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WSSC endangers us by failing to confront the PCCP problem
by Wayne Goldstein

Two days before Christmas, River Road became a river, endangering the lives of nine people when a 66-inch, 5-½ foot wide, water main burst, sending 2500 gallons per second racing down the hilly, tree-lined section where it is a two-lane road. Someone must have been watching over these people that day as it happened so close to the only fire station in the county staffed by fire and rescue personnel trained in swift water rescue. They performed in the same professional manner on River Road that day, as they routinely do on the Potomac River, assisted by a Maryland State police helicopter also doing what it sometimes does over the same river.

It is fortunate that these well-trained government employees did their job as well as they did, preventing harm in spite of the decades-long failure of WSSC to do its job the right way, which might have prevented this life-threatening event from ever happening in the first place. During several days of world-wide coverage, WSSC failed to reveal how much it had been doing wrong as well as what little it had been doing right.

In researching news coverage of big pipe breaks - present and past - and researching documents from WSSC and other sources, what I have learned both alarms and comforts me. I want readers of this column to become familiar enough with the historical and technological details so that if they decide they want WSSC to do its job right and prevent a future River Road river, they won't be tricked or confused by WSSC technical doubletalk. Readers will learn what WSSC knew, when WSSC knew it, and what WSSC has done or failed to do about it.

The water main on River Road, as well as many other large-diameter water mains in the county, is made of Prestressed Concrete Cylinder Pipe (PCCP). PCCP was introduced in 1943 as a way to deal with wartime steel shortages and still be able to build large pipes. PCCP was so successful that it was widely installed until the early 1980s, because it makes effective use of the compressive strength of concrete and the efficient use of very high strength reinforcing steel, usually referred to as prestressing steel, giving it the ability to carry water at pressures up to 300 psi (pounds per square inch) or higher. The water in the pipe coming into your house is probably about 50 psi.

However, these large pipes first began to fail in 1955. The failure rate of PCCP became much more noticeable in the early '80s across the nation and close to home. In fact, a 6/23/90 news account noted: "Yesterday's water main break was the fourth in Howard [County] since 1983. The 15-year-old pipeline system has been troublesome since 1984 and is being replaced at a cost of $7 million. The manufacturer, GHA Lock Joint Inc., has been sued by several jurisdictions, including the [WSSC]. The WSSC has had particular trouble with the company's pipes under Georgia Avenue - a 48-inch main has created serious floods there and near Andrews Air Force Base." With some local PCCP beginning to fail in Howard County as early as 1983, just 8 years after installation, WSSC knew that PCCP had problems 25 years ago.

There were far more details about this problem in a 3/14/96 news account: "[WSSC] worked to restore water pressure and customer confidence yesterday, a day after one of the area's largest water mains broke and left nearly a half-million people in Montgomery County with little or no water. But with much of the 9,500-mile system of water and sewage lines reaching a critical age, utility officials could offer no guarantees that ruptures like the one Tuesday in an 8-foot-wide main in Potomac [on Glen Road] won't happen again soon. Although officials could not say what caused the break in the pre-stressed, wire-reinforced pipe, they said premature aging was a likely culprit. The pipe was made in 1970 by Interpace Corp., of New Jersey, a now-defunct company that WSSC and other utilities successfully sued for providing inferior materials." WSSC has an estimated 200 miles of pre-stressed concrete cylinder pipe, most of which was manufactured by Interpace. WSSC statistics show more than two dozen major breaks of Interpace pipes since 1975, including the 60-inch main that failed last April in College Park and triggered a water emergency in Prince George's County.

Recent news accounts stated: "The WSSC said the pipe under River Road was manufactured by Interpace, a defunct company that became notorious for a series of water main breaks in the 1970s and 1980s. The high-strength wire in prestressed concrete pipes acts as a backbone. In the 1970s, Interpace began using a new type of wire, which it called Class IV, according to its own standards. The wire had more tensile strength than other types, but it was prone to corrosion that caused it to become brittle and break. If enough wire breaks, a rupture is much more likely. The River Road water main, however, was placed before Interpace began using Class IV wire. It used an earlier type of wire that has proved very resistant to becoming brittle, according to the utility. Interpace claimed that its pipes would last 100 years before requiring replacement."

In fact, a 2000 presentation included similar observations about the wire. The so-called Interpace Class IV wire issue has been a nightmare for the PCCP industry. The issue was the result of wire manufacture's efforts to get a little more efficiency from the prestressing wire in the late 1970's and early 1980's. There were some indicators that the high strengths achieved were accompanied by poor performance. It was a more common position that wire could no more be too strong than a person can be too rich. If only it could have been limited to Interpace, but unfortunately it was not.

Decades of studies have determined that the prestressing wires in PCCP, the source of its great strength, is also the source of its greatest weakness, through a process known as hydrogen embrittlement. Elemental hydrogen (H) readily diffuses into steel. Hydrogen can cause steel to become brittle and fail at a tensile stress less than the yield stress of the steel. This phenomenon is especially pronounced in high-strength steels, and when the steel is under stress. The existing prestressed concrete pipe is made of high-strength wire that has a high residual stress.

What happens is that the cement that coats the wires may begin to break down, perhaps because of acidic ground water. This then allows the water and the accompanying hydrogen to come in contact with the wires. Over time, the wires weaken and break. As a rough estimate, a high-pressure (200 psi or greater) pipe may tolerate fewer than 25 broken wires; pipes carrying ~50 psi can lose several hundred wires before catastrophic failure occurs.

One study notes: "A strand of ¼-inch Class III wire will possess a gross wrapping stress of 180,000 psi for ¼-in wire. A relatively small amount of corrosion will cause a wire to break." In fact, the thicker Class III is as vulnerable to breaking as the thinner Class IV; it just may take a few more years for the process to begin. This is important to know because it appears that Interpace and its Class IV has become the scapegoat and perhaps a diversion for all problems with PCCP.

Just as the strength of the wire is also its Achilles heel, so the spectacular way in which each wire fails is also the best way to prevent the even more spectacular failure of the entire pipe. The same study notes: "relatively small amount of corrosion will cause a wire to break, resulting in a sudden release of energy. The energy is dissipated along the pipe (through the pipe wall and through the water column) and the associated acoustic response can be detected." A history of PCCP further states: "The concept of monitoring pipelines for acoustic signals, based on technology used by the U.S. Naval Submarine operations, was born when workmen noticed loud popping noises made by prestressing wires as they broke. These wires can be under as much as 8000 lb. of tension and when they break, some of this potential energy is converted to sound waves that propagate though the water in the pipe.

"The initial wire break is only the first in a series of acoustic events associated with that wire. The broken wire immediately re-anchors itself in the adjacent mortar. The wire remains inactive and silent until the surrounding mortar becomes weakened by progressive deterioration. Then, the wire contracts several additional inches until it is re-anchored in strong mortar. Each of the hundreds of subsequent energy releases will send a distinct sound through the pipe. This process of deterioration may take years to progress to the point of ultimate pipe rupture.

"The system used to detect these acoustic events consists of hydrophones, a signal processor, and communication links. A series of hydrophones is inserted through the wall of the PCCP and into the water stream. When a prestressing wire breaks, the hydrophones detect the sound as it propagates through the water and the signal processor identifies the event. AET (Acoustic Emission Theory) can also discover the event's point of origin. Both the speed of sound through water and the spacing between any two hydrophones are known. By comparing the arrival time at two adjacent hydrophones, the signal processor can locate a wire break to within 5 feet."

Readers now should understand the PCCP problem and the best way to diagnose it before it is too late. This PCCP history, published in February 1997, concluded with this: "AET benefits pipe owners by reducing operating expenses, including monetary losses from disruption of service and liability for flooded structures. By monitoring the condition of PCCP pipelines, problem areas can be identified before a failure occurs. The inspection process itself costs as little as $2/linear foot, and proper maintenance with AET can extend a pipe's useful life by years or even decades. The overall cost of AET maintenance can safely be estimated as 10% - 50% less than that of replacing an entire pipeline. AET can be of assistance to municipalities making long-range capital improvement plans. A decision to completely replace a pipeline is often based on the frequency of repairs to the existing pipeline. While certain pipe sections may require rehabilitation, the greater part of the pipeline may be in perfect condition. A thorough AET analysis allows a municipality to save money by repairing only the discrete sections that need work, rather than replacing the entire line."

The next column on this subject will focus on what WSSC has done in the 25 years since it first learned of the PCCP problem.

The views expressed in this column do not necessarily reflect formal positions adopted by the Federation. To submit an 800-1000 word column for consideration, send as an email attachment to waynemgoldstein@hotmail.com