

# Ambergate Service Reservoir

## construction of the second largest service reservoir in Europe, a secure water supply across the East Midlands for a further 100 years

by Stewart King, Duncan Wratten, Gavin Noble & Anthony Heaney

**A**mbergate Service Reservoir at Fritchley has been an essential element of the water supply system to a significant number of customers in Derbyshire, Nottinghamshire and Leicestershire. It was first commissioned over 100 years ago, and although it has provided a reliable service during this time, it is nearing the end of its life in its current condition. The reservoir has exhibited significant cracking in the upper walls and is operated at a lower maximum water level than was originally intended. Similarly, the roof construction comprises a shallow barrel vaulted concrete roof which springs from steel beams which are showing significant signs of deterioration. Severn Trent Water is making this investment to ensure the asset is fit for the next 100 years.



Phase 1 under construction. Aerial view showing proximity to the existing reservoir - Courtesy of Laing O'Rourke and NMCNomenca

### Award of the scheme

Severn Trent Water (STW) awarded the detail design and construction for the scheme to a joint venture of Laing O'Rourke and NMCNomenca at the start of 2014. The JV is supported by Atkins who is providing the detail design for the scheme. The contractor engaged JC Balls & Sons to undertake the extensive earthworks required for the project and STAM Construction Ltd to complete the concrete works.

### Feasibility of the new solution

Options considered for providing the renewed asset included refurbishing the existing reservoir; however this was not possible due to being unable to take the reservoir out of service. Constructing a new reservoir in a new location was hydraulically limited because the reservoir needs to be constructed at about the same AOD level as the existing reservoir which limited the selection of alternative suitable sites. Constructing a single new reservoir of 137MI was limited due to land availability on the existing site.

Consequently the preferred solution was to construct a 2-cell reservoir (Phase 1) adjacent to the existing reservoir and, once

commissioned, demolish the existing reservoir and construct a third cell (Phase2) on the footprint of the existing reservoir. Phase 1 consists of twin 43.5MI cells and Phase 2, a 50MI cell.

### Site constraints

The physical constraints of the site and the need to be able to keep the existing reservoir operational, meant that the design and construction team had to expose the west face of the existing buried reservoir to enable the new distribution chambers and pipework to be safely constructed between the new and old reservoirs. Close collaboration between STW and the design and construction teams enabled some significant value-engineering to be adopted on the pipework and valves, reducing the size of the large diameter pipework and chamber sizes. This saved cost on the project but more significantly gave the site team valuable working room to construct the new assets.

### Reservoir flow

Flow enters the reservoir horizontally through the inlet pipe positioned close to the tank wall. This encourages the flow to 'spiral' around the plan area of the reservoir to the outlet pipe which is

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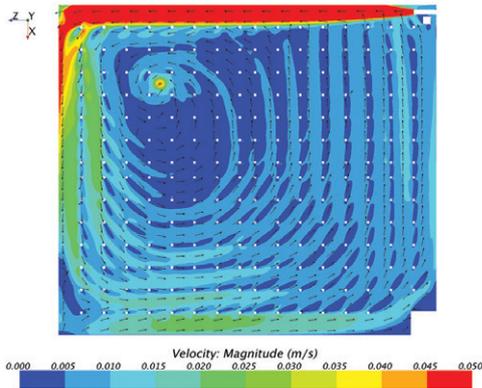
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CFD Model - Colour contours showing the flow through reservoir cell  
Courtesy of Laing O'Rourke and NMCNomenca



Profile achieved in cutting of north corner  
Courtesy of Laing O'Rourke and NMCNomenca



Twin wall in place - Courtesy of Laing O'Rourke and NMCNomenca

positioned to encourage this flow ensuring there are no 'dead spots' in the reservoir. This negated the need to adopt internal walls or curtains to ensure effective flow characteristics within the reservoir.

In close collaboration with the local authority, it was agreed that a concrete batching plant would be established on site. This gave the construction team more flexibility in the timing and size of concrete pours due to the constraints on vehicle movements and delivery times.

#### Bulk excavation

Excavation for Phase 1 of the new reservoir required major excavation of the near vertical faces of rock to be carved out of the hillside. The design team produced a full CAD 3D earthworks profile which the construction team uploaded to GPS enabled excavators.

This allowed the machine operators to dig to near perfect profiles. This also reduced the need for site engineers to set-out traditional batter profiles and negated the need for personnel to be in close proximity to operating plant, which significantly reduces the H&S risk on site.

Rock-netting was adopted on some of the steeper rock faces to capture any rock slips and protect the workforce constructing the reservoir.

#### Phase 1: Design & construction

The reservoir structure is designed as a propped cantilever but also utilises a limited number of expansion joints in the construction to limit thermal stresses on the reservoir roof and walls. Phase 1 is constructed as one structure forming two cells. The north end of the reservoir is founded on rock, but because the bedrock drops away, the south end of the reservoir is piled.

The large plan area of the reservoir enabled the site team to progress construction of the base, the walls and roof concurrently to optimise progress on the construction schedule.

The columns and roof structure for the reservoir are precast. The roof system consists of a precast roof system over which is cast a fully structural slab. This is designed to prop the walls to resist both the internal water pressure and the soil pressure externally.

#### Distribution chambers

Close collaboration between the design team and the construction team resulted in different designs being adopted for the distribution chambers. The opportunity to adopt Design for Manufacturing and Assembly (DfMA) was taken where appropriate for some of the distribution chambers. The selection being a function of the structural loading on the chamber walls and the frequency of penetrations.

Some of the chambers adopted a precast 'twin-wall' design which consists of factory produced 400mm thick wall concrete sections comprising two 80mm thick shells which act as a sandwich to contain in situ concrete once they have been placed and reinforced on site.

The roof construction for all the chambers comprise a 'lattice plank' arrangement which provide a suspended permanent shutter and avoided the need for extensive temporary support systems in these deep chambers.

#### Phase 2: Design & construction

Phase 2 consists of a single cell reservoir approximately 100m by 100m in plan. The tank walls are designed using the DfMA 'twin-wall' design which significantly increases the rate of wall production. The roof design mirrors the design for Phase 1 utilising precast columns and roof system. The efficiency of the design of the walls has been maximised by utilising the large volume of polystyrene insulation



Batching plant  
Courtesy of Laing O'Rourke and NMCNomenca



Installation of the precast columns/beams  
Courtesy of Laing O'Rourke and NMCNomenca

recovered from the original roof. Incorporating this as backfill to the tanks walls reduced the wall loading and therefore the wall thickness and reinforcement requirements to be minimised.

### Community liaison

A community liaison group has been set up to represent members of the local community and other stakeholders who may be affected by our construction activities. The group meets with representatives of Severn Trent Water on a regular basis. At the meetings, the group is provided with details of project proposals, and an update on progress and future activities.

The meetings provide an opportunity to discuss any matters of concern with the Ambergate project team, and give feedback on how the works are received within the community, and what impact the project has on local residents living near the site. The group has formed a sub-committee to develop opportunities for community support, and the committee will receive and consider requests

for funding of local initiatives which will provide a significant and lasting legacy for the villages which are the immediate neighbours of the Ambergate Reservoir.

### Conclusion

The scheme provides an excellent example of a collaborative approach between Severn Trent, their construction delivery partners and designers delivering solution utilising innovative processes and adopting a DfMA approach to assist in meeting tight delivery deadlines. The construction of Phase 2 of the reservoir, utilising the DfMA wall and roof solution, will be further described and illustrated in UK Water Projects 2016.

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Reservoir under construction - All photographs courtesy of Laing O'Rourke & NMCNomenca