Ravenfield Sewage Pumping Station

a complete overhaul of an operational site on time, on budget and with zero defects

by David Greaves

The Ravenfield, Braithwell Road, Sewage Pumping Station (SPS) is located just on the outskirts of the village of Ravenfield, South Yorkshire. The SPS is situated within a restricted footprint in a rural neighbourhood and could be accessed by small vehicles via a 250m long single road stone track. Within the compound was a small brick building, which was in a poor state of repair. The building housed 2 (No.) 30kW dry well pumps, the MCC and telemetry outstation. The dry well pumps drew the incoming flows from an outside wet well and delivered a flow of 33l/s down a 1km rising main into a trunk sewer. The scheme for the on-line replacement of the existing pumping station commenced in February 2014 and was undertaken by NMCNomenca.

Elevated view following placement of cover slabs and valve chamber - Courtesy of NMCNomenca

Background

A 5m square shallow overflow chamber had been installed next to the main wet well in the late 1990s to increase the storage capacity of the SPS. Although this was useful in times of increased flows, large build ups of rags and solids would remain in the overflow chamber and require regular jetting/cleaning by Severn Trent Water Service Delivery.

Continuous problems had been reported with the site and this SPS had been on Severn Trent Water's (STW) radar for a substantial overhaul for a number of years. As well as a significant number of high level alarms (averaging 25 per year) and pump failures (averaging 37 per year) there had been four major pollution incidents recorded for the site between 2003 and 2012.

Three out of the four pollution incidents resulted in the adjacent Hellaby Brook being polluted via the built in storm emergency overflow system located within the inlet manhole.

The other pollution incident was caused due to a burst rising main which caused significant damage to a section of arable land owned by a local farmer. After further investigation and a major hydraulic study, it was discovered that the rising main between the SPS and discharge manhole was weak, especially when negative pressure was created (during uncontrolled pump shutdown events causing flows to head back towards the SPS resulting in the main to pull in on itself) and was at an elevated risk of bursting unless action was taken.

Solution

Working closely with the STW senior solution engineer in the early design stages, it was clear that the SPS was in need of major overhaul to bring it up to current operational and safety standards. The lack of wet well storage leading to serious pollution events at the site was the main scheme driver. The weak rising main and numerous failures of the mechanical and electrical equipment were also very high on the priority list to rectify.

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Old storm overflow chamber, looking from within compound Courtesy of NMCNomenca

Breaking out of old storm overflow chamber in preparation for new shaft - Courtesy of NMCNomenca

New 6m diameter shaft under construction - Courtesy of NMCNomenca

Part of ring section cut out ready for installation of precast valve chamber - Courtesy of NMCNomenca

To satisfy the standard SPS design criteria of 2-hours wet well storage at 3 x DWF (dry weather flow), 100m^3 of extra storage would be required on site. With the storage obviously required on-line the only feasible option available was to demolish the existing storm overflow chamber and sink a new concrete shaft (5.5m diameter by 6m deep) in that location. The existing main inlet chamber, with built in emergency overflow, would be retained as part of the final solution whilst a second inlet would be created into the shaft, discharging the small amount of flow coming from the properties at the top of the access track. The existing brick building and wet well would also be demolished and replaced with a new 'walk in' GRP kiosk housing the new motor control centre (MCC).

Two control measures were adopted by the project team to alleviate the risk of causing a burst on the already weak rising main:

1. The new pump starters would be controlled on a *soft start* regime, which allowed the pumps to ramp up and down slowly at the start and end of each pump cycle.
2. As recommended by the hydraulic study, a compressed air pressure vessel was to be installed on the rising main between the valve chamber and flowmeter. The pressure vessel would maintain a safe working pressure within the rising main at all times as well as acting as an air brake/ damper in the event of any sudden pressure surges. The pressure vessel control panel and small compressor would also be housed in the new GRP Kiosk.

The final part of the upgrade required the entire replacement of all pipework and valves as well as the installation of 2 (No.) new 30kW submersible pumps complete with all the latest specification lifting chains. A swing jib crane with a 1 tonne SWL electric hoist would be installed to ensure the new pumps could be lifted from the new wet well safely.

Project innovations

Temporary access road to site: With the SPS access track being suitable for small works vehicles only, this posed a problem when it came to the major construction elements of the scheme.

Heavy duty construction plant, lifting equipment and lorries carrying the large concrete segments all had to get down to the site safely and the existing single track was not suitable along some narrow sections. To combat this problem the site team installed a 4.5m wide 330m long stone access road through an adjacent field thanks to a prior agreement with the local landowner.

The installation of this new road benefited the scheme in other areas due to it bypassing the two properties at the top of the existing access track. The residents who live in the aforementioned properties share the very top of the access track and the installation of the new temporary road bypassed these properties and avoided any potential inconvenience to the residents as well as eliminating any risks of collisions between their own vehicles and the passing construction traffic.

Precast suspended valve chamber: Due to the very tight working space available within the SPS compound, NMCNomenca worked closely with structural consultants Eastwood & Partners Ltd, to design a precast concrete valve chamber that would be partly suspended on one of the cover slab cross beams as well as being sat on the shaft collar.

As well as saving a great deal of working space the valve chamber was also designed to be precast in a location away from site, delivered to the site as one complete item and then lifted into place via mobile crane.

To round off the complete installation, the new valve chamber pipework was also pre-installed off site (at the same location it

was cast) by pipework fitting specialists. This complete installation saved a substantial amount of man hours on site (approx. 2 weeks) which in turn saved money on site materials and other machinery.

Pressurized surge vessel: SPS sites with pressurized surge vessels on the rising main are usually quite rare in comparison to their use on clean water sites, but following a recommendation in the hydraulic study a 0.6m^3 pressurized vessel was installed at Ravenfield complete with its own compressor within the new GRP kiosk.

An approved pressure vessel designer, with a significant amount of experience in the field, was appointed as contractor to design, supply and install the pressure vessel and associated items. The control panel for the equipment was manufactured by a tier 1 control panel manufacturer.

The surge vessel maintains a safe working pressure along the entire primed rising main (1km) of around 1.5bar. In the unlikely event of any surges in pressure the vessel will act as an air brake to prevent any slamming of valves or collapsing of pipework.

Project management & construction

During any SPS refurbishment, one of the major obstacles to overcome is ensuring the incoming flows are still dealt with and passed forward without issue, and this can be particularly difficult when working space and existing wet well storage are at a premium, as was the case at Ravenfield. To make matters worse, the average flow coming into the SPS was 15l/s (and significantly more during storm conditions).

The sequence of work had to be planned in great detail with as much construction being carried out 'off line' as possible. As previously mentioned, the overflow chamber had to be demolished to allow the new shaft to be sunk in that location. Doing this we could keep the existing dry well pumps running as long as possible.

When it was time to demolish the existing building and remove the old dry well pumps, 2 (No.) temporary overpumps were installed inside the small wet well and these pumps were run from 2 (No.) temporary pump starters/panels fed from the new power supply.

Fortunately the site had an existing overpumping connection flange in a chamber on the rising main leaving the SPS compound and the pipework from the temporary overpumping regime could be connected onto this flange.

Finally when the new shaft was complete and ready to receive flows the overpumps were moved into this shaft and the temporary pipes were extended to cater for the greater distance. The overpumps then remained in the new shaft (still being run from the temporary panels) until the new MCC panel and submersible pumps were successfully installed and commissioned.

Successes

During the seven months spent on site, no pollution events were recorded and only a small number of emergency alarms (pump fail, high level etc) were raised. The flows were being continually managed successfully whilst the major construction works were being carried out.

The entire construction period for the project, including the installation and removal of the temporary stone access road through the adjacent field, was 32 weeks. With the initial construction period being planned for 34 weeks, the site team beat this initial programme by 2 weeks and this was done with no reported accidents, incidents or near misses throughout.

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12 tonne precast valve chamber being lifted into position
Courtesy of NMCNomenca

View across refurbished site showing new surge vessel and crane
Courtesy of NMCNomenca

Retaining wall and crane base under construction
Courtesy of NMCNomenca

Completed site following construction - Courtesy of NMCNomenca