Royal HaskoningDHV
Enhancing Society Together

client | Environment Agency

Royal HaskoningDHV's consultant engineers responded quickly to an urgent problem, and in doing so reduced the risk of flooding to a trunk road and local community. They were always proactive and worked closely as a team with ourselves and the contractor. Throughout the design process they looked to ensure safety, and made time and cost savings. The end result means the longevity of this historic reservoir can continue."

Anya Bednarczyk, Project Manager, Environment Agency

Repairing a 19th Century reservoir

More than 170 years after its construction in 1837, the outfall structure of Cheshunt North Reservoir, located thirteen miles North West of London, was in a deteriorating condition. Some of the original mortar used in the masonry construction had been washed away over the years, leaving the structure weakened, and evidence of leakage had been observed. There were also concerns about other internal structural problems that were hidden from view. A succession of repairs over the years had not completely addressed the underlying problems, which meant a more long term sustainable solution was needed urgently.

Because it holds more than 25,000 cubic metres of water above the natural ground level, the reservoir is classified as a 'large raised reservoir' under the Reservoirs Act 1975. The client, the Environment Agency, as statutory undertaker of the Act, is required to protect public safety. The consequences of the reservoir being breached would include flood risk to nearby housing, contamination of the local water supply, and disruption to traffic on the nearby A10 trunk road.

In Spring 2010, Royal HaskoningDHV was asked to carry out an initial structural inspection to determine the extent of the problem. Tei Ho, lead design engineer on the project, explains some of the interesting issues:

"Due to the age of the structure understanding how the reservoir had been built was challenging, as very little information existed. Original sets of drawings were created during different time periods and these differed slightly. While some of the nineteenth century designs were beautifully drawn, they were hard to understand, and some of the technical terms were different to those we use today. This meant we literally had to stitch the drawings together to understand the wider picture – almost like a 'Crime Scene Investigation' series – but with a civil engineering slant.

"We also had to minimise destructive testing, as taking away part of the structure to examine it, while useful, would have defeated the purpose of repairing the reservoir. So, in addition to visual inspection and sampling, we used ultrasound scanning to identify hidden internal faults, gaps and cracks. The challenge here was that the scanner produces a graph which has to be interpreted in the context of the project, and given the lack of information from the outset, solving the puzzle was not a straightforward exercise."

Another key concern was the condition of the foundations. Given the variability of the wall conditions, the preferred option to maintain the integrity of the chamber was to fill part of the chamber with concrete. This would prevent the structure from deflecting and collapsing. However

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there was a risk that this would add too much weight to the structure. To assess the risk and determine whether the structure could bear the additional weight, bore holes were drilled to investigate the ground condition beneath the outfall structure. Fortunately the result was positive and the use of lightweight concrete helped to reduce the loading further.

On testing the iron ties that support the chamber walls, the team discovered that the iron had become corroded. Urgent repair and replacement was required to prevent the ties from breaking and the walls from collapsing.

Following feasibility studies, project appraisal and detailed design work, funding was approved by the Environment Agency and construction work began in Spring 2011. Royal HaskoningDHV carried out site supervision and design support. Tei Ho recalls much of the work was carried out in wet and cramped conditions:

“We were working in a confined space that could be likened to a giant teacup. Access to the outfall chambers was difficult, too. First we had to repair three 15 metre long culverts, and then crawl through these to access the chamber.

“The main issue here was that the ‘one third downstream’ culverts had a smaller cross-section than the rest. This meant we would have to insert precast concrete pipes into ‘two thirds upstream’ sections of the culverts, in order to create a consistent cross-section that would reduce turbulence and scouring damage. However there was only enough space available upstream to feed through pipes in two-metre long sections. This would significantly increase the risk to health and safety, construction cost, and time.

“We solved the problem by recommending substitution of the heavy precast concrete pipe with lighter composite plastic pipes, which would reduce the weight drastically. This offered the added advantage that the pipe could be manufactured in long sections without joints.

“We then demonstrated that the hydraulic performance required could be maintained even if the diameter of the ‘one third downstream’ sections, was reduced. This meant we could insert thin wall plastic pipes from the downstream end, which had much more space available. Taking this approach also meant we avoided having to cut the pipe into small sections, which we would then have to rejoin in a confined space. Our design enabled construction to be carried out safely, efficiently, and cost effectively.”

“The team brought together hydraulic, geotechnical and structural skills to solve the unique challenges presented by this historic structure. The work was completed in July 2011 and the results, according to Tei, were “better than we hoped.” He added. “The structure looks robust and should not need another major refurbishment for the next 50 years or so.” In the meantime drivers on the A10 and members of the local community are safe from the risk of flooding.

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