

Chichester WwTW

stormwater disinfection

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Southern Water's Chichester WwTW in West Sussex was substantially upgraded in 2010 to meet new consent standards for discharges to designate sensitive waters under the Urban Wastewater Treatment Directive, Habitats Directive and the Shellfish Waters Directive. The works treats sewage from a population equivalent of 45,000. Maximum flows to treatment were increased during the previous project to incorporate more stormwater in order to reduce the volume of untreated spills to Chichester harbour and also reduce local flooding issues. Southern Water has been working in partnership with a range organisations to focus on improving water quality in the harbour. This £2m improvement scheme at the site aims to significantly improve the quality of stormwater discharges into Chichester Harbour during storms and at times of high groundwater levels.



Chichester storm UV irradiation channel - Courtesy of Xylem Water Solutions

Improvement drivers

During heavy rainfall, stormwater arriving at the treatment works was held in a stormwater storage tank until flow subsided sufficiently for it to be passed through the wastewater treatment works. However, once the storage tank is full the stormwater passed through 6mm screens and was then discharged through an outfall into Chichester harbour, a designated shellfish area, to prevent flooding. Additionally, prolonged spills are also caused by substantial amounts of groundwater infiltration in the sewers.

Conventional control measures under the UWWTD approach to reducing spill frequency would have resulted in the construction of significant additional stormwater storage (in excess of 30,000m³). However, once full, the existing storm tanks typically do not empty during extended rainfall periods, and any additional storage volumes would result in the same issues.

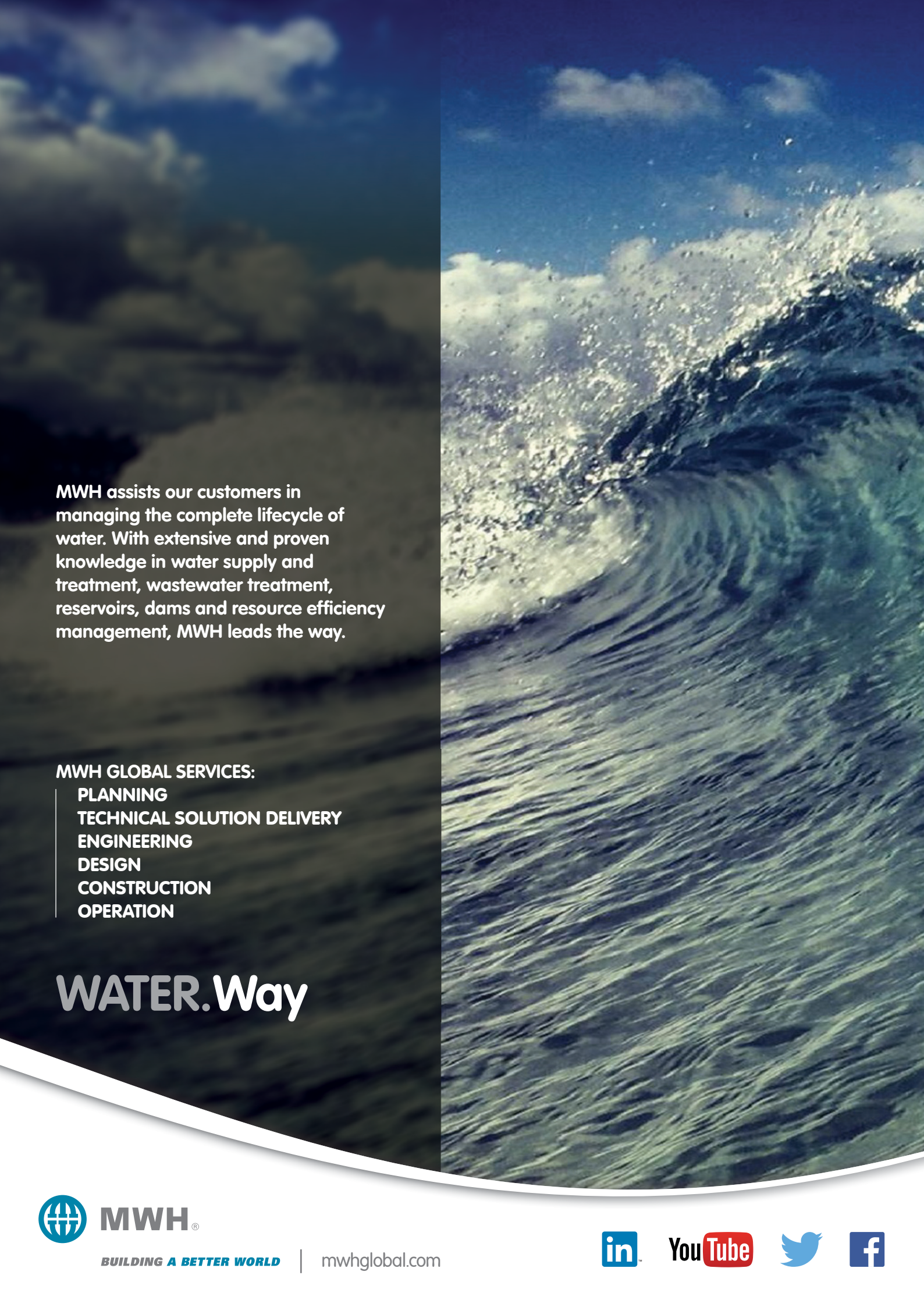
In 2012, the Environment Agency and Southern Water agreed to the use of UV disinfection of settled stormwater discharges as an interim medium-term solution to the frequent and prolonged discharges

into Chichester harbour from the storm tanks at Chichester WWTW. The long term aim is to progressively reduce the infiltration into the sewer network and reduce spills over time.

The storm tank discharge was subject to an enforcement notice in April 2013. All parties, Southern Water, the Agency and the contractor (4Delivery) worked together to resolve the challenges around permitting, designing constructing and commissioning the stormwater treatment facilities in less than a year, to meet the compliance date of 31 March 2014.

The solution

The stormwater flows from the existing storm settlement tanks were discharged via a pipeline to Chichester Harbour. In this project, flows from the storm tank are diverted to the UV irradiation channel at the storm diversion chamber through an active control penstock which limits the flow to 300 l/s. Storm flows in excess of the 300l/s bypass the UV plant by being forced over the weir in the diversion chamber to the storm outfall due to the active control increasing the hydraulic head in the diversion chamber. With the



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Chichester WwTW - Courtesy of Xylem Water Solutions

storm outfall being tidal, the water level at the discharge of the disinfected flow is affected by both the tide level and the amount of flow in the storm outfall.

Although the bypass weir in the diversion chamber is set at a level to be hydraulically safe under all tides and flow scenarios, the UV plant is unable to discharge to the storm outfall by gravity against high tide and under certain flow scenarios. To maintain hydraulic safety during the higher tides the discharge is protected by a pumping station to over-pump the disinfected flow to the storm outfall. The pumping station is controlled on the downstream level at the UV plant to ensure the plant has a free discharge over its outlet control weir; backflow from the storm outfall to the pumping station/UV outlet channel is prevented by a tidal flap valve.

This project is expected to reduce the volume of un-disinfected discharges from the works by over 90% per annum.

The key components of this project were construction of the UV irradiation channel, a pumping station to transfer disinfected flows during periods of high tide, associated pipework and chambers and a stand-by generator on the site.

Collaborative design & construction

Collaborative design (4D and Xylem Water Solutions) commenced in May 2013. Procurement of the UV plant and MCC panels were the critical path activities, so early procurement was essential to meet deadlines. Construction on site commenced in August 2013, with MEICA activities starting in November 2013. Due to prolonged periods of rain and local flooding in early 2015, final connections to turn flows and complete wet commissioning suffered delays.

To ensure the March compliance date was met, these delays were mitigated by introducing an "under-pressure live connection" to the downstream connection and major over-pumping operations throughout the night, to complete the upstream feed to the new UV plant.

Stormwater disinfection by ultraviolet irradiation

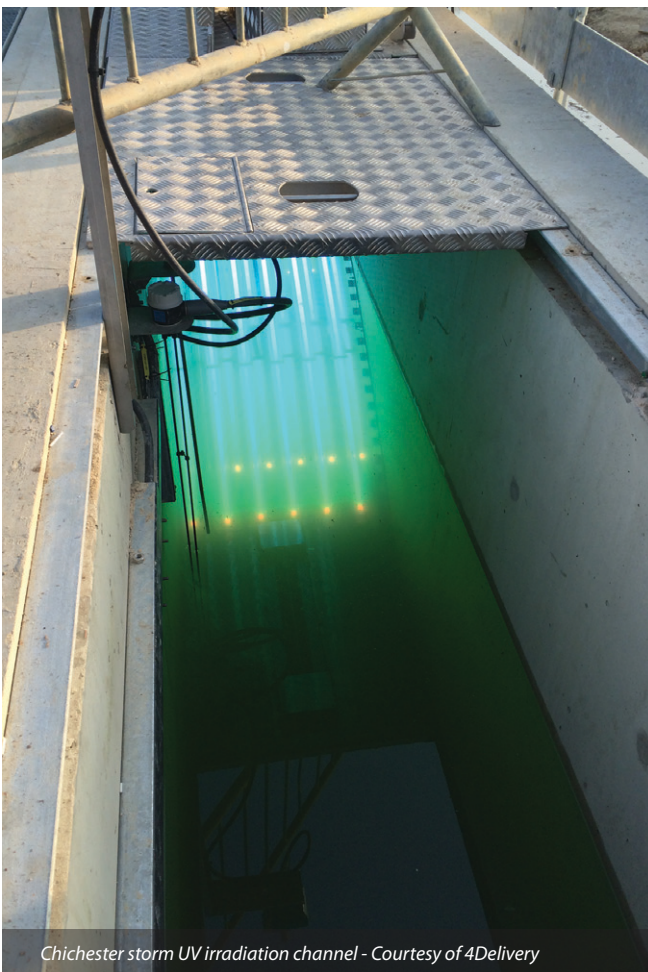
The aim of the EC Shellfish Waters Directive is to protect and improve shellfish waters to support shellfish life and growth. The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of micro-organisms in the discharges to the environment.

UV irradiation damages the genetic structure of bacteria, viruses and other pathogens, making them incapable of reproduction. It is the only process (other than the use of a barrier such as membranes) that is currently accepted by the Environment Agency for long term disinfection, due to the risk of discharging harmful by-products with chemical disinfection processes.

UV irradiation is the most widely implemented technology in the UK for disinfection (bacterial reduction) of final effluent discharges to Bathing and Shellfish Waters. However, the Agency's guidance at the time of this project for determining UV disinfection requirements (EPR 7.01) was not applicable to stormwater applications.

Following on from projects in DCWW, United Utilities and Yorkshire Water, where end of pipe permit conditions were agreed for the stormwater disinfection projects, the Agency and the water industry, supported and advised by MWH, have been working together to determine a approach for stormwater disinfection that can be based on permitting a UV dose.

For continuous discharges the Agency has committed to moving to permit a Validated Dose, currently proposed for new installations from 2017. Validation using biosimetry is based on the use of standard microbes to test the performance achieved by a given UV system under controlled conditions. This approach follows



Chichester storm UV irradiation channel - Courtesy of 4Delivery



Chichester WwTW - Courtesy of Xylem Water Solutions



Chichester stormwater disinfection project under construction - Courtesy of 4Delivery

international best practice that was originally developed for potable water applications, has become accepted practice as part of recycled water and water reuse schemes in countries such as the USA and Australia and has been extended to wastewater discharges globally. Importantly, this approach is applicable to any/all wastewaters including stormwater.

Therefore, at Chichester, in order to follow a UV dose based permit condition, SW and the Agency agreed to follow this new approach.

Ultraviolet irradiation is used at many of Southern Water treatment facilities for disinfection of final effluent discharges; however this project is a first for SW for disinfecting storm flows.

Prior and during the project, analysis of the stormwater discharges from the existing settlement tank was carried out to determine the design envelope for the UV irradiation reactor and evaluate the target UV dose required to achieve the end of pipe concentrations of indicators organisms required by the Agency. The target UV dose required agreement by SW with the Agency before selection of the UV irradiation design could be made.

Xylem Wedeco's Duron UV reactor system was selected. The system's performance has been extensively tested by an independent third party according to various validation test protocols over a wide range of test conditions, including the design envelope found during stormwater spill events at Chichester.

This is the first application of this inclined lamp UV irradiation system in the UK, and is also the first application of a low pressure high output (LPHO) UV irradiation system on stormwater disinfection, which was formerly only served by energy intensive medium pressure UV disinfection systems. To achieve delivery of the required UV dose under the wide range of UV transmittance (UVT) levels and flow rates expected, the Duron UV system was designed

with 10 (No.) banks in series. Each bank consists of 12 (No.) vertically inclined Ecoray 600 Watt UV lamps. Intelligent and autonomous UV system control brings the banks into operation automatically at the start of every storm event.

The number of UV banks in operation and the power level of the lamps are adjusted automatically in response to online monitored values of flow, UVT and UV intensity to deliver the UV target dose. This minimizes power consumption as well as lamp operating hours. At the end of a storm event the system shuts off automatically after assuring that no stormwater is discharged untreated. Maintenance activities such as lamp changing and instrument cleaning can easily be carried out due to the automatic lifting mechanism integrated into each bank of lamps.

Conclusion

The plant has been in operation since March 2014. The data collected to date indicates that it is successfully meeting the micro-organism concentrations in the treated stormwater discharges/log reduction for which it was designed. Chichester District Council collects regular samples in the harbour and report results against Bathing Water Directive classifications. Since the introduction of UV microbial water quality has improved and since December 2014 there have been no 'poor' samples.

This project was delivered by 4Delivery (4D), a consortium of Veolia, MWH and Costain, who delivered over 300 schemes for Southern water over AMP4 and 5.

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