure control measures were in place to safeguard the underlying groundwater aquifer from pollution.

Planning permission was granted in 2012 subject to compliance with several conditions.

Detailed design stage

In 2012, Barhale Trant Utilities (BTU) was appointed by Southern Water as principal contractor for the Overton WSW project. BTU, in turn, appointed Mott MacDonald as engineering consultant for the detailed design.

One of the main challenges through the detailed design stage of the scheme was to manage the interface between new and existing infrastructure, which had to be maintained in full use, whilst ensuring all equipment and upgrades stayed within the site boundary. The main feature to be constructed on the site is the building to house the Ion Exchange equipment being supplied by Ovivo UK Ltd.

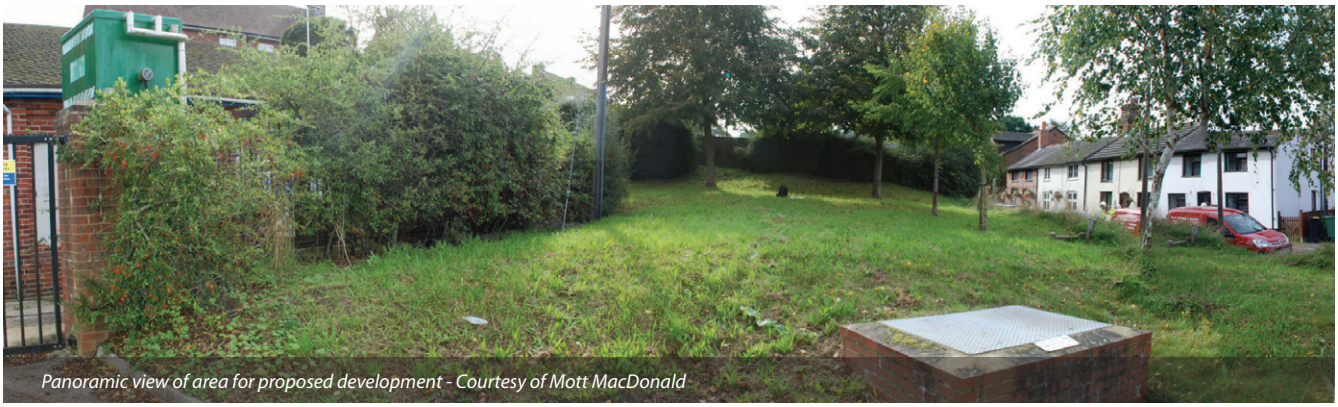
At pre-planning application stage, in order to mitigate the impact of the development, the building required was relocated towards the south of the site. This entailed partially burying the building in an existing embankment and required the temporary use of the neighbouring garden during construction. As a result, the building walls were required to retain to the reinstated slope.

Gabions were introduced as temporary works to stabilise the near vertical slope required; these will be buried and left in place in the permanent condition. Due to space constraints between the rear of the building and the site boundary, precast L-shaped concrete retaining wall panels were installed to aid the reinstatement of the slope and adjacent garden whilst maintaining clearance around the eaves of the building.

One of the planning conditions imposed by the Local Planning Authority (LPA) required that noise from the site shall be no more than 5dB (decibels) more than the existing background noise level. Following a review of the noise attenuation characteristics of the new building and a noise survey of the surrounding area, discharge of this planning condition was able to be achieved, with standard building insulation material and by specifying a roller shutter door with a high sound attenuation characteristic.

The construction of the new building and associated driveway placed additional demands on the existing site drainage and had the potential to overwhelm the local sewers. One method used to minimise the impact of the additional run-off was using sustainable urban drainage (SUDS) principles to specify the use of cellular paving on the driveway to the new building.

This has the additional benefit of further minimising the visual impact of the development for local residents. As the paving is situated over a live water supply aquifer, use of this access requires strict clean working procedures to be adopted by Southern Water.



Panoramic view of area for proposed development - Courtesy of Mott MacDonald

Other new site drainage, although connected to the existing system, is held within an attenuation tank with water pumped at a controlled rate into the local sewer at times of low flow.

During preliminary site investigation works it became apparent that an existing water main, which feeds Overton Service Reservoir, was on the same line as the proposed new fence line. However, by applying for an amendment to the planning application and making the gable end of the new building the permanent site boundary the movement of the water main was avoided.

If relocation of the main had been required it would have led to additional work required on site, delays to the programme and interruptions to the supply to Overton village.

The softener and regenerant waste produced by the Ion Exchange plant are required to be kept separate prior to discharge into a sewer. This is to prevent potential scale formation, should the two undiluted waste streams combine, leading to pipe fouling and blockage.

To facilitate this, the two waste streams have been designed such that they discharge into different sewers so that they will be sufficiently diluted prior to re-combining further downstream.

As a means of reducing the OPEX cost associated with pumping, the regenerant waste tank has been relocated above ground where it can gravitate, via a control valve, to the receiving sewer.

Summary and progress

Mott MacDonald was engaged by Southern Water to undertake the option study and outline design stage, after which Barhale Trant Utilities (BTU) engaged MM as detailed design consultant.

The scheme is nearing the completion of construction works with commissioning activities scheduled to last until July 2013.

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