SIEMENS
Ingenuity for life

Well prepared for all kinds of weather:

Sewer control at the Erftverband utility

siemens.com/water

It was a day people in northern Germany will remember for a long time: on July 28, 2014, hours of severe rainfall caused serious damage. The city of Münster received 292 mm of rainfall in just seven hours, more than it usually receives in four months. But it doesn't take such record-breaking events to create a disaster: with climate change and increasing impervious-surface coverage, even a "normal" heavy rainfall can flood sewer networks. The Erftverband utility is preparing for this eventuality with a cutting-edge project and using all available resources to take the necessary precautions for the area to the west of Cologne.

The Erftverband is a utility network with some 250 members from municipalities, counties, the public water supply, the mining and electricity industries, commercial and industrial enterprises, agriculture, and fisheries. The Erftverband is a nonprofit organization under public law that seeks to reconcile the different water-related interests of the regional players in a responsible and sustainable manner and with a sense of proportion.

The core region in which the Erftverband operates is the 1,900 km² catchment area of the river Erft. The catchment contains numerous tributaries and bodies of water along with the 104 km long river. In this area the organization purifies the domestic sewage produced by approximately 750,000 residents as well as the wastewater generated by local trade and industry, which is equivalent to the waste load produced by another 450,000 people. In addition, the Erftverband looks after a fragile natural region and protects the residential areas from flooding by operating locks and flood reservoirs, managing the river and eliminating flow barriers, managing the area's natural water-retention capabilities, issuing flood risk maps, and operating alert systems.

Severe rainfall poses a risk not only to buildings and roads but also to the environment. The heavy flows triggered by the rain may flood sewer systems, leading to an overflow of untreated sewage into rivers and lakes. This storm sewage often contains significant levels of waste and hazardous substances and impacts natural water quality. The Erftverband tries to strictly limit relief discharge as part of its floodwater management and has recently implemented an intelligent management system for the retention and buffering capacities in its sewer network. This model project for sewer control has been in operation for two years at one of the Erftverband's 35 wastewater treatment facilities. The innovative solution was developed by the Erftverband together with partners from industry and research in a project funded by the Ministry for Environment, Agriculture, Conservation, and Consumer Protection of the State of North Rhine–Westphalia. The Research Institute for Water and Waste Management at RWTH Aachen (FiW) e. V. provided the project coordination, planning, and reporting to the authorities; PFI Engineering Group from Hannover calculated the rainwater forecasts based on weather radar data and provided a solution for integrating the data into the online operation of SIWA Sewer; and Siemens supplied the technical components for the control system and implemented the solution on-site.

An innovative project that connects weather data with operational data

The Erftverband wanted to achieve several goals with this project: First, reducing the amount of relief discharge and improving the natural water quality. Second, and related to this, improving sewage transfer

to the group wastewater treatment facility in Kenten and optimally utilizing the treatment facility's ground retention filter. And finally, laying the foundations for a smooth and cost-effective rollout of similar solutions to other facilities.

To enable flexible and requirements-based sewer control when faced with significant rainfall situations, the project team wanted to automatically control the systems in the network based on current rainfall forecasts. Until then, the systems had been controlled locally or without an online data source, so the project involved implementing new technologies in Kenten.

The sewer network of the Kenten treatment facility west of Cologne collects sewage in mixed drainage from several towns. The area is relatively level, so the maximum time for sewage to reach the Kenten facility can be up to 10 hours. The long lag and drain times in the network result in a long retention duration. At present, the facility's sewer network contains 34 rain overflow basins, four spillways, and one ground retention filter. Together, these systems provide a retention capacity of roughly 65,000 m³. The wastewater treatment facility is designed to handle a mixed sewage inflow of 624 l per second, or 54,000 m³ per day. When this capacity is not enough, the mixed sewage must be released into the Erft river and its tributaries, with different bodies of water having different levels of sensitivity to the discharge.

In the course of the project, 10 rain basins along the main sewer system, with a total of 40,000 m³ of retention capacity, were integrated in a combined simulation and control tool based on the SIWA Sewer management system from Siemens. This smart control system calculates optimum control strategies and enables simulation of sewer conditions during operation. For this purpose, the system uses an advanced optimization algorithm that delivers an optimum control strategy for a given condition, taking into account the different structures and different target parameters (minimizing relief discharge, reducing retention, avoiding collector backwater, faster drainage).

For optimum flow control, the system in Kenten calculates the current inflow every 15 minutes with online radar data and radar forecasts from the German Weather Service and feeds the results automatically to SIWA Sewer via standardized interfaces. Based on current data from the rain basins and a six-hour forecast for the inflow surge, the system calculates the best control strategy every three minutes and transmits the set-point parameters for the valves and pumps to the control system. The system also provides a fallback strategy so that the system can continue operation when individual components fail – for instance, when some components cannot be operated in managed mode. The fallback strategy defines six levels of failure with associated strategies for system operation, for example, setting a substitute parameter for a defined time period, removing individual basins from the control, or even interrupting the entire control strategy.

Visible improvement in the network and the plant

The results from this model project for the German water industry have been remarkable. The intelligent sewer control has been working reliably and virtually without failures since it went into operation in March 2016. All the relevant data for the management system are logged in a separate database and are continuously evaluated so that the plant operator can fully assess the system performance. Radar data integration and forecast calculations for the inflow, as well as the data transfer to SIWA Sewer, function reliably, making the system very robust. The abstract model effectively mirrors the behavior of the physical system, so that the control strategies also perform well in the physical system. As an added benefit, the intelligent sewer control helps improve regular plant operation – for example, drainage times for the basins outside the treatment facility have been considerably reduced.

But most importantly, there have been more than 50 recorded severe rainfall events with relief discharge in one or several basins since the new solution for the 10 basins went live, and the relief discharge amount was able to be reduced significantly compared to operation without the new control solution – by up to 85% for single events. In addition, the relief discharge could be directed so as to protect sensitive bodies of water. The wastewater treatment facility also handled more mixed sewage in total, with an additional 317,000 m³ of water from precipitation treated in 2016.

Improved protection of natural water bodies, excellent operational stability and availability, and the reliable alarms and fallback strategy were compelling arguments for the Erftverband to add 2 more rain overflow basins to the management solution. As the system has a modular architecture, expanding the solution was straightforward. Since the end of 2017, the sewer management solution has comprised 12 managed basins with a total of 45,000 m³ of retention capacity in the network. In the larger picture, this means that people and the environment in the Kenten area are better prepared for rainstorms large or small – and the managers at the Erftverband are better able to operate their facilities safely and cost-effectively as well as protect water resources.

Siemens is currently developing SIWA Sewer as an online application with the extended functions by and looking for pilot projects.