

Study Finds Rash of DWP Water Main Blowouts Caused by Conse Measures [UPDATED]

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Update: Direct from the USC Center on Megacities [Report](#) (pdf.)- Expert Review of Water System Pipeline Breaks in the City of Los Angeles during Summer 2009

Background

During the summer of 2009, several high-profile water main breaks occurred in Los Angeles, raising concerns from both the media and the public with respect to the safety and overall condition of the City's water distribution system. Several questions were raised, including:

- What caused a sudden increase in water pipeline breaks?
- Were the breaks related to pressure changes as a result of the City's water-rationing program?
- Did the Monday/Thursday watering schedule cause particular damage to the City's solder pipelines?
- Were the City's water pipelines being replaced in a timely manner?



As a consequence of the public outcry for an explanation, the Mayor and City Council requested an independent investigation into the cause of the increase in water pipeline breaks and the overall vulnerability of the City's water supply and distribution system. An independent investigation team staffed by multidisciplinary experts in water distribution systems as well as other related engineering disciplines was formed and conducted its work apart from the Los Angeles Department of Water and Power (LADWP).

Independent Investigation/Study

The investigation team analyzed data collected by LADWP and identified the main factors contributing to the pipeline breaks that occurred during the summer of 2009. Specifically, the investigation team considered: (1) material sciences, (2) geotechnical engineering, and (3) statistics and geo-statistics. Apart from those considerations, the investigation team also initiated hydraulic testing to measure pressure transients with digital sensors, as well as to audit water pressures at key locations in the system. Additionally, the investigation team initiated a second pilot study in remote sensing, which was led by Jet Propulsion Laboratory (JPL), using state-of-the-art remote sensing and GPS techniques to assess the effects of tectonic deformation and earthquakes on water pipeline breaks. Finally, the investigation team conducted a review of asset management for the City's water distribution systems.

LADWP Water Distribution Systems

LADWP operates a complex water distribution system, extending over 7200 miles and is comprised of pipelines made of various materials. Approximately 65% of LADWP water pipelines are cast iron, a brittle material that becomes even more brittle when embedded in corrosive soils.

Aging Infrastructure – Cast Iron Pipes

Over 90% of blowouts observed since July 1, 2009 have occurred in cast iron pipes that were externally corroded. A common mode of failure used by LADWP to describe a pipeline break that heaves and undermines the street and requires pavement replacement is called "pipe wall failure." Pipe walls failed both circumferentially and longitudinally, resulting in significant damage to the surrounding infrastructure.

a substantial amount of water. This undermined the structural integrity of overlying streets above, creating the blowout that attracted public attention.

In addition to cast iron pipe corrosion, two significant factors — water temperature and internal pressure changes — iron pipe failures. Temperature and pressure changes increase stresses in the pipe walls and (coupled with external pipe integrity).

Investigation Team's Findings

The Investigation Team's findings reveal a connection between the City's water-rationing program and the increase during the summer of 2009, especially with cast-iron pipes. At various locations in the LADWP water distribution system, pressure dropped significantly on Mondays and Thursdays after the beginning of the water rationing program on June 1. Water pressure drops on these days were caused by an increased water flow during the watering of lawns. As a result, water pressure increased and accelerated the metal fatigue failures of aged and corroded cast iron pipes. These findings indicate that the sudden changes of water pressure in the system, attributable to the water-rationing program, had a negative impact on pipes with lower fatigue resistance (i.e. especially corroded cast iron pipes).

Investigation Team Recommendations

For the summer of 2010, the Investigation Team recommends avoiding abrupt variations in water pressure as much as possible. To avoid increased levels of water main breaks, it is recommended that LADWP alter its existing water-rationing program to distribute the variations of water pressure over time, and avoid sudden drops of water pressure. For instance, LADWP could water rationing so that properties with odd and even street numbers engage in watering lawns on different days. This would reduce sudden drops of water pressure and would impose less stress on corroded cast iron pipelines.

Starting in 2010, the Investigation Team recommends that LADWP invests in research aimed at:

- exploring and further refining our understanding of the factors affecting pipeline failure
- developing tools that better quantify, understand, and predict system failures
- improving risk-based asset management of LADWP facilities

The Investigation Team also recommends that LADWP consider:

- a more efficient pipe replacement program as part of its asset management plan, and improved field inspection
- an aggressive pipeline replacement program that reduces the effects of aging and increased vulnerability over

Explanation for Summer 2009 pipeline breaks

It has been suggested that the increase in water pipeline breaks in Summer 2009 may have been due to a concurrent program. A simplified model supporting that hypothesis is presented below:

A simplified model was developed to explain the increase in pipeline breaks that may have resulted from changes in amplitude of water pressure, during the summer of 2009, when lawn watering was restricted to i.e., an effect of watering two specific days per week. This simplified model only explains a temporary increase of water pipeline breaks during 2009, and does not cover all aspects of pipeline failure in a water distribution system.

The two main variables of the simplified model are (1) number of cycles N and (2) amplitude of cyclic pressure S . For simplicity, these variables may not represent all the types of loads applied on pipelines.

The model assumes that pipes are subjected to different numbers of cycles N , but to consistent cyclic pressure variations. Pipes break according to the same fatigue curve $S(N)$.

The model also assumes that the pressure cycles have constant amplitude, which is another drastic assumption in water variability across the LADWP system. Therefore, the simplified model only illustrates the effects of operational changes on aging water distribution system. A more realistic model would require many more variables and much more detailed account for the complexities inherent in the LADWP system.

As shown in Figure 5-45, materials in general exhibit different fatigue behaviors. Materials fatigue when they are subjected

number of stress cycles, and eventually fail after a particular number of cycles. For the cast iron pipes used in water systems, the range of fatigue behaviors corresponds to high stress cycles and finite life. In other words, pipes do not *(Read more in the report, beginning on page 83).*

From KPCC

The water rationing system in the city of Los Angeles, which limited outdoor watering to Mondays and Thursdays, led to a rash of water main breaks in the summer of 2009. That's the conclusion of an independent team led by a USC professor reported to the Environment and Energy Committee of the Los Angeles City Council.

"The investigation team findings reveals a connection between the city's water rationing program and an increase in water main breaks during the summer of 2009 especially with cast iron pipes," Jean-Pierre Bardet, who leads the Megacities project of Southern California, told the committee chair, Councilwoman Jan Perry.

L.A.'s water main system includes more than 7,200 miles of pipe, Bardet said.

Cast iron pipes were the site of 90 percent of breaks in the system since 2001.

Those pipes have been exposed to corrosive materials in which they've been buried for decades, weakening them.

Bardet said those pipes weren't able to handle large variations in pressure caused by dramatically different use on Thursdays as compared with the other days of the week.

To illustrate, Bardet held up a paper clip, which he began to bend in small circles. The metal can sustain the stress for a short energy, he said; as the circles grew, the larger pulses weakened and broke the metal.

Residents from Studio City complained about the speed with which the city's settling claims related to that blowout.

A deputy city attorney told the council committee that 83 percent of claims in that area have been settled, many by city committees. But several homeowners who reside in Councilman Paul Koretz's district complained angrily that they were unable to start repairs without financial settlement from the Los Angeles Department of Water and Power.

Bardet recommended that the city avoid large variations in water pressure in rationing efforts this year. He'll present his findings to the full City Council within a month.

(GO TO [KPCC](#) FOR MORE INFORMATION)

The [LA Times reports](#) DWP spokesman Joe Ramallo as saying scientists at the utility "have not yet analyzed Dr. Bardet's findings. We look forward to doing so."

He added that DWP's internal investigation explored water rationing as a factor, but "found the data ... to be inconclusive. The investigation found that a more likely cause was corroded, aging cast-iron pipes. That finding is not inconsistent with our findings, however."
