PVC PIPE ASSOCIATION
TECHNICAL BRIEF

DUCTILE IRON PIPE'S HAZEN-WILLIAMS FLOW COEFFICIENT DECLINES OVER TIME

Pump station design must take into consideration a pipe's flow coefficient decline to ensure continued capacity over the life of pressurized pipelines. This is important when using ductile iron (DI) pipe, since the evidence shows that its Hazen-Williams "C" value declines with time.

DIPRA'S TESTING CONFLICTS WITH ITS OWN RECOMMENDATION

In their document titled "Cement-Mortar Lining for Ductile Iron Pipe," [1] the Ductile Iron Pipe Research Association (DIPRA) claims there is no decline in the "C" factor: "Cement-mortar lined Ductile Iron Pipe provides a Hazen-Williams flow coefficient, or "C" value, of 140 — a realistic value that is maintained over the life of the pipe." However, closer inspection of the test data used in their publication shows that there is a decline over time:

- *A 12-inch cement-mortar lined iron pipe in Baltimore, MD had a degradation rate of 0.22 per year.*
- *A 12-inch cement-mortar lined iron pipe Greenville, TN had a degradation rate of 0.46 per year.*
- *Pipes from six other cities in their data set showed declines between 0.22 and 0.46 per year.*

Figure 1 shows how DIPRA's own data does not support its claim that "C" remains constant. Additionally, the DI pipe industry offers "double thickness" cement-mortar lined pipe, further confirming that its linings deteriorate.

A SIGNIFICANT BODY OF RESEARCH ALSO DISAGREES WITH DIPRA

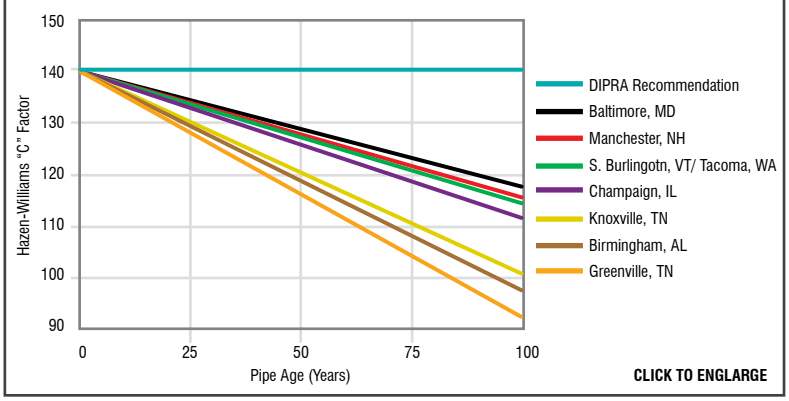
There is significant published research that disagrees with DIPRA's "constant 140" contention. A 2017 study from Virginia Tech University states: "The assumption of the head loss being constant for DI pipe throughout the life is an incorrect assumption. Hazen Williams factor and the effective diameter decrease with time due to internal corrosion and tuberculation in the DI pipe." [2]

Below is a brief review of literature that also supports decreasing "C" factors for cement-mortar lined ductile iron pipe:

- *"Detroit Water Master Plan" [3] – "C" factor projections for DI pipe: initial value is 130 with a decrease of 2.5 per decade.*
- *"Hudson" [4] – consulting firm performed "C" factor tests on metallic pipe water mains which showed significant declines in 7 major cities. Trend lines for San Antonio and Denver are included in the chart below.*
- *"PVC Pipe Life Cycle Assessment (LCA)" [5] – report utilized a "C" factor based on a 2.5 degradation rate per decade per the "Detroit Water Master Plan" after an initial decrease from a "C" value of 140 over 50-, 75- and 100-year service lives.*
- *"Army Corps of Engineers" [6] – developed equation for determining "C" values for corrosion-prone pipe at any age based on roughness growth rate.*
- *"Common Pipe Flow" [7] – authors confirm "C" factor deteriorates for cement-mortar lined iron pipe.*
- *"Pump Handbook" [8] – lists "C" factor values based on age and deterioration.*

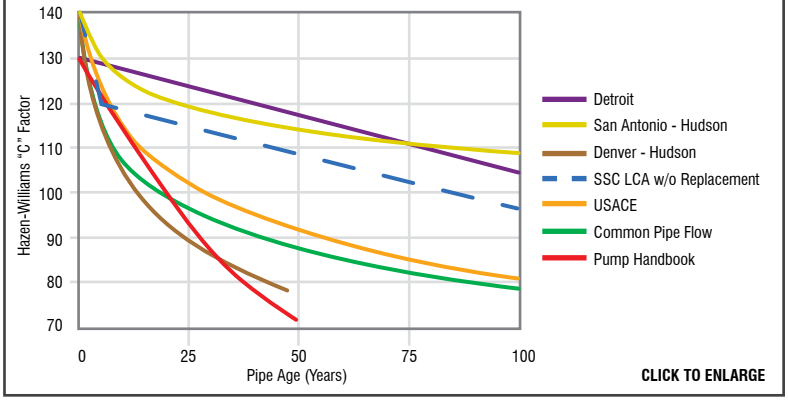
Figure 2 shows the declining "C" factors referenced in the literature above:

FIGURE 1 : DIPRA RECOMMENDATION CONFLICTS WITH DIPRA DATA



CLICK TO ENGLARGE

FIGURE 2 : CEMENT-LINED IRON PIPE "C" FACTOR DEGRADATION OVER TIME



CLICK TO ENLARGE

References: 1. "Cement-Mortar Lining for Ductile Iron Pipe," Table 2, Ductile Iron Pipe Research Association (2016); 2. "A Framework for Holistic Life Cycle Cost Analysis for Drinking Water Pipelines," M. Khurana (2017); 3. "Comprehensive Water Master Plan," Detroit (Michigan) Water and Sewerage Department (2015); 4. "Studies of Distribution System Capacity in Seven Cities," W. Hudson (1966); 5. "Life Cycle Assessment of PVC Water and Sewer Pipe and Comparative Sustainability Analysis of Pipe Materials," Sustainable Solutions Corporation (2017); 6. "Predicting Internal Roughness in Water Mains," T. Walski et al. (1988); 7. "Common Pipe Flow Formulas Compared with the Theory of Roughness," P. Lamont (1981); 8. "Pump Handbook," I. Karassik et al. (2001)

PVCPIPE association
Uni-Bell PVC Pipe Association | 201 E. John Carpenter Freeway, Suite 750 | Irving, TX 75062
Phone: (972) 243-3902 | Fax: (972) 243-3907 | info@uni-bell.org

12.12.2017