

# Phosphate Removal Batch Schemes

## realising efficiencies by batching four Severn Trent Water sites with chemical dosing plant issues into one contract

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The continual need to strive for further efficiencies in the areas of design and construction productivity has led Severn Trent Water to batch four phosphorous removal schemes within the Warwickshire catchment. At three of the sites (Rugby Newbold, Spernal and Longbridge) the delivery team, comprising Severn Trent water and CostainMWH replaced the existing dosing systems whilst at the fourth site (Coleshill) a new dosing system was installed. This paper looks at the existing set up of each of the four sites in the batch and the methodology undertaken by the team to ensure efficiencies at the design, construction and commissioning phases.



Longbridge STW ferric sulphate dosing unit - Courtesy of Costain Ltd

### Background to the sites

The four sites that made up the Warwickshire phosphate removal batch scheme are as follows:

**Rugby Newbold STW** is located on the western outskirts of Rugby and serves a population of approximately 87,000. The works has a total phosphorus (Total P) with two different consents; 1mg/l under Countryside Rights of Way (CROW) Act, and 2mg/l or 80% removal under the Urban Wastewater Treatment Directive (UWWTD). To meet its P consent an iron coagulant (ferrous chloride) is dosed into the activated sludge plant (ASP). The site has a 3mg/l iron consent. This scheme had a capital maintenance driver to address the issues with the ferrous chemical dosing plant.

**Redditch Spernal STW** is located 5km south-east of Redditch and serves a population of approximately 83,000. The works consists of an inlet works and primary settlement, followed by two streams of secondary treatment, ASP and biological filter. The works also has storm tanks, sludge digestion and chemical dosing. The driver was capital maintenance to address the issues with the ferrous and ferric chemical dosing plants. The site has an UWWTD Total

P consent of 2mg/l or 80% removal. The P consent is maintained by dosing ferrous chloride to the biological filter stream and ferric sulphate to the ASP stream.

**Longbridge STW** is located in Warwick and serves the Leamington and Warwick network catchments. The current population equivalent (PE) is 126,000. Ferric dosing has been in place to meet the phosphorus consent at Longbridge since 1998. This is achieved via simultaneous dosing into the crude and primary humus tank feeds. The consent limit for phosphorus is 1mg/l.

**Coleshill STW** is a large works (current PE 240,000) located to the east of the Birmingham conurbation serving the populations to the south and east of the city. In order to meet the new consent a phased approach was proposed.

The first stage was to install a 60m<sup>3</sup> liquid chemical dosing plant upstream of the activated sludge plants. The performance of this unit will be assessed and if solids carry over is an issue, then a 1DWF tertiary sand filter will be installed. It is not envisaged that both additional treatment stages will be required.

### Assessing the right solution

Discussions with several supply chain mechanical and electrical partners were carried out to determine the most optimal solution for the four sites. Working with the *Chemical Dosing Community of Practice* within Severn Trent, a different design template was proposed by the supply chain. This template underwent a rigorous review and assessment utilising experts and end users under a Hazop process, from across Severn Trent's One Supply Chain pulling in expertise from across design and construct partners.

The new proposal was significantly different to the previous standard template incorporating a ground level GRP tank with integral bund compared with a traditional below ground in situ concrete banded tank holding a single skinned GRP tank.

### Benefits of the new solution

A change in the specified kit had significant benefits in the whole delivery process.

#### Civil benefits:

- A cost effective dosing package led to savings in the civil construction scope.
- Standardisation of dosing plant civil design arrangement to all sites.
- There was no need for excavation for a below ground in situ concrete bund which improved time on the traditional programme and reduced the contractor's on-site prelims by approximately four weeks at each site.
- The uniform design allowed calling off materials easier and allows one set of shutters to be used on all schemes.

#### Mechanical benefits:

- The integral banded ground level tank coupled with peristaltic pumps requires a less complex pipework arrangement thereby making it easier for the operational team to understand and trouble shoot.
- The additional benefits of peristaltic pumps include:
  - ▲ Simplifying pipework requirements as there is no requirement for NRV's, dampeners, loading valves etc. This makes the set up much easier to understand and maintain.
  - ▲ No moving parts are in contact with chemicals.
  - ▲ Easier and reduced maintenance, quick release fittings for hose change.
  - ▲ Manufacturers guarantee for 5 years.

### Lean processes

Lean processes were adopted through early collaboration with the supply chain. A simple process of inviting the potential civil, mechanical and electrical suppliers to meet early and develop the programme collaboratively enabled each party to understand the critical interfaces and requirements at the start.

The aligned Severn Trent Water Programme Manager and design and construction team was used across all four sites. This meant that the civil, mechanical, electrical and commissioning lessons learned were more easily transferred between sites.

### Design phase

There is a balance between design costs and construction gains.

- Early in collaborative discussions, it was calculated to be more cost effective to design the slabs based on the worst case ground bearing condition (Longbridge) and the largest tank (Coleshill). This resulted in two structural designs (for the two templates) rather than four.
- An assessment of the ground classification across all sites was made and again, a single concrete grade was adopted across the installations.

- A suite of template specifications was generated which were then tailored to each of the sites. By starting with a set of base documents this ensured commonality across the documents.
- In the future STW and the construction team can pull off the shelf a template set of GA drawings, RC drawings and specifications for a 1 tank and 2 tank option, for tank sizes up to 50m<sup>3</sup> (or 2 x 50m<sup>3</sup>). Ultimately the approach resulted in a reduction in design time and cost. These design templates were shared with other Severn Trent supply chain partners.

### Other construction efficiencies

- **Fibre reinforced concrete access road:** The installation of a fibre reinforced concrete road was proposed, although slightly more expensive, significantly improved on-site safety and productivity by avoiding the requirement of placing traditional mesh reinforcement.
- **Minimising landfill:** Three out of the four sites required the old equipment that was contaminated with chemicals to be removed. Through a controlled and managed process all the ducting and equipment was carefully washed and chemical residue was disposed back into the treatment process to avoid excessive hazardous landfill costs.
- **Prefabricated chemical dosing sump:** A sump for the collection of spilt chemical was required at Rugby, Coleshill and Longbridge. Traditionally a 1,500mm manhole ring would form the chemical containment sump capable of retaining 2m<sup>3</sup> of liquid. Instead, a bespoke GRP prefabricated chemical containment tank was sourced.

This tank is resistant to the chemicals used in P dosing and offered the following advantages:



Rugby Newbold STW ferrous chloride dosing unit  
Courtesy of Costain Ltd

- ▲ Reduction to the frequency of lifting operations leading to a health and safety benefit.
- ▲ Construction time reduced from 3 days to 1.
- ▲ No need for confined space entry as the chamber does not require benching.
- ▲ More robust solution for the client.

- **Reuse**

At every stage the construction team sought to reuse existing assets such as existing ducts and drawpits through jetting and washing. Existing chambers were reused by utilising a prefabricated GRP liner.

### Commissioning efficiencies

Ensuring the sites maintained consent whilst undertaking the changeover could have proved rather costly requiring the provision of a temporary tanker and bunded area.

This was avoided at Redditch by cleverly converting one of the two existing ferric sulphate tanks into ferrous chloride with some simple pipework modifications and a clear commissioning plan approved by the works manager.

### Commercial successes

- **Teamwork & behaviours**

The whole team from STW, CostainMWH, Envex, EPS and Cema bought into the batching ethos, all asking each other the right challenging questions to achieve the team goals. All parties were actively involved to help with each other's roles when required.

- **Cost certainty**

Cost certainty was achieved through time spent at front end with the supply chain which meant minimal increase in order value at final account.

- **Bulk purchasing**

5 (No.) dosing rigs and associated safety showers and hose reels were purchased on one order allowing the supply chain to offer discounts. A large quantity of dual contained dosing lines were purchased direct from suppliers rather than through the dosing kit suppliers.

- **Collaborative programme**

Giving the supply chain the visibility of the programme early allowed for work continuity for the supply chain and discounts offered.

- **Value engineering**

Close contact with the supply chain early on allowed for alternative solutions to be sourced and implemented to drive savings.

### Smoother completion and handover

On-site lessons learnt were driven through the batch using a common team and commissioning engineer.

- Batched package provides continuity of work for civil subcontractor, electrical installers and chemical dosing delivery and commissioning.
- Having got over the first hurdle of understanding the information required for handover at the first site, the process then went more smoothly for the remaining schemes.
- Excellent relationships were formed with the end user, Service Delivery.
- Efficient planning of commercial completion and handover documentation.

### Carbon assessment

The new proposed solutions developed by the team contributed to a carbon reduction in both operation and delivery in a numbers of ways:

- Avoidance of a below ground reinforced concrete bund.
- Fibre reinforced concrete road instead of a traditional reinforced concrete road.
- Avoiding sending waste to landfill by using demolished concrete as fill to existing underground saturator tanks.
- Existing tanks were cleaned and passed on to a specialist to prepare for reuse.
- Avoidance of disposing hazardous material.
- Existing dosing ducts reused avoiding the need to excavate and lay new ones.
- Chemical residue diluted on site and returned into the works in a controlled manner
- Reuse of structures through relining avoiding demolition and rebuild.
- M&E savings through the need for fewer pumps and less pipework.
- Operational visits reduced through a more reliable solution.
- Chemical usage significantly reduced by more than 58% at the sites with existing dosing units.

### Lessons learnt shared with other organisations

As with all projects there are many lessons to be learnt and continual improvements to be made. A lessons learnt webinar was presented to Severn Trent's One Supply Chain partners.

### Conclusion

Early involvement and collaboration throughout the supply chain was essential to ensure successful delivery. Seeking an alternative technical solution has delivered some great opportunities in the design, procurement, construction, commissioning and handover processes, enabling 9% on-site productivity efficiencies.

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Rugby Newbold STW - Courtesy of Costain Ltd



Rugby Newbold STW: Ferrous chloride dosing unit  
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