

Abberton Reservoir Enhancement

increasing the capacity of Abberton Reservoir to meet the forecast population increase in Essex over the next 25 years

by Daniel Wilson

Abberton Reservoir is located to the south of Colchester, Essex. Originally constructed in the 1930s, the existing reservoir holds 26 billion litres of water and provides raw water for treatment at Essex & Suffolk Water's Layer WTW. This water supplies a population of 750,000 people in Essex and NE London. Demand in Essex is forecast to rise by 6% over the next 25 years. To meet this demand, and following the consideration of several options, Essex & Suffolk Water (ESW) is increasing the capacity of Abberton Reservoir by 58% and undertaking enhancements to the existing water transfer infrastructure. The reservoir is designated as a Special Protection Area (SPA), a Site of Special Scientific Interest (SSSI), and a RAMSAR site.



Aerial view of Abberton Reservoir, Near Colchester in August 2010 - Courtesy of Essex & Suffolk Water

Background

The Abberton Reservoir Enhancement is a component part of the Abberton Scheme. The Abberton scheme has been designed to capture excess water from the Ely-Ouse river system in Norfolk for transfer and storage in an enlarged reservoir at Abberton, Essex.

The Abberton Scheme comprises projects to increase the capacity of Abberton Reservoir, to up-rate an existing raw water pumping station at Kennet, to construct two large diameter raw water mains running from Kirtling Green to Wixoe and Wormingford to Abberton respectively, to construct a new pumping station and break tank at Wormingford and to vary existing abstraction licence at Denver. The project budget for the Abberton scheme is £150m. This article focuses on the work undertaken at Abberton Reservoir only.

In the early 1990s ESW began work to identify potential solutions to meet the forecast increase in water demand in the Essex area. These potential solutions included, amongst others, a new reservoir at

alternative sites, Aquifer Storage and Recovery (ASR) schemes and increasing the capacity of Abberton Reservoir. Work to increase the capacity of Abberton Reservoir by raising the main dam to 22.7m AOD from 19.8m AOD, was selected in 1997 due to its ability to satisfy raw water storage demands, its anticipated implementation timescale and both its environmental effects and ecological enhancement opportunities.

Following extensive design work undertaken with WS Atkins and MWH between 1997 and 2007, appropriate investigations and consultation with stakeholders, ESW was in a position to advertise the required works and to receive tenders against a detailed design. After an extensive tender assessment period, ESW appointed Carillion Civil Engineering as principal contractor under an NEC Option C contract in 2009. Construction work began on site in January 2010 with MWH fulfilling the roles of ECC Project Manager and ECC Supervisor and EC Harris providing quantity surveying services.

Technical description

The Abberton Reservoir Enhancement Project comprises a number of principal components including:

Raising of the main dam

The existing puddle clay core dam is to be raised from the current crest level of 19.8m AOD to 22.7m AOD to allow the water level in the reservoir to be increased from 17.8m AOD to 21m AOD. This work requires:

- The removal of the existing top soil on the down stream face, removal of the concrete erosion protection on the upstream face and excavation of solifluction material in the enlarged dam footprint.
- This work is followed by the installation of around 300 vertical wick drains and integrated with the existing dam drainage system. The existing clay core is then exposed, trimmed and elevated with clay shoulders to increase both the height and width of the dam.
- Finally, erosion protection in the form of a 150mm thick layer of Open Stone Asphalt (OSA) capped with 50mm thick layer of resin bound aggregate is placed on the upstream face of the dam.

The raising work is strictly controlled throughout the construction process and into the commissioning phase of the project to control pore water pressure beneath the enlarged dam footprint.

On the 20th July 1937, the original dam structure slipped due to increased pore water pressures in the dam foundation as a result of material placement being undertaken too quickly. This resulted in a slip approx 175m in length. To understand this slip event, MWH undertook Finite Element Analysis (FEA) of the main dam to inform the construction process.

The constraints identified through the FEA process are included within the construction contract between ESW and Carillion as a series of milestones and permissible material placement rates. Other structures requiring modification as part of the main dam work included the existing valve tower, the inlet structure and the tail bay. Each of these structures required raising, refurbishment or a combination of both.

Col dam construction

Increasing the main dam to 22.7m AOD enables the top water level of the reservoir to be increased to 21m AOD from the existing 17.8m AOD. This in turn increases the surface area of the reservoir from 4.7km² to 6.6km².

Consequently this necessitates the construction of 4 (No.) col dams to elevate low lying local topography encompassed by the increased surface area. The col dams are constructed with a puddle clay core, clay shoulders and vertical drainage filters. The 4 (No.) col dams vary in size, the largest being 1km in length and 7m in height between cut-off trench and crest level.

B1026 diversion

An existing local road, the B1026, linking the local villages of Layer de-la Haye and Great Wigborough is flooded by the enlarged reservoir. As part of the project, 1.8km of this existing road will be diverted to bring the road alignment outside the footprint of the larger reservoir.

Pumping stations

A total of 5 (No.) pumping stations are being constructed on site as part of the construction contract. These range from small land drainage pumping stations with flow capacities of 0.8MI/d (10l/s), to the refurbished raw water pumping station with a flow capacity of 231MI/d (2,674l/s).



Work on the main dam of Abberton Reservoir, August 2010 - Courtesy of Essex & Suffolk Water

This larger station extracts raw water from three draw off points within the reservoir and delivers this to Layer WTW via 1.9km of steel pipelines.

The current level of the superstructure of this building is 19.9m AOD, with the water level in the reservoir increasing to 21m AOD, this structure becomes submerged. Therefore work to demolish and rebuild this superstructure from 22.5m AOD is required.

The complexities associated with this operation, and the need to maintain supplies to Layer WTW, is mitigated by the construction of a temporary pumping station on the shoreline of the existing reservoir.

Although this temporary station does not provide the flexibility associated with the existing station, principally due to the feasibility of replicating the three draw off points associated with the existing structure, it enables a safer demolition process and reduces the risk of interruptions to raw water supply at Layer WTW.

On completion, the refurbished pumping station will retain the three existing draw off points and complements these with a further high level draw off enabling mitigation of any stratification within the reservoir.

Planning constraints

The existing reservoir at Abberton is designated as an SPA, a SSSI and a RAMSAR site. This therefore means that all work undertaken within the site boundary is constrained by a number of ecological factors. These include for example the migratory patterns and use of the reservoir by over wintering wildfowl limiting the time at which work can be undertaken adjacent to the shoreline and winter working rules.

In obtaining planning permission for the scheme ESW were committed to limiting as far as possible the impact on the local community. To this extent, where possible, material used for the construction of the enlarged reservoir is sourced from within the site boundary. This includes all clay, coarse aggregates and sand used in the construction of the main dam, the col dams, the B1026 and the new perimeter road. This substantially reduced the impact of importing the majority of the 1 million cubic metres of material required on site via public highways.

Progress to date

A number of key activities, of significant duration, needed to be undertaken within defined periods of the year, and are affected by water levels within the reservoir. Missing the window of opportunity to undertake these activities had the ability to dramatically push back the planned completion date of the project. It was therefore essential to begin the works in earnest following the contract award in December 2009.

Site offices

Work began on site in January 2010 with the establishment of the main site office, two remote offices at key locations around the reservoir, a UKAS accredited laboratory for materials testing and a material processing plant.

The establishment of these facilities allowed the site team, comprising representatives from ESW, Carillion, MWH and EC Harris to begin activities ranging from procurement, risk management and programming to the physical work associated with project delivery.

Civil engineering

The first of these physical works to begin was the excavation and processing of granular material. This allowed the construction of the drainage blanket beneath the main dam



Temporary offtake pumping station construction 2011 - Courtesy of Essex & Suffolk Water

to be undertaken followed by the installation of a grid of vertical wick drains to relieve pore water pressure beneath the enlarged dam footprint.

Once this work was completed, bulk earthwork associated with the main dam could begin in order to raise the structure. By April 2012 the dam has been successfully raised to 19.3m AOD, despite a very difficult winter period in 2010, bringing extensive rainfall, snow and freezing temperatures over a three month period.

Col dams

The construction of the 4 (No.) col dams on the southern perimeter of the reservoir is now substantially complete. The construction of these dams coincided with the re-profiling of the reservoir shoreline such that cohesive material arising from the re-profiling work could be used as bulk fill for these dams.

The granular material for these dam structures was delivered via haul routes up to 7km in length from the processing plant on the north shore of reservoir. During the most intensive earthworks period, 60 (No.) earthworks vehicles were undertaking excavation, haulage and placement functions around the reservoir to maintain progress on the dam structures.

Road diversion

The B1026 diversion was undertaken in 2011 following work to strengthen and protect an existing high pressure gas main.

Temporary pumping station

Progress with the engineering structures around site has progressed according to current programme. In November 2011 the temporary pumping station was commissioned

including full flow tests up to 182MI/d (2,106l/s) and simulated emergency shutdown testing. The completion of this significant milestone permitted handover of the existing raw water pumping station at Abberton for demolition activities.

During the commissioning phase of the temporary pumping station, high winds generated significant wave action on the reservoir that increased raw water turbidity, partially due to the re-profiled shoreline. To mitigate this raw water turbidity ESW installed a pontoon mounted pumping system to supplement water drawn into the station from close to the shoreline with less turbid water abstracted from the centre of the reservoir. This mitigated any detrimental effects on water production during the 18 months that ESW would be using the temporary station.

Forthcoming activities

Forthcoming activities in 2012/13 include the demolition and refurbishment of the raw water pumping station, completion of the main dam raising activities including construction of the crest road, and environmental works to create ecological habitats around the reservoir.

The Abberton Reservoir project is planned for completion in summer 2013. Following this, the reservoir will be filled to the new top water level of 21m AOD securing water supplies in Essex and reducing the impact of consecutive dry years in the supply area. The attainment of the 21m AOD level will be dependant upon raw water availability, weather patterns and customer demands. ESW forecast the enlarged reservoir will be full by 2015.

The editor & publishers would like to thank Daniel Wilson, Project Manager with Essex & Suffolk Water, for providing the above article for publication.



Open stone asphalt being laid at Abberton Reservoir as edge protection in July 2011 - Courtesy of Essex & Suffolk Water