Forensic Results of 60-inch PCCP Water Main Failure in Chevy Chase
July 17, 2013
The Pipe Failure

- 60-inch Water Main Failed on March 18, 2013, Reported Approx. 8:00 P.M.
- Failure Site is Located along Chevy Chase Lake Drive Near the Intersection of Connecticut Avenue in Chevy Chase.
- Estimated Loss of 60 Million Gallons of Potable Water.
- Failure Direction was Away from the Roadway in the South Embankment of Chevy Chase Lake Drive and Caused a Large Crater Approximately 90 Feet in Length and 45 Feet Wide.
- The Water Flowed into a Large Stream which Helped to Minimize Flooding and Further Damage.
Failure Site Conditions

Failure Location
- SE Away from Roadway towards a Large Stream

8401 Connecticut Ave (Office Building)

8101 Connecticut Ave (Office Building)

Stream
Monday, March 18

- 13:03 Citizen Reports Water Bubbling Near 8101 Connecticut Avenue
- 13:20 Information Relayed to Inspector
- 13:50 Inspector Determines Water Coming from 24-inch Valve Vault
- 14:30 Crew Arrives, Pumps Out Vault, Concludes Valve is Leaking – Decided to Repair Next Day
- 19:40 Montgomery Main Zone Tanks Began To Empty
- 20:01 WSSC Received Police Report of Failure
- 20:30 Crew Dispatched to Isolate Main
- 21:00 MC Fire Board Notified to Expect Fire Flow Issues
- 21:30 Gas & Electric Utilities Arrived
- 22:18 Alert Montgomery Sent Message About the Break
- 22:30 PGC Fire Board Notified of Impending Fire Flow Issues
Timeline

Tuesday, 19 March

• 02:00  Isolated Water Main (6 hours after failure was reported)
• 03:25  WSSC Notification of Water Main Shutdown
• 04:00  Montgomery Main Zone Tanks Began Refilling
• 04:49  WSSC News Release About Water Use Restrictions
• 05:30  Alert Montgomery Sent Message About Water Use Restrictions
• 07:00  Issued NTP to Emergency Contractor
• 09:00  Damaged Electrical Overhead Line Relocated
• 14:00  Excavation of Water Main Began (18 hours after failure reported)
  Installed New 10” Valve on 10” Main to Renew Water Service
Wednesday, 20 March
• **18:00** Failed Pipe Removed – Began Installing New Section

Thursday, 21 March
• **18:00** Repair Completed – Awaiting 12-hour Cure Time for Grout

Friday, 22 March
• 04:00 Began to Refill Water Main
• **09:00** Water Main Charged – Began Flushing
• 21:00 Water Samples Taken for 18-hour Bacterial Test

Saturday, 23 March
• 16:00 Water Approved for Use – Began to Open Valves
• **20:00** All Valves Open and Pipeline Returned to Service – (5 days following Police Report of Failure)
Timeline

Monday, 22 April
• **Completed Final Paving**

Wednesday, 22 May
• Completed Stream Bank Restoration

Tuesday, May 28
• Completed Grass/Sod Restoration

Friday, 21 June
• **Completed Final Stream Planting/Restoration**
60-Inch PCCP Failure - Chevy Chase

Before Excavation on March 19, 2013
60-Inch PCCP Failure - Chevy Chase

54/60-inch Water Main Runs Approximately Parallel to Connecticut Avenue – Large Sections of the Asphalt Pavement from Chevy Chase Lake Drive Were Damaged and 24-Inch Valve Vault Exposed.
Failed 60-Inch - Rupture Side

Close-up Following Main Shutdown

24-Inch Factory Installed Outlet is Located on the Opposite Side of Pipe (Buried)
The Failed Pipe

- 20 Foot Section of 60-inch Diameter SP-12 Embedded Cylinder Pre-stressed Concrete Cylinder Pipe (PCCP).

- The Water Main was 35 Years Old, Constructed in 1978.

- Failed Pipe had 24-inch Factory Installed Outlet Centered 3.82 Feet From Face of Bell End with a 13-inch Clearance from the Steel Saddle Plate to Steel Bell End Ring.

- Pipe Was Manufactured by the Interpace Corporation at the Perryman Maryland Plant in 1977 with Class IV Wire, Known to be Most Problematic.
Typical PCCP Pipe Design

Steel Bell End Ring

Steel Spigot End Ring
Failed Outlet Pipe Design

13-inch Clearance

24-inch Factory Installed Outlet

Steel Bell End Ring

Steel Spigot End Ring

¾” Steel Saddle Plate

3.82 ft
Failed 60-Inch Pipe

24-Inch Factory Installed Outlet

Steel Saddle Plate

Steel Bell End Ring

Failure Area
Failure Occurred in the Area Between the Steel Saddle Plate and the Steel Bell End Ring on the Opposite Side of the Pipe From the Outlet
What Do We Know About This Failure?

- The Pipeline was Last Inspected in the FY’10 Program.
- AFO was Installed in the FY’10 Program.
  - Since Then There Have Been Six Wire Breaks Recorded – All on Opposite Pipe End From Failure.
  - Recorded Wire Break Activity was Not a Concern.
- Failure Occurred Without AFO Warning - No Prior Wire Breaks Recorded at Failure Location.
- A Leak Was Reported Surfacing at This Location.
- The Pipe Failed Catastrophically.
- The Pipe Geometry is Atypical.
Acoustical Fiber Optic Monitoring

What Does it Do?
- Monitors Acoustical Pre-Stressed Wire Break Activity.
- Coupled with Baseline Determines Rate of Deterioration.
- Used to Prioritize/Adjust PCCP Inspection Schedule.
- Provides Advance Notice of Pending Pipe Failure Allowing for Proactive Response.

What Does it Not Do?
- Prevent Deterioration.
- Monitor for Pipe Leaks.
- Guarantee a Pipe Will Not Fail.
Forensic Analysis

- WSSC Hired DACCO SCI, INC. with Subcontractor Lewis Engineering and Consulting to Perform Forensic Analysis.
- Forensic Analysis Began Immediately Following Failure by Extensive Photographic Documentation of Site Conditions and Sample Collection.
- Forensics Included a Laboratory Analysis of Failed and Intact Pipe Materials.
- Laboratory Analysis Verified that Materials Met Manufacturer Specifications and ASTM Material Specifications in 1977 at Time Pipe was Manufactured except 6-gage wire with 19 wraps per foot was used in lieu of the specified 8-gage wire with 23.8 wraps per foot.
- Forensic Analysis Found that Failed Pipe Section had Inadequate Wire Pre-stress Between the Steel Saddle used to Attach the Factory Installed Outlet and the Steel Bell End Ring.
Significant Forensic Findings

Three Principle Conditions Caused the Pipe Failure:

1) Inadequate Wire Pre-stress Found Between the Steel Saddle Plate Used to Attach the Factory Installed Outlet and the Steel Bell End Ring Compromised the Composite Structure of the Pipe Section;

2) A Slow Leak From the Gasket at the Bell End;

3) Chemically and Physically Weakened Pipe Joint Mortar Caused by the Leaking Potable Water (More Corrosive To Steel) Allowed Water to Enter the End of the Compromised Composite Structure and to Corrode the Wires and Steel Cylinder;

Absence of Any One of These Conditions and the Pipe Likely Would Not Have Failed at This Time. This Outlet Pipe Failure was the First to Occur in the WSSC 70 Year History for PCCP Water Transmission Mains.
First Contributing Cause – Lack of Adequate Pre-Stress at Failed End of Pipe

4’- 8” Diameter – Pre-Stressed Wire Hoop From Spigot End – Adequate Pre-Stress

2’- 8” Diameter – Pre-Stressed Wire Hoop From Bell (Failed) End – Inadequate Pre-Stress
Second Contributing Cause – Slow Leak at Bell (Failure) End

Dark Gray Color Shows Smooth Consistent Gasket Seal Impression on Interior of Bell End Joint Ring

Corrosion Patterns Across 2’- 6” Length of Interior of Bell End Joint Ring at Pipe Invert Indicate the Lack of a Good Seal
Third Contributing Cause – Weakened Joint Mortar From Leak

Weakened Joint Mortar from Gasket Leak

Potable Water (More Corrosive to Steel) Entered End of Compromised Pipe Section Due to Lack of Adequate Pre-Stress and Corroded Steel Cylinder and Steel Wire
Lessons Learned – Action Plan

• **Lessons Learned**
  • PCCP Pipe Sections With the Lack of Adequate Pre-stress to Generate an Acoustical Wire Break Noise Can Fail Without Being Detected by the Acoustic Fiber Optic (AFO) Monitoring System.
  
  • The Current State-of-the-Art PCCP Inspection Technology And Methods Cannot Detect Broken Pre-stressing Wires in the Area Between the Steel Saddle Plate and the End Ring for Pipe Sections With a Factory Fabricated Outlet if the Area Between These Components is Two (2) Feet or Less.

• **Action Plan – The Road Ahead**
  • Identify and Map Similar Pipe Sections in Mains 48-inch and Larger – This Task is Complete and a Total of 234 Similar Pipe Sections with Outlets Have Been Identified.
  
  • Perform a Study Prior to the Start of the FY’14 PCCP Inspection Program to Investigate All PCCP Condition Assessment Technologies Both Existing and Emerging to Evaluate Techniques to Identify Defects in the Area Between the Steel Saddle Plate and the End Ring for Pipe Sections with a Factory Installed Outlet if the Area Between These Components is Two (2) Feet or Less.
  
  • Utilize the Techniques Found in the FY’14 PCCP Inspection Program and Excavate Suspect Outlet Pipes to Validate the Results. Continue Research to Identify Nature and Extent of the Problem.
  
  • Repair All Sections of PCCP with Outlets that are Found Suspect.
Questions