BlueConduit

PROJECT SUMMARY REPORT FOR

Alabaster Water Board (AL0001148)

Statistical Analysis Report for Absence of Lead

September 30, 2024

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Executive Summary

This report presents an analysis of work conducted within Alabaster Water Board's service area (Alabaster, AL and surrounding areas) to assess compliance with the Lead and Copper Rule (LCR) and the recent LCR Revisions (LCRR). The objective was to determine the prevalence of lead service lines in the water distribution system. For the purposes of this report, the term "unlabeled" is used for service lines which do not have a material label.

Key Findings

- **Existing Data:** There are approximately 14,543 service connection in the water system. AWB worked to verify public and private lines within their system. Upon a review of historical data, interviews with former and current staff, and these previously conducted verifications or replacements, there is no previous evidence of lead or galvanized requiring replacement service lines in AWB's system.

- **Lead-Free Service Lines:** The utility conducted 4,196 inspections on the public side of the service line and 4,077 inspections on the private side. The uniform absence of lead in this representative sample strongly supports the assertion that there are no lead service lines within AWB's system.

- **Statistical Evidence:** Best-practice statistical analyses detailed in this report support the conclusion that the absence of lead in the set of inspected service lines is representative of the broader system. Still, the only way to prove with 100% certainty there are no lead service lines in a water system is to inspect every single length of every single service line. On an address-level basis, **we can conclude with 99% confidence that the 5,479 unlabeled service lines on the public side have no more than a 0.11% probability of being lead (less than 1%), and on the private side the 5,521 unlabeled service lines have no more than a 0.113% probability of being lead (less than 1%).**

- **Recommendations:** Based on the conclusive results, we recommend that AWB indicate that there are **no lead or galvanized requiring replacement service lines** in their inventory. This conclusion is supported by the absence of lead in the inspected sample of service lines and is further validated through statistical evidence. The conclusion should be open to updates as new information arrives.

Conclusion

- This report affirms that AWB has successfully met the requirements of the Lead and Copper Rule, as evidenced by the absence of lead service lines in the inspected sample and the statistical analysis supporting this conclusion. The findings provide a strong foundation for AWB to confidently assert the absence of lead in its service line inventory. Thus, the enclosed evidence supports AWB's use of a category label of "Non-Lead" for the remaining unknown service lines in their inventory, using statistical analysis as the basis of material classification. AWB will continue with service line investigations as it completes a multi-year meter changeout project.
- The service line inventory is a living document. Information about subsequent verifications will be tracked. In accordance with LCRR, if after a service line classified as non-lead based on the results of statistical analysis is

eventually found to be lead in the field, the classification of the material would be adjusted accordingly in the inventory and proper notification and remediation steps taken.

Introduction

Alabaster Water Board (AWB), in partnership with BlueConduit, developed this report to submit to the Alabama Department of Environmental Management, outlining our Statistical Analysis Approach for the inventory development and specifically our no-lead outcomes.

BlueConduit's methodology and approach is closely aligned with the guiding Principles of Data Science for Lead Service Line Inventories and Replacement Programs and in accordance with the EPA Guidance for Developing and Maintaining a Service Line Inventory, where our work is cited several times.

To ensure that the statistical methods results are accurate and interpreted appropriately, BlueConduit recommends that water suppliers adhere to the following fundamental statistical and research principles when using statistical methods to inform the classification of the service line material at each property in the AWB system:

1. Develop a data management plan.

2. Understand existing verified service lines materials, historical records, and all other information about service lines and addresses.

3. Verify service line material for a representative set of service lines, which can be focused on some types of service lines or addresses based on risk factors. Evaluate the correspondence between historical records and verified materials.

4. Provide valid statistical documentation about how much lead may be in the service area (i.e., the estimated likelihood that the entire service area has a very small fraction of lead service lines). Provide an estimated, address-level likelihood of lead probability.

5. Ensure transparency by submitting model and analysis results, explaining how results were utilized to inform the prioritization of properties for service line investigation/replacement and/or to develop the inventory and classify material types.

Before we go any further, we want to be clear about what we mean by "lead" and "no lead." We consider lead to be present if any of these is present:

- utility-owned or customer-owned lateral service line is lead, or
- utility-owned or customer-owned lateral service line is galvanized requiring replacement (according to EPA).

When we say "no lead" as it relates to LCRR compliance, we mean that none of the above is present.

During the course of our work, it became statistically clear that AWB had an extremely low chance of finding lead in its service area.

Out of 4,196 known lines on the public side and 4,077 known lines on the private side, zero revealed a lead service line. These known materials came from a mix of previously verified lines in a geographically concentrated area (by meter reading routes) and BlueConduit's recommended inspections. AWB maintains approximately 14,580 lines across its service area.

We go into detail about our methodology for non-lead in Step 4 below.

Regulations on Statistical Methods for LCRR

On August 16, 2024, ADEM issued conditional approval for AWB's use of statistical modeling. The conditions outlined were as follows:

1. *The confidence level of service line material determination must be equal to or greater than 95%; AND*
2. *The inflection point, or the percentage likelihood at which a service line is considered lead for the purposes of classification on the inventory, must be less than or equal to 70%; AND*
3. *Documentation describing the translation of the model outputs to the required fields on the Department-approved LSLI should be included in the inventory submitted to the Department and included in any required public communication of the inventory data; AND*
4. *The optional fields "Basis of SOP SL Material Classification", "SOP Notes", "Basis of COP SL Material Classification", "COP Notes" shall be completed for all lines that use the statistical analysis approach, with the Notes column for each including the percent (%) likelihood of lead for that service line.*

As described in this document, the statistical analysis yields a confidence level of 99% (condition 1). Given the low prevalence of lead, the inflection point of 70% is not applicable as no service lines have a greater than 70% probability of being lead (condition 2). Conditions 3-4 will be met in the inventory submission accompanying this report.

BlueConduit Methodology and Approach

Step 1: Data Collection & Preliminary Inventory Development

The very first step to building an accurate and comprehensive inventory starts with data collection, records and system review. The first guiding principle in running any statistical analysis is to ensure that data is organized and consistent. For example, this means ensuring all of the information collected related to a point of service is associated with that point of service (i.e., a structure's specific water SL).

BlueConduit begins the process by analyzing data that can be classified as service lines of "known" materials. This involves reviewing verified service line material records, building codes, city ordinances about banned service line materials, and investigating other sources that provide certainty about pipe materials in the system. This initial step provides a baseline for the inventory and helps set the strategy for reducing "unknowns" for locations where pipe material is not known with high degrees of certainty.

BlueConduit requested information from AWB to begin the statistical analysis process. High-value data sources that are commonly used in an SLM Inventory project include:

- Recently Verified Service Line Material Records (both Public and Private-side)
- Records of previous materials for any service line replacements performed
- Water main age
- Historical water service line maps

- Taxable Parcel Records (year built, land size, value, zoning, etc.)
- Construction records
- Water Account Billing information
- Water Sampling Test Results
- Water Main Size and Material
- Census Data
- Fire Hydrant Locations and Attributes

Summary of AWB Inventory Work to Date

AWB has gone to great lengths to collect and organize their system data. This dataset was provided to BlueConduit to begin the statistical analysis process.

AWB has been collecting this information as part of various work activities, such as service line repairs/replacements and routine meter change outs, where crews are working in close proximity to both AWB's side and the customer's side material to gather that information. AWB has also been collecting this information as part of a meter changeout program that began in 2023. This information is being collected in Elements, the electronic work order system used by AWB, and is being transferred into the ArcGIS Service Line Inventory solution. Classifying the material is being done by visual inspection of the exposed service lines. For non-plastic lines and copper service lines, the crew members can use a couple methods to determine if the material is either lead or galvanized, such as visual identification/scratch test and using a magnet.

Step 2: Data Evaluation and Validation

There are many potential sources of data about service line (SL) information, and the types and accuracy of SL data will vary between water systems. Existing data about SL materials comes from different sources (e.g., water main repairs, water meter replacement programs, old construction records) and the accuracy and reliability of these records varies by record type and location. Replacements may have been made over time without proper record keeping or records simply may be incomplete or incorrect. It is therefore crucial to establish how correct a water system's historical records are. **Out of caution, BlueConduit does not treat historical data as 100% truth when performing statistical analysis.**

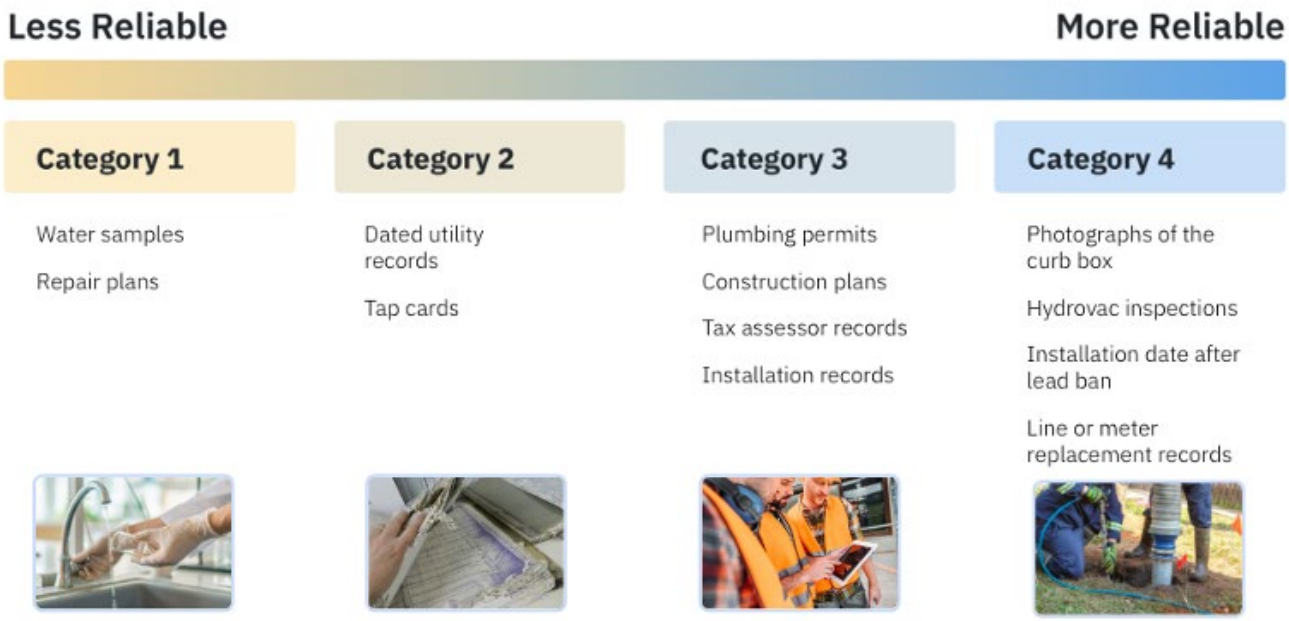

Figure 1. Spectrum of Reliability in Service Line Records

Many water systems do not know which types of records are correct and which are not. For BlueConduit, it is important to establish an understanding of how accurate those records are, while also noting that some types of records are going to be more accurate than others (Figure 1). The process of learning just how accurate (or otherwise) a system's records are an informative piece of this data-driven approach.

As a best-practice, to be considered a reliable-known material in the preliminary analysis and therefore excluded from further field investigation, a service line should meet criteria 1 or 2 below, supported by data from a reliable source:

1. The service line was recently physically verified **-OR-**
2. Ordinances or controls were in place and all of the following apply:
    - Ordinances or other controls 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 may have been included in the list of locations from which a set of sites were uniformly randomly selected for verification in Step 3.

In addition to field verifications, AWB used other methods to identify non-lead service lines in their system. These designations tend to come from categories 1-3 in Figure 1. This includes service lines where the associated structure was built after the lead ban, an install record is after the lead ban, or a record of the diameter of the line excludes it from the unknown categories.

Based on these records, AWB has designated 4,905 public side service lines and 4,982 private side service lines as non-lead. These public service lines include 4,830 lines that can be designated non-lead due to installation dates after the

lead ban or diameters larger than 2”, and the rest of the lines consist of 77.33% Non-Lead - Copper (58), 17.33% Non-Lead - Plastic (13), and 5.33% Galvanized (4). These private service lines include 4,907 lines that can be designated non-lead due to installation dates after the lead ban or diameters larger than 2”, and the rest of the lines consist of 44.00% Non-Lead - Plastic (33), 33.33% Non-Lead - Copper (25), 13.33% Non-Lead - Other (10), and 9.33% Galvanized (7). The locations of these materials are mapped in Figure 2 and Figure 3.

BlueConduit does not use these locations as verified material to base the risk assessment of lead on, as in Step 3, but they do reduce the unlabeled population. The unlabeled population of service lines is what we aim to estimate the risk of finding lead in.

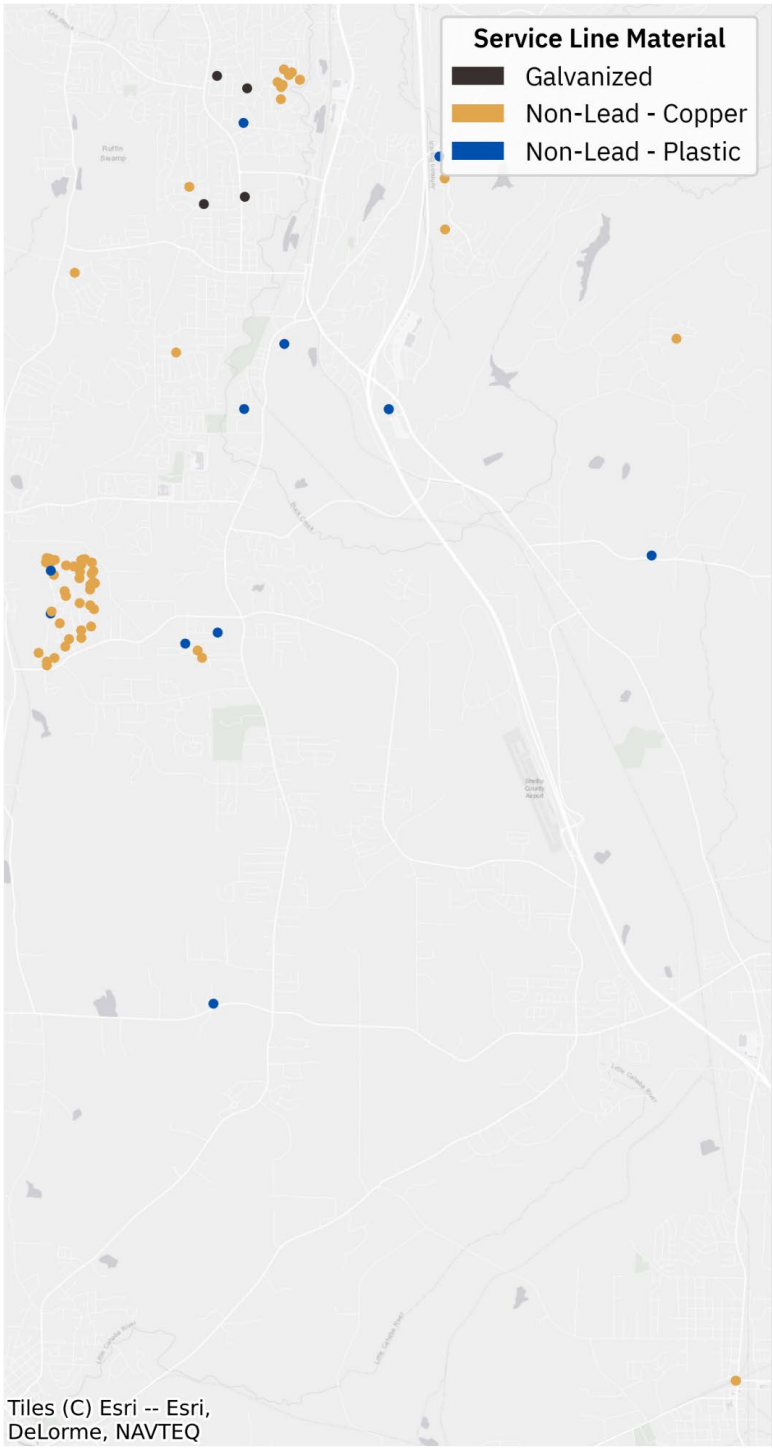

Figure 2. Locations of Public Service Lines Material based on Categories 1-3 of Figure 1.

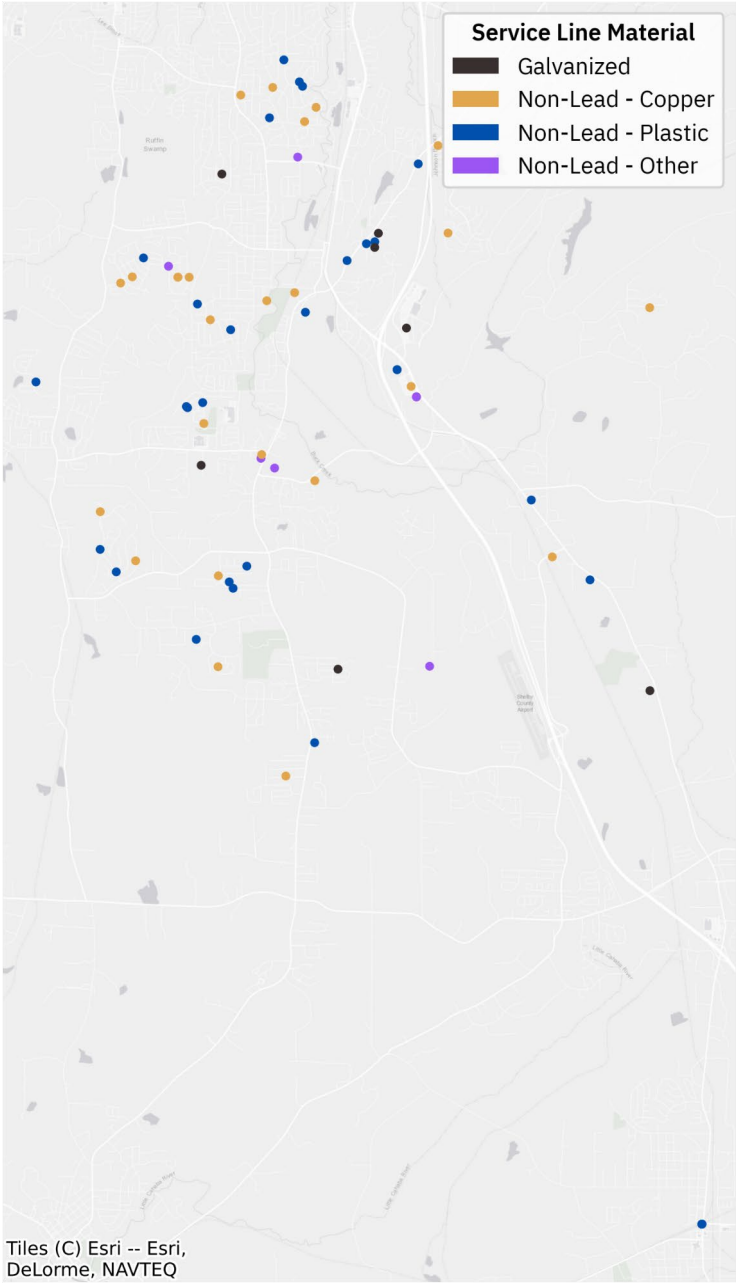

Figure 3. Locations of Private Service Line Material based on Categories 1-3 of Figure 1.

BlueConduit worked with AWB to understand how their preliminary inventory was developed, and what data and records were collected and utilized to classify known materials. In collaboration with AWB, we evaluated the accuracy and reliability of those records and recommended field investigation to validate as needed.

Step 3: Representative Field Investigation

The goal is to best estimate how much lead there may be in the water system and quantify the likelihood that there is very little lead. The accepted best practice in statistics to be able to make these kinds of estimates is gathering verified

service line material data at a random set of structures where the service line material is unknown. Statistically, only such a representative set of verified service points will truly reflect the whole system. This representative randomized sample is critical for understanding the entire system's service line materials.

Even when the water system expects to find zero lead service lines out of their currently unlabeled service line materials, the best approach is to inspect the materials of service lines that are representative of all of the remaining unknowns across the whole system.

In order to determine the appropriate number of field verifications necessary, the following information was considered: (1) total number of service lines in the system, (2) total number of unlabeled service line materials in the system, and (3) desired confidence level (e.g., 99%).

Service line selection is designed to be representative to mitigate data biases. By doing this, we ensure that every service line that has not yet been verified has an equal chance of being verified. That means the data will represent all of the service lines without labeled materials across all neighborhoods, socioeconomic factors, age of structure, and any historical records about service lines. This is critical to ensure that the water system does not make conclusions about all locations based on only the existing data, as that may not have previously been equally representative of all parts of the system.

Field Verification Method

We recognize that every system's infrastructure is different and recommend utilizing the verification method(s) most efficient and effective for AWB, so long as the chosen methods are aligned with any specific field verification requirements set forth by state regulation.

To field verify the service lines, Alabaster Water and a third-party contractor are utilizing hydro-excavation equipment and/or hand digging to expose both the Alabaster Water side and the customer side of the meter for visual inspection to identify the material used for the service lines. This data is collected electronically in the field with the work order system discussed above. Photographs are also attached in the work order system. This data goes through a QA/QC process to look for missing or possible mistakes before updating the inventory. Results were then provided to BlueConduit to be incorporated into the statistical analysis.

Description of Representative Field Inspections

AWB had worked to verify either the public or private lines of a significant number of structures before our recommendations, none of which revealed lead or GRR (galvanized requiring replacement) service lines. The 3,824 public side field inspections before our recommendations showed 69.22% Non-Lead - Copper (2,647), 18.38% Non-Lead - Plastic (703), 12.11% Galvanized (463), and 0.29% Non-Lead - Other (11). The 3,702 private side field inspections before our recommendations showed 53.30% Non-Lead - Copper (1,973), 41.65% Non-Lead - Plastic (1,542), 4.40% Galvanized (163), and 0.65% Non-Lead - Other (24). The locations of verified service lines before BlueConduit generated a representative list were numerous but tending to have clusters in certain areas (Figure 4).

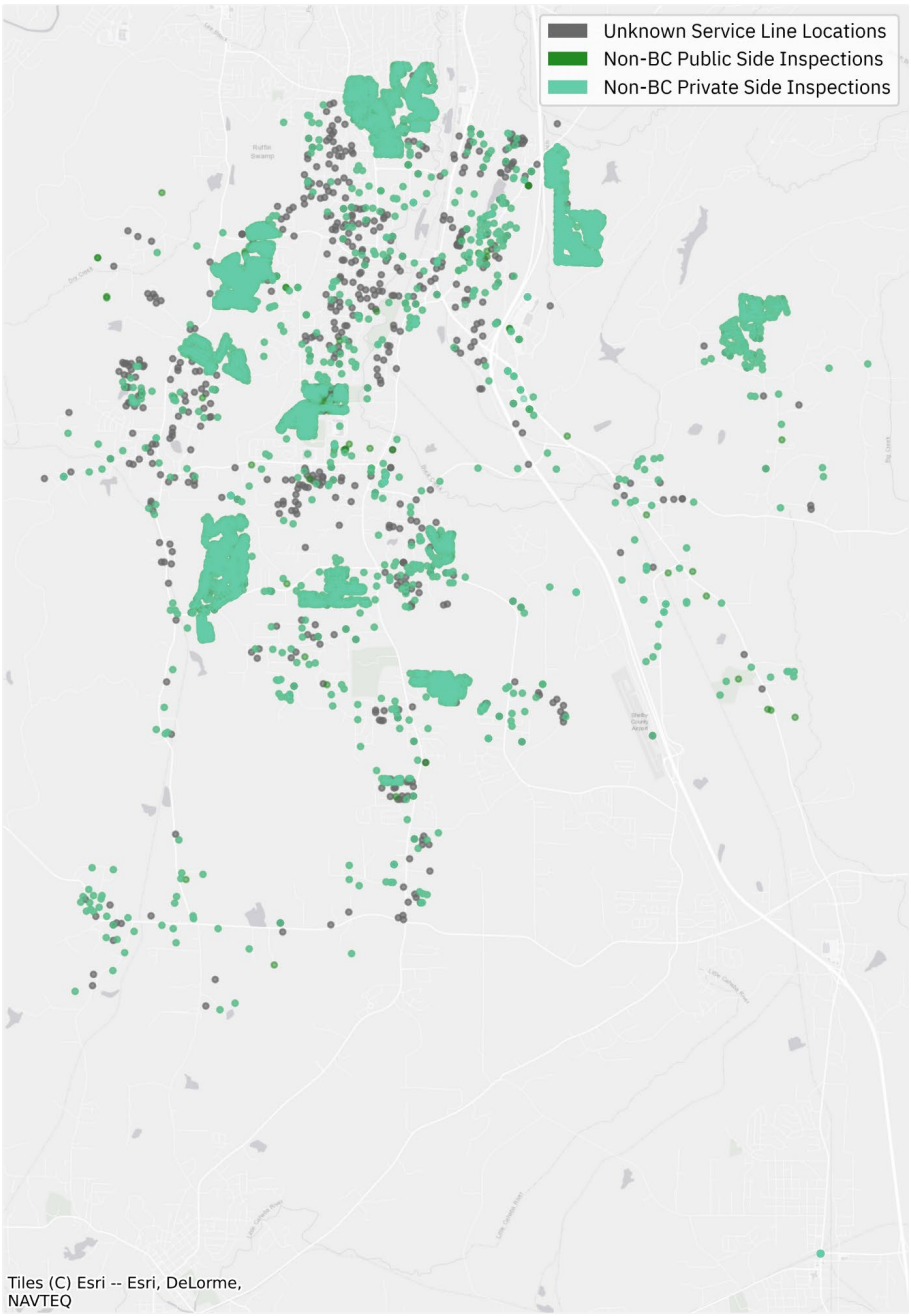

Figure 4. Locations of non-BC Verified Service Lines. Service line locations that have not been inspected (gray), as well as those that have been inspected on the public and private sides (green).

After preliminary evaluation of the quantity and quality of existing verified data, BlueConduit generated a random representative sample of 371 service lines for AWB to visually inspect and confirm the existing service line material (Figure 5).

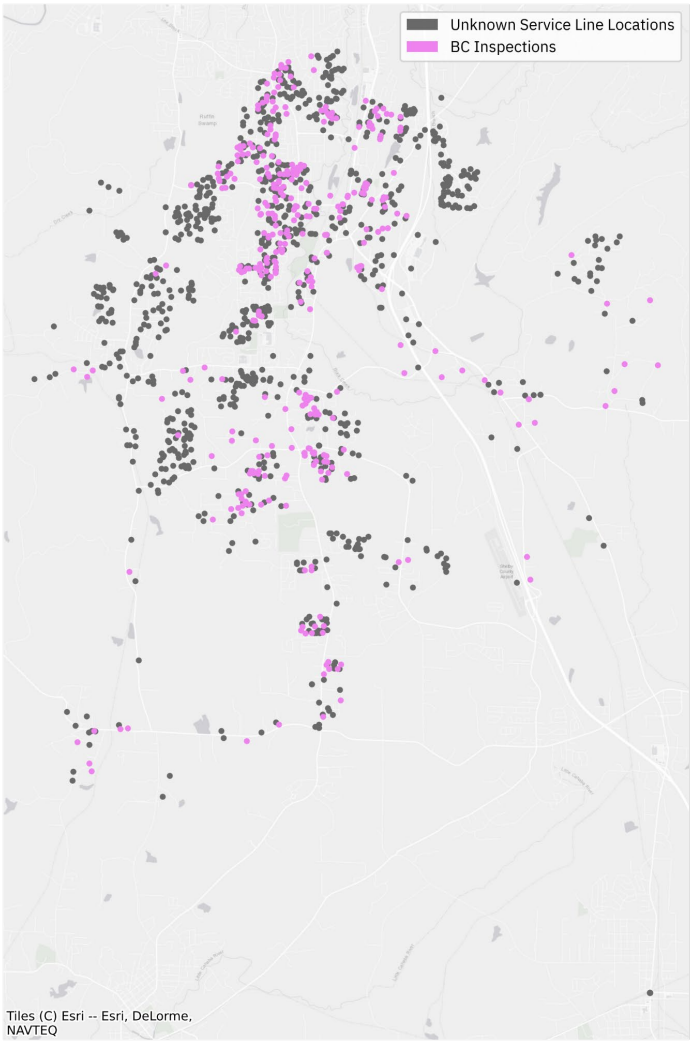

Figure 5. Locations of BC Verified Service Lines. Service line locations that have not been inspected (gray), as well as those that were inspected on both the public and private sides at BlueConduit's recommendation (pink).

The 372 public side field inspections conducted with BlueConduit's guidance revealed 45.16% Galvanized (168), 28.23% Non-Lead - Plastic (105), and 26.61% Non-Lead - Copper (99).The 375 private side field inspections conducted with BlueConduit's guidance revealed 44.53% Non-Lead - Plastic (167), 29.60% Galvanized (111), and 25.87% Non-Lead - Copper (97).

Ultimately, a total of 4,196 public service lines and 4,077 private service lines were verified. All materials investigated were found to be non-lead. The 4,196 public service lines showed 65.44% Non-Lead - Copper (2,746), 19.26% Non-Lead - Plastic (808), 15.04% Galvanized (631), and 0.26% Non-Lead - Other (11). The 4,077 private service lines showed 50.77% Non-Lead - Copper (2,070), 41.92% Non-Lead - Plastic (1,709), 6.72% Galvanized (274), and 0.59% Non-Lead - Other (24). The breakdown of materials by verification (AWB's independent work vs. BlueConduit recommendations) shows overlapping distributions of different non-lead materials (Figure 6).

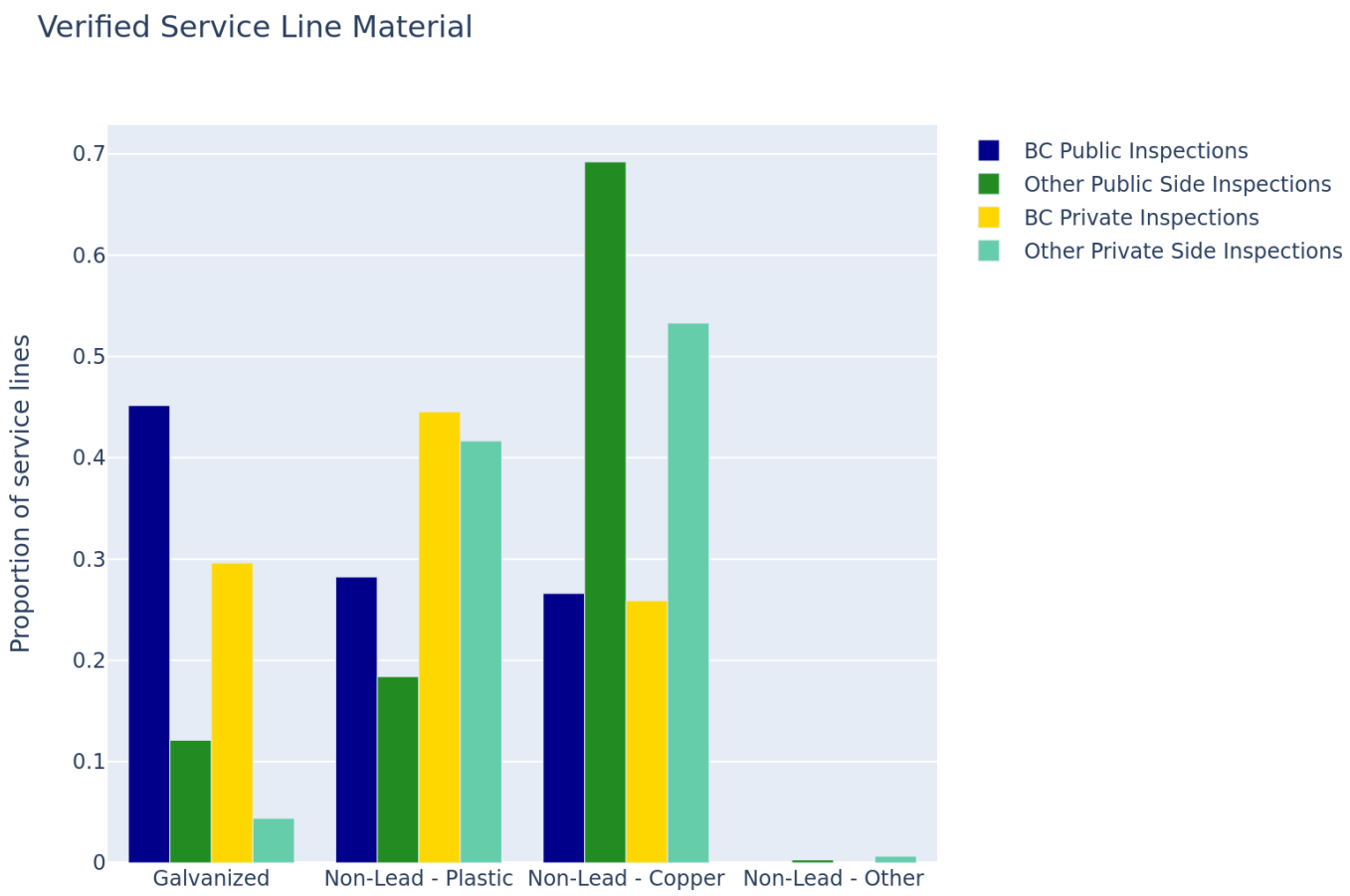

Figure 6. Verified Service Line Material. The proportion (0-1) of inspections completed by BlueConduit (BC Private/Public Inspections) or AWB (Other Public/Private Inspections) for each category of material.

After compiling results from AWB's independent inspections and BlueConduit's recommended inspections, we could see that the specific non-lead materials on both the public (Figure 7) and private (Figure 8) side were distributed in space.

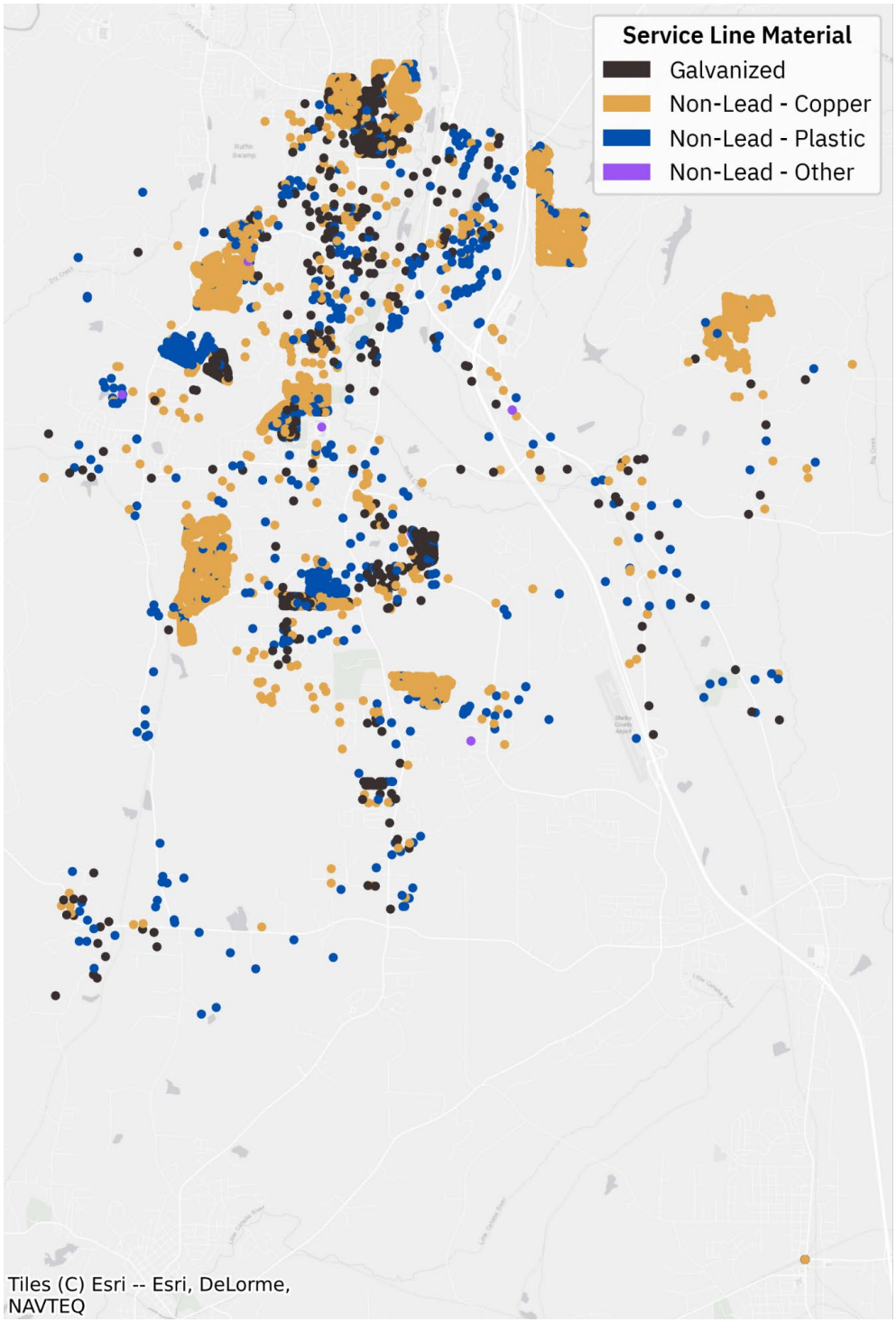

Figure 7. Locations of Verified Public Service Line Material.

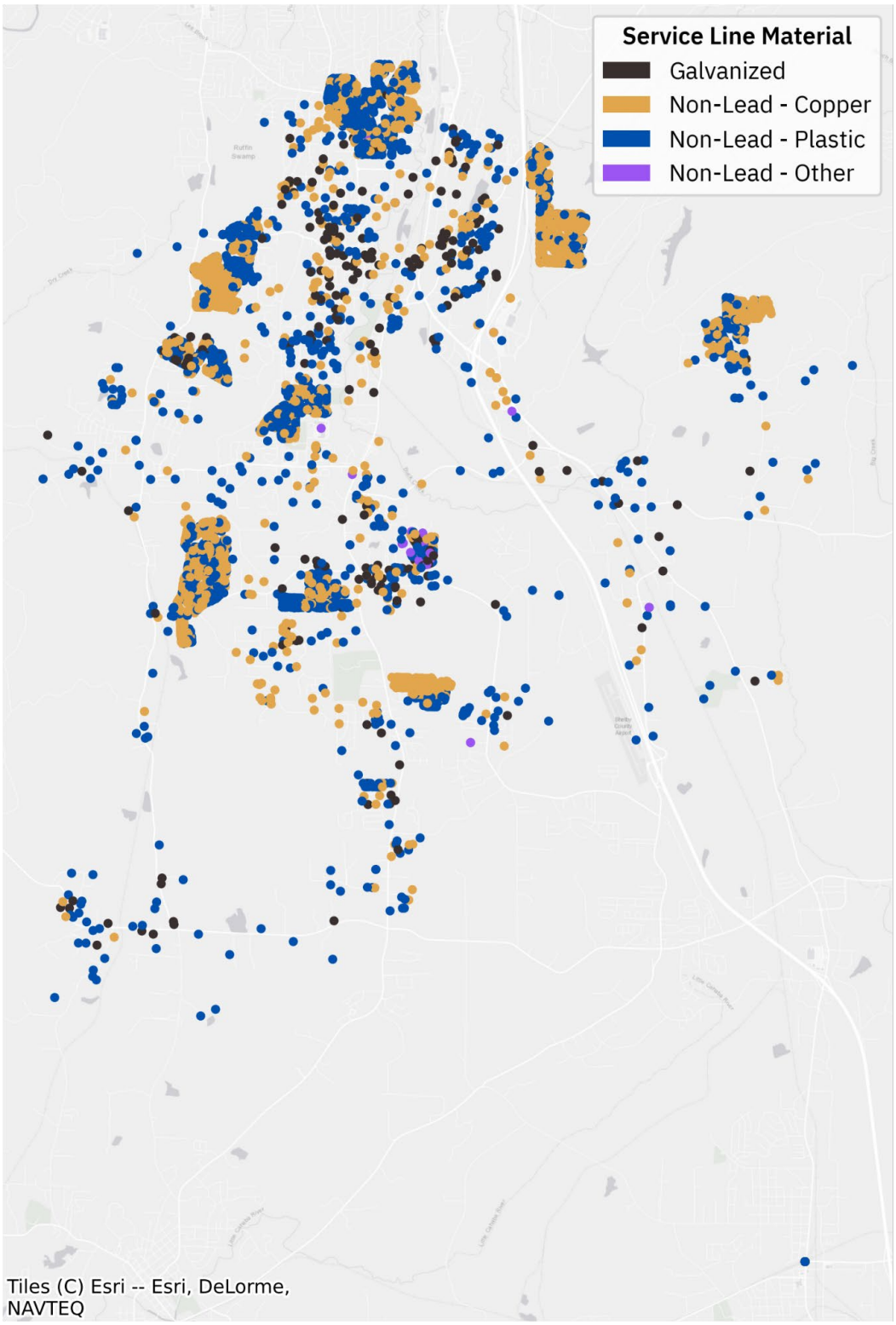

Figure 8. Locations of Verified Private Service Line Material.

In addition to being numerous and spatially representative of the water system, the verifications done by AWB are representative of the underlying population. For instance, all levels of structure parcel value have been sampled with these verifications (Figure 9).

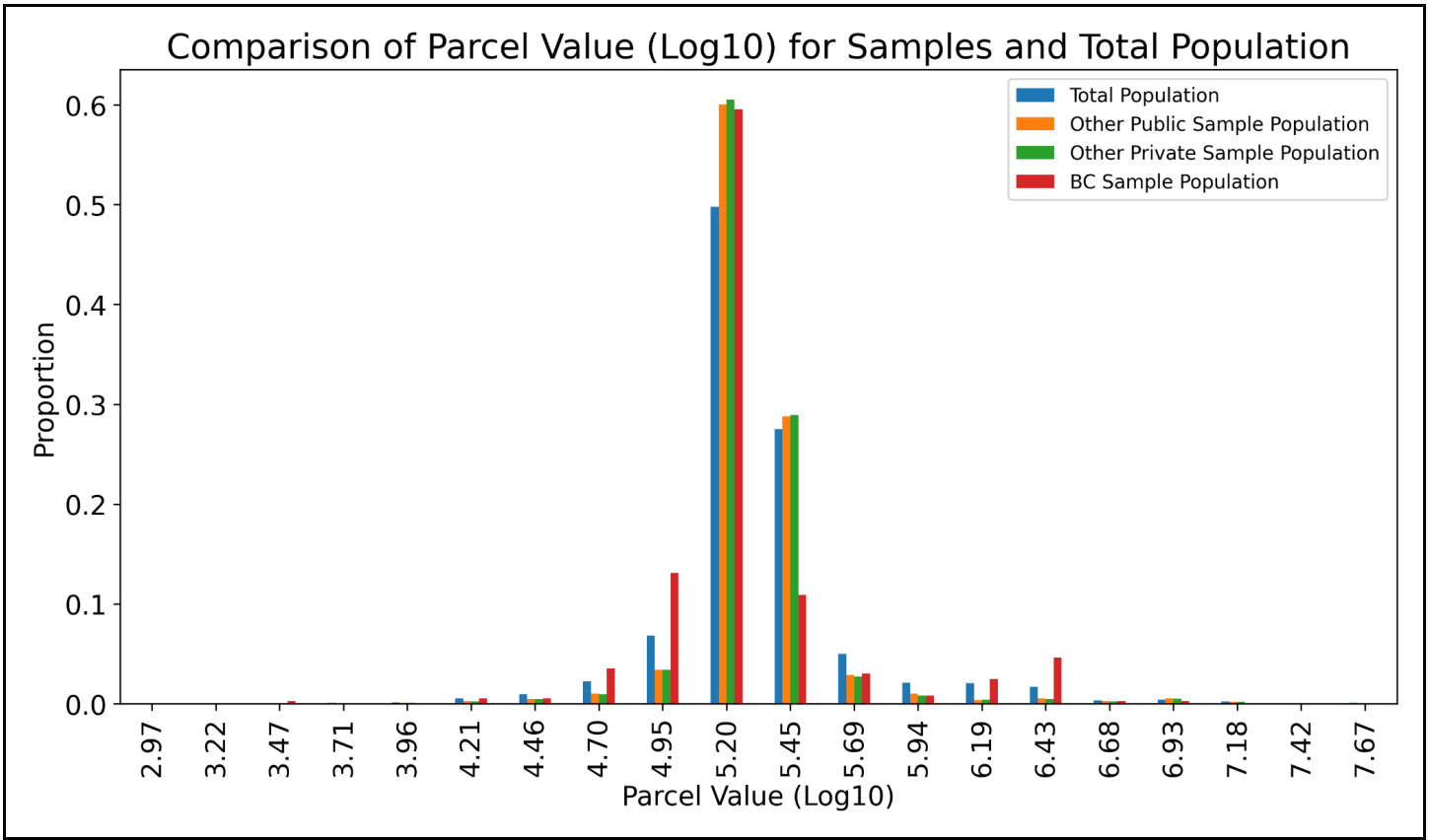

Figure 9. Comparison of Parcel Value (Log10) for Samples and Total Population. Proportion of service lines associated with structures with certain parcel value (the common log of the parcel value), as a function of whether and how it was inspected.

In summary, AWB's numerous inspections, augmented by the representative sample recommended by BlueConduit, amount to a strong representation of the underlying population. The inspections have been geographically distributed and have sampled across the population's spectrum of types of houses. These verifications will be the basis of the statistical analysis in the following step.

Galvanized Materials

Galvanized materials are found on both sides of the line, however, due to the absence of current or past lead, these are not galvanized requiring replacement.

AWB has to date not identified any lead services or lead connectors, such as lead goosenecks, in the water system. The AWB water system began in 1955 and none of the former employees contacted nor existing employees have found any lead service lines within the water system.

Step 4: Statistical Analysis

Method for Showing Evidence of the Absence of Lead

Many water systems report having never encountered a lead pipe in all of their time maintaining their water infrastructure and have no historical records of lead line installations.

However, the absence of evidence of lead at a subset of service lines alone cannot "prove" an absence of lead altogether across the whole service area — but it's an important part of the picture. If the preliminary inventory data **and** representative field investigations reveal *zero* lead - (no lead service lines, no galvanized service lines requiring replacement, or no lead goosenecks) - the remaining unlabeled service lines will have a very low probability of being lead.

The only way to absolutely prove with complete certainty there are no lead service lines in a water system is to dig up and visually inspect every single length of every single service line. Water systems and regulators alike recognize that 100% physical verification is not feasible from a time or cost perspective. This is where BlueConduit's statistical analysis approach provides significant value and is the most efficient, scientific alternative to putting eyes on every single pipe. This approach has also proven to be more effective than using historical records alone.

We can rely on a body of research in statistics spanning decades to utilize the most productive way to think about situations where information is scarcer than we would like for typical analysis methods. For instance, when patients in a particular clinical trial of a new drug have not experienced a given side effect, medical researchers do not conclude that the side effect is impossible, but that they quantify how unlikely it is. Our approach does the same.

If we have representative data that shows zero lead, our data scientists calculate the highest probability of lead you could expect for any given service line using two inputs:

1. the number of service lines in the representative sample that you inspected where you found no lead **and**
2. the desired level of confidence -

To illustrate this concept, we present a hypothetical utility with 30,000 service lines, 10,000 of which are verified, and they haven't seen any lead in their system. They want to know if they can claim there aren't lead service lines or goosenecks in the 20,000 unlabeled service lines. The utility verifies randomly selected 200 inspections (that are representative of the service area) and finds no lead, so they can conclude they are 95% certain that fewer than 1.5% of their unlabeled service lines are lead. They can also conclude that they are 99% certain that less than 2.3% of those unlabeled service lines are lead.

And as they continue to gain more information, say, another 50 representative service lines are found to be not lead, then they can update those numbers to be 95% certain that fewer than 240 (1.2% of unlabeled service lines) are lead. As the number of representative service lines found to not have any lead increases, then these metrics evolve.

When a representative set of unlabeled service lines are inspected (on both portions of the service line) and when not even one of them turns out to be lead, then we can characterize our uncertainty about that water system's remaining

unlabeled service lines with the above variable calculations. The resulting calculations can guide community and utility action even when it is very likely that there is a very low number of lead service lines in the system.

Results and Conclusion Showing Evidence of the Absence of Lead

Based on extensive and representative field investigation and verified service lines records containing 0 indications of lead, we can conclude with 99% confidence that of the system's 14,543 service lines, there are fewer than 7 lead service lines that may be present on the public side of the system and fewer than 7 lead service lines that may be present on the private side of the system. These figures represent 0.0480% of all public service lines and 0.0480% of private service lines in the whole system.

Thus, we provide evidence that could support AWB's use of a category label of "Non-Lead" for the remaining unlabeled service lines in their inventory, using statistical analysis as the basis of material classification, recognizing the following:

BlueConduit recommends that AWB recognize that additional physical verifications may be requested after review of the report and findings, including possible excavation of additional service lines. AWB is currently completing a multi-year meter changeout program that should provide for a visual verification of all existing water services by approximately 2027.

Even when there is a low likelihood of a property having lead (e.g., 99% chance that service line is non-lead), there remains a small chance that the property will have lead (e.g., 1% chance of lead).

BlueConduit guides AWB to expect the lead service line inventory to remain a living and evolving dataset as future field inspections and potential replacements are completed. In accordance with LCRR, if after a service line classified as non-lead based on the results of statistical analysis is eventually found to be lead in the field, the classification of the material should be adjusted accordingly in the inventory and proper notification and remediation steps taken.

Appendix

A: Michigan EGLE Guidance: Minimum Number of Service Lines Requiring Physical Verification
B: References

Appendix A

Source Document: Michigan EGLE - MINIMUM SERVICE LINE MATERIAL VERIFICATION REQUIREMENTS
Minimum Number of Service Lines Requiring Physical Verification (p.6)

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 the physical verification process, this represents the number of service lines that do NOT meet the criteria for "known" service lines described in Step 2 of this document. If the number of "unknowns" falls between two values on the chart, BlueConduit will either interpolate or round up to the higher number when creating the final recommended inspection list.

Appendix B

State-Guidance References

The method outlined in this plan is grounded in the academic literature for how to use data science to inventory and locate lead service lines. It draws upon recognized best practices from regulators and policy makers on how to adapt that research for the purpose of service line inventory requirements required by LCRR.

- ActiveRemediation: The Search for Lead Pipes in Flint, Michigan
- Getting the Lead Out: Data Science and Water Service Lines in Flint
- Principles of Data Science for Service Line Inventory and Replacement Programs, Association of State Drinking Water Administrators
- Michigan EGLE guidance on the use of statistical methods for developing service line inventory
    - Complete Distribution System Materials Inventory (CDSMI) Overview
    - Minimum Service Line Materials Verification Requirements
    - Complete Distribution System Materials Inventory (CDSMI), Evaluating Minimum Service Line Materials Verification Data
- Oregon Health Authority
    - Statistical Guidance for Evaluating Unknown Service Lines
- Virginia Department of Health, Office of Drinking Water
    - Guidance for Statistical Methods and Predictive Modeling
- Maryland Department of the Environment
    - MDE LCRR Service Line Inventory Guidance

BlueConduit Blog Article

When a Representative Sample of Service Lines Reveals Zero Lead, What Can You Say?
When a Representative Sample of Service Lines Reveals Zero Lead, What Can You Say? | BlueConduit

By Alice Berners-Lee, Ph.D., Jared Webb and Eric Schwartz, Ph.D.