

# Norton & Raveningham Pumping Station

## replacement pumping station project to provide improved climate resilience and help protect Britain's largest wetland, the Norfolk & Suffolk Broads

by Adam Thurtle BEng (Hons)

**N**orton and Raveningham Pumping Stations are located near the village of Reedham within the Broads. The Broads comprises of a number of nationally and internationally designated nature conservation sites. They form Britain's largest protected wetland supporting more than a quarter of our rarest flora and fauna. The Broads are a man-made landscape with the river system perched above the surrounding floodplain, contained within earth flood defence embankments. The only way to manage water levels is to pump excess water from the surrounding floodplain up into the river.



Aerial view of Norton pumping station looking towards Reedham - Courtesy of Water Management Alliance

### History

Faden's 1797 map of Norfolk shows numerous wind pumps scattered around the Broads. The wind pumps helped drain the marshland and worked in combination with gravity drainage during low tides. However, marshland ground levels reduced due to shrinkage of the peat and with rising sea levels the gravity drainage became increasingly ineffective. The traditional wind pumps were replaced by more reliable steam, diesel and more recently electric pumps.

Norton Pumping Station, constructed in 1945, had suffered major structural failure and required urgent replacement. Funding was secured in January 2022 to consolidate the Norton and Raveningham pumped catchments and build a single replacement pumping station at Norton.

The design and Early Supplier Engagement (ESE) contracts were awarded in April 2022 with the detailed design completed in May 2023. The main construction works commenced in August 2023 with the new pumping station commissioned in August 2024.

The Waveney, Lower Yare & Lothingland Internal Drainage Board (IDB) are part of the Water Management Alliance, a group of seven IDB's which includes the Broads IDB. Together they operate 55 pumping stations, managing water levels within 22,000 hectares

of low-lying land within the Broads, preventing permanent inundation.

### Statutory requirement

The replacement station manages water levels within 788 hectares of sensitive conservation grazing and agricultural land. This land provides important habitat for populations of qualifying species associated with designated nature conservation sites within the Broads. These are termed 'functional habitats' and are critical to maintaining Favourable Conservation Status by maximising the ecological potential and enabling the habitats and species, associated with the designated sites, to thrive.

Without pumping, the catchment would fill with water causing flooding and permanent damage to the habitats and key qualifying species such as rare aquatic plants found within the dykes, diverse flora, rare molluscs and breeding and over-wintering birds.

Failure of the pumped system would be a breach of statutory environmental obligations to manage water levels within functionally linked habitat. The result would be uncontrolled flooding of property, agricultural land, National Rail infrastructure, public highways, and utility infrastructure. This would also have serious repercussions for recreation and tourism which generate hundreds of millions of pounds annually for the local economy.



### Climate resilience

Rising sea levels and a changing climate make the Broads increasingly vulnerable. The project aligns with the objectives of the Broadlands Futures Initiative, a partnership investigating and establishing future flood risk management.

Climate resilience is improved with a 50% increase in duty capacity accounting for climate change predictions for intense rainfall events. This also ensures the system can better cope with overtopping events, which are likely to become more frequent. Taking into consideration future adaptive pathways to mitigate climate change, the station has the capability to adjust water levels allowing for changes in land management such as paludiculture and wetland habitat creation.

The power, control and motors are elevated above the flood level to ensure continued operation during a flood event.

### Fish-friendly screw pump

The screw pump is one of the oldest positive displacement pumps dating back over 2,000 years. The design by Fish Flow Innovations removes the leakage path by fixing the rotating screw augers to the outside casing, resulting in enhanced efficiency and the most fish friendly pump available. The screw is made from GRP composite material which does not corrode and is UV stable providing an expected design life of 80 years.

The replacement station features two Archimedes screw pumps operating in a duty/assist configuration. The 2m diameter screws lift water 4.5m over the flood embankment, and using variable frequency drives, are capable of delivering variable flow rates between 0.3 to 0.75m<sup>3</sup>/second.

Working closely with National Fisheries specialists, to minimise external stresses on fish and eels passing through the station, a number of initiatives have been incorporated including:

- Using fish friendly lightweight HDPE tidal flaps; a cambered outfall chamber ensuring water is conveyed towards the flap valve even during minimum flows.
- Setting the invert level of the outlet chamber below low water.
- Remedial measures were required to fit an impact protector to the legs supporting the pump motor and gearbox.

The lessons learnt report has been shared to prevent this issue on future projects using this arrangement.

As part of a national research project, a trial will be undertaken using sensor loaded drone fish and live specimens which will be passed through the station and recovered to confirm fish/eel friendliness.

### Funding challenges & cost savings efficiencies

Prior to awarding the main construction contract, high inflation significantly increased costs. To help mitigate this, several value engineering opportunities were implemented resulting in £1.1m in cost savings.

These included:

- Challenging maintenance access arrangements.
- Carrying out further investigations to remove the requirement to replace anchored sheet piled retaining wall.
- Taking a proportionate risk-based decision not to provide erosion protection on a new watercourse and removing covers from the screw pumps.
- Keeping the existing stations remained operational up until commissioning, removing the requirement for expensive over-pumping.



Excavation of flood embankment following installation of temporary piling - Courtesy of Water Management Alliance



Archimedes screw pump being lifted into position  
Courtesy of Water Management Alliance



Aerial view of works nearing completion  
Courtesy of Water Management Alliance



### Norton & Raveningham Pumping Station: Supply chain - key participants

**Client:** The Waveney, Lower Yare & Lothingland Internal Drainage Board IDB)

**Principal designer & supervisor:** Jacobs UK Ltd

**Main contractor:** BAM Nuttall Ltd

**ECC project & cost manager:** Turner & Townsend

**Condition surveys:** Rossi Long Consulting Ltd

**Temporary works/shoring:** Groundforce Shorco

**Dewatering system:** Dewatering Services Ltd

**Kiosk/transformer piling:** Van Elle

**Piling equipment:** Watson & Hillhouse Ltd

**Directional drilling:** SW Drilling Ltd

**Steelwork package:** Fussey Engineering Ltd

**MEICA:** Max Wright Ltd

**Telemetry:** Lee Dickens Ltd

**Archimedes screw pump:**

- Fish Flow Innovations

- Aquatic Control Engineering

**Trash system:** Landustrie | Aquatic Control Engineering

**Flap valves/stop logs:** Aquatic Control Engineering

**Traffic Management:** TMO Traffic Highways Ltd

**Scaffolding:** Ideal Scaffolding (East Anglia) Ltd

**Shear studs:** SWUK Steel Decking Ltd

**Resin injection:** Restek-Uk Ltd

**Landscaping:** Dobson Enviro LLP

**Fencing:** Dew Fencing Ltd

**Demolition:** Clark Demolition Company Ltd

Significant cost, capital and operational carbon savings have been achieved by combining the Norton and Raveningham catchments and building a single replacement pumping station. This also optimises available water resource during drought periods, improving wetland sequestering capabilities.

Early Supplier Engagement during detailed design ensured the design represented the least cost and carbon option. This included an early decision to maximise the use of steelwork and minimise concrete. Steel coping provides support for the trash rake minimising works on site, speeding up construction and reducing construction carbon.

Additional funding was secured to account for inflationary increases which could not be mitigated through project efficiencies. This enabled the £5.2m NEC4 Engineering and Construction Contract to be awarded to BAM Nuttall Ltd in June 2023.

IDB's are risk management authorities and can apply for Grant In Aid (GiA) funding for Flood & Coastal Erosions Risk Management projects. The partnership funding calculator attracted 43% Flood Defence GiA with the remaining supplemented by Environmental Statutory Allowance (ESA) funding. ESA funding was introduced in 2021 for projects required to meet statutory environmental obligations.

#### Wildlife mitigation

A carefully planned and implemented water vole mitigation strategy ensured overall net gain of water vole habitat by improving 130m of watercourse.

Reptile mitigation required hibernaculum's and reptile fencing to be constructed prior to successfully translocating reptiles found within the working area. The old pumping station roof had bat roost potential requiring a 'soft' strip of the tiles prior to demolition.



The 2m diameter Archimedes screw pumps with combined capacity of 1.5m<sup>3</sup>/second - Courtesy of Water Management Alliance



### Ground conditions

The ground is relatively weak (soft silt/clay/peat) up to 15m below ground level, requiring a boxed piled cofferdam with pile lengths up to 17.5m. The complexity of the ground and groundwater conditions and the need for multiple level propping during construction, resulted in Plaxis 2D numerical modelling being required to confirm the global stability, displacement and internal forces in the structure forming the pumping station.

Prior to the excavation of the pump chamber, to control the pressure head within the Crag Group, temporary dewatering and pressure relief wells were installed into the sand and gravels. Piezometers within the pump chamber monitored groundwater pressure during the dewatering operations.

Vibro-piling was selected to minimise damage of adjacent sensitive receptors. Disturbance to wintering birds was avoided by monitoring cold weather and imposing restrictions on piling in the event of a cold spell.

### Solutions & innovations

An innovative cloud-based telemetry system allows remote real-time monitoring and control of the station. The system records trends and numerous statistics, including the volume of water pumped providing a valuable record for future water resource planning.

An automatic greasing system on the lower bearing of the screw avoids the need to de-water and enter the inlet chamber. The motor and gearbox are easily accessible for future replacement avoiding complex lifting operations. The materials selected for the civils structure requires no treatment or future intervention.

The control kiosk has a black timber effect finish to mimic the traditional agricultural buildings helping minimise the impact on the local landscape. The external lighting, only required during urgent unplanned maintenance operations, has been designed to meet Dark Sky requirements and are bat friendly.

### Community engagement

Proactive engagement has minimised disruption and kept the local community fully informed of how the project benefits and protects the local community.

The contractor looked to maximise a circular economy approach and created a modest site set up to complement and respect the sensitive environment. The site compound included two electric vehicle chargers, made available to close community neighbours for free as a gesture of goodwill.

The project team carefully planned and delivered activities relating to 13 government National Social Value Themes designed to boost Social and Local Economic Value (SLEV). These have included: site visits from the parish council and local schools, apprenticeship talks and attendance at careers fairs, hosting a T-level work-placement student and an apprentice, donating a community bench and undertaking repairs at the local parish church, and maximising local employment and supply chain spend, where possible.

The team worked with all the surrounding schools to educate the children about the important role pumping stations play in the local landscape. A STEM (science, technology, engineering, and mathematics) exercise and competition tasked Thurlton Primary School to design a pumping station of the future.

The design considered how it might look, work, improve the local environment and nature. The winning entry had the privilege of naming the pumps and starting them during the opening ceremony, further embedding the project's social value into the local community.

### Awards

The project was awarded the Large Project of the Year at the Institution of Civil Engineers awards in September 2024 in recognition of its importance to enhancing the regions resilience to climate change and protecting vital habitats and communities. The judges were particularly impressed by the project team's outstanding collaboration during very complex operations, often with limited historic data and tight time constraints.

### Conclusion

This project is the first to be delivered as part of a programme that will continue to protect the Norfolk and Suffolk Broads from flooding and help address the challenges associated with climate change.

The Broads IDB secured funding to deliver further replacement pumping stations on the River Thurne, with construction works commencing in 2025.

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