The Optimatics Letter

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Built-in Emergency Preparedness

Water utilities today are giving increased attention to the potential vulnerabilities of their water plants and distribution system facilities. There is a very real concern that terrorist acts could impact their ability to provide safe and clean water. Security plans are being reviewed as each utility is working hard to provide the best possible defense given its particular funding limitations.

This article briefly reviews the new bioterrorism legislation that affects nearly all water utilities. The article then considers how GA optimization can be used to help utilities better prepare for intentional acts (or other emergencies) that threaten to disrupt water supplies to customers. A GA optimization case study is presented.

Bioterrorism Preparedness Act

In June 2002, the *Public Health Security and Bioterrorism Preparedness and Response Act* was signed into law. The Act authorizes funding for drinking water utilities to conduct mandatory vulnerability assessments (VAs), revise emergency response plans (ERPs), and make security upgrades. Water systems must "conduct an assessment of the vulnerability of its system to a terrorist attack or other intentional acts intended to substantially disrupt the ability of the system to provide a safe and reliable supply of drinking water."

Water systems must next certify to USEPA the completion of its ERP. The ERP shall "include actions, procedures and identification of equipment which can obviate or significantly lessen the impact of terrorist attacks or other intentional actions on the public health and the safety and supply of drinking water…".

Specific mention is made of reviewing (1) methods and means by which pipes, storage, distribution facilities, etc. could be destroyed or otherwise prevented from providing adequate supplies of drinking water, (2) how these system components could be reasonably protected from terrorist attacks or other intentional acts, and (3) "methods and means by which alternative supplies of drinking water could be provided in the event of destruction, impairment or contamination of public water systems."

Better Security Plus Redundancy

The Bioterrorism Act focuses on assessing the vulnerabilities of water systems and on preparing emergency response plans from a security planning viewpoint. Some utilities, however, are going beyond these mandatory security steps to "bullet-proof" their water systems with built-in emergency preparedness.

Some utilities are going beyond the mandatory Vulnerability Assessments and Emergency Response Plans to "bullet-proof" their systems with built-in emergency preparedness

Built-in emergency preparedness comes about by carefully upgrading a water system's redundancy and reliability to ensure that in the event of an intentionally disruptive act or other emergency, the system can still supply adequate clean, safe drinking water to all customers without interruption or with minimal interruption.

Commenting on water system security in a recent *Public Works* article[1], Metcalf & Eddy water and wastewater systems expert Larry VandeVenter suggested that improving system redundancy could be the most cost-effective choice for a utility.

(Continued on page 2)

Unsure About GA? Consider a 2-Step Study

If the idea of committing to a GA optimization study seems daunting, how about a two-step study? Step one involves discussing the utility's needs, reviewing the hydraulic model, and identifying the likely GA decisions, design/performance criteria and demand cases to be satisfied. We will then prepare a brief report defining a GA scope, approach and cost, as well as outlining the likely payoff from the study in terms of capital cost savings, improved redundancy, etc.

At the end of step one, you can cancel the study or continue. You might feel better about proceeding if the (perhaps guaranteed) payoff is millions of dollars in capital cost savings. This two-step approach also helps us to prepare an appropriate GA scope and to present our best possible cost proposal.

Mr. VandeVenter is quoted as saying:

> *This is a highly complex problem. It's as diverse as the number of water utilities that we have in this country. And more security is not always the best answer. For example, I'd rather spend money on redundancy than on security measures. If you make an asset less important through redundancy, then it's much harder to plan an effective attack that will disrupt or destroy that asset (since most attacks would merely inconvenience a redundant system). And with redundancy, you put an automatic backup system in place should an asset be immobilized. The lesson here is that there are no cookie-cutter solutions for security. And only through a deliberate common-sense, design-based approach can you truly protect a utility.*

Improving System Redundancy

During the VA and ERP update steps, a water utility will identify threats, vulnerabilities and risks. The identified critical emergency scenarios can next be studied using an up-to-date hydraulic simulation model. Model runs could evaluate existing (or future) system performance for main breaks, tank failures, forced outages of supply sources, pump stations or regulating valves, or valving-off of certain areas.

Some critical emergency scenarios will likely result in unacceptable system performance that cannot be mitigated by temporary operational changes. The utility could then investigate what capital improvements are needed to minimize disruption and achieve adequate performance. An effective way to perform such an analysis is using GA optimization.

Improving system redundancy using GA optimization involves adding the desired emergency demand conditions or scenarios to the selected base demand conditions in the GA formulation. This process can best be illustrated by describing a recent GA study that Optimatics/Frey completed for San Diego Water.

Case Study: San Diego Redundancy

In 2001, San Diego Water decided to perform a comprehensive analysis of options for seven aging transmission pipelines (24"-54") in the Alvarado WTP service area. SDW concluded that the full length of the seven area pipelines (see Figure 1) would need some sort of rehabilitation or replacement (R&R) action by the 2030design year. GA optimization would be used to identify a preferred near-optimal 2030 R&R plan.

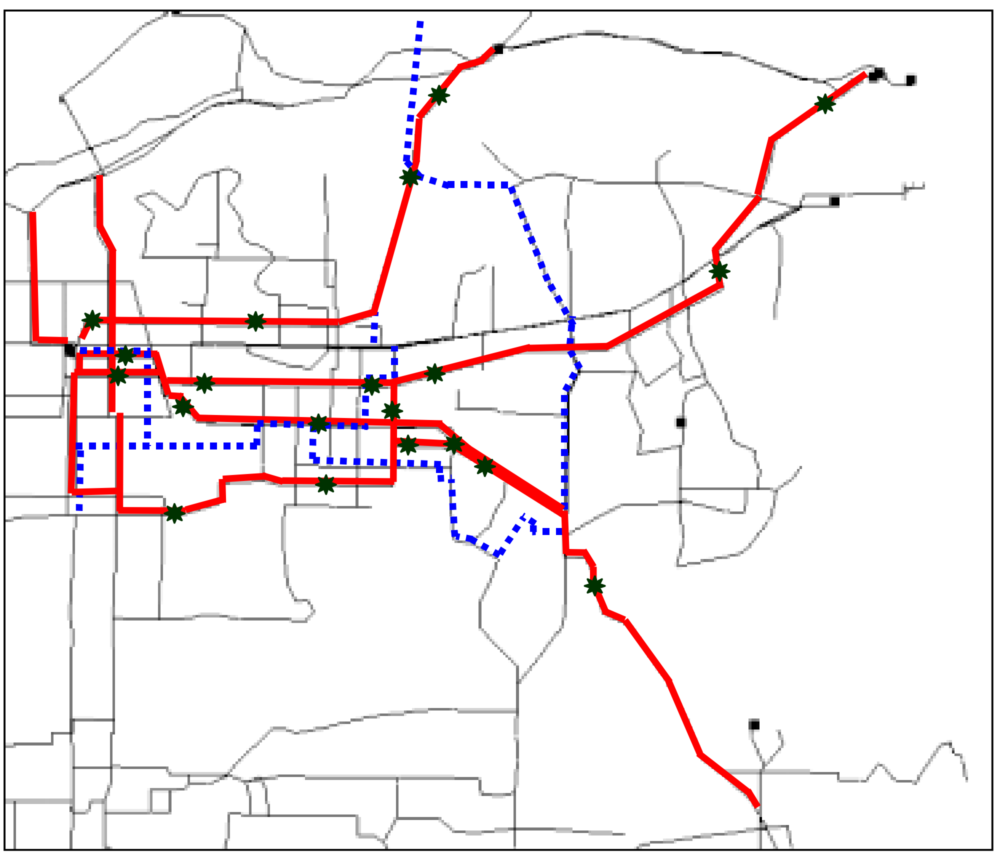

Figure 1. San Diego Pipe Choices & Outage Locations—*existing aging pipelines to be abandoned, re-lined or replaced (solid lines), and potential new pipe locations (dashed lines).*

Improved system redundancy was achieved by requiring the optimized solutions to still meet demands with a pipe break at any one of 20 locations (stars) or with an aqueduct supply source out of service.

For the GA analysis, SDW specified that the system improvements should meet a normal operating condition based on the 7:00 a.m. peak for the year 2030 maximum day. To ensure the identified future improvements would significantly enhance system redundancy, SDW also identified strict emergency demand conditions. If any major pipeline suffers a break, or if the aqueduct supply source is forced out of service, the system must still meet demands while satisfying normal 40 psi pressures.

The GA optimization aimed to minimize capital improvement costs by finding the best mix of abandonment, structural re-lining or pipe replacement choices for 171 existing pipe sections (25.7 miles), and the best pipe sizes for 27 potential new pipes (10.5 miles). The GA search evaluated millions of trial solutions as it "evolved" highly-redundant, near-optimal solutions that satisfied a year 2030 peak hour demand, 20 different pipe break demands (see Figure 1 for break locations), and one supply source outage demand.

System Redundancy Plus Cost Savings

Figure 2 shows SDW's preferred optimized solution, consisting of:

- 47 abandoned pipes (7.8 mi; $199,000)
- 15 re-lined pipes (1.8 mi; $2,950,000)
- 109 replacement pipes (16.1 mi; $25,697,000)
- 11 new pipe sections (5.3 mi; $6,491,000)

The estimated cost of the optimized solution is $35.3 million—36% less than the $55 million estimated cost of simply replacing the 25.7 miles of aging pipelines with pipe of the same size. SDW is proceeding to implement the improvements defined in the GA study.

Conclusion

If a water utility is interested to enhance its security measures with improved system redundancy, GA optimization has shown that it can identify the improvements needed to meet the specific threats that concern the utility. This built-in emergency preparedness can be planned as part of an overall master plan, CIP or mains R&R optimization study.

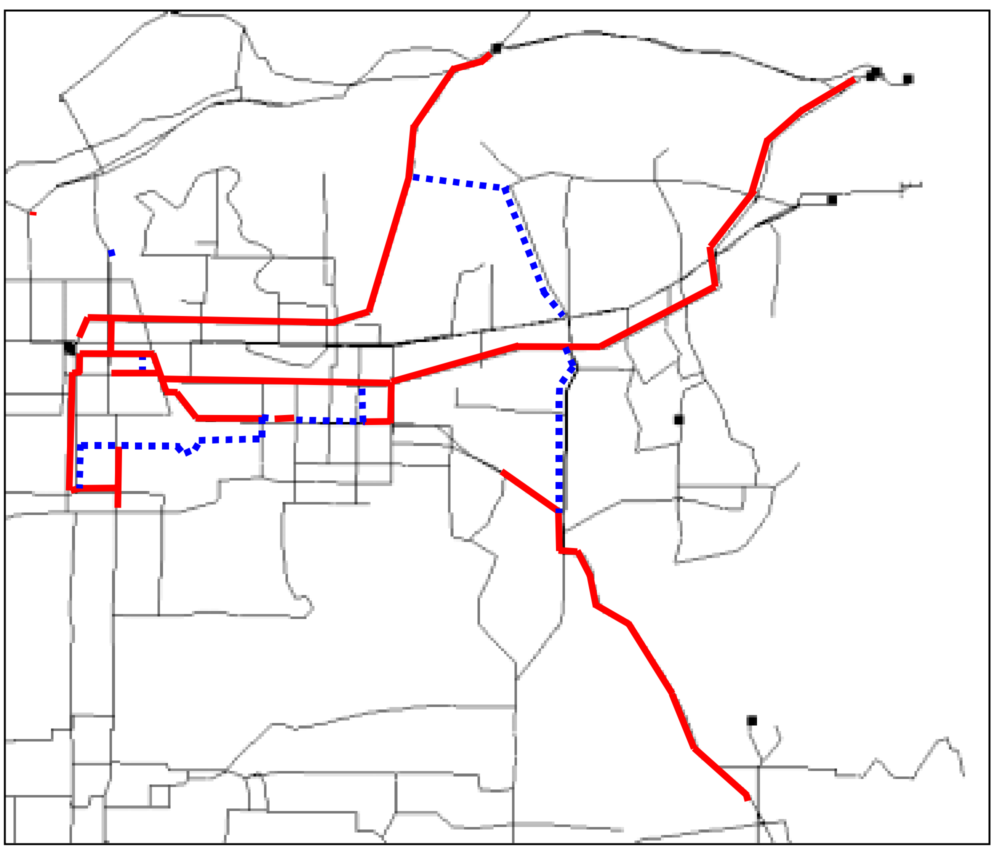

Figure 2. Optimized Solution SD-26b—*SDW's preferred mix of existing pipes for R&R (solid lines) and new pipes (dashed lines).*

In addition to improving system redundancy, solution SD-26b costs $19.7 million less than the option of simply replacing the 25.7 miles of aging pipelines with pipe of the same diameter.

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Please pass this newsletter on to key staff involved in distribution system planning and operations.

Also, please call, fax or e-mail us to update names and addresses or to be removed from the mailing list.

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[1] Larry VandeVenter, Metcalf & Eddy water and wastewater expert, quoted in September 2002 *Public Works* magazine article, "Homeland Security: On The Water Front" by Arthur Schurr

Improving system redundancy is a cost-effective means of protecting water distribution systems.

GA optimization is a tool that can help utilities improve system redundancy for the specific emergency conditions of concern.