Appendix D: INVESTIGATION METHODS

Table of Contents

GENERAL INFORMATION AND HIERACHRY OF INVESTIGATION METHODS 2

RECORDS REVIEW 7

- Plumbing Permits 7
- Local Building and Plumbing Codes, Local Ordinances, Public Works Standard 7
- Federal/State Plumbing Codes 7
- Construction Contracts 7
- Property Records on File with County 7
- Distribution System Maps and Drawings 8
- Capital Improvement Plans and/or Master Water & Sewer Plans 8
- Tap/Tie/Drill/Service Cards 8
- Records of Maintenance/Inspection Performed by Water System Personnel or Contractors 8
- Meter Installation/Maintenance/Inspection and/or Reading Records Performed by Water System Personnel or Contractors 8
- Utility Standard Operating Procedures (SOPs) 9
- Statements from Water System Senior Personnel and Retirees 9
- Interviews with Plumbers, Building Inspectors, Pipe Suppliers, Local Contractors, and/or Developers who have Specific Knowledge of the Site/Area 9
- Community Survey 10
- Other Record(s) 10

ANALYTICS/PREDICTIVE METHODS 10

- Interpolation 10
- Statistical and/or Machine Learning Modeling 11
- Special Water Sampling (non-compliance water samples) 11
- Other Analytics/Predictive Method(s) 12

FIELD INVESTIGATION METHODS 12

- Visual Inspection of Exposed Service Line Pipe (with or without Excavation) 12
- Non-Exposed Service Line Pipe Inspection Methods 16
  - Metal Detector 16
  - Ground-Penetrating Radar (GPR) 17
  - Internal CCTV Inspection of Inside of the Entire Portion of the Service Line Pipe 17
  - Other Non-Exposed Service Line Pipe Inspection Method(s) 18

GENERAL INFORMATION AND HIERACHRY OF INVESTIGATION METHODS

On MDE's Service Line (SL) Inventory spreadsheet, the classification (i.e., "Lead", "Galvanized Requiring Replacement", "Lead Status Unknown", or "Non-Lead") of each service line portion will be automatically generated based on three specific pieces of information (i.e., characteristics) related to the current service line: **Material**, **Diameter**, and **Installation Year**. The classification of each portion of the service line will then dictate the classification of entire service line (See Appendix G for more information).

When the material of the service line pipe is not known, the diameter and/or installation year of the service line can potentially help water systems determine the service line material.

- If the diameter of the service line is known, water systems could potentially narrow down possible materials of the service line pipe if they have a local knowledge of specific pipe diameters and their corresponding pipe materials in that local area. Furthermore, pipe diameters greater than 3 inches typically indicate "Non-Lead" SL classification. There have been very few instances of lead service lines as large as 3 inches in diameter in the US; most lead service lines were found to be 2 inches or less in diameter.

- Knowing when the current service line was installed can potentially help water systems determine whether the service line material is Lead or Non-Lead, especially if the pipe was installed after Lead was no longer an acceptable service line pipe material per federal, state, and/or local ordinances.

    - Based on the effective date of the federal lead ban (i.e., March 30, 1989, in Maryland), any service lines installed on or after this date are classified as a "Non-Lead" SL.

    - Additionally, Maryland regulations (COMAR 09.20.11.10, Water Supply System Materials) filed with the Clerk of the Court of Appeals of Maryland and the Maryland State Library on May 17, 1972, do not include Lead in the list of acceptable service line pipe materials. Since the regulations became effective on the date of filing (as per Article 41, Section 246(b), of the Annotated Code of Maryland (1971 Replacement Volume)), **any service lines installed on or after <u>May 17, 1972</u>** (i.e., the effective date), are **classified as a "Non-Lead" SL**. See Appendix E for a copy of 1972 COMAR 09.20.11.10 with relevant title/section highlighted.

    - If there was a local ordinance indicating that lead was not an acceptable service line pipe material and the local ordinance was in effect prior to May 17, 1972 (i.e., the effective date of Maryland regulations that excluded lead from the list of acceptable service line pipe materials), any service lines installed prior to May 17, 1972, are classified as a "Non-Lead" SL. A copy of the local ordinance will need to be provided to MDE.

In order for water systems to verify these three characteristics (i.e., material, diameter, and installation year) of the current service line, one or more investigation method will need to be conducted by the water systems. Listed in Table D1 (on Page 3) are the MDE-approved investigation methods that water systems may use to verify the material, diameter, and/or installation year of the current service line pipes.

Table D1. MDE-Approved investigation methods for the three characteristics (i.e., Material, Diameter, and Installation Year) of a service line, listed in in hierarchical order according to accuracy as viewed by MDE

Investigation Method - Material	Investigation Method - Diameter	Investigation Method – Installation Year
1. Field Investigation – Visual Inspection of Exposed Service Line Pipe (with or without Excavation) 2. Field Investigation – Non-Exposed Service Line Pipe Inspection 3. Records Review 4. Analytics/Predictive Methods	1. Field Investigation – Visual Inspection of Exposed Service Line Pipe (with or without Excavation) 2. Field Investigation – Non-Exposed Service Line Pipe Inspection 3. Records Review	1. Records Review

The methods above are listed in hierarchical order according to accuracy as viewed by MDE and are specific to each of the three service line pipe characteristics above. Field investigation methods and Records Review can be used to verify each of the three pipe characteristics (i.e., material, diameter, and installation year) needed for classification of the current service line. Water systems are required to conduct a records review of all service lines in their water distribution system regardless of ownership.

For the purpose of the inventory, water systems may use Analytics/Predictive methods to obtain a prediction of the service line material. Currently, Interpolation and Statistical and/or Machine Learning Modeling are approved by MDE; other Analytics/Predictive methods will need to be approved by MDE prior to use by water systems. Water systems may use Analytics/Predictive methods to make the prediction of service line material and/or turn these predictions into the actual material **only after** satisfying all requirements set forth by MDE. For instance, in order to use Interpolation to make predictions of material of all service lines within a homogenous neighborhood, the water system will need to verify a certain number of the service line within the neighborhood using certain MDE-approved investigation methods. For Statistical and/or Machine Learning Modeling, water systems may turn the prediction into the actual material only after a threshold (i.e., a point at which water systems consider service lines to be lead, non-lead, or a specific material) is set by the water systems in collaboration with their predictive modeling software providers/contractors; however, water systems must provide a justification that thoroughly explains and defends the threshold to MDE. For either of the Analytics/Predictive methods, a full report detailing the methodology will also need to be provided to MDE. See the "ANALYTICS/PREDICTIVE METHODS" section for more details on MDE's requirements relating to these methods.

Each of the service line's characteristics should be considered as independent pieces of information to be verified by the water systems using one (or more) investigation method(s) listed in Table D1 for that particular characteristic. For instance, a visual inspection of the exposed service line pipe (with or without excavation) can be used to verify material and diameter of the service line, but not the installation year; and, a metal detector can be used to verify only the material of the service line, but not the diameter or the installation year. In certain cases, however, the material may be determined based on diameter and/or installation year. For instance, pipe installation date on or after May 17, 1972, and/or pipe diameter of greater than 3 inches indicate that the material is non-lead.

Listed in Table D2 (on Page 4) are the MDE-approved bases of determination that water systems may use to determine the material, diameter, and/or installation year of the current service line pipes. These bases of determination are listed in the order of the ranking of MDE-approved investigation methods (as seen Table D1) that water systems may use to verify the material, diameter, and/or installation year of the current service line pipes.

Table D2. MDE-Approved bases of determination for the three characteristics (i.e., Material, Diameter, and Installation Year) of a service line, listed in hierarchical order according to accuracy as viewed by MDE

Basis of Determination - Material	Basis of Determination - Diameter	Basis of Determination - Installation Year
1. Pipe material obtained directly from records AND Field Investigation via Visual Inspection of Exposed Service Line Pipe (with or without Excavation) -- *Applicable only if material from both records and field investigation matches* 2. Pipe material obtained directly from ONLY Field Investigation via Visual Inspection of Exposed Service Line Pipe (with or without Excavation) 3. Pipe material obtained directly from records AND Field Investigation via Non-Exposed Service line Pipe Inspection -- *Applicable only if material from both records and field investigation matches* 4. Pipe material obtained directly from ONLY Field Investigation via Non-Exposed Service line Pipe Inspection 5. Pipe material obtained directly from records ONLY 6. Pipe material obtained directly from records ONLY (but Analytics/Predictive Method also performed to obtain a prediction) 7. Pipe material determined to be Non-Lead based on pipe diameter greater than 3 inches 8. Pipe material determined to be Non-Lead based on pipe installation date on or after May 17, 1972 (Maryland's regulations pertaining to acceptable service line materials) 9. Pipe material determined to be Non-Lead or Non-Lead Non-Galvanized based on pipe installation date on or after local ordinance that was in effect prior to May 17, 1972 10. Prediction of material from Analytics/Predictive Method ONLY (i.e., no records or field investigations) 11. Other Basis of Material Determination pre-approved by MDE	1. Pipe diameter obtained directly from records AND Field Investigation via Visual Inspection of Exposed Service Line Pipe (with or without Excavation) -- *Applicable only if diameter from both records and field investigation matches* 2. Pipe diameter obtained directly from ONLY Field Investigation via Visual Inspection of Exposed Service Line Pipe (with or without Excavation) 3. Pipe diameter obtained directly from records AND Field Investigation via Non-Exposed Service line Pipe Inspection -- *Applicable only if diameter from both records and field investigation matches* 4. Pipe diameter obtained directly from ONLY Field Investigation via Non-Exposed Service line Pipe Inspection 5. Pipe diameter obtained directly from records ONLY 6. Other Basis of Diameter Determination pre-approved by MDE	1. Installation year obtained directly from records 2. Installation year based on year the water system was built -- Applicable only if (a) the water system was built in or after 1973 AND (b) if structure was built prior to 1973, no reuse of existing pipe from well to structure 3. Installation year based on year the structure was built -- Applicable only if the structure was built in or after 1973 4. Other Basis of Installation Year Determination pre-approved by MDE

The inventory spreadsheet should be used by water systems to document their basis of determination, investigation methods, and findings. Since the information related to the service line may change over time, the inventory should be updated accordingly. For instance, since water systems must complete a records review of all their service lines by the initial inventory deadline (i.e., October 16, 2024), the spreadsheet should be initially filled out with findings from the records review (as applicable). If records do not exist or existing records are not useful in determination of the current service line's characteristics (i.e., material, diameter and installation year), then other investigation method(s) must be conducted in order to determine unknown characteristics of the service lines. The basis of determination should then be updated based on the investigation methods used and and the corresponding findings.

To determine the material and/or diameter of a service line, water systems may need to conduct more than one investigation method, which may or may not occur at the same time. The inventory spreadsheet should be used by water systems to document and track the investigation methods and their findings. In other words, water systems should continually update the inventory spreadsheet to reflect the information found at that time.

The general guidelines described below should be followed when completing the inventory spreadsheet.

- The water system should record the following information on the inventory spreadsheet for a service line:
    - The characteristics (i.e., material, diameter, and/or installation year) based on the basis of determination that is **ranked the highest** in MDE's basis of determination hierarchy (see Table D2)
    - The basis of determination for each of the characteristics (as applicable).
    - Details associated with the selected basis of determination.

- When new information is discovered and/or plumbing changes occur for a service line, the inventory spreadsheet should be updated accordingly based on the information that has changed. This may include, but not limited to:
    - Updating the characteristics (i.e., material, diameter, and/or installation year).
    - Updating the basis of determination.
    - Deleting/removing the details/information that is no longer relevant and/or associated with the updated basis of determination.
    - Adding and/or updating the details/information that is relevant and/or associated with the updated basis of determination.

Additional important notes when more than one investigation method is conducted:

1. When **an Analytics/Predictive method** is conducted **in addition to Records Review** for a service line, on the inventory spreadsheet for that service line, the water system should:
    - Select the material obtained from the Records Review.
    - Select "Pipe material obtained directly from records ONLY (but Analytics/Predictive Method also performed to obtain a prediction)" as the basis of material determination.
    - Under the "Records Review" section, select the type of records used to obtain pipe material.
    - Under the "Analytics/Predictive method" section, select the specific analytics/predictive method used and the prediction made, and, when applicable, provide the percentage likelihood of service line material being Lead. This information should be provided regardless of whether the material prediction aligns with the material found from records.

    In a situation where an Analytics/Predictive method provides a material prediction that does **not** align with the pipe material found through Records Review, the water system should perform the following:

- Conduct a **field investigation of the service line to confirm the material of the service line pipe** (however, the field investigation should be prioritized if Records Review indicates pipe material as "Lead" or if Analytics/Predictive method predicts "Likely Lead").
- Once the field investigation is complete, update the inventory spreadsheet accordingly based on the findings of the field investigation as this method **ranked higher** than both Records Review and Analytics/Predictive method in the method hierarchy. This update to the inventory spreadsheet will include, but not limited to, updating the basis of material determination and its associated details/information.

2. When **a Non-Exposed Service Line Pipe Inspection** is conducted to obtain a **diameter** of a service line **in addition to Records Review** and the diameter found from the Non-Exposed Service Line Pipe Inspection does **not** match the diameter from Records Review (e.g., Records Review (performed initially) indicated that the diameter of the service line is 1 ½ inches, but a Non-Exposed Service Line Pipe Inspection using Ground-Penetrating Radar (GPR) (performed later) revealed the diameter to be 2 ½ inches), the water system should perform the following:
   - Update the inventory spreadsheet with the diameter found through the Non-Exposed Service Line Pipe Inspection since it is ranked higher than Records Review.
   - Conduct a **field investigation of the service line to confirm the material of the service line pipe** only if Non-Exposed Service Line Pipe Inspection indicates diameter of greater than 3 inches and Records Review indicates diameter of less than or equal to 3 inches.
     - Note: This is because there is a discrepancy in the diameter of the same service line, the material of the service line needs to be confirmed through a field investigation to ensure accuracy.
   - Once the field investigation to verify pipe material is complete, update the inventory spreadsheet accordingly based on the findings of the field investigation as this method ranked the **highest** in MDE's method hierarchy.

3. In a situation where **both** non-exposed pipe inspection (e.g., metal detector, GPR, etc.) **and** visual inspection of exposed pipe were conducted on the same service line and the pipe material or diameter found from the non-exposed pipe inspection does **not** match the material or diameter found from the visual inspection, then the instrument used for non-exposed pipe inspection (e.g., metal detector, GPR, etc.) will need to be re-evaluated. Furthermore, MDE may not accept the findings from these non-exposed pipe inspection methods for service lines that the non-exposed pipe inspection instruments were used to obtain pipe characteristics.

It is important to note that the inventory spreadsheet should be kept up-to-date as new information is discovered and/or plumbing changes occur. One such example of the latter situation is **when a service line is replaced with a new service line pipe**. The inventory spreadsheet should be updated to reflect information related to the new service line pipe including the three characteristics (i.e., material, diameter, and/or installation year). Any other related information impacted by this plumbing change should be updated and/or documented on the inventory spreadsheet as well. Furthermore, information related to investigation methods should be deleted/removed from the inventory spreadsheet since this information would no longer be relevant to the new service line pipe.

RECORDS REVIEW

TYPES OF RECORDS

Plumbing Permits

Service line verification: Material, Diameter, and/or Installation Year

Permits may be found in county building departments or municipal clerk's office. Permit files/pre-1940 documents are especially important. (The use of LSLs in many communities was discontinued after approximately 1940). Permits may exist for replacing lead service lines.

Local Building and Plumbing Codes, Local Ordinances, Public Works Standard

Service line verification: Material

Local plumbing codes and/or local ordinances indicating the material(s) of the service line based on the installation date and/or year. Possible locations for construction and plumbing codes include:

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

This method is sufficient if relevant section of the plumbing codes, local ordinances, or public works standard is provided to MDE.

Federal/State Plumbing Codes

Service line verification: Material

Federal/State plumbing codes indicating the material(s) of the service line based on the installation date and/or year.

Construction Contracts

Service line verification: Material, Diameter, and/or Installation Year

Construction contracts indicating the material(s) and/or size(s) of the service line and when the service line was installed.

Property Records on File with County

Service line verification: Material, Diameter, and/or Installation Year

Property records on file with the county showing service line material, diameter, and/or installation date and/or year.

Distribution System Maps and Drawings

Service line verification: Material, Diameter, and/or Installation Year

Maps and drawings of the water distribution system that indicate service line and connection information including materials, line sizes (length and/or diameter), and installation dates.

Capital Improvement Plans and/or Master Water & Sewer Plans

Service line verification: Material, Diameter, and/or Installation Year

Information regarding planned or executed improvements to portions of the water distribution system may be provided by existing and/or historical capital improvements or master plans.

Tap/Tie/Drill/Service Cards

Service line verification: Material, Diameter, and/or Installation Year

Historical records on service connection installation may be in the form of tap/tie/service 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/structure. They are often handwritten index cards that contain the installation date, pipe diameter, and pipe material.

Records of Maintenance/Inspection Performed by Water System Personnel or Contractors

Service line verification: Material, Diameter, and/or Installation Year

Maintenance records (excluding meter-related maintenance) that document former/current/replacement materials and/or replacement materials of the service line that were identified during maintenance activities, such as water main repair/work or service line repair/work. Maintenance records include repair/replacement work orders. These activities may include both routine and non-routine maintenance such as cross connection inspections, responses/investigation to customer complaints, or inspections to locate leaks, etc. Water systems may store this information electronically, for example, using a computerized maintenance management system (CMMS).

Maintenance records often identify such information as 1) existing materials; 2) replacement materials; 3) date of event; and 4) particular site conditions of note. LSLs may specifically be identified and encountered during maintenance activities.

Meter Installation/Maintenance/Inspection and/or Reading Records Performed by Water System Personnel or Contractors

Service line verification: Material, Diameter, and/or Installation Year

Meter installation, maintenance and/or reading records that indicate materials and/or diameters of the service lines. These records could also provide information on the type and age of construction.

Sources of information include inspections to investigate meter issues. Water systems may store this information electronically, for example, using a computerized maintenance management system (CMMS).

Meter size is also an important element as it may be used as the basis for differentiating among structure types, i.e. single-family residences, multi-family residences, and non-residential buildings/structures.

Service line pipe may be visible from meter pit/vault.

Utility Standard Operating Procedures (SOPs)

Service line verification: Material and Diameter

Current and historical standard operating procedures (SOPs), including Operation and Maintenance Manuals (O&M), of the water system/utility indicating allowable materials to be used during construction and/or repair of distribution system service lines as well as material installed, method for replacement, and replacement materials to be used. These SOPs could also provide information on the water mains and connections.

When reviewing historical SOPs, water systems should review past procedures for connecting a new building/structure and if connection to an old service line was allowed. If it was allowed, this could indicate that some newer construction could be potentially connected to an LSL.

This method is sufficient if a copy of SOPs manual is provided to MDE with the relevant section of the SOPs clearly indicated.

Statements from Water System Senior Personnel and Retirees

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only)

Water system personnel or other agency staff experienced in the operation, maintenance, or material usages within the water distribution system and/or home plumbing environments. These personnel will often have first-hand knowledge regarding distribution system materials which can supplement incomplete records or provide basic data when information is otherwise lacking.

This method is currently <u>not</u> considered for service line verification purposes (i.e., it is for information gathering purposes only) by MDE.

Interviews with Plumbers, Building Inspectors, Pipe Suppliers, Local Contractors, and/or Developers who have Specific Knowledge of the Site/Area

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only)

These individuals may have first-hand knowledge of materials of construction for sections of the distribution system and/or service area, of materials supplied during a specific time period or to a specific development, and/or of materials used for original and remodeled homes.

This information can be used to supplement incomplete records or provide basic data for water systems lacking records.

This method is currently <u>not</u> considered for service line verification purposes (i.e., it is for information gathering purposes only) by MDE.

Community Survey

Applicable only to Customer-owned portion of the service line

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only)

A community survey may be helpful in identifying service line materials. A water system/utility could perform this survey using a standard questionnaire.

This method is currently not considered for service line verification purposes (i.e., it is for information gathering purposes only) by MDE.

However, photographs provided by customers as part of a community survey can also be used as a visual inspection technique performed at one of the locations required under "Visual Inspection of Exposed Service Line Pipe (with or without Excavation)" of the field investigation method. See "Visual Inspection of Exposed Service Line Pipe (with or without Excavation)" under Field Investigation Methods for more details.

Other Record(s)

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only), unless pre-approved by MDE.

Any other data/records/sources (historic or current) not captured in other types of records listed above.

These data/records/source must be pre-approved by MDE on a case-by-case basis; otherwise, they will not be considered for service line verification purposes (i.e., it is for information gathering purposes only).

ANALYTICS/PREDICTIVE METHODS

Interpolation

Service line verification: Material (Prediction)

Interpolation is a method of using verified service lines in one area to assume/predict that other service lines in that area are the same material based on similar characteristics within that area including date of installation, contractor used, structures served (e.g., houses), or some other characteristics.

The water system service area may be characterized by the age of various regions. Housing developments within identifiable regions may be assumed to have been constructed using plumbing codes and typical practices of that time. These areas and neighborhoods having common characteristics are referred to as homogenous neighborhoods.

In order to use this method to make predictions of material of all service lines within a homogenous neighborhood, the water system will need to verify a certain number of the service line within the neighborhood using field investigation and/or records review, with requirement that at least some of the service lines must be verified using field investigation.

For the purpose of assuring the quality of the prediction, water systems will need to provide documentation of methodology used for interpolation, including the criteria used to determine homogeneous neighborhood (i.e., neighborhood having common characteristics) to MDE.

Statistical and/or Machine Learning Modeling

Service line verification: Material (Prediction)

This method uses statistics to build a representation of the data and predict new output values from existing data. Statistical modeling may include geospatial modeling, which uses spatial patterns and proximity to known lead service line(s) to make predictions for sites with unknown materials. Output quality and accuracy rely on data inputs.

For the purpose of the inventory, water systems may turn the prediction (i.e., "Likely Lead" or "Likely Non-Lead") obtained from this method into the actual material, only after a threshold (i.e., a point at which water systems consider service lines to be lead, non-lead, or a specific material) is set by the water systems in collaboration with their predictive modeling software providers/contractors. However, since the results from this method are dependent upon the quality of the model, the data inputs, and the threshold used, water systems will need to provide a report to MDE with a detailed description of the model, process used, data inputs, and justification of the selected threshold to MDE. Water systems must thoroughly explain and defend the threshold that was set to determine the material of the service line in the justification to MDE; however, MDE retains the authority to reject the threshold. Water systems may also be required to, at the request of MDE, conduct additional field investigation, including possible excavation, of these service lines, particularly those that were predicted to be "Non-lead."

The justification for the selected threshold should be provided to MDE for review prior to water systems turning the prediction (i.e., "Likely Lead" or "Likely Non-Lead") obtained from Statistical and/or Machine Learning Modeling into the actual material on the inventory spreadsheet; however, the full report related to Statistical and/or Machine Learning Modeling should be submitted to MDE along with the inventory spreadsheet.

If, by the time the initial inventory is due and/or submitted to MDE, no threshold has been set by water systems, the prediction (i.e., "Likely Lead" or "Likely Non-Lead") should be selected as the material of the service line on the inventory spreadsheet and will be considered equivalent to "Don't Know or Unknown" service line material. If the other characteristics of the service line (i.e., pipe diameter and installation year) are not known, then the service line would be automatically classified as "Lead Status Unknown" on the inventory spreadsheet. However, if water systems indicated that the pipe diameter is greater than three inches and/or the pipe was installed after the lead ban in plumbing (Local, State, or Federal), then the service line would be automatically classified as "Non-Lead" on the inventory spreadsheet as long as water systems demonstrated that the service line pipe was never downstream from a lead service line pipe.

Special Water Sampling (non-compliance water samples)

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only)

Water sampling may be used to gather additional information on the possible presence of lead in the service line. These sampling techniques may include sequential sampling and flush sampling.

Sequential sampling (e.g., fifth liter 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.

Flush sampling uses samples collected from an interior tap after allowing the water to flow from the tap for a certain period of time to potentially capture the water from the service line.

This method is currently not considered for service line verification purposes (i.e., it is for information gathering purposes only) by MDE.

Other Analytics/Predictive Method(s)

Service line verification: Material (Prediction if pre-approved by MDE)

Any other analytics/predictive methods (not captured in other analytics/predictive methods listed above) that provide predictions of the materials of the service line.

These methods must be pre-approved by MDE on a case-by-case basis; otherwise, they will not be considered for service line material prediction.

Per EPA's guidance regarding service line sub-classifications (see page 2-6 of EPA's ***Guidance for Developing and Maintaining a Service Line Inventory*** (2022)), the prediction result from a predictive method is still considered as an "unknown" material. Therefore, the prediction result from the Analytics/Predictive method will be considered on MDE's Service Line Inventory spreadsheet as "Lead Status Unknown" classification (unless the pipe diameter is greater than three inches and/or the pipe was installed after the lead ban in plumbing (Local, State of Federal) and/or if a physical verification/visual inspection is made).

FIELD INVESTIGATION METHODS

Visual Inspection of Exposed Service Line Pipe (with or without Excavation)

Service line verification: Material and Diameter

This method involves visual inspection of the service line at MDE-specified location(s). The visual inspection must be performed in-person or through videos/external CCTV and/or photographs by water system personnel and/or third-party entities (e.g., licensed plumbers). If the portion of the service line connected to the building/structure is not owned by the water system, building/structure owners or occupants may take photographs (or videos) of the service line (and any additional material tests performed) and provide them to the water system.

In order to visually inspect the exterior of the service line pipe, excavation may be needed to expose the exterior service line pipe. **Excavation techniques** include mechanical excavation (e.g., potholing) and vacuum/hydro excavation. For **mechanical excavation**, potholing, digging, or excavating may be used for visual inspection of the service line. Potholing is a process using high-pressurized air and vacuum (also known as soil vacuum excavation, air excavation, air knife soil excavation, or potholing). **Vacuum/hydro excavation** uses a water jet or compressed air to loosen the soil. High-pressurized water and vacuum is also known as hydrovac, hydro excavation, hydro trenching, or soft digging.

In addition to visual inspection, additional **Material Tests** may be performed to determine service line pipe materials. These tests may include:

- **Pipe Surface Tests:** This type of testing technique is performed on the surface of the service line pipe. It is easy for residents if service line is accessible; however, these methods will only indicate the presence of lead on the surface of the pipe, and will not be able identify the presence of lead on the interior of pipe such as a lead-lined galvanized iron pipe. The pipe surface tests include:

- **Scratch test** is performed by scratching the pipe surface (using coin, key, etc.). The exposed outside pipe surface area will be shiny silver and flake off if the pipe surface is lead.
- **Magnet test** can be used on the pipe surface to determine whether the pipe surface is lead since a magnet will not stick to lead.
- **Lead surface swab test** can be perform using a surface swab kits approved for lead paint, which will change color after it comes in contact with a lead surface. If the pipe is painted, the surface swab test may not be accurate.

- **Electrical Conductivity (Eddy Current) or Electrical Resistance Test**: This type of testing technique is performed on the surface of the service line pipe. **Electrical Conductivity (Eddy Current)** is used to measure conductivity of materials. Different metals have varied properties and therefore act differently when electrical current is passed through them. Information on the conductivity of materials can be used to determine the composition of the materials being tested and, therefore, the metals can be sorted depending on the conductivity properties. **Electrical Resistance Test** is used to measure resistance of materials. It is a measure of its opposition to the flow of electric conductivity of materials.

MDE-Specified Locations for Visual Inspection

The visual inspection must be performed on the service line pipe (i.e., not the connector). The locations for visual inspection will depend on the scenario (see **Appendix A**) of the service line from the water main to the structure.

If Scenario A (i.e., only 1 portion -- see Appendix A) represents the service line from water main to structure:
The visual inspection must be performed on the service line pipe (i.e., not the connector) at **one** of the locations listed below. However, it is important to note that, in the future, there is a possibility that EPA may require multiple points of inspection to validate the material of a service line.

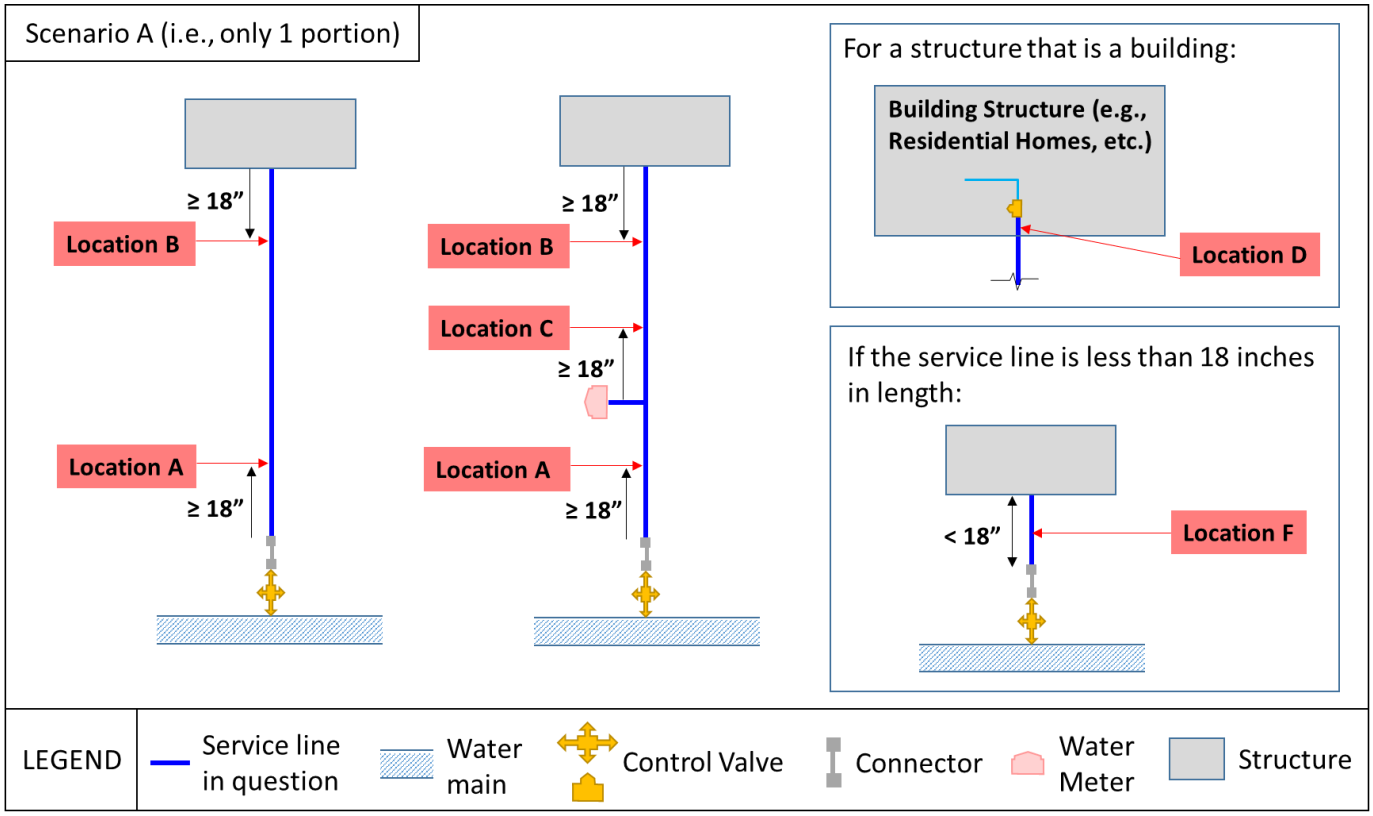
The acceptable locations are:

- **Location A**: A location along the service line that is at least 18 inches away from where the service line begins (e.g., 18 inches away from the connector, etc.);
- **Location B**: A location along the service line that is at least 18 inches away from where the service line ends (e.g., 18 inches away from the structure, building, etc.);
- **Location C**: If a water meter exists on this service line and is not inside the building/structure, a location along the service line that is at least 18 inches away from the water meter; and
- **Location D**: A location where the service line connects to the structure's premise/interior plumbing, if the service line is visible. This location can be outside or inside the structure.

If a visual inspection cannot be performed on Locations A, B, C, and/or D in order to satisfy the one-point inspection, then additional locations below may be used:

- **Location E**: Any location along the service line -- a half-way point is recommended (if not already used); and
- **Location F**: A half-way point if the length of the service line is less than 18 inches.

Locations A through C and E through F should be visually inspected by water system personnel or third-party entities contracted by the water system and/or State/local agencies. For Location D, if the service line is not owned by the water system, building/structure owners or occupants may take photographs (or videos) of the service line where it enters the building/structure (and any additional material tests performed) and provide them to the water system; otherwise, the service line must be visually inspected in-person by water system personnel and/or third-party entities contracted by the water system and/or State/local agencies.



If Scenario B, C, or D (i.e., 2 portions -- see Appendix A) represents the service line from water main to structure:
<u>For the **1st portion** of the service line (e.g., from water main to curb stop valve):</u>

The visual inspection must be performed on this portion of the service line (i.e., not the connector) at **<u>one</u>** of the locations listed below. However, it is important to note that, in the future, there is a possibility that EPA may require multiple points of inspection to validate the material of a service line.

The acceptable locations are:

- **Location A**: A location along the 1st portion of the service line that is at least 18 inches away from where the 1st portion of the service line begins (e.g., 18 inches away from the connector, etc.);
- **Location B**: A location along the 1st portion of the service line that is at least 18 inches away from where the 1st portion of the service line ends (e.g., curb stop valve, etc.); and
- **Location C**: If a water meter is located on the 1st portion of the service line, a location along the 1st portion of the service line that is at least 18 inches away from the water meter.

If a visual inspection cannot be performed on Locations A, B, and/or C in order to satisfy the one-point inspection, additional locations below may be used:

- **Location E**: Any location along the service line -- a half-way point is recommended (if not already used); and
- **Location F**: A half-way point if the length of the service line is less than 18 inches.

For the **2nd portion** of the service line (e.g., from curb stop valve to structure):

The visual inspection must be performed on this portion of the service line (i.e., not the connector) at **one** of the locations listed below. However, it is important to note that, in the future, there is a possibility that EPA may require multiple points of inspection to validate the material of a service line.

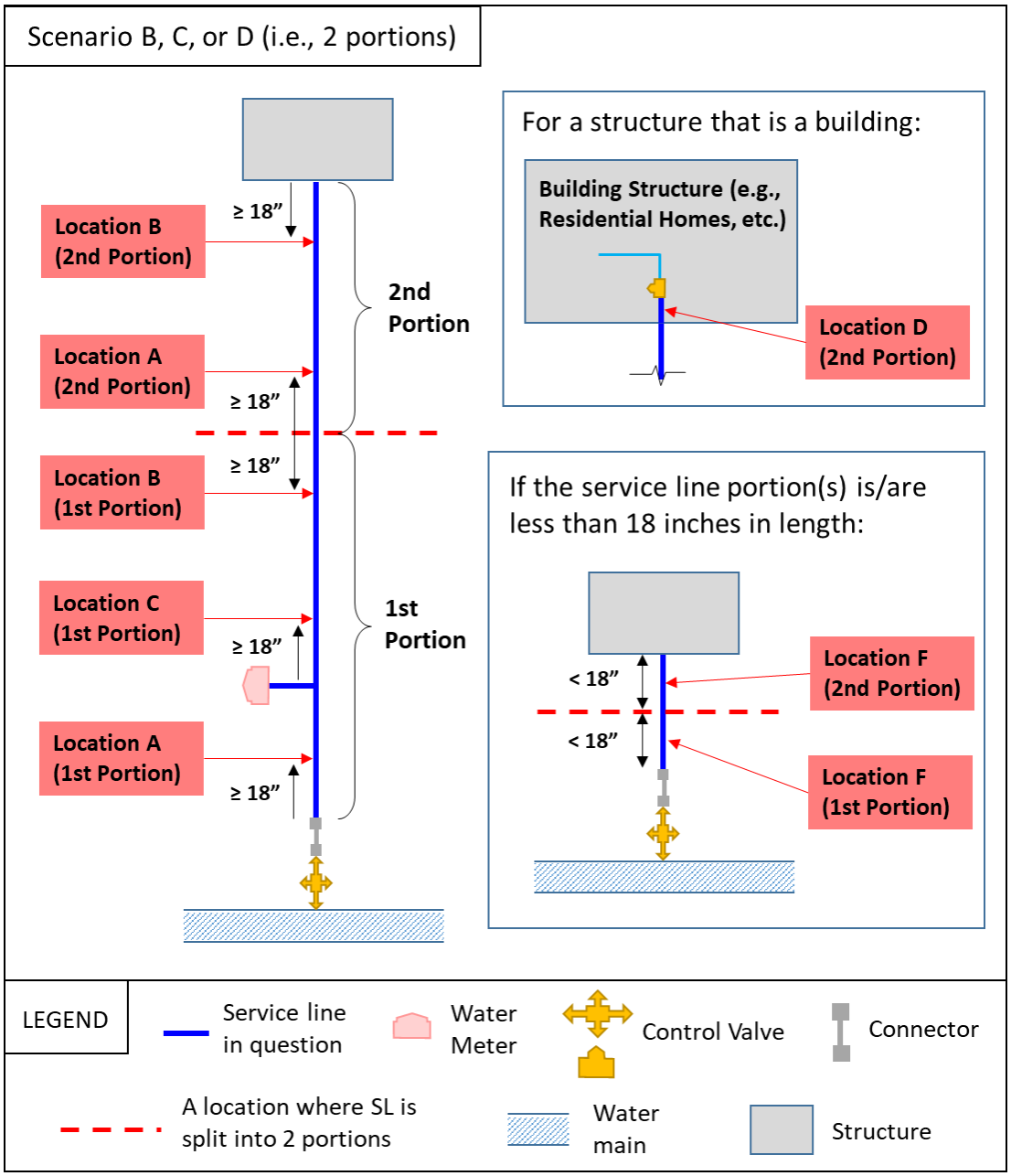
The acceptable locations are:

- **Location A**: A location along the 2nd portion of the service line that is at least 18 inches away from where the 2nd portion of the service line begins (e.g., curb stop valve, etc.);
- **Location B**: A location along the 2nd portion of the service line that is at least 18 inches away from where the 2nd portion of the service line ends (e.g., structure, building, etc.);
- **Location C**: If a water meter is located on the 2nd portion of the service line and is not inside the building/structure, a location along the 2nd portion of the service line that is at least 18 inches away from the water meter; and
- **Location D**: A location where the service line connects to the structure's premise/interior plumbing, if the service line is visible. This location can be outside or inside the structure.

If a visual inspection cannot be performed on Locations A, B, C, and/or D in order to satisfy the one-point inspection, additional locations below may be used:

- **Location E**: Any location along the service line -- a half-way point is recommended (if not already used); and
- **Location F**: A half-way point if the length of the service line is less than 18 inches.

Locations A through C and E through F should be visually inspected by water system personnel and/or third-party entities contracted by the water system and/or State/local agencies. For Location D, if service line portion connected to the building/structure is not owned by the water system, building/structure owners or occupants may take photographs (or videos) of the service line (and any additional material tests performed) and provide them to the water system; otherwise, it must be visually inspected in-person by water system personnel and/or third-party entities contracted by the water system and/or State/local agencies.



Non-Exposed Service Line Pipe Inspection Methods

Metal Detector

Service line verification: Material

Metal detectors are electronic devices that detect the nearby presence of metal objects on the surface, underground, and under water. Metal detectors can detect both ferrous and non-ferrous metal types, although they detect ferrous metals more easily due to their magnetic properties.

Since not all metal detectors are designed to be sensitive enough to detect lead, MDE will only allow the use of metal detectors that can accurately identify the type of metals being detected, including lead. Before using this method, a field test must be conducted on known lead pipes, galvanized iron, and other metals, to ensure that the

chosen metal detector can effectively and accurately identify each different pipe material. Water systems may be asked by MDE to demonstrate the effectiveness of the metal detector used.

When using this method, the detection must be performed on the service line pipe (i.e., not the connector) over three segments of the service line portion in question (i.e., 1st portion or 2nd portion) described below.

The required segments are:

- A 5-foot segment starting from where the service line portion begins;
- A 5-foot segment starting from where the service line portion ends; and
- A 5-foot segment of the middle of the service line portion.

If any segment reveals the service line material to be lead, no further detection on other segments is necessary (i.e., detection of only one segment is required).

If the service line portion is less than 15 feet in length, then the detection must be performed on the entire length of the service line portion in question.

Ground-Penetrating Radar (GPR)

Service line verification: Diameter

Ground-penetrating radar (GPR) is a non-invasive locating tool that can detect the location and diameter of the service line; however, it lacks the ability to discern service line material.

Before using this method, a field test must be conducted on pipes with known diameters to ensure that the chosen ground-penetrating radar equipment can effectively identify each different pipe diameters. Water systems may be asked by MDE to demonstrate the effectiveness of the GPR equipment used.

When using this method, the detection must be performed on the service line pipe (i.e., not the connector) on three segments of the service line portion in question (i.e., 1st portion or 2nd portion) described below.

The required locations for GPR are:

- Any location within a 5-foot segment starting from where the service line portion begins;
- Any location within a 5-foot segment starting from where the service line portion ends; and
- Any location within a 5-foot segment of the middle of the service line portion.

If the method reveals the service line diameter to be different among the three locations described above, then the smallest of the diameters should be reported to MDE on the inventory spreadsheet.

Internal CCTV Inspection of Inside of the Entire Portion of the Service Line Pipe

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only)

This method uses a high-resolution cameras equipped with a flexible, fiber optic scope and a light source to inspect the service line material from inside the pipe. This method is, however, ineffective when the service line is coated with corrosion scale and the method itself can cause disturbance to the pipe. It is recommended that measures be taken to reduce scale disturbances and lead release when using this method.

This method is currently not considered for verification purposes (i.e., it is for information gathering purposes only) by MDE; however, if water systems can demonstrate that the service line does not have any coating of corrosion scale, the method may be considered by MDE for verification purposes. Water systems will need to get approval from MDE prior to using this method for inventory purposes.

Other Non-Exposed Service Line Pipe Inspection Method(s)

Service line verification: Not Considered for Verification Purposes (i.e., it is for information gathering purposes only), unless pre-approved by MDE.

Any other tools and/or instruments (not captured in other field investigation methods listed) that provide information on materials and/or diameters of the service line.

These methods must be pre-approved by MDE on a case-by-case basis; otherwise, they will not be considered for service line verification purposes (i.e., it is for information gathering purposes only).