Building information modeling optimizes Tongzhou Water Works design process

Bentley’s 3-dimensional (3D) design software reduced the work performed by Beijing Institute of Water engineers to design the Tongzhou Water Works and other buildings, part of the South-to-North Water Diversion Project, by 50 percent. The project won Bentley’s Be Inspired 2017 Award for the category of BIM Advancements in Water and Wastewater Treatment Plants. Marie Telepneff of Bentley Systems, Inc. reports on the project.

In southeast Beijing, China, declining groundwater supplies were causing water shortages for the Tongzhou District, which is part of a cultural tourism zone designated for future urban sub-centers. To meet current and future water demand while supplying continuous water to residents, Tongzhou Water Works needed to increase capacity to 2.8 times that of 2011 and drop reliance on groundwater from 74.2 to 21.4 percent.

As part of the Beijing South-to-North Water Diversion Project, a US$56.4-million project that would ultimately deliver 600,000 cubic meters (m³) of water per day was initiated. The Water Affairs Bureau of Tongzhou District contracted Beijing Institute of Water to design the waterworks and ancillary buildings. The project, which would serve as an important infrastructure guarantee for future land development projects, needed to improve building energy efficiency, reduce construction costs, and eliminate the impact on the surrounding environment as specified by the Chinese government. It would also require the design and construction of many complex, irregular concrete structures.

**Collaborative process**
The use of Bentley’s ProjectWise building information modeling (BIM) software supports a collaborative design process. If a traditional 2D design was employed on this project, the designers in electrical and automation professions would not have been able to unify easy-to-use design software. Additionally, a 2D approach would require the designers to spend a great deal of time running calculations, performing analyses, and manually mapping. Therefore, the project team decided to use Bentley’s ProjectWise and MicroStation software to establish a collaborative 3D design management platform. This platform was used to centrally store and manage design information for 13 professions as well as the extraction of 2D construction drawings and engineering statistics. The 3D design management platform also enabled the project team to enforce production standards for the 26 engineers working on the design, securely share data and models, and minimize design errors while improving work efficiency.

Bentley’s 3D design applications allowed designers to work in a collaborative management platform, improving design accuracy and efficiencies.

**Tongzhou Water Works Design**

**Objectives:**
- Increase water capacity to 2.8 times that of 2011 and drop reliance on groundwater from 74.2 to 21.4 percent.
- Create a design that improves building energy efficiency, reduces construction costs, and eliminates the impact on the surrounding environment.
- Beijing Institute of Water designed 2D construction plans and established a 3D model of digital waterworks.

**Software used:**
- AECOsim Building Designer, LumenRT, Bentley Raceway and Cable Management, Bentley Substation, MicroStation, Navigator, OpenPlant, OpenRoads Designer, ProConcrete, ProjectWise, ProSteel, ProStructures
used to design 3D information models of standard and complex irregular concrete structures and carry out 3D reinforcement work. Designers easily and intuitively drew all types of concrete structure models by first copying a 2D drawing to get the general profile established and then subsequently used opening and cutting capabilities to conform the 3D model to the depth of the construction drawing.

Through the development of a 3D collaborative design, the design team comprehensively improved the design, progressively implemented design standards, and verified construction drawings and engineering statistics. The team also addressed the government’s requirements to improve building energy efficiency, reduce construction costs, and eliminate the impact on the surrounding environment.

Environmental benefits
Bentley’s BIM technology enabled Beijing Institute of Water to enhance the entire design in many ways – most notably, to reduce environmental impacts. The layout of the water purification technology structures and plant terrain were optimized to reduce operational electricity consumption by 5 percent, and the heat pump placement saved more than 40 percent on summer cooling and winter heating costs. By planning to take advantage of favorable sun exposure, the team implemented solar heating to reduce fossil fuel energy usage by more than 45 percent. Additionally, the facility is now able to collect and store 80 percent of rainwater for reuse because a catchment area was placed in the plant area of the site. Beijing Institute of Water used Navigator for collision inspection and review of the 3D models due to the complexity of the project and the large number of engineers and contractors involved in the design. In addition to finding more than 40 design omissions and errors, the team provided timely feedback on accurate material statistics to the construction unit, saving approximately 10 percent of the construction cost in cable material.

Reduced project costs
The 2D construction drawing and engineering statistics completed during the 2D design phase required months to implement and involved more than 50 engineers. However, using Bentley’s 3D design software, it took just 26 engineers a total of 40 days to complete all 3D modeling, 2D drawings, and engineering statistics work, saving more than 30 percent of the design effort by automatically generating engineering statistics and increasing the accuracy of calculations. In addition, more than 40 model collisions were found during collision checking of multi-disciplinary models, with findings consistent with construction site feedback.

Design for future demands
The final design achieved its objective by providing 62.9 percent of domestic water and production water supply to 900,000 people in a service area of 155 square kilometers. This improvement effectively raised the regional water supply capacity to 2.8 times that of 2011 and increased the water supply safety coefficient by 5 percent.

“Bentley provides a complete, 3D design solution for all professions in the water conservancy design field as well as an excellent management platform for the smooth development of the project, the delivery of results, and quality control.

Qi Jiang, Information Center Director, Beijing Institute of Water

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to 1.3. Moreover, by replacing local surface water with diverted groundwater, the proportion of local, underground water supply fell from 74.2 percent in 2011 to 21.4 percent, resulting in an annual reduction of 4.77 million cubic meters of groundwater exploitation, thus conserving underground water.

Since Tongzhou Water Works’ completion, the city’s subcenter and Tongzhou New Town will be incorporated into the South-to-North diversion water supply range to enhance the regional water supply quality, volume, and pressure and reach the water supply level of the central city. Water quality will be even with, or above, the World Health Organization (WHO) and the United States Environmental Protection Agency (EPA) standards. Finally, the project will greatly enhance the water conditions of the Tongzhou area, which will allow the government to relocate the city government to Tongzhou and make it a vital population sub-center in the future.

Author’s Note
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3D project design of the Tongzhou Water Works was created using Bentley Systems software.