American Water Works Association
ACE18
ANNUAL CONFERENCE & EXPOSITION

Digging Deep – Searching Decades of National Records to Find Lead Service Lines and Goosenecks

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Washington State Department of Health

CORNWELL ENGINEERING GROUP

Acknowledgements

- Washington Department of Health
  - Scott Torpie
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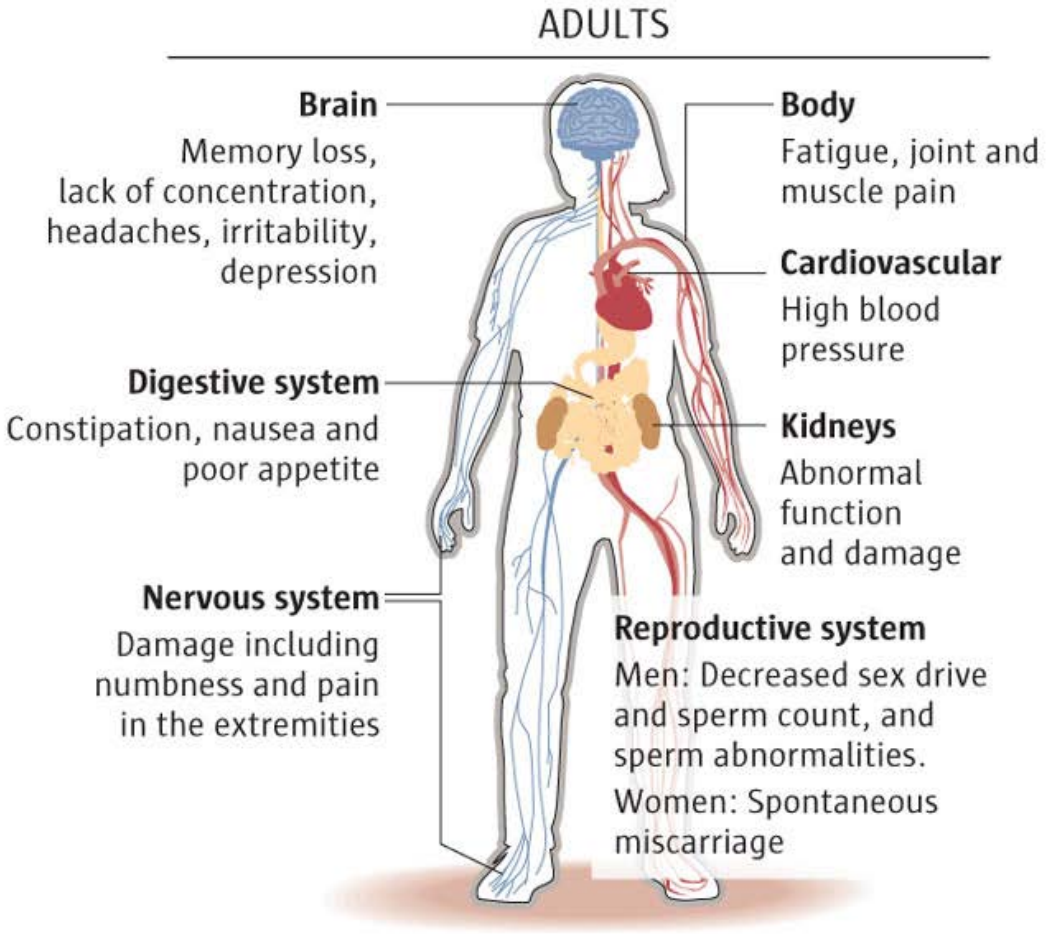
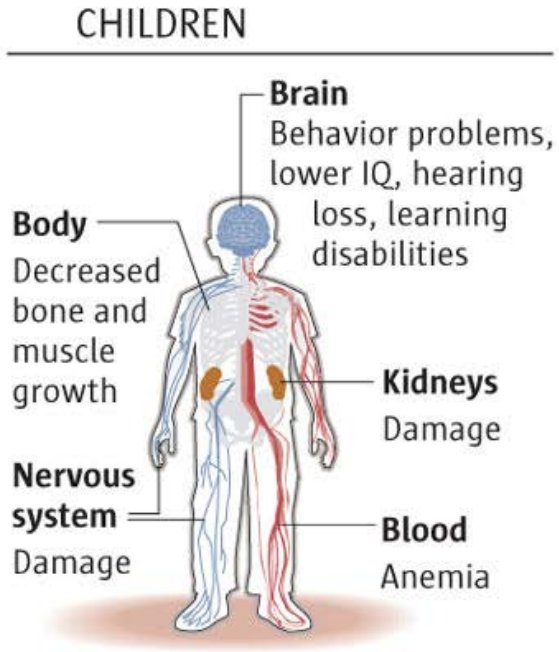
  - Matt Hadorn
- Cornwell Engineering Group
  - Richard Brown

Agenda

- Why are we talking about lead service lines (LSLs)?
  - Brief health background
  - Washington Governor's Directive 16-06
  - LSL Inventory Requirements from other states
- How to develop LSL Inventory?
  - Historic survey data
- LSL occurrence estimates
  - 2011 and 2013 AWWA Surveys
  - Recent state surveys

Health Effects of Lead





Lead Exposures and Pathways

HOME
Paint
Lead pipes
Lead solder
Consumer products
Hobbies
Imported cosmetics
Traditional remedies

OUTDOOR
Soil
Job take-home
Leaded gas residue
Industrial emissions
Ammunitions
Aircraft

AIR

DUST

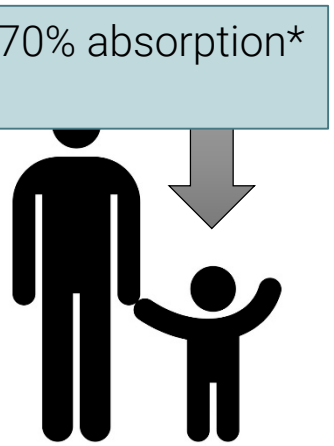
SOIL

WATER

FOOD

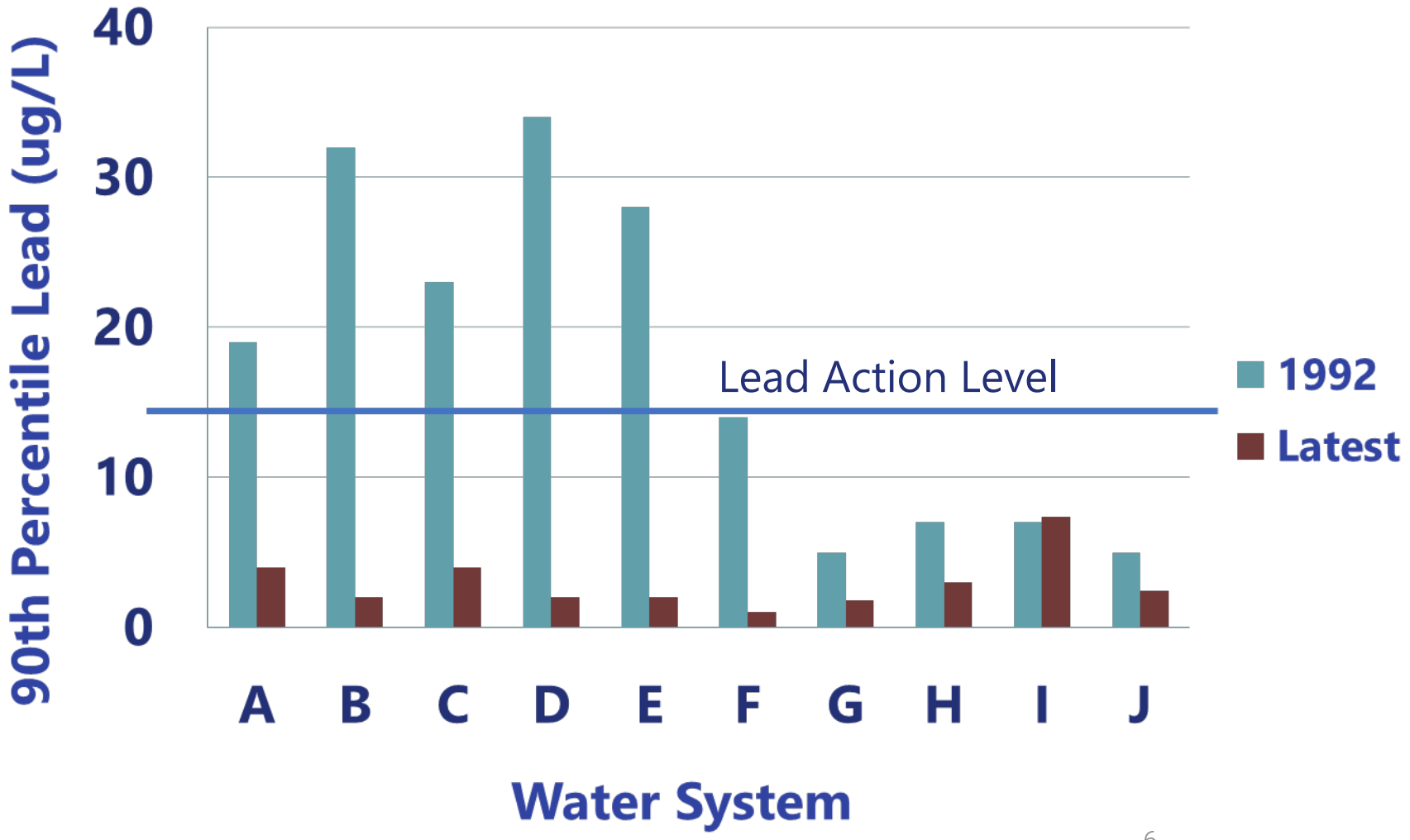
Ingestion

Inhalation



*Rates for ingested lead only, ATSDR.

Lead in Water—LCR has lowered exposure



Lead Service Lines – A Persistent Risk

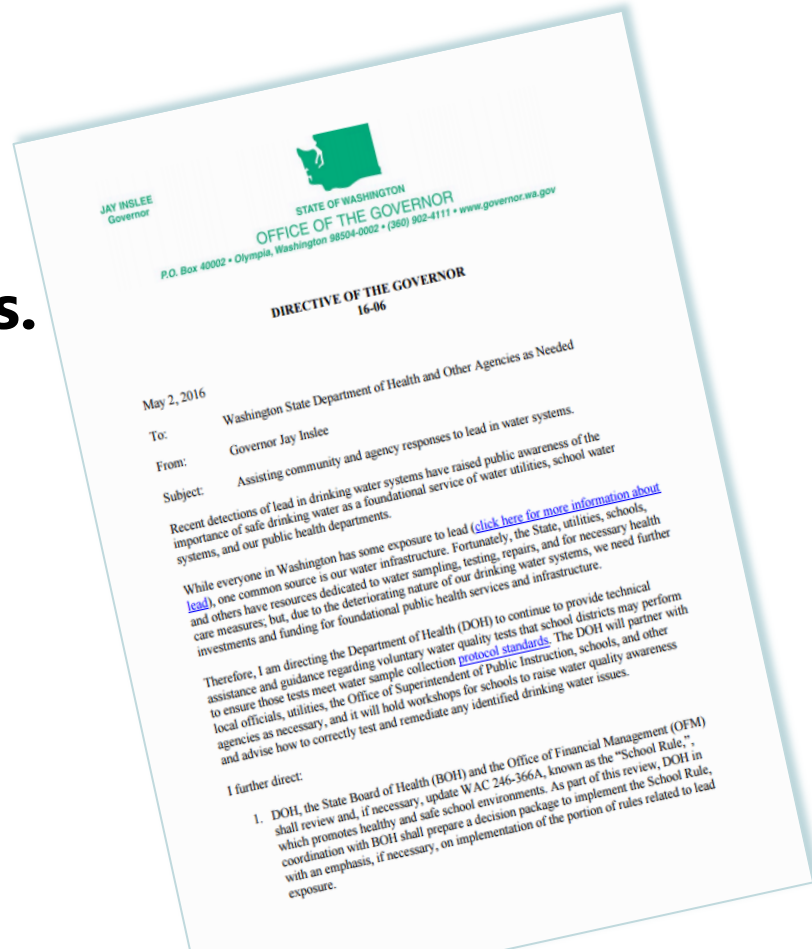
- Even with corrosion control treatment, there is a risk any time that lead-bearing materials contact drinking water
- NDWAC recommendations to USEPA include proactive lead service line (LSL) replacement programs
  - LSLs are not the only lead-bearing plumbing materials, but do comprise the largest source of lead by mass in contact with drinking water

Washington – Governor's Directive 16-06

- Signed May 2, 2016.
- Comprehensive approach to lead exposure directed at **state agencies** to work on:
  1. School Rule—review potential revisions; focus on lead exposure.
  2. Lead Rental Inspection and Registry Program
  3. Child care providers in pre-1978 buildings to evaluate lead exposure.
  4. Blood lead monitoring program—system improvements.

Washington – Governor's Directive 16-06 *(continued)*

5. Blood lead monitoring—screening rates.
6. **Lead service lines and other lead components.**
7. Work with federal partners to support efforts to reduce lead exposure.



JAY INSLEE
Governor

STATE OF WASHINGTON
OFFICE OF THE GOVERNOR
P.O. Box 40002 • Olympia, Washington 98504-0002 • (360) 902-4111 • www.governor.wa.gov

DIRECTIVE OF THE GOVERNOR
16-06

May 2, 2016

To: Washington State Department of Health and Other Agencies as Needed

From: Governor Jay Inslee

Subject: Assisting community and agency responses to lead in water systems.

Recent detections of lead in drinking water systems have raised public awareness of the importance of safe drinking water as a foundational service of water utilities, school water systems, and our public health departments.

While everyone in Washington has some exposure to lead (click here for more information about lead), one common source is our water infrastructure. Fortunately, the State, utilities, schools, and others have resources dedicated to water sampling, testing, repairs, and for necessary health care measures; but, due to the deteriorating nature of our drinking water systems, we need further investments and funding for foundational public health services and infrastructure.

Therefore, I am directing the Department of Health (DOH) to continue to provide technical assistance and guidance regarding voluntary water quality tests that school districts may perform to ensure those tests meet water sample collection protocol standards. The DOH will partner with local officials, utilities, the Office of Superintendent of Public Instruction, schools, and other agencies as necessary, and it will hold workshops for schools to raise water quality awareness and advise how to correctly test and remediate any identified drinking water issues.

I further direct:

1. DOH, the State Board of Health (BOH) and the Office of Financial Management (OFM) shall review and, if necessary, update WAC 246-366A, known as the "School Rule,", which promotes healthy and safe school environments. As part of this review, DOH in coordination with BOH shall prepare a decision package to implement the School Rule, with an emphasis, if necessary, on implementation of the portion of rules related to lead exposure.

Governor's Directive 16-06: Item 6

Requires DOH to:

- Work with each water system to identify all lead service lines and lead components within two years.

- Work with stakeholders to develop policy and budgetary proposals with a goal of removing all lead service lines and lead service components in water systems within 15 years.

LSL Inventory Requirements

- Michigan (R 325.11604(c))
  - Preliminary distribution system materials inventory (including service lines) required by January 1, 2020
  - Verified distribution system materials inventory (including service lines) required by January 1, 2025
- Ohio (3745-81-86.9)
  - Community water systems shall identify and map areas of the system that are known or likely to contain lead service lines …

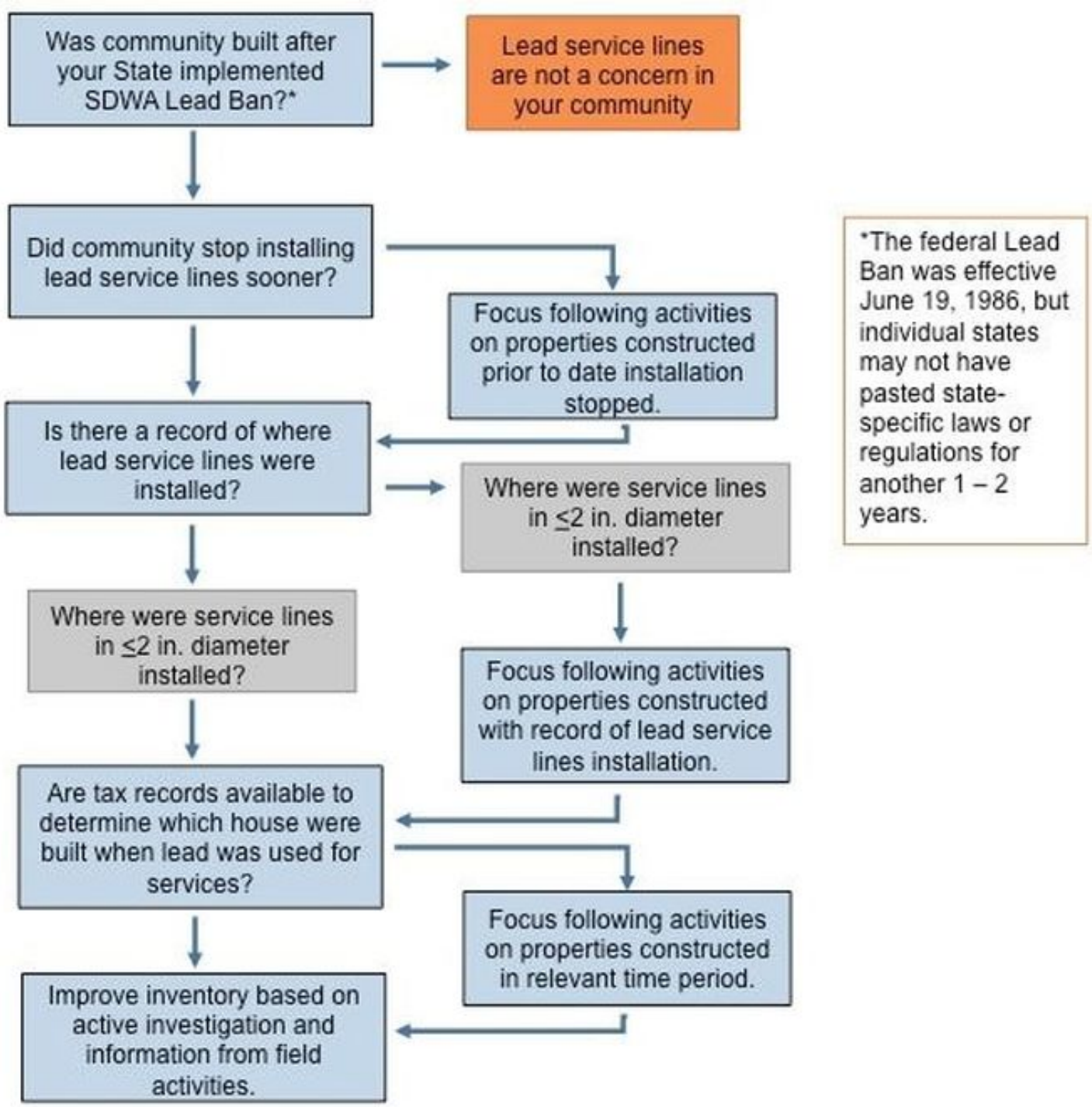
LSL Inventory Requirements *(continued)*

- California (SB-1398)
  - By July 1, 2018 a public water system shall compile an inventory of known lead user service lines in its distribution system and identify areas that may have lead user service lines …
  - By July 1, 2020 a public water system with areas that may have lead user service lines in use in its distribution system shall
    - Determine the existence or absence of lead user service lines
    - Provide a timeline to the board for replacement of user service lines whose content cannot be determined

LSL Inventory Data Sources

How to Start with LSL Inventory

https://www.lslr-collaborative.org/preparing-an-inventory-where-do-we-start.html



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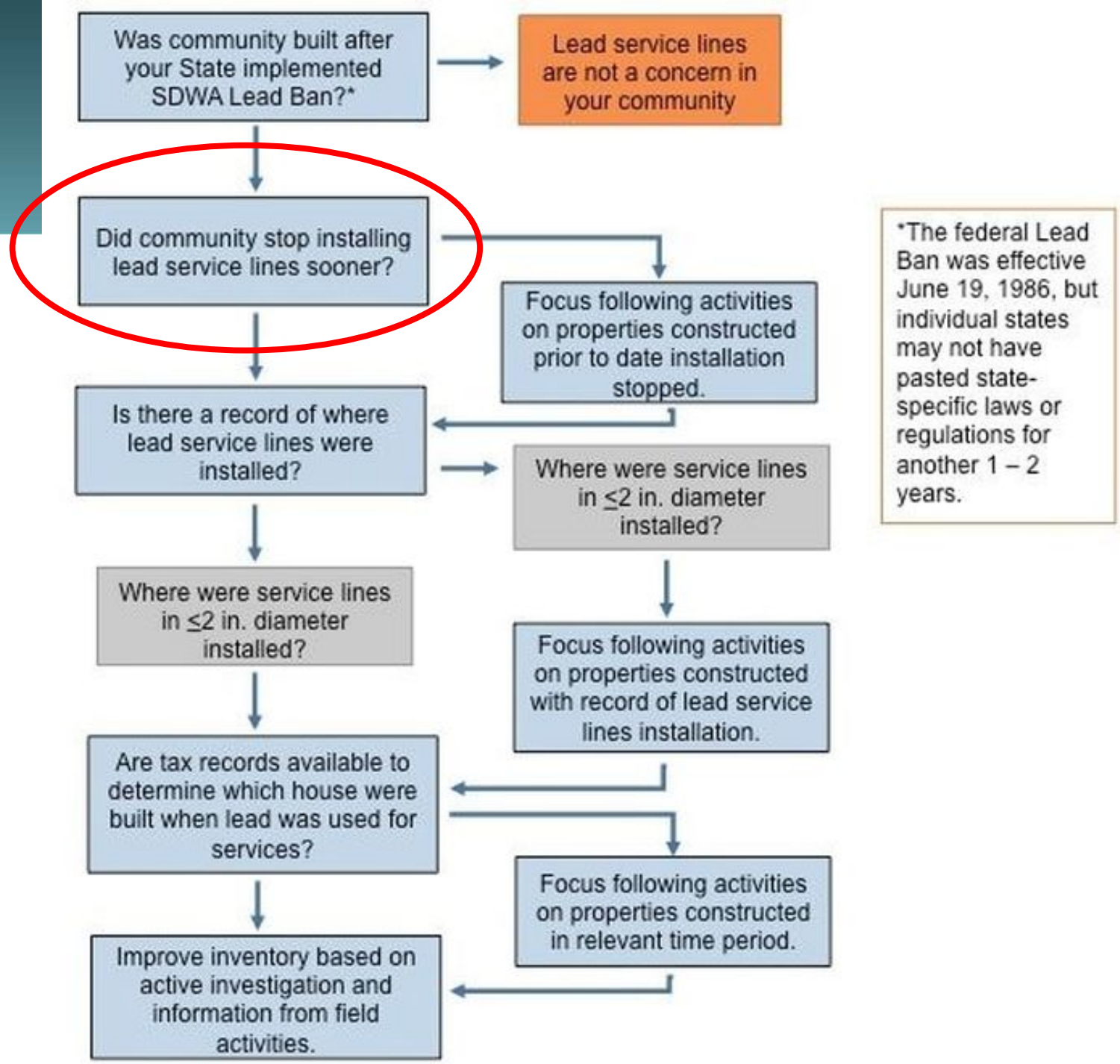


Sources of Data to Assess If/When LSLs Were Installed

1897 – The Manual of American Water-Works

1922 – Municipal Journal & Public Works

1924 – Donaldson. 1924. “The Action of Water on Service Pipes”. Journal AWWA 11(3): 649-662

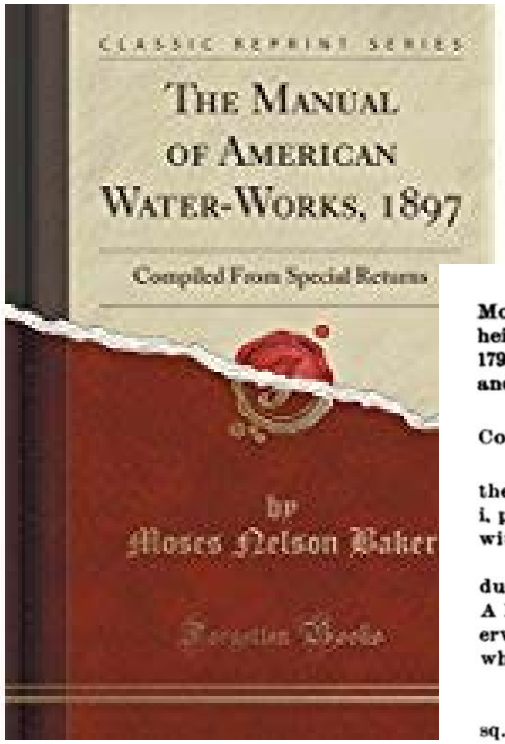
1985 – USEPA Plumbing Materials and Drinking Water Quality Seminar

1988 – AwwaRF Questionnaire in Economics of Corrosion Control (EES 1990)

The Manual of American Water-Works

Intended to be a complete collection of water-works information.

Contains information regarding service line materials approved/used by many utilities



McKEESPORT, *Allegheny Co.* (Pop., 8,212; est., 22,000.) At junction of Monongahela and Youghiogheny rivers, 752 ft. above sea, on hilly ground rising to height of 300 ft. above rivers. Manufactures steel, w. i. pipe, sheet-iron. Settled in 1795; incorp. borough in '42; and its limits were extended '47 and '73. Has sewers and electric lights.

History.—Built in '81-2 by borough. Engrs., Hatch & Taylor, McKeesport. Contrs., R. D. Wood & Co., Philadelphia.

Water Supply.—Youghiogheny river, pumping to reservoir. Well was dug on the bank of river, 28 ft. in diam., 32 ft. deep, in bottom of which 36 perforated 4-in. c. i. pipes are driven 10 ft. into saturated gravel. A 20-in. c. i. pipe connected well with engine-house.

Pumping Machinery.—Dy. cap., 8,000,000 galls.; two 1,500,000-gall. Worthington dup., high-pressure, and 5,000,000 pump erected in '88. Natural gas is used for fuel. A 1-in. pipe leads from the surface of the reservoir to the engine-house. When reservoir is full water flows through pipe, and by automatic arrangement blows steam whistle as signal to stop pumps.

Force Main.—To reservoir, 1,547 ft. of 16-in. pipe, rising 310 ft. from river.

Reservoir.—Cap., about 6,000,000 galls; in excavation and embankment, 210 ft. sq. x 20 ft. deep to water line. Bottom covered with 6 ins. of concrete on 12 ins. of puddle, and slopes with 10 ins. of stone blocks in cement on 8 ins. of broken stone, the latter being on 12 ins. of puddle.

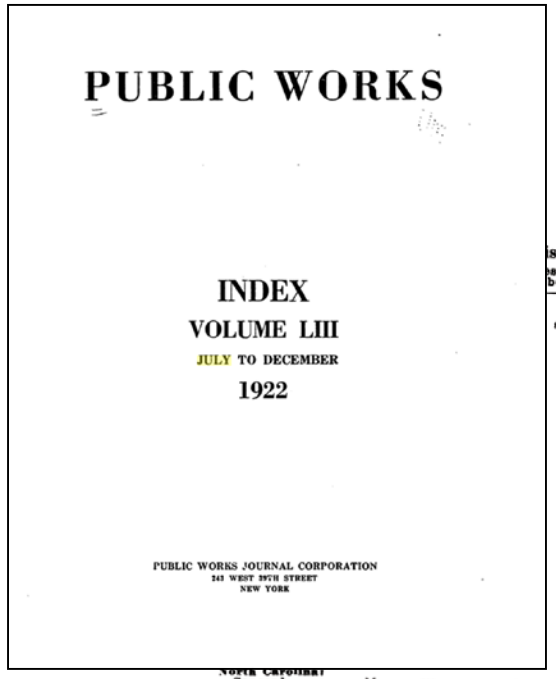
Distribution.—(Feb. 28, '89.) *Mains*, c. i., 18¼ miles. *Services*, lead. *Taps*, 1,735. *Meters*, 198. *Hydrants*, Mathews, 130.

Consumption, 1,600,000 galls. *Pressure*, 115 lbs.

Financial.—(Feb. 28, '89.) Cost, $200,059. Bonded debt, $125,809: $23,809 at 6; $102,000 at 5%. Sinking fund, $15,000. Ann. op. exp., $6,500. Ann. rev.; consumers, $19,089; city, none.

Municipal Journal & Public Works

1922 – contains tables of information collected from superintendents in nearly 800 cities, including typical service line material used.



PUBLIC WORKS

INDEX
VOLUME LIII
JULY TO DECEMBER
1922

PUBLIC WORKS JOURNAL CORPORATION
243 WEST 39TH STREET
NEW YORK

Water Works Service

issue, of tables prepared from data furnished by superintendents of nearly eight hundred cities.

Municipality.	Private (P.) or municipal (M) plant.	Services laid preparatory to paving, before needed for use. Are they required by city?	Kind of pipe specified.	Depth specified.	Trouble experienced with them after laying.
South Carolina:					
Chester	M.	...	gl., l. connections	no spec.	none
Sumter	M.	yes	g. pipe, l. to main	2 ft.	very little
South Dakota:					
Rapid City	M.	yes	l.	5 ft.	none
Watertown	M.	yes	l.	7 ft.	none
Yankton	M.	yes	l.	5 ft.	none
Tennessee:					
Clarksville	M.	yes	l.	2½ ft.	none
Covington	...	yes	l.	...	none
Dyersburg	M.	yes	l.	24 in.	none
Fayetteville	M.	yes	g., l. gooseknecks	18 in.	small leaks in gooseneck
Jackson	M.	no	l.	2½ ft.	very little
Johnson City	M.	yes	g.	18 in. or 2 ft.	...
Texas:					
Bryan	M.	usually not	l.	12-18 in.	...
Childress	M.	yes	...	16 in.	none
Clarksville	M.	yes	l.	12 in.	none
Corpus Christi	...	no	l.	30 in.	iron rust out in 15-20 years
Del Rio	M.	no	...	...	...
Eastland	M.	yes	l.	18 in.	none
Galveston	M.	no	separate 2" tap at each corner of st.	18 in.	giving out—old
Georgetown	M.	yes	black pipe, l. gooseneck	2 ft.	none
Gonzales	P.	no	½" taps for residence	no spec.	...
Gorman	M.	no	none	30 in.	none
Greenville	M.	yes	l.	...	none
Longview	M.	yes	l.	3 ft.	...
McKinney	M.	yes	l.	18 in.	scale over ¼", services not in use
Navasota	P.	no	...	18 in.	...
Orange	P.	yes	l.	18 in.	...
Weatherford	P.	no	...	18 in.	little trouble
Utah:					
Brigham	M.	yes	g.	4 ft.	none
Vermont:					
Bennington	M.	yes	l.	5 ft.	frost
Brattleboro	P.	no	...	5 ft.	...
Washington:					
Aberdeen	M.	no	...	...	settlement of pavt. breaking services
Anacortes	M.	yes	g.	20 in.	none
Auburn	M.	no	...	...	...
Bellingham	M.	no	no. spec.	24-42 in.	...
Cle Elum	M.	no pav.	...	...	...
Dayton	M.	yes	g.	24 in.	none
Ellensburg	M.	...	...	...	...
Hequiam	P.	no	...	2 ft.	none from frost
Port Angeles	P.	yes	...	24 in.	none
Snohomish	M.	lay to curb	g.	2 ft.	...
Tacoma	M.	no	...	24 in.	...
Walla Walla	M.	no	...	2 ft.	those not in use deteriorate quickly

Municipality.	Private (P.) or municipal (M) plant.	Depth specified.	Trouble experienced with them after laying.
North Carolina:			
Concord	M.	2 ft.	none
Elizabeth City	P.	3 ft.	none
Henderson	P.	no spec.	occasionally freeze
Kinston	M.	...	...
Washington	...	5 ft.	none
North Dakota:		6 ft.	none
Bismarck	P.	4'6"	none
Mandan	M.	5 ft.	...
Minot	M.	...	...
Ohio:		4 ft.	none
Bellevue	M.	...	...
Bowling Green	P.	2 ft.	none
Celina	M.	3 ft.	none
Conneaut	M.	4½-5 ft.	none
Delaware	P.	5 ft.	gooseneck burst
Dennison	P.	4 ft.	none
Greenville	M.	4 ft.*	careless plumbing, supporting & shallow laying
Leetonia	M.	...	none
Logan	M.	2 ft.	none
Marietta	M.	5 ft.	none
Middleport	P.	3½ ft.	none
Oberlin	M.	5 ft.	none
Ravenna	M.	4 ft.	service to curb have given considerable trouble, average life 8 yrs.

Municipality.	Private (P.) or municipal (M) plant.	Depth specified.	Trouble experienced with them after laying.
Henderson	P.	24 in.	clogging if unused gooseneck breaks sometimes near corp. cock
Kinston	M.	24 in.	none
Washington	...	18 in.	none
North Dakota:		7'6"	none
Bismarck	P.	7 ft.	none
Mandan	M.	8 ft.	...
Minot	M.	3-4 ft.	sometimes freezing
Ohio:		4 ft.	...
Bellevue	M.	3½ ft.	none
Bowling Green	P.	1½ ft.	none
Celina	M.	3½ ft.	none
Conneaut	M.	4 ft.	none
Delaware	P.	4 ft.	electrolysis only
Dennison	P.	...	none
Greenville	M.	3 ft.	none
Leetonia	M.	¾ ft.	practically none
Logan	M.	4 ft.	...
Marietta	M.	5 ft.	none
Middleport	P.	4 ft.	service to curb have given considerable trouble, average life 8 yrs.
Oberlin	M.	...	...
Ravenna	M.	...	...

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The Action of Water on Service PIpes

1924 – contains tabulation of various service pipe materials for 539 cities of the United States

TABLE 1

Relative use of various service pipe materials for 539 cities of United States

STATE OR PROVINCE	NUMBER OF CITIES LISTED	NUMBER CITIES HAVING SERVICE PIPE OF					
		Galvanized wrought iron or steel	Lead	Cast iron	Lead lined	Cement lined	Wrought iron or steel*
Alabama	8	7	1	1		1	
Arizona	7	5	3				3
Arkansas	9	6	1	1			1
California	29	10	2	2			20
Colorado	11	2	6				5
Connecticut	10	5	4		1		5
Florida	9	2	5	1			4
Georgia	15	5	3		1	1	10
Idaho	9	8	1				
Illinois	37	8	30	3			14
Indiana	44	11	25	2	1		13
Iowa	29	5	25	2	1		13
Kansas	26	8	16	3			18
Kentucky	13	7	7				3
Louisiana	4	1	1				2
Maine	9	4			2	1	6
Maryland	2	1			2		1
Massachusetts	50	12	10	5	8	24	22
Michigan	37	10	16	2			14
Minnesota	27	7	16	2			9
Mississippi	12	3	8			1	9
Missouri	12	2	9	1			7
Montana	9	6	8	1			1
New Hampshire	1					1	
New Jersey	1	1	1				1
New Mexico	2	2					
New York	7	1	4				4
North Carolina	5	2					4
North Dakota	3		3	1			
Ohio	22	6	14				8
Oklahoma	14	3	10	1			6
Oregon	7	5					1
Pennsylvania	14	3	7				10
Rhode Island	3	1	2				
South Carolina	2	2					
South Dakota	3		3				
Tennessee	6	2	5				2
Texas	16	2	10	3			9
Utah	1	1					
Vermont	2		1				1
Washingron	12	9	2				3
Total	539	175	259	31	16	29	229
Per cent of total		32	48	5.7	3	5.4	42

*Coating not stated.

650

USEPA Plumbing Materials and Drinking Water Quality Seminar

1984 – contains tabulated information on service line material and number of services/goosenecks for 153 cities

United States Environmental Protection Agency | Water Engineering Research Laboratory Cincinnati OH 45268 | EPA/600/9-85/007 February 1985

Research and Development

EPA

Plumbing Materials and Drinking Water Quality: Proceedings of a Seminar

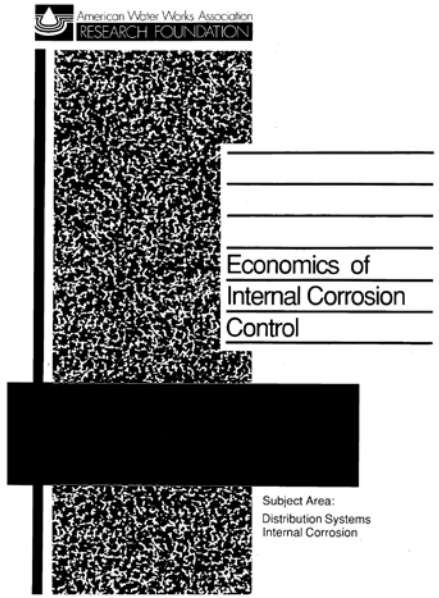
Cincinnati, Ohio
May 16-17, 1984

Name of Utility or Public Water Supply	Estimated # of people served	Total # of services	Service line material used for old installations	Service line material used for new installations	Use of lead services % or # still left	Use of lead goosenecks % or # still left	Use of lead sweatjoints % or # still left	pH in the distribution system and if adjusted
Portland, Oregon	650,000	120,000	galvanized	copper is used up to the meter	Yes, # unknown	Yes, 10,000	Yes 20,000	6.8 No adjustment
Salem, Oregon	120,000	45,000	code accepted	code accepted	unknown	none found	some, # unknown,still in use	low 6's No adjustment
Erie, Pennsylvania Bureau of Water	205,000	52,000	copper, galvanized iron	Type k copper	none known	2% remain from 1920's service area	used until early 1960's	7.3 - 7.6
Philadelphia, Pennsylvania Water Department	1,685,000	522,000	copper, galvanized & black iron	copper	Yes, # unknown	Yes, # unknown	leadite joints used; most replaced	7.0 - 8.5
Philadelphia, PA Suburban Water Company	902,000	287,000	N/A	copper	<200	none known	N/A	7.0 - 7.6
Pittsburgh, Pennsylvania Water Department	424,000	89,000	copper	copper	30%	none known	Yes, 5% remain	7.6 - 7.8
Western Pennsylvania Water Company of Pittsburgh, PA	500,000	126,512	galvanized, cast and wrought iron	copper and ductile iron	Yes 5,318	Yes, # unknown	Yes, # unknown	7.1
Metropolitano A San Juan, Puerto Rico	711,999	178,000	N/A	copper, PVC, ductile iron	none known	none known	N/A	7.4 - 8.2
Enrique Ortega La Plata, Puerto Rico	363,936	90,984	N/A	copper, PVC, ductile iron	none known	none known	N/A	7.4 - 8.0
Ponce Urbano, Puerto Rico	241,540	60,385	N/A	copper, PVC, ductile iron	none known	none known	N/A	7.4 - 8.0
Aqua Dilla, Puerto Rico	114,497	28,624	N/A	copper, PVC, ductile iron	none known	none known	N/A	7.8 - 8.2
Caquas, Puerto Rico	109,236	27,309	N/A	copper, PVC, ductile iron	none known	none known	N/A	7.2 - 7.6

Economics of Internal Corrosion Control

1990 – Contains data from a 1988 survey of ~20 systems.

Lists service material and number service lines



American Water Works Association Research Foundation — Group 2, Page 4
Economics of Internal Corrosion
Water Utility Questionnaire Results
20 December, 1988

		Metropolitan Water District of S.C	Philadelphia Water Dept	Tampa Water Dept.	S.Nevada W.System	Indianapolis Water Company
12	Pipe length mi.					
a	Steel		66.0			<1
b	Galvanized					
c	Cast Iron		2900.0			1538.0
d	Ductile Iron		290.0			513.0
e	Concrete	775.0			65.0	13.0
f	Asbestos Cement		0.0			0.0
g	Plastic		0.3			2.0
h	Other		6.6 Reinforced Concrete			<1
i	Total	775.0	3282.9	1950	65.0	2066.0
13	Data					
a	Pipe spec	Yes	Yes	No	Yes	
b	Pipe diam	Yes	Yes	Yes	Yes	Yes
c	Date inst	Yes	Yes	Yes	Yes	Yes
d	Cleaning	Yes	Yes	No		
e	Breaks	Yes	Yes	Yes	Yes	Yes
f	Break cause	Yes	No	No	Yes	Yes
g	Record start	1941	Always	1967	1971	1918
14	Replaced/Relined					
a	Replace	No	No	Yes	No	Yes
b	Material		Cast Iron	CI,Steel,Galv		Cast Iron
c	Reline	Yes	Yes	Yes	No	Yes
d	Age		1900-1920	Various		1948
15	C Value					
a	Monitor	Yes	Yes	Yes	No	No
b	Year start			1956		
16	Pumping cost					
a	Record	No	Yes	No	No	?
b	Year start					
17	Serv Matl %	NA			NA	Not tabulated
a	Copper		50-80%			
b	Plastic		1%			
c	Galv		1-2%	5%		
d	Black St					
e	Lead		10-20%			
f	Other					
18	Lead gooseneck	NA			NA	?
a	Number			N/A		
b	Percent		1-2%			

LSL Occurrence Estimates

LSLs—Number and Location

- AWWA Estimate (1990)
  - 3.3 million lead service lines.
  - 6.4 million lead service connections.

    (Ref. Weston and EES 1990 Report to AWWA.)
- EPA Estimate (2015)
  - 10.5 million lead service lines in 1988.
  - 7.3 million lead service lines (currently).

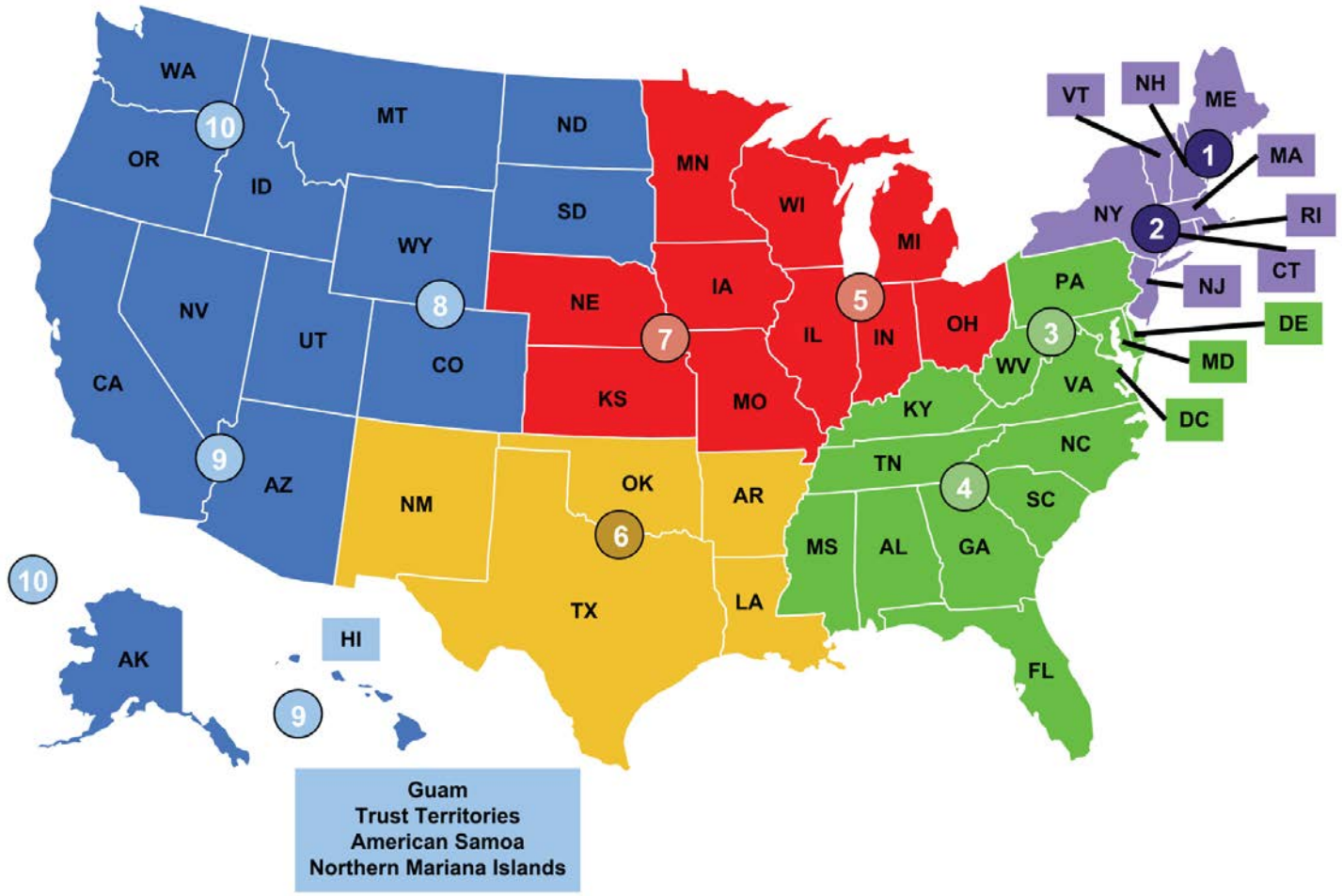
    (Ref. LCRWG Report to NDWAC 8/24/15.)
- Journal AWWA Estimate (2016)
  - 6.1 million full or partial lead service lines.
  - 27,000 estimated in Washington State.

    (Ref. Cornwell et al. 2/2016.)

2016 Journal AWWA Estimate

Data were grouped by multiple EPA regions to allow for statistically-valid analysis

Estimate on a state-to-state-basis likely to be inaccurate



Washington State LSL Occurence

- 2016 LSL and Lead Component Survey
- DOH surveyed 686 systems, representing 90.3% of Group A connections in Washington
- Five systems reported LSLs remaining in use, with 917 total LSLs remaining in service

Indiana LSL Occurrence

- 2016 Journal AWWA estimate of 290,000 LSLs
- Indiana Department of Environmental Management surveyed water systems in 2016 to assess number of LSLs in service
- Estimated 205,557 LSLs based on survey results
  - Survey responses either based on esimtates or records, and systems provided an estimate of confidence in estimate or records ranging from 1 to 10

Colorado LSL Occurrence

- 2016 Journal AWWA estimates 58,000 LSLs in Colorado
- Since the 2011 and 2013 surveys were completed, Denver has estimated that 60,000 LSLs remain in distribution system

Summary

- Removal of LSLs is desirable to reduce lead in water
- Several states are requiring development of LSL inventories
  - Anticipate this to be more prevalent in future, possibly required by LCR Long-Term revisions
- Historic records can be a useful source of information for past LSL usage
- Even the latest estimate of LSL occurrence can vary when a system-by-system inventory is performed

Questions?

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Washington State Department of Health

CORNWELL ENGINEERING GROUP