Barkers Haugh STW

new inlet works procurement and construction

by Matt Agar BSc MICE, Michael Hansen HND & Heraldo Biasi BSc MSc CEng MICE FCIWEM

Barkers Haugh STW serves the City of Durham and is located adjacent to the River Wear immediately downstream of the city centre. The population equivalent is about 34,000 and the design allows for an increase to 46,000 over the next 20 years. Combined flows arriving at the works include a twin inverted siphon under the river. Dry weather flows of 100l/s and Formula A storm flows of up to 600l/s arrive via a final length of 750mm diameter sewer. The first flush during high flows result in high grit and screenings loads arriving at the works. This case study describes the procurement and construction of a new inlet works to replace an original facility dating back to 1962. The concept, planning, design and procurement strategy is described in another case study in UK Water Projects 2014 - Virtual Edition.

Completed screw pumping station with GRP odour covers - Courtesy of MWH Treatment

Reason for the scheme

Some of the mechanical plant was over 23 years old and the installation was found to be undersized for future flows, overwhelmed by rag and grit loads and prone to frequent blockage, breakdown and damage. The plant had become very labour intensive to operate and maintain, requiring frequent ongoing manual intervention and repair. Access to the below ground plant was difficult and conditions unhygienic.

Severe knock-on effects were being experienced in downstream processes. Rags accumulated in the grit channels and storm tanks could not be automatically cleaned out. Rags in the primary sludge caused pump blockages and rendered an existing sludge thickening plant inoperable, resulting in increased sludge tanker traffic for sludge disposal and a requirement for further treatment at the sludge reception site. In all, additional operating costs and operational carbon footprint were being incurred.

Client's brief and solution

NWL engaged Mott MacDonald to design and supervise construction of a new inlet works comprising an Archimedes screw pumping station to lift flows from the incoming 6.5m deep sewer to a height of 3.5m above ground level from where flows would gravitate to re-join the subsequent treatment process. The new elevated inlet works includes: escalator fine screens; screenings dewatering/compactor plant; flow control, measurement and storm flow separation; and a cross-flow grit removal system.

Site footprint and reuse

The new inlet works was to be constructed on the site of two redundant sludge digestion tanks, demolished to create the required space. The available area was, however, tight at only 1,500m^2 plan area, so construction on a relatively small footprint would have to be well managed. An adjacent redundant boiler room was also to be stripped of redundant equipment, refurbished and brought back into use to house a control panel for the new inlet works.

Procurement strategy and risk reduction

Given the operational benefits to be gained from the project, one of the employer's objectives was to implement a solution as early as practicable. This was achieved by phasing the procurement of

the works into four distinct site-works contracts, the first two taking place concurrently with on-going design work. This approach allowed an early start to delivery of the project on site, with some early gains such as improvements to an existing sampling point for the Environment Agency, in advance of the main contract. Significantly, it allowed risks to the main contract to be managed early and steadily reduced in advance of that contract.

By the time the main contract had been awarded, long-lead items such as third party issues, service and utility diversions and plant and equipment assessments had been put in hand, and possible time delays and additional costs which could occur on the main contract were thereby mitigated or avoided, and programme and cost certainty was increased.

The main construction contract was let under an NEC3 ECC Option A Lump Sum contract, with tenderers requested to propose their own sectional completion date for turning of flows and beneficial use of the works.

Enabling works contract

Once the location of the new inlet had been decided an enabling works contract was awarded so that items which could be addressed at an early stage were tackled, to prepare the site for the eventual main contract. An overhead BT line used by the site telemetry system was diverted and, following a survey by ground probing radar, uncharted buried services were investigated by trial pit. Redundant buried cables and a mains gas supply were removed, as was asbestos-lagged pipework found in a service trench.

Underground power cables crossing the site were diverted to the perimeter of the site before earth mounds could be removed from around the two redundant sludge tanks and the tanks demolished. Their footprint was backfilled with material won from site to create a level site, the boiler room was stripped of its redundant equipment, and the enabling contractor's water and power service connections were made permanent so that they could be re-used by the subsequent main contractor. Crushed concrete from the demolished concrete tanks was processed and used to form a working platform for a piling rig under the advance piling contract which followed.

Advance piling contract

By the time the enabling works had been completed, the new inlet works layout had been fixed, and a separate contract was awarded to install the foundation piles in advance of the main contract. In this way further progress was achieved on site whilst detailed design of the main contract was still being finalised and tender documents prepared.

This approach served to remove risk of ground conditions from affecting the main contract, since any delays (eg. due to pile refusal) would be dealt with in advance of the main contract, avoiding potential on-costs to the main contract: in the event, piles had to be re-driven in three instances.

The approach adopted meant the main contractor was subsequently able to commence construction on the pre-installed piled foundations, on a fully prepared site, as soon as it arrived on site. With the majority of remaining work at or above ground level, construction (and hence programme) was now fully within the control of the main contractor.

A total of 57 (No.) 340mm diameter circular hollow steel tube foundation piles of average 15m driven depth were installed under a contract let directly to a specialist piling contractor , with pile cut-off levels being at the required heights above ground level. The design allowed significant savings in overall construction effort, use of raw materials, programme and costs to be realised at very little additional cost and construction effort.

Demolition of redundant sludge digestion tanks Courtesy of Mott MacDonald


Pouring concrete for the screw pumping station base within cofferdam excavation - Courtesy of Mott MacDonald


Advance piling: driving steel piles for the elevated inlet works. Crushed concrete working platform subsequently incorporated into the permanent works - Courtesy of Mott MacDonald


Driven steel foundation piles extend above ground level Courtesy of Mott MacDonald

The main contract

The main contract was an NEC3 Engineering and Construction Contract Option A (Fixed Price with Activity Schedule) with two sectional completions: one for full process commissioning (take over by the client); and the second for removal of redundant equipment, demolition of redundant structures, permanent reinstatement and final landscaping works.

Civils construction comprised: the screw pumping station; elevated channels containing the mechanical plant; installation of 240m of ductile iron and concrete pipework of 450mm and 675mm diameters; modifications to existing storm tanks; concrete hard-standings and surface water drainage; and a steelwork shelter for the screenings skip.

The MEICA scope of supply comprised: a new MCC, electrical system and systems integration; duty/assist/standby Archimedes screw pumps; duty/standby fine screens and screenings handling equipment; and a cross-flow grit removal system.

The new inlet works channels were successfully constructed on the pre-installed piled foundations. Redundant below-ground screens and pumps, and above ground grit channels, were decommissioned, abandoned, in-filled or demolished, as appropriate.

Odour control and treatment plant refurbishment and uprating

The new inlet works was fitted with GRP odour containment covers and air is ducted to the existing odour treatment system, which was refurbished and upgraded as a separate specialist contract in time for completion of the new inlet works.

Construction challenges

Construction on a tight site required careful planning and coordination of activities and trades so as to avoid congestion and manage site safety. Coordination with the client's on-going operation of the remaining treatment work was done at weekly look-ahead meetings.

The screw pumping station was constructed within a compact 7m deep temporary works cofferdam which had to be installed adjacent to existing buildings. Excavation within the cofferdam exposed the pre-installed foundation piles so that they could be cut down to final levels. Groundwater ingress did not prove to be significant, and a stepped formation was formed to achieve the required incline of 38º for the screw pumps.

The pumps were 1.45m diameter and 16.5m long and sourced from Belgium. An overnight ferry was used for the Channel crossing, and delivery to site was timed to be during the night-hours, to avoid traffic disruption in Durham city centre. A 105t contract lift was used to install the pumps.

The new inlet works, hence the contractor's working area, was sited immediately inside the entrance to the works. The contractor had to safely maintain access for Northumbrian Water's normal operational requirements (including skip wagons and sludge tankers) and other site visitors for the duration of the contract.

Commissioning

A commissioning plan was developed to address how tie-ins to the existing works would be made with minimal interruption to flows or adverse effects on the treatment works. Connections were carefully planned and timed to coincide with low flow dry weather conditions, since once flows were turned, there was no turning back.

Pre-commissioning and functional checks on new equipment were made in dry tests prior to turning the flows. Full process commissioning and wet testing was carried out on live flows once flows had been turned.

Installation of screw pumps - Courtesy of MWH Treatment

Since the new plant could not be run at the same time as the existing works, the power supply was permanently switched to the new MCC by a feed from a redundant section of the existing works incomer panel, without interrupting the existing works.

Health and safety

The project was delivered safely with no major or reportable RIDDOR incidents. In addition, Northumbrian Water carries out monthly audits of its project construction sites and throughout the project the contractors consistently scored high key performance indicators for health, safety and environmental performance.

Effect on local community

The main contractor, MWH Treatment, was awarded *'Performance Beyond Compliance'* for the project under the Considerate Constructors Scheme. On arrival at the site, MWHT carried out a litter pick of the adjacent riverbank and installed bird boxes in adjacent trees. At key stages, potentially affected neighbours and third parties were kept informed of activities such as short-term piling operations.

Design for construction

The project was designed to be easily built, and relatively few design changes took place during the construction phase, reducing potential for delay and increases in costs, improving programme and cost certainty for the client.

Sustainability and waste minimisation

A redundant brownfield part of the site was brought back into beneficial use. A project aim was to minimise the amount of construction materials required, and to reduce the amount of waste generated and disposed of from site. This also reduced the amount of road traffic and haulage, associated impact on the local community, disposal costs and carbon footprint.

- Arisings from excavations were reused as fill (where suitable) and to create a screening mound on a designated area of the site.
- Waste was segregated, and redundant plant and equipment was taken to NWL stores for possible reuse in other schemes.
- The old boiler room was reused to house the new control panel, avoiding the need to construct a new building.
- Crushed concrete from the demolished sludge tanks was used to form a working platform for the piling rig, and was subsequently used by the main contractor as a firm hard-standing to access the construction area. The material was finally incorporated into the sub-base for the new permanent concrete hard-standings.

Contractor design

MWH Treatment was responsible for detailed design of mechanical and electrical plant, precast concrete items, GRP covers, GMS metalwork, access covers and PLC systems integration.

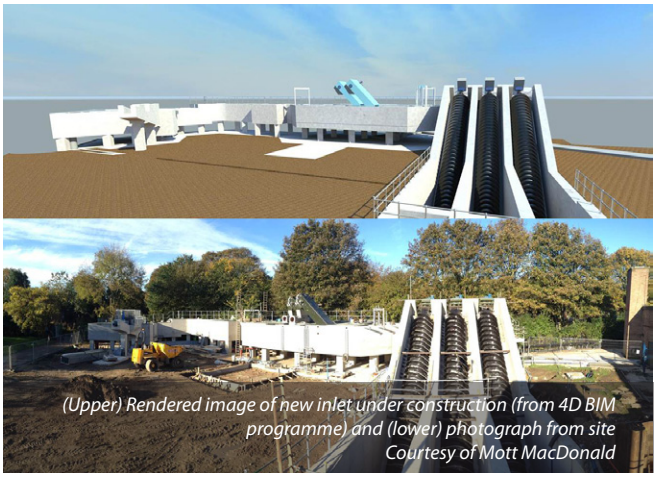
Conclusion

A new, modern inlet works has been provided within a tight footprint, on time and at an affordable price. This sustainable solution will not only reduce future site operation and maintenance costs, but will also reduce sludge tanker traffic, significantly reducing operational CO_{2e}.

The Editor & Publishers thank Matt Agar, Project Manager with Northumbrian Water, Michael Hansen, Project Manager with MWH Treatment, and Heraldo Biasi, Technical Manager with Mott MacDonald, for providing the above article for publication.

The Barkers Haugh STW concept, planning, design and procurement strategy is described in another case study in UK Water Projects 2014 - Virtual Edition.

Project Timeline	
Feasibility Study	October 2011
Detailed Design	2012
Enabling Works Contract	June 2012
Advance Piling Works Contract	July 2012
Main Contract tendered	September 2012
Main Contract awarded	December 2012
Commencement of Main Contract on site	February 2013
Beneficial use (turning of the flows & take-over)	November 2013
Contract Completion	March 2014
Key Participants	
Client	Northumbrian Water
Technical Services Consultant, Lead Designer, CDM-Coordinator and ECC Site Supervisor	Mott MacDonald
Commercial Services Consultant and ECC Project Manager	AMEC Environment & Infrastructure Ltd
Main Contractor	MWH Treatment
Enabling Works Contractor	Seymour Civil Engineering
Advance Piling Works	Green Piling Ltd
Screw Pumps	Vandezande
Escalator fine screens	Longwood Engineering
Kuhn screenings compactors	M&N
Grit detritor	Ovivo
Electrical system and control panel	TES NI Ltd
Systems Integration	IDEC
Formwork, rebar fixing and concreting	BBC Formwork
Structural Steelwork	SDM Fabrications
GRP Odour Covers	Process Fabrications
Odour treatment system refurbishment	ERG (Air Pollution Control)



(Upper) Rendered image of new inlet under construction (from 4D BIM programme) and (lower) photograph from site Courtesy of Mott MacDonald

Construction of new inlet works on a compact site Courtesy of Mott MacDonald