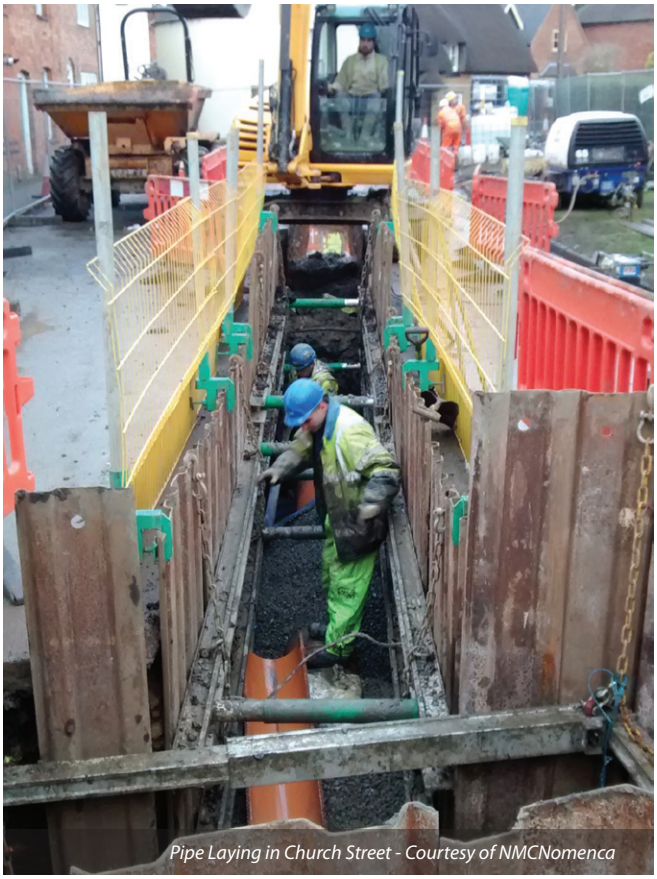
Billesdon (Church St) Flood Alleviation Scheme

an acrylic polymer injection system was utilized in areas of running sand to improve ground conditions and reduce construction risks

by Emma Price BEng CEng MICE

The small village of Billesdon is located 10km to the east of Leicester in Leicestershire. In heavy storm conditions there is surcharging of the combined sewer leading to the flooding of seven properties. Severn Trent Water have fitted temporary measures such as non-return valves and soakaways to prevent further flooding and this project is to address the long term flooding issues. A considerable site constraint was the variable ground conditions which included a high groundwater level with several different ground strata including sand and gravels. The use of an Acrylic Polymer Injection System in areas of running sand to improve ground conditions has significantly reduced the construction risks.

Drilling and Injection - Courtesy of NMCNomenca


Pipe Laying in Church Street - Courtesy of NMCNomenca

The solution

The existing combined sewer was under capacity and this scheme provided 150m online upsizing from 225mm diameter to 400mm diameter along Church Street and 300mm to 450mm diameter within the Queens Head public house access. This part of the scheme was crucial as it is the only connection from the flooding zones in Church Street to the downstream storage.

In the fields to the west of Billesdon, twin 900mm diameter plastic pipes together with a 750mm diameter carrier sewer provide 150m^3 of storage to prevent surcharging the sewerage system approximately 600m upstream of Billesdon STW.

The 450mm diameter brick egg highway sewer runs parallel to the combined sewer in Church Street and discharges to Billesdon Brook. It may be likely that the flooding problem in Church Street was partly due to this sewer being under capacity to take the flows from the village. As part of the scheme a section of the highway sewer has been repaired and replaced.

Innovation

The variable ground conditions, combined with the close proximity of utilities and buildings led to investigating different types of construction solutions. The following options were considered:

- ***Pipe bursting***: There was limited room for the reception pits and this process was likely to produce ground heave next to adjacent structures.
- ***Online auger boring***: The ground conditions could lead to a risk that the boring machine baulk may get stuck and then revert back to open cut technique.
- ***Linear well point dewatering***: This could result in damage to structures and services when lowering the ground water levels and this has a larger zone of influence.
- ***Carrier drain dewatering***: This technique would not limit the zone of influence and hence risk to nearby services & structures.
- ***Ground freezing***: This costly technique potentially would cause ground heave resulting in the potential damage of


Polymer Injection Trial in Church Street - Courtesy of NMCNomenca


Treated material - Courtesy of NMCNomenca


Material prior to excavation - Courtesy of NMCNomenca

Polymer Injection - Courtesy of NMCNomenca

the nearby highway sewer and structures. This could also lead to damaging the nearby brittle water and services due to the temperature difference combined with localised ground movement. Carrying out the process of ground freezing in a small village location would also be difficult due to limited space.

- ***Sealing trenches with bentonite slurry***: Potential difficulties in pipe laying and risk of settlement whilst excavating longer trenches.

The following construction methods were used on site:

- ***Acrylic polymer injection system***: This led to significantly less risk compared to the other options and this method was used on site in areas of running sand to improve ground conditions.
- ***Sump pumping***: Was used in short lengths of excavation.

Polymer injection system

A trial using two different injection systems was used on site. The first injection system involved pressure injecting a polyurethane through sacrificial 25mm galvanised steel rods at 300mm centres, driven into the ground using a standard 360 degree excavator, with a setting time of 30 seconds to 2 minutes. The second system was a two-part acrylic resin injected using the same method.

While the polyurethane's inherent rigidity makes excavation easier once the material has set, the acrylic resin is finer and affords greater penetration. The second system proved to give superior leak sealing capability during the trial and was therefore chosen as more suitable for the project.

Specialists Tempo-PCE were chosen for the main works utilising the polymer injection acrylic resin system. Acrylic resin injection has been used on Severn Trent sewage works to seal potable water structures. The compounds are odourless when mixed, can be safely used in confined spaces, and the resulting material is classified as inert waste. Polymer injection systems have been successfully used in the underpinning of listed buildings.

The injection helped to accelerate progress on site, with a wider 500mm grid and use of a modified soil nail for placing the injection probes. This circumvented the need to remove sacrificial probes, enabling easier excavation of the trench post injection.

To limit the risk of damaging services the first metre was excavated by hand and the services located. The polymer injection system was then carried out in short 10m sections with the main trench excavations and shoring working in tandem behind. The method statements and management of this process was detailed and closely monitored.

Project management

The framework nature of this project enabled the efficient scheme management from cradle to grave. Early identification of key stakeholders led to better involvement between land owners, local council and members of the public.

The method of construction played an important part in the planning of the project. The polymer injection system and variable ground conditions led to slower rates of progress, this led to a higher impact on local residents.
The risk management plan was an important part of this project and the significant risks to the scheme were as follows:

- Access to the works
- Close proximity to Grade II listed buildings
- Utilities clashes
- Risk of damage to the highway sewer
- Flooding during the works

Diagram 1:
Modified soil nail allows injection through a removable drill bit avoiding sacrificial probes and reducing material use.

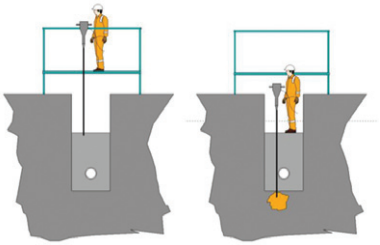
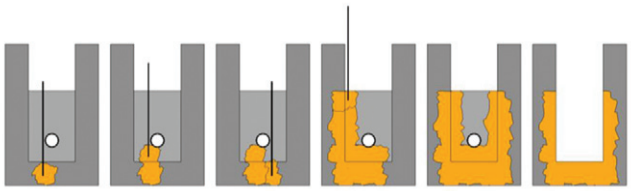


Diagram 2:
Targeted injection to perimeter excavation line minimises use of material.



- Third party land access and diversionary works on third party land.

This scheme developed by identifying each risk and removing or mitigating the risk. The significant risks were communicated to the construction teams on the site drawings in line with the CDM Regulations.

Detailed cross sections of the scheme were produced and structural condition surveys were carried out by Eastwood & Partners Structural Engineers. A Construction Methodology Report was commissioned to review the techniques and give guidance on risk and a structural monitoring plan was put into place for the Queens Head public house buildings through all stages of the works.

Liaison with the landowners and local residents has been particularly challenging on this scheme due to the close proximity of the works to the buildings and the small rural village location.

Sustainability

The route of the access road was amended to avoid a mature tree and the access into the works area involved minimal hedge removal. The material from the temporary haul road will be recycled at the end of the scheme. Plastic pipes supplied by Polypipe Civils Ltd were used to limit size of deliveries, enable easy handling in restricted working areas and limit the conflicts with services due to the smaller outside diameter.

Societal benefit

Working in a small rural village such as Billesdon has led to detailed stakeholder management plans and a customer care focus in both the planning of the works and the construction stage. Prior to starting on site, several letter drops were carried out to the whole of the village. The scheme details were discussed in detail with both Leicestershire County Council and Billesdon Parish Council and a public "Drop In" session was held at the local community centre and attended by twenty local residents.

To limit impact on the residents a temporary 220m access road from Leicester Road was built to connect the site compound and works. This limited traffic disruption and prevented larger deliveries travelling through Billesdon. The Church Street works were carried out in sections under temporary road closure and the site team liaised daily with the residents to limit disruption. During the works, a further road closure was added on Brooke Lane as a result of commuters using the diversion route as a cut through in the village.

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