



## Project Summary

### Organization:

Sabesp

### Solution:

Water Network Analysis

### Location:

São Paulo, Brazil

### Project Objective:

- Supply water to the metropolitan region of São Paulo during extreme drought conditions.
- Model various scenarios to identify a quickly achieved solution that limits any negative effects to 9 million customers.
- Prevent further drawdown of the Cantareira system and supplement the water supply by taking advantage of the water producer systems' interconnection.

### Products Used:

WaterGEMS

## Fast Facts

- Sabesp's solution to transfer water to the Cantareira system prevented millions of customers from having their access to water reduced to two days per week.
- Transferring water across five producer systems, reactivating pipelines, growing or reversing booster stations, altering control structures, and expanding water treatment plants mitigated the water crisis.
- Water availability eliminated the immeasurable impacts of scarce supply, degraded water quality, and massive business closures.

## ROI

- The integration of WaterGEMS, GIS, SCADA, and PIMS reduced data collection time by 70 percent and model calibration time by 80 percent, increasing overall crisis response time.
- Sabesp spent 50 percent less time securing a viable solution using the WaterGEMS hydraulic modeling.
- The ability to evaluate 80 scenarios enabled Sabesp to meet crucial deadlines and cut implementation costs.

# Sabesp Solves Water Crisis, Avoids Rationing for 9 Million São Paulo Customers

Optimum Water Transfer Scenario Identified by Bentley's WaterGEMS® Model in Half the Time

## Solving a Water Crisis

Sabesp supplies water to more than half of the municipalities in the state of São Paulo, Brazil, including the 20 million residents of the metropolitan region of São Paulo. When a 16-month dry spell threatened the water supply from the Cantareira basin, the metro area's main water source, Sabesp acted quickly to avoid water rationing that would be both unpopular and economically devastating. Using WaterGEMS to assemble and calibrate a hydraulic model of the entire water network, Sabesp evaluated 80 what-if scenarios before selecting an alternative that capitalized on the interconnection between producer systems. The solution allowed water to be transferred into the Cantareira system with minimal adjustments to infrastructure. Sabesp estimated that it took 50 percent less time to find a solution by modeling with WaterGEMS, the shortest hydraulic solution time the team of engineers and modeling specialists ever experienced.

## Critically Low Flow

Sabesp is one of the world's largest water and sewage services providers, with 24.8 million water supply customers and 21.3 million sewage collection customers in 366 municipalities. The state-owned company serves densely populated urban areas, where the availability of water and sanitation can be uneven.

Over a 16-month period from October 2013 to February 2015, Brazil experienced a prolonged period of extremely low rainfall, along with unusually high temperatures. This produced an alarming water shortage in the city of São Paulo, where water reservoirs dropped to historically low levels and a fraction of their capacity. The inflow rate into the Cantareira reservoir drastically diminished to 15 cubic

meters per second (m<sup>3</sup>/s), an amount half of the previously lowest recorded inflow rate. This extreme drought presented a dire situation for the nearly 9 million residents who relied upon the Cantareira reservoir for daily water use. The drought created the worst water crisis in nearly a century, calling for immediate action to impose unprecedented water restrictions until weather conditions improved and the drought subsided.

Sabesp considered the drastic measure of limiting customer access to water to only two days per week. Such a rotation would not only be unpopular but also penalize customers at higher elevations, where low pressure would restrict flow. Other issues with rationing included threats to public health, such as poor sanitation and water quality associated with low inflow, and inadequate supplies for hospitals and fire protection. Instead, the company resolved to further integrate

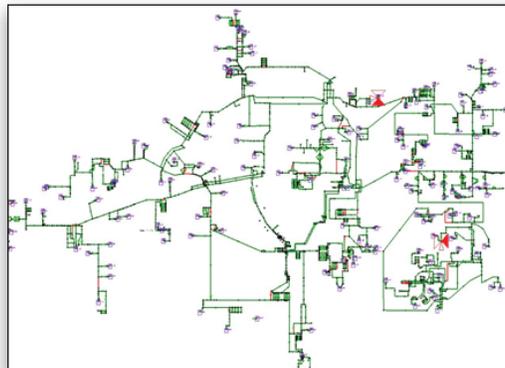
and optimize the regional water supply system, known as the Metropolitan Integrated System (SIM), to provide more equal distribution of available water.

## Running Supply Scenarios

To discover a viable solution for distributing an adequate water supply to its customers, Sabesp undertook a BRL 150 million project utilizing hydraulic modeling with WaterGEMS.

The engineering department

created 80 scenarios to determine the best possible scheme for transporting drinking water to the affected areas. The hydraulic model also revealed ways to use available water more efficiently, such as reducing consumption, curtailing water loss by identifying and fixing leaks more rapidly by increasing the partitioning of the water network into district metered areas, and by decreasing water pressure.



*Sabesp laid additional pipeline to expand the Metropolitan Integrated System (SIM), the regional water supply system, in order to equally distribute available water to residents of São Paulo, Brazil.*

*"We have been using the WaterCAD/WaterGEMS model for several years. The software and the Bentley team have effectively helped us in solving problems in the metropolitan region of São Paulo, which is one of the most complex in the world."*

*— Viviana Marli Borges,  
Engineer, Sabesp*

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The project's success relied upon an accurate simulation of the complex water supply system. Comprising 177 reservoirs and 1,300 kilometers of pipeline, the SIM has the capacity to produce water at a rate of 73 m<sup>3</sup>/s at nine water treatment plants. The distribution network includes 98 pumping stations and 25,000 kilometers of pipeline covering topography with elevations ranging from 740 meters to 1,100 meters. WaterGEMS allowed the engineering department to assemble, calibrate, and validate a hydraulic model of the entire water network with precision and reliability. Interfacing with Sabesp's geographic information system (GIS), supervisory control and data acquisition (SCADA) system, and process information management system (PIMS) accelerated the model assembly process and allowed Sabesp to leverage all the information and data provided by those systems to make better-informed decisions.

The hydraulic modeling revealed a scenario that would have the least impact on the population and pose the lowest operational risk. The reservoirs were emptying quickly under the persistent drought conditions, producing extremely low inflow to the water supply system. Sabesp offered bonus incentives to customers who reduced their consumption to help to slow the drawdown of the Cantareira reservoir.

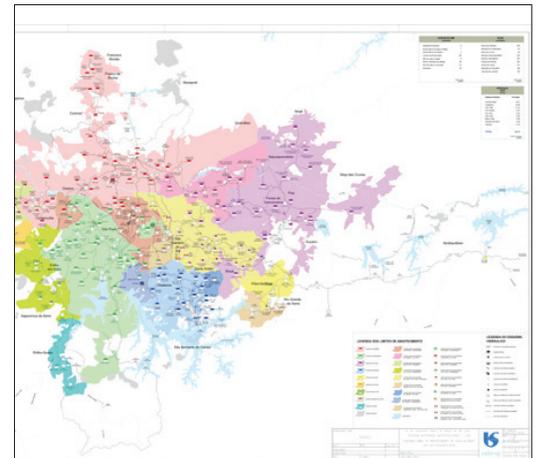
Meanwhile, the low flows provided an opportunity to modify the infrastructure and enhance the flexibility to transfer drinking water from other water producing systems to the Cantareira service area.

### **Achieving Quick Results**

The hydraulic simulation in WaterGEMS identified the emergency measures that could be implemented in the least amount of time. Sabesp's quick execution of the preferred plan caused minimal disruption to customers. Transferring water from the Guarapiranga dam to the Cantareira system water treatment plants, for example, replenished water where it was most needed, allowed the influx of water from other systems, and reduced withdrawal from reservoirs where water was most scarce.

At the same time, the hydraulic modeling accelerated a metro-area water loss reduction program that identified and fixed leaks, sectorized the network, and introduced more pressure-reducing valves to control pressure that exacerbated leaks. Implementing the necessary water network improvements required construction crews to navigate through intense traffic while meeting traffic restrictions and to limit extensive road closures in the metropolitan region. The engineering department factored these conditions into the WaterGEMS scenario, arriving at solutions that could be accomplished on short deadlines and with minimal traffic disruption.

Sabesp had to undertake the water loss reduction, pipeline rehabilitation, and other interventions within the legal and budgetary limits imposed upon a government entity. The works had to be executed with available funds and without interfering with operations. The WaterGEMS model calculated where the most water could be transferred with



*The project connected numerous water producer systems within the metropolitan area to supplement the water supply and limit pulling from the Cantareira system.*

the fewest, least costly interventions in the network. The geo-referenced model also drew upon a decade-long registry of information and images to help the team choose alternatives with the least environmental impact.

### **Saving Time, Saving Water**

Running multiple simulations in the WaterGEMS hydraulic model allowed Sabesp to identify the most viable scenario for supplying more water to its customers amid a severe drought. The whole process took half as long as previous methodologies and delivered effective solutions that could be rolled out quickly, despite daunting constraints. The integration of GIS, SCADA, and PIMS reduced data collection time by 70 percent and model calibration time by 80 percent. These time savings expedited Sabesp's crisis response time.

Timely and well-executed interventions yielded immediate results. For instance, recovering an abandoned, leaky pipe increased the flow from a pumping station in the Guarapiranga system and diverted that water to São Paulo's financial and medical center. Expanding a booster station in the Guarapiranga system moved more water into the city's western region. With more water flowing from the Guarapiranga dam into the SIM, two treatment plants were expanded to supply more water to the metropolitan area. Altering control structures, reversing boosters, and other measures served to further integrate the provider systems so that the scant water supply could be more effectively distributed.

Sabesp's dramatic initiatives reduced the metropolitan region's reliance on the Cantareira system and slowed the water drawdown from the feeder reservoirs. Modeling revealed ways to introduce more flexibility into the water supply system, so water can continue to be transferred between reservoirs. WaterGEMS enabled the engineering department to test ideas, evaluate outcomes, and make changes where they would be most effective. As a result, water withdrawal from the Cantareira system dropped from 33 m<sup>3</sup>/s in 2013 to 13.5 m<sup>3</sup>/s in 2015.