November 21, 2016

National Drinking Water Advisory Council
Attn: Ms. Tracy Ward via email: ward.tracey@epa.gov

RE: **Public Meeting Safe Drinking Water Act – Lead and Copper Rule Revisions – Written Statement**

We wish to thank the Board for permitting us the opportunity to provide a written statement in the matter involving the Lead and Copper Rule revisions.

Our prime focus is that the replacement only recommendation of LSLs is not the only viable long term option to solving the problem of leaching metals from lead and copper pipes.

Replacement is not the only option to LSL's.

"Corrosion control treatment can come in many forms" EPA's Peter C Grevatt, Director, Office of Ground Water and Drinking Water, EPA Memo dated Nov 3, 2015

Corrosion control treatment using an acceptable in-place epoxy lining, ePIPE, to LSLs is already approved by the UK's Secretary of State to protect public water supplies and is in active use in the UK as an alternative to replacement of a LSL. A made in USA technology, is solving the UK's lead pipe problem. The technology has been successfully deployed with a US east coast water supplier to protect lead service lines.

As an advanced form of corrosion control, this technology provides an internal coating, to the inside of a LSL. Other benefits include sealing of small leaks in the piping system, an environmentally small carbon foot print, minimal dig, high output rate per crew, ability to complete the customer (private) side typically with no digging to trenching on the customer's (private side) property and at minimal cost when completing a public side LSL in the same set up. Lines are completed in less than 4 hours.

Overall cost savings when compared to conventional dig and replace methods can run into the 30 to 40% range.

In the US, in-place lining technology for corrosion control of small dimeter pipes, has been used for over 15 years and is approved under both major model plumbing codes, IAPMO/UPC® and ICC, NSF Std. 61 and exceeding physical requirements for coatings as laid out by the AWWA.

Replacement with copper service lines comes with several caveats.

Replacement of a LSL with a copper pipe may result in additional unintended consequences.

Dr. Marc Edwards recognizes that dissolved copper from a copper pipe used to replace a lead service line may result in damaging pipes located downstream ie: customer side service line and/or pipes located inside a customer's home.

Copper pipes across the nation have been subject to early failure, often referred to as random pinhole leaks. AwwaRF completed a comprehensive review of the matter, AwwaRF 3015, Assessment of Non-Uniform Corrosion in Copper Piping. Copper pipes are failing at an alarming rate.

Sincerely,

Larry Gillanders
CEO
lg@aceduraflo.com
direct: 714-3563734

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Lining Lead Service Pipes

Presented to Rhode Island Water Works Association

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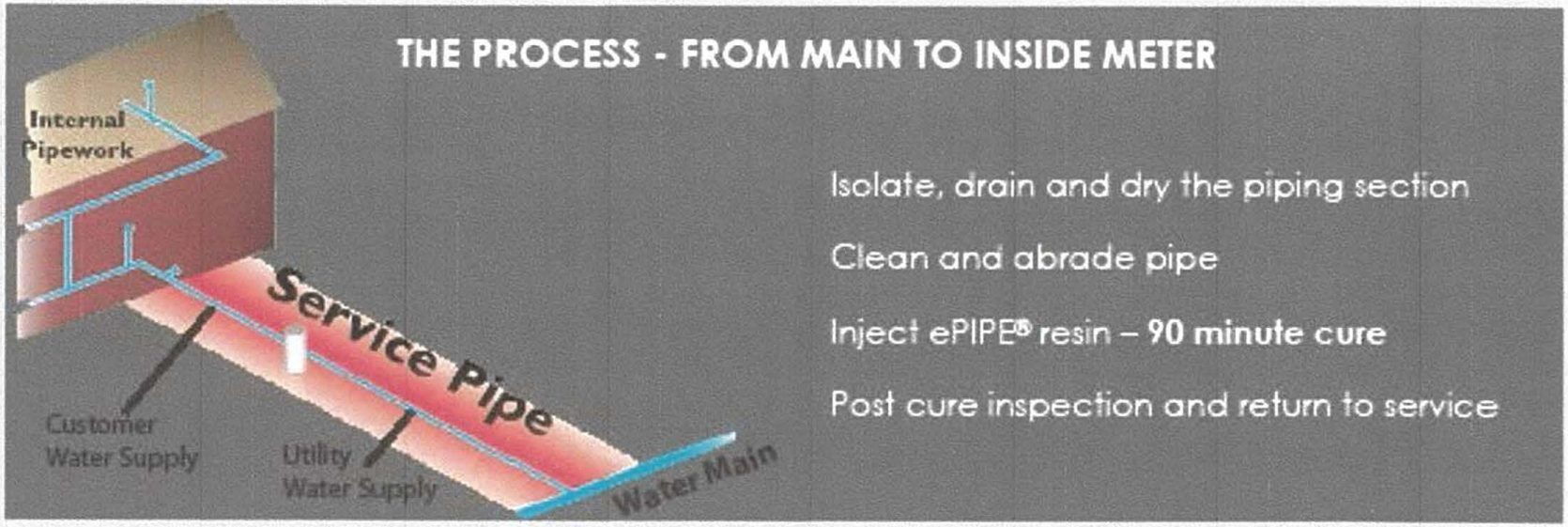

Average service line lengths* - Urban experience

Utility Portion, ft	Customer Side, ft
25 ft (3-60)	30 ft

* AwwaRF - EPA, 2008

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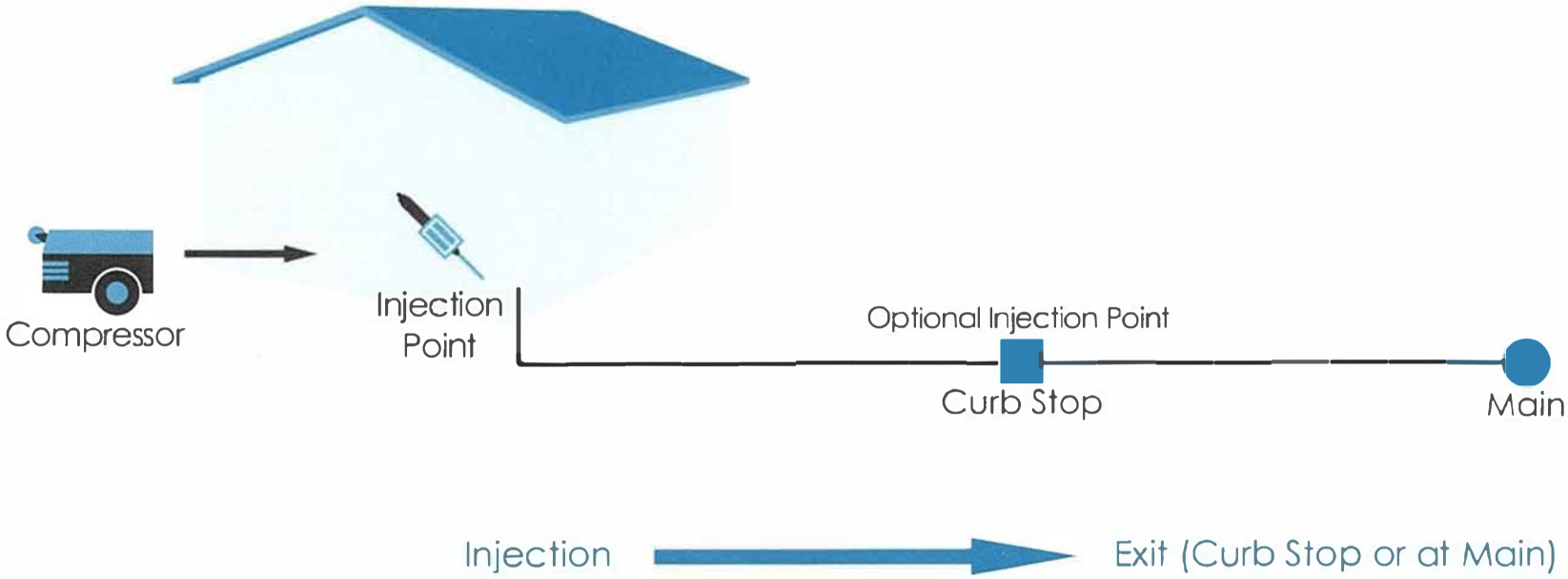
Lead Service Lining Set Up



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General Procedure

Equipment set up

Access to main and for new curb stop

Internal stop tap

Lead pipe inside house prepared for ePIPE application

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Existing lead service line at water main

Installed new curb stop and copper tail piece

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Sanding process and cutting samples

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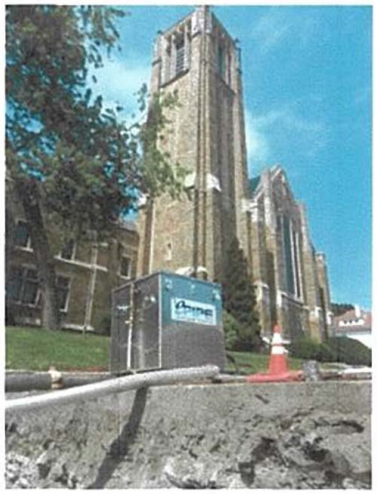
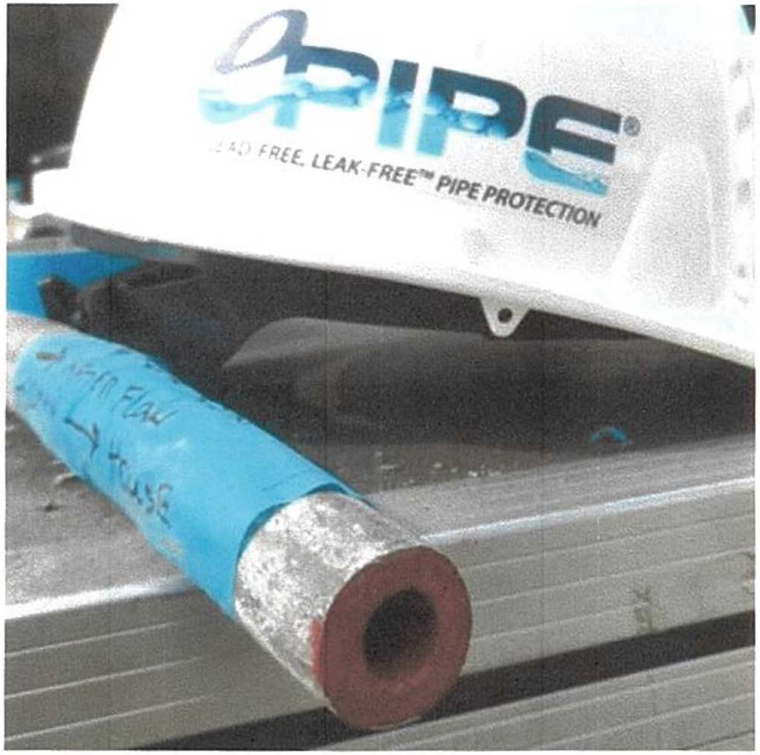


Once resin is placed,
90 minute curing process begins.
On-site portable hot water curing equipment.



End of run - lined lead pipe sample
Pipe internal diameter 5/8”

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Patented ePIPE Process

Existing curb stop and lead pipe located under the tree. No excavation on private side required. Tree saved. Applied process from inside house, through abandoned curb stop to exit before main. New curb stop installed. Customer disruption limited to 4 hours.

Lead test post ePIPE < 1ppb

Improve public health

Go beyond compliance

Better for the environment

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UK/IRE Lead Lining - Various Configurations
Lead service pipes ID - 12mm (1/2”) to 50mm (2”)

Works carried out for Severn Trent, United Utilities, Affinity Water, Yorkshire Water, Wessex Water, Southwest Water, Irish Water and Housing Councils

Lead reduction works included lining:

- **Main to curb stop - long and short sides**
- **From internal stop tap to curb stop**
- **Multiple properties – common services**
- **Single services**

Independent testing conducted by the client

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Road Crossings

- Lining lead service pipes in greater London. Pipes running up to 15m, (50 ft)
- No road closures
- Each line completed in less than 4 hours.

Reduce excavation cost and customer disruption

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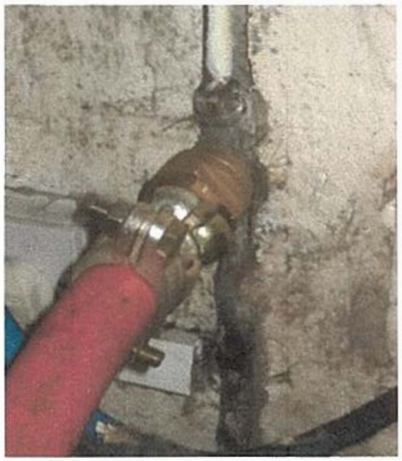
Private side - curb stop to internals



Reduce excavation cost and customer disruption

Use of engineered adaptors can permit through valve application

Multiple service lines in one set up

Better for the environment

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Lining Lead Service Pipes - UK - Results

Date	Property Number	Number of Lined Sections	Total length of lined sections	Pre lining sample result	Post lining sample result	Pre Flow l/min	Post Flow l/min	Details
			meters					
28/01/2014	17			NR	NR	n/a	n/a	Lined to external point of entry
28/01/2014	19			28.4	3.5	11	12	Lined to internal stop tap
28/01/2014	21			34.7	1	11	12	Lined to internal stop tap
28/01/2014	23	8	52.2	8.9	3.4	11	12	Lined to external point of entry
29/01/2014	14			114.4	4.1	12	12	Lined to internal stop tap
29/01/2014	16			43.4	3.8	12	12	Lined to internal stop tap
29/01/2014	18	5	33.9	17	1	12	12	Lined to internal stop tap
30/01/2014	13			54.5	2.2	10	10	Lined to external point of entry
30/01/2014	15	3	23	6	2.8	10	10	Lined to external point of entry
03/02/2014	2			52600	0.9	10	12	Lined to external point of entry
03/02/2014	4	2	11.4	19500	1.8	10	12	Lined to external point of entry
04/02/2014	9			6.2	3.2	10	12	Lined to external point of entry
04/02/2014	11	3	18.6	10.6	8.1	10	12	Lined to external point of entry
05/02/2014	3			16.7	3.1	12	12	Lined to external point of entry
05/02/2014	5			14.4	2.8	12	12	Lined to external point of entry
05/02/2014	7	5	36.3	12.8	1.9	12	12	Lined to external point of entry
06/02/2014	20			76	1.3	10	12	Lined to internal stop tap
06/02/2014	22			28.8	3.4	10	12	Lined to internal stop tap
06/02/2014	24	5	33.4	72.1	0.9	10	12	Lined to internal stop tap
11/02/2014	6			24	2.9	10	10	Lined to external point of entry
11/02/2014	8			70.6	1.8	10	10	Lined to external point of entry
12/02/2014	10			4.2	3.4	10	10	Lined to external point of entry
12/02/2014	12	5	25.9	3.7	3.7	10	10	Lined to external point of entry
	Total:	36	234.7					
	Average:	4.5	29.3375	3306.7	2.77	10.68	11.45	

Sampling and testing completed by client

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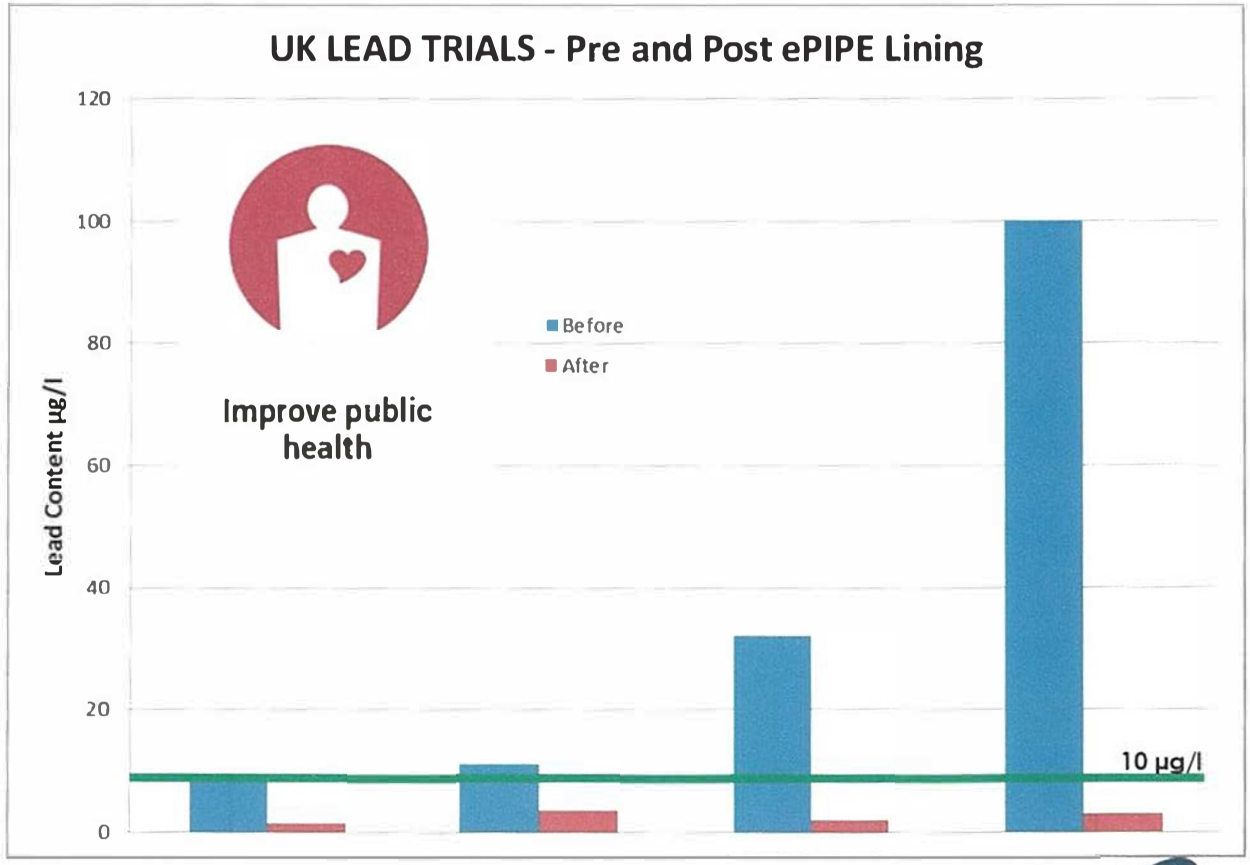
250+ properties sampled over 4 lining programs



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Quick Facts

- Typical single set up - 3 person crew - 2 ePIPE Technicians and 1 plumber (optional)
- Production average 4 lines, both sides, per crew per day. Assume access is open, reinstatement of pits by others, properties in same set up i.e.: side by side
- Assumed lengths - minimum pipe diameter 1/2", single lengths up to 30 feet per side, considered typical.
- Disruption Time to Customer - Target 4 hours or less per property

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Certified to NSF/ANSI 61

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Water Quality Association Written Statement for the National Drinking Water Advisory Council Meeting on December 6th & 7th, 2016

Dear NDWAC Members:

The Water Quality Association (WQA) is committed to addressing issues affecting drinking water quality. WQA is a non-profit association, representing the residential, commercial, and industrial water treatment industry, with over 2,700 member companies. We support the use of certified water treatment products for final barrier protection at the point-of-entry (POE) or the point-of-use (POU) – whole house or at the tap water treatment. Our technical staff and members are ready to assist with solutions to water quality issues, including lead contamination.

There is no safe amount of lead exposure. In 1991, considering economical and technical limitations, the U.S. Environmental Protection Agency established the maximum contaminant level for lead at 15 ppb before triggering remedial action for public water systems. When residents are concerned about lead detections under 15 ppb or received a notice that there was an action level detection, they should be made aware of options on the market for at-home protection and remediation that are third-party certified to remove lead. Water treatment products installed at the home are immediate solutions.

Preemptive education for the public should also be implemented before possible construction disturbance periods. During road construction or service line repairs/replacements, disturbances to the service line and neighboring service lines can occur and result in a spike in contaminant detection, including lead. Directions for actions the residents should take are important to protecting public health. Options for residents can include, but are not limited to, water testing, bottled water or filtered water through a water treatment system certified to remove lead.

To control pollutants, such as lead, from entering the water after leaving a municipal treatment facility or private well, POE/POU water treatment serves as a dependable final barrier to ensure everyone has safe drinking water. Infrastructure improvements are not always affordable, and even when they are it takes time to plan and successfully implement those improvements. POU/POE treatment provides a viable solution for communities that cannot immediately implement infrastructure improvements. Possible POU/POE options include:

-Pour-through pitchers	-Under-the-sink filters	-Distillation
-Countertop units	-Refrigerator filters	-Water softener
-Faucet-attached devices	-Reverse osmosis systems	-UV treatment

POU/POE technologies are already widely available and third-party laboratory certification for product performance and materials compatibility is a standard in the water treatment industry. American National Standards Institute (ANSI) product certification standards for drinking water treatment units not only cover federally regulated contaminants, like lead, but also unregulated contaminants, like pharmaceuticals. States such as California have adopted their own maximum contaminant levels, including chromium-6. In many cases, POU and POE systems can be used by small public water systems in the state to be complaint with the California's water quality standards.

Manufacturers can have their claims validated through an independent certifier such as the WQA Gold Seal program. Products with WQA's Gold Seal have been rigorously tested for safety and performance, ensuring that they are effective in removing the contaminants which are covered by the

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Lisle, Illinois 60532-3696 USA
Phone 630-505-0160
Fax 630-505-9637
www.wqa.org

marketing claims. Factory audits are performed by the certification program on a regular basis to ensure there are no changes to the product which would negatively impact safety or performance. A public listing of certified products is available on WQA's website <https://www.wqa.org/find-products#/>.

All ANSI certification bodies, including the WQA Gold Seal, have their own seal and product listing (i.e. if a product is certified to NSF/ANSI 44 by WQA it will be listed on the WQA website, not NSF International and vice versa). It is important for consumers to know they can look for certified products on both websites. NSF International is also an ANSI accredited standards developer, and sometimes confusion arises because the standards have the standard developing body's name in them. All certification bodies that are ANSI accredited are viewed as equal. The EPA has a useful guide for consumers including all the different certification seals and certification bodies websites <https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water#reducehome>. Most states have adopted this same factsheet, while others only cite one certifier on their website and press releases This can cause confusion for consumers when they try to verify a product's certification to remove lead or other contaminants. Continued education and consumer resources for home water filtration and product certification is needed.

In addition, it is important technical support and personnel competence is in place. While these programs can vary in each State, most States have licensing or technical personnel certification program that specially pertain to water treatment professionals. Colorado is the first state to adopt the WQA education program as its core requirement for the state's specialty license. Together, both product integrity and personnel competency is imperative.

By helping everyone receive treatment they need, exactly where they need it, the United States can protect public health in a cost-effective and reliable way. We appreciate the opportunity to collaborate with you in any way and will be happy to answer questions surrounding at home water treatment. Please do not hesitate to call me anytime to discuss further.

For additional information or assistance, please contact me at 630-929-2537 or dloveday@wqa.org.

Sincerely,

David Loveday
WQA Director of Government Affairs
4151 Naperville Road
Lisle, IL 60532

Documents on Lead and Copper Rule for submission for the NDWAC public meetings

Greg Welter <Greg.Welter@obg.com>

Mon 11/21/2016 10:39 PM

To: Ward, Tracey <Ward.Tracey@epa.gov>;

2 attachments (11 MB)

Welter WQTC 2016 presentation.ppt; Welter - WQTC Paper - rev1.doc;

Hello Ms. Ward,

Please accept the two attached documents. These are a text version and a powerpoint of a presentation that I made last week at the AWWA Water Quality Technology Conference. If you would like to discuss, or have questions please contact me at 301-275-3084, or reply by email.

Have a great day, and a happy Thanksgiving.

Greg Welter

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Coating and lining as alternative strategies for lead service line replacement

Gregory J. Welter, PE, BCEE
O'Brien & Gere Engineers (OBG)
September 8, 2016

Revelations of the adverse consequences of lead corrosion in the water system of Flint, MI, over the past year have prompted considerable discussion within the water supply profession on the need for improved strategies for prevention of recurrence of such an event. As part of its recommendations for long term revisions to the Lead and Copper Rule (LCR), the EPA National Drinking Water Advisory Council has gone on record as advocating that there be a national regulatory policy to remove all lead service lines (NDWAC, 2015). The Board of the American Water Works Association concurred with this recommendation (AWWA, 2016). Both organizations emphasized that the target should be to replace the lead service lines completely, in view of documented adverse effects from partial lead service line replacements, but with the caveat that it is a shared responsibility between the utility and its customers.

This sharing of responsibility for lead service line replacement has been a continuing challenge for utilities, with large scale replacement programs achieving only limited participation in addressing the private side. In lead service line replacement campaigns conducted in Washington, DC and Providence, RI, private side participation rates were typically 20% (or much less), despite the utilities implementing financial incentives and conducting outreach to customers, and despite the media attention to the high lead levels that prompted these mandatory replacement programs under the LCR.

The water industry has maintained that utilities do not have the option of comprehensively replacing the entire water service line, including the portion on private property, because they do not own service pipe beyond the property line, and in some cases are prohibited by local statute from spending funds for improvements on private property. However, the experience of Lansing, MI, would suggest that this situation is not immutable. In Lansing, the decision was made for this public utility to assume the ownership of the entire length of service line pipes in 1927 (Roost, 2016). This assumption of ownership was done to enable the utility to address significant leakage issues, and was accompanied by an adjustment in water rates to support this extended responsibility. The utility installed lead service lines as late as 1956; however, the utility's established ownership of the pipes from end to end facilitated its decision in 2004 to initiate a program for replacement of all lead service lines, which is now nearly completed.

The positive experience of Lansing would suggest that the water industry should take a more assertive responsibility for satisfactory resolution of this important public health problem. It is often asserted that homeowners must be relied upon to team with the utility to effect complete removal of lead service lines; however, the disappointing experience of Washington, DC, and Providence, RI, despite energetic outreach efforts and incentives by both utilities, suggest that this strategy is not likely to be successful. Also, it should be noted that all the lead services were installed during periods when lead was permitted, and sometimes even mandated, for service line use by local codes adopted by authorities who would have been thought to have superior knowledge of the known hazards of lead (Rabin, 2008).

Regardless of how the responsibilities for the private side service line are assigned, approaches that are less costly or result in less ancillary damage to property would be advantageous. Most lead service line replacements are not done with straight open-cut excavation, but employ techniques to reduce the extent of excavation, typically either by pulling the existing service line out with the replacement line attached, or by moling a new line in on an independent alignment. However, there are technologies available that rehabilitate the existing service line by installing a barrier coating or interior lining, and have the potential to reduce cost and further reduce the number of excavation points. Also, often they can be accomplished in a single operation, thus reducing the marginal cost to include the private side length with the public side remediation at the same time. There are at least three such technologies that have been developed expressly for lead service line treatment, and have been employed extensively outside of North America, but whose use in North America has been minimal because the existing regulatory language has been semantically interpreted to allow for only new

pipe installations that totally remove the lead piping from the system. These other methods include one close-fit lining technology and two competing technologies for interior coating. This paper will present summary information on these three technologies.

Close-fit Lining with Polyethylene Terephtelate (PET)

Over twenty years ago the Dutch industrial plastics firm Wavin developed a method for installing a lining system for lead pipes using polyethylene terephtelate (PET), which is a plastic of ubiquitous familiarity in its use for beverage containers. To apply the liner within a lead service line, access is needed at both ends of the line, inside the customer's home and at an excavation at the water distribution main. Typically, there is also needed an intermediate excavation at the service line shutoff valve or outside meter pit. The lead service line is cleaned with compressed air to remove water or sediments, and a small diameter liner (typically about a quarter inch diameter) is inserted in the line. The liner is then expanded to fit the inner diameter of the lead pipe by circulation of hot water, as shown schematically in Figure 1.

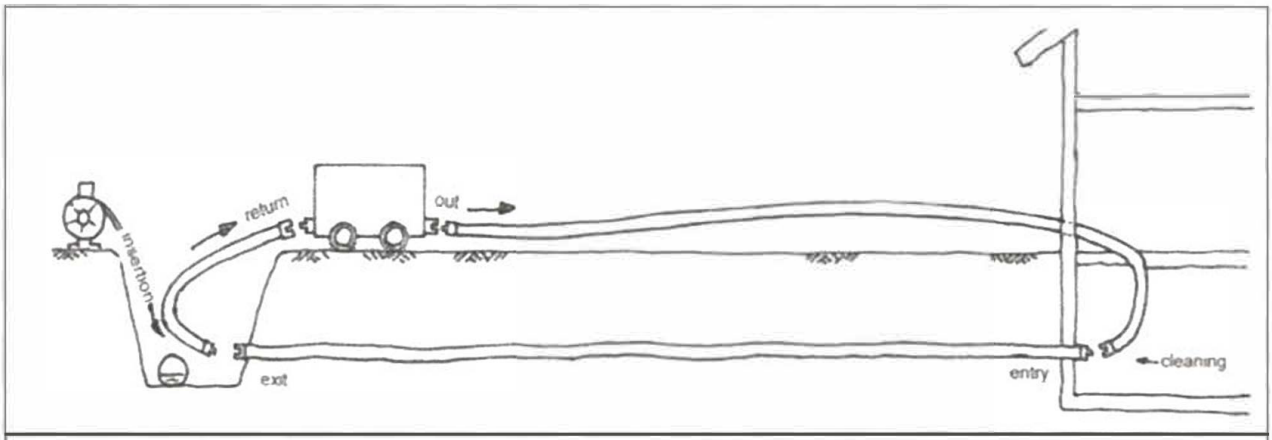

Figure 1: Setup of equipment for expansion phase. Note that liner can be inserted from either inside the home or at the distribution main.

The process is commercially installed under the trade name NEOFIT, and as of 2010 production installations were reported in France (more than 45,000 services), Netherlands and Belgium (3000 services), Germany, Australia, and Norway in Europe; and in Australia, Japan and Malaysia (Alferick and Elzink, 2010). In Australia, it is marketed under the trade name InnaTube. There have also been demonstration installations in the United States and Canada. The NEOFIT product has received international product certifications, including certification under the DWI certification in the UK and the NSF-61 standard in the United States.

The NEOFIT product has been evaluated under a number of independent water quality investigations, including a 2000 research report for the AWWA Research Foundation (Kirmeyer, et al., 2000) and an ongoing project being conducted for WaterRF (Randtke et al., 2015). A particularly useful and comprehensive review of the product was done by the Dutch water research consultancy, Kiwa, for the Dutch water utility association, Vewin (Mesman, et. al., 1995). The report reviews the experience of two utilities in production installations of the PET liner, a comparative cost evaluation, durability assessment, and water quality effects. Of particular note is the report's review of practical field installation considerations, including what can go wrong in an installation.

Figure 2. NEOFIT installation photos. Interior and exterior line insertion; heated water circulation apparatus; expanded liner ready for connection.

and deployed it, usually through the services of trained local plumbing contractors. The most prominent of the companies using the process, each with their own proprietary epoxy formulations for the application, are Pipe Restoration Services, also operating as ACE DuraFlo Systems, LLC, with its "ePipe" epoxy formulation and application technique; and Nu Flow (which is an Aquam Group company and whose epoxy coating technology was the result of its acquisition of American Pipe Lining, Inc.)

Service Line Coating: Epoxy

The "Pipeline Restoration Services / ACE DuraFlo" enterprise has been particularly active in the United Kingdom where it has been coating lead service lines with its proprietary ePipe epoxy formulation that is particularly distinctive in having a cure time of only 2 hours. Similar to the PET liner sequence described above, the epoxy coating process starts with gaining access to both ends of the lead service line (i.e. inside the home, and in the street at the water main). The liquid epoxy process has an advantage in that the coating can be run through an unexcavated intermediate valve, as long as the valve is operated a number of times during the curing period. After opening both ends, the pipe interior is prepared for coating by abrading the surface with air blown aluminum oxide. The epoxy is then injected as a slug in one end of the pipe, and propelled through the pipe with compressed air, after which it is cured with a flow of hot water.

Figure 4. A schematic of the ePipe epoxy application process; promotional photo of an epoxy coated lead pipe; and field photo of excess epoxy being blown from lead pipe in demonstration installation in Providence, RI.

Pipeline Restoration Services reports that it has successfully treated approximately one thousand lead services in the UK, with follow up testing results well below the European standard of 10 ppb. Follow-up testing was done on 19 services that were lined in a project in which a total of 176 lines were treated in May and June of 2014. The results of that sampling is summarized in the table below.

	Pre-coating test (ppb)	Post-coating test (ppb)	12 to 18 month followup (ppb)
Average	1131.3	2.6	1.5
Median	41.9	2.2	1.0
90th percentile	1238.6	5.4	3.6
Note: Two of the pre-coating samples tested at 1238.6 ppb and 19,500 ppb			

In addition to its product certifications in the United Kingdom (i.e. WRAS – Water Regulations Advisory Scheme, and DWI – Drinking Water Inspectorate), the ePipe product and process has been reviewed and certified under the NSF/ANSI 61 standard, International Code Council and IAPMO.

Service Line Coating: Modified Urea Polyurethane

As noted above, the Nu Flow/Aquam Group's North America operations are primarily directed at interior plumbing system rehabilitation projects using its epoxy formulation. However, it is also active in lead service line coating projects in the United Kingdom, but using an alternative coating product, a modified urea polyurethane developed by the 3M Corporation (Scotchkote Rapid Setting Polymeric Lining 166L) (3M, 2015), applied in a process called Serline in a partnership with Whirlwind Utilities Ltd. This product, which is represented as having a cure time of 4 hours, is applied in a similar sequence of accessing the pipe at both ends, preparing the interior surface with a blown abrasive, and air-application of the polymer. The finished polyurethane coating is represented to have the flexibility matching the host lead pipe (Serline, 2016).

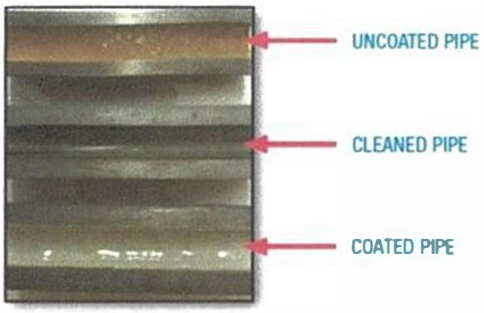

Figure 5. Polyurethane coating sequence

The Scotchkote 166L polyurethane product has received product certifications from the WRAS and DWI, in the UK. As of this time, it is not certified under the NSF/ANSI 61 standard, although its corporate cousin, the NuFlow epoxy is NSF/ANSI 61 certified.

Conclusions

The purpose of this paper is not to draw conclusions as to the relative value of the different technologies described, but rather to illustrate that there does exist alternative technologies that have not seen application in North America, but have been accepted by regulatory agencies and successfully applied for lead service line abatement in other countries. The primary reason that these lining and coating technologies have not been applied in North America is that they are not considered to be "replacement" under the regulatory agency interpretation of the LCR, and thus they are effectively not available to the utilities that have to engage in large scale lead service line abatement due to "action level" exceedances. It is recommended the revisions to the LCR currently under development use the words lead service line "abatement", "rehabilitation" or "remediation", rather than the word "replacement", so as to make available to utilities a broader set of options to successfully resolve the problem. In particular, the specifics of these rehabilitation techniques hold the potential for reduced expense and reduced property disruption, making full service line replacement more likely to be chosen.

A second recommendation, again oriented toward promoting full rather than partial lead service line replacement, is that utilities and government agencies recognize that the present paradigm of public vs private division of the service line has been and will continue to be an insurmountable obstacle to satisfactory resolution of the lead service line problem. If this legacy of past government decisions to permit, or even require that, lead pipe be used for service lines pipe is to be solved, water utilities and government agencies will have to take full responsibility, including ownership of the complete service line if necessary.

REFERENCES

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Randtke, SJ, EF Peltier, CD Adams, and JA Roberson, 2015, "Evaluation of Lead Service Line Lining and Coating Technologies," Periodic Report 15 under WaterRF Project 4351, Dec. 2015.

Roost, Randall, 2016, Presentation from Randall Roost, Lansing Board of Water and Light, at AWWA conference on "Get the Lead Out", National Press Club, May 3, 2016.

Serline, 2016, "Serline Solutions" < http://www.serline.co.uk/solutions >, accessed April 5, 2016.

3M, 2015, "3M™ Scotchkote™ Rapid Setting Polymeric Lining 166L" Data Sheet and Application Guide, 3M United Kingdom, May 2015.

Pipe coating or lining as alternative strategies for lead service line replacement

Gregory Welter, PE BCEE; OBG (O'Brien & Gere Engineers)

Presented at the AWWA Water Quality and Technology Conference (WQTC),
November 16, 2016, Indianapolis, IN

Recent official statements regarding lead service line replacement

NIDWAC Lead and Copper Rule Working Group (Aug 24, 2015)

"The LCRWG specifically recommends that EPA revise the LCR to:

Require proactive lead service line (LSL) replacement programs, which set replacement goals, effectively engage customers in implementing those goals ….. in place of current requirements in which LSLs must be replaced only after a lead action level (AL) exceedance,"

Recent official statements regarding lead service line replacement

- **NDWAC** (National Drinking Water Advisory Council) transmitted the LCRWG report to EPA Administrator on December 15, 2015.
- **AWWA** Board of Directors March 8, 2016, statement of support:

  The Board of the American Water Works Association voted unanimously Monday to support recommendations from the National Drinking Water Advisory Council (NDWAC) that strengthen the Lead and Copper Rule and ultimately lead to the complete removal of lead service lines.

  .....

  Among the NDWAC'S Dec. 15 key recommendations are that water utilities:

  1. Locate and replace all lead service lines completely, *sharing responsibility for that replacement with customers,*

LSLR implementation has generally assumed utility to have only limited ownership or "control"

- **Ownership** - Generally utilities assert that their ownership extends only to the property line. In some cases, the assertion is made that the utility owns no part of the service line, and has no legal responsibility.
- **Partial replacements** – Generally recognized to be not as effective as full replacement. Effectiveness limited in the first few months by disturbance effects, and over the longer term by galvanic corrosion. (This was basis of the NDWAC Working Group recommendation.)

Limited success in past experience by utilities in "sharing" the endeavor of replacing lead service lines

Experience in the District of Columbia has resulted in private-side participation at disappointing low rates, despite:

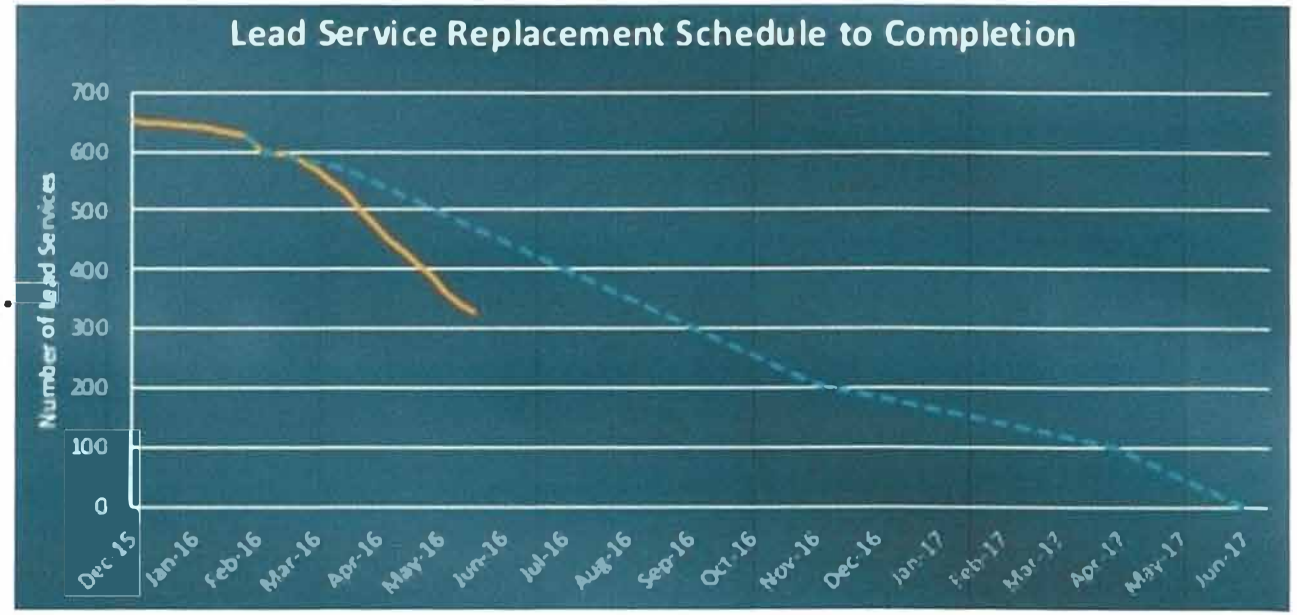
- intensive outreach, education, and project coordination;
- financial incentives, loans, and extended repayments; and
- extensive front page stories on the lead crisis in the media.

District of Columbia - Private LSLR participation since 2003

Quadrant	Public LSLRs	Private LSLRs	Percent
NW	16,256	2,109	13.0%
NE	10,721	876	8.2%
SW	490	23	4.7%
SE	5,523	458	8.3%
Total	32,990	3,466	10.5%

Lansing, MI, as a model for LSLR effectiveness, but caveated as being possible because of full ownership

- In 1990s there were an estimated 17,000 lead services
- In 2004 the policy decision was made to replace all lead service lines with ten years.
- As of May 2016, that goal has nearly been met, with only about 500 remaining.



A footnote to the Lansing caveat

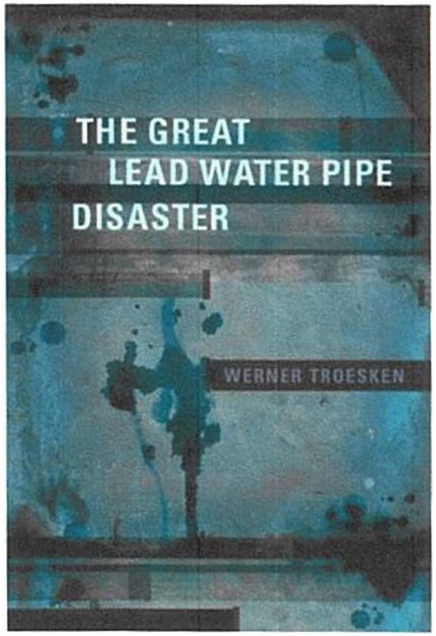
- Lansing did not always own the service lines in their entirety
- Lansing made the decision to take ownership in 1927.
- The purpose of this ownership takeover was to give the utility the ability to resolve an untractable problem (service line leakage) that was not getting solved under the “shared ownership” model.
- As part of that ownership transfer, Lansing did also implement a rate increase intended to cover the cost of this added responsibility.

So, who was responsible for original lead pipe installations?

- Not the residential customers.
- Lead was listed as an acceptable, in some cases required, service pipe material in building codes up until the late 1970s and 1980s.

The Great Lead Water Pipe Disaster,
by Walter Troesken (2006)

"The Lead Industry and Lead Water Pipes: A Modest Campaign", by Richard Rabin,
http://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2007.113555



Some historical (contemporary) AWWA sources

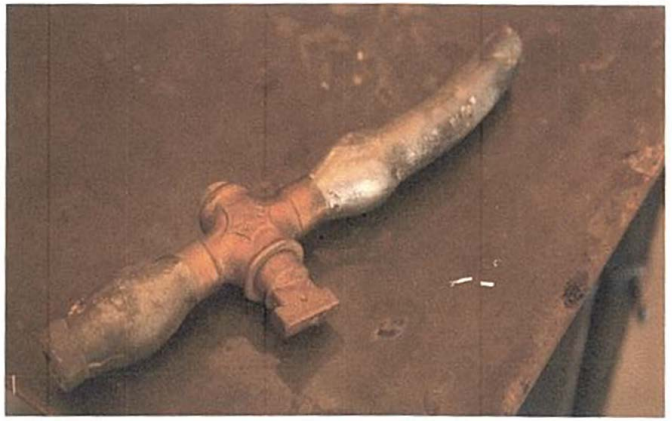
New England Water Works Association.

REPORT OF COMMITTEE ON SERVICE PIPES.

[*Presented March 14, 1917.*]

"Lead pipe is mechanically an almost ideal pipe for services, on account of its flexibility and the ease of laying in streets where there are obstructions. ..... The lead does not corrode and the pipe remains smooth and clean. The serious objection to the use of this material is the possibility that it may affect the health of those using the water."

"It seems to be practically impossible to determine in advance by laboratory tests whether or not the use of lead will be safe. The only sure test is one of several years' duration in actual service."



Some historical (contemporary) AWWA sources

- 1924 JAWWA article "The Action of Water on Service Pipes" (W. Donaldson) reports in a survey of 539 cities that 48% used lead or lead lined pipe for service lines. The article reviews what was known at that time about water lead toxicity.
- 1938 JAWWA article "The physiological aspects of mineral salts in public water supplies" (S. Negus) contains the argument that:

  "Lead ions seem to have a bad reputation, although some of it is not deserved when it comes to the traces found in most purified water supplies. If the very small amounts which persons ingest by drinking water and eating food, were as harmful as some people believe them to be, there would be many more cases of lead poisoning than are known to occur."

Some alternatives for replacement of lead services

Objective: To identify some viable alternatives that could make the treatment of the entire lead service line length more feasible:

- Field procedures for coating or lining service lines are less disruptive than replacement due to fewer excavations.
- Cost to coat or line the service line is competitive with replacement, and the incremental cost for including the private portion is marginal.

Polyethylene Terephtelate (PET) lining

- Developed by a Wavin, a Dutch plastics firm, specifically for lead pipe lining, under the trade name Neofit.
- Plastic tube insertion and expansion by heated water pressure.
- Material is a polyester, familiarly used for beverage containers.
- Certified under ANSI/NSF Std 61, plus international standards.

PET / Neofit applications outside of the US

Europe:

France (>300km)	:	40.000 services
Netherlands, Belgium	:	2.500 services
Germany, Austria	:	since 2004
Norway	:	since 2005

55 installation units

outside Europe:

Australia, Japan	:	since 2004
Malaysia	:	since 2005

6 installation units

Source: Alferick and Elzink, 2010

Previous reviews of PET/Neofit

- Kirmeyer, et al., 2000, Lead Pipe Rehabilitation and Replacement Techniques, Water Research Foundation (WaterRF) Project 465.

  Includes field demonstration in Louisville, KY

- Randtke, et. al., 2015, "Evaluation of Lead Service Line Lining and Coating Technologies," Periodic Report 15 under WaterRF Project 4351, Dec. 2015.

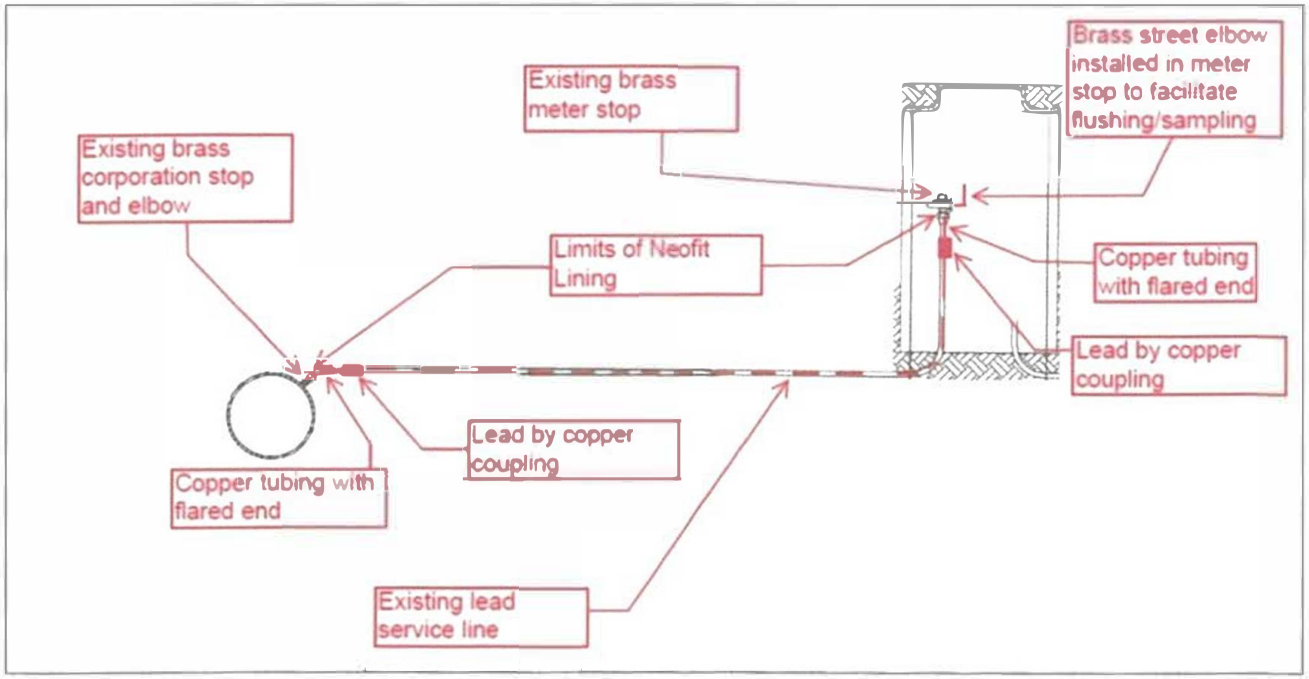
  Includes extensive lab tests for lead breakthrough (negative) and for liner component release (well below standards)

- Mesman, et al., 1995, Applicability of PET-lining for the renovation of lead service lines, KIWA report 10.0091.024

  Includes extensive review of installation methods (including review of potential problems), cost and durability.

PET/Neofit extended lead barrier effectiveness

- Original demonstration installation in Louisville, KY. Linings installed, but the service lines then abandoned in place.
- Test conducted on buried lines 7.5 years after lining installation



PET/Neofit extended lead barrier effectiveness

- Original demonstration installation in Louisville, KY. Linings installed, but the service lines then abandoned in place.
- Test conducted on buried lines 7.5 years after lining installation

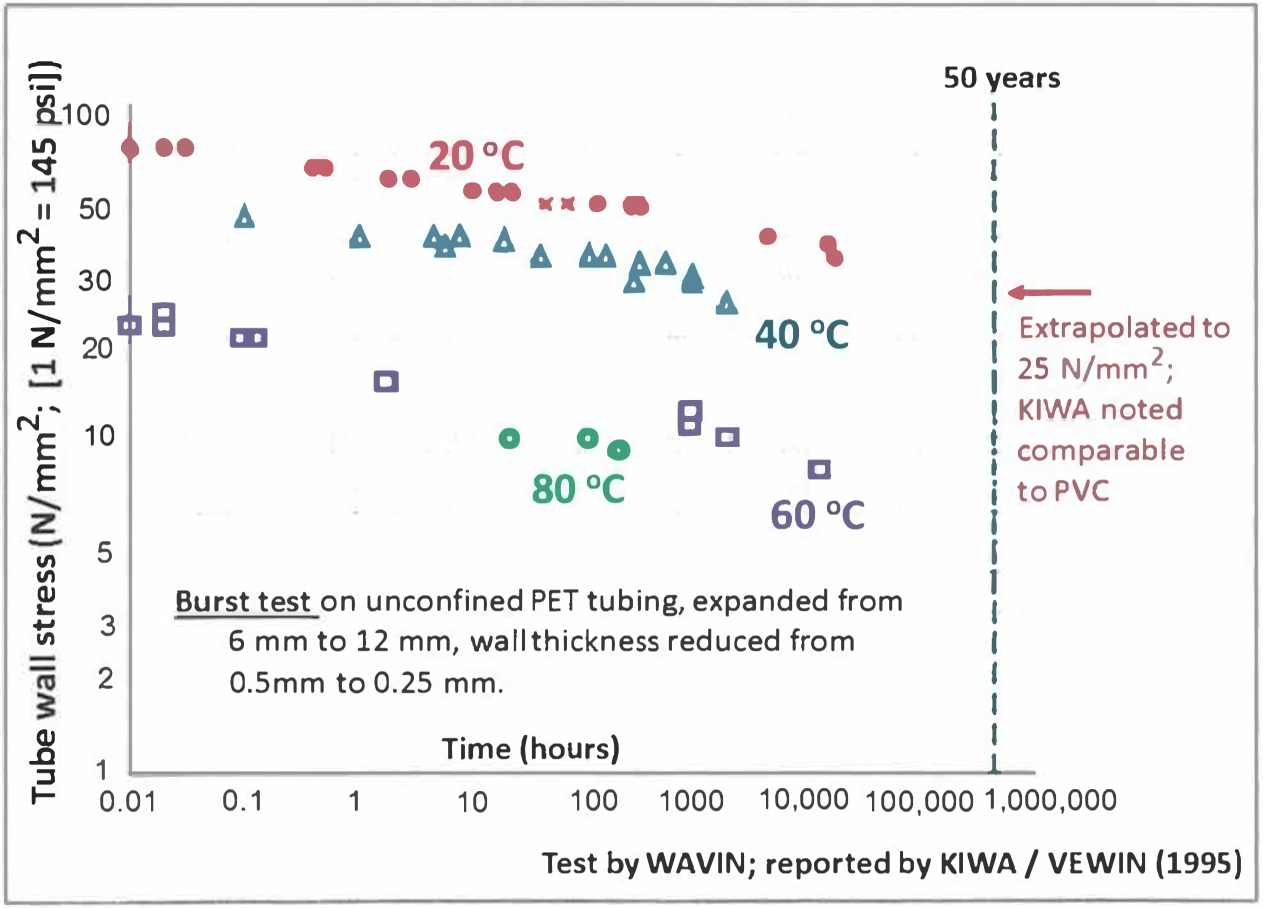
PET / Neofit Extended Lead Barrier Effectiveness Study

Address	10/8/2008	4/3/2016	4/5/2016	4/14/2016
Stagnation time	Contact time not recorded	8 hours	48 hours	8 hours
100 N. Birchwood Ave.	1.7	<1.0	<1.0	
101 N. Birchwood Ave.	1.6	2.0	2.0	
118 S. Birchwood Ave.	2.0	<1.0	<1.0	
120 S. Birchwood Ave.	3.8	<1.0	<1.0	
2520 Meadow Rd. *	1.6	15.0	10.0	<2.0

* Note: 4/3 and 4/5 sample events for 2520 Meadow determined to have been contaminated by lead from original brass fitting. This fitting was replaced for the 4/14/16 sampling event.

Ball, Tim, 2016, Water Quality Sampling Results for NEOFIT Lined Lead Drinking Water Service Lines

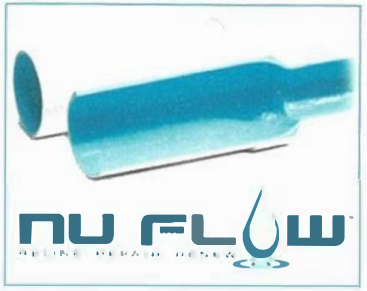
PET / Neofit durability



Pipe coatings

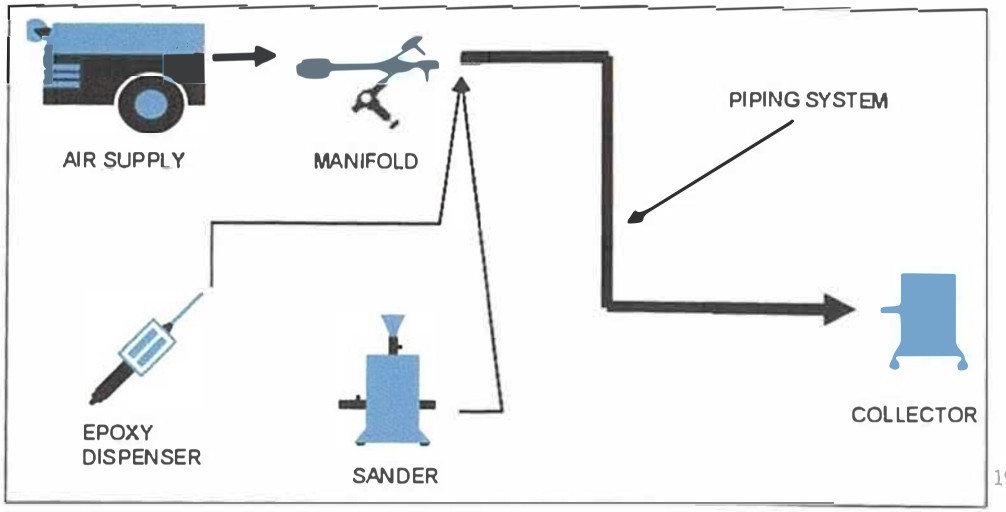
- Pipe coating by epoxies and similar materials is actually a fairly mature technology, but has been applied in North America primarily for the purposes of rehabilitation of indoor plumbing, typically in commercial establishments, hotels, military bases and ships.
- Two competitive epoxy coating vendors
  - Ace-DuraFlo / "Pipeline Restoration Services", marketing its ePipe product.

  - Aquam's Nu Flow product.



e-Pipe LSL coating experience in the United Kingdom

- Specially developed epoxy formulation that enables a 2-hour cure time and return to service. Approved by UK Drinking Water Inspectorate, and by ANSI/NSF Std 61.
- WRF project found it to be effective lead barrier, and no significant release of coating materials (e.g., bis-phenols, BADGE)
- Epoxy is applied in a process involving:
  - Access to both ends of pipe (inside and at the water main)
  - Blown in aluminum oxide to abrade the pipe wall
  - Epoxy injection as a slug, propelled with compressed air.
  - Curing with heated water.



e-Pipe LSL coating experience in the United Kingdom

12 to 18 month followup results on 19 lead services tested, out of a project in which 176 lines treated in 2014

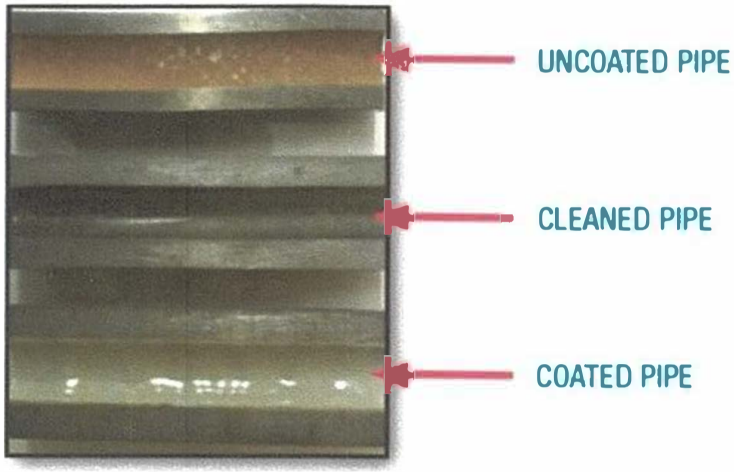
	Pre-coating test (ppb)	Post-coating test (ppb)	12 to 18 month followup (ppb)
Average	1131.3	2.6	1.5
Median	41.9	2.2	1.0
90th percentile	1238.6	5.4	3.6

Note: Two of the pre-coating samples tested at 1238.6 ppb and 19,500 ppb

ePipe demonstration in Providence RI

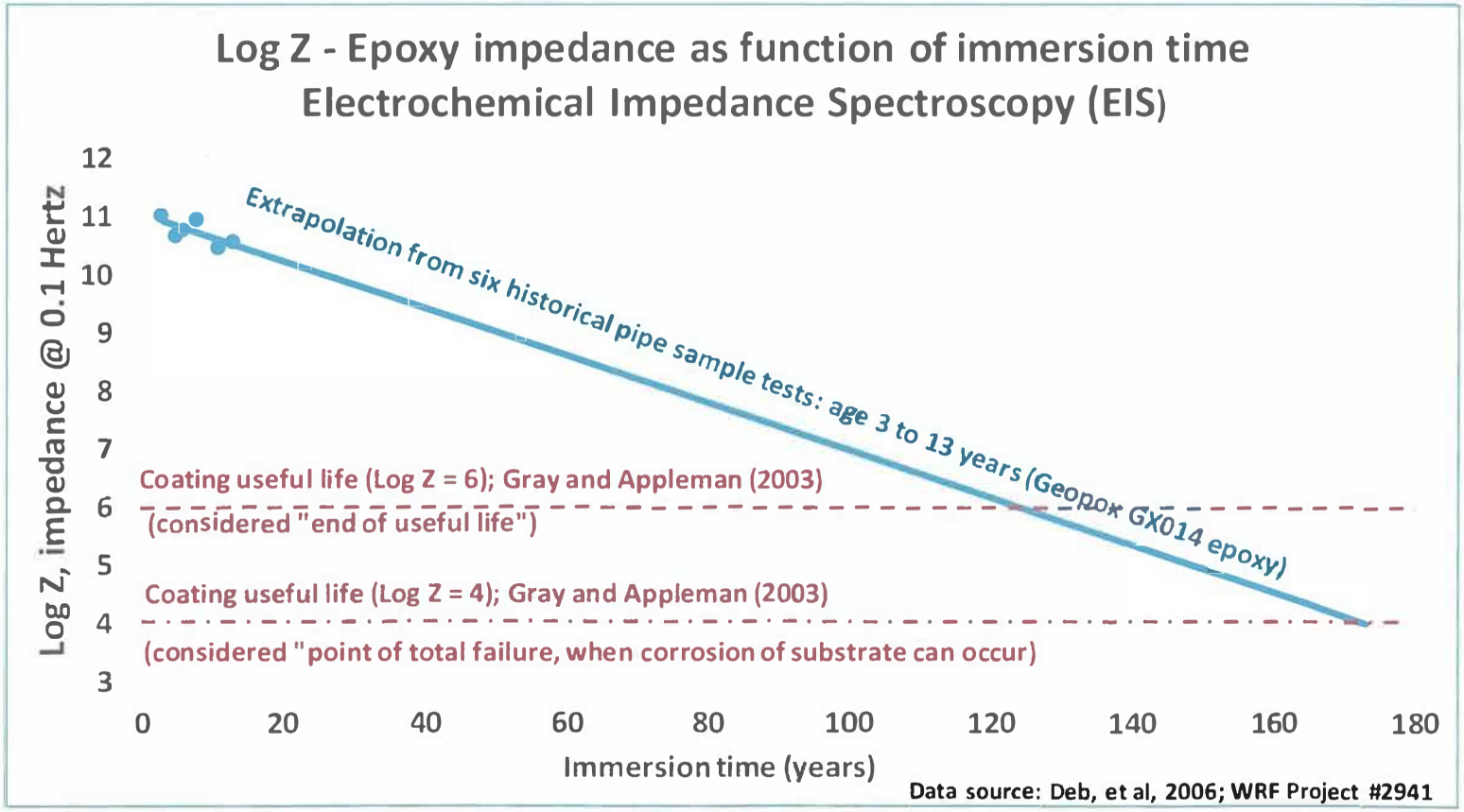
Aquam / Nu Flow experience in United Kingdom

- Operates a process called Serline, in partnership with Whirlwind Utilities, Ltd.
- Rather than epoxy, the Serline process Uses a modified urea polyurethane (3M Scotchkote Rapid Setting Polymeric Lining 166L), which has a 4-hour set time
- Scotchkote 166L is certified under UK DWI standards, but as of now has not been certified under ANSI/NSF 61.



Polyurethane coating sequence

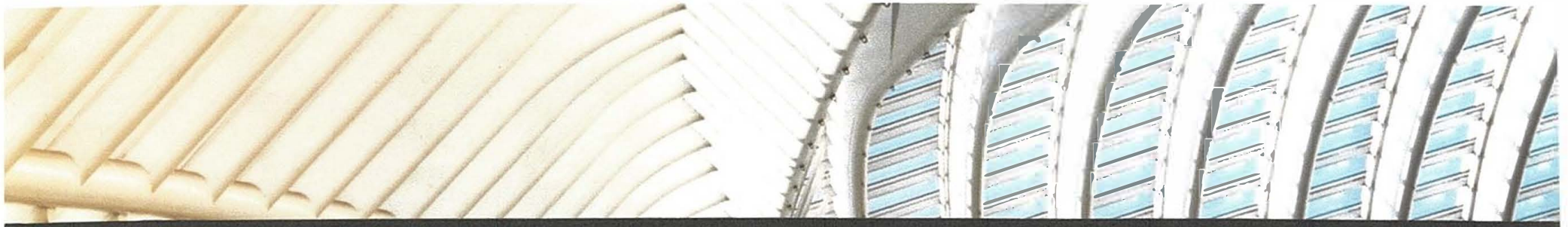
Durability of epoxy polymer linings (based on Electrochemical Impedance Spectroscopy" (EIS) extrapolation



- Studied under Water Research Foundation Project 2941 "Service Life Analysis of Water Main Epoxy Lining" (Deb, et al., 2006)

Conclusions

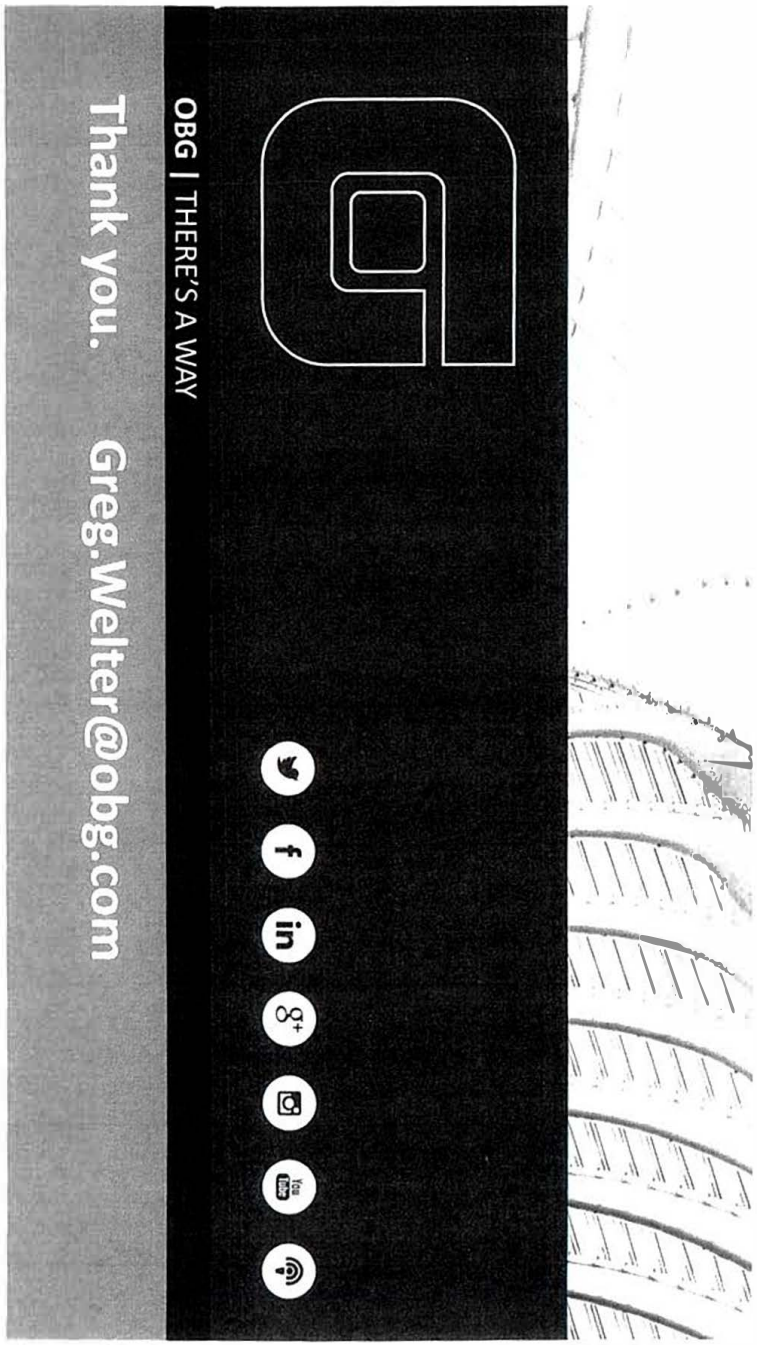
- To the extent that lead pipe replacement is actually adopted as a policy, by EPA or by utilities, it should be done effectively to address the entire length of the pipe.
- This is a matter of both effectiveness and of economic justice.
- To that extent utilities should assume responsibility for the whole.
- There are available technologies for coating / lining lead service lines that may make this more feasible, and should compete in terms of marginal cost of private side, and potential for reduced disruption.
- Lining / coating installations should have acceptance test requirements for post installation lead barrier effectiveness (i.e. water sample analysis) and hydraulic capacity.



OBG | THERE'S A WAY

Thank you.

Greg.Welter@obg.com



Documents on Lead and Copper Rule for submission for the NDWAC public meetings

Greg Welter <Greg.Welter@obg.com>

Mon 11/21/2016 10:39 PM

To: Ward, Tracey <Ward.Tracey@epa.gov>;

2 attachments (11 MB)

Welter WQTC 2016 presentation.ppt; Welter - WQTC Paper - rev1.doc;

Hello Ms. Ward,

Please accept the two attached documents. These are a text version and a powerpoint of a presentation that I made last week at the AWWA Water Quality Technology Conference. If you would like to discuss, or have questions please contact me at 301-275-3084, or reply by email.

Have a great day, and a happy Thanksgiving.

Greg Welter

Gregory J. Welter, PE, BCEE
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pipe installations that totally remove the lead piping from the system. These other methods include one close-fit lining technology and two competing technologies for interior coating. This paper will present summary information on these three technologies.

Close-fit Lining with Polyethylene Terephtelate (PET)

Over twenty years ago the Dutch industrial plastics firm Wavin developed a method for installing a lining system for lead pipes using polyethylene terephtelate (PET), which is a plastic of ubiquitous familiarity in its use for beverage containers. To apply the liner within a lead service line, access is needed at both ends of the line, inside the customer's home and at an excavation at the water distribution main. Typically, there is also needed an intermediate excavation at the service line shutoff valve or outside meter pit. The lead service line is cleaned with compressed air to remove water or sediments, and a small diameter liner (typically about a quarter inch diameter) is inserted in the line. The liner is then expanded to fit the inner diameter of the lead pipe by circulation of hot water, as shown schematically in Figure 1.

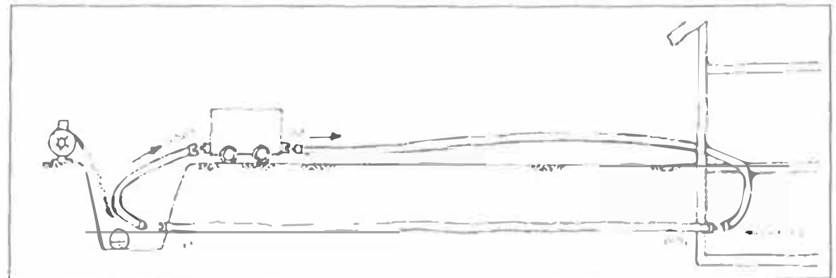


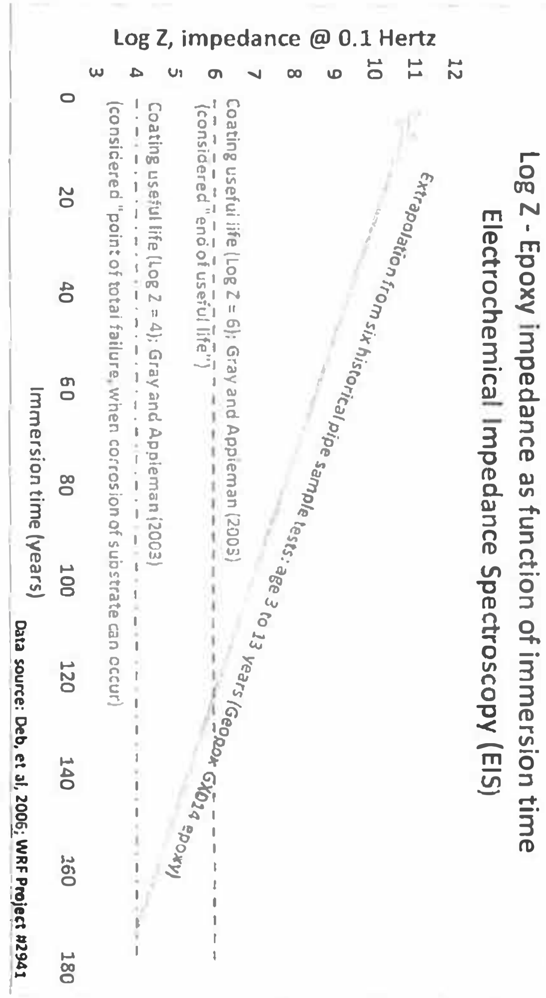
Figure 1: Setup of equipment for expansion phase. Note that liner can be inserted from either inside the home or at the distribution main.

The process is commercially installed under the trade name NEOFIT, and as of 2010 production installations were reported in France (more than 45,000 services), Netherlands and Belgium (3000 services), Germany, Australia, and Norway in Europe; and in Australia, Japan and Malaysia (Alferick and Elzink, 2010). In Australia, it is marketed under the trade name InnaTube. There have also been demonstration installations in the United States and Canada. The NEOFIT product has received international product certifications, including certification under the DWI certification in the UK and the NSF-61 standard in the United States.

The NEOFIT product has been evaluated under a number of independent water quality investigations, including a 2000 research report for the AWWA Research Foundation (Kirmeyer, et al., 2000) and an ongoing project being conducted for WaterRF (Randtke et al., 2015). A particularly useful and comprehensive review of the product was done by the Dutch water research consultancy, Kiwa, for the Dutch water utility association, Vewin (Mesman, et. al., 1995). The report reviews the experience of two utilities in production installations of the PET liner, a comparative cost evaluation, durability assessment, and water quality effects. Of particular note is the report's review of practical field installation considerations, including what can go wrong in an installation.

Figure 2. NEOFIT Installation photos. Interior and exterior line insertion; heated water circulation apparatus; expanded liner ready for connection.

Durability of epoxy polymer linings (based on Electrochemical Impedance Spectroscopy" (EIS) extrapolation



- Studied under Water Research Foundation Project 2941 "Service Life Analysis of Water Main Epoxy Lining" (Deb, et al., 2006)

Aquam / Nu Flow experience in United Kingdom

- Operates a process called Serline, in partnership with Whirlwind Utilities, Ltd.
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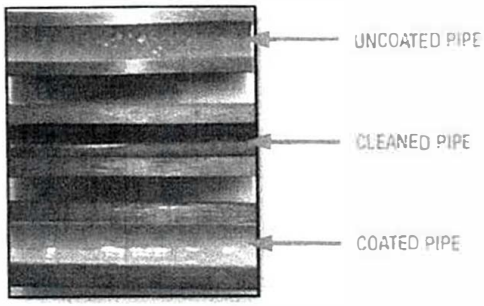


Polyurethane coating sequence

The NEOFIT product has been installed for demonstration purposes in a number of United States cities, including Zanesville, OH, Providence, RI, and more extensively, Louisville, KY. Some of the Louisville demonstration installations were done as part of the 2000 AwwaRF, and some were done independently by the Louisville Water utility as part of its own research and product vetting program. In April 2008, Louisville Water Company (LWC) partnered with Utility Services, LTD, of Melbourne, Australia, to install NEOFIT in several lead service lines. Under the demonstration project, the lead lines were lined with PET, and then left in place connected to the water main but terminating at the customer meter box. while the actual customer supply was transferred to a new copper service line. Twelve years later, in 2016, arrangements were made by Flow-Liner, LTD, the current North American franchisee of the NEOFIT process to access the lines for sample collection (Ball, 2016). The initial sampling of the five test lines was done by LWC staff, with a protocol for first flush, 2-minute flush, and 10-minute flush samples. The 2-min and 10-min samples were all below the 2.5 ppb detection limit of the LWC laboratory equipment, but the first flush samples were higher than expected, with readings ranging from 5.2 ppb to 238 ppb. However, in review of the data, it was noted that the samples were taken using the original brass meter stops installed in 2008, and that there had been visible debris in the samples, which was felt might have resulted from connecting and disconnecting the brass fittings on the flushing hoses. A follow-up round of sampling was then conducted, in which the original brass fittings were replaced (where possible) or were supplemented with non-brass valves so they wouldn't need to be operated. Removal of the older brass components took some repeated modifications to some of the lines; however, after this had been accomplished and that source of the lead removed, the sampled results from all five test addresses were reported at 2.0 ppb or less, using a private contract laboratory. Contact hour time for these sampling events was 8 hours and 48 hours. Figure 3 depicts the piping configuration for the Louisville installation

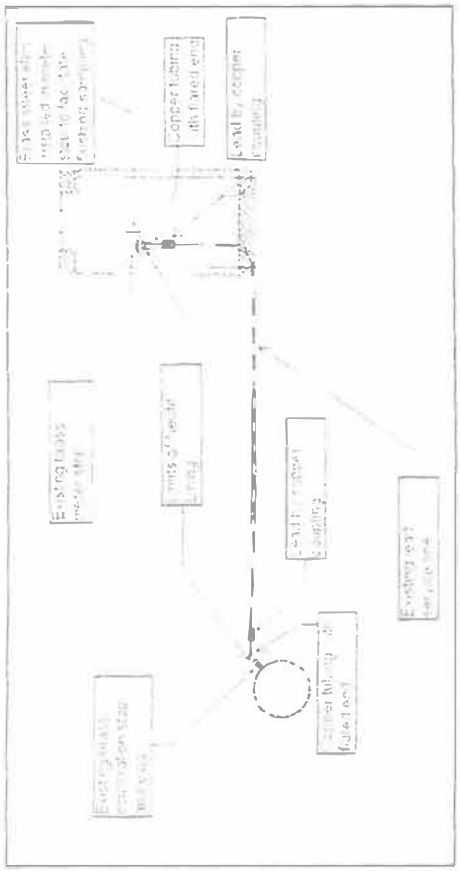
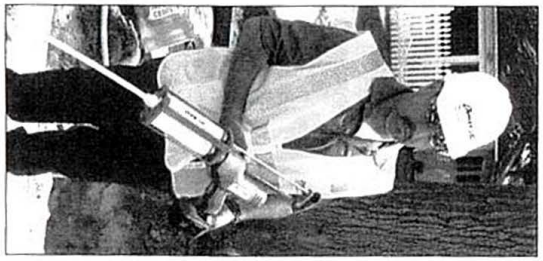


Figure 3. Louisville, KY, demonstration test configuration (5 service lines). (Ball, 2016)

Pipe Coatings

Another lead service remediation technology that has been employed on a production basis is coating the pipe with an epoxy. Epoxy coating of piping systems is a mature technology, having been deployed widely for rehabilitation of internal plumbing systems, usually for remediation of pin hole leak or other corrosion problems. In this application, it has been used for large scale remediation of commercial buildings, hotels, naval ship systems, and residential plumbing. There are a number of companies that have developed this technology,



ePipe demonstration in Providence RI

and deployed it, usually through the services of trained local plumbing contractors. The most prominent of the companies using the process, each with their own proprietary epoxy formulations for the application, are Pipe Restoration Services, also operating as ACE DuraFlo Systems, LLC. with its "ePipe" epoxy formulation and application technique; and Nu Flow (which is an Aquam Group company and whose epoxy coating technology was the result of its acquisition of American Pipe Lining, Inc.)

Service Line Coating: Epoxy

The "Pipeline Restoration Services / ACE DuraFlo" enterprise has been particularly active in the United Kingdom where it has been coating lead service lines with its proprietary ePipe epoxy formulation that is particularly distinctive in having a cure time of only 2 hours. Similar to the PET liner sequence described above, the epoxy coating process starts with gaining access to both ends of the lead service line (i.e. inside the home, and in the street at the water main). The liquid epoxy process has an advantage in that the coating can be run through an unexcavated intermediate valve, as long as the valve is operated a number of times during the curing period. After opening both ends, the pipe interior is prepared for coating by abrading the surface with air blown aluminum oxide. The epoxy is then injected as a slug in one end of the pipe, and propelled through the pipe with compressed air, after which it is cured with a flow of hot water.

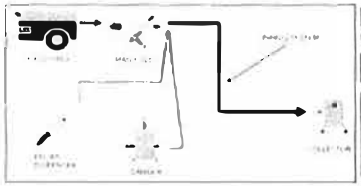


Figure 4. A schematic of the ePipe epoxy application process; promotional photo of an epoxy coated lead pipe; and field photo of excess epoxy being blown from lead pipe in demonstration installation in Providence, RI.

Pipeline Restoration Services reports that it has successfully treated approximately one thousand lead services in the UK, with follow up testing results well below the European standard of 10 ppb. Follow-up testing was done on 19 services that were lined in a project in which a total of 176 lines were treated in May and June of 2014. The results of that sampling is summarized in the table below.

	Pre-coating test (ppb)	Post-coating test (ppb)	12 to 18 month followup (ppb)
Average	1131.3	2.6	1.5
Median	41.9	2.2	1.0
90th percentile	1238.6	5.4	3.6

Note: Two of the pre-coating samples tested at 1238.6 ppb and 19,500 ppb

In addition to its product certifications in the United Kingdom (i.e. WRAS – Water Regulations Advisory Scheme, and DWI – Drinking Water Inspectorate), the ePipe product and process has been reviewed and certified under the NSF/ANSI 61 standard, International Code Council and IAPMO.

e-Pipe LSL coating experience in the United Kingdom

12 to 18 month followup results on 19 lead services tested, out of a project in which 176 lines treated in 2014

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Service Line Coating: Modified Urea Polyurethane

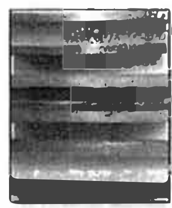

Figure 5. Polyurethane coating sequence

As noted above, the Nu Flow/Aquam Group's North America operations are primarily directed at interior plumbing system rehabilitation projects using its epoxy formulation. However, it is also active in lead service line coating projects in the United Kingdom, but using an alternative coating product, a modified urea polyurethane developed by the 3M Corporation (Scotchkote Rapid Setting Polymeric Lining 166L) (3M, 2015), applied in a process called Serline in a partnership with Whirlwind Utilities Ltd. This product, which is represented as having a cure time of 4 hours, is applied in a similar sequence of accessing the pipe at both ends, preparing the interior surface with a blown abrasive, and air-application of the polymer. The finished polyurethane coating is represented to have the flexibility matching the host lead pipe (Serline, 2016).

The Scotchkote 166L polyurethane product has received product certifications from the WRAS and DWI, in the UK. As of this time, it is not certified under the NSF/ANSI 61 standard, although its corporate cousin, the Nu Flow epoxy is NSF/ANSI 61 certified.

Conclusions

The purpose of this paper is not to draw conclusions as to the relative value of the different technologies described, but rather to illustrate that there does exist alternative technologies that have not seen application in North America, but have been accepted by regulatory agencies and successfully applied for lead service line abatement in other countries. The primary reason that these lining and coating technologies have not been applied in North America is that they are not considered to be "replacement" under the regulatory agency interpretation of the LCR, and thus they are effectively not available to the utilities that have to engage in large scale lead service line abatement due to "action level" exceedances. It is recommended the revisions to the LCR currently under development use the words lead service line "abatement", "rehabilitation" or "remediation", rather than the word "replacement", so as to make available to utilities a broader set of options to successfully resolve the problem. In particular, the specifics of these rehabilitation techniques hold the potential for reduced expense and reduced property disruption, making full service line replacement more likely to be chosen.

A second recommendation, again oriented toward promoting full rather than partial lead service line replacement, is that utilities and government agencies recognize that the present paradigm of public vs private division of the service line has been and will continue to be an insurmountable obstacle to satisfactory resolution of the lead service line problem. If this legacy of past government decisions to permit, or even require that, lead pipe be used for service lines pipe is to be solved, water utilities and government agencies will have to take full responsibility, including ownership of the complete service line if necessary.

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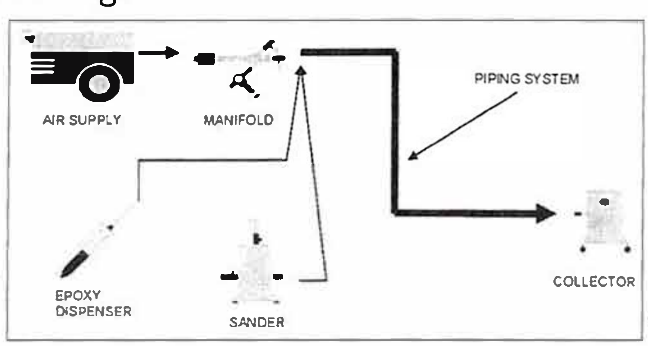
e-Pipe LSL coating experience in the United Kingdom

- Specially developed epoxy formulation that enables a 2-hour cure time and return to service. Approved by UK Drinking Water Inspectorate, and by ANSI/NSF Std 61.
- WRF project found it to be effective lead barrier, and no significant release of coating materials (e.g., bis-phenols, BADGE)
- Epoxy is applied in a process involving:
  - Access to both ends of pipe (inside and at the water main)
  - Blown in aluminum oxide to abrade the pipe wall
  - Epoxy injection as a slug, propelled with compressed air.
  - Curing with heated water.



Pipe coatings

- Pipe coating by epoxies and similar materials is actually a fairly mature technology, but has been applied in North America primarily for the purposes of rehabilitation of indoor plumbing, typically in commercial establishments, hotels, military bases and ships.
- Two competitive epoxy coating vendors
  - Ace-DuraFlo / "Pipeline Restoration Services", marketing its ePipe product.

  - Aquam's Nu Flow product.

Pipe coating or lining as alternative strategies for lead service line replacement

Gregory Welter, PE BCEE; OBG (O'Brien & Gere Engineers)

Presented at the AWWA Water Quality and Technology Conference (WQTC), November 16, 2016, Indianapolis, IN

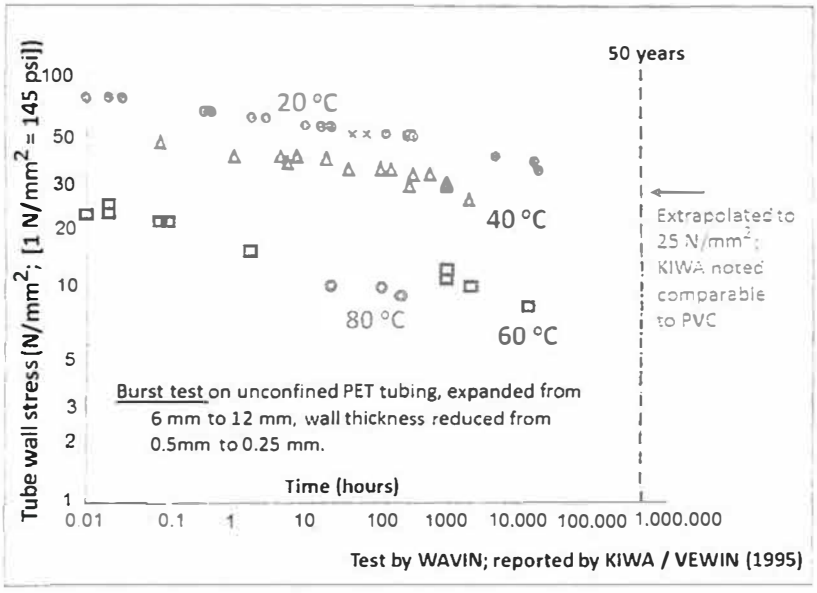
Recent official statements regarding lead service line replacement

NIDWAC Lead and Copper Rule Working Group (Aug 24, 2015)

"The LCRWG specifically recommends that EPA revise the LCR to:

Require proactive lead service line (LSL) replacement programs, which set replacement goals, effectively engage customers in implementing those goals ….. in place of current requirements in which LSLs must be replaced only after a lead action level (AL) exceedance,"

PET / Neofit durability



PET/Neofit extended lead barrier effectiveness

- Original demonstration installation in Louisville, KY. Linings installed, but the service lines then abandoned in place.
- Test conducted on buried lines 7.5 years after lining installation

PET / Neofit Extended Lead Barrier Effectiveness Study

Address	10/8/2008	4/3/2016	4/5/2016	4/14/2016
Stagnation time	Contact time not recorded	8 hours	48 hours	8 hours
100 N. Birchwood Ave.	1.7	<1.0	<1.0	
101 N. Birchwood Ave.	1.6	2.0	2.0	
118 S. Birchwood Ave.	2.0	<1.0	<1.0	
120 S. Birchwood Ave.	3.8	<1.0	<1.0	
2520 Meadow Rd. *	1.6	15.0	10.0	<2.0

* Note: 4/3 and 4/5 sample events for 2520 Meadow determined to have been contaminated by lead from original brass fitting. This fitting was replaced for the 4/14/16 sampling event.

Ball, Tim, 2016, Water Quality Sampling Results for NEOFIT Lined Lead Drinking Water Service Lines

Recent official statements regarding lead service line replacement

- **NDWAC** (National Drinking Water Advisory Council) transmitted the LCRWG report to EPA Administrator on December 15, 2015.
- **AWWA** Board of Directors March 8, 2016, statement of support:

  The Board of the American Water Works Association voted unanimously Monday to support recommendations from the National Drinking Water Advisory Council (NDWAC) that strengthen the Lead and Copper Rule and ultimately lead to the complete removal of lead service lines.

  .....

  Among the NDWAC'S Dec. 15 key recommendations are that water utilities:

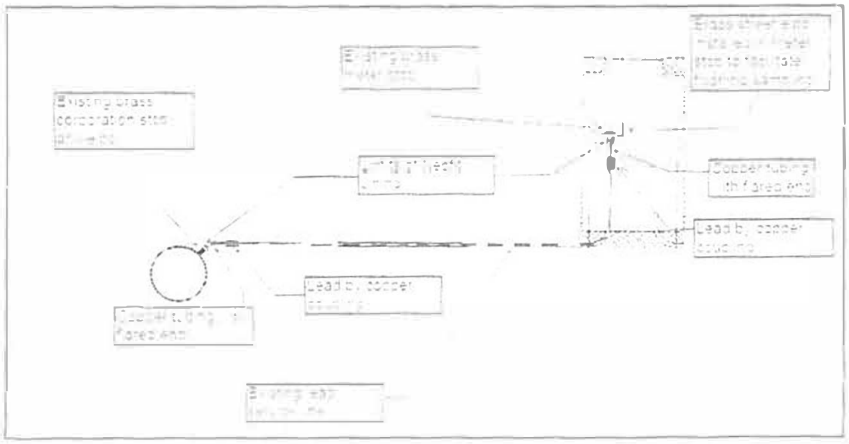
  1. Locate and replace all lead service lines completely, *sharing responsibility for that replacement with customers,*

LSLR implementation has generally assumed utility to have only limited ownership or "control"

- **Ownership** - Generally utilities assert that their ownership extends only to the property line. In some cases, the assertion is made that the utility owns no part of the service line, and has no legal responsibility.
- **Partial replacements** – Generally recognized to be not as effective as full replacement. Effectiveness limited in the first few months by disturbance effects, and over the longer term by galvanic corrosion. (This was basis of the NDWAC Working Group recommendation.)

PET/Neofit extended lead barrier effectiveness

- Original demonstration installation in Louisville, KY. Linings installed, but the service lines then abandoned in place.
- Test conducted on buried lines 7.5 years after lining installation



Previous reviews of PET/Neofit

- Kirmeyer, et al., 2000, Lead Pipe Rehabilitation and Replacement Techniques, Water Research Foundation (WaterRF) Project 465.

  Includes field demonstration in Louisville, KY

- Randtke, et. al., 2015, "Evaluation of Lead Service Line Lining and Coating Technologies," Periodic Report 15 under WaterRF Project 4351, Dec. 2015.

  Includes extensive lab tests for lead breakthrough (negative) and for liner component release (well below standards)

- Mesman, et al., 1995, Applicability of PET-lining for the renovation of lead service lines, KIWA report 10.0091.024

  Includes extensive review of installation methods (including review of potential problems), cost and durability.

Limited success in past experience by utilities in "sharing" the endeavor of replacing lead service lines

Experience in the District of Columbia has resulted in private-side participation at disappointing low rates, despite:

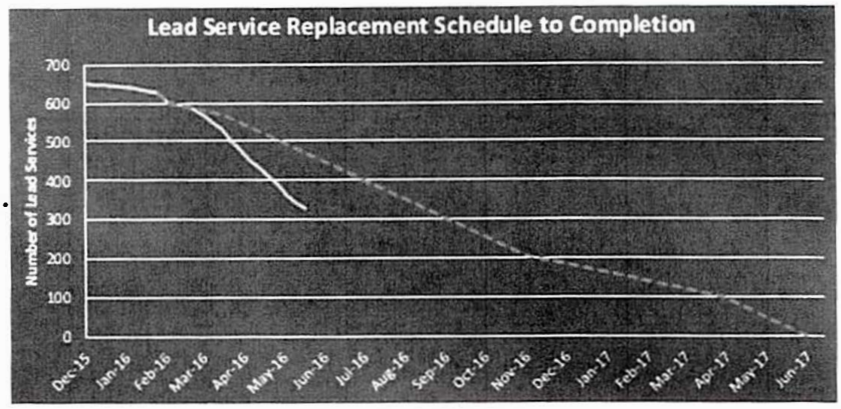
- intensive outreach, education, and project coordination;
- financial incentives, loans, and extended repayments; and
- extensive front page stories on the lead crisis in the media.

District of Columbia - Private LSLR participation since 2003

Quadrant	Public LSLRs	Private LSLRs	Percent
NW	16,256	2,109	13.0%
NE	10,721	876	8.2%
SW	490	23	4.7%
SE	5,523	458	8.3%
Total	32,990	3,466	10.5%

Lansing, MI, as a model for LSLR effectiveness, but caveated as being possible because of full ownership

- In 1990s there were an estimated 17,000 lead services
- In 2004 the policy decision was made to replace all lead service lines with ten years.
- As of May 2016, that goal has nearly been met, with only about 500 remaining.



PET / Neofit applications outside of the US

Europe:

France (>300km)	:	40.000 services
Netherlands, Belgium	:	2.500 services
Germany, Austria	:	since 2004
Norway	:	since 2005

55 installation units

outside Europe:

Australia, Japan	:	since 2004
Malaysia	:	since 2005

6 installation units

Source: Alferick and Elzink, 2010

Polyethylene Terephtelate (PET) lining

- Developed by a Wavin, a Dutch plastics firm, specifically for lead pipe lining, under the trade name Neofit.
- Plastic tube insertion and expansion by heated water pressure.
- Material is a polyester, familiarly used for beverage containers.
- Certified under ANSI/NSF Std 61, plus international standards.

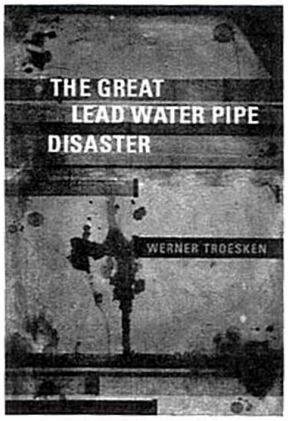
A footnote to the Lansing caveat

- Lansing did not always own the service lines in their entirety
- Lansing made the decision to take ownership in 1927.
- The purpose of this ownership takeover was to give the utility the ability to resolve an untractable problem (service line leakage) that was not getting solved under the "shared ownership" model.
- As part of that ownership transfer, Lansing did also implement a rate increase intended to cover the cost of this added responsibility.

So, who was responsible for original lead pipe installations?

- Not the residential customers.
- Lead was listed as an acceptable, in some cases required, service pipe material in building codes up until the late 1970s and 1980s.

The Great Lead Water Pipe Disaster,
by Walter Troesken (2006)



"The Lead Industry and Lead Water Pipes: A Modest Campaign", by Richard Rabin,
http://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2007.113555

Some alternatives for replacement of lead services

Objective: To identify some viable alternatives that could make the treatment of the entire lead service line length more feasible:

- Field procedures for coating or lining service lines are less disruptive than replacement due to fewer excavations.
- Cost to coat or line the service line is competitive with replacement, and the incremental cost for including the private portion is marginal.

Some historical (contemporary) AWWA sources

- 1924 JAWWA article "The Action of Water on Service Pipes" (W. Donaldson) reports in a survey of 539 cities that 48% used lead or lead lined pipe for service lines. The article reviews what was known at that time about water lead toxicity.
- 1938 JAWWA article "The physiological aspects of mineral salts in public water supplies" (S. Negus) contains the argument that:

  "Lead ions seem to have a bad reputation, although some of it is not deserved when it comes to the traces found in most purified water supplies. If the very small amounts which persons ingest by drinking water and eating food, were as harmful as some people believe them to be, there would be many more cases of lead poisoning than are known to occur."

Some historical (contemporary) AWWA sources

New England Water Works Association.

REPORT OF COMMITTEE ON SERVICE PIPES.

[*Presented March 14, 1917.*]

"Lead pipe is mechanically an almost ideal pipe for services, on account of its flexibility and the ease of laying in streets where there are obstructions. ..... The lead does not corrode and the pipe remains smooth and clean. The serious objection to the use of this material is the possibility that it may affect the health of those using the water."

"It seems to be practically impossible to determine in advance by laboratory tests whether or not the use of lead will be safe. The only sure test is one of several years' duration in actual service."