Zouch (S101a) First Time Sewerage Scheme

£2.3m project safeguarding environmental and societal benefits in line with Severn Trent's objective for rivers to reach good ecological status

by Will Hooper MEng GMICE

Zouch is a small hamlet situated along the A6006 on the border of Leicestershire and Nottinghamshire and consists of 43 properties that had no access to public sewerage. Due to the canalisation of the River Soar, the hamlet is entirely surrounded by water with the main River Soar to the South and the navigable Zouch Cut to the North. The Old Mill Race bisects the village and creates the smaller islands of Upper and Lower Holme. Following an initial application for a public sewer connection by a group of residents in Zouch, Severn Trent (ST) confirmed the application met the requirements under Section 101a of the Water Industry Act 1991. Under this legislation ST were required to provide a public sewer connection to the 27 properties that were assessed as likely causing adverse effects to the environment and the local amenity, identified as 'duty' properties. ST assessed the remaining 12 'non-duty' properties as potentially benefiting from a public sewer connection and promoted a project to provide first time sewerage to all 39 properties in Zouch.

Aerial view of Zouch on the Leicestershire/Nottinghamshire border - Courtesy on nmcn PLC

Undertakings

During initial feasibility stages it became apparent that providing a design and safely building a sewer network in Zouch would be an intricate and complicated project. Under the AMP6 framework agreement, nmcn PLC were appointed as design and build contractor and worked closely with ST to deliver the £2.3m project.

Bridging the gap

Due to the difference in levels between the islands and the existing bridges, and the need for a sewer network to remain operational during times of flood, the nmcn design team selected an innovative vacuum sewer network. These networks are infrequently promoted within Severn Trent with only 5 other networks operating in the ST catchment and required the appointment of specialist supplier CG Godfrey Ltd and the use of their Qua-Vac Vacuflow technology.

Providing a suitable sewer connection to the Upper and Lower Holme Islands proved a major design difficulty to overcome. nmcn commissioned detailed 3D laser scan surveys (Faro 3D scanner) of the existing bridges to produce high resolution point cloud models for use in remote design review meetings. The Autodesk BIM 360 access proved extremely useful to discuss proposals with CG Godfrey and during external stakeholder meetings remote from Zouch with the Environment Agency, Canal & Rivers Trust and both Leicestershire and Nottinghamshire Planning Authorities.

For the 80m long River Soar crossing, nmcn worked collaboratively with Leicestershire County Council to design a pipe bridge crossing that fixes onto the existing A6006 highway bridge structure. Complex negotiations were required to obtain permission to fix a ST asset onto a highway bridge planned for replacement, with

ST business leads taking a holistic approach by retaining future responsibilities for any pipe bridge diversion costs. The design teams worked hard to incorporate intricate sleeving details into the future bridge deck to future-proof the vacuum sewer network. This included sharing point cloud data between companies and incorporating considerations for tankering and diversion valves to facilitate future diversion considerations.

nmcn & CG Godfrey pushed to implement prefabricated items to maximise the benefits from Design for Manufacture and Assembly (DfMA). This included prefabricated vacuum pots, discharge pump chamber, vacuum tank and the large MCC kiosk which arrived fully fitted out and pre-tested with the vacuum pumps and pipework, carbon filter, electrical distribution boards and both motor control centre panels.

nmcn's design and build expertise led to the specification of the innovative slide rail shoring system (by National Trench Safety UK) to facilitate installing the prefabricated pump station and vacuum tank within a single excavation. The 9.7m x 6.5m and 3.1m deep shoring was installed within 2 working days and achieved significant programme betterment as well as reduced health and safety risks against traditional sheeted excavations.

Overcoming 'sett-backs'

When a large badger sett was discovered during a pre-site start ecological walkover, nmcn identified that the disturbance associated with the proposed site access and vacuum main excavations would be breaching the Protection of Badgers Act 1992. To remain compliant with the law the project team would usually engage licensed ecologists to exclude the sett to prevent disturbing the badgers. However during discussions with the landowner it became apparent the cattle farmer relied on the existing 'clean' badger sett to naturally defend its territory against any rival clans that could be carriers of badger tuberculosis (a cattle TB outbreak was recorded on this farm in 2010 when the badgers first occupied the territory but the clan has since classified as 'clean').

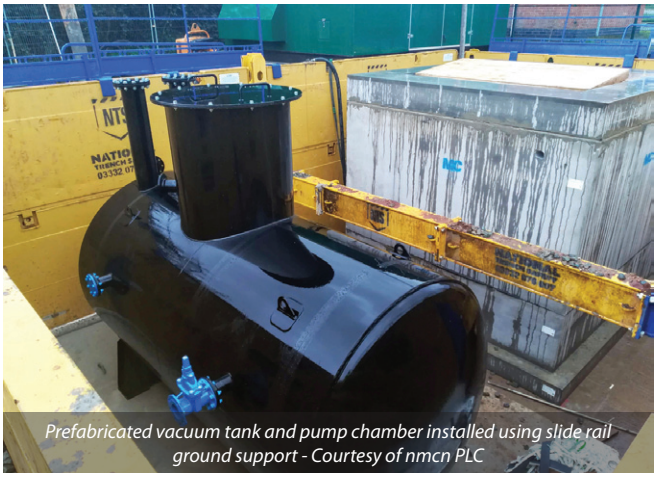
To lead on sustainable best practice, nmcn investigated a solution that allowed the badger sett to remain open during the works and developed the application of a specialist StrataWeb geosynthetic grid system that could be installed directly adjacent to the live badger sett. Having previously applied the principal of laterally dissipating construction loads through geocellular confinement structures above Tree Root Protection Zones, the team were able to propose a design to Natural England that reduced the vertical loading and potential disturbance on the badger sett. This enabled nmcn to obtain a bespoke Disturbance Licence from Natural England and approval from Leicestershire County Council Planners for the site access road. This innovative approach was published as Environmental best practice within nmcn.

Planning applications for the project incorporated Section 184 agreements to allow for the site access road to become permanent, benefiting the existing landowner and helping to enable the future Leicestershire bridge replacement project. Where ground conditions allowed, sections of the site access road utilised recycled stone from a nearby nmcn project under an Environment Agency Waste Exemption Licence.

By strategically locating the site compound adjacent to the existing Hathern SPS pump station, the cabins, welfare and site offices were able to hook up directly to the grid and avoid the traditional diesel generators usually associated with remote sites, achieving significant savings in CO2 emissions.

To further the sustainability credentials of the project and in line with nmcn's Positive Impact Plan 2025, nmcn employed a full-time apprentice site engineer specifically working and learning on the Zouch project. His site workload was balanced to allow for

Lower Holme - Courtesy of nmcn PLC



Prefabricated vacuum tank and pump chamber installed using slide rail ground support - Courtesy of nmcn PLC

Screenshot from 3D point cloud of Old Mill Bridge - Courtesy on nmcn PLC

DfMA - fully assembled vacuum equipment inside kiosk Courtesy of nmcn PLC

his off-the-job training agreement with Derby College in order to complete his Construction & Built Environment Apprenticeship.

Planning and communication

The project team delivered four public exhibitions in Zouch as open forums for residents to drop in and discuss design proposals and to deliver updates during the construction work. This included mobilising CG Godfrey's mobile vacuum display unit which replicated the vacuum sewer network, allowing demonstrations of the safe use of sewers and helping to minimise any future blockages.

nmcn & CG Godfrey developed designs to take into account specific requirements from residents such as the colour of the pipe bridges, vacuum pot locations and positioning of above ground kiosks, the BIM 360 models were also used to demonstrate the proposed pipe bridges. The upfront consultation work ensured the numerous planning applications were submitted without any public objections and successfully met the design phase programme.

The early public engagement successfully resulted in an initial 100% sign-up rate for connecting to the new network, a feat not often witnessed within first time sewerage projects. At one of the consultation events, a group of residents to the West of Zouch originally discounted from the scope became frustrated at not being offered a connection. nmcn and CG Godfrey worked together to propose design changes to the vacuum sewer network to facilitate additional connections without the original complications originally anticipated during feasibility.

The team provided ST with designs and prices for carrying out the additional work whilst guaranteeing the contract end date would be met. To prevent any potential conflict over connection offers in Zouch, ST were successfully able to retrospectively apply for additional funding to increase the total connections from 39 to 55.

Planning in the pipeline

Severn Trent worked strategically to batch the refurbishment of the nearby Hathern Pump Station with the Zouch S101a scheme along with 12 other individual projects into a single Infrastructure design and build contract worth £12.4m. This efficient programming of works allowed nmcn to offer financial savings to ST arising from a single mobilisation to site, shared site preliminaries and streamlined delivery teams. Both Hathern SPS and Zouch S101a projects were undertaken simultaneously on site with nmcn taking control over the existing operational asset from ST. By carefully phasing and programming the refurbishment works, further savings were made by incorporating the refurbished Hathern SPS MCC panels into the new Zouch kiosk. Combining the projects also allowed for a single planning application and facilitated simpler land purchase agreements.

nmcn hosted weekly collaborative planning (CP) meetings on site with ST, CG Godfrey and key sub-contractors to ensure critical sequences of work were efficiently coordinated and pre-fabricated items were delivered on time. Requests from Leicestershire County Council for sharing traffic management arrangements were carefully incorporated into the programme allowing all parties to undertake work on the A6006. The tangible aspect of CP created simple, daily visual targets for the site teams to push towards and gave clear breakdowns of planned future site activities. CP was also used extensively throughout the Design Phase to ensure the coordination of civil, structural, M&E and vacuum sewer specialist engineers.

Through careful detailing of the large prefabricated kiosk, the addition of an advanced carbon filter was incorporated on the exhaust air outlet to effectively prevent odours arising from the vacuum station. This is the first use of activated carbon technology within a vacuum pump station and supersedes the more traditional biofilters which are more cumbersome and require the

Installation of StrataWeb geosynthetic grid
Courtesy of nmcn PLC

Hathern Greenhill Rise Pump Station and Zouch Vacuum Station
Courtesy of nmcn PLC

construction of additional below ground chambers. The push for DfMA demonstrates the team's ambition in advancing the quality of the final product and promoting health, safety & environmental benefits.

Working under pressure

The proposal to design the Zouch vacuum pump station adjacent to the existing Hathern SPS required over 1.3km of vacuum sewers to link the furthest property connection. Due to vacuum networks operating around negative 0.6bar, the design teams were faced with a maximum 6m of static head across the entirety of the network. This led to extremely stringent hydraulic constraints in levels and required a complex hydraulic analysis of the network to be undertaken by Dutch vacuum sewer specialist Qua-Vac.

The Common Data Environment provided through BIM360 facilitated the integration of nmcn, CG Godfrey and Qua-Vac design teams to carry out respective checks and perform design changes within a single AutoCAD model. Detailed analysis of the hydraulics at the elevated pipe bridges demonstrated areas of low air to water ratio within the network and required the addition of three air admission kiosks. The kiosks added the additional complexity of requiring a small power feed, something which had previously been discounted in Zouch due to the lack of requisitionable power cables. CG Godfrey were able to develop three bespoke solar powered units which remotely add air to the network at critical positions, functioning completely remotely and ensuring the network operates as designed.

The installation of the pipe bridge fixings onto the existing bridges required significant upfront design and planning. Independent structural surveys were carried out and consultation held with Nottinghamshire Heritage Officers to agree repair works on any damaged sections of brickwork on the Old Mill Bridge. The pipe bridge brackets and fixing designs were undertaken by specialist structural engineers and took into account thermal expansion and the dynamic forces arising from slugs of sewage travelling at high velocities through the bends in the exposed pipework.

The A6006 bridge in particular required temporary two-way traffic management and the use of a spider crane and man-riding basket over the River Soar and under National Grid Overhead cables whilst fixing brackets to the bridge deck using a specific method statement agreed with Leicestershire CC. Bespoke permits were required from the Environment Agency and National Grid with all lifting operations undertaken through a specialist contract lift arrangement.

Health and safety

The Zouch site was selected as the flagship project to host the major milestone celebration of successfully reaching 12 months without an LTI across the whole nmcn Infrastructure division (over 670,000 hours worked).

As principal designer and contractor under CDM 2015 regulations, nmcn held regular design reviews to collaboratively identify, monitor and reduce risks as recorded in the detailed risk management plan. A notable case is the use of ground penetrating radar and electromagnetic Identification surveys to map the underground utilities along the A6006 and specifying vacuum excavation techniques for trial holes to confirm key service crossing locations. Incorporating the Site Investigation data into the coordinated, shared AutoCAD model during the design stages resulted in a quality level QL-A (PAS-128) design and confidence that the risks of service clashes had been minimised as far as reasonably practicable.

Flooded with motivation

The first public sewer network in Zouch was fully commissioned and operational by 31 March 2020, within the contract end date and within the target set by the Severn Trent business plan to meet 20% financial efficiency savings across AMP6 projects. Completing the Zouch S101a Project saw ST reach their AMP6 obligation to deliver 312 duty properties.

Motivation to deliver additional legacy came in the opportunity to sponsor Nottingham Trent University's Civil Engineering BEng Group Design Project. nmcn and ST supported the undergraduates by providing a lecture on the hydraulics of sewerage networks and used Zouch as a challenging case study for the students to solve. nmcn and ST attended three consultation sessions to give feedback on the students' proposals and the winning group were invited to see the construction project firsthand.

nmcn's enthusiasm for delivering a successful project was further witnessed when Storm Ciara caused the River Soar to flood Zouch. The site team's rapport and trust with the residents became apparent when they were on hand to support a stranded islander by providing dry logs to keep the elderly gentleman's house warm.

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Supply Chain	Company
Design and build contractor	nmcn PLC
Vacuum sewer specialist	CG Godfrey Ltd
Structural consultants	Eastwood & Partners
Vacuflow vacuum sewer suppliers	QUA-VAC BV
Kiosk suppliers	Quinshield Ltd
MCC panel suppliers	CEMA ltd
Pump suppliers	Xylem Water Solutions
Double slide rail shoring system	National Trench Safety (NTS) UK

River Soar vacuum main crossing - Courtesy of nmcn PLC

Nottingham Trent University site visit - Courtesy of nmcn PLC