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Water Systems Optimization

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Water Distribution Master Plan Optimization

System strengthening and service level improvement

THE CITY OF DAYTON employed Optimatics' GA optimization to help them determine least-cost options for overcoming pressure and head loss problems in the system, as well as for pipeline replacement planning, strengthening redundancy, and modifying maximum day operating schemes.

KEY POINTS

- Determine least-cost pipe and pump improvement scheme
- Strengthen system redundancy should one plant be out of service
- Modified operating strategies to reduce on-peak pumping

Background

The City of Dayton Department of Water supplies water to over 160,000 people within the city limits and to a number of adjacent municipalities and townships. The City owns and operates two water treatment plant facilities that are each supplied by nearby well fields. In 2004, the system had a combined annual average production of 68.6 MGD from the two plants. The distribution system is set up with two large pressure zones, labeled High and Low. Major facilities include seven booster stations in the City, four booster stations along the edge of the system serving neighboring systems, and ten storage facilities.

The Project

Though the City is not expecting significant growth over the next 20 years, the water system has a number of needs for which Optimatics GA (OGA) optimization is ideal to find solutions. There are areas of low pressure, locations with overstressed mains, and vulnerability issues with a major supply out of service. Potential solutions to overcome these problems include new pipe in selected areas; new/expanded pump stations; a prioritization plan for replacement of aging, small diameter mains; strengthening redundancy in the system in the event that one of the two plants is out of service; and modified operating schemes that reduce on-peak pumping.

The Department of Water decided that a formal optimization approach could assist them with identifying the most cost-effective set of capital improvements and operational changes as they develop a new, system-wide, water master plan.

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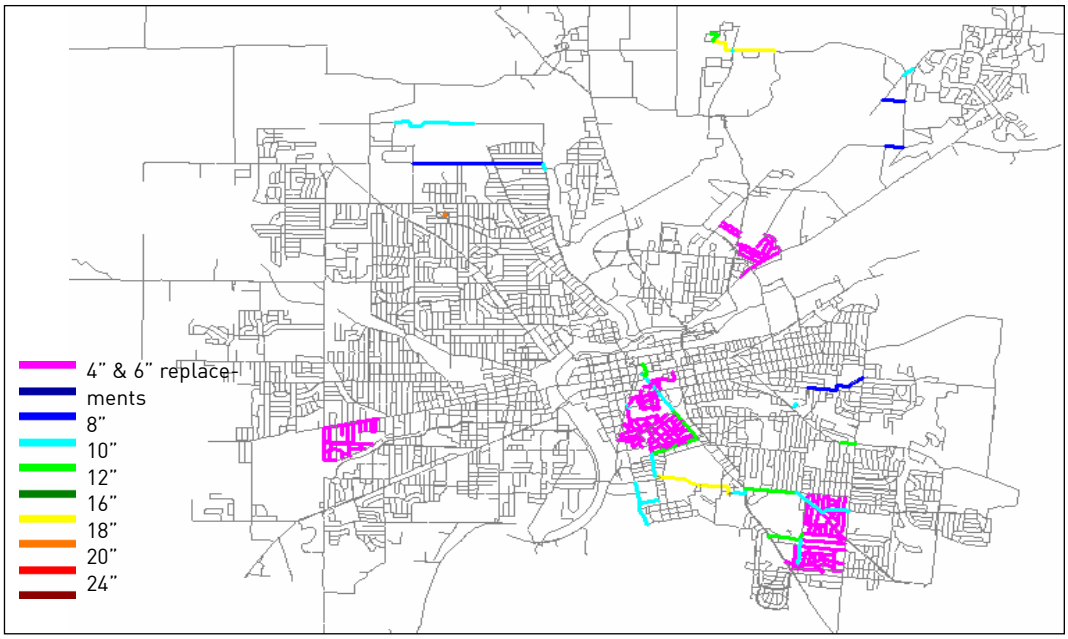

Final Solution—Pipeline Improvement Layout (with sizes)

Client Reference:

Chris Holmes, P.E.
Project Engineer
Dayton Water Department
320 W. Monument
Dayton, OH 45402
Telephone: 937-333-3736

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Study Objective

The objective of the GA analysis was to optimize both capital improvements and system operations to minimize project life-cycle costs while meeting projected year 2025 maximum day demands.

Lead consultant CH2M Hill first prepared a calibrated, extended period simulation (EPS) hydraulic model of the system. The OGA was then formulated to consider a range of options for new pipes, replacing or relining selected existing pipes, new storage or expanding existing storage at the same location, new pump stations or expanding existing pump stations, and to select trigger levels for pump stations based on water level in storage facilities.

Key Outcomes

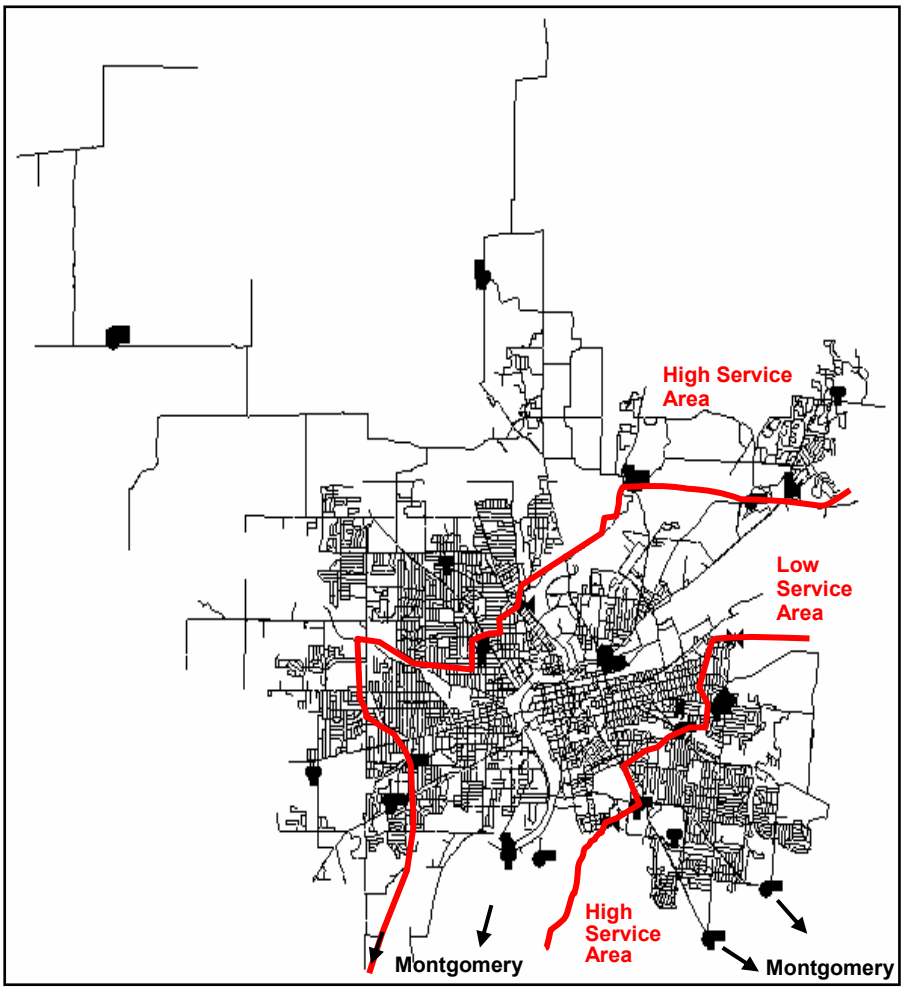
Two different design scenarios were developed. Scenario 1 had both the Ottawa and Miami water treatment plants in operation, which is how the system currently operates. Scenario 2 was developed with only the Ottawa plant operating and the Miami plant out of service.

The final optimized solutions contained new pipe alignments and diameters as well as the replacement and relining of existing pipe in selected areas of the system. Optimization results showed that these pipes will help overcome existing problems due to high head loss and low pressures and will ensure proper refill of existing storages.

New pump stations were also located and sized, and pump station upgrades recommended. The total capital cost of improvements identified for the system under Scenario 1 was approximately $27 million. The higher cost for Scenario 2 of $38 million covered the additional improvements required to meet system-wide demands from one plant.

Benefits

The net present value of electricity cost over a 50 year design life was an estimated $4.1 million in each scenario. CH2M Hill and Dayton Water have begun to design and implement the improvements.



City of Dayton - Existing System

Contact: Jeffrey Frey, President North America | Tel: 1 773 792 2661 | Email: jeff.frey@optimatics.com