Millom WwTW

new storm UV plant to disinfect stormwater prior to discharge into the Duddon Estuary

by Gill Baichoo & Joanne Rands

The traditional method for complying with a Bathing Water Directive and/or Shellfish Waters Directive is to increase storm storage volumes to reduce spills to the receiving watercourse. An alternative to large storage volumes is to disinfect the stormwater prior to discharge. At Millom Wastewater Treatment Works (WwTW), storm UV became the preferred option for treatment of storm effluent where an end of pipe disinfection target will be achieved through design and control.

Millom WwTW - Photograph shows proximity to the estuary - Courtesy of KMI

Project need

As part of United Utilities AMP5 investment programme a need was identified to reduce 2 (No.) intermittent discharges associated with King Street Pumping Station (PS) and Millom WwTW to improve the quality of the Duddon Estuary. The two discharge locations will have to comply with the Bathing Waters Directive of a maximum of three spills per bathing season and the Shellfish Waters Directive of a maximum of ten spills per year on average (the average is based over a 10 year period).

Background and description of Millom WwTW

The Millom study area is located on the shores of the Duddon Channel in western Cumbria, bordering the Lake District National Park and includes the villages of Haverigg and Millom. The catchment contains three watercourses, Haverigg Pool, Salthouse Pool and Crook Pool all of which discharge into the Duddon Estuary. The surrounding land is mostly agricultural and is generally flat and low-lying.

King Street PS is an end-of-pipeline wastewater network pumping station comprising of a low and high flow transfer pumping station and a tidal pumping station. Variable speed low flow transfer pumps and fixed speed high flow transfer pumps are used to transfer flows for further treatment at Millom WwTW. An overflow allows flow >305l/s to spill directly to the estuary.

Millom WwTW is situated on the east bank of the Duddon Estuary and treats crude sewage for a population equivalent (PE) of 7,874 and has a consented Flow to Full Treatment (FTFT) of 61l/s. The works receives flow via the King Street PS and an existing small bore delivery pipe feeding a flow balancing tank which regulates the flow to 6l/s via an existing orifice plate. The final effluent from the works discharges directly into the Duddon Estuary.

At Millom WwTW the inlet works comprises:

- Duty/standby escalator screens capable of screening up to 305l/s. 2 (No.) emergency bypass channels.
- 2 (No.) existing screening handling and compaction units.
- An existing single detritor.
- FTW and FTFT flow measurement flumes.
- Storm overflow chamber.
- Storm tanks.
- Sludge and storm return pumping station.

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Storm UV plant at the fabrication - Courtesy of Trojan

The new Storm UV Plant at Millom - Courtesy of United Utilities

Flows up to FTFT pass to primary treatment which is provided by a single PST. Flows are then passed forward for secondary treatment via an existing oxidation ditch. There are 2 (No.) final settlement tanks downstream of the existing oxidation ditch. Surplus activated sludge is returned upstream of the PST for co-settlement and RAS is returned to the oxidation ditch. Flows up to FTFT are then treated by the final effluent UV plant (fed by an existing pumping station) before exiting the site via the outfall to the Duddon Channel.

Project team

The project is being delivered by an integrated team of United Utilities, MWH and KMI+ (Kier, Murphy & Interserve) who together form part of the Process Alliance North. The concept and definition phases were the responsibility of United Utilities and MWH and the solution design package was issued in January 2012. The principal contractor, KMI+, is responsible for delivering the Implementation and handover phases.

Process options

The conventional solution to meet the bathing water and shellfish directive is to construct additional storm storage. Approximately 6,000m^3 would be required either at King Street PS or at Millom WwTW, to reduce the number of spills to the Duddon Estuary. However due to minimal land availability, the huge costs of both carbon and capital expenditure associated with the construction, third party issues and the significant impact on the works of returning such large flows to the head of the works, an alternative approach was required. A new storm UV plant was proposed to disinfect the stormwater prior to discharge into the estuary.

In the optioneering stage it was estimated that, based on whole life costs, a storm UV plant was up to £1.6m cheaper than the storm storage solution and it would take over 17 years to 'pay back' the embodied carbon equivalent with the increased operational carbon for the disinfection plant. Thus storm UV became the preferred solution.

The preferred process solution at King Street was to increase the pass forward flow to the works up to 700l/s to reduce the number of spills at the pumping station.

At Millom WwTW, the FTFT was increased to 100l/s, which involved modifications to the inlet works and final effluent UV plant, replacing the existing oxidation ditch with a new SAF plant, additional settlement tanks and to construct a new Storm UV disinfection plant.

Storm UV

A Storm UV plant utilises ultraviolet (UV) light disinfecting the stormwater. UV disinfection of the stormwater occurs either by causing cell death or by altering the genetic material in the cells so that bacteria, viruses and other micro-organisms can no longer reproduce. UV light in the range of 254nm is produced by germicidal lamps that are submerged in the water to be disinfected. As the stormwater flows over the lamps, the micro-organisms are subjected to a lethal dose of UV energy (a product of the UV intensity and the exposure time) and the numbers of microbial populations are reduced. Although UV energy demands are high the storm UV plant will only need to be used intermittently and overall energy consumption is not excessive.

Type

A medium pressure storm UV plant was chosen over a low pressure system due to the EA concerns regarding reactivation of bacteria from low pressure systems. An additional log kill to account for reactivation in low pressure systems may have been required; medium pressure systems do not have the same issue. Additionally there is a threshold dose above which the bacteria are not able to repair themselves. The threshold dose for medium pressure systems is much lower than low pressure systems.

Design development

There are no other storm UV plants within United Utilities. During the optioneering stage, site visits to existing plants in Welsh Water were arranged to allow process operators and other key personnel the opportunity to gain an understanding of the process and share knowledge of the operation. Once buy in with operations staff was established the project team approached the market place to seek expressions of interest from suppliers and Trojan Technologies was chosen as the preferred supplier.

Consent

An end of pipe limit on the storm discharge has been proposed by the EA until reliable and sustained performance of the plant installed at Millom has been demonstrated. The end-of-pipe standard proposed is 2.0 * 10^4 faecal coliforms/100ml. This limit will be assessed as an event based geometric mean.

Automatic monitoring will be used to capture the storm samples. The first sample will be taken as soon as possible after the storm occurs and within the first 10 minutes of the discharge occurring.

Each individual sample will be analysed separately for both *E-coli* and *Intestinal Enterococci*. The sample frequency will be variable, reducing as the storm continues; with a sample every 30 minutes for the first 4 hours, hourly for the next 4 hours and 2 hourly for the rest of the storm discharge. At least two summer and two winter storms will be captured each year for the first two years after which UU will review the on-going monitoring requirements.

Storm UV plant operation

Flows of up to 606l/s from the storm tanks will pass through the storm UV plant before being discharged to the Duddon Channel. Treatment is provided by a single concrete channel containing three banks of UV lamps, operating duty/assist/standby.

A weir at the downstream end of the channel maintains the minimum water level in the channel; a level probe will monitor spill events. A UVT monitor is installed in the inlet chamber to determine the UV transmittance of the influent.

A recirculation pump is installed in the channel to ensure that there is adequate cooling of the lamps/reactors during low flow conditions. If the channel is full of static water, this pump will also assist in preventing freezing and settling out of solids in the channel.

The sleeves are cleaned by wipers that are hydraulically operated and powered by a hydraulic pump. The ballasts are cooled by coolant pumped by the duty or standby coolant pumps. The hydraulic and coolant pumps are housed in the hydraulic system centre which is an enclosure mounted above the reactor.

Modules can be raised for maintenance while the remainder of the bank remains in the channel. An electric winch is provided per bank to lift a module from the channel to a raised maintenance position.

Conclusion

Works started on site in spring/summer 2012 and at the time of writing (June 2013) construction work is ongoing. The project is presently targeting an early project in-use date.

The continued teamwork, dedication and performance of KMI/Trojan Technologies and United Utilities/MWH teams, will ensure that it is delivered on schedule and will successfully achieve the take-over and performance test required in the contract.

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