Cambridge Modeling helps network management

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Cambridge, UK, is a typical medium size town full of history. Boasting one of the oldest Universities in the world, it also comprises the internationally renowned Addenbrooke´s Hospital, a shopping area, residential properties, some industrial premises and even a small airport. Water was first piped to Cambridge in 1325 when Franciscans laid a lead pipe a distance of 1.5 miles (2.4 km) from a natural spring. Today Cambridge Water services 293,350 customers and supplies an average of 19.5 million US gallons (74,7 megaliters) of high quality drinking water per day.

Cambridge Water was challenged with building a model that would represent the dynamic operation of the utility's pumping stations, valves, control valves and reservoirs. The purpose of the model was to act as a tool to better plan for new infrastructure improvements, develop operational strategies and proactively manage the system. A successful model would ensure that both short term and long term future planning would be better, faster and more efficient. Of particular concern was the need to be able to plan for growth in demand in a region where the water resources are already stretched. The model was to be constructed from three different sources of data, which was anticipated to be time-consuming with a high possibility of error. Modelers were concerned at the prospect of spending large amounts of time gathering and cleaning data combined with the challenge of working with inaccurate or missing data. Not only would the three data sources (Smallworld GIS, drawings & files and local knowledge) need to be merged and digitized, they would then need to be accurately validated for the model build to be a success.

The model

For the purpose of this model, the distribution zone is made of 72,000 properties, supplied by 584 miles (940 km) of pipe work in various sizes and materials. The oldest pipe dates back to 1853, and the largest are 24" diameter. The water is supplied by 15 chalk borehole pumping stations. A number of stations pump 24 hours a day at fixed speeds while others are manually switched in control rooms to manage reservoir levels. Station outputs vary from 100 to 500 m3/h (440 to 2200 US gpm). The network is fed by reservoirs on the east of town, and there is a bulk transfer to reservoirs on the west, which act as suction tanks for booster stations supplying other areas.

Pulling together the data

Most of the data came from Smallworld GIS, and had already undergone digitization from paper maps in the mid 1990s. Customers were located on the GIS map and connected to the appropriate mains. Elevations for pipe terminations, fittings and customers were obtained by using spot heights rather than digital terrain mapping. Data was extracted from the GIS using Modelworld, which converts the data to Wesnet file formats. These files were then imported into InfoWorks WS. Pipes, hydrants, air valves and boundary valves were imported into the model. Valves which are normally open were not included in the model. InfoWorks was used extensively to examine the imported data, paying particular attention to:

• pipes that appeared to touch but did not join

• pipes that overlapped

• zero elevations (due to missing GIS spot heights and due to quirks in the export process)

• missing diameters due to invalid GIS data

• missing diameters for meters.

The InfoWorks grid views and SQL query tool were extremely useful for this part of the process. Where corrections were needed these were fed back into GIS, however the data quality was generally good.

Many drawings were also studied to ensure accurate representation of operational sites, major intersections etc. Local knowledge of the pumping stations and reservoirs was modeled in detail and valuable data was obtained from drawings showing reservoir capacities (checked against original drawings where possible). Care was taken over the operational details; especially shut valve operation, cross-zone transfers and boundary valves as documentation in these areas were poor at the time the model was built.

The unique strength of InfoWorks is in the flexible way data can be imported, edited, managed, updated, reported and exported. These features significantly simplify and improve the network modeling process, and enable data from a wide variety of corporate systems to be brought together with a clear audit trail that helps ensure efficient planning and operations activities within the water supply network.

Looking at demand

Once the data had been accurately assembled in the model, Cambridge Water looked at quantifying the demand. This proved to be a challenge, as they had no District Meter Areas (DMA), and large reservoirs with no flowmeters. Cambridge Water took the decision to assume that all customers have the same demand profile, with the exception of a few of the largest customers, whose meters were logged to obtain accurate demand profiles. This simplified approach to demand modeling was found to give acceptable results in all but a few very localized areas.

Validating the model

Extensive field work was carried out to obtain pressure and flow data at strategic points in the network. The results from over 200 logger and telemetry points were easily managed using InfoWorks´ Live Data tools, and the model was successfully validated.

Using the model

The working model means that Cambridge Water are better able to respond to requests for water supplies to proposed building developments and evaluate the impact of such developments on existing customers. The model, which allows controlled permission access, is now successfully implemented and plays a vital role in everyday business. With the model now having consolidated data from multiple sources in one coherent interface, engineers are able to easily determine future trends, plan for mains outages or assess the impact of proposed rezoning of the network. Cambridge Water now manages existing and new model libraries with confidence.

John Brock is responsible for all aspects of network modeling at Cambridge Water and explains:

“The future and ongoing challenge is now to focus on optimizing pumping and storage systems to enable us to look at costs especially with looming electricity cost increases on the horizon. InfoWorks has provided a comprehensive model management solution to help us build and manage the models more efficiently and accurately than ever before. We have successfully built the Cambridge Model using complex validated data and are now able to show valuable benefits.”