Guidance for Developing and Maintaining a Service Line Inventory

Office of Water (4606M)
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Disclaimer

This document provides recommendations to public water systems in developing and maintaining a service line inventory. The guidance within this document can be used to comply with the requirements under the Lead and Copper Rule Revisions (LCRR) that are in effect at the time of document publication. As described in the Environmental Protection Agency's (EPA's) *Federal Register* notice of December 17, 2021 ("Notification of conclusion of review"), EPA intends to publish a proposal to revise the LCRR and take final action on the proposal by October 16, 2024, but EPA does not expect to propose changes to the requirements for information to be submitted in the initial service line inventory. However, the rulemaking could include changes to the requirements for inventory updates (USEPA, 2021a). This guidance can also assist public water systems with financing applications for Bipartisan Infrastructure Law (BIL) (P.L. 117-58) funds and for implementation once funding is received. Note that the BIL is also known as the Infrastructure Investment and Jobs Act (IIJA). The BIL contains a historic $15 billion in dedicated funding through the Drinking Water State Revolving Fund (DWSRF) for lead service line (LSL) identification, planning, design, and replacement. LSL projects also may be funded using the General Supplemental DWSRF fund of $11.7 billion as well as annual base appropriations for the DWSRF. The BIL mandates that 49 percent of funds provided through the DWSRF General Supplemental Funding and DWSRF Lead Service Line Replacement Funding must be provided as grants and forgivable loans to disadvantaged communities. EPA encourages water systems to begin service line inventory and replacement efforts as soon as possible. EPA emphasizes that given the many benefits of lead service line replacement (LSLR), water systems should not wait until their inventory is complete to begin replacement efforts. In fact, conducting replacements while developing the inventory can have synergistic effects that enhance inventory development while accelerating and increasing the efficiency of replacement programs. The statutory provisions and EPA regulations described in this document contain legally binding requirements. This document is not a regulation itself, nor does it change or substitute for those provisions and regulations. Thus, it does not impose legally binding requirements on EPA, states, or the regulated community. This document does not confer legal rights or impose legal obligations upon any member of the public.

Although EPA has made every effort to ensure the accuracy of the discussion in this document, the legally binding requirements applicable to public water systems are determined by statutes and regulations. In the event of a conflict between the discussion in this document and any applicable statute or regulation, this document would not be controlling.

The information collections associated with the LCRR have been submitted for approval to the Office of Management and Budget (OMB) under the Paperwork Reduction Act. The recordkeeping and reporting requirements described in this draft guidance align with the existing regulations and this guidance also includes recommendations for voluntary expanded data collection and recordkeeping. An agency may not conduct or sponsor, and a person is not

required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control number for the service line inventory is 2040-0297.

The recommendations provided here may not apply to a particular situation based upon the circumstances. Because they are recommendations, and not legally binding requirements, public water systems retain the discretion to follow the recommendations or adopt approaches that differ from those described in this document. In some cases, recommendations may reflect the existing custom and practices of some states.

Note that this document does not address lending requirements or state or local regulations related to service line inventories that may apply.

Mention of trade names or commercial products does not constitute endorsement or recommendation for their use.

This is a living document that EPA may revise periodically to reflect changes in regulatory requirements and research regarding service line material identification. EPA welcomes comment on this document at any time; please send comments to LCRR@epa.gov.

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List of Exhibits

Acronyms

µg/L	Micrograms per liter
ACHD	Allegheny County Health Department
ASDWA	Association of State Drinking Water Administrators
AWWA	American Water Works Association
BIL	Bipartisan Infrastructure Law
CBI	Curb Box Inspection
CCR	Consumer Confidence Report
CCTV	Closed-Circuit Television
CFR	Code of Federal Regulations
CMMS	Computerized Maintenance Management System
CWS	Community Water System
DWINSA	Drinking Water Infrastructure Needs Survey and Assessment
DWSRF	Drinking Water State Revolving Fund
EDF	Environmental Defense Fund
EGLE	Michigan Department of Environment, Great Lakes, and Energy
EPA	United States Environmental Protection Agency
FTP	File Transfer Protocol
GCWW	Greater Cincinnati Water Works
GIS	Geographic Information System
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GRR	Galvanized Requiring Replacement
GRWS	Grand Rapids Water System
IIJA	Infrastructure Investment and Jobs Act
LCR	Lead and Copper Rule
LCRI	Lead and Copper Rule Improvements
LCRR	Lead and Copper Rule Revisions
LSL	Lead Service Line

LSLR	Lead Service Line Replacement
LWC	Louisville Water Company
NPR	National Public Radio
NTNCWS	Non-Transient Non-Community Water System
OMB	Office of Management and Budget
ORP	Oxidation-Reduction Potential
PWS	Public Water System
PWSA	Pittsburgh Water & Sewer Authority
PWSID	Public Water System Identification Number
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
USEPA	United States Environmental Protection Agency
WIIN	Water Infrastructure Improvements for the Nation

Glossary

Term	Definition[1]
Curb stop	An exterior valve located at or near the property line that is used to turn on and off water service to the building.[2]
Community water system	A public water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents (40 CFR §141.2).
Full lead service line replacement	Replacement of a lead service line (as well as galvanized service lines requiring replacement) that results in the entire length of the service line, regardless of service line ownership, meeting the Safe Drinking Water Act (SDWA) Section 1417 definition of lead free[3] applicable at the time of the replacement. See 40 CFR §141.2 for the full regulatory definition.
Galvanized requiring replacement	A galvanized service line that is or was at any time downstream of a lead service line or is currently downstream of a lead status unknown service line. If the water system is unable to demonstrate that the galvanized service line was never downstream of a lead service line, it must presume there was an upstream lead service line (40 CFR §141.84(a)(4)(ii)).
Galvanized service line	Iron or steel piping that has been dipped in zinc to prevent corrosion and rusting (40 CFR §141.2).
Gooseneck, pigtail, or connector	A short section of piping, typically not exceeding two feet, which can be bent and used for connections between rigid service piping. For purposes of this subpart, lead goosenecks, pigtails, and connectors are not considered to be part of the lead service line but may be required to be replaced pursuant to §141.84(c)[4] (40 CFR §141.2).
Lead service line	A portion of pipe that is made of lead, which connects the water main to the building inlet. A lead service line may be owned by the water system, owned by the property owner, or both. For the purposes of this subpart, a galvanized service line is considered a lead service line if it ever was or is currently downstream of any lead service line or service line of unknown material. If the only lead piping serving the home is a lead gooseneck, pigtail, or connector, and it is not a galvanized service line that is considered a lead service line, the service line is not a lead service line (40 CFR §141.2).
Lead status unknown service line	A service line where the material is not known to be lead, galvanized requiring replacement, or a non-lead service line, such as where there is no documented evidence supporting material classification. It is not necessary to physically verify the material composition (*e.g.,*, copper or plastic) of a service line for its lead status to be identified (*e.g.*, records demonstrating the service line was installed after a municipal, state, or federal lead ban[3]) (40 CFR §141.2).
Non-lead	A service line that is determined through an evidence-based record, method, or technique not to be lead or galvanized requiring replacement (40 CFR § 141.84(a)(4)(iii)).

Term	Definition[1]
Non-transient non-community water system	A public water system that is not a community water system and regularly serves at least 25 of the same persons over 6 months per year (40 CFR §141.2).
Service line	The pipe connecting the water main to the interior plumbing in a building.[2] The service line may be owned wholly by the water system or customer, or in some cases, ownership may be split between the water system and the customer.
State	State means the agency of the State or Tribal government that has jurisdiction over public water systems. During any period when a State or Tribal government does not have primary enforcement responsibility pursuant to Section 1413 of the Act, the term "State" means the Regional Administrator, U.S. Environmental Protection Agency (40 CFR §141.2).
Water main	A pipe that conveys water to a connector or customer's service line. In residential areas, it is usually located underground.[2]
Water meter	An instrument, mechanical or electronic, used for recording the quantity of water passing through a particular pipeline or outlet.[2]

Notes:

[1] Definitions without a regulatory citation are recommended definitions for use in this guidance document.

[2] Source: Seventh Drinking Water Infrastructure Needs Survey and Assessment: Lead Service Line Inventory for America's Water Infrastructure Act – State Survey Instruction (USEPA, 2021b).

[3] In 1986, Congress amended the Safe Drinking Water Act (SDWA), prohibiting the use of pipes, solder, or flux that were not "lead free" in public water systems or plumbing in facilities providing water for human consumption. See Appendix D: Summary of Lead Ban Provisions by State. At the time, "lead free" was defined as solder and flux with no more than 0.2 percent lead and pipes with no more than 8 percent. In 2011, Congress passed the Reduction of Lead in Drinking Water Act (RLDWA) that amended Section 1417 of SDWA and updated the definition for "lead free" as a weighted average of not more than 0.25 percent lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and not containing more than 0.2 percent lead for solder and flux. On September 1, 2020, EPA published the final regulation "Use of Lead Free Pipes, Fittings, Fixtures, Solder, and Flux for Drinking Water" to make conforming changes to existing regulations based on the RLDWA. https://www.federalregister.gov/documents/2020/09/01/2020-16869/use-of-lead-free-pipes-fittings-fixtures-solder-and-flux-for-drinking-water

[4] Section 141.84(c) of the January 15, 2021 Lead and Copper Rule Revisions (LCRR) specifies the operating procedures for replacing lead goosenecks, pigtails, or connectors. The LCRR is under revision and all rule provisions except for the initial inventory requirements may be subject to change.

Chapter 1: Introduction

This introductory chapter provides:

- The benefits of a comprehensive and accurate service line inventory (Section 1.1);
- The purpose of the guidance and its intended audience (Section 1.2);
- An overview of the inventory and related requirements of the January 15, 2021 Lead and Copper Rule Revisions (LCRR) and related requirements under the Lead and Copper Rule (LCR) (Section 1.3); and
- A brief discussion of how the remainder of the guidance is organized (Section 1.4).

1.1 The Benefits of a Comprehensive and Accurate Inventory

Given the many benefits of LSLR, EPA encourages water systems to begin LSLR as soon as possible, regardless of the stage of their inventory development.

Service line inventories are the foundation from which water systems take action to address a significant source of lead in drinking water − lead service lines (LSLs). Establishing an inventory of service line materials and identifying the location of LSLs is a key step in getting them replaced and protecting public health. Lead service line replacement (LSLR) is not dependent on knowing the location of all LSLs; in fact, simultaneously developing an inventory while conducting LSLR can have many benefits. For example, systems can save costs by replacing LSLs when crews find them onsite during service line investigations. Systems can also leverage the opportunity for LSLR by seeking customer consent and private property access during service line investigation. Replacing LSLs in a safe and prompt manner while crews are in the field for inventory development provides an opportunity for public health benefits for consumers by more quickly eliminating this potential source of lead exposure from drinking water.

Congress recognized the importance of LSLR when it appropriated supplemental Drinking Water State Revolving Fund (DWSRF) funding as part of the 2021 Bipartisan Infrastructure Law (BIL) (P.L. 117-58). The BIL contains a historic $15 billion in dedicated funding through the DWSRF for LSL identification and replacement. This funding is being provided to states with no match requirement. The BIL also provided $11.7 billion over five years to enhance DWSRF base funding. EPA is collaborating with state DWSRF programs to share models, guidance, and build state capacity to assist local communities and ensure LSL funding is effectively and equitably deployed (USEPA, 2022). DWSRF BIL LSLR funding, DWSRF BIL General Supplemental funding, and base appropriations for the DWSRF can all be used for LSL identification, such as service line material classification and validation, and replacement. The new resources available under BIL, in particular, provide a tremendous opportunity to make rapid progress on permanently removing a significant source of lead in drinking water and achieving major improvements in public health.

For the DWSRF, 49 percent of the DWSRF funding must be provided to disadvantaged communities. Other federal programs also have available funding available for LSLR and related technical assistance.[1]

A comprehensive and accurate inventory has many additional benefits beyond regulatory compliance. Inventorying service line material permits notification to consumers about potential lead risks affecting them, which can facilitate customer actions to reduce lead in drinking water, including flushing, use of filters certified to reduce lead, and customer-initiated LSLR. Inventories allow water systems to publicly track their progress on LSL identification and replacement, engaging the community and enhancing transparency. Inventories can also help water systems and consumers determine the source of high lead levels in drinking water at a home or building and the possible solutions for reducing exposure. Water systems with inventory information can also proactively mitigate lead exposure caused by disturbances of a lead or galvanized requiring replacement (GRR) service line, for example, during street construction. Inventories can also make LSLR programs more efficient. Even incomplete inventories may create cost-saving opportunities for water systems by better targeting locations served by LSLs, stretching the value of internal or external funding that water systems receive, such as from the BIL. In addition, service line inventories can help inform decisions for other drinking water rules and could inform future needs surveys and potential future costs.

1.2 Purpose and Audience

The purpose of this document is to guide water systems as they develop and maintain service line inventories and to provide states with needed information for oversight and reporting to EPA. The guidance contained in this document can also position water systems to begin replacing LSLs as soon as possible. Locating LSLs is the first and critical step to replacing them; however, water systems do not need to complete the entire inventory process before designing and implementing their LSLR programs.

This guidance covers the lifecycle of the inventory, including inventory creation, material investigations, system reporting, state review, public accessibility of service line information, and service line consumer notification. In addition, the guidance provides best practices, case studies, and templates related to topics such as the classification of unknowns, goosenecks, and galvanized plumbing; best practices for service line material investigations; inventory form and format; inventory accessibility; tools to support inventory development and data tracking; and ways to prioritize service line investigations.

[1] Additional information is available at https://www.epa.gov/ground-water-and-drinking-water/funding-lead-service-line-replacement.

The practices surrounding service line material inventories are rapidly evolving as water systems create their inventories and improve them over time. Additionally, emerging research on service line identification methods is ongoing. Given the potential for new, relevant information to become available, EPA anticipates that future updates to the guidance are possible. In addition, although EPA anticipates this guidance will be useful for water systems of all sizes, EPA intends to develop an additional tailored guidance for small community water systems (CWSs) and non-transient non-community water systems (NTNCWSs).

1.3 Overview of Regulatory Requirements and LCRR Review

Section 1.3.1 provides an overview of the initial inventory requirements specified in the January 15, 2021 LCRR. Section 1.3.2 provides information on EPA's review of the LCRR and plans to develop the Lead and Copper Rule Improvements (LCRI). Section 1.3.3 discusses inventory-related regulatory requirements under the LCR.

1.3.1 Overview of the LCRR Inventory Requirements

EPA published the LCRR in the *Federal Register* on January 15, 2021 (USEPA, 2021c). It applies to all CWSs and NTNCWSs. The initial inventory requirements of the LCRR specify:

- Information that water systems must include in their service line inventory,
- When water systems must submit their initial inventories to their primacy agency[2],
- Requirements for water systems to make their information publicly accessible and to notify all persons served by the water system at the service connection with a lead, GRR, or lead status unknown service line, and
- Reporting requirements for states.

> *Note that this guidance addresses **inventory** requirements of the LCRR only. All LCRR requirements aside from the initial inventory are subject to change under the LCRI. See Section 1.3.2 for discussion.*

Exhibit 1-1 provides a summary of these requirements with the relevant LCRR citations and the section(s) in this guidance with additional information. Note that Exhibit 1-1 includes only the LCRR initial inventory requirements that EPA stated would be retained for the LCRI. The LCRR contains additional requirements that may be subject to change under the LCRI and are therefore not included in the exhibit below.

[2] EPA delegates primacy, which is primary enforcement responsibility to implement SDWA's Public Water System Supervision Program, for public water systems to states, territories, and Indian tribes if they meet special requirements. Throughout this guidance, the terms "state" or "states" are used to refer to all types of primacy agencies including U.S. territories, Indian tribes, and EPA Regions.

Exhibit 1-1: LCRR Inventory Requirements

Inventory Requirement	40 CFR Citation	Information Provided in:
WATER SYSTEM REQUIREMENTS		
Inventory Specifications		
Material Classification: Classify each service line or portion of the service line where ownership is split as lead, galvanized requiring replacement, non-lead, or lead status unknown.	§141.84(a)(4)	Section 2.1
All service lines and ownership: Prepare an inventory that includes the system- and customer-owned portions of all service lines in the system's distribution system.	§141.84(a), (a)(2)	Section 2.2
Information to Identify Material: Use previous materials evaluation, construction and plumbing codes/records, water system records, distribution system inspections and records, information obtained through normal operations, and state-specified information.	§141.84(a)(3), (a)(5)	Sections 3.4 & Chapter 4
Deadlines for Submission		
Initial Inventory: Submit an initial inventory or demonstrate the absence of LSLs by October 16, 2024.	§141.80(a)(3)[1]	Section 1.3.2 & Section 6.4
Updates to Primacy Agency: Submit updated inventories to the primacy agencies annually or triennially based on lead tap sampling frequency, but not more frequently than annually Water systems that have demonstrated the absence of LSLs by October 16, 2024 are not required to provide an update. However, if these systems subsequently find any LSL or galvanized requiring replacement service line, they have 30 days to notify the state and prepare an updated inventory on a schedule established by the state.	§141.90(e)(3), §141.90(e)(3)(ii)	Sections 6.3 & 6.6
Public Accessibility and Consumer Confidence Report		
Public Accessibility: Make the inventory publicly available and include a locational identifier for LSLs and galvanized requiring replacement. Water systems serving more than 50,000 people must provide inventories online.	§141.84(a)(8)	Section 2.3 & Chapter 7

Inventory Requirement	40 CFR Citation	Information Provided in:
Consumer Confidence Report (applies to CWSs only): • **CWSs with LSLs**: Indicate how the public can access the service line inventory information. • **CWSs with only non-lead service lines:** Provide a statement there are no LSLs and how to access the service line inventory (or a statement in lieu of the publicly accessible inventory with a description of methods used to make this determination in 40 CFR §141.84(a)(9)).	§141.84(a)(9), §141.153(d)(4)(xi)	Section 7.4
Service Line Consumer Notification		
Provide notification to persons served by the water system at the service connection with an LSL, GRR, or lead status unknown service line. If the water system serves communities with a large proportion of non-English speaking consumers, as determined by the state, public education materials must be in appropriate languages or contain a telephone number or address where persons served may contact the water system to obtain a translated copy of the materials or to request assistance in the appropriate language. **Timing:** Notification within 30 days after completing of initial inventory and repeated annually until only non-lead remains. For new customers, water systems must also provide this notice at the time of service initiation. **Content:** Statement about service line material, lead health effects, and steps to minimize lead exposure in drinking water. If: • Confirmed LSL, must include opportunities to replace the LSL, any available financing programs, and statement that the system must replace its portion if property owners notify the system they are replacing their portion. • GRR, must also include opportunities for service line replacement. • Lead status unknown, must also include opportunities to verify the material of the service line. **Delivery:** By mail or by another method approved by the state. **Reporting to states:** Demonstrate that the water system delivered the notification and provide a copy of the	§141.85(a)(1)(ii), §141.85(e) & §141.90(f)(4)	Section 6.5

Inventory Requirement	40 CFR Citation	Information Provided in:
notification and information materials to their states annually by July 1 for the previous calendar year.		
STATE REPORTING		
Reporting to EPA: For each water system, the number of lead, galvanized requiring replacement, and lead status unknown service lines in its distribution system, reported separately.	§142.15(c)(4)(iii)(D)	EPA will include additional details in the data entry instructions guidance for the LCRR.
Special Primacy: The LCRR specifies special primacy requirements for states to adopt in 40 CFR §142.16(d)(5) that include: (1) providing or requiring the review of any resource, information, or identification method for the development of the initial inventory or inventory updates, and (2) requiring water systems whose inventories contain only non-lead service lines and the water system subsequently finds an LSL to prepare an updated inventory on a schedule determined by the state.	§142.16(d)(5)	Chapters 4 – 6 EPA plans to include additional information in a separate state implementation guidance.

Notes:

[1] On June 16, 2021, EPA published a rule to extend the compliance date from January 16, 2024 to October 16, 2024 (40 CFR §141.90(e)(1), USEPA, 2021d).

Note that this guidance uses the terms "system-owned" and "customer-owned" because they are consistent with the LCRR language. EPA recognizes that states and systems may use other terms to describe ownership status such as "public" and "private" or other terms besides "ownership" to describe the division of responsibility between the water system and the customer. EPA recommends water systems using different terminology to provide clear explanations of those terms to the state and the public.

> *States may have laws or regulations for initial service line inventories that are **more stringent** than federal requirements. For the most accurate and up-to-date requirements, systems should reach out to their state primacy agencies.*

1.3.2 Outcome of EPA Review of the LCRR

On June 16, 2021, EPA published the agency's decision to delay the effective and compliance dates of the LCRR, published on January 15, 2021. The effective date was extended from March 16, 2021 to December 16, 2021, while the compliance date was extended from January 16, 2024 to October 16, 2024 to ensure drinking water systems and primacy states continued to have the full

three years provided by the Safe Drinking Water Act to take actions needed for regulatory compliance. They delay allowed time for EPA to review the LCRR in accordance with Presidential directives issued on January 20, 2021, to the heads of federal agencies to review certain regulations and conduct important consultations with affected parties (USEPA, 2021d). The agency's review included a series of virtual public engagements to hear directly from a diverse set of stakeholders.

EPA published the outcome of its review on December 17, 2021. The review stated that EPA actions to protect the public from lead in drinking water should consider the following priority areas for improvements: replacing 100 percent of LSLs is an urgently needed action to protect all Americans from the most significant source of lead in drinking water systems; equitably improving public health protection for those who cannot afford to replace the customer-owned portions of their LSLs; improving the methods to identify LSLs and trigger action in communities that are most at risk of elevated drinking water lead levels; and exploring ways to reduce the complexity of the regulations. In the notice, EPA explained it would also consider changes to other areas of the rule to equitably improve health protections and improve implementation of the rule to ensure that it prevents adverse health effects of lead to the extent feasible (USEPA, 2021a). This could include changes to the requirements applicable to the inventory updates.

To achieve these policy objectives, EPA announced its decision to proceed with a proposed rule that would revise the LCRR while allowing the January 2021 rule to take effect. Through the LCRI, EPA stated that it does not expect to propose changes related to the initial service line inventory requirements because continued progress to identify LSLs is integral to lead reduction efforts regardless of potential revisions to the rule. The LCRR effective date is December 16, 2021, and the compliance date is October 16, 2024. In the review notice, EPA also highlighted non-regulatory actions that EPA and other federal agencies can take to reduce exposure to lead in drinking water.

1.3.3 Related Requirements under the LCR

As mentioned in the previous section, EPA reviewed the requirements in the LCRR and published its intent to revise the rule with the exception of the initial inventory requirements (USEPA, 2021a). Thus, this document focuses on guidance related to the LCRR initial inventory requirements, while also including general best practices applicable to the later stages of the inventory lifecycle.

This section describes existing LCR requirements that rely on service line inventory information and provides recommendations on how these requirements can be supported by initial inventory efforts. Water systems must comply with the requirements of the LCR (40 CFR §§141.80-141.91 as codified on July 1, 2020) between December 16, 2021 and October 16, 2024 (40 CFR §141.80(a)(3)).

Inventory-Related Requirements in the Event of Action Level Exceedance

Under the LCR (40 CFR §141.84(b)), systems subject to LSLR requirements[3] must replace annually at least seven percent of the initial number of LSLs in their distribution system. The initial number of LSLs is the number of lead lines in place at the time the replacement program begins. Water systems must identify the initial number of LSLs in their distribution system under this requirement. EPA recommends that systems use information gathered for the initial inventory under the LCRR to help identify the required initial number of LSLs.

How the Inventory Relates to the Tap Monitoring Requirements

Required lead and copper tap monitoring under the LCR is based on a tiering system for prioritizing sample sites (40 CFR § 141.86(a)). Single family homes with LSLs are in the highest tier (*i.e.*, Tier 1), meaning systems should prioritize these locations for lead and copper tap monitoring. Systems may gather more information on the location of LSLs under their initial inventory efforts.

1.4 Document Organization

The remainder of this document is organized as follows:

- **Chapter 2: Elements of the Inventory** includes information that must be included in the service line inventory to meet LCRR requirements as well as additional information EPA recommends that water systems consider tracking in their inventory.
- **Chapter 3: Inventory Planning** includes approaches for developing an inventory, considerations for choosing an inventory format, procedures for collecting information during normal operation, and guidelines for developing partnerships with third parties.
- **Chapter 4: Historical Records Review** summarizes the rule requirements for reviewing historical records and provides additional recommendations on how the various types of historical records can be used and where to find them.
- **Chapter 5: Service Line Investigation Methods** summarizes and compares service line identification methods, including visual inspection, water quality sampling, excavation, statistical data analyses, and emerging methods.
- **Chapter 6: Developing and Updating the Inventory** provides recommendations for classifying service line materials, planning for proactive investigations, submitting the initial inventory, and inventory updates. It includes requirements and recommendations specific to systems with no LSLs and provides guidance to states related to inventory

[3] Under the LCR, systems that exceeded the lead action level of 15 µg/L based on their 90th percentile sample result after installing corrosion control and/or source water treatment (whichever sampling occurred later) are required to replace 7 percent of their LSLs annually until they no longer exceeded the lead action level for two consecutive monitoring periods (40 CFR §141.84(a)).

review and reporting. This chapter also contains requirements and recommendations for notifying customers with LSLs, GRR, or unknown service lines.

- **Chapter 7: Public Accessibility** includes LCRR requirements for water systems to make their inventory publicly accessible and provides suggestions for inventory content and effective presentation, promoting public input, considerations for states, and Consumer Confidence Report inventory-related requirements.
- **Chapter 8: References** provides a full list of references that were used in the development of this document.

This guidance also includes key points to remember at the end of Chapters 1 through 7. In addition, these chapters are supported by the following appendices:

- **Appendix A** provides blank forms from EPA's Service Line Inventory Template, which is a companion tool to help water systems and states comply with the LCRR service line inventory requirements. The blank forms can be used for documenting inventory methods and an inventory summary. The appendix also contains a blank form for the state review checklist.
- **Appendix B** includes case studies for three water systems that have begun developing their service line inventories.
- **Appendix C** includes example instructions on how customers can identify their service line materials and example customer materials when the water system conducts the material service line verification of the customer-owned portion.
- **Appendix D** provides a summary of 1986 SDWA lead ban provisions by state.
- **Appendix E** includes Michigan's Minimum Service Line Verification Requirements.
- **Appendix F** includes examples of data quality disclaimers regarding the accuracy of the inventory provided to the public.

Key Points to Remember

LCRR Requirements

- All CWSs and NTNCWSs must develop an inventory of service lines that meets the LCRR requirements, including service line materials classification, information sources, and public accessibility (40 CFR § 141.84(a)).
- Water systems must submit their initial inventories to their state by October 16, 2024 (40 CFR § 141.84(a)(1)) and 141.90(e)(1)).
- All CWSs and NTNCWSs must notify all persons served by the water system at the service connection with a lead, GRR, or lead status unknown service line within 30 days of completing their service line inventory (40 CFR § 141.85(e)).
- All LCRR requirements other than the initial inventory requirements are subject to change under the LCRI.

Recommendations (Not Required under the LCRR)

- Water systems should not wait until their inventories are complete to begin conducting LSLR. Replacing LSLs while developing the inventory may create synergies or introduce opportunities for cost-savings.
- This guidance covers the lifecycle of the inventory, including inventory creation, inventory updates, material investigations, system reporting, state review, and public accessibility of service line information. The inventory is based on the best available data and should improve over time with updated information.
- States may have passed laws or regulations for a service line inventory that are more stringent than the federal inventory requirements.
- For water systems, a comprehensive and accurate service line inventory will facilitate LCRR compliance, improve LSLR program efficiency, provide greater public health protection, potentially assist in obtaining external funds for inventory development and LSLR, and provide potential cost savings.
- For states, a robust inventory will provide information for oversight and reporting.

Chapter 2: Elements of the Inventory

This chapter contains the required elements of the service line inventory based on the January 15, 2021 Lead and Copper Rule Revisions (LCRR) (USEPA, 2021c) and is organized as follows:

- Section 2.1 presents requirements and recommendations for materials classification for service lines and other related infrastructure,
- Section 2.2 presents requirements and recommendations for what to include in the inventory,
- Section 2.3 includes a discussion of location identifiers for service lines, and
- Section 2.4 provides other suggested service line information for inclusion in the inventory.

2.1 Inventory Materials Classifications

This section summarizes the required service line material classifications and presents additional classifications and subclassifications for states and water systems to consider.

2.1.1 Required Service Line Inventory Material Classifications

Under the LCRR, the inventory must use one of the following four material classifications to describe the entire service line, including separate material classifications for the water system-owned and customer-owned portions of each service line where ownership is split:

- Lead
- Galvanized requiring replacement (GRR)
- Non-lead (or the actual material, such as copper or plastic)
- Lead status unknown service lines (or unknown)[4]

Exhibit 2-1 provides the required criteria for assigning each of the four material classifications and additional information that may be helpful to states and water systems.

[4] This guidance document uses the term lead status unknown interchangeably with unknown.

Exhibit 2-1: Required Inventory Materials Classifications

Material Classification	Use This Classification If:
Lead	The service line is made of lead (40 CFR §141.84(a)(4)(i)). ***Keep in Mind**:* • The LCRR updates the definition of a lead service line (LSL) as "a portion of pipe that is made of lead, which connects the water main to the building inlet" (40 CFR §141.2). • If the only lead pipe serving the building is a lead gooseneck, pigtail, or connector[1], the service line is **not** considered an LSL under the initial inventory requirements of the LCRR. EPA recommends that the system track the material of all components that potentially contain lead, including connectors.[2]
Galvanized Requiring Replacement (GRR)	The galvanized service line is or ever was at any time downstream of an LSL or is currently downstream of a lead status unknown service line. If the water system is unable to demonstrate that the galvanized service line was never downstream of an LSL, it must presume there was an upstream LSL (40 CFR §141.84(a)(4)(ii)). ***Keep in Mind**:* • Galvanized service lines that are or ever were downstream from an LSL can adsorb lead and contribute to lead in drinking water. • An example of a GRR service line is when the customer-owned portion from the meter to the building is galvanized, and the system-owned portion from the water main to the meter was previously lead but has been replaced. The customer-owned portion of the service line would be GRR. • Under the initial inventory requirements of the LCRR, a galvanized service line that was never downstream of an LSL but is downstream or previously downstream of a lead gooseneck, pigtail, or connector is not considered GRR. However, systems should check with their states if they have more stringent requirements.
Non-Lead	The service line is determined through an evidence-based record, method, or technique that it is not lead or GRR (40 CFR §141.84(a)(4)(iii)). ***Keep in Mind**:* • If a system can demonstrate that a galvanized service line was never downstream of an LSL, it may be classified as non-lead. • The water system may classify the actual material of the service line (for example, galvanized, plastic, or copper) as an alternative to classifying it as non-lead. • The term "non-lead" refers to the service line material only and does not include other potential lead sources present in solder, connectors, and other plumbing materials.

Material Classification	Use This Classification If:
Lead Status Unknown	The service line material is not known to be a lead, GRR, or non-LSL, such as where there is no documented evidence supporting material classification (40 CFR §141.84(a)(4)(iv)). ***Keep in Mind**:* • Water systems have the option to use the terminology of unknown instead of lead status unknown service line (40 CFR §141.84(a)(4)(iv)). • Water systems may elect to provide more information regarding their unknown lines as long as the inventory clearly distinguishes unknown service lines from those where the material has been determined through records or inspections (40 CFR §141.84(a)(4)(iv)).

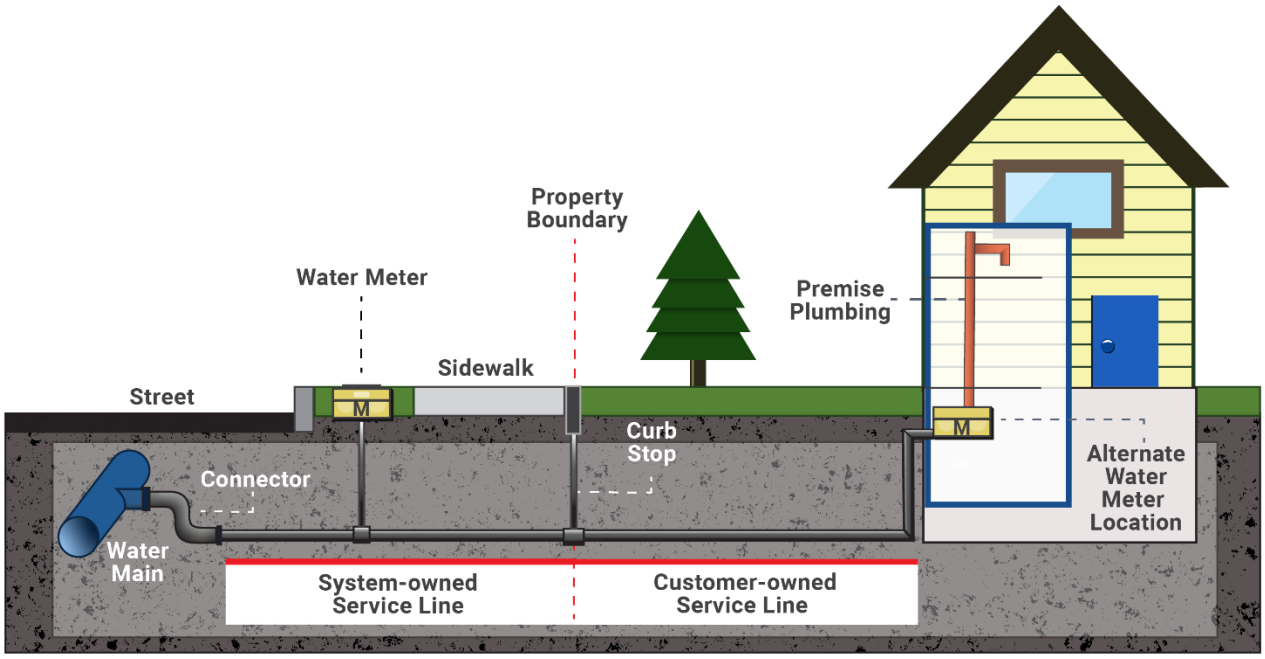
Note:

[1] A lead gooseneck, pigtail, or connector is defined as "a short section of piping, typically not exceeding two feet, which can be bent and used for connections between rigid service piping" (40 CFR §141.2).

[2] Some states include lead connectors in their definition of an LSL. In these instances, the state requirements are more stringent than the LCRR and water systems must follow these requirements.

Exhibit 2-2 is a diagram of a possible division in service line ownership (or responsibility) between the customer and water utility in which the system-owned portion of the service line is from the water main to the curb stop and the customer-owned portion is from the curb stop to the water meter. For some systems, the delineation may be different, (*e.g.*, the ownership or responsibility distinction is at the water meter or property line). In other instances, the water system may share ownership with customers, or the water system or customer may have sole ownership of the service line. Note that ownership of the property on which the service line is located does not always equate to ownership or responsibility of the service line.

Exhibit 2-2: Example of Service Line Ownership Distinction between the Water System and Customer



While the LCRR requires the inventory to categorize each service line or portions of the service line where ownership is split, a single classification per service line is also needed to support various LCRR requirements, such as lead service line replacement (LSLR), tap sampling, and risk mitigation. Systems should follow these guidelines to comply with the LCRR requirements when classifying the entire service line when ownership is split:

- Service line is lead if either portion is a lead service line (LSL) (40 CFR §141.84(a)(4)(i)).
- Service line is GRR if the downstream portion is galvanized and the upstream portion is unknown or currently non-lead, but the system is unable to demonstrate that it was never previously lead (40 CFR §141.84(a)(4)(ii)).
- Service line is lead status unknown if both portions are unknown, or one portion is non-lead and one portion is unknown (40 CFR §141.84(a)(4)(iv)).
- Service line is non-lead only if both portions meet the definition of non-lead (40 CFR §141.84(a)(4)(ii)).

EPA recognizes that some segments of the system- or customer-owned service lines could be made of more than one material. EPA recommends that systems follow the guidelines above to classify the system-owned or customer-owned portion in these cases. Exhibit 2-3 provides

examples for classifying the entire service line for various system-owned and customer-owned material combinations.

Exhibit 2-3: Classifying Service Line Materials When Ownership is Split According to the LCRR 40 CFR §141.84(a)(4)

System-Owned Portion	Customer-Owned Portion	Classification for Entire Service Line
Lead	Lead	Lead
Lead	Galvanized Requiring Replacement	Lead
Lead	Non-lead	Lead
Lead	Lead Status Unknown	Lead
Non-lead	Lead	Lead
Non-lead and never previously lead	Non-lead, specifically galvanized pipe material	Non-lead
Non-lead	Non-lead, material other than galvanized	Non-lead
Non-lead	Lead Status Unknown	Lead Status Unknown
Non-lead, but system is unable to demonstrate it was not previously Lead	Galvanized Requiring Replacement	Galvanized Requiring Replacement
Lead Status Unknown	Lead	Lead
Lead Status Unknown	Galvanized Requiring Replacement	Galvanized Requiring Replacement
Lead Status Unknown	Non-lead	Lead Status Unknown
Lead Status Unknown	Lead Status Unknown	Lead Status Unknown

If the only lead pipe serving a building is a lead gooseneck, pigtail, or other connector (*i.e.,* a non-LSL attached to a lead connector), then the line should not be designated as an LSL in the initial service line inventory required under the LCRR. The line may be required to be identified separately by the state. In addition, as will be discussed in more detail in Section 2.1.3, EPA recommends water systems identify the lines with only these components separately in their inventory. Also note that service material classifications can change over time as the system gathers more information and updates the inventory.

2.1.2 Recommended Subclassifications and Additional Information (Not Required Under LCRR)

Water systems may also consider going beyond the requirements of the LCRR by subclassifying service line materials and tracking additional information. These subclassifications are discussed below and can provide additional information not only to help facilitate material classification, but also to inform the public about service lines in their homes and community.

Recommended Subclassifications

A Lead Status Unknown's "LSL Likelihood." Some water systems have incorporated additional information that indicates the probable material of an unknown service line, such as an "LSL Likelihood." For example, Flint, Michigan, categorized unknowns as low likelihood of lead, medium likelihood of lead, and high likelihood of lead (see their online map showing these subclassifications[5]). Systems using predictive models may also assign numerical probabilities to unknowns representing the probability they are LSLs.

Systems could rely on historical records described in Chapter 4, service line material investigations described in Chapter 5, and the methodology described in Section 6.1 to determine various subclassifications of unknown service lines. For example, if an individual service line material is unknown but was installed when lead was not commonly used in the system based on interviews with experienced system staff and plumbers, the system could consider subclassifying the service line as "Unknown- Unlikely Lead" or a similar designation. If the system has confirmed service line materials in a representative number of locations in a neighborhood to be lead, it could consider subclassifying the remaining unknown service lines in the neighborhood as "Unknown- Likely Lead" or a similar designation until its material can be investigated.

Although systems are not required to track this information or include it in their publicly accessible inventories or submittals to the state, internally tracking this information could help focus proactive inventory investigations and LSLR efforts. If subclassifications are made available to the public, EPA recommends that water systems clearly communicate this information to the public by providing easy-to-understand definitions for each subclassification and explaining how the subclassifications were determined.

GRR Known or Unknown to have been Downstream of an LSL. EPA recommends that systems that identify GRR service lines, as defined in Section 2.1.1, consider tracking and differentiating these lines into subclassifications to indicate if: 1) the galvanized pipe is known to be currently downstream of an LSL, 2) if the galvanized pipe was previously downstream of an LSL, or 3) the system is unable to demonstrate that the galvanized service line was never downstream of an LSL. This information could be used for many purposes, such as informing an LSLR prioritization

[5] https://flintpipemap.org/map. Accessed December 8, 2021.

approach or serving as an input for a predictive model. The system could also consider subclassifying galvanized service lines that are or were downstream of a lead gooseneck, pigtail, or connector.

Lead-lined Galvanized Pipes. EPA is aware of the existence of lead-lined galvanized service lines but found limited information indicating their prevalence[6]. A lead-lined galvanized service line is consistent with the definition of an LSL under the LCRR ("a portion of pipe that is made of lead, which connects the water main to the building inlet") (40 CFR §141.2) and must therefore be classified in the inventory as an LSL. These lines would be subject to the same LCRR requirements as other LSLs in the inventory, such as LSLR, public education, tap sample tiering, and risk mitigation. Inventorying these types of lines will be more straightforward where water systems have records of their known or likely use. Given that these pipes may appear to be non-lead on the exterior, attempts to identify their material by visual observation or excavation may not reveal an interior lead lining. EPA recommends that water systems consider any available information that indicates where (if ever) lead-lined galvanized pipes were used in the system, along with approaches such as service line sampling, to populate the inventory with these types of connections.

Actual Material for Non-lead. The LCRR states that water systems may classify the actual material of the service line (*e.g.*, galvanized, plastic, or copper) as an alternative to classifying it as non-lead (40 CFR §141.84(a)(4)(iii)). If states and systems wish to classify these lines as non-lead, EPA encourages water systems to track the actual materials as additional information internally and/or as part of the publicly accessible inventory. Including these classifications could improve system asset management and better inform a statistical model, if used.

2.1.3 Recommendations for Other Drinking Water Infrastructure

EPA encourages water systems to include information on lead-containing infrastructure in their inventories, including:

- **Goosenecks, Pigtails, and Connectors**: EPA encourages water systems to identify the location and material of goosenecks and pigtails (connectors) and to include this information in their inventories. This would allow water systems to track and manage this potential source of lead, improve asset management, and increase transparency with customers. This could also help water systems identify where lead connectors are or were previously upstream of galvanized pipe and to manage this additional potential source of lead in their system. As previously discussed, lead from an upstream source can adsorb onto the galvanized pipe over time. The LCRR requires that when lead connectors

[6] http://sedimentaryores.net/Pipe%20Scales/Fe%20scales/Galvanized_lead-lined.html. Accessed December 6, 2021.

are encountered, they be removed or disconnected.[7] In addition, funding sources, such as the Drinking Water State Revolving Fund (DWSRF), Bipartisan Infrastructure Law (BIL), and Water Infrastructure Improvements for Nations Act (WIIN), can be used to pay for lead connector removal and replacement.

Note that systems must follow any state requirements that are more stringent than the LCRR for these materials. For example, Michigan includes lead connectors in their definition of an LSL (Michigan EGLE, 2018). California requires water systems to include in their inventory lead fittings on a non-lead pipe, lead fittings on a lead pipe, and fittings of unknown material (ASDWA, 2019).

- **Lead Solder:** EPA recommends that water systems track the presence of lead solder in the service line or premise plumbing, such as after encountering information indicating their presence in records or if seen during system inspections or maintenance. Tracking the presence of lead solder in the service line improves system asset management and can inform future actions for reduction of lead sources in drinking water. In addition, knowing locations with lead solder in premise plumbing can help identify tap monitoring locations under the Lead and Copper Rule (LCR) and LCRR.
- **Fittings and Equipment Connected to the Service Line:** Devices such as curb stops and meters may be made of older brass that pre-date the effective date for the Reduction of Lead in Drinking Water Act (January 4, 2014). These devices may not meet the revised lowered lead-free standard[8] and could contribute to lead exposure (Sandvig et al., 2008). EPA recommends water systems consider tracking these devices if information is available.

2.2 Include All Service Lines Regardless of Ownership Status and Intended Use

2.2.1 Required under the LCRR

All community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) must prepare an inventory of **all service lines** connected to the public water distribution system, regardless of ownership status (40 CFR §141.84(a)(2)). This means that any service line connected to the public water system, even where the water system owns no portion of the service line, must be included in the inventory. In those instances where ownership is split, the inventory must include both the system-owned and customer-owned portions of the service line. Water systems must internally track address locations of each service line and their

[7] The LCRR is under revision and all rule provisions except for the initial inventory requirements may be subject to change.

[8] In 2011, Congress passed the Reduction of Lead in Drinking Water Act that amended Section 1417 of the Safe Drinking Water Act (SDWA) and established an updated definition for "lead free" as a weighted average of not more than 0.25 percent lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and not containing more than 0.2 percent lead for solder and flux.

respective material classification (40 CFR §141.84(a)). Where a single service line serves multiple units in the same building, the water system may choose to exclude unit numbers from the address. Note that unit numbers may be required to comply with other LCRR requirements, such as the notification requirements of 40 CFR §141.84(d) and 40 CFR §141.85(e). Because LSLs were generally not constructed with an interior diameter over two inches, they will typically be connected to single family homes or buildings with a limited number of units.

Note that some CWSs and NTNCWSs may not have an extensive distribution system, such as those with a direct connection from a well to a single building. Systems must report the material from the well to the building inlet for their inventory. EPA intends to develop a separate guidance that is tailored to small CWSs and NTNCWSs.

Systems must include all service lines (40 CFR 141.84(a)(2)), regardless of the actual or intended use. These include, for example, service lines with non-potable applications such as fire suppression or those designated for emergency. These service lines could be repurposed in the future for a potable or non-emergency use. Water systems must include in their inventory service lines connected to vacant or abandoned buildings, even if they are unoccupied and the water service is turned off.

2.2.2 Recommendations (Not Required under the LCRR)

Documentation that Describes System and Customer Responsibility or Ownership

As a best practice, where service line ownership or responsibility is divided between the customer and the system, water systems may want to include with their inventory relevant information that describes how ownership or responsibility is divided. Examples could include local ordinances or local water utility tariff agreements or state laws or regulations. This information may be helpful to provide to customers who have questions about how the responsibility for the service line is divided as well as the utility's authority to access and maintain the portion of the service line that is located on the customer's property.

> ***Remember:*** *States and systems may use other terms to describe ownership status such as "public" and "private" or other terms besides "ownership" to describe the division of responsibility between the water system and the customer. Systems should include clear definitions in their publicly accessible inventory.*

Recommended Procedures for Service Lines of Vacant or Abandoned Buildings

Water systems could have service lines that connect to vacant or abandoned homes or buildings that must be included in their inventory even if they are unoccupied and the water service is

turned off. EPA recommends water systems have procedures in place for managing the service lines for these structures. For example, water systems could consider:

- Prioritizing occupied homes for service material investigation or replacement to achieve a greater lead exposure reduction from their overall program, provided that the water is turned off at the vacant or unoccupied structure.
- Investigating these structures' service lines if they are doing maintenance or construction work in the area.
- Identifying service material before service is restored, or not reconnecting LSLs on previously vacant homes or buildings (or new construction built after demolition).
- Using the transfer of property as an opportunity for service line identification or LSLR.

2.3 Location Identifiers

This section describes the LCRR requirements for providing location identifiers for LSLs and GRRs in the publicly available inventory as well as suggested identifier information.

2.3.1 Required under the LCRR

Water systems must make a service line inventory publicly available (40 CFR §141.84(a)(8)) that includes a location identifier for any lead or GRR service lines, such as a street address, intersection, or landmark (40 CFR §141.84(a)(8)(i)). The LCRR does not require water systems to make an inventory with the exact street addresses publicly available. Some local or state privacy laws may prohibit the publication of address-level information. The water system has flexibility to determine which location identifier best meets the needs of its own community. If the street address is not used, systems must use a meaningful location identifier. The location identifier could be, for example, a block, intersection, landmark, GPS coordinates, emergency 911 address for systems in rural areas, or an alternate indicator (such as water meter location). Regardless of which identifier the water system chooses, it must not be so overly broad (*e.g.*, census tract or zip code) that the public could not adequately track general LSL locations or where the system is making progress in replacing LSLs.

2.3.2 Recommendations (Not Required under the LCRR)

Include a Location Identifier for All Service Line Materials. Water systems are not required to make a location identifier for lead status unknown service lines or non-lead service lines publicly available. However, EPA suggests, as a best practice, systems publish locations of all service lines for the greatest transparency and relevant information for its customers.

Consider Publishing Street Addresses. Although EPA determined in the LCRR that a federal requirement for a publicly accessible inventory that uses specific addresses is not necessary, EPA encourages states and water systems to consider including specific addresses in their publicly

accessible inventory. Relevant factors states and water systems might consider include: underlying data quality, transparency and consumer awareness, simplification of inventory development and public communication, availability, impacts on replacement program participation, environmental justice concerns, state or local privacy laws or constitutional protections, and potential property value impacts (both positive and negative). EPA also suggests that systems that serve multiple municipalities include the city or town with the street address.

Include Additional Location Descriptors When Multiple Service Lines Serve the Same Address. Sometimes multiple service lines serve the same address (*e.g.*, hospital or apartment building). Water systems should consider adding additional descriptors that would allow each service line to be uniquely identified.

2.4 Other Recommended Service Line Characteristics

EPA recommends that water systems consider tracking additional service line characteristics, such as the information source(s) used to identify material for each service line, pipe diameter, and installation date. ***These are not LCRR requirements***, but tracking this information could benefit the water system, as discussed below.

Source(s) of information for each service line. This includes recording the source(s) of information used to identify the material of each service line. Refer to Chapter 4 and Chapter 5 for a description of possible sources. Tracking this information is valuable for systems to assess their confidence in the accuracy of an individual service line's material classification, evaluate the reliability of certain records or identification methods as a whole, and facilitate updates to the inventory in the future. This information can also assist states in reviewing the inventory.

Pipe diameter. As explained in Chapters 4 and 6 of this guidance, pipe diameter can be an important input to determining service material classification, considering that LSLs are often 2 inches or smaller in diameter. Tracking pipe diameter is important for asset management and can be useful for other information collection efforts such as the Drinking Water Infrastructure Needs Survey and Assessment (DWINSA). States may have their own requirements. For example, Wisconsin requires material reporting to their public service commission by diameter.[9]

Installation or replacement date. As detailed in Chapter 4 and Chapter 6, the date of service line construction or replacement can be an important input in screening for potential LSLs. This information should also be tracked for general asset management purposes. Where precise dates are not available, the year (*e.g.*, 1985) or estimated date range (1950-1960) of installation or replacement can be provided.

[9] See https://blogs.edf.org/health/2020/04/16/latest-wisconsin-data-on-water-service-lines-provides-important-insights-reveals-over-150000-lead-pipes/.

Key Points to Remember

LCRR Requirements

- The inventory must include all service lines connected to the public water distribution system regardless of intended use (40 CFR §141.84(a)(2)). Lead connectors, gooseneck, and pigtails are not required to be included unless required by the state.
- The inventory must include information on both the system- and customer-owned portions where ownership is split (40 CFR §141.84(a)(4)).
- Service lines must be classified as lead, GRR, non-lead (or the actual material), or lead status unknown service lines (or unknown) (40 CFR §141.84(a)(4)).
- A classification of non-lead must be supported by evidence-based records, methods, or techniques to prove it is not lead or GRR (40 CFR §141.84(a)(4)(iii)).
- The water system must create and maintain an inventory that includes the exact address associated with each service line connected to the public water system. (40 CFR §141.84(a)).
- An inventory of lead and GRR service lines must be made publicly available, but the LCRR does not require the publicly available inventory to include the specific address of each lead and GRR service line. Systems may use a location identifier for any lead and GRR service lines (40 CFR §141.84(a)(8)(ii)).

Recommendations (Not Required under the LCRR)

- EPA encourages water systems to consider including street addresses, when available, as their location identifier for all service lines in its public-facing inventory. Identifiers should be significantly detailed to allow the identification of a specific service line.
- EPA encourages water systems to expand their inventories to include service line subclassifications, other plumbing components such as lead connectors, and other details such as source of information, pipe diameter, and installation date.

Chapter 3: Inventory Planning

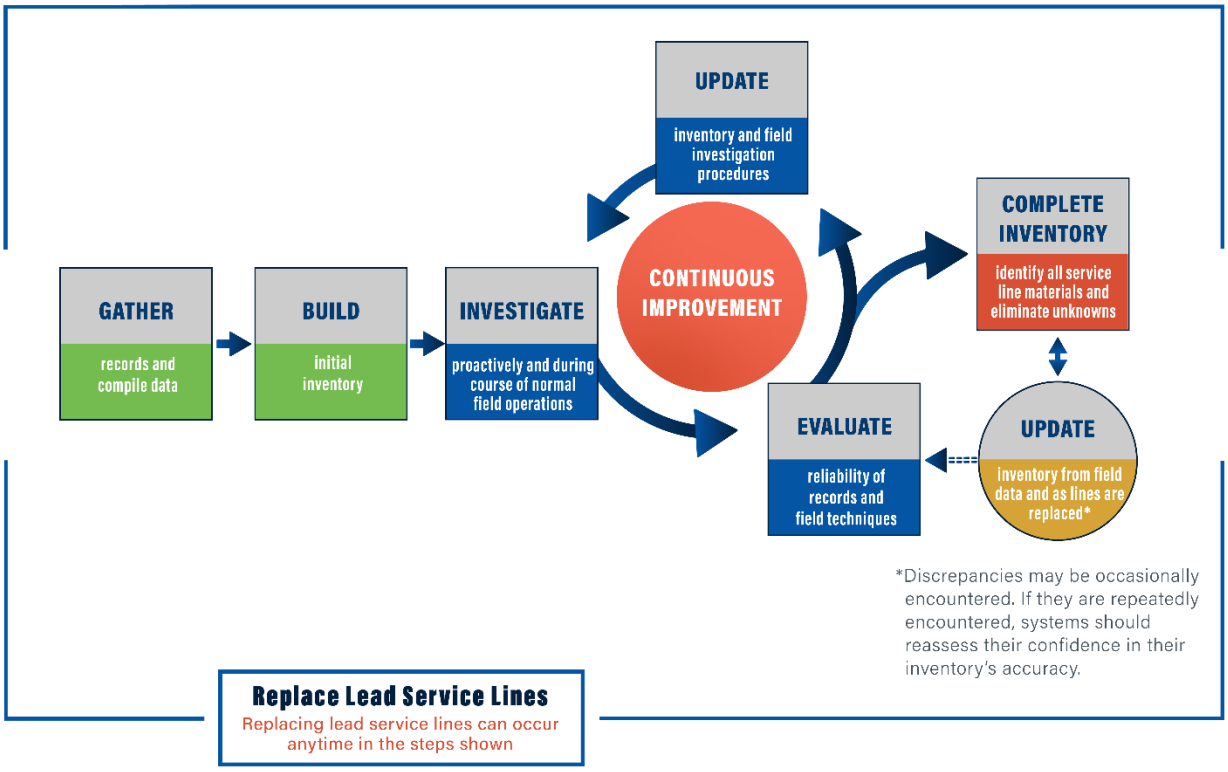
This chapter addresses planning steps that systems should consider when developing their inventory. This information is intended to be helpful for all systems, regardless of where they are in their inventory process. The chapter is organized as follows:

- Section 3.1 provides an introduction to the inventory development process,
- Section 3.2 includes considerations when identifying staff and resources needed for inventory development,
- Section 3.3 includes options and considerations for water systems in the selection of an inventory format,
- Section 3.4 provides recommendations for developing procedures for the collection of service line information, and
- Section 3.5 suggests partnering with third parties for assistance in obtaining information on service line materials.

3.1 Inventory Development Approach

As stated in Chapter 1, this guidance covers the lifecycle of the inventory, including inventory creation, material investigations, system reporting, state review, and public accessibility of service line information. As noted previously, water systems should not wait to replace lead service lines (LSLs) until they have identified the materials of all service lines. In fact, verification of service line materials during lead service line replacement (LSLR) could be part of a water system's strategy to continuously improve its inventory over time. Exhibit 3-1 provides a schematic of this inventory lifecycle.

Exhibit 3-1: Inventory Lifecycle



Other best practice approaches for developing an inventory are available in the literature (Liggett et al., 2022; LSLR Collaborative, 2021; Hensley et al., 2021). No matter the specific approach and steps used, water systems should treat the inventory as a ***living dataset*** that is continuously improved over time as the inventory is updated. The number of unknowns in the inventory should decrease as systems gather new information through normal operation and any proactive material identification activities in which the water system is engaged. The water system should also gain confidence over time in the accuracy of the inventory as records or material identification methods are assessed. As a reminder, water systems should review state regulations and follow required steps that are more stringent than the Lead and Copper Rule Revisions (LCRR) when developing the initial inventory.

3.2 Identifying Staff and Resources

The level of effort needed to prepare an initial inventory is highly dependent on the size of the system, the availability of historical records, the format and condition of those records, LSL investigation methods chosen by the water system, and methods required and/or approved by the state (Liggett, 2021; Hensley et al., 2021; Liggett et al., 2022).

When records are in paper format, large systems have hired temporary staff (*e.g.*, interns) to digitize the data. Liggett et al. (2022) notes that "staff requirements ranged from 2-3 full time employees working 6 days a week for 2 months to several employees working continuously from the start of their lead reduction program" based on a survey of 10 large water systems serving approximately 100,000 to 1.5 million people. All surveyed systems indicated that a significant allotment of staff was needed for at least an initial period. Where customers were engaged in the inventory process, water systems staff were needed to assist customers, gather information from customers, and in some cases verify the information (Liggett et al., 2022).

Interviews with experienced system staff and plumbers can be used to focus the inventory effort and verify utility practices (LSLR Collaborative, 2021; Bukhari et al., 2020). Experienced staff may also know where relevant historical records are located. Classifications of service line materials based on interviews, however, should not be used as a sole source of information for the initial inventory. Systems may also consider interviewing their neighboring water systems to inquire about regional practices (California Water Board, 2020).

3.3 Selecting an Inventory Format

EPA does not require a specific format for the service line inventory. In some states currently requiring submission of inventory information, systems have submitted spreadsheets, geospatial maps, lists, and handwritten notations. ASDWA (2022) notes that states that have required inventory information prefer an electronic submittal over paper or PDF submissions that only provide "a snapshot in time." The subsections below discuss lists, spreadsheets, databases, and maps. Systems should check with their states for any specific requirements.

When water systems consider the inventory format, they should consider that the service line inventory will change over time as new information is added, records evaluations and investigations are conducted, and LSLs are replaced. The format should be flexible enough to accommodate updates, be easily transmittable to the state, include location identifiers, and be in a format that can be made publicly accessible. Water systems should also consider whether a format will be easy-to-use and understand for consumers, community-based organizations, and other organizations that may be interested in using this information, for example to identify whether a consumer is served by an LSL, support community outreach, or develop additional research or data tools for consumers.

Systems may also wish to internally track additional information that is not required but is recommended as best practices in Chapter 2. For central internal data tracking of required and additional inventory elements, EPA recommends that systems consider how they will use their internal data system to generate regulatory state submittals and the publicly accessible inventory.

3.3.1 List, Spreadsheet, or Database

Systems may be able to create a simple list of all addresses with a service line material designation for each. While a location identifier is sufficient for a publicly accessible inventory, some states may require systems to include the source of information used to classify each line to ensure the requirements in 40 CFR §141.84(a)(3) are met. See Section 2.4 for other recommended inventory elements to include.

Electronic spreadsheets and databases have an added advantage over lists for tracking additional information fields. Spreadsheets and databases can be organized in a way that information can be searched, filtered, sorted, and updated. They can be configured to include photos of service line material. The ability to store and communicate a large amount of information in one central location makes electronic spreadsheets and databases a useful inventory method, particularly for systems with large numbers of LSLs. General recommendations for preparing a spreadsheet inventory from a white paper by the Association of State Drinking Water Administrators (ASDWA) and BlueConduit (2020) include the following:

- Each home/service line is a row in the spreadsheet.
- Each column refers to different data points available for each service line (*e.g.*, address, installation date, service line materials classification, and source of information).
- System-owned and customer-owned portions, if applicable, are tracked separately.
- Information regarding goosenecks, pigtails, and connectors is tracked separately.
- Labeling is consistent across the data, and the spreadsheet has a data dictionary to define the column headers.
- Previous information is not lost when new information is found, which will help the utility evaluate the accuracy of historical records.

EPA developed a spreadsheet template that systems may consider using to organize their inventory. The template contains color-coded worksheets for documenting system information, inventory methods, and how the system is making the inventory publicly accessible. The template also includes a detailed worksheet that systems can use to track the materials and other relevant information for each individual service line. This detailed inventory worksheet is designed for users to enter information on one service line, including the system-owned and customer-owned portions where ownership is split, in a single row. It includes columns for required and recommended elements and dropdown menus for some columns to expedite data entry and analysis. The detailed inventory worksheet is customizable; systems can add or delete columns to fit their needs.

A description of each inventory template worksheet is provided in Exhibit 3-2. Some cells in the spreadsheet are linked, (*i.e.*, the system's name and Public Water System Identification Number (PWSID) entered on the public water system (PWS) information sheet carry over to the heading of

the other worksheets). The inventory summary includes a formula that will auto-calculate the total numbers of each of the four service line materials classifications based on the detailed inventory. In addition to the electronic version, fillable forms for several worksheets (PWS information, Inventory Methods, Inventory Summary, Public Accessibility Documentation, and State Checklist) are in Appendix A. The detailed inventory template is available electronically at https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule. Water systems can save a copy of the template to their network or computer and submit the entire file to their state.

Exhibit 3-2: Organization of EPA Inventory Template

Worksheet Type	Worksheet Name	Description
Background	**Template Instructions_System**	Contains detailed instructions for systems.
	Template Instructions_States	Contains detailed instructions for states.
	Classifying SLs	Summarizes requirements for classifying the entire service line when ownership is split (*i.e.* , when the system owns a portion and the customer owns a portion).
Templates for Water Systems	**PWS Information**	For systems to document basic system information.
	Inventory Methods	For systems to document the methods and resources they used to develop and update their inventory.
	Inventory Summary	For systems to provide a summary of their service line inventory, including information on ownership, inventory format, and the number of service lines for each of the four required materials classifications. Systems can enter the totals into this worksheet or automatically generate totals based on information in the **Detailed Inventory** worksheet.
	Detailed Inventory	Provides a customizable format water systems can use to track materials for each service line in their distribution system. Each row equals one service line connecting the water main to the customer's plumbing. Separate columns track location information, the system-owned portion, the customer-owned portion, other possible sources of lead, information for assigning a tap sample tiering classification, and information for lead service line replacement (LSLR). Systems can customize the worksheet by adding or deleting columns.
	Public Accessibility Doc.	For systems to provide documentation to states on how they met the public accessibility requirements of the LCRR.
Templates for States	**State Checklist**	Provides a checklist that states can use to determine and document if water systems met all of the January 15, 2021 LCRR requirements for their Initial Inventory including timely submission, required elements, use of information sources, public accessibility, and public notification of service line materials.

Source: EPA Inventory Template (https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule).

Other spreadsheet templates are available for download. For example, ASDWA's website (https://www.asdwa.org/lead-and-copper-rule-lcr/) provides a link to their separate inventory

template spreadsheets for community water systems (CWSs) and non-transient non-community water systems (NTNCWSs). Another example is the template developed by Kansas Department of Environmental Health.[10] In addition to the information needed to track material classifications including GRR for system- and customer-side portions of the service line, their template includes columns for additional elements. For example, it includes water main material, connector material and replacement, installation dates, sources of information used for service line identification, and other data needed to assign a lead tap sampling tier to the service line. In addition, Kansas' template includes color-coded instructions to highlight cells in which data must be typed and columns containing drop-down menus or auto-calculation. Systems should check with their states to determine if they have developed an electronic template that they should or must use to organize and/or report their detailed inventory.

3.3.2 Maps

Many water systems have developed simple or interactive web-based maps to present their service line inventory, share information with the public, and inform their LSLR program. These maps provide systems with an easily updatable platform for storing inventory data while also having the ability to instantaneously share that data in an intuitive, easy-to-use format with anyone with internet access. Moreover, geospatial databases supporting online maps can store attribute information. For example, systems with high-level mapping capabilities can link image files of historical tap cards with LSL locations (Liggett, 2021). Additional benefits of mapping may include the ability to more easily plan LSLRs along with planned capital improvement projects or to identify LSLR priority locations using existing environmental justice map tools (such as EPA's EJSCREEN[11]) along with a system's map. Also, maps can be augmented over time to include additional information, such as important infrastructure (*e.g.*, water mains and water towers), to improve a system's asset management. See Section 7.2.2 for additional information on web-based map applications, including best practices from recent publications by Hiltner et al. (2019) and Woods and Webb (2021).

Two examples of water system maps are DC Water and Greater Cincinnati Water Works, which are described in Appendix B. Note that these maps were developed prior to the LCRR and do not include GRR. EPA recommends that water systems maps also include a color scheme for GRR.

3.4 Develop Procedures for Collecting Service Line Information

Under the LCRR, systems must identify and track information on service line material as they are encountered in the course of normal operations (40 CFR §141.84(a)(5)). This information could be based on visual inspection – see Section 5.1 for guidance on visually identifying service line material.

[10] The template is available at https://www.kdhe.ks.gov/547/Lead-Copper-Rule.
[11] https://www.epa.gov/ejscreen.

Information collection by water system staff and contractors, who typically have relevant experience and/or training regarding lead in drinking water, enhances quality control of the information they collect (LSLR Collaborative, 2021). Opportunities for data collection under normal operation include but are not limited to:

- Water meter reading
- Water meter repair or replacement (see picture of an excavated meter with service line material exposed)
- Service line repair or replacement
- Water main repair or replacement
- Backflow prevention inspections
- Other street repair or capital projects with open cut excavations

Example of Meter Pit
Source: LSLR Collaborative 2018

Inventory activities should be considered as something that can be worked into the day-to-day activities of the system rather than treated as an independent effort. Systems should consider developing ***standard operating procedures*** (SOPs) or modifying existing SOPs to document how their staff and contractors will collect this information and use it to update their inventory. SOPs can help ensure that a consistent method of tracking, updating, and reporting is used for staff and contractors of all experience levels. Written SOPs can also provide a way for water systems to document how they met the requirement to collect information during normal operations. SOPs can be brief, but the key is to disseminate them to appropriate staff and contractors, use them to conduct training, and ensure that they are incorporated into normal operations. Water systems should consider incorporating quality assurance reviews into their SOPs and procedures that ensure accountability before a project is completed.

Example: Custom app for information collection

The Pittsburgh Water and Sewer Authority (PWSA) developed specific service line and meter replacement work orders in the tablet-based application used by utility workers and plumbers, allowing them to update service line material observations and record information on replacements in the field.

One way to facilitate information collection and inventory updates is the use of electronic field capture records.

Water systems should consider developing procedures for customer service representatives and other staff or contractors that have interactions with customers. Any one-on-one interaction is an opportunity to educate customers about the importance of the service line inventory and to obtain permission for water system personnel to access the home for service line material investigation, or an interaction can be used to provide information to the customer on how to self-identify the material for their portion of the

service line and submit it to the system. See Section 5.1.1 for additional guidance on customer self-identification and Appendix C for examples of customer service line material instructions from water systems.

3.5 Establish Partnerships with Third Parties

EPA encourages water systems to reach out and partner with plumbers, plumber trade organizations, local plumber union organizations, and other third parties to obtain as much information as possible on service line materials and coordinate LSLR where possible. There are many potential third parties that could be included, such as homeowner associations, community-based organizations, building agencies, building inspectors, social services, landlords or realtors, public health departments, departments of education, universities, Tribal Consortia, religious organizations, and technical assistance providers.

There are different ways that third parties can help systems obtain this information:

- The third party may be able to determine service line material as part of their normal field procedures (*e.g.*, plumbing modifications, building inspections, etc.).
- The third party may be able to facilitate outreach and engagement with specific communities, encouraging residents to conduct self-identification of service line and plumbing materials and to report this information to the water system.

Coordination and training should take place early in the process to ensure third parties are aware of the purpose, schedule, and procedures for the inventory and the importance of notifying the water system with any information on service line materials.

Real world examples of successful partnerships include:

- The Pittsburgh Water and Sewer Authority (PWSA), Pennsylvania, partners with their local health department to obtain information during plumbing inspections. PWSA works with their local health department to add service line inspection and reporting to plumbing inspection forms. PWSA automatically receives information by email whenever a plumbing inspection report contains customer-side service line information (Duffy and Pickering, 2021). See the PWSA case study in Appendix B for more information.
- Denver Water, Colorado, partners with community organizations to remove barriers. Denver Water's Ambassador Program focuses on developing partnerships with trusted community organizations to help eliminate possible barriers that could prevent communities from understanding and participating in their Lead Reduction Program. The Ambassadorship Program works in a neighborhood-by-neighborhood basis to share information about the Lead Reduction Program in multiple languages, so everyone receives the same information and resources, regardless of their background. One goal of

this program is to encourage homeowners to confirm if they have an LSL and to sign a consent form allowing Denver Water to replace it at no direct charge to customers.[12]

- The City of Newark, New Jersey, partnered with Clean Water Action, local residents, and retired utility workers as volunteers and trusted messengers to talk to residents. The City of Newark used door hangers and lawn signs to reach renters, who make up approximately 74 percent of residents. An interactive website was key to providing information to customers regarding their service line material (LSLR Collaborative, 2020).
- Grand Rapids Water System (GRWS), Michigan, partners with rental property owners. In Grand Rapids, many LSLs serve rental properties. Because only property owners can sign the agreements for LSLR in Grand Rapids, GRWS met with rental property owner associations to encourage participation in their LSLR program. The water system met well in advance of scheduled replacements to present information about the LSLR program and answer questions that property owners might have (USEPA, 2021e).

Real estate transactions may also provide additional opportunities for educating residents, engaging them to identify service line material, and ultimately facilitate LSLR. McCormick et al. (2017) noted that four states (Connecticut, Delaware, New York, and Pennsylvania) required mandatory disclosure of lead pipes or fixtures. Six additional states (Illinois, Michigan, New Mexico, North Carolina, South Carolina, and Wisconsin) and the District of Columbia required mandatory disclosure of pipe material; however, lead was either not specifically addressed or was only included if the seller identified conditions as unsafe (McCormick et al., 2017). Lu et al. (2019) found that when homebuyers have access to a seller's disclosure, indicating the presence of an LSL, the sellers were willing to negotiate to replace it or provide compensation for the replacement cost. Water systems can work with real-estate agents and home inspectors to support disclosures of identified service line materials (ideally through an online inventory) and provide procedures for customer service line self-identification or verification by trained personnel. See Chapter 7 for recommendations related to inventory accessibility and Section 5.1.1 and Appendix C for customer self-identification guidance.

[12] (https://www.denverwater.org/your-water/water-quality/lead/events-outreach). Accessed November 2, 2021.

Key Points to Remember

LCRR Requirements

- Systems must identify and track information on service line material as they are encountered in the course of normal operations (40 CFR §141.84(a)(5)).

Recommendations (Not Required under the LCRR)

- EPA recommends systems consider a continuous improvement approach for inventory development.
- The inventory is a living dataset that is continually improved over time with new and better information including when LSLs are replaced.
- Interviews with experienced staff and plumbers can help focus the inventory effort and locate system records.
- Water systems should consider interviewing neighboring water systems about regional construction practices.
- Systems can use a variety of formats for the inventory; however, an electronic format is recommended over paper or PDF formats.
- Water systems should consider developing or modifying SOPs to document how they will collect service line information during normal operations and update their inventories.
- Inventory activities should be considered as something that can be worked into the day-to-day activities of the system rather than treated as an independent effort.
- EPA encourages water systems to partner with plumbers and other third parties to obtain information on service line materials.

Chapter 4: Historical Records Review

The Lead and Copper Rule Revisions (LCRR) specifies the types of historical records that water systems must review to develop their initial service line inventory. Sections 4.1 through 4.4 provide guidance on how the required types of historical records can be used and where to find them.

EPA recognizes that service line configuration and existing records may vary widely. For example, water systems will have different numbers of lead service lines (LSLs) and unknowns, varying ownership delineations, and access to historical records of varying accuracy. In addition, systems will have different avenues of information gathering and priorities that are tailored to their specific community.

Systems should document the records they reviewed as a best practice. Templates are available in an electronic form, "Inventory Methods" from EPA's template available at EPA's website, https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule or the hard copy form in Appendix A to document each type of record reviewed and when it was reviewed. Systems should also consider tracking and including the records used to identify the material of each portion of the service line (*e.g.*, plumbing code or water system record) in their inventory.

Water systems should continue to gather information on service line materials after they have been classified and assess the accuracy of historical records. As the Association of State Drinking Water Administrators (ASDWA) states in their white paper about using data science for inventory development (ASDWA, 2019), "the process of learning just how accurate (or otherwise) a system's records are is a powerfully informative piece of this data-driven approach." ASDWA points out that some types of records will be more accurate than others, given each community's unique historical development patterns. For example, more recent records resulting from confirmation during road construction may be more reliable than decades-old tap cards. EPA recommends evaluation of the accuracy of historical records and that, if a specific record source proves to be inaccurate, systems consider reclassifying service line materials that rely solely on that record source as "unknown" until additional information can be gathered.

Exhibit 4-1 lists required records systems must use to identify service line materials for the initial inventory under the LCRR (40 CFR §141.84(a)(3)). The last column of the exhibit includes how the records can be used to develop the initial inventory.

Exhibit 4-1: Requirements for Historical Records Review for Initial Inventory Development under the LCRR

Type of Historical Records	Regulatory Requirement (citation)	Primary Uses for Inventory Development (Including but not limited to)
Previous Materials Evaluation	Water systems must use the information on lead and galvanized iron or steel that it identified under 40 CFR § 141.42(d)[1] when conducting the inventory of service lines in its distribution system for the initial inventory (40 CFR §141.84(a)(3)).	• Reporting construction materials present in their distribution systems. • Identifying LSL material for subset of sites that were used for lead and copper tap monitoring.
Construction and Plumbing Codes and Records	Systems must review all construction and plumbing codes, permits, and existing records or other documentation which indicates the service line materials used to connect structures to the distribution system to identify service line materials for the initial inventory (40 CFR §141.84(a)(3)(i)).	• Identify when LSLs were allowed/specified or banned from use. • Identify service areas most likely to have LSLs by home/building construction date and service line size. • Review construction and plumbing permits for identification of service line (customer and/or system-owned) and plumbing materials.
Water System Records	Systems must review all water system records, including distribution system maps and drawings, historical records on each service connection, meter installation records, historical capital improvement or master plans, and standard operating procedures, to identify service line materials for the initial inventory (40 CFR §141.84(a)(3)(ii)).	• Identify service line material for system-owned and customer-owned sides.
Distribution System Inspections and Records	Systems must review all inspections and records of the distribution system that indicate material composition of the service connections that connect a structure to the distribution system to identify service line materials for the initial inventory (40 CFR §141.84(a)(3)(iii)).	• Identify service line material for system- and customer-owned portions. • Verify construction and water system records.

Type of Historical Records	Regulatory Requirement (citation)	Primary Uses for Inventory Development (Including but not limited to)
State Requirements	Systems must review any resource, information, or identification method provided or required by the state to assess service line materials, to identify service line materials for the initial inventory (40 CFR §141.84(a)(3)(iv)).	• Identify service line material for system- and customer-owned portions.

Note:

[1] Under 40 CFR §141.42, water systems were required to identify and report to their state if certain construction materials were present in their distribution system in the early 1980s (USEPA, 1980). Under the 1991 Lead and Copper Rule (USEPA, 1991a), water systems were required to use this evaluation to identify a pool of targeted sampling sites that meet the tiering criteria for lead and copper tap monitoring and was sufficiently large enough to meet the required number of lead and copper tap samples.

4.1 Previous Materials Evaluation

Under 40 CFR §141.42(d), or special monitoring for corrosivity characteristics, water systems were required to identify if certain construction materials were present in their distribution system that included:

- Lead from piping, solder, caulking, interior lining of distribution mains, alloys, and home plumbing;
- Copper from piping and alloys, service lines, and home plumbing;
- Galvanized piping, service lines, and home plumbing;
- Ferrous piping materials such as cast iron and steel; and
- Asbestos cement pipe.

In addition, there may be additional state requirements for the identification and reporting of other materials. EPA requires systems to use the information they identified on lead and galvanized iron or steel under 40 CFR §141.42(d) when preparing their initial inventory.

In addition to the previous materials evaluation described above, other previous material evaluations can be useful in developing the inventory. Under the 1991 Lead and Copper Rule (LCR) (USEPA, 1991a), water systems were required to complete a materials evaluation of their distribution systems to identify a pool of targeted sampling sites that met the sample site requirements and was sufficiently large to meet the required number of lead and copper tap samples (40 CFR §141.86(a) of the LCR). The LCR also required in 40 CFR §141.86(b) that water systems review:

- Information collected under the pre-LCR materials evaluation under 40 CFR §141.42(d);

- All plumbing codes, permits, and records in the files of the building department(s) that document the plumbing materials installed within publicly- and privately-owned structures connected to the distribution system;
- All inspections and records of the distribution system that indicate the material composition of the service connections that connect a structure to the distribution system; and
- All existing water quality information that includes the results of all prior analyses of the system or individual structures connected to the system, indicating locations that may be particularly susceptible to high lead or copper concentrations.

Also under the LCR, systems subject to lead service line replacement (LSLR) requirements[13] were required to identify the initial number of LSLs in their distribution system, including the portion(s) owned by the system, based on the prior materials evaluations (40 CFR §141.84(b)).

In addition to previous materials evaluations described above, EPA recognizes that systems may have previously reviewed historical records proactively for asset management, pre-LCRR inventory efforts, and LSLR activities. It is important to note that records already reviewed for service line material information need not be reviewed again. EPA recommends that water systems document previous reviews as part of their initial inventory effort, including the date and scope of the reviews.

4.2 Construction and Plumbing Codes and Records

Systems must review all construction and plumbing codes, permits, and existing records or other documentation that indicate the service line materials used to connect structures to the distribution system (40 CFR §141.84(a)(3)(i)). Each of these record types is described below.

Construction and Plumbing Codes

Municipal construction codes (also known as "building codes") and plumbing codes may indicate when the use of lead or lead-containing pipes for potable use applications were prohibited by the code. This information, combined with distribution system and building records, can identify structures that were built after lead bans became effective and would not have LSLs.

The 1986 Safe Drinking Water Act (SDWA) amendments prohibited the use of pipe, solder, and flux that were not "lead free" as defined in 1986 in new installations and repairs[14] and directed

[13] Refer to footnote 3.

[14] In 1986, Congress amended the Safe Drinking Water Act (SDWA) to prohibit the use of pipes, solder, or flux that were not "lead free" in the installation or repair of public water systems or plumbing in residential and non-residential facilities providing water for human consumption. At the time, "lead free" was defined as solder and flux with no more than 0.2 percent lead and pipes with no more than 8 percent. This is often referred to as the 1986 SDWA lead ban.

states, as a condition of receiving grants for the Public Water System Supervision program, to enforce the provision effective 24 months after June 19, 1986, through state or local plumbing codes or other means (42 U.S. Code §300g-6(b)). Some states adopted their own laws before the federal requirement. Thus, water systems should check with their state to determine the appropriate date. See Appendix D for a summary of lead ban provisions by state (USEPA, 1991b).

In addition to information on when LSLs were allowed and banned, municipal construction and plumbing codes can also indicate a maximum diameter of LSLs. Most LSLs are ***2 inches or less*** in diameter and serve primarily single-family homes or small multi-family residences. Larger apartment complexes and commercial and industrial building are typically served by larger diameter service lines. There have been very few cases of installed LSLs as large as 3 inches (LSLR Collaborative, 2021). The service line material verification requirements in Michigan exclude service lines that are 4 inches or more in diameter (Michigan EGLE, 2018).

Most Lead Service Lines are Old!

LSLs were primarily installed from the late 1800s to the 1940s (Hensley et al., 2021). Some communities, however, continued to install them through the 1980s until they were banned at the federal level.

Systems should also review any local ordinances relevant to LSLs. For example, systems may be aware of an ordinance which prohibits reburial of exposed lead pipe in their community. Water systems could compare the ordinance effective date with records of construction projects subject to the ordinance requirements to determine if service line material can be inferred.

Possible locations for construction and plumbing codes include (Liggett, 2021; LSLR Collaborative, 2021):

- Municipal building permit/code enforcement department
- Agency overseeing state plumbing code
- Local governing body (*e.g.*, city or town council)

Other possible locations include city archives, which are often in city public libraries. Additionally, online databases have many historical city codes and reports available online.

States and municipalities often adopt into state or local law national or international building or plumbing codes written by trade organizations. The codes may be adopted into law as written or, they may be modified. In addition to checking with the state on the date they enforced the 1986 lead ban as recommended above, systems may also check with their state or local government for any additional requirements related to adoption of codes. Exhibit 4-2 provides examples of municipal code language and its meaning from Hensley et al., 2021.

Exhibit 4-2: Illustrative excerpts from municipal codes, specifying that lead was allowed or required as pipe material for service lines

TABLE 1 Illustrative excerpts from municipal codes, specifying that lead was allowed or required as pipe material for service lines (Miguel Del Toral, personal communication, July 2018)

Municipal code language	What the code language meant
Water Service...Sec. 23. All water pipes laid underground whether outside or inside the building and of a diameter less than 2 inch. shall be "extra strong" lead pipe	The entire service line was required to be made of lead
Pipe Material. Sec. 17. All service pipe, from the point of union with the main to the service stop inside of curb line shall be of lead, known and designated as "Extra Strong," weighing as follows per lineal foot:	Lead pipe was only required between the water main and the property line
Sec. 14. Pipe, Kind Used, Water Commissioner to Purchase.–Either lead, galvanized or enameled iron service pipes may be used at the option of the applicant. All lead and iron pipes must have sufficient strength to sustain a pressure of not less than 200 pounds to the square inch, and at the point of connection with the street main between the corporation cock and the coupling in the iron service pipe there must be at least 18 inch. of lead pipe to retain rigidity of the iron pipe	The service line could be lead pipe, galvanized iron pipe, or enameled iron pipe. However, a short lead pipe at least 18 inch. long (commonly called a 'lead gooseneck') was required at the connection with the water main
Section 995. Water Connections for Buildings: All pipes leaving the curb cock and used for connecting buildings with the City water system, shall be laid under ground, and at least 18 inch. below the established grade, and shall be of lead or galvanized wrought iron or steel	Lead was not required but was one of the types of pipes allowed
Section 660 A. Materials of Water Pipe and Fittings. All water service and distribution pipes shall be of lead, galvanized wrought iron, galvanized steel, brass, copper, or cast iron with brass, copper, galvanized iron or galvanized or malleable iron fittings	Lead was not required but was one of the types of pipes allowed

Source: Hensley et al., 2021.

Permits

Water system, local government, or local plumbing codes may require plumbers to obtain permits to install or replace service lines. These permits should include the location and the date of installation or replacement and may include information on service line materials. In addition, there may be an inspection record that accompanies the permit.

If permits do not specify service line material, systems may be able to cross-reference the permit with construction practices at the time of replacement. Systems may be able to find these permits at their municipal building department, code enforcement department, or municipal water system (LSLR Collaborative, 2021).

Other relevant permits may include those for general renovation or other plumbing-related building activities. Many jurisdictions require permits and inspections when plumbing is modified for remodeling for renovations or additions.

Other Existing Records and Documentation

In addition to construction and plumbing codes and permits, other records may exist that indicate the service line materials used to connect structures to the distribution system. For example, municipal tax records typically contain the date of building construction, which when cross-

referenced with construction practice information from other sources, could help identify service line materials. Also, the date of building construction can be compared to water main installation records. A newer tap installation date for an older home could mean the service line was partially replaced on the system side. The reverse could also be true – a newer building construction date compared to tap installation date could indicate a partial service line replacement on the customer side. These records may be found at the municipal tax assessor's office or the centralized municipal government geographic information system (GIS) office (LSLR Collaborative, 2021).

Community planning documents and maps may also contain information on the date of construction, which can be useful to identify potential locations of LSLs. These documents may be found at municipal planning departments, regional planning agencies, the public library, or the local historical society (LSLR Collaborative, 2021). Property appraisal records might include the year a structure was built and when it was modified. County or city council meeting minutes may also contain additional relevant records.

4.3 Water System Records

Water system records are a key source of information and are one of the many sources that systems must review to identify service line materials and develop the initial inventory. Systems can use any relevant water system records they may have to develop their inventory, but at minimum must review the water system records listed in 40 CFR §141.84(a)(3)(ii).

Exhibit 4-3 lists the type of water system record that must be reviewed, what the record may contain, and the possible formats of the records. Other possible water system records that could be used to develop the initial inventory include historical water system standard operation procedures (SOPs), water main replacement records, water loss studies, and annual reports. Additional discussion of a key type of record, service line installation records or "tap cards", follows the exhibit.

> *Note when reviewing historical SOPs, systems should review past procedures for connecting a new building and if they allowed connection to an old service line. If allowed, this could indicate that some newer construction could be potentially connected to an LSL.*

Exhibit 4-3: Water System Record Examples and Uses

Type of Water System Record Required under the LCRR[1]	Relative information	Possible Formats
Distribution system map and drawings	Date of construction of different parts of the distribution system may help inform when and where LSLs were used.	Hard copy maps, digital maps, or web-based map applications
Historical records on each service connection	Detailed information on service line material, location, and size.	Ledgers, cards (*e.g.*, tap cards or drill records), or databases
Meter installation records	May contain the service line material. Meter size and/or type can indicate service line size or building usage.	Water system files and records
Historical capital improvement or master plans	Historical installation patterns may help inform when LSLs were used.	Archived report or electronic document
Standard operating procedures	Allowable materials for construction of service lines and for service line repairs.	Specifications and standards used by the water system

Notes:

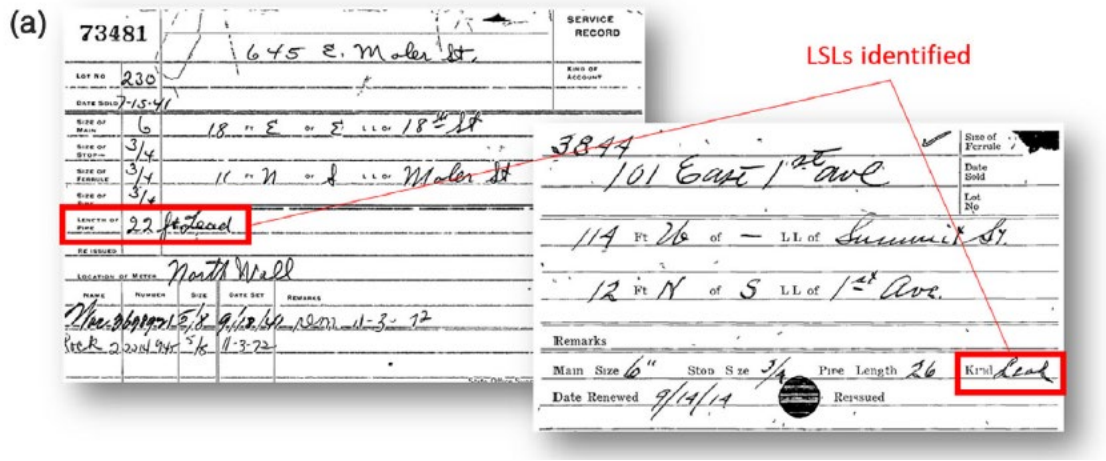
[1]Each type of water system record must be reviewed to develop the initial inventory (40 CFR §141.84(a)(3)).

Historical records on service connection installation may be in the form of ***tap cards*** (also called ***drill records***), which are recorded when a service line is tapped into the water main and connected to an individual home or building. They are often handwritten index cards that contain the installation date, pipe diameter, and pipe material. Exhibit 4-4 provides examples of tap cards specifying lead pipe material. The LSLR Collaborative (LSLR Collaborative, 2021) recommends digitally categorizing tap cards as one of the first steps in building an inventory.

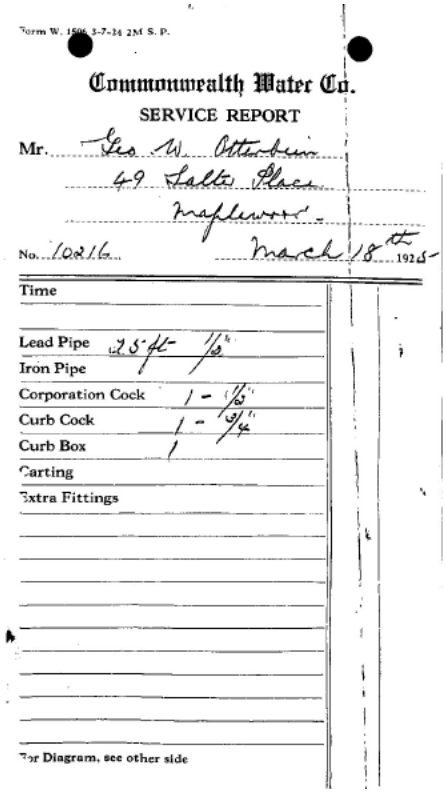
Example: Scanning tap cards as a starting point

In 2017, the Pittsburgh Water and Sewer Authority (PWSA) scanned almost 130,000 paper service record folders and 3,000 microfiche records and created an initial database with the results. PWSA found that many of these records, however, were inaccurate because of maintenance conducted since they were initially installed (Duffy and Pickering, 2021). See Appendix B for the PWSA case study.

Exhibit 4-4: Examples of Tap Cards with Lead Listed as Service Line Material



Source: Hensley et al., 2021



Source: Bukhari et al., 2020, Figure 3-1 from American Water, 2019.

Bukhari et al. (2020) notes that "using tap cards alone can be challenging since information can be inconsistent, unreliable, or altogether absent. For example, there may be situations where a line was repaired or replaced, but the location-specific tap card was never updated." Moreover, tap cards may only contain information on the system-owned portion of the service line (Duffy and Pickering, 2021). It is important to supplement tap card information with service line replacement or repair data; water main installation, rehabilitation, or replacement records; meter installation records; and other field data and investigations.

Example: Meter Installation as an Information Source

The City of Evanston, Illinois, replaced approximately one-third of their meters in 2018. They documented the service material type and inputted the information into their computerized maintenance management system (CMMS) (AWWA, 2021).

4.4 Inspections and Records of the Distribution System

Historical records of inspections might indicate service line materials. Sources of information include responses to customer complaints, inspections to locate leaks, or inspections to investigate meter issues. Cross connection inspections may also provide information on service line material. Systems may store this information electronically, for example, using a computerized maintenance management system (CMMS) (Liggett, 2021).

Water systems have opportunities to directly view the service line materials during a variety of maintenance activities. See Section 3.4 for recommendations for collecting service line material information during normal operations.

Key Points to Remember

LCRR Requirements

- Water systems must use any information on lead and galvanized iron or steel that it has identified pursuant to 40 CFR §141.42(d); review the records explicitly identified in the LCRR; as well as use any additional resource, information, or identification method required by the state to develop the initial inventory (§141.84(a)(3)).

Recommendations (Not Required under the LCRR)

- Water systems should document the records they reviewed as a best practice and include the source of material classification in their inventory.
- Water systems should continue to gather information on service line materials after they have been classified and assess the accuracy of historical records.
- If systems find certain historical records to be unreliable, they should consider reclassifying service line materials that rely solely on those records as "unknown" until additional information can be gathered.
- Water systems should incorporate previous reviews (as required by the LCRR and other reviews done to comply with LCR or other proactive activities) into their initial inventory and document the date and scope of the reviews. Records already reviewed for service line material information do not need to be reviewed again.
- Tap cards are often handwritten index cards that contain the installation date, pipe diameter, and pipe material. The LSLR Collaborative recommends digitizing tap cards as one of the first steps in building an inventory.

Chapter 5: Service Line Investigation Methods

This chapter provides a description of the service line investigation methods that water systems have used to verify historical records and gather information when service line material is unknown. These methods are not required under the Lead and Copper Rule Revisions (LCRR), but rather provide examples for systems to consider. The methods included here are:

- Visual inspection of service line material (Section 5.1)
- Water quality sampling (Section 5.2)
- Excavation (Section 5.3)
- Predictive modeling (Section 5.5)
- Emerging methods (Section 5.6)

Section 5.4 provides a comparison of methods from the literature.

Some of these methods require state approval before use for service line classification, such as water quality sampling, predictive modeling, and emerging methods. Water systems should consider the method(s) that are best suited to their particular distribution system and community, considering state approval, cost, labor skill requirements, disruption to consumers, overall time, and accuracy. Water systems should be aware of identification methods provided or required by their state under the LCRR (40 CFR §141.84(a)(3)(iv)). If a water system chooses an investigation method not specified by the state under 40 CFR §141.84(a)(3)(iv), state approval is required (40 CFR §141.84(a)(3)). States may want to consider identifying approved methods that can be used by any system in their state to classify service lines. States could approve different methods for classifying lead, galvanized requiring replacement (GRR), and non-lead. This chapter provides states with information they can use to make their approval decisions. Note that service line investigation methods are evolving; states may wish to revisit approval decisions in the future based on new research or other information.

As noted previously in this guidance, EPA recommends that systems consider including the sources of the material classification (*e.g.*, excavation or visual inspection by customer) in their inventory. In some cases, systems may replace lead service lines (LSLs) when they find them in the field during investigations. EPA recommends systems document where there was an LSL, as recording lead service line replacement (LSLR) activities may be useful for systems to track and demonstrate the LSLR rate achieved.

5.1 Visual Inspection of Service Line Material

The material composition of a service line can be identified through visual inspection. Exhibit 5-1 provides a comparison of common service line materials:

- Plastic is a smooth pipe of various colors (*e.g.*, white, blue, black, and green).

- Lead is a soft metal that is a dull, silver-gray color. It is easily scratched with a coin or key, and the scratched areas will be shiny. It is non-magnetic, meaning a magnet will not stick to it. Lead pipe is commonly attached to other pipe with a “wiped” joint.
- Copper is the color of a penny.
- Galvanized is a dull, silver-gray color that is difficult to scratch. It is magnetic, meaning a magnet will stick to it.

Exhibit 5-1: Examples of Commonly Found Pipe Materials

Source: https://www.epa.gov/ground-water-and-drinking-water/protect-your-tap-quick-check-lead-0.

Lead can also be distinguished from other materials by a “wiped” joint, which is a rounded ball of lead that connects the lead pipe to other materials. See Exhibit 5-2 for a picture of a wipe joint on an LSL.

Exhibit 5-2: Example of Wiped Lead Joint

Source: https://www.skokie.org/766/Lead-Water-Line-Information

The remainder of this section describes service line materials identification approaches through visual inspection without excavation. See Section 5.3 for a description of excavation techniques.

5.1.1 Visual Inspection of Service Line by Customers

Many utilities have enlisted the public's help to identify the material of the customer-owned portion of the service line. The service line may be visible where it comes into the building, such as in the basement where it connects to the water meter and/or premise plumbing. Exhibit 5-3 shows the possible location of the visible portion of the line connected to the water meter. Note that incoming service lines may have different configurations, which can make it difficult for customers to locate the service line entering the home. DC Water has created a video to assist customers, advising them to locate the meter pit in the yard to estimate where the service line enters the building.[15] Systems may wish to provide guidance on typical configurations to assist customers in finding their water service lines.

[15] https://www.dcwater.com/do-you-have-lead-pipes-let-us-help-you-find-out.

Exhibit 5-3: Example of Location of Exposed Service Line in Basement

Source: Philadelphia Water System. https://water.phila.gov/pool/files/how-to-check-your-service-line-for-lead.pdf. Accessed December 20, 2021. Right edge of image represents basement wall in contact with soil.

After locating the service line, the customer can visually inspect the pipe. A common approach to determine pipe material is a ***scratch and magnet test***. If the pipe is a silver metallic color, the customer can carefully scratch the pipe with a key or coin. It is important to not use a sharp object that could puncture the pipe. If the pipe is soft, scratches easily, and reveals a shiny silver color, the pipe is likely lead. The customer can use a magnet to confirm the material since magnets will only react to steel and will not stick to lead (Hensley et al., 2021). Customers can also look for a wiped joint as shown in Exhibit 5-2 that can be an indicator of an LSL. Systems may want to suggest that customers wear gloves when performing a scratch test and cleaning up debris.

In addition to the scratch and magnet test, lead paint test kits can be used to test the pipe for lead (Hensley et al., 2021; LSLR Collaborative, 2021). Surface swab kits approved by EPA for lead paint will change color after coming in contact with a lead surface. A list of approved test kits are available on EPA's website (https://www.epa.gov/lead/lead-test-kits). Care should be taken in interpreting results because the kits can react to lead paint if the pipe is painted.

EPA developed the online step-by-step guide "Protect Your Tap: A Quick Check for Lead" [16] to help people identify LSLs in their homes. It also provides tips on actions to reduce lead exposure in drinking water, information on certified laboratories for water testing, and other resources. The guide is for everyone, and EPA has provided Protect Your Tap outreach toolkits for community groups, government and health organizations, and water utilities. The guide is also available in Spanish. To access this information and the online guide, refer to EPA's website at https://www.epa.gov/ground-water-and-drinking-water/protect-your-tap-quick-check-lead.

Examples of instructions for identifying service line materials prepared by the Philadelphia Water Department; Rockford, Illinois; and Newark, New Jersey, are provided in Appendix C. The independent, non-profit media organization National Public Radio (NPR) has also developed an interactive tool available on their website[17] that instructs customers on how to determine if their service line is lead. Other innovative examples of systems that enlist the customer to self-identify their portion of the service line include:

- **Greater Cincinnati Water Works (GCWW), Ohio,** provides instructions for the scratch test on their website[18], along with a fillable form asking for name, email, return phone number, and property address. Customers can select copper, lead, or other from a dropdown menu to specify their service line material. The website asks users to "please upload a picture of your meter setting that we can use to help identify the pipe material."
- **The City of Grand Rapids, Michigan,** has used free video conferencing software to guide homeowners through the verification process. This approach worked especially well during the COVID pandemic, when customers were reluctant to let others into their homes and could be replicated for harder-to-reach customers who are more comfortable with a video call than letting system personnel enter their homes (USEPA, 2021e).
- **Madison, Wisconsin,** distributed customer surveys to residents in 2000, asking them to perform scratch tests on their exposed portion of service lines in their homes (Bukhari et al., 2020). During that time, the City of Madison held meetings to teach customers how to perform scratch tests. Madison Water Utility still provides instructions on how to

[16] https://www.epa.gov/ground-water-and-drinking-water/protect-your-tap-quick-check-lead#:~:text=Protect%20Your%20Tap%20Outreach%20Toolkits%20%20%20,Article%20%28Utilities%29%20%28docx%29%20%206%20more%20rows%20. Accessed December 17, 2021.
[17] https://apps.npr.org/find-lead-pipes-in-your-home/. Accessed December 15, 2021.
[18] https://la.mygcww.org/do-i-have-a-lead-service-line/. Accessed December 8, 2021.

perform scratch tests on their website[19], along with a number and email to contact if an LSL is discovered.

Water systems can also use community surveys to enlist residences to self-identify service line material (see above for Madison, Wisconsin). Outreach and education can improve the quality of the survey results (Hensley et al., 2021). Systems can also offer financial assistance for customer-side LSLR as an incentive to inspect their service line. The Association of State Drinking Water Administrators (ASDWA) (2022) recommends that systems consider providing incentives for service line identification such as credits on water bills or gift cards.

EPA recommends that systems ask customers to ***submit a photograph*** of their service line entering the home to the utility to increase confidence in the customer's response and additional visual verification by the water system. Hensley et al. (2021) notes that even with outreach and education, service line material information from residents may be inaccurate and a water system's confidence could be increased with an additional verification step (such as reviewing a customer-submitted photograph of the service line) by the water system staff, a licensed plumber, or other trained personnel. Note that the system's data management structure may need to be revised in order to accept and organize uploaded photos. Partnerships with plumbers and other third parties, such as building inspectors, can facilitate visual inspection and service material identification (see Section 3.5 for recommendations on establishing partnerships).

Note that some water systems elicit customer assistance by requesting access to the customer's home for verification rather than asking the customer to perform visual inspection themselves. For example, the City of Menasha Utilities Electric & Water in Wisconsin sends postcards to residents where the customer-owned portion of the service line material has not been verified. The postcard includes water system contact information to schedule a free service line material inspection by the water system. Those accepting the system's offer receive follow-up information on what the customer can expect during the inspection process, and reminders (see Appendix C for a copy of the postcard and water service inspection information). Inspection by the system or other trained personnel, or asking the customer to submit a photo along with their identification, can increase the degree of confidence the system has in the service line's material classification. Water systems could also determine if existing ordinances already give them access rights to the inside of the home for inspections and/or maintenance, including inspection of the service line material.

[19] https://www.cityofmadison.com/water/water-quality/lead-service-replacement-program/lead-in-water-what-you-should-know. Accessed December 20, 2021.

5.1.2 CCTV Inspection by the Water System

This section describes visual inspection using closed-circuit television (CCTV). Note that visual inspection by the water system during normal operations is discussed in Section 3.4.

CCTV has been used widely by the wastewater industry to inspect the interior of gravity sewer lines. Recently, probe or insertion style CCTV cameras have been used by water utilities to visually inspect service line material. CCTV inspections usually fall into one of two categories: 1) inspection of the interior of the service pipe of the service line or 2) inspection of the exterior (Bukhari et al., 2020).

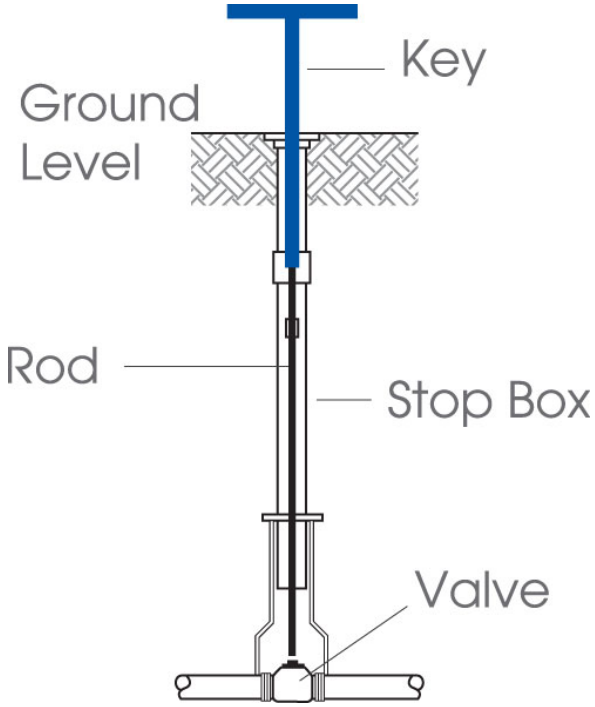
External CCTV Inspection

External inspections involve inserting the CCTV camera into the curb box to view the outside of the pipe on either side of the shutoff valve. As previously shown in Exhibit 2-2, a curb stop could be flanked with the system-owned portion and customer-owned portion on either side. Bukhari et al. (2020) notes the following about curb box configurations:

> "There are a variety of curb box styles on the market, but in cold climates, they usually consist of a telescoping pipe that extends vertically from the ground surface down to the shut-off valve, which is typically situated 3 to 5 feet below grade. In warmer climates, curb stop boxes may be larger plastic or fiberglass enclosures buried at shallower depths. The bottom of the curb box is frequently arched, so the service line passes through the arch without the valve box resting on the line itself."

Exhibit 5-4 shows an example schematic of a curb or stop box with a telescoping pipe from Des Moines Water Works.

Exhibit 5-4: Example Stop Box Schematic from Des Moines Water Works, Iowa



Source: Des Moines Water Works, IA (https://www.dmww.com/water_service/service_lines/index.php). Accessed December 20, 2021.

A small diameter CCTV camera can be inserted into the curb box to visually inspect the exterior of the service line connected at each side of the valve. A bulb-shaped "wiped joint" connection to the curb stop indicates an LSL. It is often necessary to first vacuum soil and debris out of the curb box before inspection (Bukhari et al., 2020). Exhibit 5-5 shows a picture of a lead pipe that was excavated and previously connected to a curb stop (LSLR Collaborative, 2021). Exhibit 5-6 shows example pictures from CCTV inspection in Pittsburgh, Pennsylvania, showing an LSL, a non-LSL, and a service line that is not identifiable. Water systems using this method should use it first on known LSLs and other service lines of known materials to determine the visual elements that allow them to differentiate among the pipe materials.

Exhibit 5-5: Lead Pipe at a Curb Stop

Source: LSLR Collaborative, 2021 from Philadelphia Water Department, PA

Exhibit 5-6: Examples CCTV Camera Pictures for LSL, non-LSL, and Unable to Determine

Source: Baribeau, 2021

In 2018, the Pittsburgh Water and Sewer Authority (PWSA), Pennsylvania, implemented a curb box inspection program and inspected approximately 45,000 locations. They found that there were no usable data for approximately 75 percent of the locations for the following reasons (Duffy and Pickering, 2021):

- Problems with locating the curb box,
- An inability to access the curb box because the box was damaged or misaligned,
- Degradation of the line, and/or
- Lack of clarity of the photograph.

Results were very accurate when an LSL was identified (PWSA confirmed 97 percent of LSLs identified through curb box inspections via excavation). However, lead was found at approximately 35 percent of locations where the curb box inspection indicated a non-LSL. Duffy and Pickering (2021) explain that, in some locations, this happened because the curb box and a

small portion of the service line were replaced but the remainder of the service line was still lead (see PWSA case study in Appendix B for more information). For these reasons, PWSA no longer uses curb box inspections "to verify the presence of non-lead" (Bolenbaugh, 2022, personal communication). EPA recommends that water systems using this method consider conducting a pilot study at a subset of sites to determine its accuracy, possibly supplementing determinations of non-LSLs with additional evidence prior to expanding its use to the entire distribution system.

Internal CCTV Inspection

Some water systems have used high-resolution cameras equipped with a flexible, fiber optic scope and a light source to inspect the service line material from inside the pipe (Bukhari et al., 2020). Tucson Water, Arizona, and Green Bay, Wisconsin, used internal CCTV inspections after shutting off water service and disconnecting the water meter located inside the curb box. A benefit of this technology is that a greater length of the service line can be visually inspected. However, the drawbacks are that the method is ineffective when the line is coated with corrosion scale and the method itself can cause disturbance to the pipe (Bukhari et al., 2020; Hensley et al., 2021). Hensley et al. (2021) recommend measures be taken to reduce scale disturbances and lead release when using this method. For example, the LSLR Collaborative has guidance on alerting customers to potential disturbances of LSLs.[20] The LSLR Collaborative also has guidance on actions customers can take to reduce lead exposure after a replacement or disturbance.[21] Systems could also consider immediately replacing service lines identified as LSLs where possible.

5.2 Water Quality Sampling

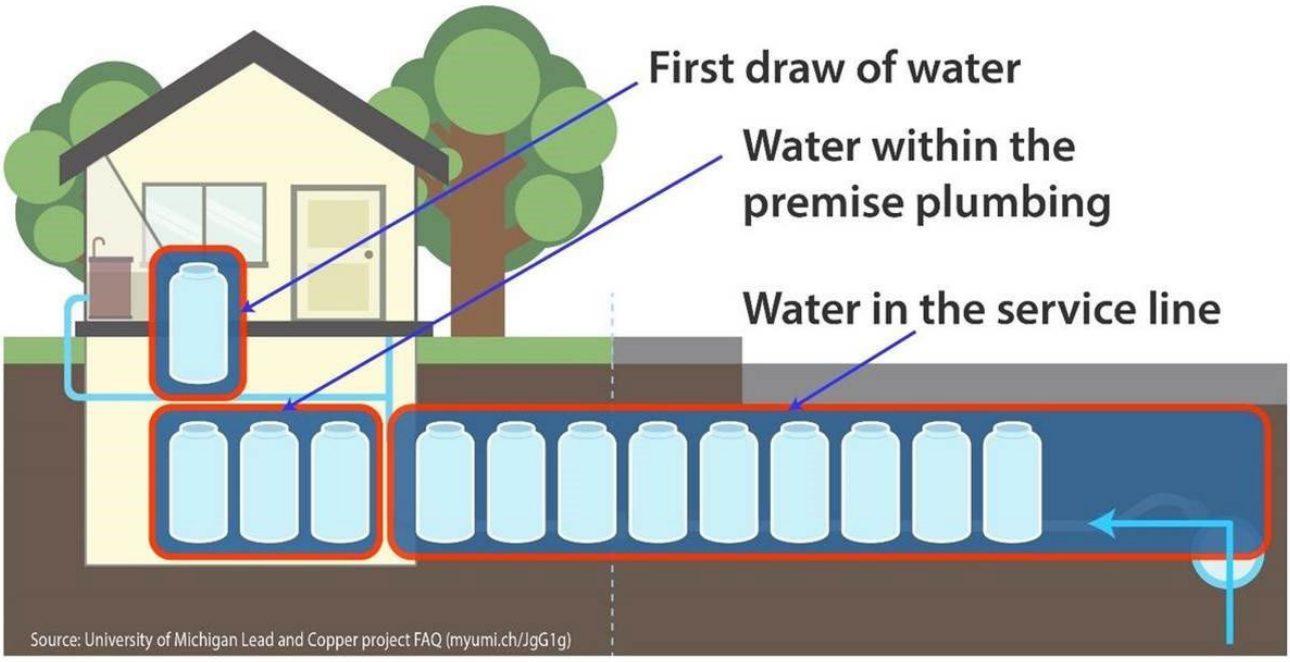
Water quality sampling protocols have been used by water systems to detect the presence of LSLs. Three sampling protocols are described in Hensley et al. (2021), each with varying degrees of cost, complexity, accuracy, and customer cooperation required:

- **Targeted service line sampling** involves flushing out the volume of water in the premise plumbing and collecting and analyzing a sample from the service line. The volume of water from the tap to the service line can be estimated based on pipe diameters and lengths. Cartier et al., 2012 (as cited in Hensley et al., 2021) found that based on typical premise plumbing volumes in Montreal, Quebec, a lead concentration threshold of 3 micrograms per liter (µg/L) in the second liter after 15 minutes of stagnation was indicative of an LSL.
- **Flushed sampling** involves collecting a sample from the customer's tap after a set flushing time. For example, flushing for five minutes could result in a sufficient difference in lead levels to distinguish LSL sites from non-LSL sites (Cartier et al., 2012; Deshommes et al., 2016). This method is simple and can be done as an initial screening.

[20] https://www.lslr-collaborative.org/disturbing-lead-service-lines.html.
[21] https://www.lslr-collaborative.org/techniques-to-control-lead-exposure-from-lsl-replacement.html.

- **Sequential sampling** uses series of consecutive samples (typically 500 mL to 1 L) collected from an interior tap after a stagnation period (typically 6 hours or more). The number of samples needed depends on the length and diameter of the plumbing from the tap through the length of the premise plumbing and service line, but it is commonly between 8 and 15 liters (Hensley et al., 2021). See Exhibit 5-7 for an example of sequential sampling. Although sequential sampling can be a sensitive tool for identifying LSLs, it is relatively invasive to the resident and more complex than other water quality sampling methods (Schock et al., 2021; Hensley et al., 2021).

Exhibit 5-7: Example of Sequential Sampling



Note: The number of bottles for each part of the plumbing system and service line is site-specific.

It is important to note that water quality sampling is a more appropriate screen for the presence of LSLs since low and non-detect lead levels may not reliably detect the absence of LSLs (Hensley et al., 2021). The key to using water quality sampling for identifying LSLs is establishing a ***community-specific threshold*** above an indicator for the possible presence of an LSL. Examples of water systems using water sampling protocols and thresholds to screen for LSLs include:

- **Denver Water** (Denver, CO), which uses pH adjustment for corrosion control, uses a subset of three samples to assess if a location has an LSL: a first draw, a second draw after a 30-second flush, and a third draw after another 30-second flush. If the average lead concentration is 5 µg/L or greater, they consider it an LSL (Denver Water, 2019, cited in Hensley et al., 2021).

- **DC Water** (Washington, DC), which uses orthophosphate for corrosion control, conducts sequential sampling and uses a screening value of 5 µg total lead mass in ten 1-liter sequential samples (Schmelling, 2019, cited in Hensley et al., 2021; Bukhari et al., 2020).
- **Three Canadian utilities** (Montreal, Quebec; Guelph, Ontario; and Ottawa, Ontario) use either targeted service line sampling or flushed sampling protocols and thresholds of 1 to 5 µg/L to screen for LSLs (Schock et al., 2021).

A study by Schock et al. (2021) investigated the reliability of using the flushed sampling protocol and the sequential sampling protocol at two communities with varying levels of corrosion control. They were able to establish community-specific threshold levels to identify LSL sites based on the maximum flushed sample lead concentration and the weighted average sequential profile lead concentration. The authors recommend a four-step sampling approach for identifying LSLs as follows:

(1) Establish baseline threshold lead concentrations for fully flushed and sequential samples from homes that have never had LSLs.

(2) Collect fully flushed and sequential samples from homes with LSLs.

(3) Collect fully flushed samples from homes with unknown service line materials suspected to be lead (*i.e.*, unknown, likely lead).

(4) Collect sequential samples from the same homes in step 3 if fully flushed samples do not clearly indicate the presence of an LSL.

Researchers found this combination of sampling to be robust in predicting the presence of LSLs under different corrosion control and household plumbing scenarios (Schock et al., 2021).

5.3 Excavation

If a service line is not accessible for visual inspection, the water system may need to excavate soil, and potentially remove portions of the road, sidewalk, or other obstacles to determine service line materials. Excavation methods require different levels of disturbance, time investment, and cost as well as coordination with the property owner. This section discusses two approaches: mechanical excavation and vacuum excavation, which are described in Sections 5.3.1 and 5.3.2, respectively.

5.3.1 Mechanical Excavation

Example of a Mechanical Excavation
Source: Duffy and Pickering, 2021

Mechanical excavation involves using a backhoe or other mechanical excavator to dig a "pothole" or test pit to expose the service line (Hensley et al. 2021). This is typically done at the curb box or shutoff valve. A full trench can also be dug, exposing the entire length of the service line. Digging a full trench can have a higher accuracy than methods that only expose sections of the service line because it typically exposes a longer length of the service line, up to 10 feet in some situations (Weaver, 2018). However, it is labor- and time-intensive, and it is more likely to result in disturbance or damage to the yard, service lines, and nearby infrastructure (Katerndahl & Bizal, 2003; Lewis et al., 2017 (as cited in Hensley et al., 2021)). Disturbances to LSLs can cause elevated lead levels in drinking water (Del Toral et al., 2013). If an LSL is found during trench excavation which unearths the entire service line, EPA recommends replacing it right away given the efficiency gained by conducting an LSLR under such circumstances. If an LSL or GRR is disturbed during the excavation, EPA recommends alerting the customer that such disturbance can potentially cause temporarily elevated lead levels in drinking water and providing them with information about how to reduce lead levels, such as flushing.

This risk may be mitigated by using a handheld shovel in combination with machinery for delicate work. Further, this method of identification can be costly for utilities and residents as some non-LSLs may be dug up and reburied and the site restored (*e.g.*, paving and landscape restoration). See the PWSA case study in Appendix B.

5.3.2 Vacuum Excavation

Example of Vacuum Excavation.
Source: Hensley et al., 2021

Vacuum excavation[22] involves using a water jet or compressed air to loosen soil, which is vacuumed up resulting in a small hole to access the service line. This method is faster, less intrusive, less likely to disrupt or damage the service line or other buried utilities, and cheaper than mechanical excavation (Abernethy et al., 2018; Feick, 2018; Kuhl, 2018; Oswald, 2018; Zahra, 2019, as cited in Hensley et al., 2021; Bukhari et al., 2020).

Excavation can be done at the curb box to access sections of the customer-owned and system-owned portions of the service line and might be within the water system's authority to conduct without customer approval, though EPA encourages prior notification to the resident. However, due to the size of the inspection hole, there is a risk of missing an LSL segment in a service line, such as when a service line is partially replaced (Kuhl, 2018, as cited in Hensley et al., 2019; Bukhari et al., 2020). This can be mitigated by conducting vacuum excavation at multiple points along the service line or by combining vacuum excavation with another identification method, such as visual inspection where the service line enters a building. If an LSL or GRR is disturbed during the excavation, EPA recommends alerting the customer that such disturbance can potentially cause temporarily elevated lead levels in drinking water and providing them with information about how to reduce lead levels, such as flushing.

5.4 Pros and Cons of Field Investigation Methods (Hensley et al., 2021)

Hensley et al. (2021) provides a comparison table of service line investigation methods that is shown as Exhibit 5-8 and includes visual observation, water quality sampling, and excavation methods. This table can be used by systems to help select service line identification methods that are best suited to their particular distribution system and community. Note that the first row is community records review, which are required under the LCRR.

[22] This technique is also referred to as "hydro-excavation" when water is used instead of air (Bukhari et al., 2020).

Rankings for each service line investigation method are based on cost, skill (labor and technical interpretation), disruption to the customer (water service interruption, property damage, and involvement), disturbance (service line and traffic flow), overall time, and accuracy.

Exhibit 5-8 was developed using feedback from three anonymous water utilities and is included as a guide. Experiences of other utilities may differ. Thus, the effectiveness of the approaches should be validated by the water system.

Exhibit 5-8: Comparison of Service Line Identification Techniques (Hensley et al., 2021)

	Utility cost			Disturbance		Impact on resident			Utility skills required		Overall	
LSL ID method	Financial	Onsite time	Pre-/ post-time	Service line	Traffic flow	Water service disruption	Property damage	Resident involvement (includes pre-/post-time)	Technical interpretation	Labor	Time	Accuracy
Community records review	L or M (if digitized)	NA	M to H (L if digitized)	None	None	None	None	None	L to M	None	M	L to H
Basic/visual observations (on private side)	L	L	L to M	None	None	None	None	L	L	L	L	M to H
Water quality sampling—flushed	L	L	M to H	None	None	None	None	L	M	L	M	L to M
Water quality sampling—sequential	M	L	M to H	None	None	M	None	M to H	M	L to M	M	L to H
Water quality sampling—targeted	L	L	M to H	None	None	M	None	M to H	M	L to M	M	M
Excavation—mechanical	H	H	M to H	H	M to H	H	H	L	L to M	H	H	H
Excavation—vacuum	M to H	L to M	M to H	M	L to M	M to H	M to H	L	M	M to H	M	M to H

Source: Table 2: Relative pros and cons of lead service line identification methods using a ranking system of H: high, M: medium, and L: low (Hensley et al., 2021).

Note: This table does not include CCTV investigations in the evaluation of the basic/visual observation method.

5.5 Predictive Modeling

Predictive models look for patterns in a dataset to develop rules or algorithms. Geostatistical models use attributes from known locations to make inferences about areas of unknown condition. Examples of model inputs may include water system or community data, such as the distribution of known materials, along with other factors, such as building age and location. These models are typically built using an initial dataset and can be continually "trained" or improved as more data are added (Muylwyk, 2020).

Geostatistical models have been used by water systems to estimate the probability that a service line is lead, prioritizing areas for service line investigations and expediting LSLR (Abernathy et al., 2018; Muylwyk, 2020; Bukhari et al., 2020; Hensley et al., 2021). These models can be enhanced by incorporating machine learning algorithms in which the model improves itself as new data are added. Information on sensitive subpopulations and socioeconomic factors can be added as layers to enhance planning and prioritization of LSLR (Muylwyk, 2020).

The literature provides successful examples of geostatistical and machine learning modeling in Flint, Michigan, and Denver, Colorado (Abernathy et al., 2018; Muylwyk 2020; Walker 2020). Detroit, Michigan, is also using these models to inform their service line investigation and LSLR programs.[23] A key factor in the success of predictive modeling is the use of representative data. Using a representative set of known data on service line material is important in maximizing accuracy and reliability and minimizing bias.

For more information and examples of how predictive modeling has been used in Flint, Michigan, and Denver, Colorado, systems and states can refer to the 2020 ASDWA webinar, "Predictive Tools for Lead Service Line Inventories" (ASDWA, 2020).

5.6 Emerging Methods

Service line material identification technology is the subject of ongoing research. A review of emerging methods is provided in Hensley et al. (2021) and Bukhari et al. (2020). A central theme of these techniques is identifying creative ways to isolate the service line material and location based on physical signatures of the pipe, largely by assessing how service line materials respond to stimuli such as electrical or wave energy and pairing that information with documented characteristics of potential service lines in the evaluation area. Many of these emerging methods apply the basic tenets of subsurface material identification from a different discipline. In many cases, general information about service line materials in the area is required to inform data collected in the field. For example, ground-penetrating radar (GPR) can accurately detect service line location and diameter; however, it lacks the ability to discern service line material. Local knowledge of lead pipe diameter versus diameters of other pipe materials allows GPR to

[23] Detroit will use predictive modeling to find its 80,000 lead service lines (detroitnews.com).

potentially function as a service line inventory technique by linking the detected diameter of the pipe with the corresponding service line material for that diameter (Deb et al., 1995; Bukhari et al., 2020). Other examples of emerging technologies include electrical resistance testing and stress wave propagation.

Application of these emerging technologies can be limited by signal interferences, caused by the presence of other pipe materials and subsurface environments, and the development of signal processing algorithms. Hensley et al. (2021) notes that emerging methods have "technical basis but limited research or field implementation to demonstrate their effectiveness."

Key Points to Remember

LCRR Requirements

- Water systems should be aware of identification methods provided or required by their state under the LCRR (40 CFR §141.84(a)(3)(iv)).

Recommendations (Not Required under the LCRR)

- Service line investigation methods can be used to verify historical records and gather information when service line material is unknown.
- Investigative methods include visual observation, water quality sampling, and excavation.
- Many systems have enlisted the public's help in visually identifying service line material where the service line enters the building.
- Water quality sampling has been used to identify the presence of LSLs. There are several approaches in the literature – including to establish a system-specific threshold above which may indicate the presence of an LSL.
- Some water systems have found water quality sampling and CCTV to be reliable in positively identifying LSLs but not in confirming the absence of LSLs.
- Mechanical and vacuum excavation can be used to visually inspect service line material. Mechanical inspection can be more accurate than vacuum excavation if it exposes a larger length of service line but is often more expensive and likely to disturb or damage service lines and nearby infrastructure.
- Predictive models have been used to estimate the probability that a service line is lead, prioritize areas for service line investigations, and to expedite LSLR.
- Water systems should select the method(s) that are best suited to their particular distribution system and community, considering cost, labor skill requirements, disruption to homeowners, overall time, and accuracy.

Chapter 6: Developing and Updating the Inventory

This chapter provides guidance on preparing the initial inventory under the Lead and Copper Rule Revisions (LCRR) and improving it over time. This section is organized as follows:

- Section 6.1 provides requirements and recommendations for developing the initial inventory.
- Section 6.2 provides recommendations for prioritizing service line investigations.
- Section 6.3 includes requirements and recommendations specific to systems with only non-lead service lines.
- Section 6.4 includes guidelines for submitting the initial inventory to the state.
- Section 6.5 presents requirements for notifying customer of known or potential lead sources in their service lines.
- Section 6.6 provides requirements and guidance for updating the inventory.
- Section 6.7 provides recommendations for state review of the initial inventory.

6.1 Developing the Initial Inventory

6.1.1 Required under the LCRR

Systems should review Chapters 1 through 4 for a complete listing of initial inventory requirements under the LCRR. Key requirements systems should keep in mind as they prepare an initial inventory include:

- The initial inventory must include all service lines regardless of ownership (40 CFR §141.84(a)(2)).
- The initial service line inventory must use historical records as described in Chapter 4 (40 CFR §141.84(a)(3)(i)-(iii)), information gathered during normal operations as described in Section 3.4, and any resource, information, or identification method provided by or required by the state (40 CFR §141.84(a)(3)(iv) and (a)(5)).
- Non-lead must be determined not to be lead or galvanized requiring replacement (GRR) through an evidence-based record, method, or technique (40 CFR §141.84(a)(4)(iii)).
- If the water system is unable to demonstrate that the galvanized service line was never downstream of a lead service line (LSL), it must presume there was an upstream LSL and classify it as GRR (40 CFR §141.84(a)(4)(ii)).

6.1.2 Recommendations (Not Required under the LCRR)

EPA recommends that systems create an initial inventory that is as thorough as possible. Doing so would minimize the number of unknowns and benefit water systems and customers by:

- Potentially reducing the number of field investigations conducted by water systems to identify unknowns.
- Providing service line material information more quickly to customers, thereby allowing them to take steps to minimize their lead exposure, including replacing their LSLs and GRR.
- Facilitating access to the current funding available for lead service line replacement (LSLR) activities, allowing for systems to demonstrate the need and scope of LSLR projects.

> *EPA recommends that systems track the sources of the material classification (e.g., specific historical record, visual inspection, records and inspection) in their inventory.*

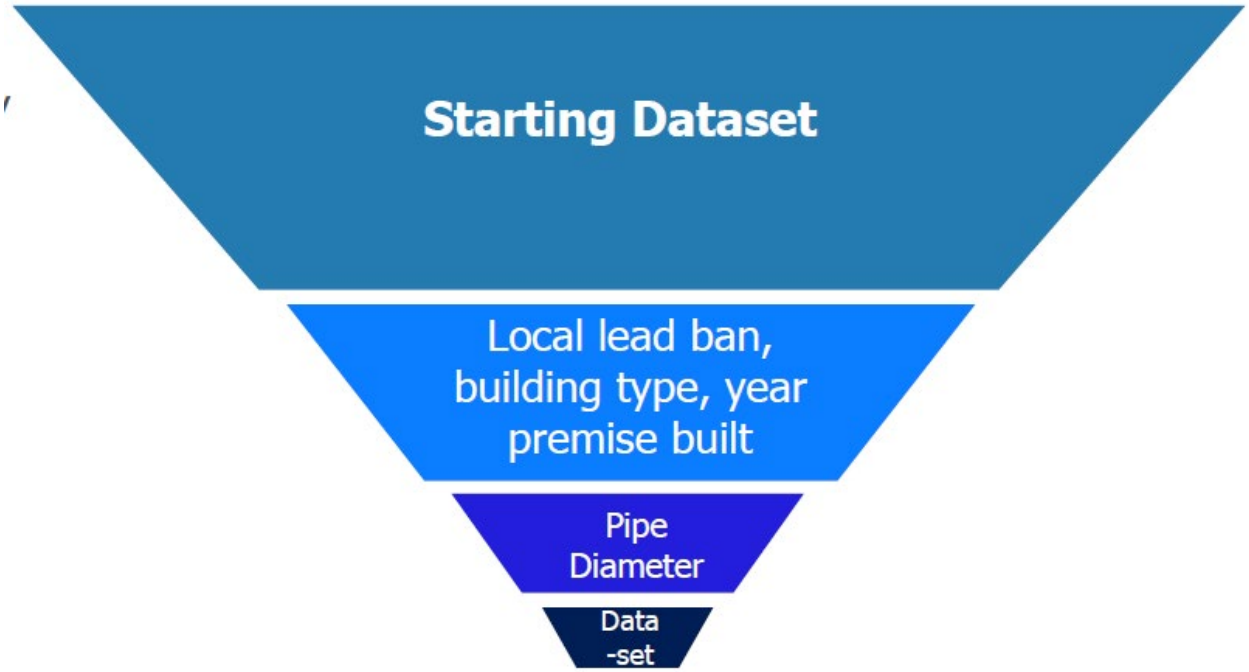
EPA recommends that systems check their inventory for completeness by comparing the total number of service lines to the number of service connections in their system. Additional recommendations for reviewing historical records, demonstrating that a galvanized pipe is not GRR, and conducting service line investigations are discussed below.

Approaches to Historical Records Review

When starting their review of historical records, systems may want to refer to an approach from the literature. Remember that no matter the approach, systems must review all historical records as listed in the LCRR and laid out in detail in Chapter 4. Example approaches include:

- **Initial Screening Process (Liggett et al., 2022):** Exhibit 6-1 shows a possible approach from Liggett (2021) to screen service lines using historical records. The starting dataset at the top of the diagram represents all service lines. Non-lead service lines can be screened out based on lead ban and construction records (*i.e.*, service lines constructed after the 1986 Safe Drinking Water Act lead ban became effective are unlikely to have an LSL). That dataset is then further reduced by screening out non-lead lines based on size, such as a maximum diameter of lead pipe that was manufactured or installed. The dataset in black represents the remaining number of service lines that could potentially be lead or GRR. See Chapter 4 for information and guidance on reviewing these types of historical records. EPA recommends that systems track pipe diameter and installation date in their inventories and document the municipal and plumbing codes and construction records used to make determinations under this approach.

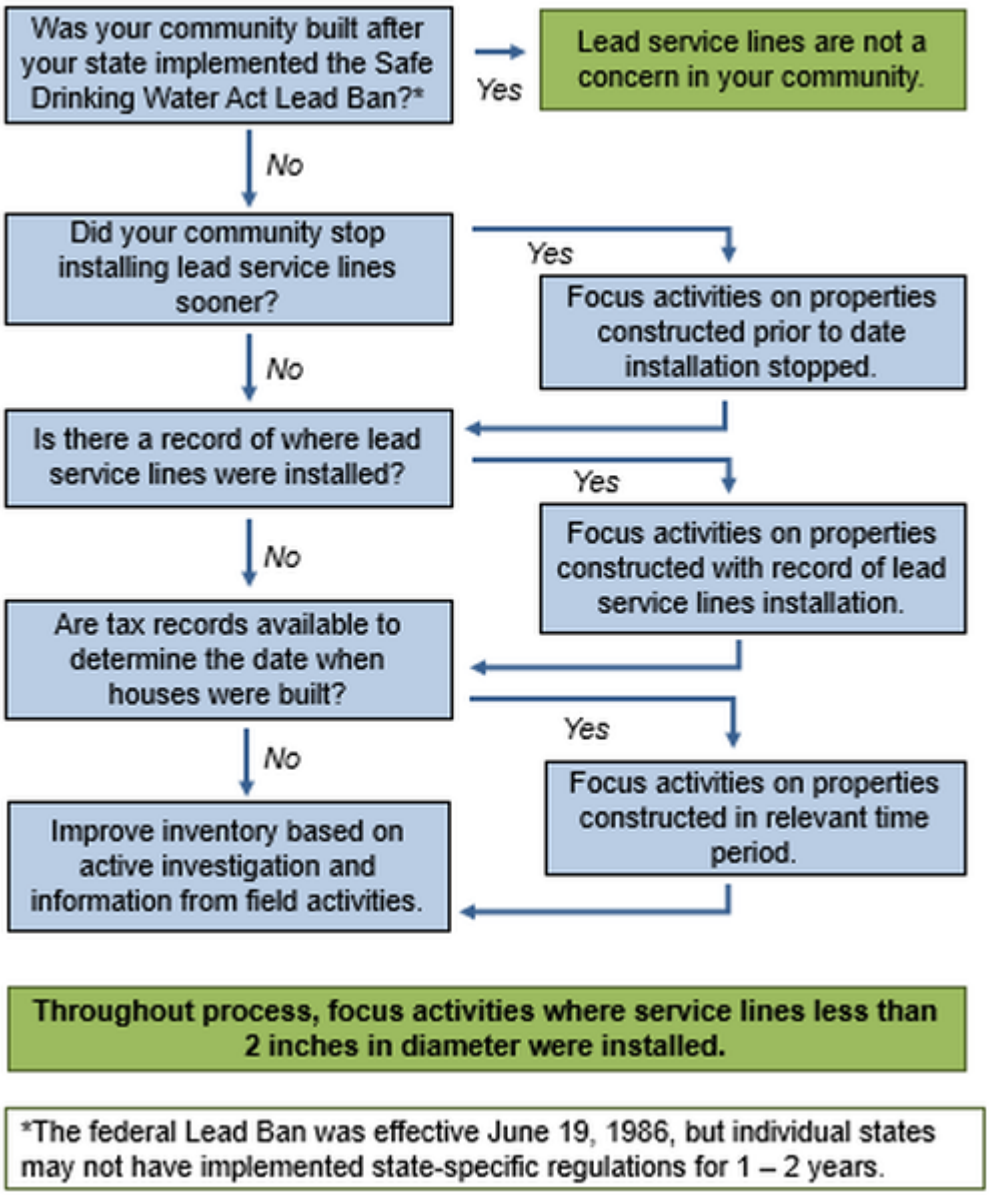
Exhibit 6-1: Service Material Screening Process Based on Records



Source: Liggett, 2021 (April 2021 webinar slides)

- **Asking Key Questions (LSLR Collaborative, 2022):** The Lead Service Line Replacement (LSLR) Collaborative provides a flowchart with key questions on their website titled, "Preparing an Inventory: Where Do We Start?" The flowchart is included here as Exhibit 6-2. It outlines key questions to ask when starting the process of preparing an initial inventory and points the reader to available sources. Liggett et al. (2022) notes that several of the water systems interviewed for case studies found this resource to be a beneficial starting point. Similar to the initial screening approach above, EPA recommends that systems document the municipal and plumbing codes and construction records used to make their determinations under this approach.

Exhibit 6-2: LSLR Collaborative Flow Chart



Source: LSLR Collaborative website: Preparing an Inventory: Where do we Start? - LSLR Collaborative (lslr-collaborative.org). Accessed April 25, 2022.

- **Weight-of-Evidence Approach:** DC Water uses a weight-of-evidence approach to evaluate multiple historical records and field information to classify service line materials (Schmelling, 2021). A weight-of-evidence approach involves compiling all data indicating an individual service line's material composition and assessing the system's confidence in each record and investigative technique in order to classify a service line's material for the inventory. Corroboration of historical records by another method makes a strong

case for any service line classification. However, some water systems have reported finding conflicting records. EPA recommends using a conservative approach whereby service lines with unresolved conflicts in records and field information are assigned as unknown (or lead, where one or more data sources indicate that lead is present) until they can be resolved.

Demonstrating a Galvanized Service Line is Non-lead

Under the initial inventory requirements of the LCRR, if a system can demonstrate with an evidence-based record that a galvanized service line was never downstream of an LSL, it may be considered non-lead for inventory classification. Some examples of evidence to support a demonstration that a service line is not a GRR could include:

- An original tap card from installation showing the material is not lead.
- The date lead was banned or not used. Service lines installed after that date would be non-lead.
- Construction practices showing uniform pipe material was installed (*e.g.*, galvanized steel was used for the entire service line).
- Any other record showing lead was not used at a particular site.

See Chapter 4 for information on historical records related to those described here.

Conducting Service Line Investigations

Although water systems are not required to conduct on-site investigation of service lines under the LCRR for the initial inventory, if on-site investigations are performed and documented, they would be a required source of information for the inventory because they would be a water system record and a record of an inspection. In addition, they can be useful for verifying existing records and reducing the number of unknowns. Water systems should review the information in Chapter 5 to assist in identifying appropriate additional investigation methods for their situation. The literature suggests that multiple records and investigation techniques can increase confidence in a service line's material classification (Abernethy et al., 2018; Feick, 2018; Kuhl, 2018; Oswald, 2018; Zahra, 2019, as cited in Hensley et al., 2021). Water systems should be aware of identification methods provided or required by their state under the LCRR (40 CFR §141.84(a)(3)(iv)). For example, see Appendix E for the State of Michigan's requirements. Remember that if a water system chooses an investigation method not specified by the state under 40 CFR §141.84(a)(3)(iv), state approval is required (40 CFR §141.84(a)(3)).

Section 6.2 identifies possible approaches that water systems could consider for prioritizing locations for on-site investigations. Note that the Association of State Drinking Water Administrators (ASDWA) recommends that systems develop their own specific process of

identifying unknowns and improving the inventory through service line investigations (ASDWA, 2022).

EPA expects initial inventories to have varying percentages of unknowns, depending on the condition of existing records and prior inventory development. EPA discourages systems from submitting inventories to states with all unknowns. EPA notes that as part of the LCRR initial inventory requirements, systems must identify and track service line materials as they are encountered during normal operations, such as when performing maintenance activities (40 CFR §141.84(a)(5)). EPA recommends that water systems also begin engaging customers and conducting proactive, on-site investigations before the compliance date.

Systems should continue to gather information on service line materials after service lines have been designated non-lead and assess the accuracy of records and investigative techniques in accordance with the continuous improvement framework recommended in Chapter 3. If water systems later find a certain information source to be unreliable, they should consider reclassifying service line materials that rely solely on that method as unknown until additional information is gathered. ***Remember, water systems must update their inventory as better information becomes available*** (40 CFR §141.84(a)(6)).

6.2 Prioritizing Field Investigations

EPA recommends that systems conduct on-site investigations to reduce the number of unknowns in the system as quickly as possible. The extent of proactive service line investigations should be based on the following:

- The completeness of historical records (*e.g.*, how many of the total service lines are included, and how much of the distribution service area is covered)
- Confidence in the accuracy of historical records (*e.g.*, based on cross-checking with other records and field investigations)
- The extent the system will already be in the field doing work, such as meter replacement and LSLR
- Previous service line investigations
- Number of unknowns

There are many ways to prioritize locations for service line investigations. Examples are described below and are not necessarily listed in order of importance. EPA recommends that systems consider using multiple prioritization criteria in planning for investigations.

Consider vulnerable or environmental justice populations when targeting areas for investigations. For example, a water system may want to consider prioritizing investigations at locations served by unknown service lines where children are present, such as schools or child care facilities. In some cases, smaller child care facilities operated out of single family residences

could be more likely to be served by an LSL based on the diameter of the service line. Water systems could consider prioritizing other factors as well, such as populations that have been disproportionately exposed to lead from all sources or face additional disparities that may make it more difficult to cope with the impacts of lead exposure. Systems could also consider income-based prioritization, conducting investigations at sites serving customers who qualify for reduced rates. Systems could also consider referencing requirements of external LSLR funding they have received. For example, if the customer eligibility for LSLR funding is based on income, water systems could consider prioritizing investigations of unknowns based on the same criteria to facilitate use of the LSLR funding.

Target areas with the most unknowns. Systems with many unknowns may want to consider targeting proactive investigations in areas where there are many unknowns to improve efficiency.

Prioritize investigations by the likelihood of finding LSLs. Prioritizing investigations of service lines that are unknown-likely lead and replacing them if found can lower costs and save time related to access agreements, traffic control, and field crew mobilization. This approach may also reduce the costs associated with false negatives (*i.e.*, digging up a suspected lead line and finding that it is non-lead). This prioritization approach can benefit from predictive modeling by indicating the probability that a service line is lead. EPA also recommends replacing lead and GRR service lines when found to expedite LSLR and improve public health.

Prioritize investigation in areas undergoing LSLR. Systems with existing LSLR programs could prioritize proactive investigations in areas undergoing LSLR projects to save time and cut costs related to access, traffic, and crew mobilization.

Use field investigations to verify historical records. Systems can use field investigations to verify the accuracy of historical records. One possible approach is as follows:

(1) Select a random set of addresses where service line material has been assigned based on historical records.

(2) Use one or more of the investigation methods described in Chapter 5 (*e.g.*, visual observation, excavation) to identify the service line material for the system- and customer-owned portions.

(3) Compare field results to historical records.

An example is the approach required by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). Michigan requires a minimum number of service line investigations with the goal of reaching a 95 percent confidence level in the accuracy of historical records. See Appendix E for minimum service line materials verification requirements in the state of Michigan.

6.3 Requirements and Recommendations for Systems with Only Non-Lead Service Lines

6.3.1 LCRR Requirements

Systems may be able to demonstrate through evidence-based records, methods, or techniques that ***all*** service lines in their system (both system- and customer-owned) are non-lead. Water systems with only non-lead service lines are subject to the following requirements under the LCRR:

- Develop an initial inventory that complies with the requirements to use and review certain information as described in 40 CFR §141.84(a)(3). Submit the initial inventory by ***October 16, 2024*** (40 CFR §141.90(e)(1), USEPA, 2021d). Remember that all systems, even those with initial inventories that identify all service connections as non-lead service lines, are required to create and submit their initial inventory to the state (40 CFR §141.80(a)(3)).
- Systems whose initial inventory contain only non-lead service lines may provide a written statement that the system has no LSLs or GRRs and a general description of methods used to make the determination to meet inventory public accessibility requirements of the LCRR (40 CFR §141.84(a)(9)).
- Include language in their annual Consumer Confidence Report (CCR) explaining how customers can access the inventory or provide a statement with the description of methods used to make the determination (40 CFR §141.153(d)(4)(xi)). Note that this requirement applies to community water systems (CWSs) only.
- Notify the state within 30 days and prepare an updated inventory on a schedule established by the state if the system subsequently finds an LSL or GRR service line (40 CFR §141.90(e)(3)(ii)).

6.3.2 Recommendations (Not Required under the LCRR)

Recommended Approaches and Documentation for Demonstrating all Service Lines are Non-Lead. Water systems can use different approaches to demonstrate that all service lines are non-lead. Some may be able to use municipal codes and construction dates to show that all service lines were constructed after lead was banned in the system (*i.e.*, the system never had LSLs). Others may be able to positively identify non-lead materials (*e.g.*, copper or PVC) for all service lines through historical records, field investigations, or both. Other water systems may be able to demonstrate that they have no LSLs or GRRs because they have replaced both the system- and customer-owned portions everywhere in the system. Water systems can use a combination of evidence-based records, methods, or techniques; for example, when a portion of their distribution system was constructed after the lead ban, and the remainder is verified as non-lead based on historical records and verification. Exhibit 6-3 recommended documentation for different types of systems with all non-lead service lines depending on their basis of determination.

Exhibit 6-3: Recommended Documentation for Systems with all Non-Lead Service Lines

Scenario	Basis of Determination[1]	Recommended Documentation[2]
Never had LSLs	Municipal codes and construction dates (*e.g.*, all service lines were installed after lead was banned)	• Relevant municipal code language and dates and references/web links to materials that are available online. • Dates when service lines were constructed, and a list of service line materials used instead of lead. • Confirmation that no LSLs have ever been found in the system.
	Detailed historical records on service line material, location, and size indicating that all service lines are a material other than lead (*e.g.*, copper or PVC)	• Description of historical records including format of the records and condition. • Specific standard operating procedures (SOPs) or policies regarding LSL installation. • Description of how the system verified the accuracy of historical records including the method(s) and number of verified service lines records compared to the total. • Confirmation that no LSLs have ever been found in the system.
	Field investigations	• Description of methods including how the system inspected the material of the system-owned and customer-owned portion, if applicable. • The number of service lines that were investigated using each method. • Confirmation that no LSLs have ever been found in the system.
Replaced all LSLs and GRR	Detailed historical records of non-lead lines and records showing when each LSL and GRR service line was replaced	• Description of historical records documenting non-lead service line material along with description of how the system verified the accuracy of non-lead records. • Specific SOPs or policies regarding LSL installation. • Detailed list of where and when each LSL and GRR was replaced.

Notes:

[1] Basis of determination for systems that have all non-lead service lines can be a combination of the information shown. Systems should include all relevant documentation for all their bases of determination.

[2] Should include records for both the system-owned and customer-owned portions where ownership is split.

Submitting the Initial Inventory to the State. Systems with all non-lead service lines must still submit an initial inventory to their state by October 16, 2024. The inventory should have all service lines categorized as non-lead or a non-lead subclassification (*e.g.*, copper or plastic) and zero service lines categorized as lead, GRR, or unknown. EPA developed an inventory template to support systems as they prepare and submit their inventory. The template materials are described in Section 3.3.1 with the electronic version available at EPA's website[24] as well as blank forms in Appendix A. EPA recommends that systems check with their primacy agency if they have specified a mechanism or format for their inventory submission. States may require additional information be submitted as well.

Discovery of LSLs or GRRs after submission of initial inventory with no LSLs, GRRs, or Unknowns. EPA recognizes that even when systems' inventory and LSLR efforts have progressed such that all service lines have been classified as non-lead, it is possible that an LSL or GRR may subsequently be found. Systems should work closely with their state if they discover an LSL, notifying the state as soon as possible (within 30 days as stated above in Section 6.3.1). The system must prepare an updated inventory in accordance with 40 CFR §141.84(a) on a schedule established by the state (40 CFR §141.84(a)(6)(i)). Although not required, EPA recommends systems strive to replace the LSL as soon as practicable as well as investigate the circumstances of LSLs (*e.g.*, when was it installed and who installed it).

EPA recommends that states consider whether the LSL discovery was an isolated event that is unlikely to occur again or a potential indicator of additional LSLs in the distribution system. If the state determines that the discovery of an LSL is an indicator of other potential LSLs in the system, EPA suggests that the state work with the water system to determine which service lines should be reclassified as unknown and develop a plan for field investigations.

6.4 Submitting the Initial Service Line Inventory

Systems must submit their initial inventory of service lines in accordance with 40 CFR §141.84(a) to their state by **October 16, 2024** (40 CFR §141.90(e)(1); USEPA, 2021d). The initial inventory must include the system- and customer-owned portions of all service lines in the system's distribution system (40 CFR §141.84(a)(2)) and each service line or portion of the service line must be classified as lead, GRR, non-lead, or lead status unknown (40 CFR §141.84(a)(4)).

The LCRR does not require a specific format for the inventory; however, states may have additional requirements or recommendations regarding inventory format. See Section 3.3 for a discussion of possible inventory formats. As noted in Section 3.3.1, EPA developed a multi-worksheet template to assist water systems and states in developing their service line inventory. An electronic version of the template is available at https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule, and blank forms for each template worksheet are

[24] https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule.

also provided in Appendix A. The template includes an "Inventory Methodology" worksheet to document the methods and resources used to develop the inventory. The "Inventory Summary" worksheet supports documenting service line ownership and reporting the total number of service lines by the four material classifications. These templates are presented as a possible tool; there is no requirement that a system or state use these templates.

6.5 Notification of Known or Potential Service Line Containing Lead

Water systems with LSL, GRR, or lead status unknown services lines must provide notification to people served by these lines within 30 days after completing the initial inventory. For new customers, the notice must be provided at the time of service initiation. The notification must be repeated annually until the entire service line is no longer a lead, GRR, or lead status unknown service line (40 CFR §141.85(e)). Delivery must by mail or another state-approved method (40 CFR §141.85(e)(4)).

All notifications must include the following:

(1) A statement that the service line material is lead, GRR, or lead status unknown

(2) Information on the health effects of lead. Details on required health effects language are available in 40 CFR §141.85(a)(1)(ii)[25]

(3) Steps to minimize exposure in drinking water

Additional content is required based on service line material classification as follows for:

- **Confirmed LSLs**, the notification must also include information about opportunities to replace the LSL, any available financing programs, and statement that the system must replace its portion if the property owners notify the system that they are replacing their portion.
- **GRR,** the notification must also include information about opportunities for service line replacement.
- **Lead status unknown**, the notification must also include a statement that the service line is unknown but may be lead and information about opportunities to verify the material of the service line.

Water systems serving communities with a large proportion of non-English speaking consumers, as determined by the state, must provide public education materials, including those in 40 CFR §141.85(e), in the appropriate language(s) regarding the importance of the notice or contain a telephone number or address where persons served may contact the water system to obtain a translated copy of the public education materials or to request assistance in the appropriate language. Water systems must demonstrate that they delivered the notification and provide a

copy of the notification and information materials to their states annually by July 1 for the previous calendar year (40 CFR §141.90(f)(4)).

Recommendations (Not Required under the LCRR)

While not required by the LCRR, EPA recommends that water systems develop notifications that are easy-to-use and understand for consumers and adhere to best practices that are most likely to prompt consumers to take action to protect their households from lead exposure.

- Water systems should use simple, plain language and short sentences that can be easily understood by the members of the public. Notices should avoid long paragraphs or legalistic language.
- Notices should be designed to convey the urgency of the information, differentiate the notice from other mail that a household receives, and draw consumers' attention to key information. For example, notices can use colored envelopes, large-sized envelopes, or text on the external envelope to make the notice stand out compared to other mail. Notices can also use bold design practices to draw consumers' attention to key information, including large, bold, underlined, or colored font, bullet points or numbered points, or boxes around key information.
- Notices should be action-oriented, emphasizing the key steps consumers can take and providing specific instruction on how to do so. Water systems should consult their local health department on resources that consumers can be directed to, including water filters and blood lead level testing.

6.6 Inventory Updates

EPA anticipates that water systems will improve and update their inventory over time, decreasing the number of unknowns and confirming service line material classifications. The LCRR includes requirements for systems to update their inventory based on all applicable sources described in 40 CFR §141.84(a)(3) and (5) and any LSLRs or service line material inspections that may have been conducted. As with the initial inventory, the water system may use other sources of information if approved by the state and must use other sources of information provided or required by the state. The LCRR also requires submission of the updated version of the inventory on the same schedule as a system's tap sampling monitoring, but no more frequently as annually (40 CFR 141.90(e)(3)); however, EPA may revise the inventory requirements under the Lead and Copper Rule Improvements (LCRI). Until any change in the regulation, systems must comply with the LCRR inventory requirements, including the update requirement.

As will be discussed in Chapter 7, EPA suggests that systems consider updating their publicly accessible inventory in real-time. Systems should also follow any state requirements for updates and submittals.

6.7 State Review and Reporting

6.7.1 State Review of the Initial Inventory

Required under the LCRR

State review of each water system's initial inventory for compliance with LCRR requirements:

- The inventory must include all service lines connected to the public water distribution system regardless of ownership status (40 CFR §141.84(a)(2)).
- The system must use and review the sources of information listed in 40 CFR §141.84(a)(3) and other sources of information if approved by the state. In addition, water systems must identify and track service line materials as encountered in the course of normal operations (40 CFR §141.84(a)(5)).
- Service lines, or portion of the service line where ownership is split, must be categorized as lead, GRR, non-lead, or lead status unknown (40 CFR §141.84(a)(4)).
- A publicly accessible inventory must include location identifiers for each lead and GRR service line (40 CFR §141.84(a)(8)(i)).
- Water systems with lead, GRR, or lead status unknown services lines in their inventory must inform all persons served by the water system at the service connection within 30 days of completion of the initial inventory and repeat the notification on an annual basis until the service connection is no longer a lead, GRR, or lead status unknown line (40 CFR §141.85(e)(1) and (2)). The notification must comply with the content requirement in 40 CFR §141.85(e)(3) and delivery requirements in 40 CFR §141.85(e)(4). In addition, water systems must demonstrate that they delivered the notification and provide a copy of the notification and information materials to their states annually by July 1 for the previous calendar year (40 CFR §141.90(f)(4)). Refer to Section 6.5 for additional detail.

Recommended (Not Required Under the LCRR)

EPA has developed a checklist for the initial inventory submittal with recommended considerations for states to use in their review. States can refer to a fillable copy of the state checklist in Appendix A or the electronic version in the EPA Inventory Template, available at EPA's website, https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule. The checklist has sections for reviewing timely submission, required elements, information sources, public accessibility, and customer notification of service line material.

The ASDWA State Implementation Framework (2022) provides additional recommendations for states to consider in their review of the initial inventory. They note that states may want water systems to submit the evidence used and attest to the non-lead areas of the distribution system.

States may also want to perform a cursory review of historical lead sampling data. Lead tap monitoring results could reinforce non-lead service line classifications or indicate that more documentation from the water system is needed (ASDWA, 2022).

For systems with all non-lead service lines, ASDWA's framework includes a suggestion for states to consider requiring verification from the water system that there is no lead and a description of the evidence the system used to make this determination. The state could consider tap monitoring results when evaluating the initial inventory for non-lead systems. ASDWA (2022) notes that "a state should feel more comfortable accepting a non-lead certification if there are no lead detections and the records show distribution installation after the state's effective date of the June 19, 1986, Lead Ban."

6.7.2 State Reporting Requirements

The LCRR requires that states report separately the number of lead, GRR, and lead status unknown service lines for each water system. EPA is potentially revising reporting requirements for inventory updates under the LCRI.

Key Points to Remember

LCRR Requirements

- All systems, including systems with all non-lead service lines, must create and submit their initial inventory of service lines to their state by **October 16, 2024** (40 CFR §141.90(e)(1), USEPA, 2021d). Water systems must begin tracking materials as they are encountered during normal operations before the rule compliance date (40 CFR §141.84(a)(5)).
- Non-lead service lines must be determined through an evidence-based record, method, or technique not to be lead or GRR (40 CFR §141.84(a)(4)(iii)).

Recommendations (Not Required under the LCRR)

- Water systems should begin engaging customers and conducting proactive, on-site service line material investigations as soon as possible to improve their inventory, verify existing records, and reduce the number of unknowns. Water systems should capture as much information as possible for unknowns and consider assigning a likelihood that they are lead.
- Non-lead classification could be based on when LSLs were banned and service lines were installed, along with pipe diameter (most LSLs are less than 2 inches).
- When systems have conflicting records of service line materials, they should consider classifying the line as unknown (or lead if one or more information sources suggest lead is present) until the conflict is resolved.
- EPA discourages water systems from submitting an initial inventory with all unknowns.
- The inventory is a living document that should be continually improved over time.

Chapter 7: Public Accessibility

Under the Lead and Copper Rule Revisions (LCRR), community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) must make a portion of their inventory publicly available (40 CFR §141.84(a)(8)). This chapter describes those requirements and provides recommendations for implementation of the public accessibility requirement.

In addition to the public accessibility requirements, the LCRR also requires all systems to inform all persons served by the service connection with a lead service line (LSL), galvanized requiring replacement (GRR), or unknown service line of their service line material within 30 days following completion of the initial inventory[26] (40 CFR §141.85(e)). See Section 6.5 for additional detail.

Informed customers are better equipped to take actions to limit exposure to lead in drinking water, make decisions regarding replacement of their portion of a lead or GRR service line, and understand the prevalence of lead sources in drinking water systemwide.

Chapter 7 includes:

- Inventory information water systems must make publicly accessible and other useful information to consider in Section 7.1.
- Suggestions on how to make the inventory information publicly accessible and real-world examples in Section 7.2.
- Recommendations for states to review and facilitate public accessibility of inventory information in Section 7.3.
- A discussion of the Consumer Confidence Report (CCR) inventory-related requirements for CWSs in Section 7.4.

7.1 What Information to Include

7.1.1 Required under the LCRR

Under the LCRR, systems are **required** to provide the public with a location identifier, such as a street address, block, intersection, or landmark, associated with each service line classified as lead or GRR (40 CFR §141.84(a)(8)(i)). As described in Section 6.3, water systems that have demonstrated they have no lead, GRR, or lead status unknown service lines in their inventory (*i.e.*, have only non-lead service lines regardless of ownership) may, in lieu of publishing their inventory, provide a ***written statement*** that there are no LSLs along with a ***general description*** of the sources specified in the regulations used to make that determination (40 CFR §141.84(a)(9)).

7.1.2 Recommendations (Not Required under the LCRR)

EPA encourages water systems to consider including other information in their publicly available inventory, including but not limited to:

- **Location identifier for all service lines, regardless of material.** The LCRR requires a system's publicly accessible inventory to include location identifiers for LSLs and GRRs. As discussed in Section 2.3.2, EPA recommends that systems include a location identifier for all service lines in their publicly accessible inventory. Doing so provides consumers with up-to-date information on their service line material and allows them to track progress on lead service line replacement (LSLR) in their entire community over time. This information could incentivize consumers to assist in the identification of their service line material and those with LSLs to participate in the LSLR program.
- **A street address as the location identifier.** As mentioned above, water systems are required to provide a location identifier in their publicly available inventory associated with each LSL and GRR. EPA recommends that water systems consider including street addresses (or emergency 911 addresses for rural areas) as their location identifiers. EPA also suggests that systems include the town with the street address if they serve several counties that have the same street address (*e.g.*, 100 Main Street). In addition, EPA also recommends when multiple service lines serve the same address, *e.g.*, hospital or apartment building, the water system should include additional descriptors that would allow each service line to be uniquely identified.

  A few examples of maps and databases that are searchable by street address or customer account number include the following:

  - DC Water, Washington D.C.[27], Greater Cincinnati Water Works, Ohio[28], and Tucson Water, Arizona[29] have an interactive map on their website that allows users to enter an address to learn if they might have an LSL.
  - Milwaukee, Wisconsin, provides lists of addresses with LSLs on their website extracted from their database as PDF files. The list includes house number range, street name, city, state, and zip code. Milwaukee Water Works advises residents to search their address to determine if they have an LSL. For more information, visit their website.[30]

[27] https://geo.dcwater.com/Lead/. Accessed December 16, 2021.
[28] https://gcww.maps.arcgis.com/apps/webappviewer/index.html?id=0a170c268c694e46a8a4e394630df0bd. Accessed December 8, 2021.
[29] https://cotgis.maps.arcgis.com/apps/webappviewer/index.html?id=8dd30cd29ad64d58bbf1d7ebe86d6abc. Accessed December 8, 2021.
[30] https://city.milwaukee.gov/water/WaterQuality/LeadandWater/Lead-Service-Line-Records. Accessed December 8, 2021.

- Louisville Water Company (LWC), Kentucky, has a tool on their website[31] where customers can use their LWC account number to determine if the Louisville Water-owned lines are lead, but not the customer-owned lines. Note, to comply with the LCRR, customer-owned service lines will need to be included.

- **Actual material for non-lead**. The LCRR gives water systems the option to classify the actual material of the service line that is non-lead (*e.g.*, galvanized, plastic, or copper) as an alternative to classifying it as non-lead (40 CFR §141.84(a)(4)(iii)). EPA encourages water systems to consider providing the actual materials as part of the publicly accessible inventory for greater transparency.
- **A summary of the total number of LSLs, GRRs, unknowns, and non-lead.** Summary information allows the public to more easily track a system's overall progress in identifying service line materials and replacing LSLs. For example, Denver Water, Colorado,[32] and the City of Newark, New Jersey, publish the number of LSLs replaced on their websites[33] to communicate their progress.
- **Clear disclaimer language.** A disclaimer will help water systems communicate any uncertainty inherent in their inventory, such as the varying reliabilities of some data sources. The inventory represents the best data the water system has at a certain point in time. Some water systems include disclaimer language about the quality of the information and require users to accept the disclaimer before they have access to the inventory information. Appendix F includes a few examples of disclaimer language.
- **Instructions on how to read and interpret the inventory.** These instructions will depend on the inventory format selected by the water systems. For example, a spreadsheet could provide a definition of material classifications and any sub-classifications, include a data element dictionary, and provide clear labeling of column headings. Additional recommendations for communicating information using maps is provided in Section 7.2.2.
- **Information on steps that consumers served by LSLs can take to protect themselves.** Because some consumers may learn for the first time through the inventory that their home is served by an LSL, water utilities should provide links or references to information on steps that consumers can take to reduce lead or protect themselves from lead exposure. For example, water utilities may consider sharing information from EPA[34] or their local health department.
- **Statements that other lead sources may exist in drinking water plumbing or the building.** Systems should raise customer awareness that even when LSLs or GRRs are not

[31] https://www.louisvillewater.com/servicelinelookup. Accessed December 8, 2021.
[32] https://www.denverwater.org/your-water/water-quality/lead/dashboard. Accessed April 21, 2022.
[33] https://www.newarkleadserviceline.com/replacement. Accessed December 8, 2021.
[34] See, *e.g.*, https://www.epa.gov/sites/default/files/2017-08/documents/epa_lead_in_drinking_water_final_8.21.17.pdf

present, other lead sources may remain. Examples include materials inside the home or building, such as copper pipes with solder installed prior to the state's lead ban,[35] some faucets purchased prior to January 4, 2014,[36] and lead paint in homes that pre-date 1978[37]. In addition, lead can be present in dust and soil. EPA's website[38] includes information prepared by EPA and other agencies about different sources of lead and how consumers can protect themselves. Water systems could include a statement about the possible presence of these lead sources, *e.g.*, on their website, in materials distributed to their customers in hard copy or electronically, or in their CCR.

- **A schedule for investigating unknowns.** This could include the date that specific neighborhoods or other areas of the town or city have been scheduled for investigation.
- **Information on the water systems' actions to reduce lead.** This could include actions on how the water system is reducing lead and opportunities for customers to participate in the inventory and LSLR efforts (USEPA, 2017).
- **Information about tap sampling.** The system may inform customers about ways they can test their water for lead, such as if the system has a lead testing program, or directing customers to certified laboratories that can provide testing services.
- **System contact information.** Systems could direct customers to different departments depending on the request, such as general inquiries about lead in drinking water or how to submit inventory information (such as customer-owned service line material identification). This could also include links to the information in other languages, other information about the LSLR program, and instructions on how customers can identify their service line materials. See Appendix B, the City of Newark, for an example.

EPA recommends that systems weigh the benefits of making additional and/or detailed inventory information publicly accessible with the drawback of compromising a user's ability to find the most relevant information. Water systems could consider indicating what other inventory

[35] In 1986, Congress amended the Safe Drinking Water Act (SDWA), prohibiting the use of pipes, solder, or flux that were not "lead free" in public water systems or plumbing in facilities providing water for human consumption. At the time, "lead free" was defined as solder and flux with no more than 0.2 percent lead and pipes with no more than 8 percent lead. See Appendix D for a summary of lead ban provisions by state.

[36] The Reduction of Lead in Drinking Water Act, which became effective on January 4, 2014, revised the definition of lead-free as a weighted average of not more than 0.25 percent lead calculated across the wetted surfaces of pipe, pipe fitting, plumbing fitting, and fixtures and not containing more than 0.2 percent lead for solder and flux. It also prohibited the use or sale of such items that did not meet the revised lead-free definition.

[37] In 1978, the Consumer Products Safety Commission banned consumer uses of lead-based paint, but some states banned it even earlier.

[38] https://www.epa.gov/lead/protect-your-family-sources-lead#older. Accessed April 26, 2022.

information is available on request, and systems providing the data electronically could include links to the information.

7.2 How to Make the Data Publicly Available

Required under the LCRR

Water systems must make the inventory publicly accessible, including a location identifier for each LSL and GRR. The LCRR requires water systems that serve more than 50,000 people to provide their inventory online (40 CFR §141.84(a)(8)).

Recommendations (Not Required under the LCRR)

There are many factors to consider in determining how to best reach the target audience. When first considering the best method for sharing inventory data with the public, a water utility may consider the following questions:

- Do our customers have internet access?
- Does our water system currently have a website? If not, do we have the resources to create one?
- Does our water system have someone that understands how to create maps using geographic information system (GIS) tools?
- What format of information would be easiest to use for the public?

As mentioned above, only water systems serving more than 50,000 people must post their inventory online. Water systems serving 50,000 or fewer people are not required to post their inventories online, as long as they are publicly accessible in some fashion. This may include availability by mail or in-person at the water system's office. EPA encourages all water systems to consider providing online inventory access. This approach could decrease water system burden by eliminating costs to print and mail inventories on request as well as eliminating staff time to process additional customer transactions. For smaller water systems that do not currently have a website, providing their inventory online could be as simple as uploading a list, spreadsheet, or a simple map to a free filesharing service or publicly viewable social media account for the system. NTNCWSs that do not have a website could consider using email, posting the information in frequented locations (*e.g.,* breakroom or notice board), or include the information in a newsletter. In addition, systems that do not have a website can check if their state has an option to host the inventory.

7.2.1 Description of Available Web-Based Map Applications

An effective means for distributing service line inventory information is via an online map. Online inventory maps allow interested parties to view a water system's service line materials anywhere there is access to the internet. The primary advantages of making inventory data available via web

maps are user accessibility, data transparency, and the system's ability to regularly update the data.

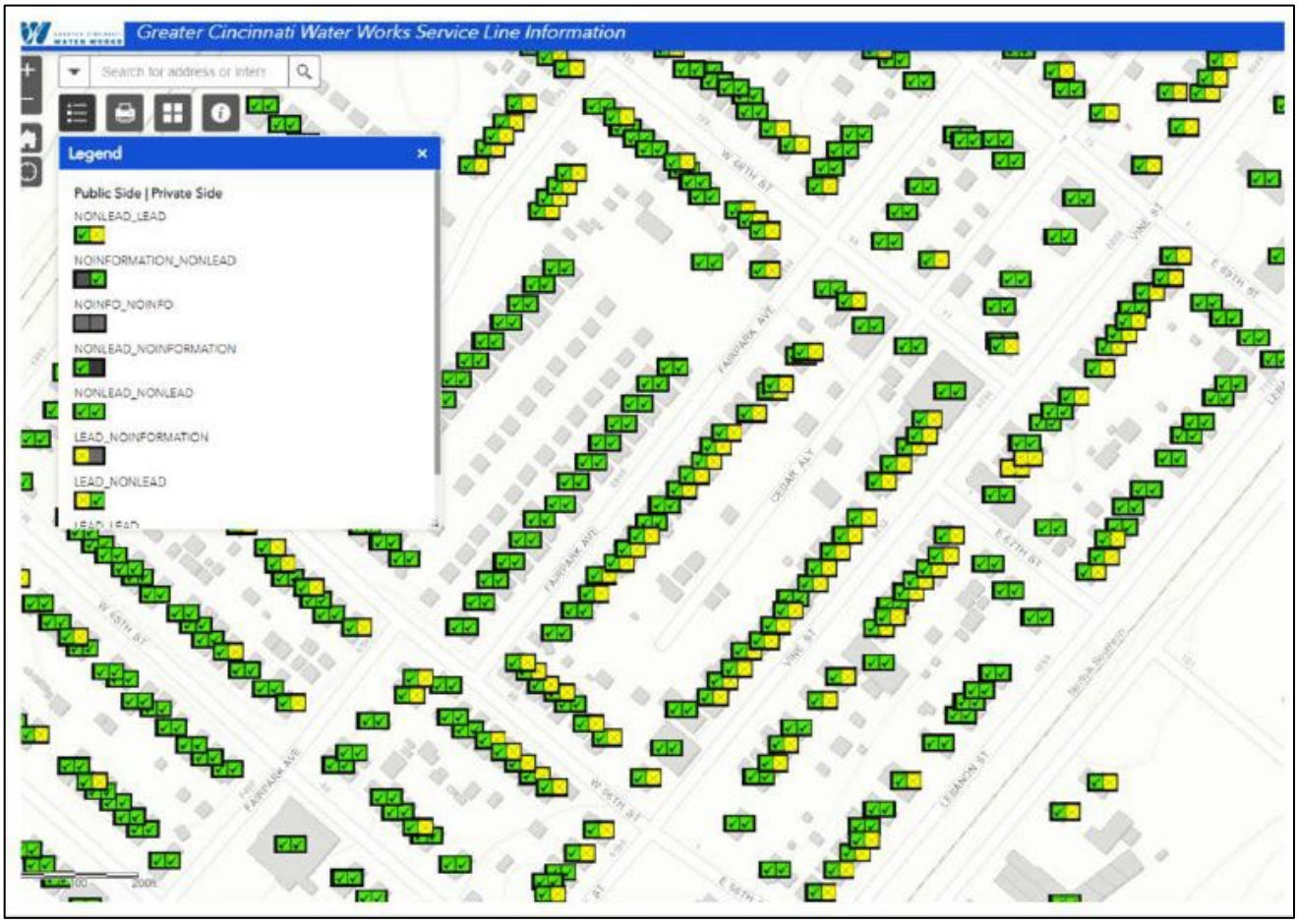
Systems that collect inventory data with GPS coordinates (latitude and longitude) can save those points with corresponding attribute information (*e.g.*, service line material, address, data inventoried, etc.) to one of various file types. Systems could also collect inventory data via GPS devices, such as smart phones that have a mapping app, and can upload GPS files directly from those devices (.gpx). Once uploaded, the collected point locations can be overlaid with base maps and the point symbology (*e.g.*, point locations represented by dots versus "X" symbols) and the legend information and symbology can be customized to the inventory dataset. Alternatively, street addresses can be converted to point locations using a process called geocoding. Geocoding assigns a latitude and longitude to a location using text information to make the determination, such as address or place name. For example, a dataset of street addresses with service line information can be converted to point locations that could then be easily displayed in a map application.

7.2.2 Web-Based Map Application Best Practices

Web-based map applications are one of the most effective methods for conveying service line inventory information to the public. As Hiltner et al. (2019) explained, interactive online maps can be a more powerful tool for disseminating location-based LSL information than static maps and tabular databases. Key components of effective interactive maps include the deliberate use of data, thoughtful selection of colors and symbology, and awareness of inclusivity. Exhibit 7-1 shows how the Greater Cincinnati Water Works, Ohio uses colors to denote materials information for service lines by property.

Fundamental to an inventory map is a layer of locational data that displays the service line material, such as points or polygon boundaries. The locational data should be the primary data displayed on the map. A best practice for map development is to only display informative data to the users. For example, while utilities may have access to geospatial railway data, adding this layer to the map is not critical to the user and distracts from the intention of the map. Layer attributes in online maps can be displayed using pop-up tables, color-coding, or map symbology to display attributes. Of particular note is the use of service line symbology to denote the service line material on the customer-owned side versus the system-owned side of the service line, as demonstrated in Exhibit 7-1.

Exhibit 7-1: Greater Cincinnati Water Works Service Line Information Map



Source: Greater Cincinnati Water Works Service Line Information map. https://gcww.maps.arcgis.com/apps/webappviewer/index.html?id=0a170c268c694e46a8a4e394630df0bd. Accessed December 16, 2021.

Accessibility and inclusivity considerations should be made throughout the map development process (Woods and Webb, 2021). These include:

- Using a color-blind safe color scheme,
- Using simple terminology and defining acronyms, and
- Offering text in multiple languages, where appropriate.

Color-blind sensitive map color schemes are simple to create using free online tools. Alternatively, map interfaces could include a check box to allow users to select their preferred color scheme from a list of options. Another important component of map accessibility is terminology. The inventory process involves acronyms and terms generally unfamiliar to the intended public audience. Map text should be carefully reviewed for these types of language and edited accordingly. Lastly, the map interface should be made available in multiple languages, as appropriate, depending on the population served by the system. For example, to serve the

Spanish-speaking population of the Tucson, Arizona, the service line map[39] displays all map text both in English and Spanish. Water systems may also want to consider providing alternate text for maps that can be read aloud using software for the visually impaired.

7.2.3 Public Data Sharing Alternatives

Some systems may not have the capacity for online GIS map applications. In these cases, there may be other online data sharing methods that better fit the needs of systems and their users. Important first steps are to determine what established online data sharing capabilities and protocols are already in place and what types of inventory information are going to be shared (*e.g.*, tabular data versus narrative information).

Many systems may have a website where a new webpage or subsection could be added for hosting inventory document downloads and updates. Depending on the website structure and server limitations, this option may only be available for small-sized documents. Some systems may have a File Transfer Protocol (FTP) site where the data could be hosted and linked to for download. Utilizing an FTP server may be optimal for some systems because FTP sites are better suited for transferring large data files. If systems do not have the capacity to provide downloads via their own servers, there are many options for cloud-based server storage that can easily be shared and downloaded. See Exhibit 7-2 for a summary of online data sharing alternatives.

Exhibit 7-2: Examples of Online Data Sharing Alternatives

File Sharing Method	Description
Online Cloud-based Data Sharing	Cloud-based storage and data sharing allows access to files from any computer, hosted by a third-party vendor; base storage plans may be free.
Online Spreadsheet	Cloud-based spreadsheets, some of which can be accessed online without any product licensure or installation requirements; this may be a good option for systems with little data infrastructure.
FTP/SFTP Server	Standard file sharing protocol for transferring files from a server to another computer (client); water systems may already have FTP functionality they can use.
System Website	Data may be hosted on a system's website as text or image or can be made available in a downloadable format.

The best platform for online data sharing will vary by system. Another key part of that decision-making process is the data format and complexity. For example, a system without their own online data sharing platform (server) and a simple spreadsheet-based inventory may elect to use

[39] https://cotgis.maps.arcgis.com/apps/Cascade/index.html?appid=13b3899bb7374156a031414de36007fe. Accessed December 8, 2021.

an online spreadsheet. Users could then access the inventory spreadsheet via a weblink on the system's website. Systems wanting to share high-resolution PDF maps, however, may consider a data sharing option optimized for large file sizes. This may be a good option if the system already has an FTP server for public file sharing. If not, a cloud-based file sharing option could be a good solution.

The circumstances of some systems and users may not allow for web-based data sharing of any kind. In these cases, systems will need to develop a plan for effectively distributing inventory information without the use of electronic data sharing. Potential data sharing options include:

- Printed service line maps
- Printed tabular data
- Information in water utility mailings or newsletters
- Information available at the water system's office

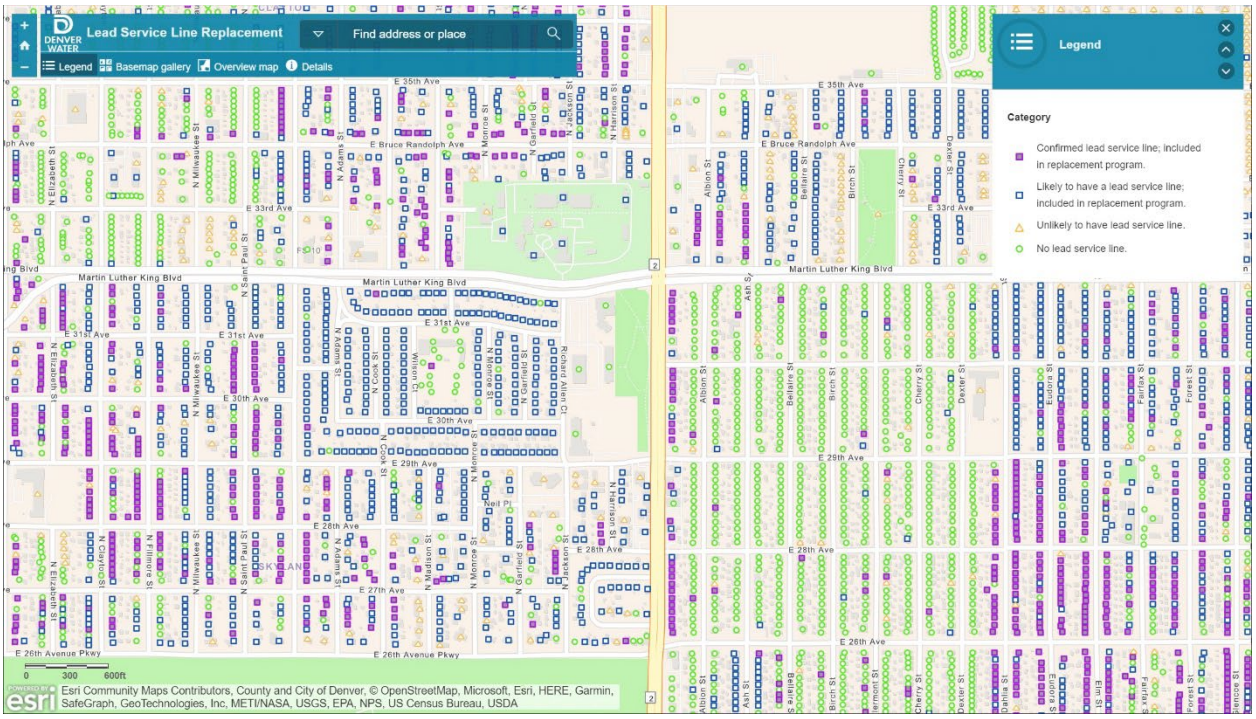
7.2.4 Public Input and Updates

Active community participation in the inventory process helps cultivate a more robust inventory dataset and engage the community on public health issues potentially affecting them. LSL data can be strengthened by asking for public feedback on existing inventory data or possible updates to information on LSLs or GRRs not already reflected in the inventory. Given this participatory process, there is also a higher likelihood of continued and widespread engagement with the inventory and LSLR efforts throughout a system's distribution network.

Public feedback can take many forms. For example, the system can provide contact information on the system's website for individuals to submit corrections and updates via email or phone. Another example can be a user submission form where customers identify the service line material and include photographic evidence, providing an additional level of confidence to their classification. Inventories that are updated regularly based on public input should consider indicating the dataset version or the date of the last update in an obvious location.

Providing a platform for public input provides an opportunity for users to learn about their own service line and the presence of LSLs more broadly. An additional consideration for encouraging community awareness is offering an email subscription for regular updates on the service line inventory, such as Denver Water who offers a subscription opportunity within their service line inventory map (Exhibit 7-3).

Exhibit 7-3: Denver Water's Lead Service Line Replacement Map



Source: https://dw.maps.arcgis.com/apps/View/index.html?appid=cb5d6630085b4e4b96ff7fd1adf39025. Accessed December 15, 2021.

EPA suggests updating the inventory in real-time (or as close as possible) to provide the public with the most up-to-date information. Externally facing updates to the inventory may require quality assurance and quality control or may be most efficiently processed in batches rather than updated continuously.

7.3 Considerations for States

States seeking to determine a system's compliance with the LCRR inventory requirements may use the checklist in Appendix A. One component of that review is determining a system's compliance with its public accessibility requirements. Appendix A includes a checklist that states can use to help document if systems meet these requirements. This form is also available electronically at EPA's website (https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule).

In their 2022 framework, the Association of State Drinking Water Administrators (ASDWA) recommends that states consider additional ways to make the relevant information available to the public, including hosting information on the state's website (ASDWA, 2022). For example, states could consider creating a portal or using another method to allow systems to upload their

information directly. For a full list of additional considerations, refer to ASDWA's framework (ASDWA, 2022).

7.4 Consumer Confidence Report Inventory Requirements

The LCRR requires CWSs to include in their annual CCR a statement that they have prepared a service line inventory and instructions on how to access the inventory (40 CFR §141.84(a)(10) and §141.153(d)(4)(xi)). Systems with no lead, GRR, or lead status unknown service lines can instead provide a statement that they have no LSLs or GRRs with the description of methods used to make that determination (40 CFR §141.84(a)(9)). EPA may potentially revise these requirements under the Lead and Copper Rule Improvements (LCRI). Regardless of the final LCRI requirements, EPA recommends that systems provide inventory-related information in their CCRs.

Key Points to Remember

LCRR Requirements

- Water systems must make an inventory of the lead and GRR service lines publicly accessible. The publicly accessible inventory must include a location identifier associated with each lead or GRR service line (40 CFR §141.84(a)(8)(i)). The identifier could be a specific address; however, this is not required under the LCRR.
- Water systems serving more than 50,000 people must provide their inventory online (40 CFR §141.84(a)(8)(ii)).
- Non-lead systems can fulfill the requirement to make the inventory publicly accessible by providing a statement they have no LSLs and including a general description of how they made that determination (40 CFR §141.84(a)(9)).
- CWSs must indicate in their CCR how to access service line inventory information. Non-lead CWSs must also include a statement they have no LSLs in their CCR (40 CFR §141.84(a)(10)).
- Within 30 days of completion of the initial inventory, systems must notify persons served by lead, GRR, and lead status unknown lines (40 CFR §141.85(e)).

Recommendations (Not Required under the LCRR)

- Water systems should consider their data sharing infrastructure, customer demographics, and staff limitations when selecting the best method for sharing data with the public.
- An interactive online mapping application can be an effective means for distributing service line inventory information and allows users to comprehensively evaluate a water system's service line materials anywhere there is access to a basic computer and internet.
- Accessibility and inclusivity considerations should be made throughout the map development process, *e.g.*, using a color-blind safe color scheme, providing alternate text that can be read aloud using software for the visually impaired, using simple or defined terminology, and offering text in multiple languages.
- Other online data sharing options are available for water systems, such as online cloud-based sharing, online spreadsheet, FTP/SFTP server, and website hosted download.
- Non-web-based data sharing options include printed service line or tabular data as well as information on water utility mailings or newsletters.
- Active community participation in the inventory process helps cultivate a more robust inventory dataset.
- EPA suggests water systems update their inventories in real-time or as close as possible.

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Woods, S. and Webb, J. 2021. Effective Mapping to Communicate Lead Pipe Locations: How We Built A Better Map for Flint, MI [Webinar]. BlueConduit. AWWA Virtual Summit: Lead & Water Quality, April 7-8, 2021.

Zahra, A. 2019. Flint city council subpoenas MDEQ to answer questions at finance hearing. https://www.mlive.com/news/flint/ 2018/10/post_513.html.

APPENDICES

- **Appendix A:** Blank Forms from the EPA Service Line Inventory Template
- **Appendix B:** Case Studies
- **Appendix C:** Instructions for Self-Identifying LSLs and Information When Water System Conducts Verification
- **Appendix D:** Summary of State Lead Ban Provisions by State
- **Appendix E:** Michigan Minimum Service Line Verification Requirements
- **Appendix F:** Examples of Data Quality Disclaimer Language

Appendix A: Blank Forms from the EPA Service Line Inventory Template

PWS Information

Inventory Methodology

Inventory Summary

Public Accessibility Documentation

State Checklist

See EPA's website at: https://www.epa.gov/ground-water-and-drinking-water/revised-lead-and-copper-rule for a downloadable, spreadsheet version of the template which contains the forms below as well as additional sheets for inventory tracking.

PWS Information

Purpose of this worksheet: *For water systems to document basic system information.*

Facility Information			
Water System Name:			
PWSID:	Population Served (number of people):	Number of Service Connections:	PWS Type:
			☐CWS ☐NTNCWS
If you are a CWS, do multi-family residences comprise at least 20% of the structures you serve?			*Indicate "Yes" or "No"*
Mailing Address			
Street or P.O. Box:			
City or Town:		State:	Zip Code:
System Contact Person			
Name:		Title:	
Telephone:		Email:	
Person Who Prepared Inventory (if different from above)			
Name:		Title/Affiliation:	
Telephone:		Email:	

Inventory Methodology

PWS Name:	
PWSID:	
Enter Date Last Updated:	

Purpose of this worksheet: *For water systems to document the methods and resources they used to develop and update their inventory.*

Part 1: Historical Records Review	
Type of Record	**Describe the Records Reviewed for Your Inventory and Indicate Your Level of Confidence (*e.g.* , Low, Medium, or High)**
1. Previous Materials Evaluation *Example: Locations of Tier 1 lead tap sampling locations that are served by a lead service line.*	
2. Construction Records and Plumbing Codes *Examples: Local ordinance adopting an international plumbing code. Permits for replacing lead service lines.*	
3. Water System Records *Examples: Capital improvement plans. Standard operating procedures. Engineering standards.*	
4. Distribution System Inspections and Records Examples: *Distribution system maps. Tap cards. Service line repair/replacement records. Inspection records. Meter installation records.*	
5. Additional Records Required by Your State	
6. Other Records	

Inventory Methodology (Continued)

Part 2: Identifying Service Line Material During Normal Operations

1. During which normal operating activities are you collecting information on service line material? Check all

- ☐ Water meter reading
- ☐ Water meter repair or replacement
- ☐ Service line repair or replacement
- ☐ Water main repair or replacement
- ☐ Backflow prevention device
- ☐ Other

If "Other", please explain:

2. Did you develop or revise standard operating procedures to collect service line material information	*Indicate "Yes" or "No"*

If "Yes", please describe:

Part 3: Service Line Investigations

1. Identify the service line investigation methods your system used to prepare the inventory (check all that apply). If a water system chooses an investigation method not specified by the state under 40 CFR §141.84(a)(3)(iv), state approval is required. ***Note that investigations are not required by the LCRR but can be used by systems to assess accuracy of historical records and gather information when service line material is unknown.***

- ☐ Visual Inspection at the Meter Pit
- ☐ Customer Self-Identification
- ☐ CCTV Inspection at Curb Box - External
- ☐ CCTV Inspection at Curb Box - Internal
- ☐ Water Quality Sampling - Targeted
- ☐ Water Quality Sampling - Flushed
- ☐ Water Quality sampling - Sequential
- ☐ Water Quality Sampling - Other
- ☐ Mechanical Excavation
- ☐ Vacuum Excavation
- ☐ Predictive Modeling
- ☐ Other

If "Other", please explain:

2. If "Predictive Modeling", please briefly describe the model and inputs used:

3. How did you prioritize locations for service line materials investigations? For example, did you consider environmental justice and/or sensitive populations, did you use predictive modeling, and/or did you target areas with high number of unknowns?

Inventory Summary

PWS Name:	
PWSID:	
Enter Date Last Updated:	

Purpose of this worksheet: *For water systems to provide a summary of their service line inventory, including information on ownership, inventory format, and the number of service lines for each of the four required materials classifications.*

Part 1. General Information

1. Is this the **Initial Inventory** or an **Inventory Update**?	
2a. Who **owns the service lines** in your system?	
2b. Is there documentation that defines service line ownership in your system, such as a local ordinance? *If yes, please describe below and explain where ownership is split (e.g., property line, curb stop).*	
3a. Describe when lead service lines were generally installed in your system.	
3b. When were lead service lines banned in your system? Reference the state or local ordinance that banned the use of lead in your system.	
4. Do you have lead goosenecks, pigtails or connectors in your system?	*Indicate "Yes", "No", or "Don't Know"*
5. What is your overall level of confidence in the inventory (*i.e.* , "Low", "Medium", or "High.") Please explain your rationale below.	

Part 2. Inventory Format

Describe your inventory format in the space provided below (*e.g.* , the **Detailed Inventory** worksheet, custom spreadsheet, GIS map). Provide the filename and/or web address if applicable. ***Note that the state may require you to submit your detailed inventory of each service line in your distribution system.***

Inventory Summary (Continued)

Part 3. Inventory Summary Table [1]

Enter the number of service lines in the aqua-colored cells. ***Remember this is the classification for the entire service line.***

Service Line Material Classification	Definition	Total Number of Service Lines (REQUIRED to be reported under the LCRR)
Lead	Any portion of the service line is known to be made of lead.[2]	
Galvanized Requiring Replacement (GRR)	The service line is not made of lead, but a portion is galvanized and the system is unable to demonstrate that the galvanized line was never downstream of a lead service line.	
Non-Lead	All portions of the service line are known NOT to be lead or GRR through an evidence-based record, method, or technique.	
Lead Status Unknown	The service line material is not known to be lead or GRR. For the entire service line or a portion of it (in cases of split ownership), there is not enough evidence to support material classification.	
	TOTAL	

Notes

[1] This summary table is for reporting material for the entire service line connecting the water main to the customer's plumbing. See Section 2.1 for additional guidance on assigning a materials classification to the entire service line when ownership is split. Remember that systems must track the system-owned and customer-owned portions separately in their inventory.

[2] A lead-lined galvanized service line is consistent with the definition of an LSL under the LCRR ("a portion of pipe that is made of lead, which connects the water main to the building inlet") (40 CFR §141.2) and must therefore be classified in the inventory as an LSL. Do NOT, however, count non-lead service lines with a lead gooseneck or pigtail as lead service lines unless required by your state.

Public Accessibility Documentation

PWS Name: PWSID:	
Enter Date Last Updated:	

Purpose of this worksheet: For systems to provide documentation to states on how they met the public accessibility requirements of the LCRR.

1. Select the location identifiers that you use for your service line inventory. Check all that apply.

- ☐ Address
- ☐ Street
- ☐ Block
- ☐ Intersection
- ☐ Landmark
- ☐ GPS Coordinates
- ☐ Other

If "Other", please describe:

2. Does ***every service line*** have a location identifier? Indicate "Yes" or "No"

If "No", explain. Remember that location identifiers are required for service lines that are lead and galvanized requiring replacement.

3. How are you making your inventory publicly accessible? Check all that apply. *Remember that if your system serves > 50,000 people, you* ***must*** *provide the inventory online.*

- ☐ Interactive online map
- ☐ Static online map
- ☐ Online spreadsheet
- ☐ Printed service line map
- ☐ Printed tabular data
- ☐ Information on water utility mailings or newsletter
- ☐ Hard copy information available in water system office
- ☐ Other

If "Other", please describe:

State Checklist for Initial Inventory Submittal	
PWS Name: PWSID:	
Enter Date Last Updated:	

Purpose of this worksheet: *For states to determine and document if water systems met all of the January 15, 2021 Lead and Copper Rule (LCRR) requirements for their* **Initial Inventory** *including timely submission, required elements, use of information sources, public accessibility, and public notification of service line materials.*

Part 1: Person Completing This Checklist	
Name:	Title:
Telephone:	Email:

Part 2: Review for Timely Submission	
1. Was the initial inventory submitted by the deadline of October 16, 2024?	*Indicate "Yes" or "No"*
Consider post-mark or date sent via email or reported into a state data system.	

Part 3: Review for Required Elements	
1. Does the inventory include ***all*** service lines connected to the distribution system?	*Indicate "Yes" or "No"*
Consider if the total number of service lines in the ***Inventory Summary*** *worksheet, Part 3, matches sanitary survey and monitoring data in the state's database (e.g., SDWIS/State) based on population served, number of service connections (including those for non-potable use), number of accounts, census data, or other information.*	
2. Does the inventory include portions owned by the water system and the customer?	*Indicate "Yes" or "No"*
Check the service line ownership type selected in the ***Inventory Summary*** *worksheet, Part 1, Question 2a. If the system selected "Ownership is Split" check that their inventory includes information for both the system-owned and customer-owned portions.*	
3. Did the system classify all service lines as either Lead, Galvanized Requiring Replacement (GRR), Non-Lead, or Lead Status Unknown?	*Indicate "Yes" or "No"*
Consider if the system completed each row of the inventory summary table in the ***Inventory Summary*** *worksheet, Part 3. Some rows may be zero.*	
4. In the space below, provide additional comments/documentation related to required elements of the system's initial inventory.	

State Checklist for Initial Inventory Submittal (Continued)

Part 4: Review for Information Sources	
1. Did the system use the following historical records to prepare their initial inventory: previous materials evaluation, construction and plumbing codes/records, water system records, distribution system inspections and records.	*Indicate "Yes" or "No"*
Consider if the system identified historical records in each row of the ***Inventory Methods*** *worksheet, Part 1, Rows 1 through 4. Consider if the system completed Row 5 if additional records are required in your state.*	
2. Is the system collecting service line material information during normal operations?	*Indicate "Yes" or "No"*
Consider if the system checked one or more normal operations activities in the ***Inventory Methods*** *worksheet, Part 2. Consider asking the systems to submit updated or new standard operating procedures documenting service line material information collection.*	
3. Has the system conducted investigations to verify service line material?	*Indicate "Yes" or "No"*
This is not required by the LCRR but recommended by EPA to verify historical records and gather information where records do not exist to reduce the number of unknowns in the system as quickly as possible. Consider: • *If the system checked one or more of the investigative methods on the* ***Inventory Methods*** *worksheet, Part 3.* • *If in their inventory, the system indicated that the materials classification was based on investigations.* • *The number of unknowns - EPA strongly discourages systems from submitting inventories with all unknowns. If all service line materials are lead status unknown, consider asking the water system to conduct investigations.*	
4. In the space below, provide additional comments related to information sources used to develop the system's initial inventory.	

Part 5: Review for Public Accessibility	
1. Does the inventory include location identifiers for each service line that is lead or galvanized requiring replacement?	*Indicate "Yes" or "No"*
Consider checking the inventory for location identifiers and reviewing the system's answers in the ***Public Accessibility Doc.*** *worksheet, Questions 1 and 2.*	
2. Did the system make its inventory publicly accessible?	*Indicate "Yes" or "No"*
Consider reviewing the method by which the water system is making its inventory publicly accessible as identified in the ***Public Accessibility Doc.*** *worksheet, Question 3. Check that systems serving more than 50,000 people have posted their service line inventories online.*	
3. In the space below, provide additional comments/documentation related to public accessibility of the system's initial inventory.	

State Checklist for Initial Inventory Submittal (Continued)

Part 6: Review of Customer Notification of Service Line Material	
1. Does the water system's inventory consist of all Non-Lead Service lines? *If No, complete questions 2 through 5. If Yes, stop here.*	*Indicate "Yes" or "No"*
2. Did the water system deliver the notification to people served by a lead service line (LSL), GRR, or lead status unknown service line within 30 days of completing the initial inventory?	*Indicate "Yes" or "No"*
3. Did the water system demonstrate that they delivered the notification and provide a copy of the notification to the state by **July 1** for the previous calendar year?	*Indicate "Yes" or "No"*
4. Did the notification include the required content?	
a. For **confirmed LSLs,** does the notification include: • A statement that the service line material is lead, • Information on lead health effects including mandatory health effects language of 40 CFR §141.85(a)(ii), • Steps to minimize exposure to lead in drinking water, • Opportunities for service line replacement, • Available financing programs, and • A statement that the system must replace its portion if the they are replacing their portion?	*Indicate "Yes" or "No" or "N/A"*
b. For **GRRs,** does the notification include: • A statement that the service line material is GRR, • Information on lead health effects including mandatory health effects language of 40 CFR §141.85(a)(ii), • Steps to minimize exposure to lead in drinking water, and • Opportunities for service line replacement?	*Indicate "Yes" or "No" or "N/A"*
c. For **Unknowns,** does the notification include: • A statement that the service line material is lead status unknown, • Information on lead health effects including mandatory health l effects language of 40 CFR §141.85(a)(ii), • Steps to minimize exposure to lead in drinking water, and • Opportunities to verify the service line material?	*Indicate "Yes" or "No" or "N/A"*
5. If the water system serves communities with a large proportion of non-English speaking consumers, as determined by the state, did they provide public education materials, including those in 40 CFR §141.85(e), in the appropriate language(s) or containing a telephone number or address where persons served may contact the water system to obtain a translated copy of the materials or to request assistance in the appropriate language?	*Indicate "Yes" or "No"*
6. In the space below, provide additional comments/documentation related to customer notification for people served by an LSL, GRR, or lead status unknown service line.	

Appendix B: Case Studies

DC Water

Greater Cincinnati Water Works

Pittsburgh Water and Sewer Authority

DC Water

Key Topics

- Consider the Inventory as a Living Data System
- Water Quality Sampling to Identify LSLs
- Making Inventory Information Publicly Accessible

Background/Water Utility Description

DC Water provides approximately 92 million gallons of treated drinking water per day to about 700,000 residents of the District of Columbia. DC Water is a consecutive system, purchasing treated water from the Army Corp of Engineers. The Army Corp treats water from the Potomac River using conventional treatment with chlorine for primary disinfection and chloramines for secondary disinfection. Orthophosphate is added for corrosion control, along with pH adjustment. The DC Water distribution system is comprised of approximately 1,350 miles of water main. DC Water estimates that they have 28,000 lead or galvanized iron service lines with plans to replace them all by 2030 (DC Water, 2021a).

Consider the Inventory as a Living Data System

DC Water has a long history of identifying and replacing lead service lines (LSLs) in response to exceeding the lead action level in 2002 through 2004 (Deignan, 2021). Schmelling (2021) stressed that the inventory is not a one-time data extraction, but a living dataset that can be updated as new information is collected and records are improved over time. DC Water also records information on the integrity of the data, such as the data source.

DC Water uses many sources and methods to gather service line information, including (Schmelling, 2019, 2021):

- Research done to identify service line materials for the original Lead and Copper Rule (LCR) in 1991, *i.e.*, interviews with plumbers to determine when LSLs stopped being installed in Washington, DC (DC Water found this to be an excellent starting point for their inventory);
- Historical records, including tap cards, permits, and engineering documents;
- Construction records on when service lines were replaced in coordination with water main replacement or in response to service line leaks;
- Customers reporting that they replaced their service lines;
- Customer self-identification;

- Water meter replacement; and
- Water quality sampling.

DC Water is also working with the Water Research Foundation to investigate non-invasive service line identification techniques, such as x-ray diffraction, stress wavers, and acoustic technology (Schmelling, 2021).

Water Quality Sampling to Identify LSLs

DC Water assessed the ability of 6-hour stagnation sequential samples to predict the presence of LSLs (Bukhari et al., 2020; Schmelling, 2019). Customers collected 10 sequential 1-liter samples, indicated the suspected service line material at the point of entry (*i.e.*, lead, copper, brass, galvanized iron, or not visible), and provided a supporting picture when possible. DC Water predicted that half of the 172 homes in the study had lead pipes based on the trend of lead concentrations in the 10-bottle set. They also determined that a total lead mass of at least 5 micrograms (µg) from all 10 samples was another factor supporting the presence of LSLs in their system. Subsequent service line work indicated that DC Water correctly predicted 26 of 30 homes to be lead and 2 of 4 to be non-lead. DC Water concluded that sequential sampling is a useful tool for predicting the presence of LSLs, but it cannot predict the absence of lead pipe due to factors that may impact the stagnation period prior to sampling (*e.g.*, leaks, water use, and dripping faucets). DC Water also notes the water sampling effort is time consuming considering sample distribution and customer communication; therefore, there is still a significant need for another non-invasive pipe material identification technology (DC Water, 2022).

Making Inventory Information Publicly Accessible

DC Water provides an interactive map with service line pipe material data for the public and private sides in their entire service area, which is available on their website (DC Water, 2021b). Each service address is indicated by a circle that contains two color-coded semi-circles for the service line type: one for the public space and another for the private side. Gray denotes lead, green indicates non-lead, and no shading indicates no information. A screenshot of the map is provided as Figure 1.

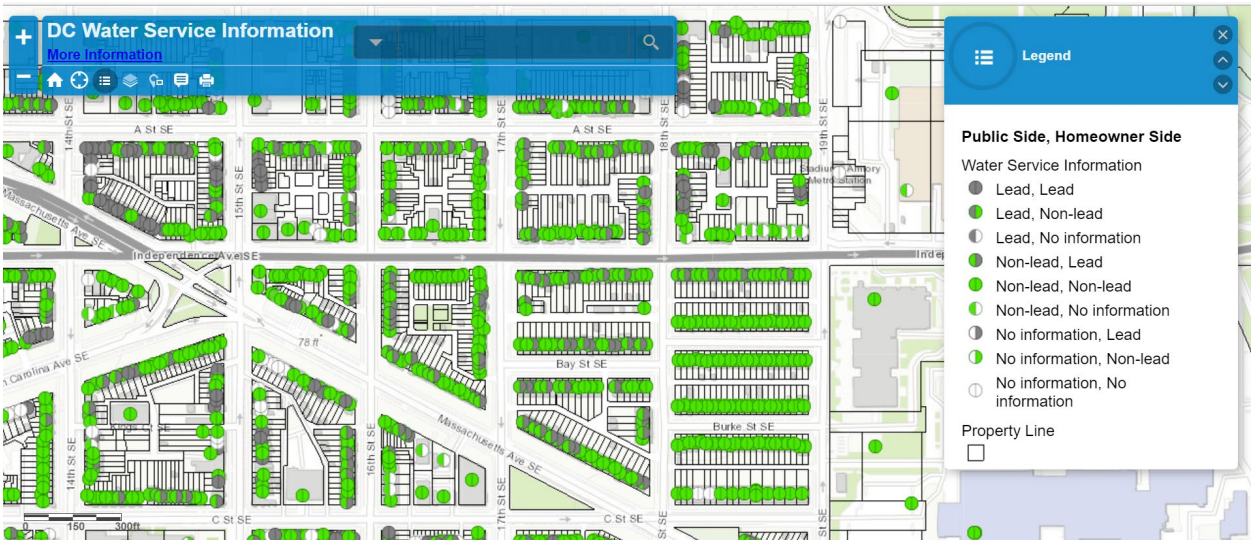


Figure 1: Screenshot of DC Water Interactive Service Line Map (DC Water, 2021b).

When a service address is selected, a pop-up box appears that includes the type and description for the public and private portions separately as well as a link to frequently asked questions and a fact sheet on how customers can identify their water service pipe material. The description field includes the source for the determination, *e.g.*, when the service line was replaced and if it was verified by test pit or visual observation (shown as "excavation"). An example of the pop-up box is shown as Figure 2.

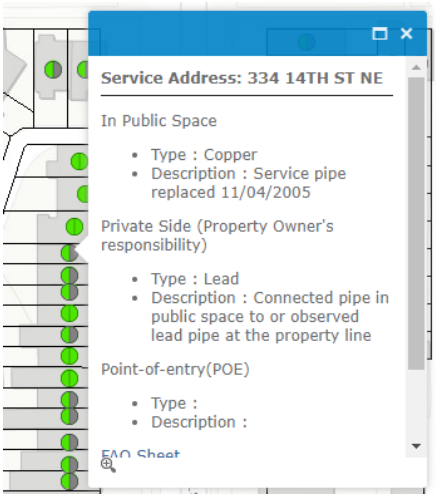
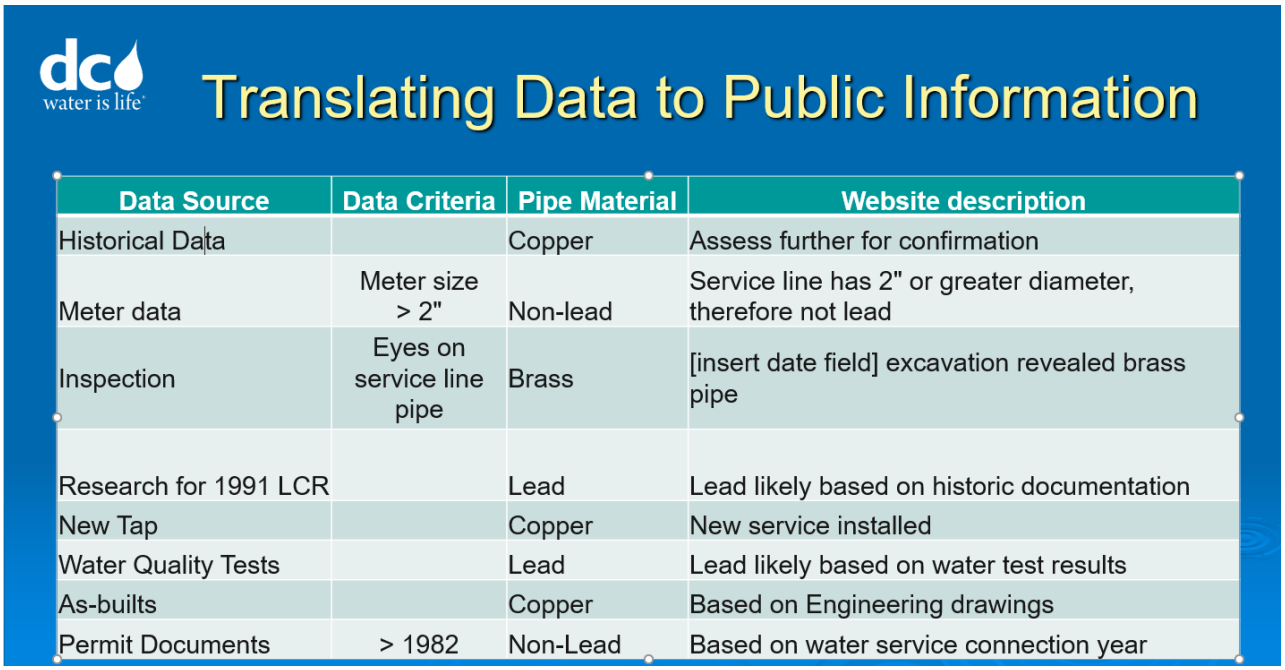


Figure 2: Screenshot of Description Field (DC Water, 2021b).

DC Water took several steps to clearly communicate service line information to the public. For example, they developed a standard process for translating internal documentation for their service line data system into plain language for the online publicly accessible map. An

example is shown below in Figure 3 (Schmelling, 2021). DC Water also provides their inventory in list format as a downloadable CSV file (DC Water, 2021c).



Data Source	Data Criteria	Pipe Material	Website description
Historical Data		Copper	Assess further for confirmation
Meter data	Meter size > 2"	Non-lead	Service line has 2" or greater diameter, therefore not lead
Inspection	Eyes on service line pipe	Brass	[insert date field] excavation revealed brass pipe
Research for 1991 LCR		Lead	Lead likely based on historic documentation
New Tap		Copper	New service installed
Water Quality Tests		Lead	Lead likely based on water test results
As-builts		Copper	Based on Engineering drawings
Permit Documents	> 1982	Non-Lead	Based on water service connection year

Figure 3: DC Water Translation of Data to Public Information (Schmelling, 2021).

DC Water worked with their legal department to develop disclaimer language, as shown below. Schmelling (2021) noted that disclaimer language is important because it recognizes that, although the inventory is based on the best available information at the time, the inventory is dynamic and there may be inaccuracies.

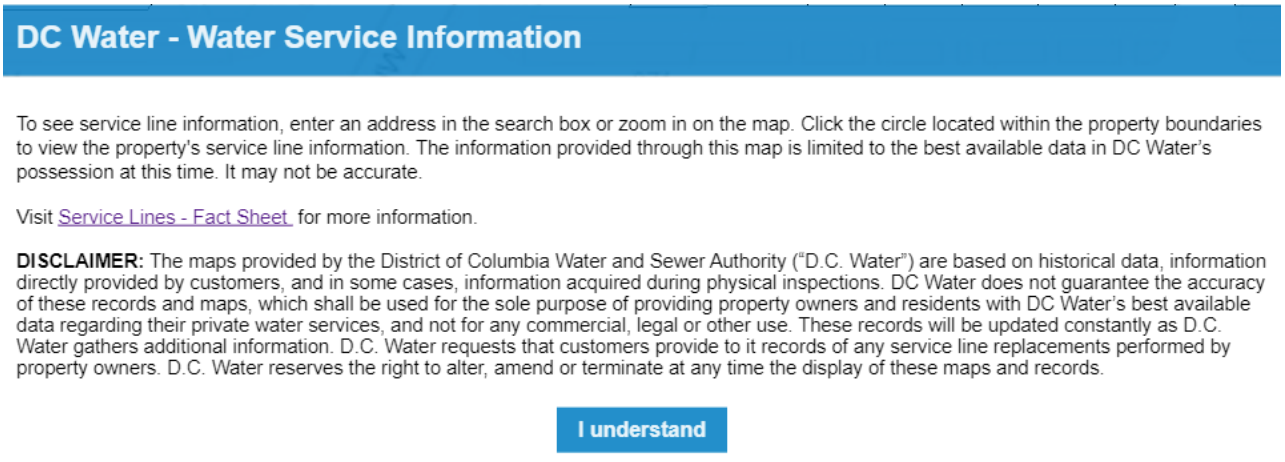


Figure 4. DC Water Disclaimer Language for Their Interactive Service Line Map (DC Water, 2021b).

Summary of Main Points

- DC Water's service line inventory is a living dataset designed to add and revise data from multiple sources over time.
- DC Water has found sequential water sampling to be a useful tool for predicting the presence of LSLs, but it is not a good predictor of the absence of lead pipe due to factors that may impact the pre-sampling stagnation period.
- An interactive online map is a useful tool for communicating information on service line material to the public. It is important to translate technical data into public information and include clear disclaimer language to communicate the limitations of the service line inventory.

Resources

Bukhari, Z., Ge, S., Chiavari, S., and Keenan, P. 2020. Lead Service Line Identification Techniques. The Water Research Foundation. https://www.waterrf.org/system/files/resource/2020-06/DRPT-4693.pdf

DC Water. 2021a. Lead Free DC by 2030. https://www.dcwater.com/lead. Accessed December 3, 2021.

DC Water. 2021b. DC Water – Service Line Information https://geo.dcwater.com/Lead/. Accessed December 3, 2021.

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DC Water. 2022. Personal communication between EPA staff and Maureen Schmelling, DC Water. April 19, 2022.

Deignan. John. 2021. DC Water's LSR Program Journey from Mandated to Planned [Webinar]. AWWA Virtual Summit: Lead & Water Quality, April 7-8, 2021. https://www.awwa.org/Events-Education/AWWA-Virtual-Summits/Lead-Water-Quality-Summit#11394909-event-faqs

Schmelling, M. 2019. Lead service line identification and replacement webinars. Retrieved from USEPA website https://www.epa.gov/dwreginfo/lead-service-line-identification-and-replacementwebinars.

Schmelling, M. 2021. DC Water's Service Line Inventory and Display Maps [Webinar]. ASDWA Annual Conference: 2021. Lead Service Line Inventories. October 18 & 19, 2021. Available at: https://www.youtube.com/watch?v=IaZEbnXnQpQ. Accessed 1/19/22.

Greater Cincinnati Water Works

Key Topics

- Building and Updating Service Line Inventory
- Interactive Public Inventory Map

Background/Water Utility Description

Greater Cincinnati Water Works (GCWW) provides water services to Cincinnati, Ohio and several surrounding counties. GCWW treats around 132 million gallons of water daily. They use high consistent oxidation-reduction potential (ORP) (free chlorine at approximately 1.3 mg/L) and pH promoting lead (IV) scales to control corrosion (Liggett et al., 2022). GCWW serves over 1.1 million customers through 3,180 miles of water mains (GCWW, 2021a).

In 1927, the City of Cincinnati stopped installing lead service lines (LSLs), yet some of those LSLs still remain. GCWW estimates they have a total of 39,165 service lines that are part or all lead, including 25,980 private, 13,085 full, and 100 public LSLs in their service area (GCWW, 2022).

Following EPA's 1991 Lead and Copper Rule, GCWW launched a lead reduction program (Arnette, 2020). For years, GCWW has replaced LSLs and used corrosion control treatment. In 2016, GCWW launched their Enhanced Lead Program, a two-tiered strategy that focused on consumer education and outreach (Tier 1) and removal of all LSLs (Tier 2) (GCWW, 2021b, Burlingame et al., 2018).

Building and Updating the Service Line Inventory

In 2000, GCWW began their effort to populate an inventory of public-side materials in GIS using billing system information, the branch or service line number, and water main project inspection reports (Arnette, 2020). Later, to develop an inventory of customer-side materials, GCWW created a new attribute in GIS for the customer-side material type (Arnette, 2020). To populate customer-side data, GCWW used the following sources of information (Arnette, 2020; Liggett et al., 2022; GCWW, 2016):

- Historical records and asset management records.
- Maintenance, repair, and replacement work.
- Work orders.
- Water main replacement inspections.
- Water main and service line records.

- Customer-initiated replacement inspection reports.
- Visual inspections.

Following the effort in 2000, GCWW found that at branch number 101808, the public service line materials transitioned from lead to copper. For the private side, GCWW also designated the service line as lead or copper based on their branch numbers as follows:

- Branch numbers 102000 or higher and diameter of 2 inches or less as copper.
- Branch numbers below 102000 as lead except if GCWW had evidence that the customer renewed the line, then designated as copper.

In 2016, GCWW created an electronic tool to collect information from their water main project inspections, update their inventory, and allow the information to be available to the public the next day (Arnette, 2020). This is accomplished using an electronic form on inspectors' phones created using Microsoft Power Apps. The information is sent directly to GIS Editors. A snapshot of this app is provided as Figure 1.

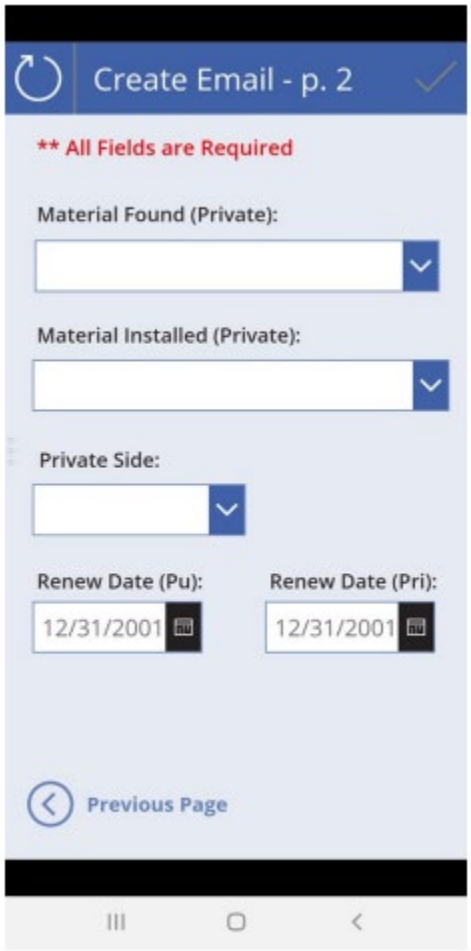

Figure 1: Screenshot of Water Main Project Inspection App (Arnette, 2020).

The inventory is continuously updated as GCWW retrieves more data, including information provided by customers who verify the service line material on their property using a scratch test and an online form on the GCWW website. Step-by-step instructions, along with contact information, are provided on GCWW's website (GCWW, 2021c). Figure 2 below shows a screenshot of the online form with instructions for customers to upload a picture of their meter setting to help identify the pipe material.

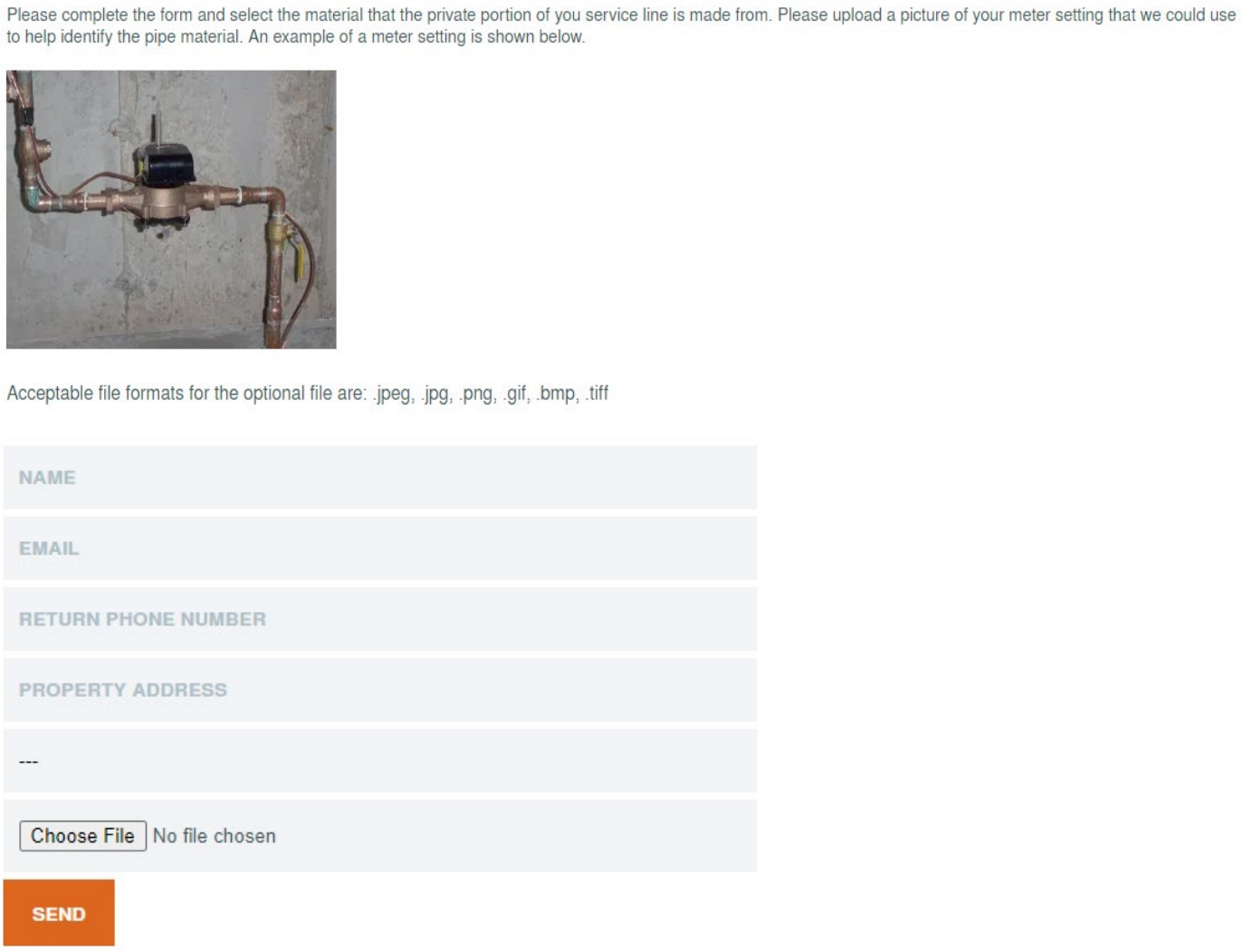

Figure 2: Screenshot of Instructions and Online Form from GCWW's website (GCWW, 2021c).

Interactive Public Inventory Map

GCWW developed the interactive Lead Look-up Map to provide the public with easy access to information from their service line inventory (GCWW, 2021d). After reading and accepting a disclaimer regarding the accuracy and use of the data (see Figure 3), users can search their address to view a map of their service lines and materials. The map includes a legend that identifies materials on the public and private side, shown as a divided rectangle (left side is public side and right side is private side). The map uses a combination of colors and symbology. A green checked box denotes non-lead, yellow and an X is lead, and gray and no symbol indicates no information. GCWW updates their map regularly as they retrieve more data. A snapshot of the map is provided in Figure 4.

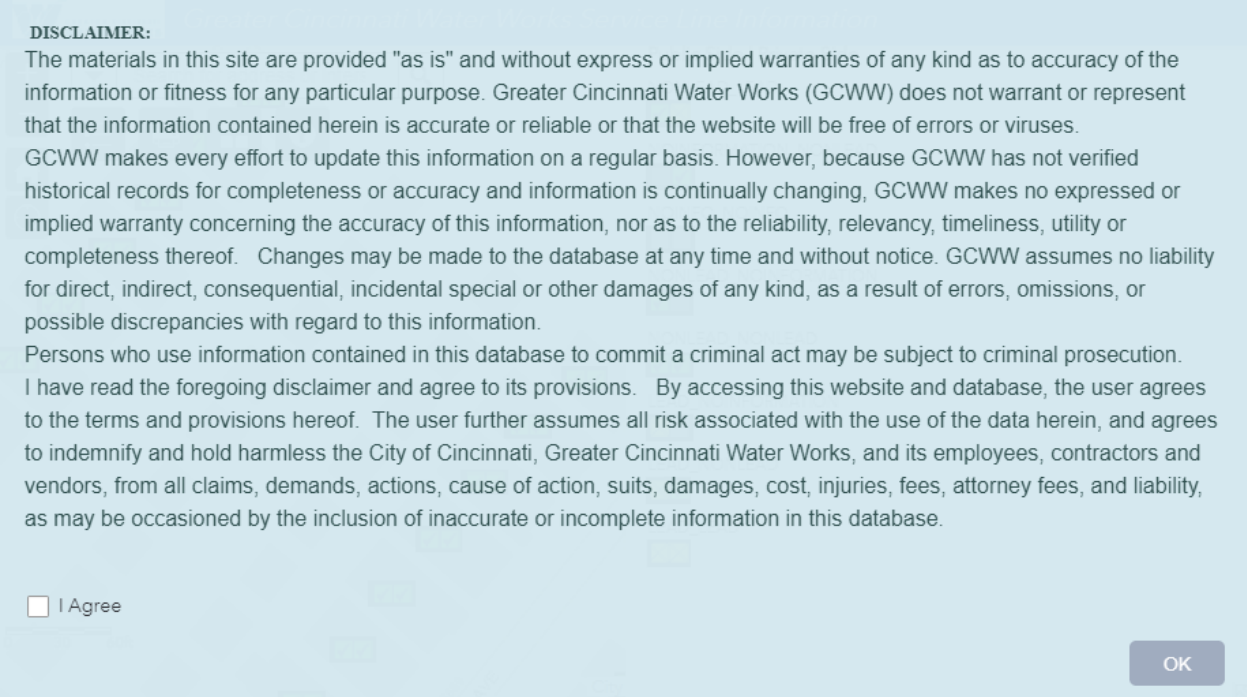

Figure 3: Screenshot of GCWW Disclaimer Language (GCWW, 2021d).

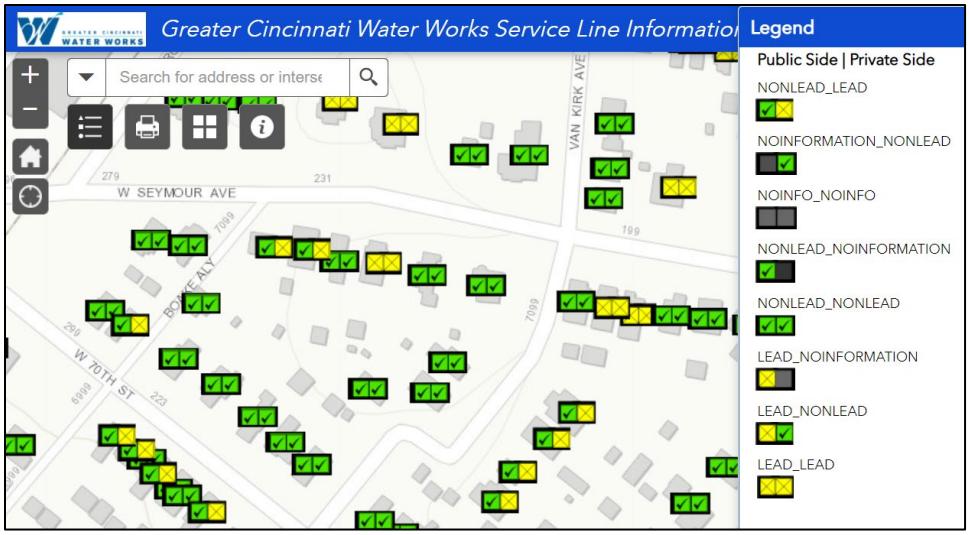

Figure 4: Snapshot of the GCWW Lead Look-up Map (GCWW, 2021d).

Summary of Main Points

- **Use Multiple Information Sources to Develop the Inventory.** GCWW used a variety of records to initially build the inventory and then verified and improved accuracy using a custom-built app as well as information provided by customers.
- **Develop User-friendly Tools.** It is important to ensure that public-facing tools are understandable by a range of users. Hiltner et al. (2019) found the GCWW map very comprehensible, especially in comparison to other similar tools. A visual, with clear legends can aid users' understanding. Providing property-specific LSL information, distinguishing private- and public-side information, being clear about what is not known, and choosing legend colors and icons carefully, are all factors that can improve the usability and understandability of a tool.

Resources

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Pittsburgh Water and Sewer Authority

Key Topics

- Dealing with Uncertain Historical Records
- Experience with Field Techniques
- Statistical (Predictive) Data Analysis
- Innovative Field Data Forms
- Example of the Continuous Improvement Approach

Background/Water Utility Description

The Pittsburgh Water and Sewer Authority (PWSA) provides water to 520,000 people in the Pittsburgh area (USEPA, 2021). Publicly owned and operated, the system produces a daily average of 69.6 million gallons of finished water (PWSA, 2021a). Approximately 965 miles of water lines and 11 tanks comprise the distribution system (PWSA, 2021b). Water is treated using a clarifier pretreatment system and rapid sand filtration system (PWSA, 2021c). In the spring of 2019, PWSA also optimized their corrosion control treatment by switching to orthophosphate, resulting in consistently lower lead levels (PWSA, 2021d). The initial water distribution system was put into service in 1828 and expanded over time through the early half of the 1900s (PWSA, 2021c). In November of 2020, PWSA estimated that in their system, there are 10,995 public and 28,171 private lead service lines (LSLs), and 14,440 public and 4,997 private service lines of unknown material (Liggett et al., 2022).

Inventory Approach

Unless otherwise noted, the source of information for the inventory approach is the 2021 Journal AWWA Article Developing and Verifying a Water Service Line Inventory. Duffy, D. and Pickering, W. (2021).

Overview

PWSA began updating their inventory of service line materials in 2016. To organize and publicize their service line inventory, PWSA launched an online Lead Map on their website (Figure 1). They update the map monthly as they gather more data. Users can search their unique address on the map to display the results for their service line materials on the public- and private-side, as well as to display the source of that data (Figure 2). Data sources include historical records, verification by excavation, replacement information, and curb box inspection (CBI) results.

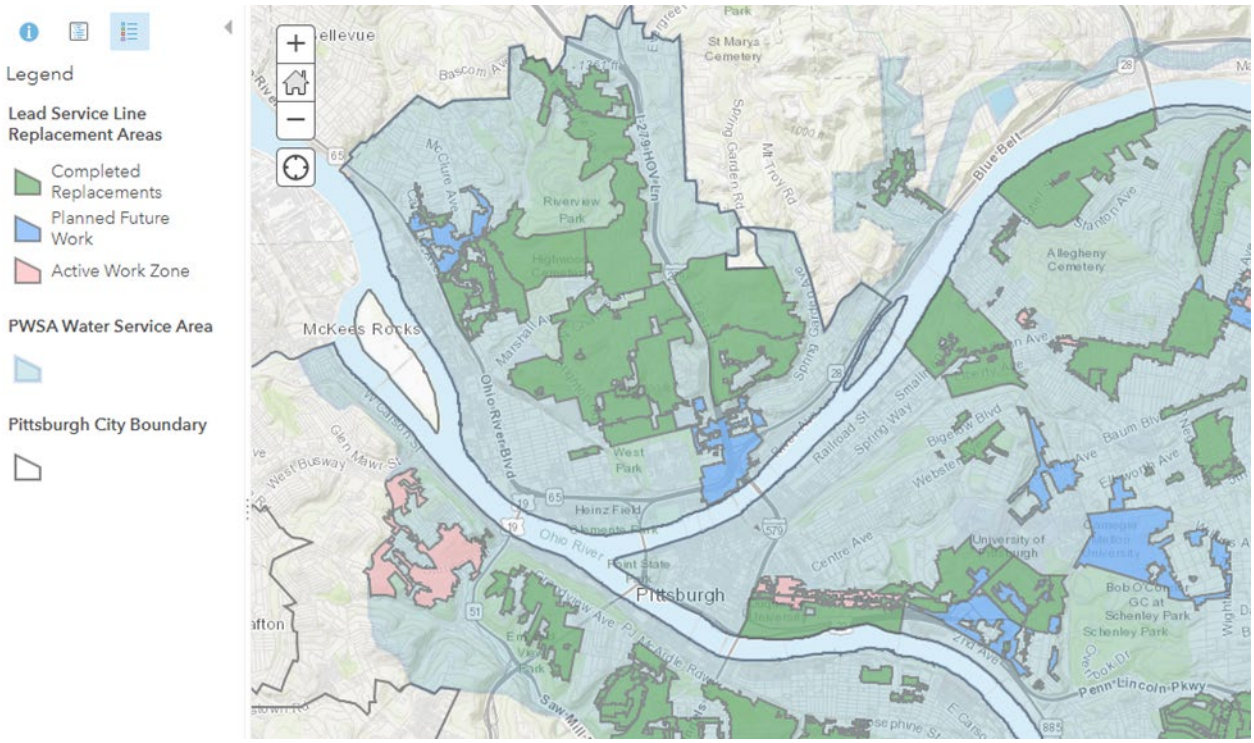

Figure 1: Snapshot of PWSA Lead Map (PWSA, 2021e).

Figure 2: Snapshot of a neighborhood in Pittsburgh, PA, as viewed on the PWSA Lead Map (PWSA, 2021e).

Dealing with Uncertain Historical Records

To begin their service line inventory update, PWSA reviewed historical drill records of water main tapping and material identification endeavors, and historical private-side service line inspections. PWSA digitized over 130,000 hard copies of these records and published them to their Lead Map.

Because many service lines had been maintained and repaired since being installed, PWSA found that only 63 percent of their historical records were accurate. Further, prior to 1984, water main tapping and material identification were only done on the public-side. Private-side service line inspection records had not been consistently updated or prepared at every drill record site. As such, PWSA has a disclaimer on their online Lead Map (PWSA, 2021e), cautioning that some of the historical records are inaccurate and that PWSA will update as more information becomes available. PWSA began gathering data through alternative approaches, including through the field techniques described below.

Experience with Field Techniques

PWSA began excavating curb stops where the location either had no historical record or had a record of lead. PWSA requires a minimum of 24 inches be excavated on each side of the curb stop because in many instances they found that the curb stop and small part of the service line had been replaced with non-lead materials but tied back into lead. PWSA used an ArcGIS Collector app to add a photo of each curb stop and log the type of service line materials. Although effective, this excavation process was slow, less efficient due to the larger required excavation size, and very costly to PWSA. In 2018 and 2019, PWSA spent $5 million excavating sites that they found to not contain LSLs.

To evaluate a more efficient service line identification approach, PWSA began doing CBIs using small cameras sent down into the curb stop where the public and private service lines were visible to identify the material. After inspecting approximately 15,000 locations in 2018, PWSA found that about 25 percent of the data was usable. Often, they were either unable to locate a curb box, reach the curb stop, or identify the service line material because of its degradation or the photo quality. When CBI identified lead, results were very accurate (97 percent of locations were verified as LSLs. However, lead was later discovered at 35 percent of locations identified by CBI as non-lead. Duffy and Pickering (2021) explain that this is because in some locations, the curb box and a small length of the service line was replaced but not the entire service line. PWSA began considering other ways to gather information on service line material, as described below.

Statistical (Predictive) Data Analysis

The University of Pittsburgh helped PWSA develop a model to predict service line materials at locations across their system. The model used data from various sources, including property assessments, tap sampling water results, and service line records, to predict what houses might also have lead levels in their water above 15 micrograms per liter (Hajiseyedjavadi et al., 2020). With an accuracy of 73 percent, the model was ultimately only slightly more accurate than the historical records. Thus, PWSA decided not to use the model to estimate service line materials but is using the model to prioritize LSL replacement areas.

Innovative Field Data Forms

PWSA developed specific service line and meter replacement work orders in the tablet-based application used by its utility workers and plumbers. Utility workers and plumbers update service line material observations and record data for any replacements they conduct. In addition, the Allegheny County Health Department (ACHD) uses an app for their plumbing inspectors to record data about the private-side service line inspections they complete. ACHD's app sends PWSA an email with the information logged during each inspection that helps PWSA update the private-side of their service line material inventory.

Example of the Continuous Improvement Approach

PWSA's approach to developing an inventory fits into the EPA-recommended **Continuous Improvement** framework to build and update the inventory using new and better data as follows:

- Upon identifying the action level exceedance in 2016, PWSA began updating their inventory of residential service line materials by reviewing historical records.
- PWSA began reviewing historical drill records and private-side service line inspections.
- Upon review, PWSA realized there were too many gaps, inaccuracies, and inconsistencies to solely rely on the historical records. The data were only 63 percent accurate.
- PWSA began exploring alternative approaches that would be more cost effective and increase accuracy.

They modified their approach for conducting excavations at the curb box to use cameras to try to reduce costs and improve the likelihood of finding LSLs. Although less invasive and reliable for identifying LSLs, CBIs were less reliable for confirming that no LSLs were present. Then PWSA experimented with predictive modeling but found that the model was only slightly more accurate than historical records. Thus, PWSA decided not to use predictive modeling to estimate service line materials but instead uses it to prioritize LSL replacements.

PWSA has found that no one method is superior to all others and that a combination of methods works best (see Lessons Learned).

Lessons Learned

Duffy and Pickering (2021) provided a summary of lessons learned from their efforts to build a service line inventory:

- **Use Multiple Data Collection Methods.** Although PWSA could not solely depend on historical records and CBI to update the service line inventory, these methods added value to the inventory and ultimately helped refine PWSA's approach. Further, although the predictive data analysis could not be used to estimate service line materials, PWSA is using that analysis to prioritize lead service line replacement areas.
- **Understand Your Historical Data and Limitations.** Upon further evaluation, PWSA discovered that water main replacements before the 1970s only replaced a few feet of service line. Thus, they could not classify all water main replacements as non-lead.
- **Use Electronic Forms and Apps.** PWSA developed multiple apps and tools along the way, including their Lead Map and ArcGIS Collector app. The map is user-friendly and consistently updated. The app eases the service line material reporting process for workers. In short, the tools meet the needs of both the back-end and front-end users.

Resources

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Hajiseyedjavadi, S., Blackhurst, M., and Karimi, H. (2020). A Machine Learning Approach to Identity Houses with High Lead Tap Water Concentrations. Association for the Advancement of Artificial Intelligence, 13300-13305. https://ojs.aaai.org/index.php/AAAI/article/view/7040

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Appendix C: Instructions for Self-Identifying LSLs and Information When Water System Conducts Verification

Examples of Customer Service Line Material Identification Instructions

- Philadelphia Water System
- Rockford, Illinois
- Newark, New Jersey
- Washington, DC

Water Service Verification Materials from Menasha, WI

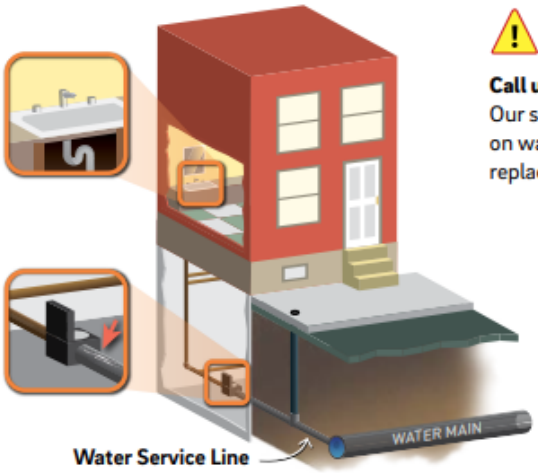
Philadelphia Water System Customer Instructions for Self-Identifying LSLs

PHILADELPHIA WATER DEPARTMENT

How to check your water service line material

The City's water mains are not made of lead. However, the water service line running from the water main to your home may be made of lead or steel.

Lead can also be found in older brass fixtures and valves and in old solder or epoxy, where pipes are joined.



You can test the water service line where it connects to the water meter in the basement.

Water Service Line
May be made of lead, copper, galvanized steel or plastic.

For any questions about lead in your water:

Call us at (215) 685.6300.
Our staff will provide information on water testing, safety tips and replacement options.

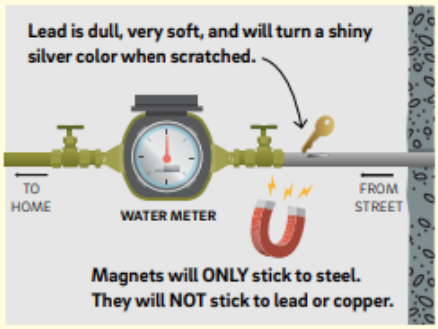
Possible Pipe Materials

Follow these steps:

You will need:

- Key or a coin
- Strong refrigerator magnet

1. Find the water meter in your basement. Look at the pipe that comes through the outside wall of your home and connects to your meter.
2. Carefully scratch the pipe (like you would a lottery ticket) with a key or a coin. Do not use a knife or other sharp tool. Take care not to make a hole in the pipe. If the scratch turns a shiny silver color, it could be lead or steel. **NOTE:** If pipe is painted, use sandpaper to expose the metal first.
3. Place the magnet on the pipe. If a magnet sticks, it is a steel pipe.



Other ways you can check for lead:

- **Purchase a lead test kit at a hardware or home improvement store.** These kits test what the pipe is made from—not the water inside. Look for an EPA recognized kit.
- **A licensed and insured plumber can inspect your pipes and other plumbing for lead or steel. Replacing an older brass faucet or valve might reduce the lead in water.**

12/7/21

Source: https://www.phila.gov/media/20211208161245/HowToCheckYourServiceLineForLead-21.12.07.pdf.

Rockford, IL System Customer Instructions for Self-Identifying LSLs

Pipe Identification Procedures

How To Identify A Lead Water Service Pipe

Tools Needed:

Flathead Screwdriver, Refrigerator Magnet & A Penny (or other coin)

Step 1:
Locate the water service line coming into the building.
This is typically found in the basement. An "inlet valve" and the water meter are installed on the pipe after the point of entry.

Identify a test area on the pipe between the point where it comes into the building and the inlet valve. If the pipe is covered or wrapped, expose a small area of metal.

Step 2:
Scratch the surface of the pipe.
Use the flat edge of a screwdriver or other tool to scratch through any corrosion that may have built up on the outside of the pipe.

Step 3:
Compare your pipe to the chart below.
Each type of pipe will produce a different type of scratch, react to the magnet differently and produce a unique sound when tapped with a metal coin.

Lead Pipes

The Scratch Test
If the scraped area is shiny and silver, your service line is lead.

The Magnet Test
A magnet will not stick to a lead pipe.

The Tapping Test
Tapping a lead pipe with a coin will produce a dull noise.

Copper Pipes

The Scratch Test
If the scraped area is copper in color, like a penny, your service line is copper.

The Magnet Test
A magnet will not stick to a copper pipe.

The Tapping Test
Tapping a copper pipe with a coin will produce a metallic ringing noise.

Galvanized Pipes

The Scratch Test
If the scraped area remains a dull gray, your service line is galvanized steel.

The Magnet Test
A magnet sticks to a galvanized pipe.

The Tapping Test
Tapping a galvanized pipe with a coin will produce a metallic ringing noise.

THE CITY OF ROCKFORD ILLINOIS, USA

Source: https://rockfordil.gov/city-departments/public-works/water-division/lead-and-drinking-water/. Accessed November 2, 2021.

Newark, NJ Customer Instructions for Self-Identifying LSLs

HOW DO I CHECK MY SERVICE LINE'S MATERIAL?

To find out if you have a copper, lead or galvanized steel service on your property, you (or your landlord) can perform a Materials Verification Test on the water service line where it connects to the water meter to determine the material of the water service line on your property.

Please follow the steps below, and then send the results of the test along with your address to info@newarkleadserviceline.com. The City of Newark will include your results in their water service line inventory records.

What You Need

- A house key or coin
- A strong refrigerator magnet

Steps to Check Your Service Line

1. Find the water meter on your property.
2. Look for the pipe that comes through the outside wall of your home and connects to your meter.
3. Use a key or coin to gently scratch the pipe (like you would scratch a lottery ticket). If the pipe is painted, use sandpaper to expose the metal first.
4. Place the magnet on the pipe to see if it sticks to the pipe.
5. Determine your pipe material and send your results and address to info@newarkleadserviceline.com

Your Test Results

If your pipe is **copper**:
The pipe may appear dull brown on the outside but will be the color of a bright penny if gently scratched. A magnet won't stick to a copper pipe.

Newark, NJ Customer Instructions for Self-Identifying LSLs (continued)

If your pipe is **lead**:
The pipe will appear dull and soft but will turn a shiny silver color when scratched. A magnet won't stick to a lead pipe.

If your pipe is **galvanized steel**:
The scratched area will remain a dull gray, and a magnet will stick to the surface. If you have a galvanized steel pipe, you may still have a lead gooseneck on your service line.

Please send your results and address to info@newarkleadserviceline.com

I PERFORMED A VISUAL INSPECTION OF MY LEAD SERVICE LINE. WHAT IF I AM STILL NOT SURE ABOUT MY LEAD SERVICE LINE MATERIAL?

If you tested your water service line, and are still unsure of your lead service line material, the City will visit your home to inspect your service line at no cost to you. To schedule an inspection, contact the Lead Service Line Replacement Team at (973) 733-6303 or email waterandsewer@ci.newark.nj.us

ARE THERE OTHER WAYS I CAN CHECK TO SEE IF I HAVE A LEAD SERVICE LINE?

For more information on identifying a lead service line, including NPR's interactive tool for lead pipe identification, visit https://www.lslr-collaborative.org/identifying-service-line-material.html

Lead test kits to test the pipe can be purchased at your local hardware store. Look for an EPA recognized kit. You can purchase an EPA-approved lead test kit at https://www.epa.gov/lead/lead-test-kits or https://www.amazon.com/dp/b008bk15pu

For questions about lead in water or testing your water service line, contact the Lead Service Line Replacement Team at (973) 733-6303 or email waterandsewer@ci.newark.nj.us

Source: https://www.newarkleadserviceline.com/check-your-line. Accessed December 21, 2021.

DC Water Customer Instructions for Self-Identifying LSLs

dc water is life

Water Service Pipe Material Identification

	Lead	Galvanized Iron	Copper	Brass
Outer Appearance	Dull gray, bendable; Often curves between wall/floor and valve	Dark gray or black; Straight rigid pipe	Brown; Can have green corrosion spots	Brown; Can have green corrosion spots
Threads at connections	None	Yes	None	Yes
Scratch Test (coin or key)	Shiny silver	Hard to scratch, remains gray	Copper, like a penny	Gold color
Magnet Test	Does not stick	Magnet WILL stick	Does not stick	Does not stick

Lead

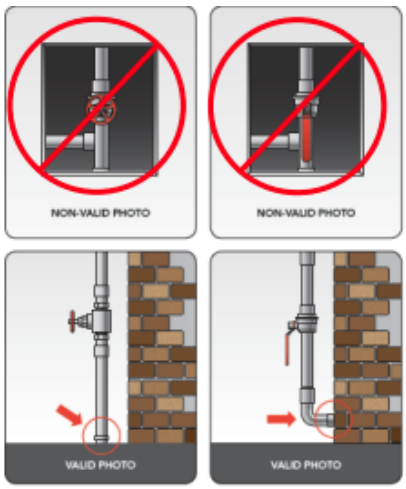
Galvanized Iron

Copper

Brass

DC Water Customer Instructions for Self-Identifying LSLs (continued)

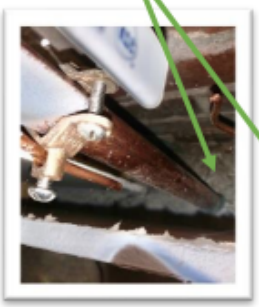
Step 1
Locate the water service line entering the building. You need to see the pipe where it comes through the floor or wall. In the basement or lowest floor, or whole-house water shut-off valve nearby.

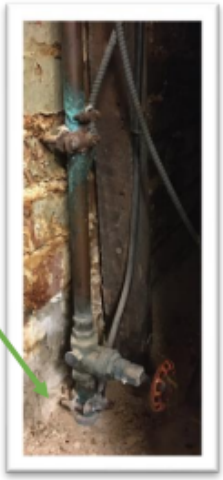


Cannot see where pipe comes through - try to pull back insulation and use phone camera to view pipe at breakthrough.

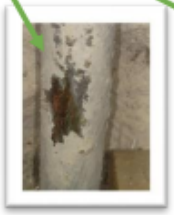
Step 2
Use Pipe Material Identification Sheet
- Look for threads at connections.
- Scratch pipe with a coin or key to reveal the metal. You may need to scratch through corrosion or paint. Lead is soft and scratches easily.
- See if a kitchen magnet sticks to the pipe. A magnet will not stick to a lead pipe.

Pipe coming through floor





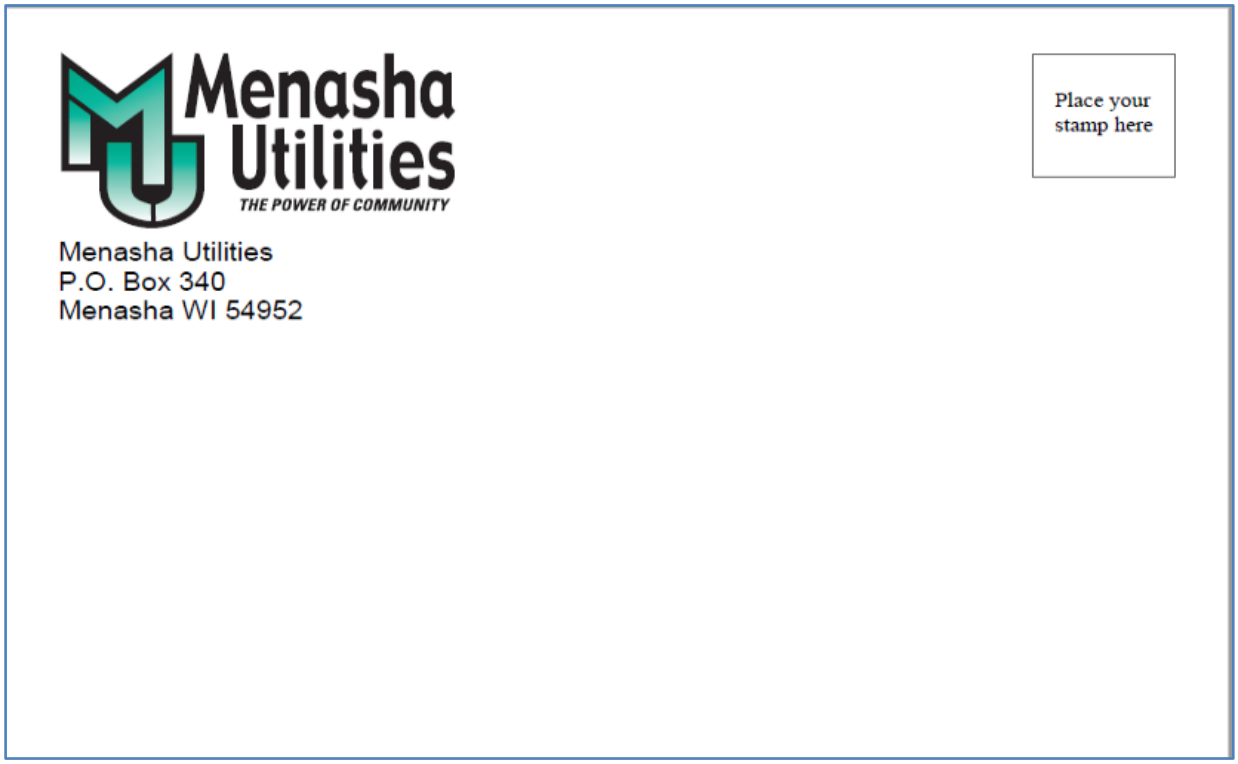
Step 3
Take three (3) photos.
1. Pipe coming through wall or floor.
2. Closer view of pipe with scratch.
3. Further view of pipe that includes shut off valve.



Step 4
Send photos to leadtest@dcwater.com.

Source: https://www.dcwater.com/sites/default/files/Lead-Testing/DCWPipeMaterialIdentificationGuide_2021.pdf.

Customer Information When System Verifies Customer Service Line Material – Menasha Utilities Postcard



Menasha Utilities
THE POWER OF COMMUNITY

Menasha Utilities
P.O. Box 340
Menasha WI 54952

Place your stamp here

Action Required

Dear Menasha Utilities Customer:

Menasha Utilities Water Department does not have record of your water service pipe material

We are updating our records and working toward a lead free water supply for our customers. We would like to verify and confirm the type of water service coming from the water main in the street to your home. The appointment will take approximately five minutes and we will need to access your water meter usually located in your basement.

Please call the Water Distribution Department at **920-967-3431** to schedule an appointment between the hours of 7:00 a.m. and 3:00 p.m. Monday thru Friday.

For more information visit our website: www.menashautilities.com/water-department.

Thank you in advance for your cooperation,

[Insert Contact information]

Customer Information When System Verifies Customer Service Line Material – Menasha Utilities Information When Appointment is Scheduled

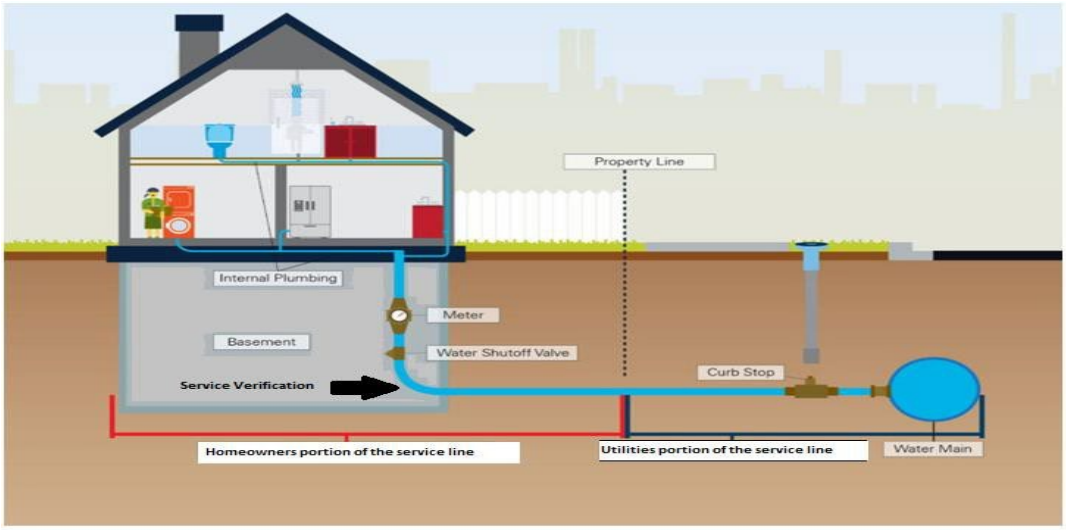
Water Service Verification

Appointment Expectations

Water service lines can be made of lead, copper, galvanized steel, or plastic. Without excavating the service line to expose the pipe, Menasha Utilities employees can determine the pipe material by locating the pipe that connects the water meter to the water main (usually in the basement). Once the pipe is located, employees will conduct a scratch test and find out if the pipe is magnetic to determine the service line material. Images of the different service line materials are shown below.

Reminders

- All Menasha Utility employees have photo identification. Please request to see credentials if they are not visible.
- Someone 18 years or older must be present for the entire appointment.
- Please secure and maintain control of pets.
- Menasha Utility employees will need a safe and clear path to access the water meter.



Menasha Utilities Information When Appointment is Scheduled (continued)

<table>
<tr>
<td>

- Bronze to brown in color
- Not magnetic
- When scratched the pipe will shine like a penny

</td>
<td>

- Blue or black
- Not magnetic
- When scratched the pipe does not change

</td>
</tr>
<tr>
<td>

- Dull gray color
- Magnetic
- Very hard when scratched

</td>
<td>

- Dull gray color
- Not magnetic
- Soft and shiny silver when scratched

</td>
</tr>
</table>

Source:
https://www.menashautilities.com/sites/menashautilities.com/files/Water%20Service%20Verifications%20webpage%20content%202019.pdf. Accessed November 29, 2021.

Appendix D: Summary of Lead Ban Provisions by State

Below is a summary of the 1986 lead ban provisions by EPA Region and then by state. The tables have been recreated with some modification to the format from Table 3-1 of EPA's Lead and Copper Rule Guidance Manual. Volume I: Monitoring (USEPA, 1991b), but the content has not been updated. Thus, water systems should verify the lead ban effective dates with their states.

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region I	Connecticut	Yes	Public Act No. 66-192; Sec. 29-261 General Statutes; State Plumbing Code	12/31/88	Governor 03/29/89	X	X	X	Requires solder warning label
	Maine	Yes	Internal Plumbing Rules 10-144A CMR238; Chapter 9,8,10; Chapter 3, Table 3,5; and Chapter II.D.1	08/01/87	Commissioner, Dept. of Human Services 02/23/89	X	X	X	State purchased Pb solder test kits for inspectors, etc. to use in field testing.
	Massachusetts	Yes	State Plumbing Code, 2-18 CMR; Pg. 55, 201, 208, 207	01/01/86	Commissioner, Dept. of Env. Protection 03/08/89	X	X	X	
	New Hampshire	Yes	State Plumbing Code, Chapter ??? 700, Part ??? 701	08/01/87	Governor 03/28/89	X	X	X	Adopted BOCA
	Rhode Island	Yes	Regulation S.B.C.-3; Article 4, P402.3 and P402.4; and Article 5, P508.4 and P509.5	01/01/87	Governor 03/28/89	X	X	X	Adopted BOCA
	Vermont	Yes	VT Residential plumbing code, ABC Envir. Protection Rules for public buildings	12/28/88 09/10/82	Commissioner of Health, 03/27/89	X	X	X	New legislation eff. June 1989 consolidating plumbing codes and clarifying lead ban.

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region II	New Jersey	Yes	Uniform Construction Code, Plumbing Subcode 5:23-3,15	02/02/87	Governor 02/02/89	X	X	X	Pipe is covered under Bureau of SDWA Regulations
	New York	Yes	Executive Law, Section 905,5 of Titles 9 NYCRR	01/01/86	Commissioner of Health 01/11/89	X	X	X	Lead ban law; Load labeling law
	Puerto Rico	Yes	Planning Board Regulation #7 (Building Regulation) Article V- 8-10	06/19/88	Governor	X	X	X	
	Virgin Island	Yes	VI Interim Primary DW Standards Title 12, VI Rules & Regs. Chapter 51, Section 1303	02/06/89	Governor 02/06/89	X	X	X	

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region III	Delaware	Yes	State Plumbing Code, Section 119 Chapt. 79, Sec. 7906; Chapt. 1, Sec. 122e	06/17/88	Secy. Dept. Health & Social Services	X	X	X	Adopted BOCA
	D.C.	Yes	D.C. Plumbing Code Supplement of 1986, Article 5	08/19/88		X	X		Requires PN; bans>8% pipe, but not fittings
	Maryland	Yes	COMAR 09.20.05.02., 09.20.11.10E,0901.01.09/ 01.03	08/16/88	Secy. Environment 09/15/88	X	X	X	Effective 03/30/89 for pipes and fittings
	Pennsylvania	No	Plumbing System Lead Ban and Notification Act of 7/69	01/06/91		X	X	X	Act also bans the sale of materials that are not lead free
	Virginia	Yes	Uniform Statewide Plumbing code P-501.7.3, P-501.8.4 and P-210-1,4	04/01/86	Governor	X	X	X	Adopted BOCA 04/15/87

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
	West Virginia	Yes	Legislative Rules, Dept. of Health, Plumbing Requirements 64 CSR 57	06/19/88	Governor	X	X	X	Requires PN

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region IV	Alabama	Yes	State Lead Ban Act, ADEM Admin. Code R.335-7-11-05	05/10/88 01/89	Governor/ADEM Director	X	X	X	
	Florida	Yes	Florida Statues, Subsection 553.11 and 553.06	06/10/88 12/88	Governor/DER Secretary	X	X	X	Dept. of Community Affairs to adopt amended State Plumbing Codes
	Georgia	Yes	State Plumbing code, Section 402.1, Section 114.5, and Section 1109.1; State Regs.	07/87 01/89		X	X	X	
	Kentucky	Yes	State Plumbing Code, Section 17, PC-60-3	01/04/88	Commissioner of Bd. Of Housing Mgr. D.w. Branch	X	X	X	Formalization of enforcement procedures with the Div. of Plumbing with the next few months. (11/90)
	Mississippi	Yes	Board of Health, Envir. Regs. Division 300-Water Supply, Part 301 Section 301.5(c)	04/13/88 05/88	Exec. Secy. Bd. Of Health/Asst. Dir. Div. Water Supply	X	X	X	Requires PN
	North Carolina	Yes	State Plumbing Code Volume II, Section 602.4 (solder & flux) Section 1008 (solder, pipe, flux)	03/87	Comm. of Insurance/head Public Water Supply Branch	X	X	X	Requires PN

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
	South Carolina	Yes	State SDWA, 61-58.4 (1)	11/88	Chief Bureau DW Program	X	X	X	Requires PN; State Plumbing Codes expected to be amended during next legislative session.
	Tennessee	Yes	Tennessee Code Annotated, Title 88, Chapter 13, Part 7	03/18/88	Governor/Dir. Div. Water Supply	X	X	X	

EPA Region V	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
	Illinois	Yes	Illinois Administrative Code, Chapter 1, Section 890.620d	04/86	Dir. Of H. EPA & Dir. Of Dept. of Health, 09/13/88	X	X	X	
	Indiana	Yes	IN Plumbing Code, title 675, Sec 7 Subsec. 113g and Sec. 602, Subsec. d	03/01/87	NA	X	X	X	
	Michigan	Yes	Mi Construction Code Act	06/07/88	Governor 11/21/88	X	X	X	
	Minnesota	Yes	Minnesota Statues, Chapter 326, Section 326 371, MN Plumbing Code	06/01/85	Comm. Of Health 09/27/88	X	X	X	Sellers of lead solder must display warning sign.
	Ohio	Yes	OH Basic Building Code	09/12/88	OH EPA & Governor 9/26/88	X	X	X	
	Wisconsin	Yes	Wisconsin Administrative Code	1986	Governor 09/28/88	X	X	X	

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region VI	Arkansas	Yes	State Plumbing Code, 10.1.6 and 10.1.7	06/01/88	Governor Bill Clinton 06/16/88	X	X	X	
	Louisiana	Yes	State Sanitary Code, chapter XII (Water Supplies)	09/20/88	Dept. Asst. Secy. of Dept. of Health & Hospitals 09/12/88	X	X	X	Requires PN
	New Mexico	Yes	State Plumbing Regulations	04/01/87	Governor Garrey Carruthers 12/06/88	X	X	X	Requires PN
	Oklahoma	Yes	Rules and Regulations Governing Plumbers	05/06/87	Governor Henry Bellman	X	X	X	Adopted BOCA
	Texas	Yes	Rules and Regulations for Public Water Systems, 337.206(b)	07/01/88	Governor Clemenis 09/29/88	X	X	X	

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region VII	Iowa	Yes	IA Administrative Code, Chapters 40 and 41	09/14/88	Larry Wilson Exec. Fir. Of IDNR	X	X	X	Requires PN
	Kansas	Yes	KS Statutory Authority 65-1710 and 65-171R	04/19/88	Dr. Stanley C. Grant Secy. KDHE	X	X	X	Requires PN
	Missouri	Yes	10CSR 60-10.040 and 60-8.020; and MS Released Statues, Chapters 311.060	08/31/88	Dr. F. Brunner Dir. MDNR	X	X	X	Requires PN
	Nebraska	Yes	NB Safe Drinking Water Act, Title 179, Chapter 2, Sections 003, 004, 005	05/88	Greg Wright, Dir. Dept of Health	X	X	X	Requires PN

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region VIII	Colorado	Yes	CO Plumbing Code, Chapters 8 and 10	01/31/88	Governor 11/21/91	X	X	X	Adopted Uniform Plumbing Code
	Montana	Yes	Administrative Rules, 8.70.304, Plumbing Permits (4)	12/31/87	Chief, Water Quality Bureau, 10/11/88	X	X	X	
	North Dakota	Yes	State Plumbing Code, Sections 62-03--033,1-08(5), 63-03-04-02(4)	01/01/88	Governor 09/19/88	X	X	X	
	South Dakota	Yes	State Plumbing Code	09/03/87	Secy. Dept. of Water Resources	X	X	X	
	Utah	Yes	State Plumbing Code	04/24/89	Dir. Division of Env. Health 03/08/89	X	X	X	
	Wyoming	No	The Region is trying to implement a lead ban at the local level while pursuing the adoption of a state lead ban.						

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region IX	Arizona	Yes	AZ Revised Statues, 49-353.A2(k) and 49-353.B	08/18/87	Governor 08/28/88	X	X	X	Requires PN, Adopted uniform plumbing code.
	California	Yes	Health and Safety Code, SB164 Sections 300.6 and 300.7	07/01/86	Gov. George Daukmejian, 03/28/89	X	X	X	Effective 01/01/88 for pipes solder warning label
	Hawaii	Yes	HI Revised Statues, Chapter 340B	06/05/87	Dir. Dept. of Health 03/22/89	X	X	X	Requires PN; fines
	Nevada	Yes	NAC, Chapter 445,412, Revised Statues	01/89	State Health Officer 02/18/89	X	X	X	Requires PN
	American Samoa	Yes	AS D.W. Regs. Sec. 25.0431.1	01/89	Yes	X	X	X	
	N. Mariana Is.	Yes	CNMI Drinking Water Regs. Section 5.51	03/13/89	Gov. Pedro Tenorio 03/13/89	X	X	X	
	Guam	Yes	Revised Uniform Plumbing Code, 1988	03/01/88	Gov. Joseph p. Ada, 04/07/89	X	X	X	
	Rep. of Palau	NO							Trust Territory

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
EPA Region X	Alaska	Yes	Section 1, AS 18.60.705	06/05/88	Governor, 04/11/88	X	X	X	Covers all water systems as of 4/89
	Idaho	Yes	Idaho Code Chapter 26, Title 54	08/11/88	Governor, 03/30/89	X	X	X	Adopted Uniform Plumbing Code
	Oregon	Yes	Health Division Rules 333-61-020, 333-61-040 and 333.61.087	09/04/84	Governor, 03/10/89	X	X	X	Warning Labels; removal of lead service lines; public notification lead flux was banned in 1988
	Washington	Yes	State Building code, Chapter 551-16 WAC, Section 15-16 060	04/27/87 03/17/88	Governor, 03/30/89	X	X	X	

	State	Implemented Lead Ban	Method	Date Effective	Certification Signature	Requires Solder	Use of Flux	Lead Pipe	Notes
Total	All	Yes: 54 No: 3				56	56	55	

Appendix E: Michigan Minimum Service Line Verification Requirements

In 2018, Michigan EGLE revised their regulations to require systems to prepare a complete distribution system materials inventory by January 1, 2025. One goal of the materials inventory is to " . . . Demonstrate through physical verification that the inventory is accurate." Michigan designed their verification process using the principles outlined in their "Minimum Service Line Verification Requirements (Michigan EGLE, 2021). These requirements in their entirety are provided as Appendix E.

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
DRINKING WATER AND ENVIRONMENTAL HEALTH DIVISION

MINIMUM SERVICE LINE MATERIAL VERIFICATION REQUIREMENTS

A reliable inventory of potable water service line materials is important for service line replacement planning, effective asset management, and notification of citizens served by lead service lines. Reliability and completeness of service line records can vary both across and within water supplies; therefore, it is important that supplies take steps to verify service line materials and records. Water supplies are not expected to physically verify every service line, but rather a statistically sound subset. To effectively evaluate the accuracy of service line records and/or predict service line materials, a representative, uniformly random number of service lines must be physically verified.

Information gathered through random material verification processes provides:

- A verified estimate of the proportion of each service line material and material configuration across the distribution system, providing a sound basis for planning service line replacement and notification efforts.
- A basis for evaluating the reliability of existing service line material records and identifying areas where additional physical verification or information may be needed. For water supplies with high confidence in existing records, this may serve to demonstrate that records are, in fact, reliable.
- A baseline data set for predicting materials at other locations (in combination with other information).

This random material verification process does **NOT** provide:

- The service line material configuration of every building served; or
- The extent to which specific areas of the distribution system may differ from the system-wide average occurrence rate of each service line material.

Verification Exceptions:

- A water supply may avoid the material verification process if all potable water service lines within the water supply meet the strict definition of "known" described below.
- Water supplies may exclude from this verification service lines four inches or more in diameter. Guidance for addressing these service lines as part of the Complete Distribution System Materials Inventory (CDSMI) will be provided separately.

Timing of Verification:

It is recommended that water supplies conduct this verification early enough in the CDSMI process to allow sufficient time for additional work, as needed, before the CDSMI is due to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) by January 1, 2025. Consider completing this verification by the end of 2022, thereby allowing an additional two years to undertake any additional activities that may be necessary to complete the inventory.

Random Material Verification Process

To evaluate the accuracy of potable water service line records and/or predict service line materials, a statistically sound, uniformly random number of service lines should be physically verified. Some supplies have already conducted recent physical verifications and/or have controls in place that dictate service line materials, resulting in a very high level of confidence in the materials of some

service lines. In recognition of this, the following protocol requires random verification of only those service lines of "unknown" material.

For the purpose of this verification, a **conservative** approach is used to determine when a service line's material can be characterized as "known" and be excluded from the verification process.

To be considered "known," and therefore excluded from the pool of sites from which a random sample will be drawn, a service line must meet criteria 1 or 2 below:

1. The service line was recently[1] physically verified and all of the following apply:
   - **ALL** points, as defined in Step 5 below, were recently physically verified;
   - The physical verification was **well documented** as to the material at each point; **AND**
   - The water supply has **not observed deviations** from these records during operations and maintenance.

OR

2. Ordinances or controls were in place and all of the following apply:
   - Ordinances[2] or other controls[3] were in place at the time the service line was installed specifying materials used in service line construction **AND**
   - The water supply has **not observed deviations** from these ordinance(s) or control(s) during operations and maintenance.

Any service line that does not meet one of the two criteria above is considered "unknown" for the purpose of this verification process and should be included in the list of locations from which a set of sites will be uniformly randomly selected for verification.

>>NOTE: Service lines four inches or more in diameter may be excluded from the verification process.

>> NOTE: This definition of "known" and the three- or four-point verification process described below in Step 5 **are specific to this baseline verification process** and may not apply to other aspects of the CDSMI. Further guidance on completing the rest of the CDSMI will be provided at a later date.

---

[1] "Recently" in this context is water supply-specific. Supplies must define recent to include a time after which its records have been demonstrated to be reliable. No records prior to 1989 may be considered recent for the purpose of this portion of the verification process. The use of lead service lines was officially prohibited in Michigan in 1988; therefore, the health risk due to unreliable records is higher before this date. This does not mean service line records prior to 1989 have no value. They may have great value in finalizing a system's CDSMI, but they cannot be used to exclude a location from the pool of sites from which random sites are selected for this verification.

[2] An ordinance is defined as: A law, statute, or regulation enacted by a municipal corporation. An ordinance is a law passed by a municipal government. A municipality, such as a city, town, village, or borough, is a political subdivision of a state within which a municipal corporation has been established to provide local government to a population in a defined area.

[3] A control, for the purposes of this guidance, is defined as: A general set of approved specifications or binding construction documentation that explicitly demonstrates that there were controls in place dictating the material usage in all public and private portions of a service line. Any controls must first have been explicitly adopted by the water system or directly defined for each blueprint used in construction.

Material Verification Process Steps

Step 1: Identify all potable water service lines of "unknown" material.

Identify all potable water service lines of "unknown" material (i.e., those not meeting the criteria of "known" provided above). Determine the total number of these "unknown" service lines. Service lines four or more inches in diameter may be excluded from this verification process.

Note: For the purpose of this verification process, assumed service line materials cannot be used to classify a service line as "known."

Step 2: Identify how many service lines should be physically verified.

- Water supplies with fewer than 1,500 "unknown" service lines must physically verify at least 20 percent of the total number of "unknown" lines.
- Water supplies with 1,500 or more "unknown" service lines must physically verify enough lines to reach a 95 percent confidence level. See **Appendix A** to determine the number of service lines requiring verification.

Step 3: Randomly select service lines for physical verification.

From the list of "unknown" service lines identified in Step 1, randomly select enough service lines to at least meet the number requiring physical verification as determined in Step 2. Selection must be uniformly random and not selected based on any specific criteria which can introduce bias. In other words, each "unknown" service line must have an equal chance of being chosen for verification.

See **Appendix B** for an easy way to generate a uniformly random set of locations for verification.

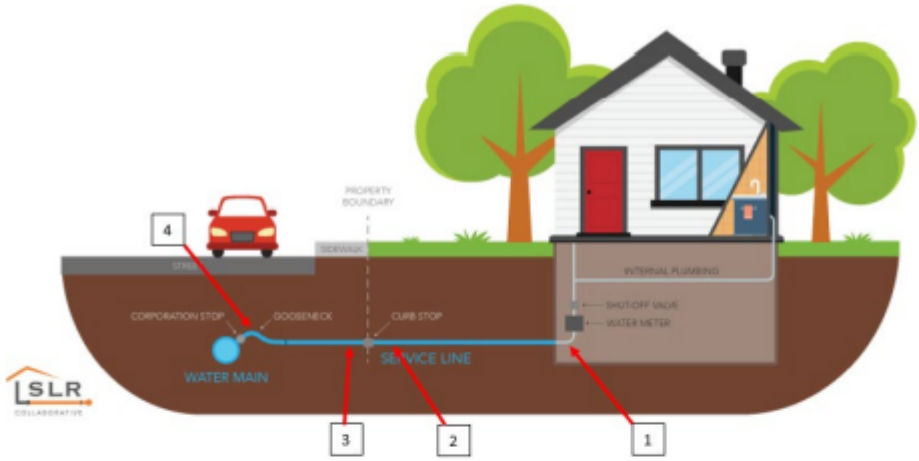
Note: It may be tempting to introduce a "logic" to the site selection process, such as selecting within periods of construction or targeting portions of town. However, doing so can unintentionally bias the data set. Be certain to use a truly random selection method such as the one described in Appendix B.

Step 4: Create a tool for tracking records and materials during verification.

Create a spreadsheet (or other tracking mechanism) containing the randomly selected locations identified in Step 3. Include columns or fields for tracking both existing records and results of the physical verification. In this step, enter currently available information about service line materials based on pre-verification records. See **Appendix C** for an example spreadsheet.

Step 5: Conduct three- or four- point physical verification.

Three or four points of physical verification are required for each service line. Physical verification methods may include potholing (by a variety of methods including hydro-vac, air-knifing, hand digging, etc.), trenching, televising, and in-home inspections. Always record the actual material observed for each point described below, even if the material was as expected. Do not use "non-lead" to describe the material.



Each service line requiring verification **must have the following three or four points physically verified** (numeric bullets refer to the numbered location in the illustration above):

1. **Interior portion** of the service line up to the first shutoff valve or 18 inches inside the building, whichever is shorter;
2. **Curb stop to building**, a minimum of 18 inches from the curb stop; and
3. **Main to curb stop**, a minimum of 18 inches from the curb stop.
4. **Lead connector (gooseneck/pigtail)**, if present. In this context, a gooseneck or pigtail is a short section of material, typically not exceeding two feet, which can be bent and used for connection between a rigid fitting (corporation stop) and the service line piping.
   If a lead connector is present, a water supply must **EITHER**:
   - Conduct a physical verification;

     OR

   - Have a control that was in place demonstrating they were never used;

     OR

   - Assume locations with galvanized service lines between the main and curb stop contain (or previously contained) a lead connector. If a water supply makes this assumption, they may skip physical verification of the gooseneck material.

Note: Unless assuming the current or previous presence of a lead gooseneck, most water supplies with galvanized service lines between the main and curb stop must physically verify the connector material.

Step 6: Record results of physical verification in the spreadsheet created in Step 4.

In the spreadsheet or tracking tool created in Step 4, enter the service line material observed at each point of the service line during the physical verification conducted in Step 5. Always record the actual material observed, such as lead, copper, plastic, galvanized steel, or other. Do not use "non-lead."

Step 7: Evaluate results of physical verification.

This representative, uniformly random sample of service line materials should be, with a high probability, representative of service line materials from the portion(s) of the system from which the random set was selected. You can use this information to assess the reliability of your existing records and make sound assessments/decisions as you complete a system-wide inventory.

Assess Reliability of Existing Records:

Compare the historical records of your randomly selected sites with the new physically verified materials for those sites to evaluate the reliability of your water supply's historical records. For example, what percent of the time did the physical verification match the historical records? If historical records are found to be unreliable, additional physical verification may be necessary.

Predict Service Line Materials at Other Locations:

The results of this verification, in combination with other available information, can be used to predict service line materials at other sites. Water supplies may need assistance with this process. Additional information will be provided in a separate guidance document.

Retain Verification Records:

Create, compile, and retain documentation of your verification efforts. You may be asked by EGLE to produce or submit these records.

Beyond This Verification:

This is not the end of the CDSMI process. As noted in Step 7, additional verification may be necessary if records are found to be unreliable, additional work may be needed to build-out the inventory, notifications to residents may be necessary, reporting to EGLE will be required, etc. Additional guidance on these steps will be provided later.

Lead Service Line Notification Reminder:

Written notification must be provided to the owner and occupant(s) of any building with a service line known, or assumed, to contain lead in any portion.

This guidance was created in collaboration with the University of Michigan and with consideration of the ASDWA/BlueConduit white paper "Principles of Data Science for Lead Service Line Inventories and Replacement Programs" which can be found at: https://www.asdwa.org/2020/09/25/asdwa-blueconduit-release-white-paper-on-lsl-data-methods.

Appendix A: Minimum Number of Service Lines Requiring Physical Verification

Number of "Unknown" Service Lines*	Number to Physically Verify
Fewer than 1,500	20% of "unknown" lines
1,500	306
1,600	310
1,700	314
1,800	317
1,900	320
2,000	322
2,200	327
2,400	331
2,600	335
2,800	338
3,000	341
3,500	346
4,000	351
4,500	354
5,000	357
6,000	361
7,000	364
8,000	367
9,000	368
10,000	370
15,000	375
20,000	377
30,000	379
40,000	381
60,000	382
90,000	383
225,000 or more	384

* For the purposes of this verification process, this represents the number of service lines that do **NOT** meet the criteria for "known" service lines described at the beginning of this document. If the number of "unknowns" falls between two values on the chart, either interpolate or round up to the higher number.

Appendix B: Generating a Uniformly Random Set of Service Lines for Verification

You can use a spreadsheet (such as Microsoft Excel or Google Sheets) to generate a uniformly random set of "unknown" locations for verification using the following steps:

1. In the first column of a spreadsheet, list every unique service location of "unknown" material. They can be listed by address, service line ID, or other identification method.
2. In the second column, generate uniformly random numbers, so that each service line is associated with a randomly generated number, using the following steps:
    a. Enter the following formula in the second column: =RAND( )
    b. Put the '=RAND( )' formula next to each location.
    c. This generates a number between 0 and 1 for each location.
    d. Then select the column with the random values and use the spreadsheet's "Copy" feature.
    e. Then use the "Paste Special" option to "Paste Values Only" in the same column that you have already selected. This will ensure your random numbers remain static.
    f. Then use the "Sort" feature to list the randomly generated numbers from lowest to highest. If the "Sort Warning" appears, select "Expand the selection," then "Sort."
3. Select only the top N homes, where N is the number requiring verification. For example, if you need to verify 20 locations, select the first 20 locations on the list. These are the 20 uniformly random locations requiring verification.

Here is a short online tutorial for generating random samples in Microsoft Excel. The same formulas and method work for Google Sheets.

Appendix C: Example Field Verification Tracking Spreadsheet

Service Line ID & Location		Service Line Material Based on HISTORICAL RECORDS							Service Line Material Based on FIELD VERIFICATION					
Parcel ID/ Service Line ID	Address	Connector (gooseneck)	Historical Record Main-to-Curbstop	Historical Record Curbstop-to-Home	Interior (18" or 1st shutoff)	Date of Historical Record	Type of Record	Year Built	Connector (gooseneck)	Verified Material Main-to-Curbstop	Verified Material Curbstop-to-Home	Interior (18" or 1st shutoff)	Date Verified	Method
123456789	23 Main St	NA	Copper	Copper	Unknown			1958	NA	Copper	Copper	Copper	1/2/2020	Hydrovac
123456790	60 1st Ave	NA	Copper	Copper	Unknown	12/1/1956	Note card	1951	NA	Copper	Copper	Copper	12/6/2019	Hydrovac
123456794	12 Michigan Ave	Unknown	Unknown	Copper	Copper			1927	Lead	Galvanized	Lead	Lead	6/20/2020	Excavation
123456795	34 2nd Ave	Lead	Galvanized	Copper	Copper				NA	Copper	Copper	Copper	11/22/2020	Hydrovac
123456796	941 W Main St	NA	Copper	Copper	Copper	3/15/1986	Permit	1954	NA	Copper	Copper	Copper	11/13/2019	Hydrovac
123456798	24 North St	Lead	Galvanized	Copper	Copper			1935	Lead	Galvanized	Lead	Lead	10/25/2020	Excavation
123456800	26 Grand Ave	Unknown	Unknown	Copper	Unknown	6/15/1929	Note card	1926	NA	Copper	Lead	Copper	11/28/2019	Excavation
123456803	13 24th St	Lead	Galvanized	Copper	Unknown	1/11/1952	Note card	1871	NA	Lead	Galvanized	Galvanized	5/25/2020	Hydrovac

NOTE: This table is only an example. Water supplies must document the location, existing records (if available), and findings of the physical verification. Water supplies should consider adding any additional columns that will capture data useful to the verification process or completion of the CDSMI.

Appendix F: Examples of Data Quality Disclaimer Language

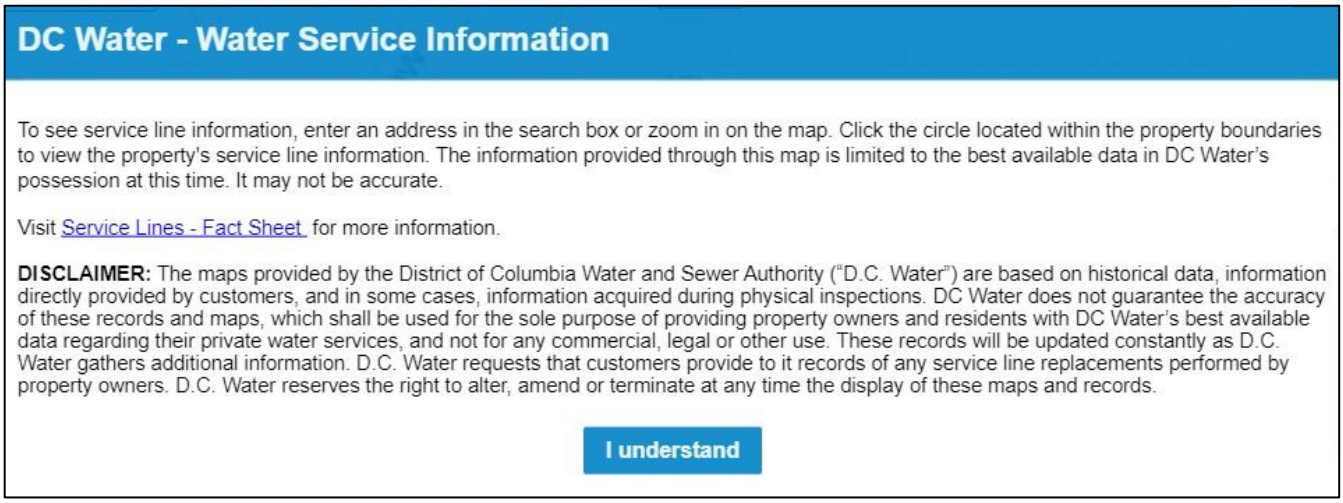
DC Water

Greater Cincinnati Water Works

Pittsburgh Water and Sewer Authority

Below are just a few examples of disclaimer language from DC Water, Greater Cincinnati Water Works, and Pittsburgh Water and Sewer Authority's websites regarding the accuracy of the inventory information provided to the public. This information can be adapted for use.

DC Water



DC Water - Water Service Information

To see service line information, enter an address in the search box or zoom in on the map. Click the circle located within the property boundaries to view the property's service line information. The information provided through this map is limited to the best available data in DC Water's possession at this time. It may not be accurate.

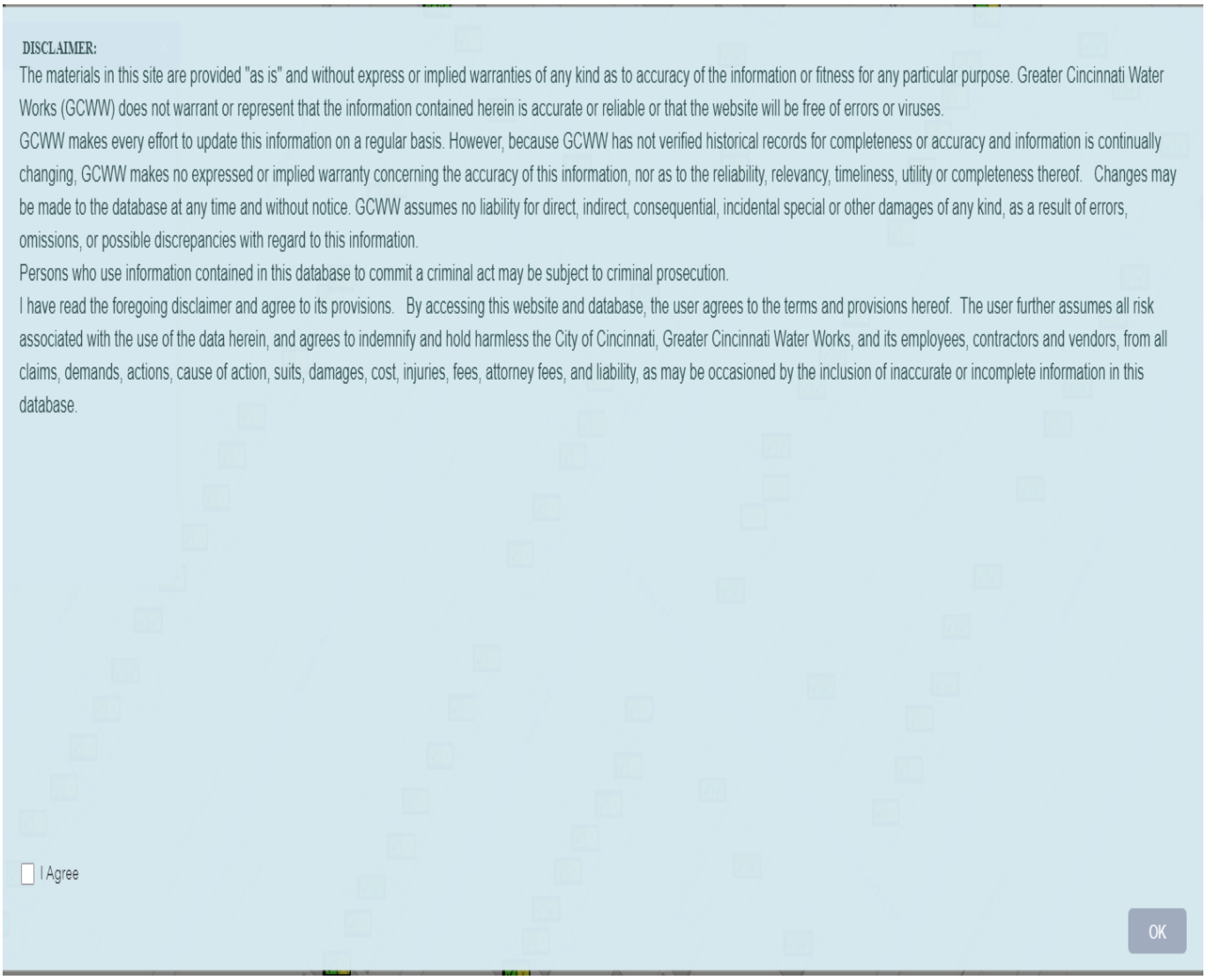
Visit Service Lines - Fact Sheet for more information.

DISCLAIMER: The maps provided by the District of Columbia Water and Sewer Authority ("D.C. Water") are based on historical data, information directly provided by customers, and in some cases, information acquired during physical inspections. DC Water does not guarantee the accuracy of these records and maps, which shall be used for the sole purpose of providing property owners and residents with DC Water's best available data regarding their private water services, and not for any commercial, legal or other use. These records will be updated constantly as D.C. Water gathers additional information. D.C. Water requests that customers provide to it records of any service line replacements performed by property owners. D.C. Water reserves the right to alter, amend or terminate at any time the display of these maps and records.

I understand

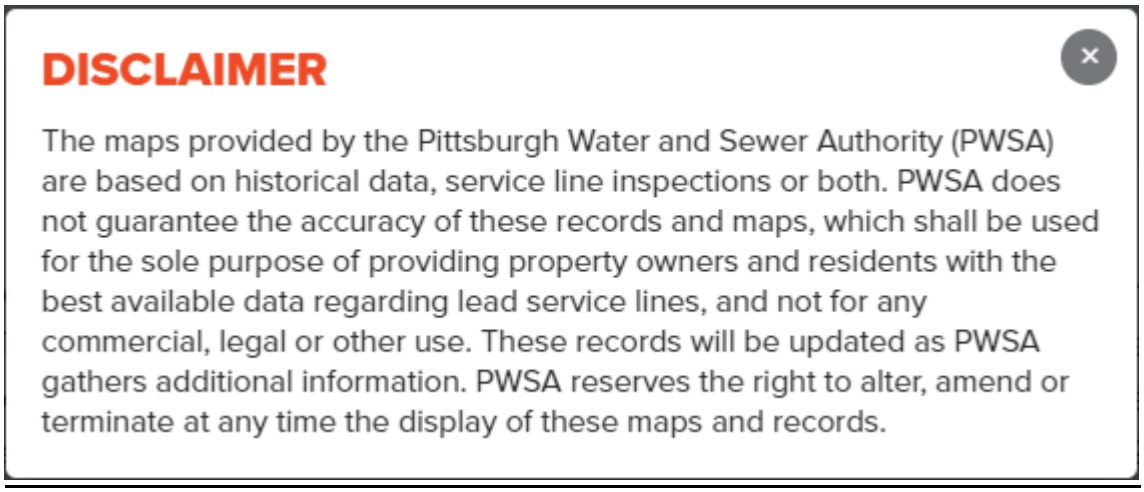
Source: https://geo.dcwater.com/Lead/. Accessed December 21, 2021.

Greater Cincinnati Water Works



Source:
https://gcww.maps.arcgis.com/apps/webappviewer/index.html?id=0a170c268c694e46a8a4e394630df0bd
Accessed December 21, 2021.

Pittsburgh Water and Sewer Authority



Source: https://lead.pgh2o.com/your-water-service-line/planned-water-service-line-replacement-map/. Accessed December 21, 2021.