



September 2018

# DRINKING WATER

## Approaches for Identifying Lead Service Lines Should Be Shared with All States

Accessible Version

# GAO Highlights

Highlights of [GAO-18-620](#), a report to congressional committees

## Why GAO Did This Study

The crisis in Flint, Michigan, brought increased attention to lead in drinking water infrastructure. Lead in drinking water primarily comes from corrosion of service lines connecting the water main to a house or building. In 1991, EPA issued the Lead and Copper Rule that required water systems to conduct a “materials inventory” of lead service lines. In light of the events in Flint, EPA sent a letter to all states in February 2016 encouraging them to work with water systems to publicly post the materials inventory, along with any additional updated maps or inventories of lead service lines—actions the rule does not require.

A House Committee report accompanying a bill for the Department of the Interior, Environment and Related Agencies Appropriations Act, 2017, includes a provision for GAO to review lead service lines. This report examines (1) what is known about the number of existing lead service lines among states and water systems and (2) states’ responses to EPA’s February 2016 request to work with water systems to publicize inventories of lead service lines and any steps EPA has taken to follow up on these responses. GAO reviewed existing studies of lead service lines, reviewed the websites of the 100 largest water systems, and interviewed EPA officials in headquarters and its 10 regional offices.

## What GAO Recommends

GAO recommends that EPA share information about the successful approaches states and water systems use to identify and publicize locations of lead service lines with all states. EPA agreed with the recommendation.

View [GAO-18-620](#). For more information, contact J. Alfredo Gómez at (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov).

September 2018

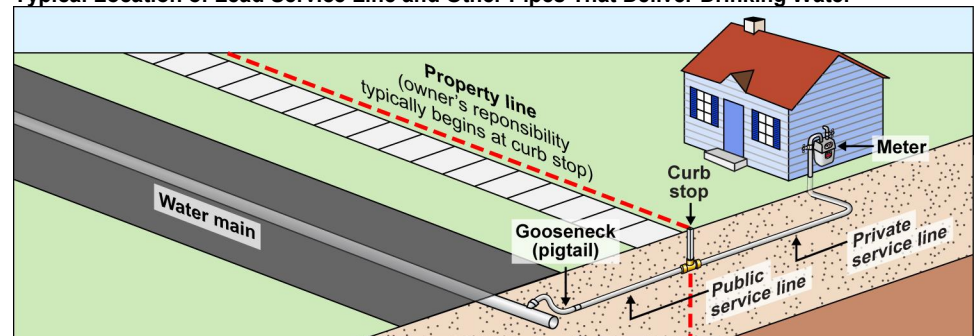
## DRINKING WATER

### Approaches For Identifying Lead Service Lines Should Be Shared With All States

## What GAO Found

The total number of lead service lines is unknown and while national, state, and local estimates exist, approaches used to count lead service lines vary. A 2016 American Water Works Association study estimated that nationally there were 6.1 million lead service lines, but the study has significant sampling limitations and, as a result, likely does not accurately reflect the total number of lead service lines nationwide. In addition, at least two states—Massachusetts and Washington—published reports with estimates of lead service lines and reported 22,023 and 1,000-2,000 lead service lines as of 2016 and 2017, respectively. Certain water systems also have estimates, such as the approximately 7 percent of publicly owned lead service lines out of the area’s total number of service lines cited by a representative for the system serving Cincinnati, Ohio and surrounding areas, as of May 2018.

Typical Location of Lead Service Line and Other Pipes That Deliver Drinking Water



Source: GAO. | GAO-18-620

While most states informed the Environmental Protection Agency (EPA) that they intend to fulfill the agency’s request to publicize inventories of lead service lines, EPA has identified potential challenges to these efforts. Of the approximately 43 states that responded that they would fulfill EPA’s request, almost all (39) reported to EPA that, although they had encouraged water systems to publicize inventories, few systems had completed these actions. GAO found in January 2018 that, of the 100 largest water systems, 12 had publicized information on the inventory of lead service lines. According to EPA, among challenges in conducting inventories of lead service lines and publicizing information about lead service lines were concerns about posting on public websites information about lead service lines on private property; and a lack of records about the locations of lead service lines. EPA told GAO the agency was focused on state compliance with drinking water rules, and not following up with information on how states could address the challenges cited. By sharing information with all states about the approaches that some states and water systems are using to successfully identify and publicize information about lead service lines, including responses to potential challenges, EPA could encourage states to be more transparent to the public and support the agency’s objectives for safe drinking water.

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**Abbreviations**

EPA	U.S. Environmental Protection Agency
SDWA	Safe Drinking Water Act

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September 21, 2018

The Honorable Lisa Murkowski  
Chairman  
The Honorable Tom Udall  
Ranking Member  
Subcommittee on Interior, Environment, and Related Agencies  
Committee on Appropriations  
United States Senate

The Honorable Ken Calvert  
Chairman  
The Honorable Betty McCollum  
Ranking Member  
Subcommittee on Interior, Environment, and Related Agencies  
Committee on Appropriations  
House of Representatives

The crisis in Flint, Michigan, brought increased attention to the country's challenge of addressing lead in drinking water infrastructure. According to the U.S. Environmental Protection Agency (EPA) and others, there is no level of lead that is safe in drinking water. Lead poses the greatest risk to infants, children under the age of 6, and pregnant women. In children, it can delay growth, cause learning and behavioral problems, and lower IQ, while in pregnant women it can reduce fetal growth and cause premature birth. Lead in drinking water primarily comes from the corrosion of pipes (such as service lines made of lead) that connect the drinking water main (a primary pipeline) to a house or building. The corrosion results from a chemical interaction between water and pipes that wears the metal and allows lead to dissolve or lead particles to flake away over time. Other sources of lead in drinking water include solder that connects pipes, and fixtures made with lead or with brass that contains lead.

Lead was widely used in plumbing materials, including service lines, until 1986 when the Safe Drinking Water Act (SDWA) was first amended to

generally prohibit the new installation of lead pipes and solder.<sup>1</sup> According to EPA, homes built before 1986 are more likely to have lead pipes, solder, and fixtures. Consequently, these homes are a priority for monitoring under EPA's Lead and Copper Rule, which minimizes the amount of lead in the nation's drinking water supply.<sup>2</sup> As of December 2016, the approximately 68,000 drinking water systems covered by the Lead and Copper Rule served about 312 million people—most of the U.S. population. When the Lead and Copper Rule was promulgated in 1991, it required all covered drinking water systems to collect information about the infrastructure that delivered water to customers, including any known lead pipes and lead service lines.<sup>3</sup> The purpose of this effort—referred to as materials evaluation (hereafter materials inventory)—was to identify locations that may have been particularly susceptible to high lead or copper concentrations, from which water systems would collect drinking water samples.<sup>4</sup> According to 2010 EPA guidance, in developing the materials inventory, water systems should survey all records documenting the materials used to construct and repair the drinking water distribution system and buildings connected to the system.<sup>5</sup>

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<sup>1</sup>In 1986, SDWA was amended to generally prohibit the new installation of lead pipes and plumbing fixtures. In 1996, the SDWA was again amended to generally prohibit the sale of pipes and plumbing fixtures that are not lead free, as defined in the act. In 2011, the Reduction of Lead in Drinking Water Act lowered the maximum allowable lead content in "lead free" materials. This act amended the SDWA's definition of "lead free" with respect to pipes, plumbing, fixtures and fittings from containing "not more than 8 percent lead" to "not more than a weighted average of 0.25 percent lead (0.2 percent with respect to solder and flux)."

<sup>2</sup>See 40 C.F.R. pt. 141, subpt I. The Lead and Copper Rule also includes requirements to minimize copper in drinking water. This report addresses only lead.

<sup>3</sup>The Lead and Copper Rule applies to community and non-transient, non-community water systems. A community water system supplies water to the same population year-round. A non-transient, non-community water system regularly supplies water to at least 25 of the same people at least 6 months per year and includes schools, office buildings, and hospitals that have their own water systems. The Lead and Copper Rule does not apply to water systems that provide water in places where people do not remain for long periods of time, such as a gas station or campground.

<sup>4</sup>The Lead and Copper Rule uses the term "materials evaluation," but recent EPA documents discussing the rule, for example the *Lead and Copper Rule White Paper*, use the term "materials inventory." In this report, we use the term "materials inventory".

<sup>5</sup>Environmental Protection Agency, *Lead and Copper Rule Monitoring and Reporting Guidance for Public Water Systems*, EPA 816-R-10-004, (Washington, D.C.: March 2010).

In a January 2016 letter to Michigan’s Governor, EPA noted its concern with lack of transparency and accountability to the public in Flint. In light of events in Flint and other U.S. cities, EPA sent a letter to all state environmental commissioners in February 2016 requesting near-term actions to assure the public that EPA and the states were working together to address risks from lead in drinking water, and to increase transparency in water systems’ implementation of the Lead and Copper Rule.<sup>6</sup> In this letter, EPA encouraged states to work with water systems to post, on a public website, the water system’s original materials inventory along with any additional updated maps or inventories of lead service lines—actions the Lead and Copper Rule does not require. EPA also encouraged states to place an emphasis on large water systems, which EPA regulations define as those serving populations greater than 50,000.<sup>7</sup>

House Report No. 114-632, accompanying a bill for the Department of the Interior, Environment, and Related Agencies Appropriations Act, 2017, includes a provision for us to review the number of lead service lines.<sup>8</sup> Our objectives were to examine (1) what is known about the number of existing lead service lines nationally, and among states and water systems; and (2) states’ responses to EPA’s February 2016 request to work with water systems to publicize inventories of lead service lines and any steps EPA has taken to follow up on these responses. This report addresses lead in drinking water, not other sources of lead such as paint, paint chips, dust, toys, or food.

To examine what is known about the number of existing lead service lines nationally, and among states and water systems, we reviewed existing studies and other documents regarding the extent of and experience with such lines. We found three written studies with estimates of lead service lines—one using national data and two that were state-specific. We took

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<sup>6</sup>Environmental Protection Agency, *Letter to Commissioners on State Actions with the Lead and Copper Rule*, (Washington, D.C.: Feb. 29, 2016).

<sup>7</sup>Under the Lead and Copper Rule, a large system serves more than 50,000 people, a medium system serves from 3,301 to 50,000 people, and a small system serves up to 3,300. EPA classifies water systems according to the number of people they serve and whether they serve the same customers year-round or on an occasional basis.

<sup>8</sup>The Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2017 specifies that language in House Report No. 114-632 carries the same emphasis as language in the explanatory statement itself and should be complied with unless contradicted by the explanatory statement. 163 Cong. Rec. H3327, H3874 (May 3, 2017).

a number of steps, including conducting interviews with each study's authors, to examine the reliability of the data used in the studies. For the one study we reviewed that used national data, the data were of undetermined reliability because the sample of water systems included in the study was not generalizable to all water systems and the authors could not verify the accuracy of the information provided by water systems.<sup>9</sup> Appendix I provides more information on our reasons for designating the data as undetermined reliability. For the two state-specific studies, we determined that the data represented reasonable efforts to estimate the number of lead service lines, although the states also could not verify the accuracy of the information provided by water systems.<sup>10</sup> Therefore, we also found these estimates to be of undetermined reliability. Appendix I provides more information on our reasons for designating the data as undetermined reliability. We did not find any studies with information comparing the quality of estimates among water systems. However, we interviewed representatives of the Greater Cincinnati Water Works water system about their estimate and found the data to be sufficiently reliable for the purpose of describing their reported best available estimate. We also interviewed EPA staff about their knowledge of estimates provided by states and water systems; and subsequently interviewed officials in some of these states, namely Massachusetts, Ohio, and Washington. We also interviewed representatives of water organizations to identify potential studies and other sources of information about the number of lead service lines. We selected these organizations based on their knowledge of conducting inventories of lead service lines as a part of the process for replacing such lines.

To examine states' responses to EPA's request and any steps EPA has taken to follow up on these responses, we reviewed the websites of the 100 largest water systems (by population served) to identify which water systems have made the information available to the public. We used a structured process to review each website for the presence or absence of

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<sup>9</sup>David A. Cornwell, Richard A. Brown, and Steve H. Via, *National Survey of Lead Service Line Occurrence*, Journal American Water Works Association, vol. 108, no. 4 (2016), pp.E182-pp.E191.

<sup>10</sup>Massachusetts Department of Environmental Protection Drinking Water Program, *Lead and Copper Rule Survey*. (Nov. 7, 2016) and Washington State Department of Health, Environmental Public Health, Office of Drinking Water. *2016 Lead Service Line & Lead Component Survey of Washington's Water Utilities*. Publication Number 331-599. (Oct. 2017).



such information so that we could reliably tabulate the results. We also conducted an in-depth, semi-structured interview with representatives from the Greater Cincinnati Water Works about their experiences in mapping lead service lines and providing the information to the public. We selected this water system based on the extent of its mapping initiative and based on recommendations from EPA and several nonprofit and water advocacy organizations. The results of this interview are not generalizable to other water systems but provide illustrative examples. We also conducted semi-structured interviews with officials in EPA's headquarters and all 10 of its regional offices. Finally, we compared EPA's actions to follow up on state responses with federal standards for internal control for information and communication.<sup>11</sup>

We conducted this performance audit from October 2017 to September 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Background

Generally, the responsibility for reducing lead in drinking water and ensuring safe drinking water overall is shared by EPA, states, and local water systems. EPA is responsible for, among other things, national implementation of the Lead and Copper Rule, setting standards, overseeing states' implementation of the rule, and conducting some enforcement activities.<sup>12</sup> However, most states have primary responsibility

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<sup>11</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

<sup>12</sup>Generally, states with primary enforcement responsibility initiate enforcement actions against water systems that do not comply with the Lead and Copper Rule and other drinking water regulations. However, EPA can also issue orders necessary to protect human health where a contaminant in a public water system presents an imminent and substantial endangerment and state and local authorities have not acted to protect human health. 42 U.S.C. § 300i(a).

for enforcing the requirements under SDWA as amended.<sup>13</sup> Water systems are generally subject to requirements under SDWA as amended, such as the Lead and Copper Rule, and are responsible for managing and funding the activities and infrastructure needed to meet those requirements.

Such infrastructure includes storage facilities and drinking water mains and may include other pipes such as service lines. There are 1 million miles of drinking water mains in the country, according to a 2017 American Society of Civil Engineers study.<sup>14</sup> As figure 1 illustrates, service lines are the smaller pipes that connect the water mains to homes and buildings. According to EPA guidance, service lines also include any smaller pipes used for connecting a service line to the water mains (e.g., gooseneck pipes which are also known as pigtails).<sup>15</sup> Service lines can generally be made of lead, steel, copper, or plastic. Service lines can be fully owned by the water system (publicly owned) or by the homeowner (privately owned), or ownership can be shared. In most communities, lead service lines are partially owned by the water system and partially owned by the homeowner. With shared ownership, the water system typically owns the service line from the water main to the curb stop, and the homeowner owns the service line from the curb stop into the home. In such cases, each party is responsible for maintaining the part of the service line that it owns.

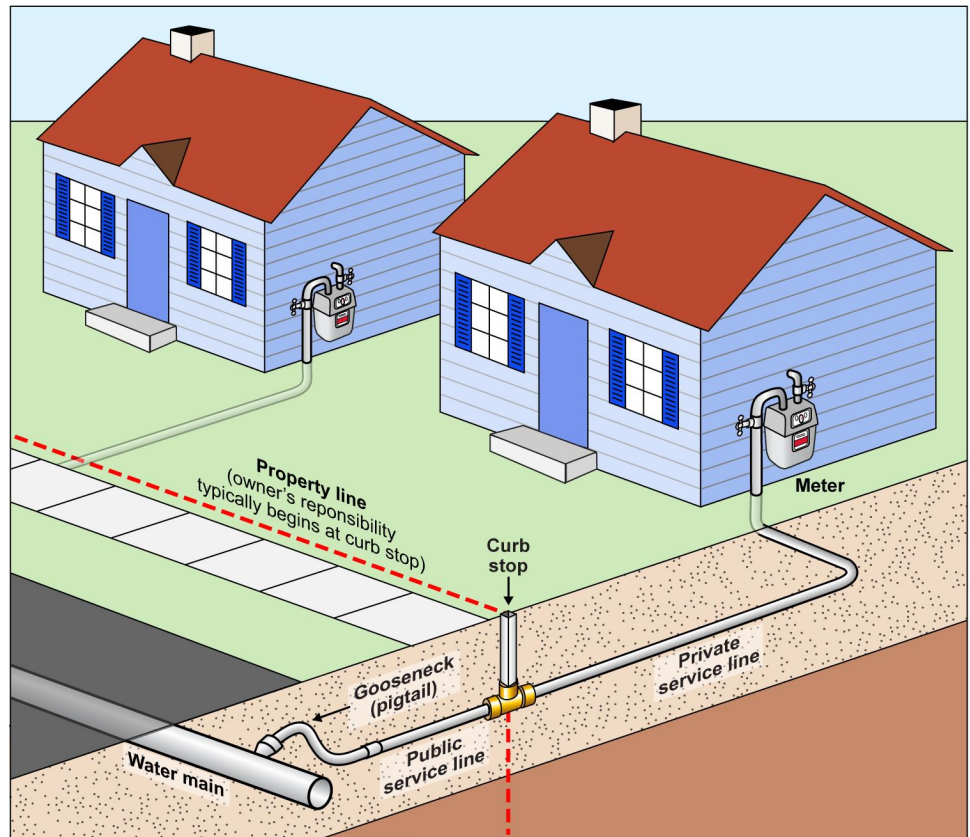
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<sup>13</sup>EPA has authorized all states and jurisdictions except Wyoming and the District of Columbia to have primary responsibility for monitoring and enforcement of SDWA as amended requirements. EPA administers drinking water programs directly in those two jurisdictions.

<sup>14</sup>American Society of Civil Engineers, *2017 Infrastructure Report Card: A Comprehensive Assessment of America's Infrastructure* (Reston, VA: 2017).

<sup>15</sup>Environmental Protection Agency, *Lead and Copper Rule Monitoring and Reporting Guidance for Public Water Systems*, EPA 816-R-10-004, (Washington, D.C.: March 2010).

**Figure 1: Typical Location of Water Main, Lead Service Line, and Other Pipes That Deliver Drinking Water to Homes**



Source: GAO. | GAO-18-620

In some circumstances, if lead levels are higher than the Lead and Copper Rule allows and other measures do not alleviate the problem, the Lead and Copper Rule requires water systems to replace lead service lines under the systems' control. The Lead and Copper Rule does not require homeowners to replace the portion of lead service lines they own, but if they choose to do so they are generally responsible for the associated costs. The Lead and Copper Rule allows for a partial replacement by the water system when an owner of a home or building is

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unable or unwilling to pay for replacement of the portion of the service line not owned by the water system.<sup>16</sup>

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## The Total Number of Lead Service Lines Is Unknown, and National, State, and Local Estimates Vary

The total number of lead service lines is unknown and while national, state, and local estimates exist, approaches used to count lead service lines vary. The total number of lead service lines is unknown because, among other things, the Lead and Copper Rule does not require all water systems to collect such information. National, state, and local estimates exist, but the methods used to arrive at these estimates vary, making it challenging to compare estimates.

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## The Lead and Copper Rule Does Not Generally Require Water Systems to Maintain Complete Information about Lead Service Lines or Report Such Information to EPA

The total number of lead service lines is unknown, in part because the Lead and Copper Rule does not require all water systems to develop and maintain a complete inventory of lead service lines, and there are no national repositories of information about lead service lines. According to EPA headquarters officials we interviewed in 2017, the materials inventory required under the Lead and Copper Rule is not intended to be a census of lead service lines (and other lead pipes such as goosenecks/pigtails). Instead, it is intended to provide sufficient information to develop

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<sup>16</sup>While the Lead and Copper Rule allows for a partial replacement when an owner of a home or building is unable or unwilling to pay for replacement of the portion of the service line not owned by the water system, experts have expressed reservations about this approach. In 2010, EPA asked its Science Advisory Board to evaluate the data regarding the effectiveness of the partial lead service line replacement, in comparison with full line replacement. The board found the quantity and quality of the data inadequate to fully determine the effectiveness of partial lead service line replacement. In addition, despite the limitations, the board concluded that partial lead service lines have not been shown to reliably reduce drinking water lead levels in the short term and potentially even longer. The board also found that partial replacements are frequently associated with short-term elevated drinking water lead levels for some period of time after the replacements. See Environmental Protection Agency, *SAB Evaluation of the Effectiveness of Partial Lead Service Line Replacements*, EPA-SAB-11-015 (Washington, D.C.: Sept. 28, 2011).

a plan for periodically obtaining tap samples. For example, according to 2008 EPA guidance to water systems, if a system contains lead service lines, then, if possible, half of the sample sites should include those served by a lead service line.

The Lead and Copper Rule requires water systems to conduct complete inventories only if the water system is required to begin replacing lead service lines. In these instances, water systems are required to expand the materials inventory to a complete inventory that identifies the total number of lead service lines for the purpose of tracking replacements over time.<sup>17</sup> As we reported in 2017, based on the available data, the majority of the 68,000 water systems subject to the Lead and Copper Rule at the time of our review had not been required to replace lead service lines and therefore were not required to conduct complete inventories.<sup>18</sup>

Moreover, there are no national repositories for information about lead service lines. In September 2017, we recommended that, as a part of revisions to the Lead and Copper Rule, EPA require states to report data on lead pipes (including lead service lines) and incorporate these data in the agency's Safe Drinking Water Information System. EPA agreed with the recommendation but has not implemented it. In May 2018, EPA noted that it was in the process of reviewing comments received through consultations with state and local officials and tribes.<sup>19</sup> According to EPA officials, final revisions to the Lead and Copper Rule are expected by February 2020. We continue to believe that EPA should collect data about lead pipes (including lead service lines) from states. By doing so, EPA and congressional decision makers would have important information at the national level on what is known about lead

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<sup>17</sup>More specifically, a complete inventory must include all of the service lines, including goosenecks/pigtails, connected to the distribution system, and identify those with lead.

<sup>18</sup>We reported in January 2006 and September 2017 that EPA did not have complete data on lead service line replacement. See GAO, *Drinking Water: EPA Should Strengthen Ongoing Efforts to Ensure That Consumers Are Protected from Lead Contamination*, [GAO-06-148](#) (Washington, D.C.: Jan. 4, 2006) and *Drinking Water: Additional Data and Statistical Analysis May Enhance EPA's Oversight of the Lead and Copper Rule*, [GAO-17-424](#) (Washington, D.C.: Sept. 1, 2017).

<sup>19</sup>Executive Order 13132 directs federal agencies to consult with state and local officials in the development of regulations that have substantial direct effects on the states, among other things. Executive Order 13175 directs federal agencies to consult with Indian tribes on, among other things, regulations that have substantial direct effects on one or more tribes.

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infrastructure in the country, thereby facilitating oversight of the Lead and Copper Rule.

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### National, State, and Local Estimates of Lead Service Lines Exist, and Those We Reviewed Had Significant Limitations; but the Methods Used to Arrive at These Estimates Vary

The total number of lead service lines is unknown, and while some entities have developed estimates of lead service lines at the national, state, or local water system level, the estimates we reviewed have significant limitations to their reliability. Moreover, the approaches used to arrive at these estimates vary, making it challenging to compare estimates. Nationally, according to EPA's October 2016 *Lead and Copper Rule Revisions White Paper*, there are an estimated 6.5 million to 10 million homes served by lead service lines.<sup>20</sup> This range of estimates, based in part on data from a study for the 1991 Lead and Copper Rule, has significant limitations. In appendix I we explain why EPA's estimate may not accurately reflect the total number of lead service lines, nationwide.

An April 2016 American Water Works Association study estimated 6.1 million lead service lines nationwide.<sup>21</sup> The authors of this study extrapolated the number based on survey responses from 978 water systems in 2011 and 2013. While this study is the most recent attempt to provide a national estimate, it has significant limitations. First, the sample was not statistically representative of all 68,000 water systems subject to the Lead and Copper Rule. Rather, the water systems that responded to the American Water Works Association's survey are not a statistical sample. Second, according to the study's authors, survey responses were based on water systems' best guesses of the number of lead service lines in their systems. However, since water systems have not been required to maintain inventories of lead service lines, many of them do not know the exact number. For these reasons, we are not confident that the number accurately reflects the total number of lead service lines nationwide.

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<sup>20</sup>Environmental Protection Agency, *Lead and Copper Rule Revisions White Paper* (Washington, D.C.: October 2016).

<sup>21</sup>Cornwell, David A., Richard A. Brown, and Steve H. Via, "National Survey of Lead Service Line Occurrence," *Journal of the American Water Works Association*, vol. 108, no. 4 (2016): E182- E191.

An American Water Works Association official told us that the organization is not planning to update the study. EPA officials told us that they were not aware of a more recent study than the association's 2016 study. In addition, EPA officials said in May 2018 that the results in the American Water Works Association study likely represent a lower-bound estimate for the number of lead service lines in the country because the sample was not generalizable, and had other data quality issues. EPA officials in one region we interviewed said that estimates of lead service lines can decrease or increase as a water system replaces lead service lines and as a water system does or does not count lead service lines on private property.

The Lead and Copper Rule does not require states to collect statewide information about lead service lines, but at least two states collected data from water systems in their states and published reports with these data:

- A 2016 report by the Massachusetts Department of Environmental Protection's Drinking Water Program reported 22,023 lead service lines and 15,809 lead goosenecks and pigtails statewide.<sup>22</sup> The report counted goosenecks and pigtails separately from lead service lines. Officials from the Massachusetts Department of Environmental Protection told us that the state has about 2 million service lines total; therefore, about 1 percent of the total service lines are lead.
- A 2017 report by the Washington State Department of Health estimated 1,000-2,000 lead service lines statewide and 8,000 goosenecks statewide.<sup>23</sup> According to Washington State officials, they continued to update their estimates in early 2018 with selected water utilities.

Generally, the purpose of both studies, as stated in each report, was to identify areas in which water systems would need technical assistance in complying with the Lead and Copper Rule or state requirements. However, for the purposes of estimating the number of lead service lines, complete details were not available about the methodologies and some systems that did respond were only able to provide rough guesses rather than precise counts of lead service lines. EPA headquarters officials told

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<sup>22</sup>Massachusetts Department of Environmental Protection Drinking Water Program, *Lead and Copper Rule Survey*. (Nov. 7, 2016).

<sup>23</sup>Washington State Department of Health, Environmental Public Health, Office of Drinking Water. *2016 Lead Service Line & Lead Component Survey of Washington's Water Utilities*. Publication Number 331-599. (Oct. 2017).

us that Massachusetts and Washington were at the forefront of states' efforts to gather information about lead service lines. EPA officials also told us that they were not aware of any other states with published reports estimating the number of lead service lines. However, at least two states have also collected information about lead service lines but have not published the information in official reports, at the time of our review. For example, in 2016, officials in Indiana and Maryland sent questionnaires to water systems in their states asking for information about the number of lead service lines.

A representative of a water association told us that, generally, water systems were in the beginning stages of conducting complete inventories of lead service lines. However, some local water systems also have estimates. For example, EPA officials told us that water systems in the states of Ohio, Michigan, and Washington had estimates of lead service lines. In May 2018, a representative of the Greater Cincinnati Water Works water system estimated there were approximately 7 percent of publicly owned and approximately 18 percent privately owned lead service lines out of a total of 240,000 service lines in the area served by that water system. In March 2018, representatives of the Greater Cincinnati Water Works water system said that their estimates of lead service lines are best characterized as what is known at any given point in time. These representatives also told us that they collect this information on a continual basis from historical and on-going maintenance records, reports of lead service lines by customers, and the water system's lead service line replacement program, among other sources.

To conduct complete inventories and develop estimates, water systems have used varying approaches, which can hinder comparisons among states and water systems. The publicly available reports that existed as of May 2018 provide some insight into the various approaches water systems have used. For example, to identify lead service lines, water systems have used visual inspection or a combination of visual inspections, existing water system records, and discussions with homeowners. In addition, water systems have used various definitions of lead service lines. For example, water systems have counted:

- only active service lines delivering water to customers, or both active and inactive (no longer delivering water to customers) service lines; or
- only the publicly owned lead service lines, or both the publicly and privately owned portions of the lead service lines; or



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- only lead service lines or the lead service lines and goosenecks/pigtails separately.

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## Most States Reported Fulfilling EPA's Request, but Potential Challenges Remain that EPA Information Sharing Could Help to Address

While most states informed EPA that they intend to fulfill the agency's request to work with water systems to publicize inventories of lead service lines, EPA has identified potential challenges to these efforts. Nonetheless, the agency has not followed up with all states since 2016 to share information about how to address these challenges. Most states that said they intended to fulfill EPA's request to encourage water systems to publicize materials inventories reported in subsequent letters to or meetings with EPA that they did so; however, as of May 2018, most large water systems had not made such information public.

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## Most States Reported Fulfilling EPA's Request to Encourage Water Systems to Publicize Materials Inventories, but Most Large Water Systems GAO Reviewed Did Not Do So

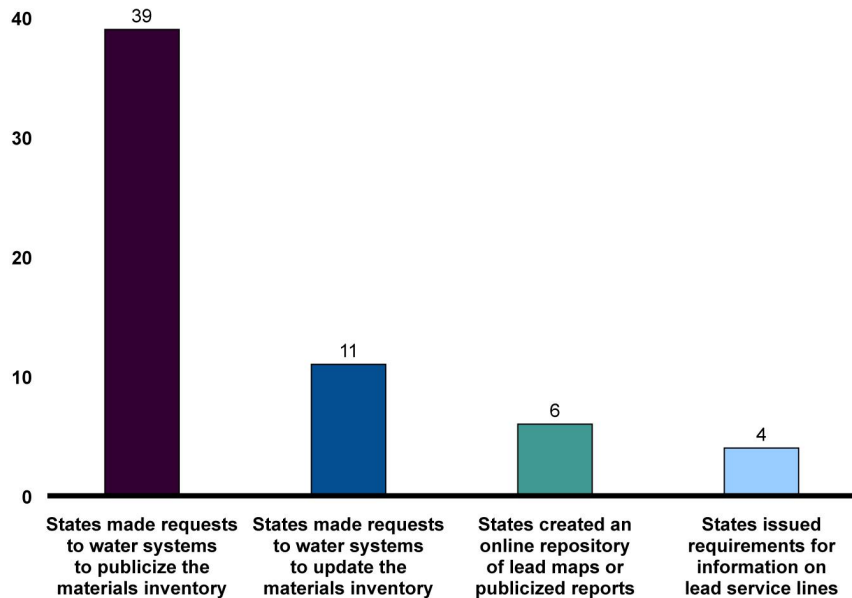
Our analysis of states' written responses to EPA's 2016 request, and information obtained through interviews with EPA officials as of February 2018, found that most (43) of the 50 states indicated an intent to fulfill EPA's request, 3 states said that they may consider it, and 4 states did not intend to fulfill EPA's request.<sup>24</sup> Of the approximately 43 states that responded that they would fulfill EPA's request, almost all (39) reported in subsequent letters to or meetings with EPA that they had encouraged water systems to publicize their materials inventories or other information about lead service lines. In these letters and meetings, states also reported taking other actions to increase their knowledge about lead service lines such as requesting that water systems update the materials inventory required by the Lead and Copper Rule, creating online repositories of maps of lead service lines, posting reports on lead service lines, and issuing requirements for water systems to collect information

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<sup>24</sup>We updated the analysis conducted for our September 2017 report on elevated lead in drinking water.

on lead service lines. For example, in May 2016, the governor of Washington issued a directive requiring the state’s Department of Health to work with certain water systems to identify all lead service lines and lead components within 2 years. Figure 2 shows the number of states that reported fulfilling EPA’s request or taking other related actions.

**Figure 2: States’ Reported Actions in Response to EPA’s 2016 Request to Encourage Water Systems to Publicize Information on Lead Service Lines**



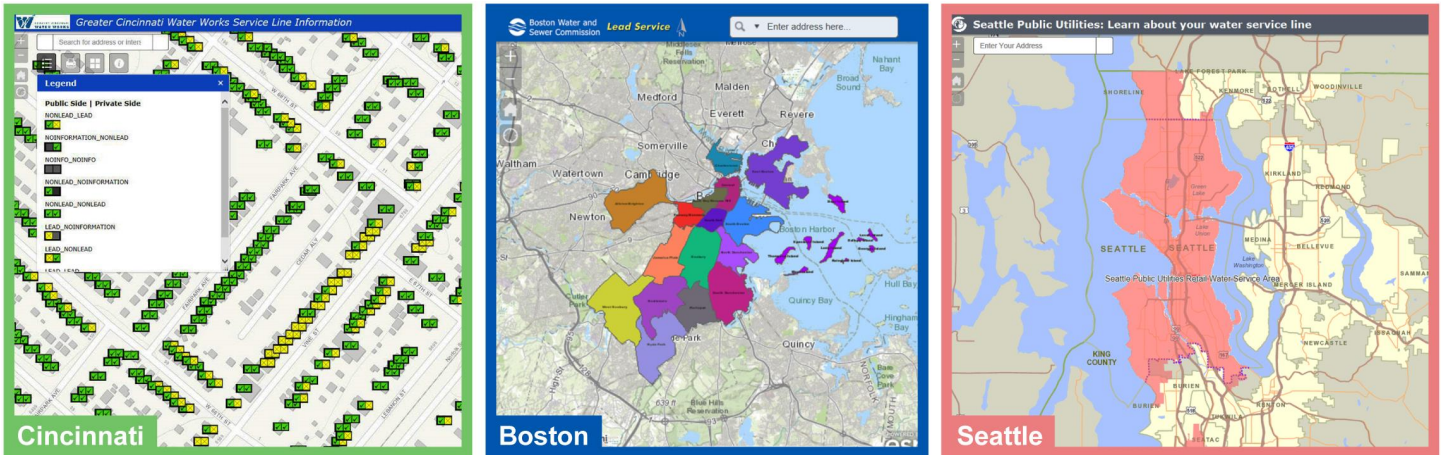
Source: GAO analysis of states’ letters to Environmental Protection Agency (EPA) and interviews with EPA officials. | GAO-18-620

Note: The numbers in this figure are approximate. Some states reported taking multiple actions and the categories are not mutually exclusive; therefore, the sum across the categories is greater than 50. Three states did not explicitly state that they would encourage their water systems to publicize the materials inventory or updated maps of lead service lines; however, those states said that they took other actions. In addition, some actions taken by states were already underway prior to their response to EPA’s 2016 letter.

Because EPA asked states to prioritize large water systems (those servicing populations greater than 50,000), we reviewed the websites for the 100 largest water systems. As of January 2018, we found 12 of these water systems had publicized information on the inventory of lead service lines; the rest had not. The information on the websites for the 12 water systems varied. For example, the water system for Tulsa, Oklahoma posted a map that highlighted where lead service lines may be present. Water systems such as Cincinnati, Ohio, Boston, Massachusetts, and Washington, D.C., provided interactive maps that showed locations identified as having lead service lines. See figure 3 for examples of the interactive maps of lead service lines that some selected large water

systems have provided to the public. Water systems that serve populations greater than 50,000 but were not among the 100 largest water systems at the time of our review may have also publicized information on the inventory of lead service lines. For example, the water systems for Akron, Ohio, Flint, Michigan, and Providence, Rhode Island each publicized an interactive or other type of map of lead service lines.

**Figure 3: Examples of the Interactive Maps With Information About Lead Service Lines for Selected Large Water Systems**



Sources: Greater Cincinnati Water Works (<https://www.cincinnati-oh.gov/water/lead-information/>); Boston Water and Sewer Commission (<http://bwsc.org/home/home.asp>); Seattle Public Utilities (<http://www.seattle.gov/util/index.htm>). Used with permission. Copyright © 2018 Esri, ArcGIS, HERE, Garmin, Intermap, Increment P Corp., General Bathymetric Chart of the Oceans, U.S. Geological Survey, Food and Agriculture Organization, U.S. National Park Service, Natural Resources Canada, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, © OpenStreetMap contributors, and the GIS User Community. All rights reserved. | GAO-18-620

Note: The maps for Boston, MA, Cincinnati, OH, and Seattle, WA are interactive. To locate, view and navigate the maps, click on the city name: [Boston](#), [Cincinnati](#), and [Seattle](#).

## EPA Identified Potential Challenges to Publicizing Materials Inventories but Has Not Followed Up with All States about How to Address Such Challenges Since 2016

EPA officials in the regional offices provided a range of reasons why water systems may be challenged in conducting inventories of lead service lines and making any information about lead service lines public, however, it has not followed up with all states about how to address such challenges since 2016. In September 2017, we reported that the six states that would not fulfill EPA’s 2016 request had highlighted challenges in finding historical documentation about lead pipes to create plans for collecting tap water samples or in dedicating staff resources to do so. In January and February 2018, some officials whom we interviewed in

EPA’s 10 regional offices agreed that these would be challenges for states and water systems. The officials also mentioned additional potential challenges in conducting complete inventories of lead service lines or publicizing information about lead service lines. Table 1 describes the challenges mentioned by EPA officials in the 10 regional offices.

**Table 1: Challenges That States and Water Systems May Face in Conducting and Publicizing Inventories of Lead Service Lines, as Identified by Officials in the U.S. Environmental Protection Agency’s (EPA) 10 Regional Offices**

Challenges	Number of times EPA regions identified the challenge
Concerns about posting information about lead service lines on private property on a public website (e.g. impacts on homeowner property values)	7
Lack of records about the locations of lead service lines or old records	6
Limited resources (e.g. time, staff, funding) to conduct complete inventories or post information on a website	5
Difficulty obtaining access to private property to verify lead service lines	4
Difficulty locating lead service lines that are underground	3
Limited operator knowledge about locations of lead service lines	2
Lack of a website for the water system on which to post and retain information about lead service lines	1

Source: GAO analysis of interviews with EPA’s Regional offices. | GAO-18-620

Note: These counts are approximates based on our analysis of responses provided by EPA regional officials to our open-ended questions about challenges states and water systems may face in conducting and publicizing inventories of lead service lines. The total number does not equal 10 because EPA regional officials mentioned multiple challenges.

Since the February 2016 letter, EPA followed up in July 2016 with a letter to the Association of State and Territorial Health Officials and Environmental Council of States, which represents all states. In that letter, EPA provided two examples of state practices that increase public transparency: some drinking water systems are providing online searchable databases that provide information on known locations of lead service lines, or are providing videos that show homeowners how to determine whether their home is served by a lead service line.<sup>25</sup> The letter also said that EPA would continue to work with states to ensure that the identification of the locations of lead service lines remains a priority for drinking water systems.

<sup>25</sup>Environmental Protection Agency, July 6, 2016, Letter to the Environmental Council of States and the Association of State and Territorial Health Officials, accessed May 31, 2018, [https://www.epa.gov/sites/production/files/2016-07/documents/lcr\\_ashto-ecos\\_follow-up\\_letter\\_7.6.16.pdf](https://www.epa.gov/sites/production/files/2016-07/documents/lcr_ashto-ecos_follow-up_letter_7.6.16.pdf)

However, EPA has conducted limited follow-up since then, mainly, EPA headquarters and regional officials said, because they have focused their efforts on ensuring states appropriately comply with the Lead and Copper Rule. As previously noted in this report, posting materials inventories or other information about the location of lead service lines is not a requirement of the Lead and Copper Rule. In May 2018, EPA headquarters officials we interviewed said that they learned of some states' and water systems' efforts toward making information about lead service lines available to the public since 2016, through conferences and discussions with states. These headquarters officials told us that they have shared such efforts with those states who, in 2016, said they did not intend to fulfill EPA's 2016 request. For example, EPA shared how states that were publicizing information about lead service lines were addressing privacy concerns with states that originally said they would not fulfill EPA's request. However, as of January 2018, most of the 100 largest water systems had not made their materials inventories or additional maps or updated inventories public. According to EPA's February 2016 letter, the agency's objective in encouraging states to work with water systems to post, on a public website, the water system's original materials inventory along with any additional updated map or inventories of lead service lines was to assure the public that lead risks were being addressed. Under federal standards for internal control, management should externally communicate the necessary quality information, so that external parties can help to achieve the entity's objectives. By sharing information with all states about the approaches that some states and water systems are using to successfully identify and publicize information about lead service lines, including responses to potential challenges, EPA could encourage states to be more transparent to the public and support the agency's objectives for safe drinking water.

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## Conclusions

Lead service lines present a significant risk of lead contamination in drinking water. Publicizing drinking water systems' knowledge about lead service lines, and other lead infrastructure, would facilitate oversight of the Lead and Copper Rule. In September 2017, we recommended that, as a part of revisions to the Lead and Copper Rule expected by February 2020, EPA require states to report data on lead pipes (including lead service lines) and incorporate these data in the agency's Safe Drinking Water Information System. EPA agreed with the recommendation, and we continue to believe that EPA should require data about lead pipes (including lead service lines) from states. Most states reported that they

had encouraged their water systems to publicize information about lead service lines in response to EPA's February 2016 requests. EPA headquarters officials told us that they had learned of some states' and water systems' efforts since 2016 and shared this information with the few states that said that they would not take action in response to EPA's letter. This information did in fact help at least one state take action, according to information we received from EPA and the state. By sharing information with all states about the approaches that some states and water systems are using to successfully identify and publicize information about lead service lines, including responses to potential challenges, EPA could encourage states to be more transparent to the public and support the agency's objectives for safe drinking water.

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## Recommendation for Executive Action

The Assistant Administrator for Water of EPA's Office of Water should share information with all states about the approaches that some states and water systems are using to successfully identify and publicize information on lead service lines, including responses to potential challenges. (Recommendation 1)

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## Agency Comments

We provided a draft of this report to EPA for review and comment. In its comments, reproduced in appendix II, EPA agreed with our recommendation. The agency also highlighted a recently developed website that showcases efforts to identify and replace lead service lines and said that it will continue to ensure states and water systems are aware of this resource.

We are sending copies of this report to the appropriate congressional committees, the Administrator of EPA, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.

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A handwritten signature in black ink that reads "Alfredo Gómez". The signature is written in a cursive style with a large, stylized initial 'A' and 'G'.

J. Alfredo Gómez  
Director, Natural Resources and Environment

# Appendix I: Objectives Scope and Methodology

Our objectives were to examine (1) what is known about the number of existing lead service lines nationally, and among states and water systems; and (2) state responses to EPA's February 2016 request to work with water systems to publicize inventories of lead service lines and any steps EPA has taken to follow up on these responses.

To examine what is known about the number of existing lead service lines nationally, and among states and water systems, we relied on interviews and publicly available reports for which we could assess the reliability of the data. We reviewed the requirements under the Lead and Copper Rule for assessing the number of lead service lines.<sup>1</sup> We interviewed officials from EPA's Office of Water and the following water organizations concerning what these officials knew about the number of lead service lines nationally and among states and water systems: the American Water Works Association, Association of State Drinking Water Administrators, and Regional Community Assistance Partnership. We also interviewed an official with the Environmental Defense Fund regarding the available information about the number of lead service lines nationally and among states and water systems. We selected these organizations because they are all members of the Lead Service Line Replacement Collaborative, a consortium that provides information about voluntary lead service line replacement for states and water systems. On behalf of the Lead Service Line Replacement Collaborative, the organizations we spoke with are collecting examples of states' and water systems' experiences in conducting inventories of lead service lines, as the first step in replacing lead service lines. Using information from these interviews, we identified three published studies from the American Water Works Association,<sup>2</sup> the state of Massachusetts,<sup>3</sup> and the state of

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<sup>1</sup>See 40 C.F.R. pt. 141, subpt I.

<sup>2</sup>David A. Cornwell, Richard A. Brown, and Steve H. Via, *National Survey of Lead Service Line Occurrence*, Journal American Water Works Association, vol. 108, no. 4 (2016), pp.E182-pp.E191.

<sup>3</sup>Massachusetts Department of Environmental Protection Drinking Water Program, *Lead and Copper Rule Survey*. (Nov. 7, 2016).



Washington.<sup>4</sup> We interviewed the authors of the studies to determine the reliability, completeness, and accuracy of the data presented in the studies.

For the 2016 American Water Works Association study, we determined that the data were of undetermined reliability because the responses of the water systems surveyed were not generalizable to all water systems and the study authors could not verify the accuracy of the information. Specifically, the sample in the 2016 American Water Works Association study was not based on a statistical sample, and therefore the sampling error was not calculated and information was not available to determine whether responding water systems were similar to nonresponding water systems. For example, the estimate is based on survey responses from 978 of the approximately 23,000 water systems that existed around the time of the surveys, and therefore may not represent all water systems nationwide. In addition, since many water systems do not have complete inventories of their lead service lines, the accuracy of data that water systems submitted in response to the survey is difficult to verify. For example, our interview with the study authors indicates that the information provided by water systems varied in quality, with some systems basing their responses on rough estimates. We based our determination about the data using the criteria of Total Survey Error, which is a framework for assessing the validity and reliability of survey estimates. It includes sampling error (the difference between the population and the sample), nonresponse error, measurement error (the difference between the true response and the response provided by the respondent) and coverage error (the discrepancy between the list of individuals that is used to select a sample and the target population). EPA's 2016 Lead and Copper Rule Revisions White Paper also identified an estimate of lead service lines. According to EPA officials, this estimate used data from the 2016 American Water Works Association study and a 1988 American Water Works Association study cited in the regulatory impact analysis for the 1991 Lead and Copper Rule.<sup>5</sup> The 1991 estimate also had significant limitations in measurement error and representation

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<sup>4</sup>Washington State Department of Health, Environmental Public Health, Office of Drinking Water. *2016 Lead Service Line & Lead Component Survey of Washington's Water Utilities*. Publication Number 331-599. (Oct. 2017).

<sup>5</sup>Environmental Protection Agency, *Lead and Copper Rule Revisions White Paper* (Washington, D.C.: October 2016). Environmental Protection Agency, *Final Regulatory Impact Analysis of National Primary Drinking Water Regulations for Lead and Copper* (Washington, D.C.: April 1991).

error as well as a lack of documentation about key aspects of the methodology. As such, we determined the estimate was not reliable for the purposes of establishing the total number of lead service lines in existence as of 1991.

The two state-specific studies represent reasonable efforts to estimate the number of lead service lines in these states. However, they generally could not verify the accuracy of the information provided by these systems because, as we note elsewhere in this report, water systems may not know the number of lead service lines they have. Therefore, for the state-specific studies, we also determined that the data were also of undetermined reliability. Finally, while the Greater Cincinnati Water Works water system did not publish a report about lead service lines, we collected the information through an in-person interview and corroborated the information through a review of the water system's geographic information system database. The Greater Cincinnati Water Works' GIS database includes the location and material information for all of the water system's distribution system. According to the Greater Cincinnati Water Works website, the water system continues to update its map as it obtains more information from its customers. Based on these steps we deemed the data provided by the water system to be sufficiently reliable for the purposes of describing the estimate reported by representatives of the Greater Cincinnati Water Works system.

To examine states' responses to EPA's February 2016 request to work with water systems to publicize inventories of lead service lines and any steps EPA has taken to follow up on these responses, we relied both on the publicly available letters from each state to EPA and on interviews with EPA regional and headquarters officials. We did not interview state officials in all 50 states, but reviewed some state documents, where available. We used a standard set of open-ended questions to interview officials in EPA's headquarters and in each of the 10 regional offices. To analyze states' and EPA officials' responses, we conducted two analyses. Specifically, we conducted two analyses to summarize updates in state responses to EPA's February 2016 letter and EPA's responses to challenges states and water systems may face in conducting and publicizing materials inventories. To confirm each analysis, one analyst independently summarized the information and another analyst verified the accuracy of the information. All initial disagreements were discussed and reconciled. All numbers in our analysis are considered approximate because interpretations of the states' responses to EPA's 2016 letter can differ, and states may have taken actions after our interviews with EPA regional officials, or may have taken actions that they did not report to

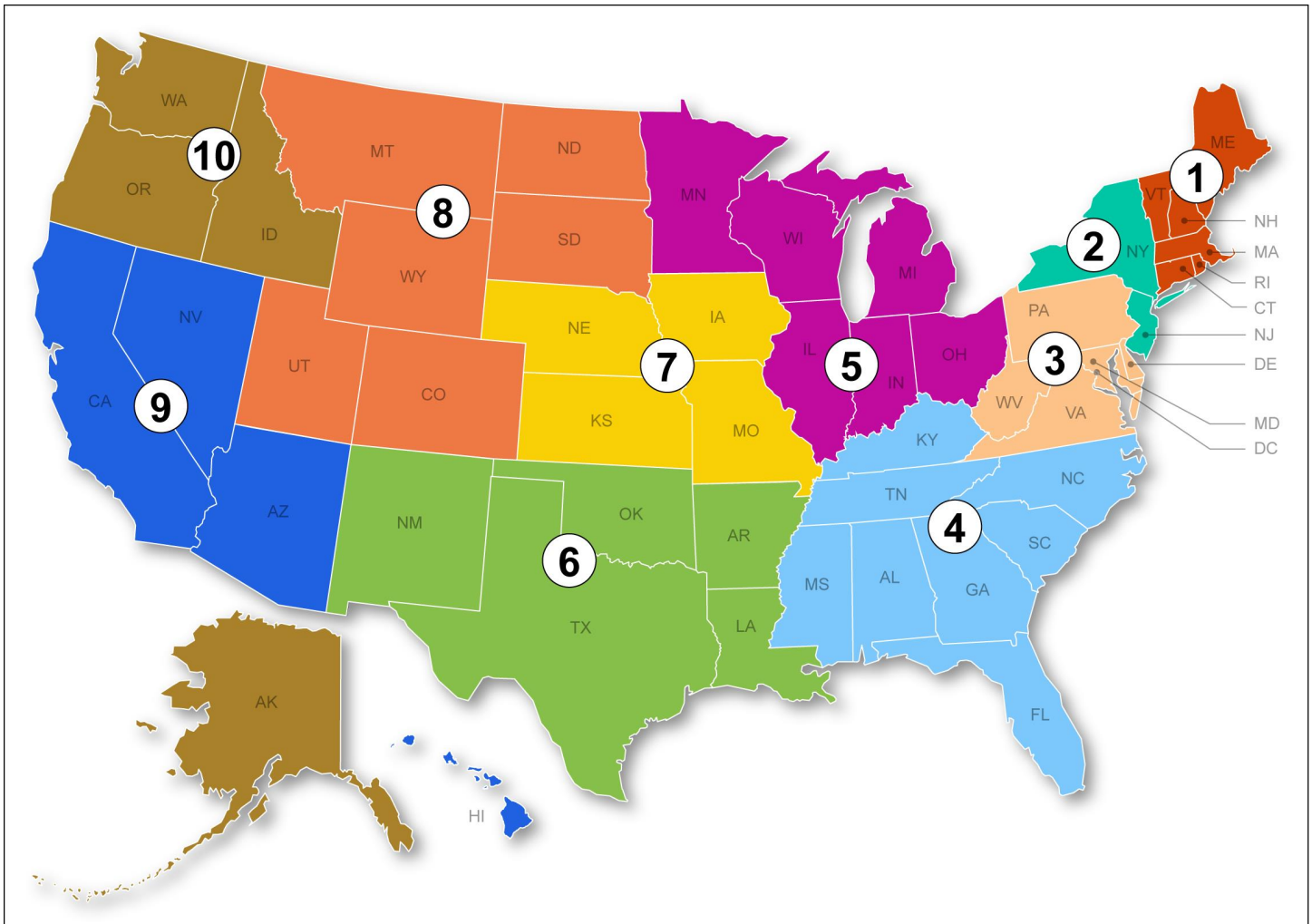
EPA. Figure 4 shows the EPA regions and the states within those regions. We also reviewed EPA documents related to EPA's request that states take certain actions following the events in Flint, Michigan.<sup>6</sup> In addition, we reviewed federal regulations; EPA guidance to water systems on how to implement the Lead and Copper Rule; and other relevant documents such as an EPA white paper.<sup>7</sup>

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<sup>6</sup>Environmental Protection Agency, *Letter to Commissioners on State Actions with the Lead and Copper Rule*, (Washington, D.C.: Feb. 29, 2016).

<sup>7</sup>Environmental Protection Agency, *Lead and Copper Rule Monitoring and Reporting Guidance for Public Water Systems*, EPA 816-R-10-004, (Washington, D.C.: March 2010).

Figure 4: States in the Environmental Protection Agency’s 10 Regional Offices



Sources: Environmental Protection Agency; Map Resources (map). | GAO-18-620

Note: EPA’s 10 regional offices also include territories and tribes. Region 2 includes Puerto Rico and the U.S. Virgin Islands. Region 9 includes the Pacific Islands and 148 tribes. Region 10 includes 271 tribes.

Because EPA asked states to place an emphasis on working with large water systems to publicize their materials inventories or updated inventories or maps of lead service lines, we reviewed the websites of the 100 largest water systems by population. Our review was conducted in January to February 2018; and since then, additional water systems may have provided information to the public on lead service lines. We identified the largest water systems, based on population served, from data in EPA’s Safe Drinking Water Information System/Fed. EPA has

stated on its website that the agency acknowledges challenges related to the data in the Safe Drinking Water Information System/Fed, specifically underreporting of some data by states. GAO has also reported on EPA's challenges with the Safe Drinking Water Information System/Fed.<sup>8</sup> Even with these challenges, the information on the populations served by water systems in the Safe Drinking Water Information System/Fed is generally reliable. We used a standard set of search terms on each website to ensure the consistency of our searches, as well as information from water organizations and EPA officials, where applicable. We counted a water system as having an inventory if the water system provided a map, interactive map, list of pipes or service lines, or numerical count of lead service lines available to the public. To ensure the completeness of this analysis, one analyst independently conducted the search of websites and another analyst verified the search. All initial disagreements were discussed and reconciled. We compared EPA's actions to follow up on state responses with federal standards for internal control for information and communication.<sup>9</sup>

We conducted this performance audit from October 2017 to September 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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<sup>8</sup>GAO, *Drinking Water: Unreliable State Data Limit EPA's Ability to Target Enforcement Priorities and Communicate Water Systems' Performance*, [GAO-11-381](#), (Washington, D.C.: June 17, 2011).

<sup>9</sup>GAO, *Standards for Internal Control in the Federal Government*, [GAO-14-704G](#) (Washington, D.C.: September 2014).

# Appendix II: Comments from the U.S. Environmental Protection Agency



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

AUG 31 2018

OFFICE OF WATER

Mr. Alfredo Gomez  
Director  
Natural Resources and Environment  
U.S. Government Accountability Office  
Washington, D.C. 20548

Dear Mr. Gomez:

Thank you for the opportunity to review and comment on the U.S. Government Accountability Office's (GAO) draft report, "Approaches for Identifying Lead Service Lines Should Be Shared With All States," GAO-18-620, date August 2018.

In this report, the GAO examines (1) what is known about the number of existing lead service lines, nationally, and among states and water systems; and 2) states' response to the EPA's February 2016 request to work with water systems to publicize inventories of lead service lines, and any steps the EPA has taken to follow up on these responses. The GAO provided one recommendation to the EPA. The EPA agrees with the GAO's findings, conclusions, and recommendations.

**GAO Recommendation and the EPA Response:**

**"The Assistant Administrator for Water of EPA's Office of Water should share information with all states about the approaches that some states and water systems are using to successfully identify and publicize information on lead service lines, including responses to potential challenges." (Recommendation 1)**

The EPA agrees with this recommendation. The EPA's Office of Water recently developed a website (see <https://www.epa.gov/ground-water-and-drinking-water/leaders-lead-service-line-replacement>) that showcases leading efforts by states, public water systems, and communities to identify and replace lead service lines. An interactive map allows states and water systems to explore communities across the country and learn about their programs to replace lead in drinking water systems. The EPA will continue to ensure states and water systems are aware of this resource.

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**Appendix II: Comments from the U.S.  
Environmental Protection Agency**

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Thank you for the opportunity to review the draft report. The EPA looks forward to continuing to work with the GAO to improve the sharing of information about successful approaches to publicize locations of lead service lines. If you have any questions, please contact Peter Grevatt, Director of the Office of Ground Water and Drinking Water, at (202) 564-3750.

Sincerely,



David P. Ross  
Assistant Administrator

cc: EPA GAO Liaison Team  
Bobbie Trent, OCFO  
Mark T. Howard, OCFO

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# Appendix III: GAO Contact and Staff Acknowledgments

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## GAO Contact

J. Alfredo Gómez, (202) 512-3841 or [gomezj@gao.gov](mailto:gomezj@gao.gov)

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## Staff Acknowledgments

In addition to the contact named above, Diane Raynes (Assistant Director); Tahra Nichols (Analyst in Charge); David Blanding, Jr.; Mark Braza; Lawrence Crockett, Jr.; Justin Fisher; Richard P. Johnson, and Jeanette Soares made key contributions to this report. In addition, Cynthia Norris and Dan Royer made important contributions.



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# Appendix IV: Accessible Data

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## Agency Comment Letter

### Page 1

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Page 2

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Sincerely,

David P. Ross  
Assistant Administrator

cc: EPA GAO Liaison Team  
Bobbie Trent, OCFO  
Mark T. Howard, OCFO

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## Related GAO Products

*Drinking Water: Additional Data and Statistical Analysis May Enhance EPA's Oversight of the Lead and Copper Rule.* [GAO-17-424](#). Washington, D.C.: September 1, 2017.

*Water Infrastructure: Information on Selected Midsize and Large Cities with Declining Populations.* [GAO-16-785](#). Washington, D.C.: September 15, 2016.

*Water Infrastructure: EPA and USDA Are Helping Small Water Utilities with Asset Management; Opportunities Exist to Better Track Results.* [GAO-16-237](#). Washington, D.C.: January, 27, 2016.

*Drinking Water: Unreliable State Data Limit EPA's Ability to Target Enforcement Priorities and Communicate Water Systems' Performance.* [GAO-11-381](#). Washington, D.C.: June 17, 2011.

*Drinking Water: The District of Columbia and Communities Nationwide Face Serious Challenges in Their Efforts to Safeguard Water Supplies.* [GAO-08-687T](#). Washington, D.C.: April 15, 2008.

*Drinking Water: EPA Should Strengthen Ongoing Efforts to Ensure That Consumers Are Protected from Lead Contamination.* [GAO-06-148](#). Washington, D.C.: January 4, 2006.

*District of Columbia's Drinking Water: Agencies Have Improved Coordination, but Key Challenges Remain in Protecting the Public from Elevated Lead Levels.* [GAO-05-344](#). Washington, D.C.: March 31, 2005.

*Drinking Water: Safeguarding the District of Columbia's Supplies and Applying Lessons Learned to Other Systems.* [GAO-04-974T](#). Washington, D.C.: July 22, 2004.

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