Photo by John Erickson.

Utility workers repair a water main damaged by the installation of a storm sewer.

WATER

Flow, Interrupted

by John Erickson

Imagine waking up at 1:00 every morning to fill barrels in your backyard with water, since water only comes to your tap in the middle of the night. While much easier than hauling water from a well, this isn't exactly what most people think of when they hear that a city has a piped water supply with a tap in every house. However, this situation is common in many cities in low- and middle-income countries.

With support from the Tinker Foundation, I spent last summer in Managua, where some houses have rooftop tanks that fill up automatically when the water comes on, but most households have barrels, buckets, and cement tubs called *pilas* to store water until it comes on again.

Water supply becomes intermittent when utilities can't keep the pipes full and pressurized continuously. This situation normally results from a combination of problems that develop over time.

Consider a hypothetical (but typical) informal residential settlement built at the edge of a city, next to an existing neighborhood. In the beginning, new residents haul water from neighbors who have existing connections to the drinking water system. Later, they uncover the drinking water mains and install their own pipes to bring water directly to taps in their yards.

Since the settlement was unplanned and unsanctioned, the water utility is not prepared for the new demands on the system. The pipes and wells that were designed to supply existing neighborhoods are now insufficient.

In the morning, when everyone wakes up and turns on the water, pressure drops and the pipes begin to empty.

Only the houses in the low areas have water, and the houses in the high areas — whether they are in the new settlement or the old neighborhood — are left dry. The houses in the high parts only get water at night, when everyone else turns off their taps.

To make matters worse, the informal pipe system built by the residents of the new settlement has a lot of leaks, so, even at night, much water is lost. Power failures, which stop the water utilities' pumps and wells for hours at a time, are also common.

Soon, with increasing demand for water in the new settlement and high rates of leakage, some houses are barely getting any water at all, even in the middle of the night. To ensure that everyone has at least some water, the water utility divides the area into sectors, with each sector receiving water at a certain time, or on certain days, as controlled by valves operated by the utility. For those settlements at the highest elevation, water only comes in by tanker truck.

The scenario described above is highly simplified and just one example of how intermittent water supply can develop. In practice, urban drinking water systems are continuously evolving. Growth, planned or unplanned, puts new stress on the system's capacity, and the water utility does what it can to respond.

Often, water service is already intermittent when new settlements are built. New, informal settlements are not added onto a well-planned water distribution system but rather onto a patched-together system that evolved as earlier settlements became established neighborhoods.

Aside from inconveniencing users and causing headaches for the water utility, intermittent supply can affect water quality and lead to further deterioration of pipe infrastructure. When the water is off and there is no pressure in drinking water pipes, contaminants in groundwater surrounding the pipes can seep in through leaks. The risk of contamination increases if drinking water pipes have lots of leaks or if they are installed alongside leaky sewer pipes or drainage canals.

Water can also be contaminated during household storage, which is made necessary by intermittent supply. Drinking water stored in a bucket can be contaminated by something as simple as a child's hand reaching in to dip out water with a cup.

Drinking water utilities in Latin America normally chlorinate water, both to kill microbes that may be in the source water and to leave a residual concentration of chlorine that is intended to kill microbes that could re-contaminate the water during distribution. Nevertheless, chlorination practices are often not 100-percent consistent, and residual chlorine is not always strong enough to handle contaminants that seep into the distribution system.

Intermittent operation of drinking water systems causes pressure variations and frequently results in a mix of air and water being present in the pipes. According to a 2011 article in Water 21 by Bambous Charalambous, intermittent supply results in more pipe breaks and more leaks. If this theory is correct, pipes develop more leaks once a water supply becomes intermittent, making it even harder to maintain a continuous supply in the future.

Clearly, there are many advantages to maintaining a continuous supply of drinking water. However, many water utilities facing unplanned urban growth in cities with limited resources have been unable to avoid intermittent supply.

Once a water system is operating intermittently, returning it to

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In Managua, power outages and surges often cause utility water wells to shut down temporarily.

Photo by John Erickson.

continuous supply can be difficult and costly. Despite its many disadvantages, intermittent supply is one way to reduce leakage from the distribution system in the short term. When only a portion of the system is pressurized at any given time, only a portion of the system is leaking. Even if enough water is available to pump into an intermittent system to make it continuous, rates of water loss will likely soar if nothing is done to first reduce leakage.

More research is needed to better understand how intermittent supply affects water quality, water consumption, leakage, water pressure conditions, and infrastructure integrity. This improved understanding would help governments and water utilities decide how big a priority continuous water supply should be. A better understanding of the specific effects of intermittent water supply could also help water utilities reduce or mitigate its negative consequences. It might also be helpful for formulating strategies to avoid intermittent supply in the first place.

With the support of a grant from the Tinker Foundation, I spent last summer in Managua, Nicaragua, observing workers from ENACAL, the country's national water and sewer utility. I rode around with the workers who open and close valves, monitor wells, repair pipes, look for leaks, measure water pressure, and monitor water quality. I also got the chance to talk to utility managers about how operations decisions are made and how my research could be useful to them.

Based on what I learned last summer in Managua, I formulated a research plan to monitor water quality and pressure in an intermittent system. The results of this research, which will be carried out in Panama, another Latin American country affected by intermittent supply, will hopefully help water utilities to better manage intermittent supply and understand its effects.

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A water utility employee collects a sample from a customer's tap to be tested for contamination.

Photo by John Erickson.