ENVIRONMENTAL FINANCIAL ADVISORY BOARD

Public Comments Received for Environmental Financial Advisory Board

Water Affordability Listening Session

February 20, 2024

American Water Works Association
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February 20, 2024

Janet Clements, Workgroup Co-chair
Cynthia Koehler, Workgroup Co-chair
Environmental Financial Advisory Board
Water Infrastructure and Resiliency Finance Center
Office of Wastewater Management
Office of Water
1201 Constitution Ave NW
Washington, DC 20004

TRANSMITTED VIA EMAIL (*efab@epa.gov*)

RE: Public Listening Session of the Environmental Financial Advisory Board (EFAB) Water Affordability Workgroup

Dear Co-chairs Clement and Koehler:

The American Water Works Association (AWWA) appreciates the opportunity to provide comment to the Affordability Workgroup (Workgroup) as the Environmental Financial Advisory Board (EFAB) prepares recommendations for the U.S. Environmental Protection Agency (EPA) on the important issue of affordable water service. EPA's charge to EFAB includes five specific questions. It is important that in responding to the charge that EFAB consider the following:

1. **EPA is a regulatory agency whose decisions impact affordability**. EPA is charged with establishing prudent regulations to protect public health and the environment through the Safe Drinking Water Act (SDWA) the Clean Water Act (CWA) and other statutes. The agency can help the sector maintain affordable water rates most effectively by:

    a. Focusing its regulatory program on opportunities for significant health risk reduction and environmental protection,

    b. Giving serious consideration to the fiscal sustainability of rule frameworks when regulations are developed, and

    c. Recognizing and taking into account the cumulative financial impact of its regulatory actions.

    The water sector is fundamental to community health and economic vitality. Aligning EPA's regulatory focus with sustainable water service will significantly improve EPA's contribution to water service affordability nationally.

2. **Technical, managerial, and financial (TMF) capacity of water systems.** Capacity development is the most cost-effective strategy for simultaneously building the TMF capacity of individual communities to manage the escalating price of water service and avoid rate shock where sudden increases in water rates disrupt individual household budgets. TMF capacity is a well-established concept within Safe Drinking Water Act (SDWA) financial assistance and standard setting activities.

3. **Communities pay for water services**. The same households pay for drinking water treatment and distribution, sewer collection and treatment, stormwater management, community-level reuse, water supply development, and associated sub-programs. The burden on households takes a number of forms including drinking water bills, wastewater fees, stormwater management taxes, subsidies from community general fund accounts, community faith and credit for loans, and other mechanisms. Affordability cannot be viewed through the single lens of household water rates. The financial impact of sustainable water service for all water services are borne by individual households first and foremost in the form of a monthly bill. Affordability solutions for water service must consider all water services. Moreover, while the monthly water bill is the primary mechanism through which households bear the burden of water service costs, those same households are still burdened if water costs are distributed through another mechanism (e.g., local property taxes, additional fees for specific services, debt rating impacts on the cost of borrowing, etc.).

4. **Numerous drivers behind escalating cost of service are beyond EPA's purview.** Water systems like any governmental or commercial enterprise must replace aging infrastructure, contend with inflation, absorb increased energy costs, and staff operations in tight labor markets. In instances when a community struggles to pay for water service these economic drivers alone can lead to spiraling affordability concerns and eventually failures in water service. John Young, the retired chief operating officer for American Water who has assisted several distressed systems address their challenges, discusses this issue in a recent article[1] that the EFAB would benefit from considering.

With the above considerations in mind, attached are specific comments relative to the existing charge questions.

The Water Affordability Workgroup report can provide timely and important advice to EPA. AWWA requests that the Workgroup provide a draft report for public comment prior to finalizing the report. And, that the public comment period both afford stakeholders a chance to give the draft document meaningful review and for the Workgroup to have adequate time to consider and amend the final report to reflect useful feedback.

Thank you for the opportunity to inform the Workgroup's deliberations. If you have any questions regarding this correspondence or if AWWA can be of assistance in some other way, please contact Adam Carpenter at (202) 326-6126 or acarpenter@awwa.org.

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[1] Young, J. 2023 April 5. Troubled Utilities: Seeing the Way Forward. Journal AWWA 115:3:24-29. https://doi.org/10.1002/awwa.2069.

Best regards,
FOR THE AMERICAN WATER WORKS ASSOCIATION

G. Tracy Mehan, III
Executive Director of Government Affairs

cc: Andrew Sawyers, EPA/OW/OWM
Jennifer McLain, EPA/OW/OGWDW
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Deidre Finn, CIFA
Alan Roberson, ASDWA

Who is AWWA?

The American Water Works Association (AWWA) is an international, nonprofit, scientific and educational society dedicated to providing total water solutions assuring the effective management of water. Founded in 1881, the Association is the largest organization of water supply professionals in the world. Our membership includes more than 4,500 utilities that supply roughly 80 percent of the nation's drinking water and treat almost half of the nation's wastewater. Our 50,000-plus total membership represents the full spectrum of the water community: public water and wastewater systems, environmental advocates, scientists, academicians, and others who hold a genuine interest in water, our most important resource. AWWA unites the diverse water community to advance public health, safety, the economy, and the environment.

FORMAL COMMENTS BY THE
AMERICAN WATER WORKS ASSOCIATION
TO THE
PUBLIC LISTENING SESSION OF THE ENVIRONMENTAL FINANCIAL ADVISORY BOARD (EFAB)
WATER AFFORDABILITY WORKGROUP

89 Federal Register 7397, February 2, 2024

The Environmental Financial Advisory Board's (EFAB's) Affordability Workgroup (Workgroup) is charged with taking on an important issue which communities across the United States face. That is how to adequately invest in pressing infrastructure improvements, address escalating operating expenses, and take on additional regulatory burdens, while continuing to provide safe and reliable water services at an affordable cost.

The U.S. Environmental Protection Agency (EPA) has sought advice from EFAB as to how EPA can "support communities in their affordability efforts." The agency's request for recommendations is then broken into five questions. The following are observations and recommendations for EFAB's consideration as the Workgroup and ultimately the Board as a whole crafts its response to EPA.

1. Capital Projects

Modern Infrastructure Option Selection Processes -- For capital projects that are "innately less burdensome on local ratepayers" (question 1), the cost to ratepayers is a reflection of several key factors:

1. The capital cost of the project
2. The finance cost related to the project
3. The operations and maintenance cost associated with the project

Factors such as project design, source of funding/financing, and the operations and maintenance plans related to projects influence how much that project will ultimately impact the water system's rates and for how long. Rates also include accounting for costs not associated with particular projects, such as costs associated with billing and addressing customer service requests.

Water infrastructure projects are often large and complex. The planning process for such projects is innately focused on identifying viable, least-cost solutions. Ideally communities are positioned to adequately assess infrastructure investments from a full life-cycle cost perspective. Given water system's responsibilities to their communities, managing costs is top of mind and there are rarely "shortcuts" or "one-size-fits-all" solutions to decrease project costs. More typical are decision processes where tradeoffs must be made between the most ideal infrastructure solutions and those that are achievable given resource constraints.

Assuring that all viable options are considered can help reduce (or defer) capital costs and control operational costs. Although considering multiple approaches would once have been considered novel, it is now common practice. Depending on the needs of the community, certain alternatives may or may not be viable, and conducting a comprehensive analysis can add time and cost to projects. Often, optimal solutions are those that best accommodate not only available funding but other considerations (e.g., legal and/or political feasibility, integration with overall capital improvement needs, etc.). While the above is most easily thought of with respect to water systems that are a component of local government, the engineering professionals that advise any community water system would, in keeping with their professional training and responsibilities, have a duty to apply similar considerations. Although attempts to reduce project costs through design revisions can reduce overall costs, it does not guarantee the alternatives will be available at lower prices than the originally considered design.

Role of Federal Subsidy -- Most federal assistance currently available to water systems helps to reduce finance costs, although some mechanisms (such as principal forgiveness under the SRF) can also help to reduce the effective capital cost. Generally, there is no mechanism for projects to be "innately less burdensome on local ratepayers" unless they are reduced in scope (which can reduce the benefits associated with them) or subsidized by an outside source. By providing less expensive financing, SRFs allow systems that are financially challenged to increase water rates less through lower financing costs. But federal subsidies are not without complications that can delay and increase the cost of individual project applications:

1. Dependency – Infrastructure investments are delayed and become more expensive to address as systems risk delaying a project in order to access subsidized funding.

2. Procedural delays – Typically SRF programs follow a fixed annual cycle and funding is obtained on that cycle as opposed to on the schedule most advantageous to timely project initiation and completion.

3. Federal crosscutters – Federal funding also entails meeting federal requirements regarding labor rates, environmental impact assessment, domestic preference requirements, and others. These requirements serve important national objectives but have the effect of delaying, increasing costs, and complicating implementation of individual projects. Typically, the use of federal funds will increase the project's capital costs (and possibly O&M costs) due to crosscutters, which can be a tradeoff with the typically reduced finance costs.

4. State requirements – There are also state-specific criteria that complicate and increase the preliminary work needed to successfully obtain subsidized funding. Examples include demonstration of TMF, implementation of asset management plans, and other threshold criteria. Again, the goal of these criteria are to safeguard public investment by focusing subsidized funds to those water systems that are or are willing to become sustainable entities. This is sound policy, but it has the immediate effect of delaying access to funding for specific project applications when the applicant system is not sufficiently prepared.

AWWA asks that EFAB's recommendations recognize that current infrastructure planning practice focuses on managing costs within a number of fiscal, legal, social, and political realities. One aspect of which is balancing long-term cost effectiveness with immediate exigencies. There is not a solution set EPA can draw on that is innately less burdensome. There are appropriate solutions that meet community objectives at the least financial cost. The right solution in any one instance is place and fact specific.

"Innately Less Burdensome" and Economies of Scale – There are almost 50,000 regulated community water systems in the United States. Consequently, the sector periodically assesses how to reduce the number of regulated entities (increasing economies of scale) and improve the TMF of the resulting smaller set of entities (e.g., regionalization, partnership, consolidation, privatization). Currently, Drinking Water SRF applicants must consider regionalization as a potential solution prior to or as part of developing an SRF application.

AWWA encourages EFAB to engage CIFA to discern:

1. If the drinking water SRF requirement that regionalization be evaluated in loan applications is having the intended effect envisioned?
2. Are the capacity development provisions of SDWA successful? If so, to what degree and under what circumstances?
3. Is there value in developing a similar program set of approaches under the CWA or does the more informal Effective Utility Management (EUM) program achieve similar benefits?

Facilitating Good Samaritans -- While the capacity development provisions of SDWA were a feature of the 1996 SDWA amendments, in 2018 Congress sought to overcome another challenge to partnerships in America's Water Infrastructure Act (AWIA). EPA summarizes this provision saying:

> *"… authorizes EPA and state primary enforcement authorities (primacy agencies) to mandate an assessment of restructuring options for a public water system (PWS) that repeatedly violates health-based standards, is unwilling or unable to take feasible corrective actions to return to compliance, or that has unsuccessfully attempted feasible and affordable actions to return to compliance, and for which restructuring is both feasible and could result in greater compliance."*[2]

The "Water System Restructuring Assessment Rule" (WSRAR) remains in the Federal Unified Regulatory Agenda. EPA is now more than three years past the statutory deadline for promulgating this rule. Congress's passage of this provision and the agency's failure to advance this rule illustrate one of the vexing issues with utilizing partnerships to achieve economies of scale and improve system TMF, the legal and reputational risk that must be borne by fiscally sound and well-managed potential partners. As currently implemented systems that are reliably compliant and fiscally sound are asked (perhaps forcefully by the state) to (1) take on the financial, technical, and administrative burden of resolving water quality challenges for users that are not currently a part of their service area and (2) put themselves in legal and reputational jeopardy even as they take steps the prior system management could not or did not take. The WSRAR would provide a compliance shield for a limited period of time that is likely inadequate when the system being restructured has significant ongoing violations, particularly when remedying those violations requires significant infrastructure investment.

[2] RIN 2040-AF98, Unified Agenda, Reginfo.gov.

AWWA encourages EFAB to explore recommendations that reduce the barriers to Good Samaritans involvement in assisting troubled systems. EPA has ready opportunities in addition to proposing and finalizing WSRAR, including as it reviews and drafts:

1. Federal environmental regulations and guidance (e.g., CWA Integrated Planning)[3]

2. Policies that guide CWA and SDWA enforcement discretion

Regionalization Requires Appropriate Expertise -- Regionalization has benefits but it also creates challenges. The State of Kentucky conducted an extensive program to regionalize water systems through a deliberate, state-facilitated program. This model effort was successful in reducing the number of water systems. It also led to challenges with water quality associated with long hydraulic detention times. Said differently, regionalization is a complex undertaking involving financial, governance and technical considerations. Today, evaluating regionalization requires thoughtful consideration of system regulatory compliance, resiliency, and sustainability in a place-based decision-making process staffed by appropriately trained professionals with relevant expertise. While regional planning district commissions, environmental finance centers, and some nongovernmental entities may be able to organize such place-based decision-making processes, to be successful such processes must be supported with adequate and appropriate engineering expertise, practiced facilitators, and relevant legal expertise. Regionalization is a process that when done well leads to a stable organization with local political buy-in, adequate local revenues to be financially sustainable, and a common mission with established priorities. Such processes take time and cannot be imposed without significant applied expertise. Historically federal programs have been most successful when the agency provided supplemental funding that allowed local organizations (e.g., existing utilities, county government, regional planning district commissions, etc.) initiate dialogues to support regionalization using experts that had standing for important constituencies for local decision-making.

AWWA encourages EFAB to reflect on the place-based nature of efficient infrastructure investments with a focus on incentivizing locally-led sustainable solutions.

2. Customer Assistance Programs (CAPs) Barriers

Legal authority - The legal barriers to customer assistance have been well documented.[4] Legal ambiguity is as challenging for public entities, like community water systems, as specific prohibitions. As fiduciaries who manage public finances through elected and appointed boards, and constantly at risk of public scrutiny, municipally-based water systems can ill afford to take on legal risks. Privately-held water systems are similarly subject to regulatory oversight by public utility commissions (PUCs). The lack of clear legal authorization under state law is a powerful disincentive to implementing CAPs.

AWWA asks that EFAB not dismiss legal ambiguity as a barrier as it crafts its recommendations for EPA.

System size - The size distribution of community water systems is an important consideration. It is worth noting that systems of all sizes can have programs to assist customers that face delinquent

[3] EPA, Integrated Municipal Stormwater and Wastewater Planning Approach Framework (aka, The Stoner Memo). June 2012.

[4] UNC School of Government, Environmental Finance Center. Navigating Legal Pathways to Rate-Funded Customer Assistance Programs. July 2017.

accounts (e.g., delaying shutoffs, referrals to other public assistance providers, etc.). CAPS that more actively subsidize water rates are not as viable, when the cost of subsidy cannot be distributed across a large customer base. The system counts by system size in the following table are drawn from the Economic Analysis for the Proposed Lead and Copper Rule Improvements. Note that a small percentage of community water systems reach a scale where considering a self-supported and administered subsidized rate financially sustainable.

System Size (Population Served)	Total
≤100	11,732
101–500	15,084
501–1,000	5,330
1,001–3,300	7,967
3,301–10,000	5,026
10,001–50,000	3,374
50,001–100,000	571
100,001–1M	421
> 1M	24
TOTAL	49,529

<u>Social Safety Net for Water Service</u> – Household water rates are increasing and small changes in water rates have demonstrable impacts, even though the cost of water service is typically very low relative to other basic utilities. As EFAB members prepared for the listening session, investigative reporters found that an 8% increase in water rates in one midwestern community lead to a 25% increase in accounts being sufficiently delinquent to triggers shutoffs.[5] The rate increase in 2016 and 2017 correlated with this increase in shutoffs, was $1.00 per month for a typical residential customer. Today, as a COVID moratorium on shutoffs comes to an end, 6% of the community's accounts are delinquent (i.e., >$100 in debt).

There is a need for a social safety net for households that have financial difficulty and struggle to afford water service, perhaps even experiencing water shutoffs. The federal program most closely aligned with household water rate subsidization was the Department of Health and Human Services Low Income Household Water Assistance Program (LIHWAP). LIHWAP, like its predecessor for household energy costs, Low-Income Household Heat and Energy Assistance Program (LIHEAP), is a federal customer assistance program targeting households that find water rates unaffordable.

The LIHWAP Coalition, of which AWWA is a member, supports developing such a program.[6] An analysis[7] funded collaboratively by the water sector found that such a federal program would need to be comparable in size to the LIHEAP program.

[5] Whitaker, Audrey. 3,000 could get their water shut off in Kalamazoo starting next month. MLive.com. Feb 14, 2024.
[6] Water Sector Associations' Recommendations for a Permanent Federal Low-Income Household Water Assistance Program. April 2023.
[7] Berahzer, Stacey Isaac et al. Low-Income Water Customer Assistance Program Assessment, April 2023

3. Rate Structure / Design

"Principles of Water Rates, Fees and Charges" (also known as "M1")[8] goes into great detail on the methodology of developing water rates. Setting water rates requires balancing an array of considerations within a sound "cost of service" model. M1 also addresses numerous factors through rate design including but not limited to, water system sustainability, customer class equity, sending appropriate conservation signals, affordability and others. Although always evolving and tailored to specific circumstances, water rate design is well-established and has a proven track record.

Customer assistance programs can help to fill the gap between effective and efficient water rate design and affordability for the lowest-income customers, but are in most instances considered to be separate from the rate design itself. In other words, assistance programs (whether internal or external) are in most instances one of the means by which water bills are paid, rather than directly altering the pricing structure itself.

A related opportunity is to use conservation programs to help address inefficient or wasteful water usage for low-income customers. Targeted conservation can help to simultaneously meet water system needs while lowering the typical bill seen by low-income customers by helping to reduce usage without altering the water rates themselves.

AWWA strongly encourages EFAB to encourage EPA to become an active participant in the professional community of rate practice so that the agency can develop an appreciation of water rate setting before EPA issues guidance or supports provision of technical assistance regarding rate setting. AWWA's Rates and Charges Committee is responsible for updating M1 and an excellent forum for EPA to become familiar with the underlying considerations in rate setting.

4. SRF Subsidies

Purpose of SRF Subsidy - The charge question from EPA appears to mistake Congressional intent with respect to targeted State Revolving Loan Fund subsidization for disadvantaged communities. The charge suggests that SDWA and Clean Water Act (CWA) subsidization is intended to subsidize household water rates for some households. This is not how the SRF programs operate under their respective statutes. The drinking water and clean water SRFs are intended to facilitate timely investment to protect public health and the environment. This focus is most clearly demonstrated by the organization of SRF programs around state intended use plans. Projects are prioritized to maximize the effectiveness of the SRF programs toward reduction of health risks and potential environmental harm. Subsidization of loans is a strategy to ensure that fiscal circumstances do not prevent targeted investment. The origin, history and current practice of SRF programs is not and should not be focused on subsidization of household water rates.

Even the specific discussion of disadvantaged household subsidization for lead service line replacement is not about water rate subsidies, it is about accelerating particular groups of households facing financial challenges obtaining non-lead service lines.

Deputy Assistant Administrator's Request – The current charge does not address the more relevant and actionable request made by Mr. Pigott to the EFAB at the October 2022 EFAB meeting. The meeting

[8] AWWA. M1 Principles of Water Rates, Fees and Charges, Seventh Edition. 2016.

summary describes the request as, "*…make recommendations about the current suite of metrics that exist and an analysis on conducting fiduciary oversight and whether there are other ways to analyze or gage whether a program is meeting that requirement* [effective use of federal water infrastructure investment]."[9]

As noted frequently by EPA, the Bipartisan Infrastructure Law (BIL), made significant federal funds available for loans and specifically for loans with principal forgiveness available to support drinking water and wastewater investment (e.g., infrastructure renewal, emerging contaminant removal, lead service line replacement, etc.). Over the next several years EPA and state SRF programs should anticipate significant scrutiny of the program having been implemented (1) efficiently and (2) in keeping with Congressional direction. The metrics requested of EFAB by Mr. Pigott would be tremendously valuable to EPA and states as they implement the program and prepare for subsequent retrospective analyses of the program. EPA will want to demonstrate that funds targeted by Congress to disadvantaged communities, reached that subset of communities and indeed accelerated the timeliness of infrastructure investments to protect public health in a meaningful way in those communities.

AWWA requests that EFAB take up this aspect Mr. Pigott's request as quickly as possible, perhaps providing interim work products to EPA SRF program staff and Council of Infrastructure Financing Authorities (CIFA) for their review. Unfortunately, the oversight guidance that EPA employs to inform practice by state SRF programs is not readily available to the public. Therefore, AWWA is not able to offer you specific recommendations to pursue, beyond the following suggestion. EFAB should request EPA's guidance to state SRFs, forms, and the details of data collection practice soon, so that you will have the information you need for your review.

Disadvantaged Communities – The EFAB Affordability Workgroup may need to revisit current state SRF practice regarding the delineation of "disadvantaged communities." When Congress utilized the Drinking Water SRF as the primary vehicle for distributing BIL funds, it did not modify the general structure of the SRF with respect to how "disadvantaged communities" are characterized by states. The most current and useful summary of state SRF practice in this regard is prepared by the Association of State Drinking Water Administrators (ASDWA) and maintained on the ASDWA website at www.asdwa.org/environmental-justice/.[10] The Workgroup can review EPA's memoranda[11,12] on the topic for ground already covered by the agency.

This remains an area that continues to need evaluation and could be a topic that Environmental Finance Centers support advancing, with appropriate guidance. As members of the Workgroup are aware, CIFA would be an important organization to engage in order to better understand the challenges states face in adapting disadvantaged community definitions to better utilize lead service line replacement funding available through BIL.

[9] EPA. Meeting Summary, Environmental Financial Advisory Board Meeting, October 18-19, 2022.
[10] ASDWA. State Definitions of Disadvantaged Communities. www.asdwa.org/environmental-justice/. December 2022.
[11] EPA. Bipartisan Infrastructure Law: State Revolving Funds Implementation Memorandum. March 2022.
[12] EPA. DWSRF Disadvantaged Community Definitions: A Reference for States. Oct. 2022. EPA 810-R-22-002.

5. EPA Support

Best Opportunity for EPA to Contribute to Water Affordability -- The greatest opportunity for EPA to influence affordability rests in critically reviewing its own decisions. EPA does not currently analyze or attempt to remedy the affordability impacts of its SDWA rulemakings. EPA's regulatory decisions are based primarily on policy choices evaluated using inputs such as health assessments and occurrence information. But SDWA also requires EPA's regulatory decisions be informed by cost and feasibility.[13] Current practice is to substantiate policy choices by comparing national-level benefits and costs.

At present drinking water economic analyses to support rulemakings do not consider:

1. Community-level impacts beyond estimating household costs (typically average costs) for nine system size categories with a particular focus on systems serving less than 10,000 persons.

2. Distributional impacts on low-income individuals (such as the lowest 20% of income; the lowest quintile) are not often[14] evaluated.

3. The impacts of multiple rulemakings cumulatively over time nor concurrent impacts from contemporaneous rulemakings which will be implemented simultaneously.

4. Environmental justice implications of household water rate implications of rule requirements.

These current practices can be revisited and revised to adequately consider affordability as a part of routine agency regulatory decision making.

Capacity Development – The SDWA and CWA are delegated regulatory programs. Congress provided this regulatory structure because state government will be more familiar with the governance, financial, and environmental constraints within which regulated entities operate. In crafting the Drinking Water SRF set-asides and in particular the SDWA Capacity Development provisions, Congress embedded TMF capacity development in the state implementation programs, not at EPA regions or EPA headquarters.

To the extent that EFAB focuses, as requested by EPA, on how to best align available technical assistance program resources, AWWA recommends that EFAB:

1. Engage CIFA and ASDWA members in a dialogue regarding effective capacity development programming.

2. Recommend a technical assistance delivery structure that is directed through state SDWA and CWA program offices rather than through EPA Region or headquarter offices.

Reflect input from CIFA and ASDWA in prioritization of product and tools recommended to EPA.

[13] 42 U.S. Code § 300g–1(b)(3)(C).

[14] EPA did conduct additional analysis in Economic Analysis for the Proposed Per- and Polyfluoroalkyl Substances National Primary Drinking Water Regulation for a select set of system sizes. March 2023.

COMMUNITY WATER CENTER
EL CENTRO COMUNITARIO POR EL AGUA

February 13, 2024

U.S. Environmental Protection Agency
Water Infrastructure and Resiliency Finance Center Office of Water,
Office of Wastewater Management
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Comment to the Environmental Financial Advisory Board (EFAB) Water Affordability Workgroup on community water and wastewater needs in California

Honorable Members of the Water Affordability Workgroup,

We thank you for the opportunity to submit our comments in response to the workgroup's request for feedback on meeting community water and wastewater service needs across the country. Community Water Center (CWC) is a community-based organization that advocates alongside low-income, farmworker communities of color in the Central Valley and Central Coast regions of California in their fight to secure safe, clean, and affordable water. We work at the local, state, and federal levels in order to highlight the financial burden that falls on our communities and hope to provide insight as to how community-driven solutions can meet ratepayers' needs more efficiently.

Small, rural, and economically disadvantaged water systems face many challenges in providing safe and affordable drinking water for residents across the country. In California, 395 small water systems, providing water to 808,875 people are failing due to contamination, inadequate supplies, or unaffordable water rates.[1] Hundreds of other systems serving just under three million Californians are either at-risk of failing or potentially at-risk of failing.[2] A 2021 analysis found that California needed almost $10 billion. Those numbers are likely much greater today due to inflation and the increased number of failing and at-risk systems.[3]

Additionally, these communities tend to have higher water rates because they lack a large base of ratepayers to spread fixed costs for infrastructure to bring safe water into homes. Infrastructure and treatment costs, including fixed costs to pay for operations and maintenance, have to be paid for by fewer households, ensuring higher per household rates. While grants and low-interest loans can help offset some of these costs, as noted above, ongoing operations and maintenance costs cannot be covered by existing infrastructure sources, like the State Revolving Funds or bonds and many small water systems are disadvantaged when it comes to receiving these funds.

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[1] State Water Resources Control Board, SAFER Dashboard, (2023), *available at* https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/saferdashboard.html.
[2] *Id*.
[3] State Water Resources Control Board, 2021 Drinking Water Needs Assessment, (Apr. 2021), p. 22, *available at* https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2021_needs_assessment.pdf
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As mentioned, programs like the State Revolving Funds (SRFs) are difficult to access for small water systems. While SRFs contain set asides for technical assistance, that assistance is not reaching every community and is insufficient to ensure long-term solutions are community-driven. In California, we established the $130 million annual Safe and Affordable Funding for Equity and Resilience Program (SAFER). SAFER funds community outreach and engagement to allow water systems to work with their communities to develop projects that meet community needs. By frontloading this assistance across California, we are beginning to develop projects in the hardest-hit communities to create a pipeline of projects eligible for funding and ensure more of these projects are being funded through the SRF.

The SAFER program also authorizes funding for operations & maintenance (O&M) costs that have traditionally been omitted from federal funding sources. Funding O&M will be critical to avoid situations where communities will have to choose between toxic water riddled with contaminants and affordable water. By ensuring funding to cover all costs of long-term solutions, we can avoid impacts to affordability. The EPA should support Congress in expanding the SRFs to fund O&M funding for projects necessary to bring disadvantaged communities into compliance with drinking water standards.

Ultimately, we support the establishment of a sustained low-income rate assistance program at the EPA for water bills. Given the unfunded pilot program for small and rural water systems established by Section 50109 of the Bipartisan Infrastructure Law, we implore this workgroup to consider the importance of ensuring that funding is provided for this pilot so that existing water debt can be reduced and funding can be redirected towards projects dedicated to meeting communities' long-term water and wastewater needs.

We also urge EPA to reject implementing solutions that are not in the best interests of communities on a long-term, sustained basis. In instances where the EPA is able to provide water and wastewater service needs, the agency must also account for what future costs and system adjustments could look like for residents, and what the financial impacts could be on these households. For example, point-of-use or point-of-entry (POU/POE) filtration systems force residents to front the costs of replacements and repairs to ensure that they continually receive clean water and should not be seen as a long-term solution without strict requirements to ensure replacement and maintenance costs are funded and managed. EPA cannot rely on incomplete solutions in order to reduce overall costs and must ensure long-term solutions are durable.

* * *

Once again, we appreciate the opportunity to provide feedback on policy solutions that can be considered at the federal level. We look forward to collaborating in the future with the water affordability workgroup in order to ensure that the hardest-hit communities' needs are addressed and we can advance a long-term solution for safe, clean, and affordable water across the country.

Respectfully,

Celina Mahabir
Federal Policy Advocate,
Community Water Center

From:	Roxanna Johnston
To:	EFAB
Cc:	Liz Thomas
Subject:	Water Affordability follow up
Date:	Tuesday, February 20, 2024 4:55:31 PM

Hello all,

Thank you for the opportunity to listen and comment during today's public comment meeting.

I'm the chairperson for the Cayuga Lake Watershed Intermunicipal Organization (CWIO). I spoke about the lack of capacity for small municipalities to access/use available funding. Some watershed organizations, including CWIO, are trying to fill that capacity gap with Watershed Managers.

We have a list of recommendations for New York State to support water quality protection. The recommendations are relevant to my comments today and can be found here: https://cwio.org/wp-content/uploads/2023/08/2023-CWIO-Recommendations.pdf

If our watershed model is of interest to you or can be helpful in this discussion, you can find out more at our website: www.cwio.org

In my day job, I'm the lab director at the City of Ithaca, NY drinking water plant, and have 25 years of experience in this field. Many of the infrastructure topics discussed today are daily topics here.

I'd be happy to answer any questions you have and thank you again for the opportunity to provide input today.

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Roxanna Johnston, Chair
Cayuga Lake Watershed Intermunicipal Organization (CWIO)
cwioChair@gmail.com
cwio.org

EFAB Water Affordability Public Listening Session
February 20, 2024
Public Comment from Chat

Here's information about the Cayuga Lake Watershed Intermunicipal Organization, in case the model can provide helpful information to you: www.cwio.org   Thank you again for your time and this opportunity.
Roxanna Johnston, City of Ithaca NY

Comments of National Association of Clean Water Agencies (NACWA) for EFAB February 20, 2024 Listening Session

The National Association of Clean Water Agencies (NACWA) appreciates this opportunity to provide comments to EPA's Environmental Financial Advisory Board (EFAB) regarding affordability of clean water services. NACWA represents nearly 350 public clean water utilities across the nation that provide critical wastewater and stormwater management services. These utilities are anchor institutions in their communities, supporting local economies and ensuring the protection of public health and the environment.

The affordability challenges facing the public clean water sector have increased significantly in recent decades. There are many reasons for this, including decreased federal funding for water investment, increased costs due to greater regulatory requirements, aging infrastructure, inflation, and supply chain challenges. And while the recent infusion of funds from the Bipartisan Infrastructure Law (BIL) are helpful and extremely welcomed, they do not come close to meeting the true investment needs for the clean water sector. Even with the BIL funds, water affordability challenges will continue to persist across the country.

NACWA appreciates EFAB's interest in looking at new technologies and other innovations that can help lower capital costs for clean water utilities and address affordability concerns. There are many new technologies available today that were not even on the market a decade ago that can help utilities meet new and increased regulatory requirements in more cost-efficient ways.

However, it is important to understand that for utilities to feel comfortable trying these technologies – which can potentially help address their affordability challenges - there must be an appropriate regulatory climate that encourages their use. Public clean water utilities work in a very strict regulatory environment and have historically been risk adverse to trying new technologies that may not help them fully meet their regulatory obligations.

In order to facilitate the widespread adoption of new and innovative technologies in a manner that could truly help clean water agencies address affordability concerns, it is critical that federal and state regulators work collaboratively with utilities to address these risk concerns and create a path forward to trying new approaches. This is a vital element of the discussion around new technologies and affordability, and one NACWA strongly encourages EFAB to consider as part of its deliberations.

Integrated planning is one regulatory approach that can play an important role in encouraging the use of innovative technologies. NACWA played a key part in helping advance integrated planning as a regulatory concept and incorporate it into the Clean Water Act (CWA). One of the benefits of integrated planning is that it empowers local communities and utilities to be more proactive in outlining the types of approaches they would like to use to in meeting their clean water obligations. This can include use of new technologies that can be cheaper and more effective, helping reduce costs and address affordability concerns.

EPA Headquarters has been extremely supportive of integrated planning, and NACWA and its members greatly appreciate this support. And some EPA regional offices have also been supportive. But some EPA regional offices and many state regulatory authorities have been at best neutral and at worst hostile to the use of integrated planning. If these regulatory entities are not willing to allow utilities to pursue integrated planning approaches, it is going to severely limit the ability of utilities to consider and use new innovative technologies to help address affordability issues.

NACWA encourages EFAB, as part of its study of this important issue, to advise EPA to work more closely with its regional offices and state regulatory partners to promote the use of integrated planning, especially in the CWA permitting context.

NACWA also encourages EFAB to advise EPA to revise its February 2023 Financial Capability Assessment Guidance. This document will substantially limit the ability of clean water utilities to effectively address affordability concerns in their communities, including the adoption of new technologies. NACWA previously filed detailed comments outlining our concerns with the Guidance, available here.

NACWA appreciates the opportunity to provide these comments. If you have any questions or would like to discuss further, please contact Nathan Gardner-Andrews, NACWA's Chief Advocacy & Policy Officer, at *ngardner-andrews@nacwa.org* or 202/833-3692.

PACIFIC INSTITUTE

To: Environmental Finance Advisory Board
U.S. Environmental Protection Agency
Water Infrastructure and Resiliency Finance Center
Office of Water, Office of Wastewater Management
1200 Pennsylvania Avenue, NW (Mailcode 4202M)
Washington, DC 20460

February 13, 2024

Dear Environmental Finance Advisory Board (EFAB),

Thank you for the opportunity to submit a comment on the topic of research, data, and case examples that demonstrate approaches to reduce the capital intensity of meeting communities' water and wastewater service needs. In this letter we have sought to provide an overview of the links between affordability and water conservation and efficiency, which can and have been applied to successfully reduce utility capital and maintenance costs in the short and longer term. More research and data supporting this discussion are at the links and references throughout the letter.

The Pacific Institute, a 501(c)3 organization, has more than three decades of experience creating and advancing solutions to the world's most pressing water challenges. Specific to water and wastewater affordability, the Pacific Institute has worked with water (inclusive of wastewater) utilities, state agencies, federal government, community-based organizations, corporations, and others to identify barriers, solutions, best practices, policies, tools, and other resources for addressing affordability challenges. For example, in 2012, we published an issue brief in partnership with the Community Water Center[1] titled, Water Rates: Water Affordability Issue Brief, which presented water rates as a human rights issue in cases where they create an exceptional burden for low income households. The following year, 2013, Pacific Institute and the Community Water Center again partnered to publish Assessing Water Affordability: A Pilot Study in Two Regions in California, which examined the impact of water rates on households in two California communities, one urban and one rural. This analysis found that many households, even within affluent communities, routinely spent over the affordability threshold of two percent of their household income on their water bill. In 2018, we published a report, Measuring Progress Toward Universal Access to Water and Sanitation in California: Defining Goals, Indicators, and Performance Measures. This report focuses on how to measure progress towards the state of California's Human Right to Water policy (California Water Code §106.3), which includes metrics and goals for household affordability. In 2021, Pacific Institute, the Rural Community Assistance Partnership[2], and the Rural Community Assistance Cooperation[3] published Customer Debt and Lost Revenue: The Financial Impacts of COVID-19 on Small Community Water Systems. This report provided information on revenue losses experienced by small community water systems (serving fewer than 10,000 people) in the United States and debt accumulated by their customers during the pandemic. These are just a few publications by the Pacific Institute and its partners that directly address water and wastewater affordability.

Specific to EFAB's request for research, data, and case examples of approaches that reduce the capital intensity of meeting a community's water and wastewater needs, one of the

[1] www.communitywatercenter.org
[2] www.rcap.org
[3] www.rcac.org

+1-510-251-1600 344 20th Street, Oakland, CA 94612, US pacinst.org

strategies that Pacific Institute has researched deeply is water conservation and efficiency. Conservation and efficiency are multi-benefit approaches to reducing demand for water while also saving energy, improving instream flows, protecting groundwater during times of drought, and reducing the need for costly chemicals and certain maintenance tasks at water and wastewater facilities (e.g., Cooley et al. 2019; Diringer et al. 2019; Spang et al. 2018; 2020; Woltemade and Fuellhart 2012). Critically, water conservation and efficiency have been shown to save water utilities from needing to make expensive capital improvements when conservation and efficiency are appropriately accounted for in demand forecasting models (Diringer et al. 2018).

Water conservation and efficiency are typically less expensive than developing new water supply and treatment infrastructure, especially when evaluated from the combined perspective of the customer and the utility (e.g., Berhanu et al. 2016; Cooley et al. 2019; Rupiper et al. 2022). As a result, investments in efficiency measures - rather than in new supply and treatment facilities - reduce costs for ratepayers. But better water demand forecasting and planning are essential for realizing the cost savings of water conservation and efficiency improvements and avoiding stranded assets.

When evaluating the long-term effects of conservation and efficiency on water costs, the key question is: “what would be the cost of water and wastewater in the absence of conservation?” Economists typically answer this question using an avoided cost analysis. The table below, from Cooley et al. 2022a, summarized the results from four avoided cost analyses for water utilities in the western United States.

	City of Westminster (Feinglas, Gray, and Mayer 2013)		Tucson Water (Mayer 2017b)		Town of Gilbert (Mayer 2017a)		Los Angeles Department of Water and Power (Chesnutt, Pekelney, and Spacht 2018)	
Years Compared	1980	2010	1989	2015	1997	2015	1990	2016
Population	Not Reported		512,000	717,875	75,144	247,542	3,650,000	4,100,000
Water Use (gpcd)	180	149	188	130	244	173	180	110
Costs Avoided by Water Conservation and Efficiency Improvements								
Avoided Capital Costs	$591,850,000		$350,862,732		$340,807,075		$9,455,060,179	
Avoided Operations and Maintenance Costs	$1,238,000 per year		$29,387,158 per year		$3,671,346 per year		$1,600,448,745	
Bill Impacts without Conservation								
Additional Charges on Annual Customer Bills	$596		$133		$38		$13.48 per Hundred Cubic Feet	
% Increase in Customer Bills	91%		13.3%		6.1%		36.4%	
Additional Connection Fees	$16,952		Not Reported		$7,733		Not Reported	
% Increase in Connection Fees	80%		Not Reported		81.7%		Not Reported	

Notes: Water and wastewater costs are included for all agencies except the Los Angeles Department of Water and Power (LADWP). Avoided costs shown for Los Angeles are for water supply and do not include wastewater. Previous studies show that avoided costs for wastewater were at least as large as for water supply, suggesting that actual bill savings for water and wastewater would be at least twice as high as is shown in the table. LADWP uses an increasing tiered billing structure, and the estimate provided for additional charges on customer bills is for the Tier 4 billing rate.

The cost savings that water conservation and efficiency can provide for water and wastewater utilities can only be realized if these organizations effectively integrate water conservation and efficiency improvements into their long-range planning and avoid unnecessary investments in expensive new capital projects. Yet, studies show that water demand forecasts routinely overestimate future water demand due, in part, to failures to adequately account for future water conservation and efficiency improvements that are driving reductions in per capita water use (Diringer et al. 2018; Abraham et al. 2020). Additional unnecessary costs are passed to consumers through higher water bills and connection fees. Greater effort is needed to integrate conservation and efficiency standards, codes, and trends into demand forecasts (Diringer et al. 2018).

In many parts of the United States, water use has decoupled from population and economic growth (Richter et al. 2020). This is due to numerous factors, including federal and state policies that require more efficient fixtures and appliances, incentives from utilities for conservation and efficiency (e.g., rebates for toilets), conservation-oriented water rates, and more efficient water use by industrial users (Richter et al. 2020). Yet, opportunities still exist in nearly all homes, businesses, and utilities to improve water conservation and efficiency. While California has been a leader in implementing water conservation and efficiency, a 2022 analysis found that urban water use could be reduced by an additional 30-48% using existing technologies and practices (Cooley et al. 2022b). In 2024, Pacific Institute will release a national assessment of the opportunities for conservation and efficiency for the entire United States.[4] And in 2025, the Water Research Foundation, led by researchers at the Pacific Institute, UCLA Luskin Center for Innovation, CIS Inc., and UNC Environmental Finance Center, is planning to release a guidebook on innovative approaches led by utilities to water affordability, including a section focused on those related to conservation and efficiency.[5]

Thank you again for the opportunity to submit this comment letter for consideration by EFAB. We hope that water conservation and efficiency can be component of the advisory board's work to address affordability challenges faced by utilities and the communities whom they serve.

Sincerely,

Morgan Shimabuku
mshimabuku@pacinst.org
Senior Researcher
Pacific Institute

Heather Cooley
hcooley@pacinst.org
Director of Research
Pacific Institute

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[4] To be notified of the release of this national assessment, please contact media@pacinst.org.
[5] For more information, see the project page at https://www.waterrf.org/research/projects/feasibility-and-applicability-emerging-utility-led-innovations-addressing.

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From: Morgan Shimabuku
To: EFAB
Cc: Heather Cooley
Subject: Re: EPA EFAB Water Affordability Public Listening Session - Thank You for Registering!
Date: Tuesday, February 20, 2024 1:43:40 PM

Caution: This email originated from outside EPA, please exercise additional caution when deciding whether to open attachments or click on provided links.

Dear EFAB,

Please refer to the documents at the following links that I referenced during my public comment, which build on the public letter that we submitted last week.

- Benefit Accounting of Nature-Based Solutions for Watersheds Guide Version 2
- Guide for Developing Onsite Water Systems to Support Regional Water Resilience
- Joining Forces: Innovative Co-Funding to Enhance Corporate Water Stewardship Impact in the Colorado River Basin

Thank you again for this opportunity.

Sincerely,
Morgan Shimabuku

From: Morgan Shimabuku <mshimabuku@pacinst.org>
Sent: Tuesday, February 13, 2024 2:20 PM
To: EFAB <EFAB@epa.gov>
Cc: Heather Cooley <hcooley@pacinst.org>
Subject: Re: EPA EFAB Water Affordability Public Listening Session - Thank You for Registering!

Dear EFAB,

In advance of my public comments on February 20, I would like to submit the attached comment letter to the board, on behalf of Pacific Institute, myself, and my colleague, Heather Cooley.

Thank you,
Morgan Shimabuku

From: EFAB <EFAB@epa.gov>
Sent: Tuesday, February 13, 2024 8:13 AM
To: EFAB <EFAB@epa.gov>
Subject: EPA EFAB Water Affordability Public Listening Session - Thank You for Registering!

From:	Paul
To:	EFAB
Subject:	Public Listening Session
Date:	Monday, February 5, 2024 1:02:15 PM

In 2003, our community volunteers began working with the (then) National Onsite Demonstration Project at WVU in Morgantown WV. Long story short, professional engineers provided a viable alternative STEP sewer design in 2019 but the project was terminated mainly due to not needing a non-profit starting up a new utility with an existing public sewer utility nearby.

After 20 years, our communities are still without public sewer, and we are back to waiting for a new design and plans for centralized sewer extension. The effluent sewer design is not an option being provided for many municipal systems and Public Service Districts to build and operate even with the onsite (STEP/STEG) effluent sewer benefits of lower construction costs, no manholes, no I&I and no CSO's.

I believe that the EPA should require all states to demand more comparative analysis and cost studies of effluent sewer systems for any federally funded community project. During the regulatory reviews, it seems that alternatives are just noted as considered while the centralized system continues to be thought of and accepted as the most cost effective and environmentally sound alternative.
It’s About Time Government Invests in Septic... | Onsite Installer

It’s About Time Government Invests in Septic System Infrastructure | Ons...

It’s About Time Government Invests in Septic System Infrastructure

It's About Time Government Invests in Septic System Infrastructure

The designers at Penn's Trail Environmental go beyond the drawing board to lobby legislators for support of decentralized wastewater

Appeared in print as *"Industry Influencers"*

By **David Steinkraus**

December 2023

Cover Story

Adam Browning of Penn’s Trail Environmental in Hatfield, Pennsylvania.

(Photos by Hannah Beier)

When Piedmont Environmental dissolved in 2008 during the Great Recession, three employees bought the assets of the Pennsylvania company. They formed Penn’s Trail Environmental, and after 15 years the business has grown and expanded into design and consulting work in two states.

Those three people were Paul Golrick, Maureen McDermott and Jack Dudish, says Adam Browning. Formally Browning is manager of the wastewater division, but he acts as operating officer for the company. Dudish is a macrobiologist, Golrick a professional geologist, and McDermott a wetland scientist. In both states, Penn’s Trail provides a wide variety of services reflecting its founders’ expertise including environmental assessments, geology and onsite design.

A couple of years after its founding, the company expanded into Maryland. The northeastern corner of Maryland is about an hour’s drive from the Penn’s Trail base in Hatfield, Pennsylvania, and the expansion happened because of a manufacturer’s rep, Browning says. “He brought us down to assist with a drip dispersal design. That was about 12, 13 years ago, and we never left.”

TWO-STATE SOLUTION

Although Penn's Trail technically covers all of Maryland, Browning says, they don't do much work on the eastern shore of Chesapeake Bay. "As far as soils are concerned, the majority of the inland side of Maryland is very similar to Pennsylvania. Both lie primarily on the piedmont geologic formation, so the soils are very similar. Once you get to the eastern shore, it's sandy; it's completely different. The need for our services isn't nearly as prevalent as it is on the dry side of the state."

Onsite design standards in Maryland and Pennsylvania are similar, he says. "They're all based off the Wisconsin mound system. However, Maryland is closer to the Wisconsin mound in its design details. Pennsylvania devised its own version of the Wisconsin mound."

Yet Pennsylvania's version is more designer-friendly, Browning says. For example, lateral spacing and hole spacing on laterals are fixed. In Maryland, he says, the size of the mound dictates hole spacing and lateral spacing. For perk tests, Maryland requires open holes and infiltrometer tests. Pennsylvania requires perk tubes for sand mounds and in-ground systems, he says.

There is some seasonal slowdown in the business, he says, but you can look at soils at any time. "In fact, the last couple years, the way housing has been going, we barely saw a difference in business when winter came through," Browning says.

The far northwestern and southern corners of Maryland are about a four-hour drive from the Penn's Trail headquarters. Browning splits his time between the two states. "I'm usually in Maryland one to two days a week, and I'm doing soil testing, infiltration testing, that kind of stuff, to support a design."

The rest of his week is spent in the office. He maintains compliance documents on several systems that require regular samples. “What I like about my job is there’s not a lot that’s typical about it. In general I’m designing and doing infiltration and soil work daily, but it does vary.”

TAKING COMPLEX JOBS

Personally, Browning says, he produces three to four system designs per week on average. The company’s other designer outputs about the same.

Penn’s Trail services don’t break down into clean categories, Browning says. Everything is interrelated. Most of the soil work leads to design work, which in turn leads to compliance and maintenance work. Sewage-related services make up about 65% of the business, he says. Environmental disciplines such as site assessments account for the rest.

Because of the high skills of its staff, Penn’s Trail tends to take on more complex jobs, he says. The company has done several multi-lot community systems and small-flow systems serving welcome centers.

When he talked to Onsite Installer, Browning was on the site of what would be a convenience store and next to a commercial complex the company also designed.

The commercial complex produced about 3,800 gpd and was served with a subsurface low-pressure dose system. The convenience store has a design flow of 3,000 gpd. On the same property is a liquor store with 400 gpd, and the system will use advanced treatment.

Membrane bioreactors have come up in conversation, he says, but he has yet to use one in a design. The technology does result in better soil loading rates, he says, but in the case of projects like the commercial complex, state regulations would require a licensed operator to be at the work site daily. “It just wasn’t financially feasible for that particular project,” he adds.

Related: System Site Plans: Soil Evaluation, Loading Determination and Treatment Train Components

His largest project was a 28,000 gpd drip-irrigation field for a residential development of about 105 homes.

PREFERS PRESSURE

In Maryland the company designs a mix of systems using mounds or drip irrigation. For new construction, most systems use septic tanks and trenches although there is an increase in sand mound use, he says. Drainfields are typically hard pipes on top of aggregate and using gravity distribution. Chambers are used when access limitations make it difficult to bring in the stone for trenches.

“I’m not a fan of gravity. I would always prefer to have a pump in a system. Equal distribution is kind of my thing,” Browning says. Gravity distribution doesn’t work that well, he says, because the first couple of holes in a lateral will receive all of the water until they start to plug. So in a gravity system, a homeowner who paid for 300 feet of trenches is really using only 15 or 20 feet of them at any given time, he says.

Any time a pump is added to a system, such as to move water from a septic tank to a drainfield on a higher grade, it makes sense to eliminate the D-box, pressurize the whole system, and use the entire drainfield, Browning says.

Obviously, all the company’s projects are controlled by soils on site, he says. “Where we’re located in the southeast region of Pennsylvania, geologic formations clash so we have a mix of everything from really deep, well-drained soils to stuff that you can barely get a fork into.”

Related: Goats on the Drainfield and Other Odd Encounters

Developers in his area would like to see more municipal sewer system extensions, Browning says, but municipalities balk at the cost. “The biggest problem where I am is that the majority of the sewer is so old that the money goes to upgrading what is already there.”

EFFECTIVE EQUIPMENT

Because the company’s dirt work is limited, the list of heavy equipment that technicians use is short. A pair of John Deere 32G mini-excavators, one a 2021 and the other a 2019, handle any digging. Other equipment is much smaller.

Permeameters from American Manufacturing Company Inc. measure soil loading capacity.

“We’ve just recently purchased GPS surveying equipment. Although we’re not surveyors, it’s beneficial to us to be able to provide solid GPS coordinates to our clients,” Browning says.

For design work, the subcentimeter accuracy of their Emlid surveying gear gives very precise locations of wells, property lines and other factors, which makes plans more accurate and designing easier, he says. All design work is done with the drafting software AutoCAD.

Related: A Family Business Faces Design Challenges Working in the Protected Chesapeake Bay Watershed

"With the GPS I can pick up every point I want to use. So home locations, locations of the corners of my septic system, test pits, perk holes, that kind of stuff can all be collected with the GPS unit. It's directly put into an AutoCAD-friendly format so I can bring that information into AutoCAD and have it placed accurately on a plan in a matter of seconds. What it's done for us is cut down what used to be a two- or three-hour process on site into 15 or 20 minutes, and it increased the accuracy pretty substantially."

Exact information can also be transferred to engineers or surveyors who need to look at a specific location, he says.

In addition to the principals, the Penn's Trail team includes Terry Harris, Devon Tarantino, James Haklar, Cody Kline, Shannon Petrillo, Abigail Stauffer, Marcy Witt and Holly Berryman-Moss.

INDUSTRY ADVOCATE

Each year, Browning says, he joins the NOWRA fly-in day to Washington, D.C., where he and other onsite advocates try to redirect some of the money that traditionally has gone to municipal wastewater projects. "We have also been pushing [U.S. Environmental Protection Agency] to investigate the environmental benefit of using onsite systems over public sewer even where public sewer is available. We haven't gotten that through the feds yet, but it's been talked about the last four or five years we've been down there. I think we're getting closer to it.

"Our potable water sources are depleting quickly, and septic systems are the No. 1 recycler of groundwater," he says.

"I certainly think we're getting noticed. We had success in this recent infrastructure budget. We were able to get what seems a quite large amount of money set aside for onsite systems. Up until that point, the money we got from the Clean Water Fund was about 1% of one-tenth of the overall funding. Countrywide, 30% of us are served onsite systems, and 80% of the country could only be served by onsite because the big pipe's not out there yet."

Browning says he also sits on the Sewage Advisory Committee in Pennsylvania. It's a stakeholders group that helps legislators review and write legislation. At the moment the Legislature is rewriting the section of law governing onsite systems. Two laws passed the Legislature to allow some newer onsite technologies, but the state Department of Environmental Protection did not interpret them as legislators or stakeholders intended, he says. The coming draft rules will supposedly remedy that, he adds. By the end of the year, he says, his advisory committee expects to receive the draft rules, and hopefully they will be ready for public comment early in 2024, he says.

LEARNING AND DOING

Browning is a certified sewage enforcement officer in Pennsylvania. “I don’t necessarily have to be for what I do,” he says. “Everybody in our office are certified sewage enforcement officers, more for the education that came along with it and to understand the program we’re dealing with.”

To earn the certification, Browning says, he attended a seven-day program. Recently he took a course that will enable him to train new sewage enforcement officers. “I want the industry to continue to advance as much as possible.”

The same goes for the Pennsylvania wastewater operator’s license exam, he says. He took it to inform his work, but he’ll never qualify for a full license because he has no opportunity to acquire the necessary hands-on operational experience.

“For me to be at the top of my game, I need to be aware of everything that’s going on, so I make it a point to involve myself in anything and everything I can,” he says.

Browning did not grow up in the wastewater industry. “I come from heavy construction. I paved highways, built buildings, ran machinery, pretty much since I was 12 until I was about 21, 22 years old.”

At the time he owned his own paving/excavating company, but he grew tired of the hustle. To an excavator friend he mentioned a plan to go back to school for another career. The friend worked for Piedmont Environmental. “About 20 minutes later he waved me over and said, ‘You have a job starting tomorrow if you want it.’ So I took the job, and I’ve been here ever since.”

Browning says he’d always been interested in design work and learned about automated design during 18 months in community college. Everything he’s learned, he’s learned on the fly, he says, “which I think in certain aspects I’ve benefited from because it wasn’t being told to me. It was, if you want to know, you have to go find it, and you appreciate what you’re finding a lot more when you’re the one digging.”

Construction experience makes him a better designer, Browning says, because he can allow for problems that someone without his experience won’t foresee. For example, he will understand from the outset that heavy equipment won’t be able to fit a small space to place a concrete tank, and he’ll design for a plastic tank. That’s minor stuff, he adds, but it’s the kind of minor stuff that can make or break a project.

Popular Stories

Lead Service Line Replacement Costs and Strategies for Reducing Them

February, 2024

Prepared by Elin Warn Betanzo, Safe Water Engineering, LLC and Vanessa Speight

This report was funded by the Natural Resources Defense Council (NRDC). The views contained herein are those of the author and do not necessarily reflect those of NRDC.

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Lead Service Line Replacement Costs and Strategies for Reducing Them

Executive Summary

Where present, lead service lines (LSLs) are the largest source of lead in drinking water (Sandvig et al., 2008), and they provide a constant risk of exposure to lead even in water systems with corrosion control treatment (USEPA, 2023d). The U.S. Environmental Protection Agency's (USEPA) proposed requirement to remove all LSLs from water systems in the United States (USEPA, 2023d), known as the Lead and Copper Rule Improvements (LCRI), is an important and effective intervention for reducing and preventing exposure to lead in drinking water. Protective public health policy requires realistic cost estimates to ensure all LSLs are identified and removed quickly and efficiently. Inflated cost predictions slow health protective policy and provide an environment where contractors are enabled to overcharge for their services, further delaying public health protection for vulnerable populations who have had no option but to drink water from LSLs for decades.

In December 2022, the American Water Works Association (AWWA) presented a cost estimate for lead service line replacement (LSLR), which it submitted to USEPA as an attachment to comments concerning USEPA's development of the LCRI. This new full lead service line replacement (FLSLR) cost estimate (CDM Smith, 2022) was two times the previous average cost estimate provided by USEPA and 23% larger than the previous average provided by AWWA, which were both presented in the Lead and Copper Rule Revisions (LCRR) Economic Analysis in 2020 (USEPA, 2020). In November 2023, USEPA proposed the LCRI, which includes a requirement to replace all estimated 10.5 million lead service lines (LSL) and galvanized requiring replacement (GRR) service lines in the United States. The proposed LCRI is supported by a new Economic Analysis, which presents USEPA's own updated cost estimates (USEPA, 2023b).

This report was prepared to assist with evaluation of LSLR costs, for the purposes of developing Safe Drinking Water Act regulations and implementing local LSLR programs. This report analyzes the most recent AWWA and USEPA LSLR cost estimates, compares similarities and differences, and provides an additional literature review to further contextualize available data. This report's purpose is to understand current and reasonable cost ranges for LSLR at the unit scale.

This report also presents independent construction cost estimates using data from RS Means, an industry standard construction cost tracking database. The results of this analysis provide the relative magnitude of individual line-item costs to identify major LSLR cost drivers, allowing for exploration of opportunities to reduce those costs.

This cost analysis serves not only to inform policy makers, municipalities, and water systems, but also to allow community members to hold local decision makers accountable for LSLR projects so that funding is spent wisely and efficiently to complete the most LSLRs as quickly as possible. The information presented here is necessary to support efficient planning and procurement, and to ensure that public health protection is prioritized throughout the LSLR process.

Historically, cost estimates for water distribution renewal needs have not included LSLR, making the cost of LSLR appear to be "extra" even though the service line is the final critical pipe that affects the quality of all water delivered to an individual home. Although replacing 10.5 million LSLs and GRRs will be a large task, LSLR represents a small percentage of overall water infrastructure replacement needs that the utility sector has estimated as being in the multiple trillions of dollars (AWWA, 2013). LSLR costs represent an even smaller percentage of utilities' total budgetary needs when operating expenses are also considered (Value of Water Campaign, 2020). Adding LSLR to our water infrastructure needs does not represent the last, singular cost that makes water unaffordable – it is merely one of many costs necessary to continue providing safe drinking water in community water systems. According to previous estimates (Betanzo, 2022) adding the cost of replacing all LSLs to water distribution needs estimates results in a mere 3% increase in the national cost estimate for water main renewal. In contrast to most water infrastructure funding needs, the need to remove the health hazard of LSLs represents a one time, all at once cost. While service lines will need to be maintained and replaced in the future on a maintenance schedule, the need to remove this urgent health risk is a one-time cost.

Analysis

AWWA Cost Estimate Analysis

In November 2022, CDM Smith published a report, *Considerations when Costing Lead Service Line Identification and Replacement* (CDM Smith, 2022), that analyzed data collected by phone interview with 9 water utilities and a literature review of reported costs. This report's analysis of the CDM Smith dataset focuses on the full lead service line replacement (FLSLR) projects and considers both construction and auxiliary cost estimates for engineering services, internal labor administration, customer outreach, permitting, and post-replacement provisions.

The CDM Smith analysis established a baseline estimate for minimum, average, and maximum construction costs using historical (from literature) and survey data. Auxiliary costs were then identified based on the type of activity and applied to the construction cost as a percentage multiplier (26.5%) to arrive at an estimated total LSLR cost. While the report discusses the options and costs for preparing a lead service line inventory, these costs were not included in the final CDM Smith LSLR cost estimate. Costs for restoration were also estimated but not included.

Findings from this evaluation of the data sources and approach taken in the CDM Smith report include:

- *Selective inclusion of projects in baseline construction cost estimate*: The projects included in the baseline construction cost estimate appear to have been selective, with criteria for exclusion of costs from the literature unclear. Most estimates appeared to have a similar degree of missing information, even those that were included. Information about the 9 utilities that were surveyed is not provided so it is difficult to contextualize that data and understand how it might relate to other LSLR replacement programs across the country. In all, 31 projects were included from a survey of 9 utilities, resulting in oversampling from the utilities that were selected on the basis of undisclosed criteria.
- *Averaging per project versus per LSLR*: The CDM Smith analysis does not use a weighted average approach because limited data on the quantity of LSLRs was reported. As a result, for example, the $13,213 LSLR cost for an unknown quantity of LSLRs has equal weight to $8,014 that was averaged over 206 replacements.
- *Auxiliary costs may be double counted*: In many cases, some of the noted auxiliary costs such as permitting or engineering services are likely already included in the baseline construction cost

estimate. The lack of a detailed breakdown of cost components in the literature makes this difficult to estimate and this fact should be acknowledged.

- *Using a percentage of construction cost results in an overestimate of auxiliary costs*: While there is precedent for using a percentage of the total construction cost as an estimate of engineering services costs, this is not the case for other auxiliary costs. For per-replacement services like permitting, outreach, and post replacement provisions, the cost will not be related to the construction costs, which are largely driven by factors such as depth of service line and soil conditions.

CDM Smith reported an average FLSLR construction cost of $9,900 and an average total cost including auxiliary items of $12,500, with a range from $7,600 to $37,800 (2022$). Recalculating that baseline average construction cost using all 25 FLSLR projects listed by CDM Smith, the average construction cost becomes $8,700. Further, using the auxiliary costs delineated by CDM Smith but adding them as fixed costs rather than a percentage, the resulting average total LSLR cost would be $10,800, with a range from $4,400 to $24,600.

EPA Lead and Copper Rule Improvements Economic Analysis

EPA estimated LSLR cost for the LCRI based on information submitted for the 7th Drinking Water Infrastructure Needs Survey (DWINSA) (USEPA, 2023a). To be included in the LCRI Economic Analysis (USEPA 2023b; USEPA 2023c), USEPA required adequate documentation with information on the number of service lines and replacement costs. As such, the inclusion criteria were clearly defined and 33 projects were included covering 13 states, 6 USEPA regions, and include states in the Northeast, Midwest, and the West. Populations ranged from 3,000 to 2,000,000 and covered a period from 2012 to 2022. The resulting average USEPA cost estimate for FLSLR was $6,930 (2020$).

Figure ES- 1 presents a histogram for the DWINSA and CDM Smith data, showing the frequency distribution of reported FLSLR costs by total number of LSLs replaced, grouped into $2,000 cost bins. Figure ES- 1 includes only those projects that reported the number of services replaced (n=12 for FLSLR projects included in the CDM Smith dataset). The histogram clearly demonstrates that the vast majority of LSLRs fell within the $8,000 to $10,000 cost range. Further analysis of these datasets reveals that:

- The highest reported FLSLR costs are associated with a very small number of LSLRs relative to other projects,
- Average FLSLR cost can be less than $10,000 for projects addressing a small or very large number of LSLRs, and
- Larger quantities of LSLRs do not drive up the average LSLR cost.

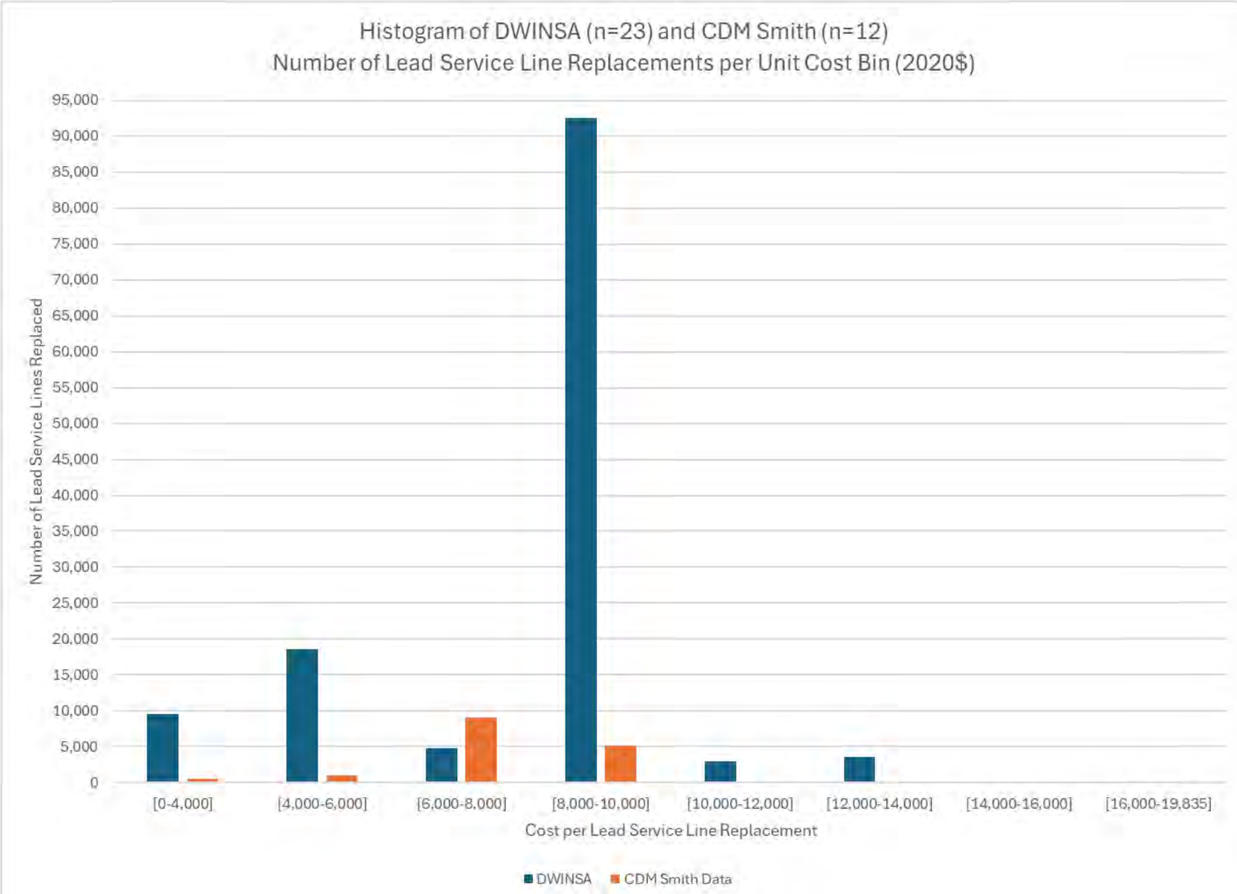

Figure ES- 1: Histogram of DWINSA and CDM Smith Number of Lead Service Line Replacements per Unit Cost Bin 2020$ (Source: USEPA, 2023b; CDM Smith, 2022)

Literature Review

An independent literature review was conducted for this study to further explore the range of published costs for LSLR projects. The literature from CDM Smith (2022) was collected, along with a literature review focused on AWWA publications, USEPA analyses, court testimony, and media reports regarding cities with publicized LSLR programs. This literature review is valuable in that it illustrates the range of real and potential outlier LSLR program costs given a sufficiently broad spectrum of reported programs.

The findings of the independent literature review are consistent with the observed trend that very high FLSLR costs are real but limited. The majority of FLSLR unit costs are substantially lower than the maximum and reliably below $10,000. The outlier project costs in CDM Smith (2022) are, in fact, outliers. Although the maximum LSLR cost for the independent literature review is higher than the DWINSA or CDM Smith data, the median and mean FLSLR costs are not. The different cost estimates from the different datasets are summarized in Figure ES- 2. For consistency with numbers published by USEPA, Figure ES- 2 includes only the 18 CDM Smith projects that USEPA included in its comparison published in the LCRI Economic Analysis Appendix A (USEPA, 2023c).

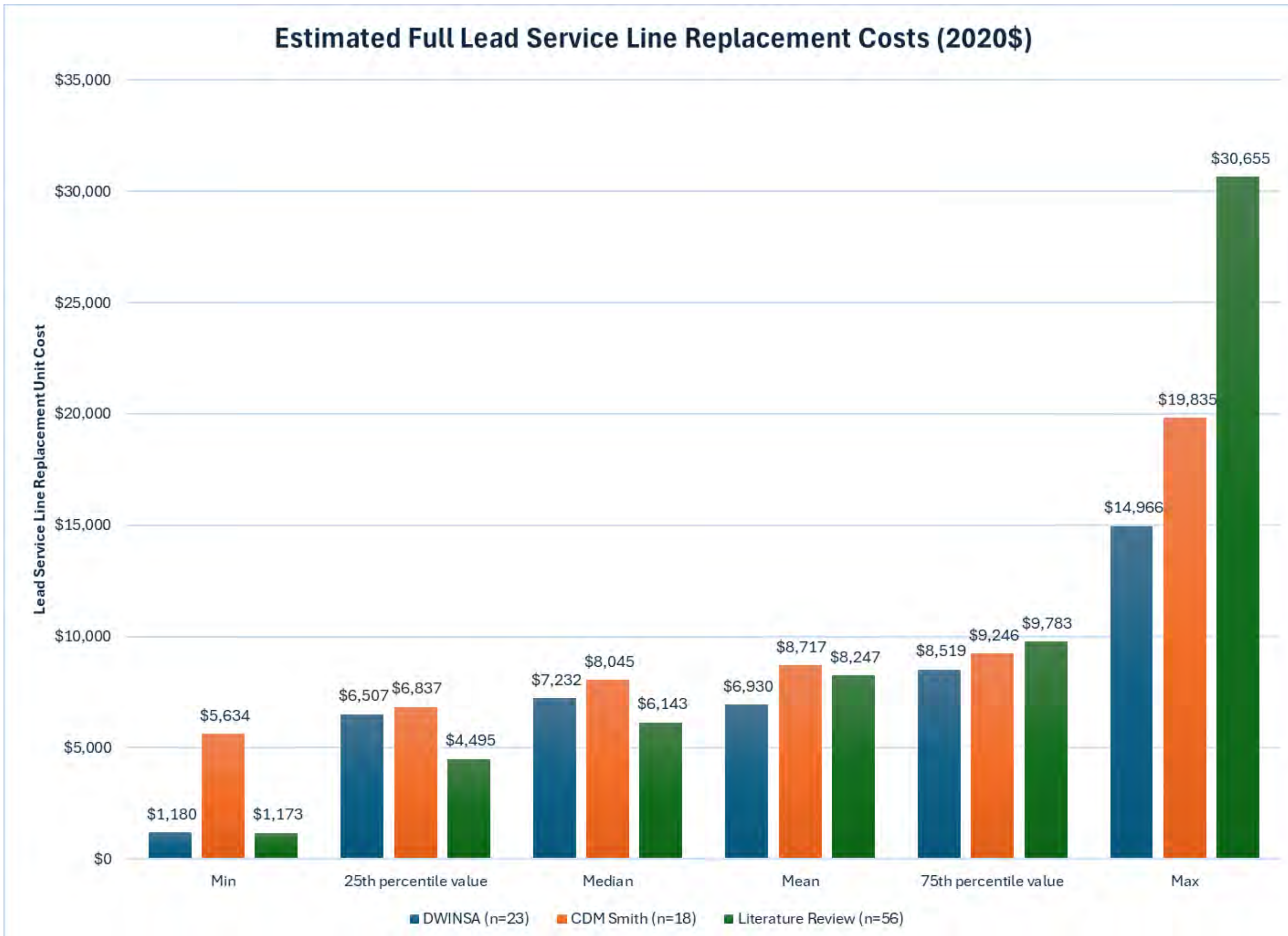

Figure ES- 2: Estimated Full Lead Service Line Replacement Costs (Sources: USEPA, 2023c; CDM Smith, 2022; literature as listed in Table 4)

In summary, this analysis finds that the USEPA estimates for FLSLR construction cost are reasonable in comparison to the values reported in the literature.

Independent Cost Estimate

An independent cost estimate was prepared as described in the full report using the industry standard RS Means Online Construction Cost Database, Year 2024 edition (www.rsmeans.com). A set of scenarios was developed to estimate typical costs for different configurations of LSLRs that might be encountered by utilities. The scenarios were developed as examples of typical construction costs, excluding auxiliary items such as inventories, permits, traffic control, and program management. In reality, the conditions encountered and degree of restoration needed will be highly site specific, so these examples are intended to provide benchmark reference values to help utilities understand the components of the work and relative costs.

Low, medium, and high cost scenarios were created to illustrate a range of cost estimates. Figure ES- 3 provides the results of the RS Means cost estimation across the different scenarios, ranging from $2,096 for low cost scenario, short-side, open trench polyethylene (PE) pipe to $33,408 for the high cost scenario long-side, open trench copper pipe with extensive road restoration. Comparing the results for different low-cost scenarios, copper pipe adds approximately $900 to the cost for a short side replacement, or $1,400 for a long side replacement (copper is $23.41 per foot installed versus $5.40 per foot installed for PE).

The independent cost estimates exclude auxiliary costs. The DWINSA values were developed to minimize auxiliary costs, and the literature values include unspecified auxiliary costs. The independent construction cost estimates are consistent with the values reported in the literature and DWINSA, considering low and high cost scenarios as comparable to the minimum and maximum reported costs, respectively. The alignment of the DWINSA values and independent cost estimates that both exclude auxiliary costs further validate the USEPA cost estimate.

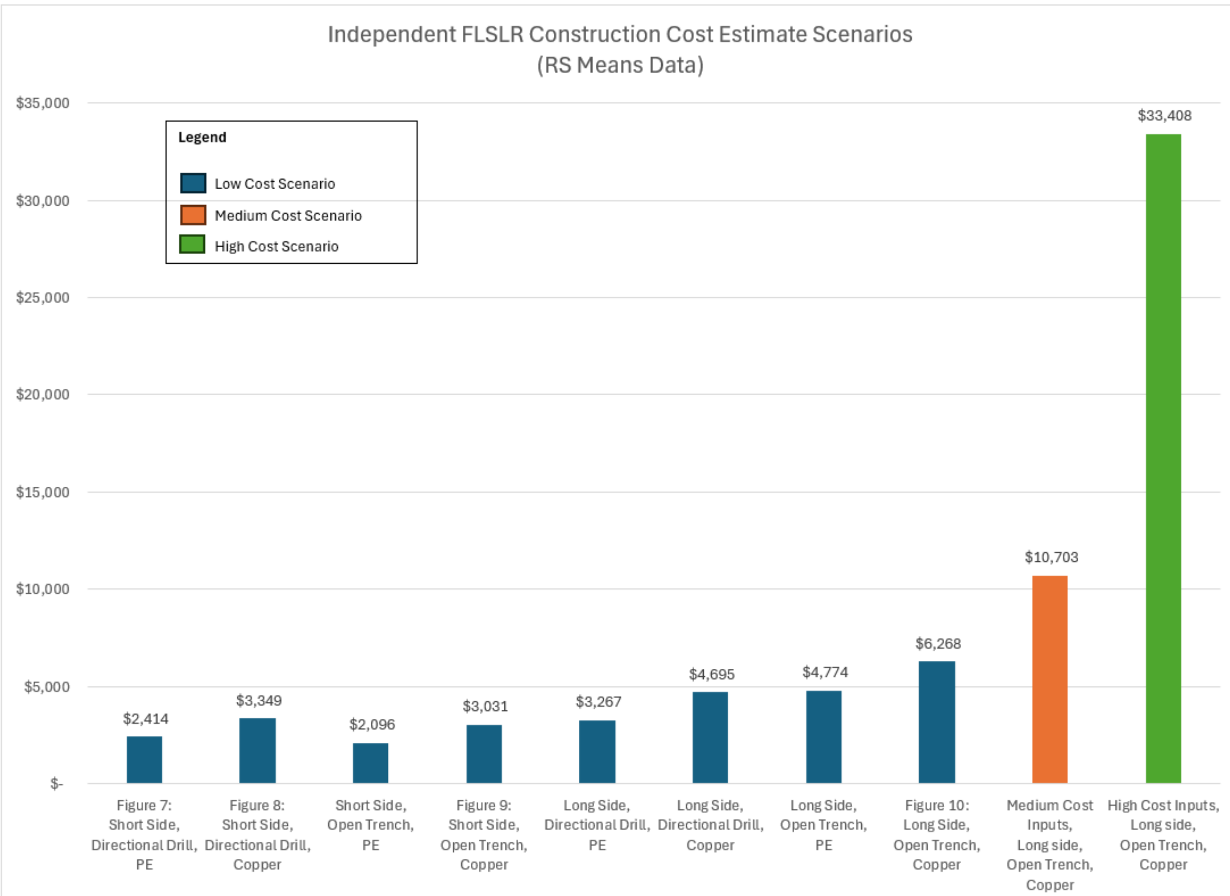

Figure ES- 3: Independent FLSLR Construction Cost Estimate Scenarios

Conclusions

This section summarizes the report findings and conclusions related to the multiple cost estimates presented in this report, the significant cost factors that tend to drive LSLR costs, and important LSLR program design considerations that can bring down overall LSLR cost at both the program scale and at the individual replacement scale.

LSLR Costs and the LCRI

The LCRI as proposed would require public water systems to replace all LSLs and GRRs within 10 years, with some exceptions. The cost of LSLR includes the planning, program, and construction tasks shown in Figure ES- 4. Restoration after LSLR to backfill all excavations, patch any disturbed interior wall, patch disturbed sidewalk and street, and lay grass seed is essential and inherent to any LSLR. However, additional paving, sewer line, and finished basement restoration is not compelled by the LCRI. For example, paving an entire street after LSLRs is not an essential cost to obtain the public health benefits of LSLR. Consolidating LSLRs to maximize the benefit of planned paving programs is strongly encouraged as an asset management and customer relations benefit to that community and will also bring down the cost of LSLR when the cost is shared with other capital improvements. Full restoration is encouraged but not required in the LCRI proposal.

Unit Cost Analyses and Construction Costs

1. Overall, there is a large degree of consistency across the USEPA, literature, and independent RS Means construction cost estimates, as can be seen in Figure ES- 2 and Figure ES- 3. The CDM Smith cost estimates as published are higher than the other estimates presented here, but when the CDM Smith data are adjusted to avoid selective inclusion of projects and more accurately reflect fixed auxiliary costs they are also consistent with the other unit cost estimates presented here.

2. The DWINSA analysis for the USEPA's LCRI proposal provided more information on inclusion and screening criteria for the DWINSA LSLR cost estimates. This dataset emphasizes the lower to mid-range of cost data that are found in the CDM Smith estimate and is consistent with our analysis of the published literature costs.

3. Our independent cost estimate shows that, in practice, most of the construction costs do not vary substantially. There is a small set of construction conditions that can drive up costs, but as reflected in the literature review cost estimates, these conditions are not experienced in the majority of replacements.

4. The low unit cost values in the independent cost estimates indicate that several auxiliary costs are likely already included in the cost estimates and literature review presented here.

5. Important construction cost considerations for LSLR planning:
   - Numerous predetermined factors affect construction cost including the depth of the water main and service line, the soil type and subsurface conditions, the need to excavate and restore hard surfaces like driveways and sidewalks, the configuration and accessibility of internal plumbing including when homeowners have refinished basements and other modifications.
   - The largest factor influencing construction costs is the degree of restoration needed and/or required. While it is to be expected that some LSLRs will encounter extensive restoration on public or private property, it would be an overestimate to use those high costs as a basis for modelling nationwide costs of complying with the LCRI.

- The cost of the replacement pipe can be a large percentage of the construction cost, especially for copper pipe in cases where restoration costs are low. Lifecycle estimates suggest copper service lines will last twice as long as PE, effectively doubling the cost of PE service line replacement over longer time horizons. The longevity and public health protection benefits of copper pipe may make this investment worthwhile (Beyond Plastics, 2023).

Program Design Strategies to Reduce Costs

1. Program decisions and cost inputs should be carefully considered in the design of an LSLR program. There are generally more opportunities to reduce overall LSLR cost through non-construction costs compared to construction costs because they reflect project planning and policy decisions.

2. Planning and policy decisions that affect costs include:
    - Engineering services
    - Outreach
    - Cumulative impact of unit costs across large numbers of LSLRs
    - Local policy driven costs
        - Maintenance of traffic (including police)
        - Permitting
        - Plumbing codes and requirements
        - Procurement approaches and procedures
        - Paving
    - Federal policy driven costs
        - Service line material inventory
        - Post replacement provisions

3. LSLR bids can have widely varying line item costs, even when total project costs are approximately equal. Large variability can reflect ambiguity in the bid documents in the best case or of gamesmanship by bidders in the worst case. A large unit cost difference multiplied across hundreds of LSLRs can add up quickly and can result in excessive overall project costs. Clarity in bid documents, scrutiny of bids, and making bids and final contracts publicly available can help build cost transparency and support better decision making.

4. A lack of transparency in bid documents, project reports, and financial accounting can result in LSLR funds being diverted to co-located non-LSLR infrastructure projects that do not maximize LSLR with LSLR funding (e.g., paving, stormwater, sewer line replacement). There is a need for transparency and better data tracking of the different project cost components to ensure that only LSLR is being completed with funding intended for LSLR.

5. Completing LSLR in tandem with other CIP projects can reduce the cost per LSLR but may draw out the timeline necessary to replace all LSLs because planning decisions are not driven solely based on the presence of LSLs. It is important to balance the priorities of reducing cost per infrastructure project with the public health benefits of removing LSLs as quickly as possible.

6. Developing LSLR program plans in consultation with community members can identify efficient strategies to reach impacted community members.

7. Programs that require homeowners to pay for LSLR under private property slow progress and drive up the unit LSLR cost due to intense one-on-one outreach and one-off replacements being the primary type of LSLR. LSLR funding should be used to maximize the public health protection gained through LSLR.

8. Using water utility funding to pay for FLSLR at all properties, including the portion of LSL that runs under private property, allows more money to go directly to public health protection and reduces the overall cost of FLSLR.

9. Prioritizing simultaneous inventory verification and LSLR may reduce the duplicative cost of completing a standalone service line inventory while improving cost efficiencies and public health protection.

10. The full report includes a comprehensive description of the elements of program design in Figure 16 and Appendix A. It also provides a detailed discussion of the most impactful program design strategies for reducing costs, which are outlined here in Figure ES- 4.

11. The analysis presented here demonstrates that LSLR costs have *not* skyrocketed since USEPA's cost estimates published with the 2020 LCRR (USEPA, 2020). The LSLR cost increases documented between 2020 and now reflect inflation.

The cost analyses presented in this report provide a clear basis for understanding and estimating the current construction cost of LSLR, and it provides many strategies for controlling LSLR costs. Several water systems with planned LSLR programs, including Cincinnati, Milwaukee, and Denver, have found that adapting programs based on experience allows them to bring down the cost of LSLR over time even as some materials costs increased due to inflation (Moening, 2020; Dettmer and Beversdorf, 2019; A. Woodrow, personal communication, March 8, 2022). This documented cost reduction over time further demonstrates the important role of LSLR program planning and adaptation in controlling the cost of LSLR programs and ensuring that LSLR funding and spending results in the most LSLRs possible.

LSLR Planning Costs	Opportunities for Reducing Costs
LSLR Program Planning and Design	Fully fund LSLR; Adopt municipal ordinances to support FLSLR; Revisit local policies
Community Engagement and Consultation	Engage customers in LSLR program planning and implement proactive customer engagement and outreach strategies
Contract Planning	Consolidate contracts by geography or replacement type; increase bid transparency; Completion incentives and termination conditions
Legal Review	Adopt municipal ordinances to support FLSLR
LSLR Public Education and Outreach Design	Consult with community to identify effective outreach strategies; Share information widely

LSLR Program Plan

Program Scale (Auxiliary) Costs
Project and/or Contract management
Engineering Services
Construction Management (e.g., Inspections)
Misc. Repairs (e.g., Water Main)
Support Software (Work order management, GIS)
Program Wide Outreach and Education

Construction Tasks	Opportunities for Reducing Costs
Mobilization	Geographic consolidation of projects; group as many replacements and inventory inspections together as possible
Permitting	Batch permit processing, LSLR funded dedicated permit staff
Inventory excavation	Verify all service line materials within a neighborhood while mobilized for LSLR in that location
Customer Outreach	Community engagement to design LSLR Outreach; Hire trusted community members
Replacement Construction	Revisit traffic control policies
Household flushing	
Restoration	Consolidate LSLRs; Revisit local paving policies
Completion services	
Demobilization	

Figure ES- 4: LSLR Program Planning and Implementation Opportunities for Reducing Costs

Introduction

Where present, lead service lines (LSLs) are the largest source of lead in drinking water (Sandvig et al., 2008), and they provide a constant risk of exposure to lead even in water systems with corrosion control treatment (USEPA, 2023d). The U.S. Environmental Protection Agency's (USEPA) proposed requirement to remove all LSLs from water systems in the United States (USEPA, 2023d), known as the Lead and Copper Rule Improvements (LCRI), is an important and effective intervention for reducing and preventing exposure to lead in drinking water. Protective public health policy requires realistic cost estimates to ensure all LSLs are identified and removed quickly and efficiently. Inflated cost predictions slow health protective policy and provide an environment where contractors are enabled to overcharge for their services, further delaying public health protection for vulnerable populations who have had no option but to drink water from LSLs for decades.

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Historically, cost estimates for water distribution renewal needs have not included LSLR, making the cost of LSLR appear to be "extra" even though the service line is the final critical pipe that affects the quality of all water delivered to an individual home. Although replacing 10.5 million LSLs and GRRs will be a large task, LSLR represents a small percentage of overall water infrastructure replacement needs that the utility sector has estimated as being in the multiple trillions of dollars (AWWA, 2013). LSLR costs represent an even smaller percentage of utilities' total budgetary needs when operating expenses are also considered (Value of Water Campaign, 2020). Adding LSLR to our water infrastructure needs does not represent the last, singular cost that makes water unaffordable – it is merely one of many costs necessary to continue providing safe drinking water in community water systems. According to previous estimates (Betanzo, 2022) adding the cost of replacing all LSLs to water distribution needs estimates results in a mere 3% increase in the national cost estimate for water main renewal. In contrast to most water infrastructure funding needs, the need to remove the health hazard of LSLs represents a one time, all at once cost. While service lines will need to be maintained and replaced in the future on a maintenance schedule, the need to remove this urgent health risk is a one-time cost.

Purpose of this report

This report was prepared to assist with evaluation of LSLR costs, for the purposes of developing Safe Drinking Water Act regulations and implementing local LSLR programs.

First, the report analyzes the most recent per-line cost estimates developed separately by AWWA and USEPA, compares similarities and differences, and provides an additional literature review to further contextualize available data. Our purpose is to understand current and reasonable cost ranges for LSLR at the unit scale. Because specific conditions and requirements vary greatly across communities, this estimate may not match precise costs for any specific community, but it gives a sense of magnitude for planning purposes. It also identifies underlying assumptions that can result in low or inflated cost projections that may not reflect real life situations.

Second, this report presents an independent construction cost estimate using RS Means data, an industry standard construction cost estimating database, to be compared to AWWA and USEPA estimates. By doing so, we identify relatively consistent LSLR cost inputs and those inputs that fluctuate widely in differing conditions. We provide the relative magnitude of line-item costs to identify major LSLR cost drivers. In doing so, it will be possible for public water systems looking to comply with the LCRI to explore opportunities to reduce those costs to drive down the overall cost of LSLR.

The range of realistic costs presented here can be used to inform public comment on the proposed LCRI and by USEPA to evaluate various cost estimates in developing a final LCRI. It also allows municipalities and water system decision makers to compare their own cost estimates to these ranges and identify where bids are reasonable and where they are not.

This cost analysis serves not only to inform policy makers, municipalities, and water systems, but also to allow community members to hold local decision makers accountable for LSLR projects so that funding is spent wisely and efficiently to complete the most LSLRs as quickly as possible. The information presented here is necessary to support efficient planning and procurement, and to ensure that public health protection is prioritized throughout the LSLR process.

Analysis

This report analyzes four approaches to calculating the cost of lead service line replacement (LSLR):

1. CDM Smith (2022) Approach
2. USEPA Lead and Copper Rule Improvements Economic Analysis Approach (2023)
3. Literature review
4. Independent construction cost estimate developed using RS Means data

LSLR costs are further explored through targeted sensitivity analyses for major cost drivers.

Each cost estimating approach is discussed below, along with a discussion comparing approaches.

CDM Smith Report

In November 2022, CDM Smith published a report, *Considerations when Costing Lead Service Line Identification and Replacement* (CDM Smith, 2022), that analyzed data collected by phone interview with 9 water utilities and a literature review. The compiled dataset consisted of 45 projects: 31 from the phone survey and 14 from the literature review. This analysis of the CDM Smith dataset focuses on the full lead service line replacement (FLSLR) projects summarized in that report. CDM Smith reported 25 FLSLR projects but excluded 6 from their analysis because they did not clearly specify whether the scope of replacements included full, private, or public side replacements.

There is a lack of documentation and inconsistencies in the approach of the CDM Smith Report that result in unquantified bias in the analytical results:

- The report does not describe the criteria that were used to select the 9 utilities for a telephone interview. Without further information, it is difficult to contextualize the cost data, understand how the 9 were chosen, or determine how they relate to other LSLR programs across the country.
- The expanded literature review added 14 LSLR projects. The projects included were selective – for example, costs for Denver were reported in Hawthorne (2021) and included in Table 4-2, but costs for Detroit ("Detroit replaced 1,100 pipes costing an average of $5,000 per line in 2018") and Chicago ("Chicago officials estimate it will cost $27,000 to replace each of the 650 lead service lines") were reported in Hawthorne (2021) but not included in Table 4-2. Cost inclusions and exclusions appear to be arbitrary or not explained in the report.
- Thirty-one projects were included from a survey of 9 utilities, resulting in oversampling from the utilities that were selected on the basis of undisclosed criteria.
- The report does not use a weighted average approach because limited quantity data were reported or collected. As a result, the $13,213 LSLR cost for an unknown quantity of LSLRs has equal weight to $8,014 that was averaged over 206 replacements.
- The report identified 25 FLSLR projects but excluded 6 of these from the cost analysis because the original sources did not clearly specify whether the scope of replacements included full, private, or public side replacements. However, the documentation for the scope of the 6 excluded FLSLR projects did not differ significantly from the documentation available for the included projects.

Given the vague, high level cost data reported in media articles from the literature review and lack of quantity data from the survey, it seems the determination of when cost data is relevant or not is arbitrary. The CDM Smith report provides a construction cost estimate derived from the collected data and calculates additional auxiliary costs for expenses assumed not included in the published cost. However, the literature cited provides no clear reporting that auxiliary programmatic and engineering costs are NOT included in the published costs. Given the lack of documentation in the cited literature, it is difficult to conclude that the published costs are limited to construction only.

For example, Sweeney (2020) is included in CDM Smith (2022) Table 4-2 but not in the average construction cost calculation with the justification that equipment, restoration, traffic control, permitting, and environmental protection were excluded from the scope of the reported cost. Yet, the source article is not any less specific in its published documentation than other data points that are included in the overall average, such as Jeznach and Goodwill (2021) and Hawthorne (2021). The media reports of LSLR costs are vague across the spectrum of projects presented in the literature review, which is typical of media reporting about engineering projects. However, the exclusion of specific projects in the CDM Smith Report because they might include ancillary costs is not consistent. It is just as likely that the projects that were included account for ancillary costs that were not mentioned in the media.

As shown in Table 1, CDM Smith reported an average FLSLR construction cost of $9,900 (in 2022$). However, if all 25 FLSLR projects are included in the calculation, the average construction cost becomes $8,700.

The CDM Smith report calculates auxiliary costs as a percentage of the LSLR construction cost equal to 26.5% overall. These auxiliary costs include restoration, engineering services to support bidding, funding applications, construction management and project management, internal labor administration, customer outreach, permitting, and post-replacement provisions such as sampling and water filter provision. As mentioned above, the data sources are not clear or consistent on whether these auxiliary costs are included in the construction cost numbers reported.

Most of these auxiliary costs do not vary based on the magnitude of construction costs and therefore, using a percentage of construction cost overestimates the impact of auxiliary costs by $500 in the average cost scenario and up to $5,600 in the max cost scenarios presented. Engineering services are relatively fixed for project initiation and per individual replacement. If the construction cost is driven up due to extensive pavement requirements (e.g., a municipality that requires complete street repaving for a small percentage of LSLRs on the street), there may be a slight increase in project management costs, but not in proportion to the complete cost of paving. Likewise, internal labor administration, permitting, and post-replacement provisions are relatively fixed costs per LSLR. The costs of water quality sampling and household flushing do not increase due to a deeply buried service line and they do not decrease for a simple, short replacement. Outreach costs can vary significantly from household to household, but this variability is typically due to the ownership status or employment schedule of the resident and has nothing to do with construction cost.

Based on our familiarity with some of the projects reported, it is clear that some but not all auxiliary costs are included in reported literature. Media reports do not provide a sufficient level of detail, and project design strategies in different utilities use different terminology making it difficult to definitively separate construction costs from all other project costs and compare consistently across water utilities and projects. For example, Hawthorne (2021) states "Denver replaced 5,200 lead service lines at an average cost of $10,000 per line last year..." Previous analysis of the Denver program indicated that the Denver program costs reported around the same time includes the auxiliary costs of street paving, outreach, and permit fees (Betanzo, 2022). As a result, some auxiliary costs are double counted to some degree in the CDM Smith cost estimate. Engineering services and outreach appear to some degree in both the survey and construction cost literature and again in the auxiliary assumptions applied on top. The lack of detail in media reporting is true of all literature reviews presented in this report and is not unique to the CDM Smith estimate.

Table 1 below presents a reproduction of CDM Smith's summary table showing their estimated minimum, average, and maximum per-LSLR costs.

Table 1: CDM Smith Full Replacement Summary Costs (2022$) (Source: Table 4-10, CDM Smith, 2022)

LSLR Component	**Min Cost ($/LSLR)**	**Average Cost ($/LSLR)**	**Max Cost ($/LSLR)**
Full Replacement (Utility and Private Side)	$ 6,000	$ 9,900	$ 30,000
Restoration (not included in calculation)	$ 1,769	$ 8,847	$ 2,919
Engineering Services	$ 660	$ 1,090	$ 3,300
Internal Labor Administration	$ 175	$ 289	$ 876
Customer Outreach	$ 108	$ 178	$ 539
Permitting	$ 576	$ 950	$ 2,879
Post-Replacement Provisions)	$ 78	$ 118	$ 158
Totals	$ 7,600	$ 12,500	$ 37,800

Table 1 was recalculated and presented in Table 2 using the following revisions to CDM's approach:

1. The actual low, average, and max cost of all 25 FLSLR projects listed in CDM Smith (2022) Table 4-2 (using the average cost for projects that were reported as a range) are used, for consistent treatment of all reported projects,
2. CDM Smith's average estimate of reported engineering services as a fixed cost of $1,090 is applied to all three cost levels, rather than calculating engineering costs as a uniform percentage of construction costs (note: much of this cost is likely already included in the reported construction cost but documentation is inconsistent),
3. The middle estimate ($289) of internal labor administration is applied to both the middle and high cost levels, rather than calculating engineering costs as a uniform percentage of construction costs,
4. The weighted average of Customer Outreach ($78) and Permitting ($543) calculated from costs as reported in CDM Smith (2022) Tables 4-6 and 4-7 are applied to all three cost levels, rather than calculating outreach and permitting costs as a uniform percentage of construction cost, and
5. The post-replacement provisions cost ($118) from CDM Smith (2022) Table 4-8 is applied to all three cost levels, rather than 1.2% of construction cost as described in CDM Smith (2022).

On this basis, the average LSLR cost would be $10,800, with a range from $4,400 to $24,600. These average calculated costs are 14-42% less than CDM Smith's reported estimate indicating that CDM Smith's flawed interpretation of the data resulted in significantly inflated cost estimates relative to what the data they selected and included in their report actually suggest.

Table 2: Recalculated CDM Smith Full Replacement Summary Costs (2022$) (Source: Table 4-10, CDM Smith, 2022)

LSLR Component	Min Cost ($/LSLR)	Average Cost ($/LSLR)	Max Cost ($/LSLR)
Full Replacement (Utility and Private Side)	$ 2,400	$ 8,700	$ 22,500
Engineering Services	$ 1,090	$ 1,090	$ 1,090
Internal Labor Administration	$ 175	$ 289	$ 289
Customer Outreach	$ 78	$ 78	$ 78
Permitting	$ 543	$ 543	$ 543
Post-Replacement Provisions	$ 118	$ 118	$ 118
Totals	$ 4,400	$ 10,800	$ 24,600

EPA Lead and Copper Rule Improvements Economic Analysis (2023)

EPA estimated LSLR cost for the LCRI based on information submitted for the 7th Drinking Water Infrastructure Needs Survey (DWINSA) (USEPA, 2023a). To be included in the LCRI Economic Analysis (USEPA 2023b; USEPA 2023c), USEPA required adequate documentation with information on the number of service lines and replacement costs. For consistency with USEPA's documentation, the Economic Analysis data presented here is referred to as the DWINSA dataset.

From the DWINSA reported data, six projects were excluded because the cost was less than $700 without explanation, or they included activities other than LSLR that could not be separated. USEPA excluded projects that explicitly included auxiliary activities since the cost of these activities were quantified separately in the Economic Analysis. After these adjustments were made, USEPA included 33 (23 full replacements plus 10 customer/utility side partial replacements) of 275 projects for which information was submitted. These projects cover 13 states, 6 USEPA regions, and include states in the Northeast, Midwest, and the West. Populations ranged from 3,000 to 2,000,000 and they covered the period of 2012-2022.

USEPA converted the costs to 2020 dollars and adjusted for regional differences. USEPA weighted the resulting summary statistics by the number of service lines and the DWINSA sampling weight. For FLSLR, the number of replacements per project ranged from 12 to 58,668 and the cost per replacement ranged from $1,248 to $15,837.

Compared to the CDM Smith analysis, a more consistent description for the scope of activities included (or excluded) from the total cost is available for each project. This dataset is more geographically representative and less biased compared to projects included in the CDM Smith Report. These are direct reports from water utilities that responded to USEPA's mandated survey, rather than selected reports from utilities that have a high public profile or the means to publish journal articles about their work. Table 3 presents a reproduction of Exhibit A-3 in the *Economic Analysis Appendices for the Proposed Lead and Copper Rule Improvements.* It should be noted that Table 3 shows CDM Smith (2022) values converted from their original 2022$ to 2020$ for comparison purposes.

Table 3: USEPA Economic Analysis Comparison of LSLR Costs (2020$) (Source: Exhibit A-3, USEPA, 2023c)

Statistic	**Full Replacement**		**Customer-Side Replacement**		**Utility-Side Replacement**	
	DWINSA	CDM Smith	DWINSA	CDM Smith	DWINSA	CDM Smith
Number of	23	18	10	8	10	12
Min	$1,180	$5,634	$1,677	$2,512	$1,677	$3,658
25th percen	$6,507	$6,837	$1,920	$3,572	$1,920	$4,613
Median	$7,232	$8,045	$3,273	$4,155	$3,273	$5,295
Mean	$6,930	$8,717	$3,803	$4,399	$3,803	$6,300
75th percen	$8,519	$9,246	$5,400	$4,905	$5,400	$6,997
Max	$14,966	$19,835	$8,099	$6,612	$8,099	$15,427

As USEPA (2023c) observes and we concur,

> *"Notably, the median full replacement cost and customer-side replacement cost from this [CDM Smith] report are almost $1,000 higher than that of EPA's estimates based on the DWINSA data. The utility-side replacement is also approximately $2,000 higher than that of EPA's estimates based on the DWINSA data.*
>
> *There are several possible reasons why the CDM Smith report's findings for the median LSLR unit cost are higher than the findings calculated from the 7th DWINSA data. First, the data from the CDM Smith report were derived from fewer systems and regions, i.e., from only nine systems in five states and three regions, as well as project data from five American studies and one Canadian study via literature review. The 7th DWINSA data were derived from 31 systems in 13 states and six regions, which include the states and regions observed in the CDM Smith phone survey. Therefore, it is possible that the DWINSA data may have collected a wider geographic range of responses and potential project costs.*
>
> *Additionally, the survey data collected from the CDM Smith study were only from systems that served populations over 10,000 and, therefore, may not be factoring in LSLR unit costs for smaller systems. The utilities surveyed by CDM Smith may represent more dense, urban areas that have higher costs for traffic coordination and pavement removal or replacement compared to more rural areas. The 7th DWINSA captured systems serving populations ranging from 3,000 to 2,000,000. The DWINSA also applies a system sampling weight and is weighted by the number of service lines replaced per project to ensure that these small- and medium-system costs are properly represented in a national value. In addition, it does not appear that the CDM Smith report regionally indexed estimates to reflect a national cost. The 7th DWINSA estimates calculated under this analysis, conversely, are adjusted to reflect both inflation and regional construction cost differences among states. "*

It is important to note that any summary level published LSLR cost value from a water utility is not going to provide enough detail to analyze with precision the number of known lead and unknown services included, or to know which itemized costs are included or not in the published project cost. Although notes are more consistently provided, USEPA's projects are almost as ambiguous as the documentation for projects included in the CDM Smith report regarding what costs are included. The following two graphs (Figure 1**Error! Reference source not found.** and Figure 2) present histograms for the DWINSA and CDM Smith data, showing the frequency distribution of reported FLSLR costs. DWINSA and CDM Smith project data were converted to 2020 dollars (ENR, 2024) for consistency with USEPA's presentation. All 25 CDM Smith projects that included FLSLRs were included in the histograms (see discussion above for more information). The first histogram shows the distribution of the average FLSLR cost per utility project and the second shows the cost distribution by total number of LSLs replaced, using only those projects that reported the number of services replaced (n=12 for FLSLR projects included in the CDM Smith dataset).

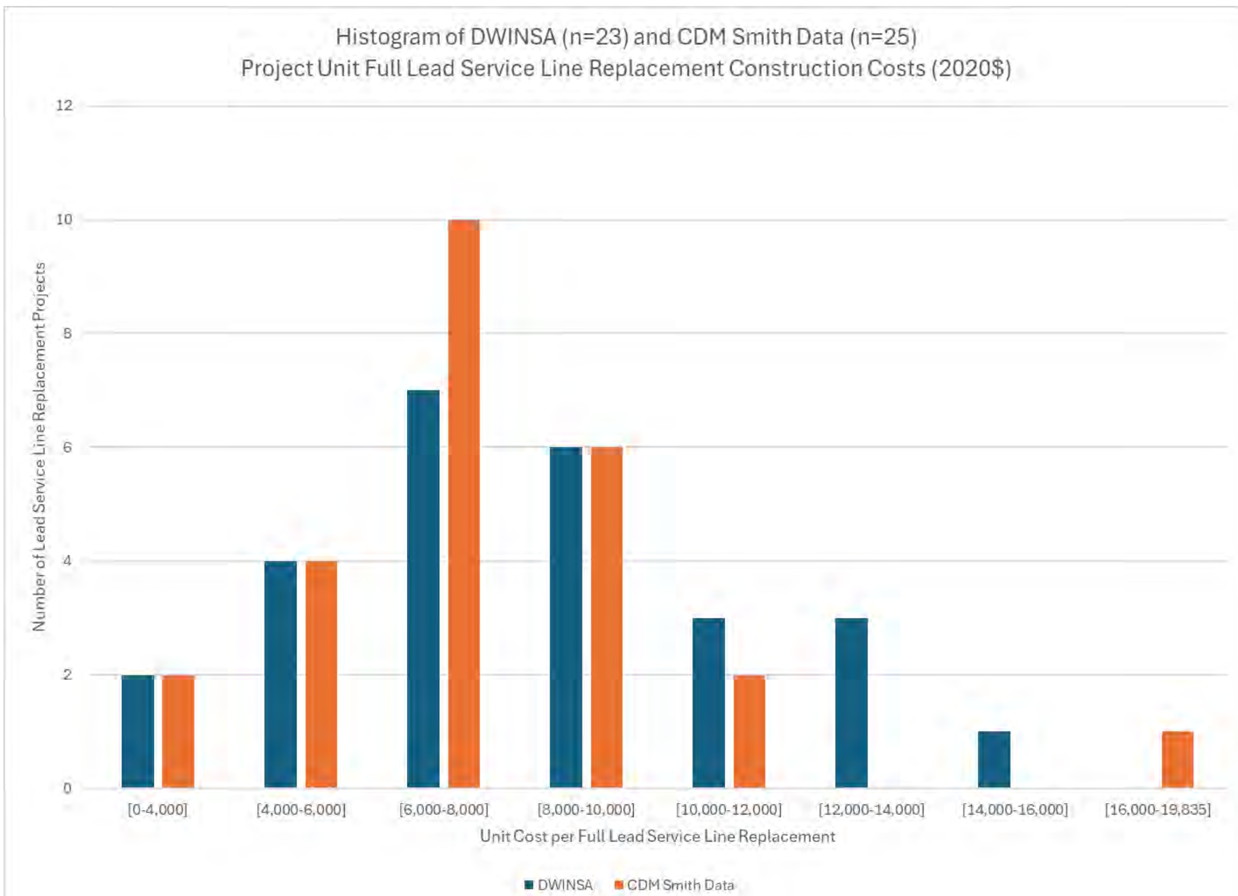

Figure 1: Histogram of DWINSA and CDM Smith Data Project Unit Full Lead Service Line Replacement Construction Costs (2020$) (Source: USEPA, 2023b; CDM Smith, 2022)

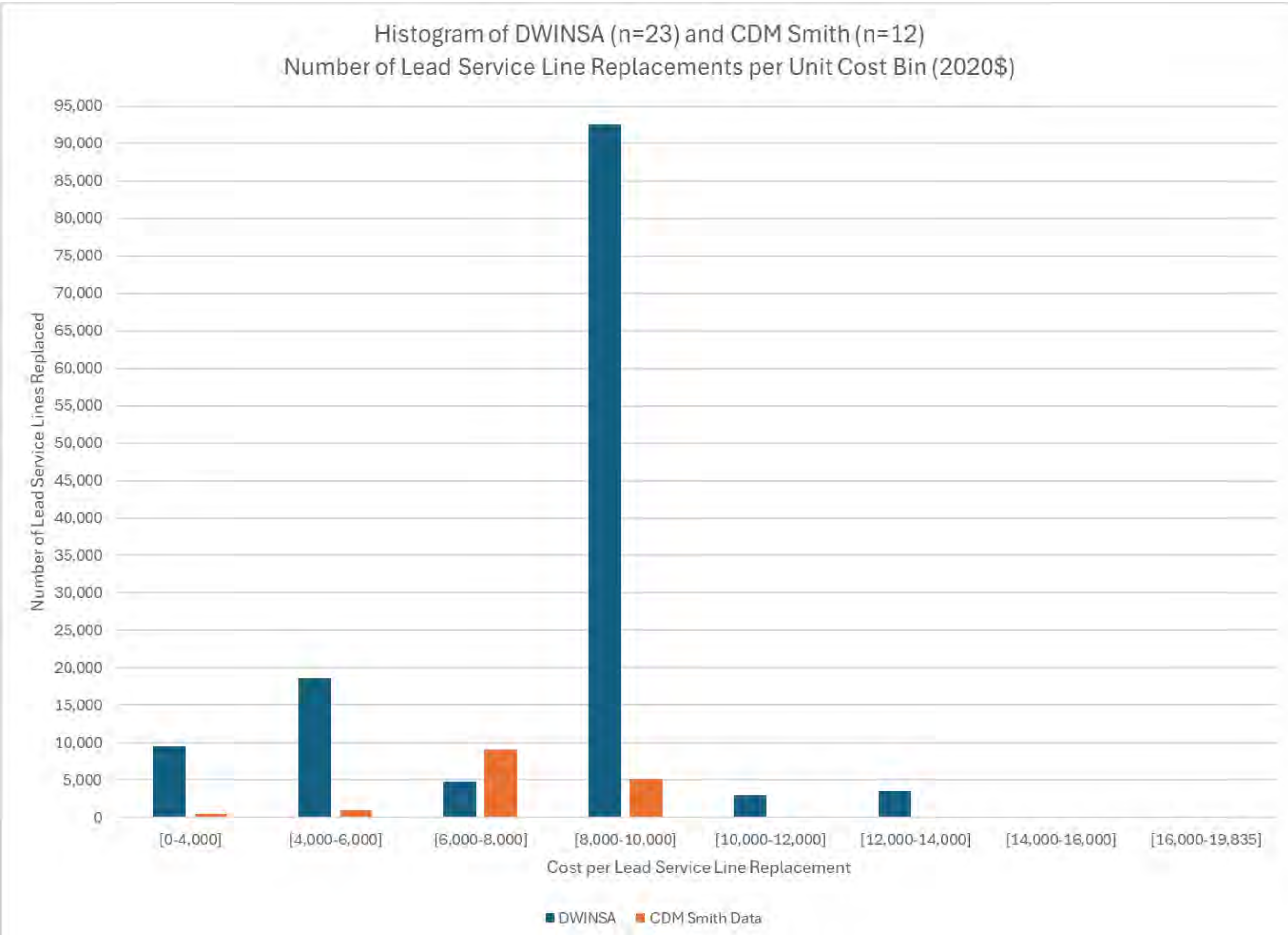

Figure 2:Histogram of DWINSA and CDM Smith Number of Lead Service Line Replacements per Unit Cost Bin (2020$) (Source: USEPA, 2023b; CDM Smith, 2022)

These graphs demonstrate that the majority of projects have an average FLSLR cost less than $10,000. While significantly higher costs do exist, they are outliers compared to the majority of data.

An analysis of FLSLR unit cost versus the number of LSLs replaced is shown in Figure 3, combining both datasets. The DWINSA dataset identifies the specific utilities that provided project data, but the CDM Smith dataset does not provide this information. Denver, CO appears to be included in both datasets, but at different costs and quantities. There may be other duplicates displayed in this graph. The figure indicates:

1. The majority of reported projects include fewer than 4,000 LSLRs,
2. The highest reported FLSLR costs are associated with a very small number of LSLRs relative to other projects,
3. Average FLSLR cost can be less than $10,000 for projects addressing a small or very large number of LSLRs, and
4. Larger quantities of LSLRs do not drive up the average LSLR cost.

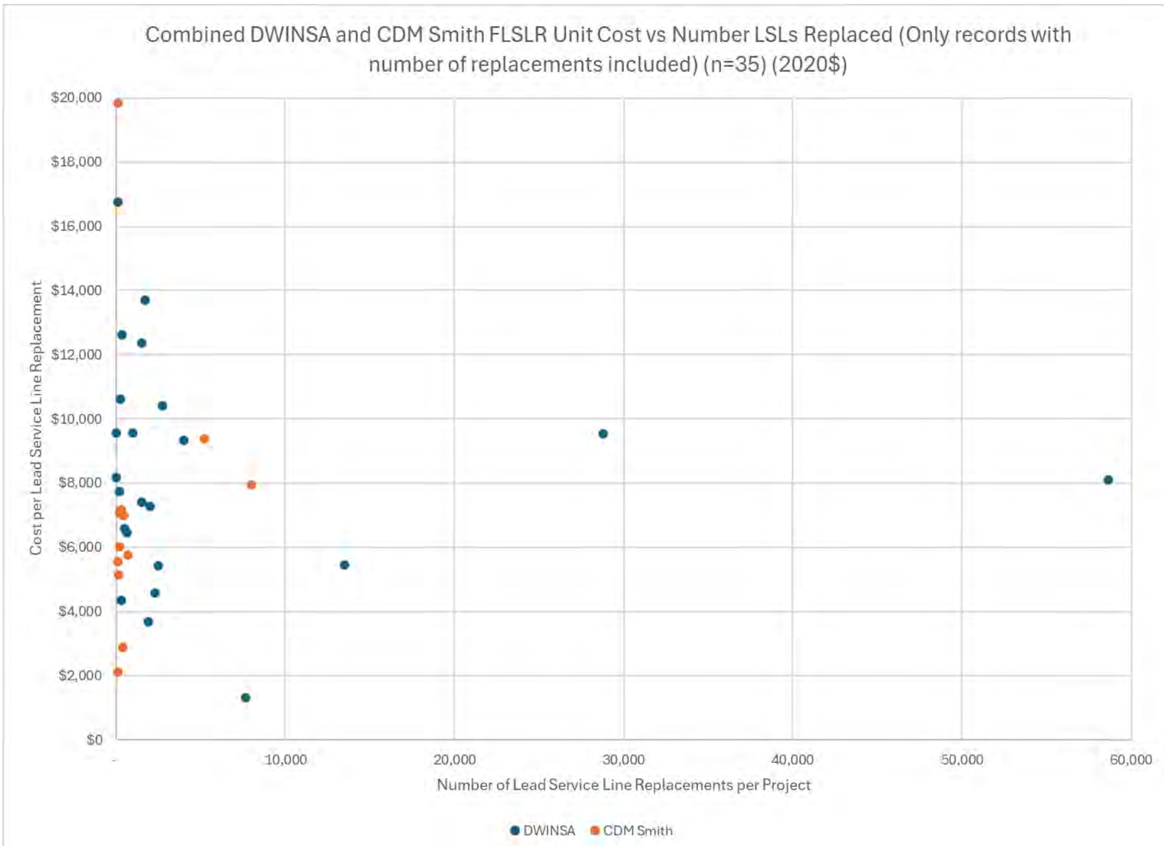

Figure 3:Combined DWINSA and CDM Smith FLSLR Unit Cost vs Number LSLs Replaced (2020$) (Source: USEPA, 2023b; CDM Smith, 2022)

Literature Review

An independent literature review was conducted for this study to further explore the range of published costs for LSLR projects. The literature from CDM Smith (2022) was collected, along with a literature review focused on AWWA publications, USEPA analyses, court testimony, and media reports regarding cities with publicized LSLR programs. A literature review for cost data is inherently biased. The literature is going to be biased toward high profile projects that were captured in the national media or had sufficient budget to write articles about the project. A literature review is still valuable in that it begins to illustrate the range of real and potential outlier LSLR program costs if it covers a sufficiently broad spectrum of programs. It is less likely to represent program costs for disadvantaged water systems that do not have the budget to publish or share public relations information about their infrastructure programs. This literature review includes multiple entries for the same cities, because different projects are reported in multiple years. For example, there are three LSLR costs from Washington, DC from 2022 that reflect three different ongoing projects. Survey data and summarized statewide data are also included in this literature review. This literature review is summarized in Table 4 and produced data points for 56 LSLR projects.

Table 4: Literature Review Results

Type	Total LSLRs	Unit LSL Costs ($ per LSL) Reported	Year of Cost Data	Unit LSL Costs (2020$ per LSL) Calculated	Data Source
Full	n/a	850	2008	1,173	Sandvig *et al*., 2008
Full	n/a	1,600	2020	1,600	Smalley and Peckinpaugh, 2020
Full		2,000	2019	2,033	NYDOH, 2019
Full	115	2,000	2016	2,218	Sweeney, 2020
Full	1,600	2,700	2017	2,883	Welter, 2018
Full	460,000	3,765	2022	3,319	Read *et al*., 2022
Full	1,782	3,367	2020	3,367	AWWA, 2020
Full	13,000	3,150	2016	3,494	AWWA, 2016
Full	12,000	3,667	2018	3,800	Beitsch, 2018
Full	37,000	4,054	2020	4,054	Catalini, 2020
Full		4,000	2019	4,065	NYDOH, 2019
Full	4,000	4,750	2022	4,187	Astolfi, 2022
Full		4,978	2022	4,388	CDM Smith, 2022
Full		5,140	2022	4,531	CDM Smith, 2022
Full	1,100	5,000	2021	4,725	Hawthorne, 2021
Full		4,700	2019	4,777	USEPA, 2020
Full	6,256	4,800	2018	4,975	Welter, 2018
Full		5,753	2022	5,071	Betanzo, 2022
Full		3,150	2004	5,076	Welter, 2018
Full	3,600	4,920	2018	5,100	Welter, 2018
Full	156	5,100	2018	5,286	MWRA, 2023
Full		5,800	2020	5,800	Bukhari *et al*., 2020
Full		6,584	2022	5,804	Betanzo, 2022
Full		6,000	2020	6,000	Smalley and Peckinpaugh, 2020
Full	176	5,835	2018	6,048	MWRA, 2023
Full	18,500	6,486	2021	6,130	Campbell and Wessel, 2021
Full		7,172	2023	6,156	USEPA, 2023a
Full		6,145	2018	6,369	Welter, 2018
Full	300	6,960	2018	7,214	MWRA, 2023
Full		7,936	2018	8,226	Welter, 2018
Full		9,900	2022	8,727	CDM Smith, 2022
Full		6,226	2007	8,961	Welter, 2018
Full		9,000	2019	9,147	NYDOH, 2019
Full	5,600	5,047	2000	9,302	Welter, 2018
Full	5,200	10,000	2021	9,450	Hawthorne, 2021
Full		7,000	2008	9,658	Sandvig *et al*., 2008

Type	Total LSLRs	Unit LSL Costs ($ per LSL) Reported	Year of Cost Data	Unit LSL Costs (2020$ per LSL) Calculated	Data Source
Full	2,310	11,835	2023	10,158	New Jersey American Water, 2023
Full		11,000	2019	11,180	NYDOH, 2019
Full		12,541	2018	12,999	Welter, 2018
Full		12,675	2018	13,138	Welter, 2018
Full	610	12,675	2018	13,138	Gonda, 2018
Full		14,949	2022	13,178	Betanzo and Attal, 2022
Full		9,300	2004	14,987	Welter, 2018
Full		16,100	2021	15,214	Shields, 2022
Full	11,000	15,545	2019	15,800	Twiddy, 2019
Full		15,527	2018	16,094	Welter, 2018
Full		18,774	2022	16,549	Betanzo and Attal 2022
Full		24,535	2022	21,628	Betanzo and Attal 2022
Full	650	27,000	2021	25,515	Hawthorne, 2021
Full	42,000	35,714	2023	30,655	Bonk, 2023
Full or partial	433	6,930	2017	7,400	MWRA, 2023
Full or partial	206	6,860	2017	7,326	MWRA, 2023
Full or partial	3,100	4,871	2023	4,181	13 On Your Side, 2023
Full or partial	470	8,298	2023	7,122	May, 2023
Full or partial	3,900	8,111	2022	7,150	Fleming, 2022
Full or partial		5,100	2018	5,286	MWRA, 2023

This independent literature review reiterates that the outlier project costs in CDM Smith (2022) are in fact outliers. As shown below in Figure 8, although the maximum LSLR cost for the independent literature review is larger than the DWINSA or CDM Smith data (drawn from Table 3), the median and mean FLSLR costs are not. This is consistent with the observed trend of real but limited very high FLSLR costs. The majority of FLSLR costs are substantially lower and reliably below $10,000.

For consistency with numbers published by USEPA, Figure 4 includes only the 18 CDM Smith Projects that USEPA included in its comparison published in the LCRI Economic Analysis Appendix A (USEPA, 2023c).

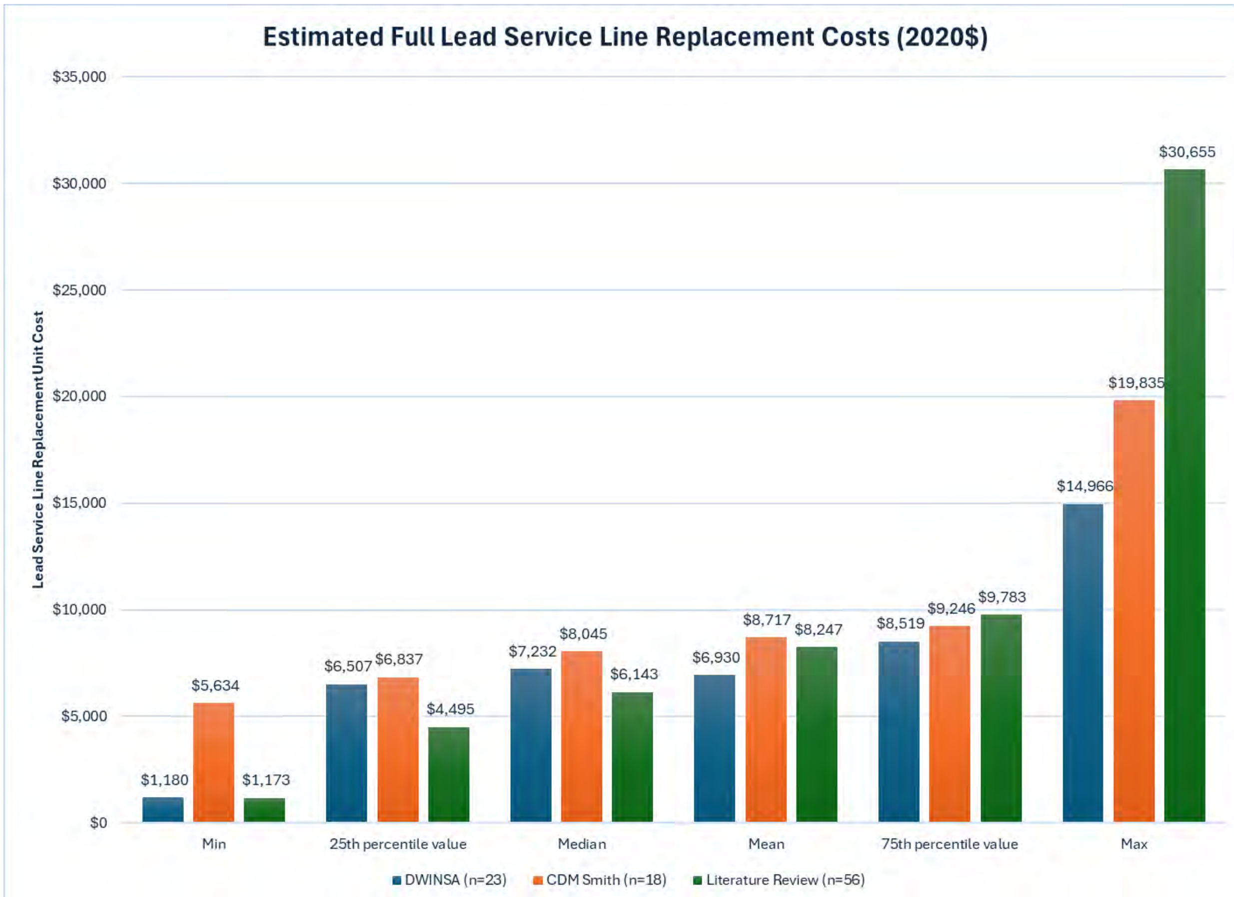

Figure 4: Estimated Full Lead Service Line Replacement Costs (2020$) (Source: USEPA, 2023a; CDM Smith, 2022, literature as listed in Table 4)

Independent Cost Estimate

A set of scenarios was developed to estimate typical costs for different configurations of LSLs that might be encountered by utilities. Construction costs for each component of the LSLR were taken from the industry standard RS Means Online Construction Cost Database, Year 2024 edition (www.rsmeans.com), with the exception of directional drilling costs as discussed below. RS Means data is compiled from across the US for more than 92,000 material, labor, and equipment cost items, and includes overhead and profit at prevailing rates. US national average costs with standard union rates were used for this analysis. Note that RS Means data projects forward to year 2024$ while historical costs can only be corrected to the nearest ENR historical cost index, which is December 2023. A full breakdown of all costs is provided in Appendix C.

The scenarios were developed as examples of typical construction costs, excluding ancillary items such as inventories, permits, traffic control, and program management. The scenarios differed in LSL configuration by considering short- versus long-side replacement (short meaning not crossing a street, long meaning crossing a street), different construction methods (open trench excavation, directional drilling/trenchless), different pipe materials (polyethylene or PE, copper) and different quantities of restoration of pavement and sidewalks. In reality, the conditions encountered in the subsurface (soil, rock, etc.) and degree of restoration will be highly site specific so these examples are intended to provide benchmark reference values to help utilities understand the components of the work and relative costs.

There are a number of trenchless pipe replacement technologies now in use. RS Means data does not include specific cost components for small diameter (generally less than 6 inches) directional drilling or similar trenchless construction options such as pneumatic mole or pulling. Therefore, a typical cost for this component of work was estimated from the literature and a web search for household-sized service line or communication (cable, phone) line installation. Allouche et al. (2005) reports a cost from $5 to $7 per foot which equates to $8.95 to $12.53 as of the end of 2023 (ENR Construction Cost Index, 2024; note the 2024 ENR cost indices were not available at the time of writing). The Federal Highway Administration lists urban installation of communications cable as ranging from $8 to $19 per foot (FHWA, n.d.). HomeGuide, a web-based home contractor recommendation service, lists water line directional drilling as $10 to $20 per foot (Carlson, 2023). Based upon these values, a reasonable estimate of $20 per foot was used in all scenarios for directional drilling. Other trenchless construction options are considered to be of similar cost, possibly less expensive (Bloetscher, 2019), so the directional drilling scenario is also meant to represent a reasonable estimate for all types of trenchless LSLR.

Field engineering staff are included in all estimates, with one full time junior engineer as field engineer plus one 50% time project manager. Labor costs for construction cost line item are included based on the typical crew skills required as part of the RS Means database. Additional staff time for detailed design, recordkeeping, and program management is considered an ancillary item, not a core construction cost. Several references (e.g. Sweeney, 2020; City of Newark, 2019) report an average LSLR time as 4 hours so this was used as a replacement rate (2 replacements per day, or 10 per week, per crew) for all scenarios except the high-cost scenario, where 1 replacement per day (5 per week, per crew) was used to account for the extensive pavement restoration taking additional time. Two replacements per day may also be a conservative estimate; more replacements per crew per day have been discussed (City of Newark, 2019). This is an opportunity where improving efficiency over time can increase the number replaced per crew per day, further driving down unit cost from the estimate provided here. A water utility can hire as many crews per day; cost per line is minimized by maximizing the number of LSLRs per crew.

A number of other site-specific factors can affect the cost of a specific LSLR such as house layout (e.g. water connection at rear of house), plumbing configurations, homeowner features including driveways and landscaping, repeat visits required to obtain access, and complications with other buried utilities. These complexities would be illustrated by the high cost scenario which examines the cost of only 1 LSLR per crew per day. Contingency funding should be allowed to cover these situations, which will typically occur at a fraction of LSLR locations.

As described here, where an option was available, the higher cost option was used for the analysis. Cumulatively this means that the independent cost estimate presented here may represent higher costs than those experienced in the field.

The following sections summarize the assumptions for each set of scenarios, with the summary provided in Table 5 and Table 6 along with the resulting cost estimates.

Low-Cost Scenarios

These scenarios were selected to represent the simplest configurations with the least excavation and restoration to develop a minimum benchmark cost estimate and understand the cost implications of pipe material and construction method choices. In these scenarios, the water main is assumed to be located in a grassy utility strip between the street and sidewalk based upon a typical suburban street layout (VDOT, 2009). Low cost scenarios represent both short-side LSLR with a length of 40 feet (Figure 5) and long side LSLR with a length of 71 feet (Figure 6), which includes 3 additional feet of utility strip and 28 feet of roadway width (VDOT, 2009). Figure 5 and Figure 6 indicate the service line alignment on a standard cross section drawing. In an urban layout which lacks the grassy utility strip, the water main can be located in the roadway, under the sidewalk, or in a grassy easement. The first two urban situations would not qualify as low cost scenarios given the need to do more pavement and sidewalk restoration.

For directional drilling (DD) installation, only pits are excavated. A shallow LSL depth of 3 feet was assumed. This estimate assumes that the curb stop is replaced but corporation stop and water meter are reused. All sod is assumed to be replaced but fill material is reused. There is no pavement demolition or restoration in the short-side replacement scenarios, even in the open trench (Open) installation. The long-side replacement scenarios include trench restoration only. An urban layout (lacking a utility strip) with the water main located in the roadway would result in a higher cost for the pavement excavation and therefore was not considered as a low cost scenario for directional drilling, although the open trench long side scenario does include the pavement excavation and restoration costs.

The two materials evaluated that water utilities tend to use for water service line construction are polyethylene (PE) and copper (Cu), although some regional differences may exist due to plumbing codes and local regulations (Bloetscher, 2019). These two materials were estimated in the low cost scenarios to understand the difference in cost. The medium and high cost scenarios include only copper.

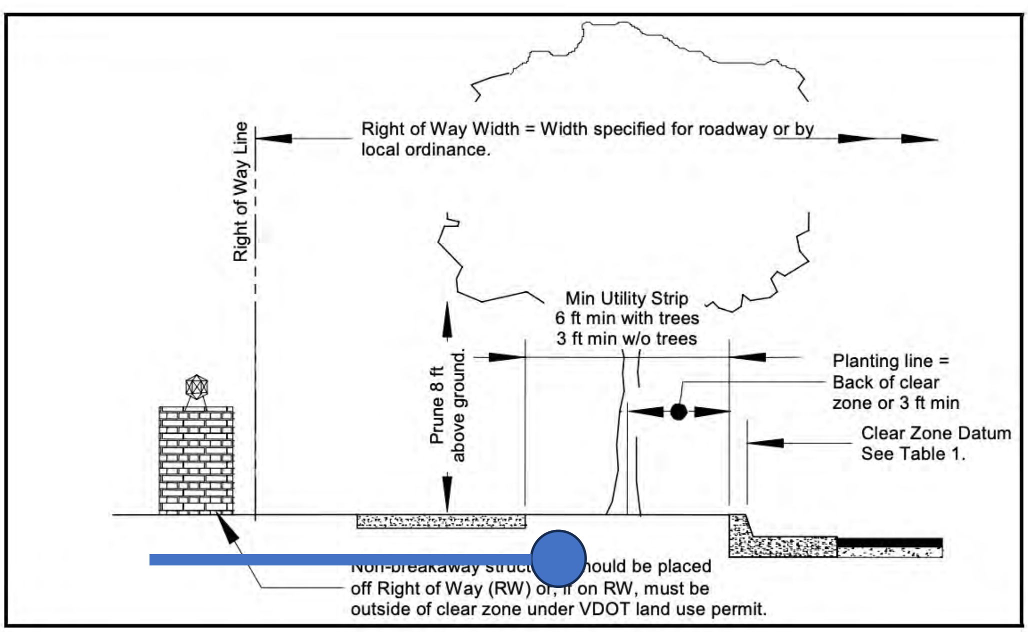

Figure 5: Low cost, short side scenario diagram (adapted from VDOT, 2009)

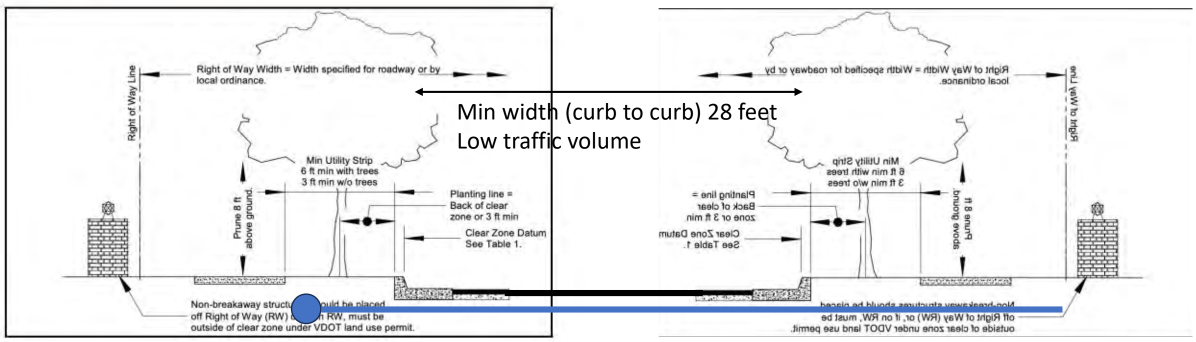

Figure 6: Low cost, long side scenario diagram (adapted from VDOT, 2009)

Medium and High Cost Scenarios

A medium cost scenario was developed to represent a long-side replacement with a 6-foot burial depth and open trench installation with a 6-foot trench to accommodate the excavation. This estimate assumes that a new curb stop and corp stop are required but that the water meter is reused. All sod is assumed to be replaced but fill material is reused. Sidewalk and roadway restoration of the trench are included. Only copper pipe was considered for these scenarios.

The high-cost scenario considers the same long-side replacement configuration as the medium scenario. Given that the majority of cost difference between all scenarios will be the costs for restoration of sidewalk and roadway (excluding homeowner features that would be case specific), only the open trench excavation option was considered for the high-cost scenario. Extensive road and sidewalk restoration was included for this option, with requirements to repave an entire city block (typical length 660 feet) and replace the curb and gutter on both sides of the block, with new fill material. Sidewalks are repaired at trenches only. The rate of installation was reduced to 1 LSLR per day to allow for the additional restoration work, so the resulting restoration cost was allocated across 5 LSLRs per week in this scenario.

Scenario Results for Full LSLR

Table 5 summarizes the input values for different elements of the low-cost scenarios and the resulting cost (rounded to nearest dollar) for each scenario. Table 6 summarises the medium and high-cost scenarios. Full details of each scenario's cost breakdown are provided in Appendix B.

Table 5: Summary of inputs and results for low-cost scenarios

		Value in Scenario							
Item	Unit	Low Short DD PE	Low Short DD Cu	Low Short Open PE	Low Short Open Cu	Low Long DD PE	Low Long DD Cu	Low Long Open PE	Low Long Open Cu
Length of Service Line	LF	40	40	40	40	71	71	71	71
Width of trench	LF	0	0	3	3	0	0	3	3
Depth	LF	3	3	3	3	3	3	3	3
Fittings	EA	2	2	2	2	2	2	2	2
Excavation	CY	1	1	13.33	13.33	1	1	23.67	23.67
Backfill	CY	1	1	13.33	13.33	1	1	23.67	23.67
New fill material required	CY	0	0	0	0	0	0	0	0
Hauling	CY	0	0	0	0	0	0	2.05	2.05
New curb stop	EA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
New corp stop	EA	No	No	No	No	No	No	No	No
New water meter	EA	No	No	No	No	No	No	No	No
Sod replacement	SF	18	18	120	120	18	18	129	129
Sidewalk restoration	SF	0	0	15	15	0	0	15	15
Curb and gutter restoration	LF	0	0	0	0	0	0	3	3
Pavement demolition	SY	0	0	0	0	0	0	9.33	9.33
Pavement restoration	SY	0	0	0	0	0	0	9.33	9.33
Number of LSLRs per week	EA	10	10	10	10	10	10	10	10
Field staff, junior engineer	FTE	1	1	1	1	1	1	1	1
Field/office staff, project manager	FTE	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total Construction Cost (2024$)		**2,414**	**3,349**	**2,096**	**3,031**	**3,267**	**4,695**	**4,774**	**6,268**

Comparing the results for different low-cost scenarios, it can be seen that copper pipe adds approximately $900 to the cost for a short side replacement, or $1,400 for a long side replacement (copper is $23.41 per foot installed versus $5.40 per foot installed for PE). However, an independent analysis of the longevity and public health protection benefits of copper pipe has found that this investment is worthwhile (Beyond Plastics, 2023). In the simplest short side configuration with little or no pavement excavation involved, open cut trench installation is approximately $300 cheaper than directional drilling given that it uses more inexpensive equipment. However, as soon as pavement excavation becomes involved in the long side options, directional drilling becomes less expensive due to the avoidance of pavement repairs which add about $1,300.

Figure 7 and Figure 8 present a breakdown of construction cost elements for low scenario, short side replacement using directional drilling with PE and copper pipes, respectively. For the PE case, the cost is dominated by directional drilling costs (33%) because the pipe is relatively inexpensive (9%). For the copper case, the pipe becomes a larger cost element (28%), closer to the cost of the directional drilling (24%).

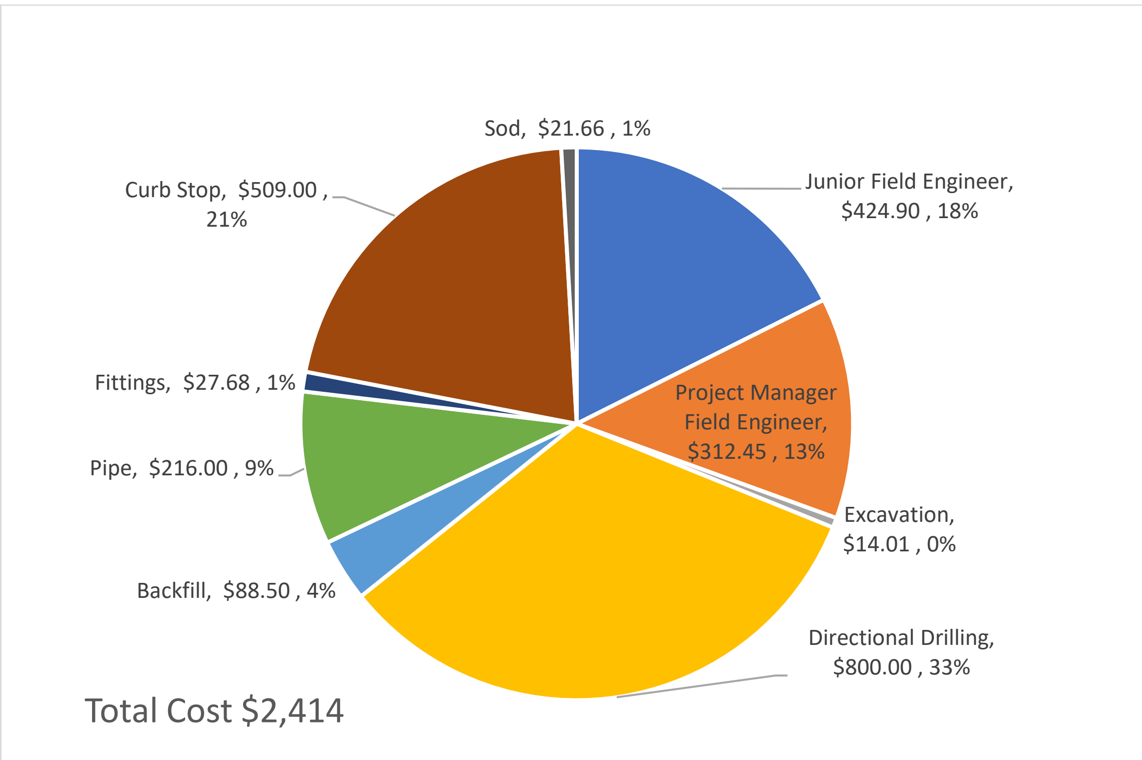

Figure 7. Breakdown of costs (2024$) for low scenario short side, directional drill PE

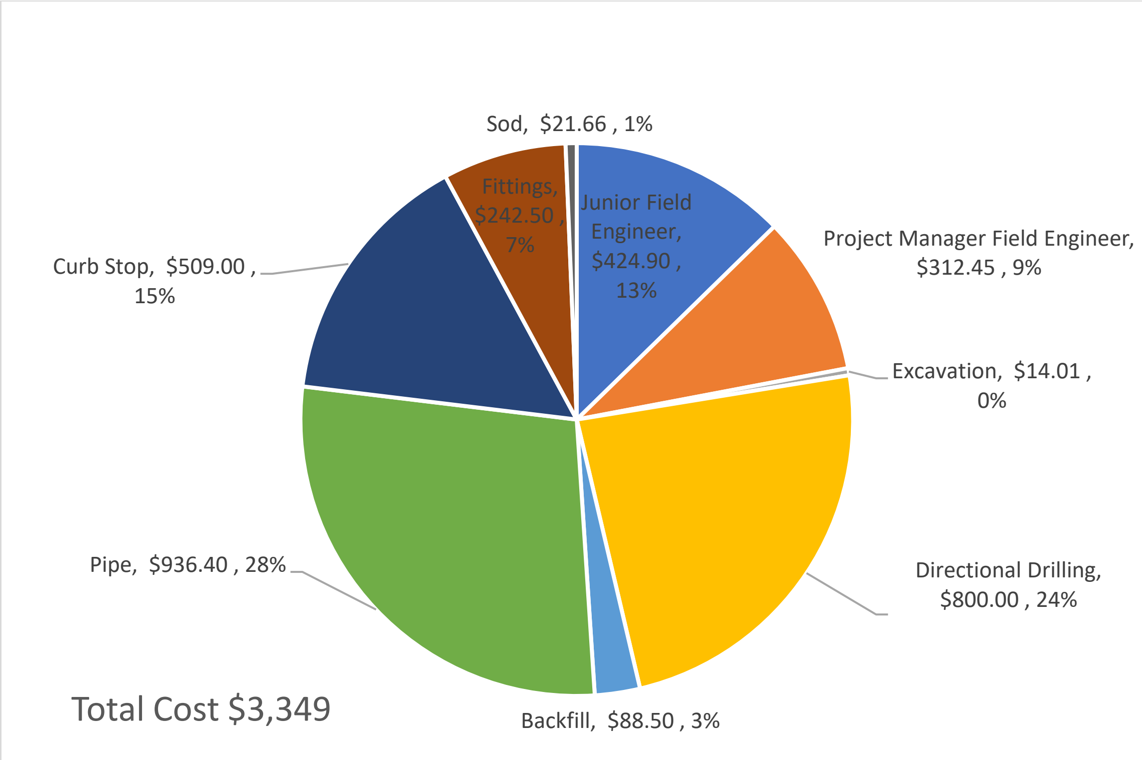

Figure 8: Breakdown of costs (2024$) for low scenario short side, directional drill copper

Comparing the low scenario short side replacement using open cut trench (Figure 9) to the directional drilling option (Figure 8), the simple excavation of grassed areas can be seen as a less expensive option than directional drilling, under ideal conditions. For long side replacement using open cut trench and copper pipe (Figure 10), the dominance of pavement demolition and restoration costs can be seen (3% + 31% = 34% overall). Sidewalk, curb and gutter restoration represent another 5% of the construction cost.

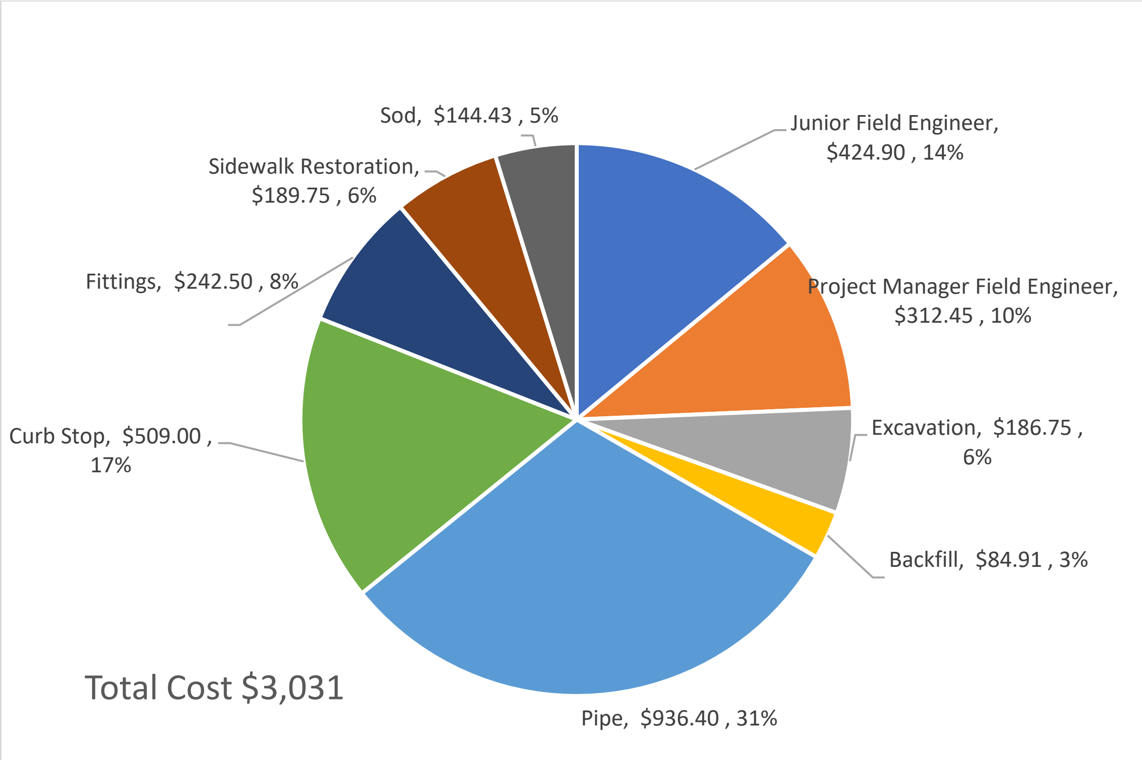

Figure 9: Breakdown of costs (2024$) for low scenario short side, open cut trench copper

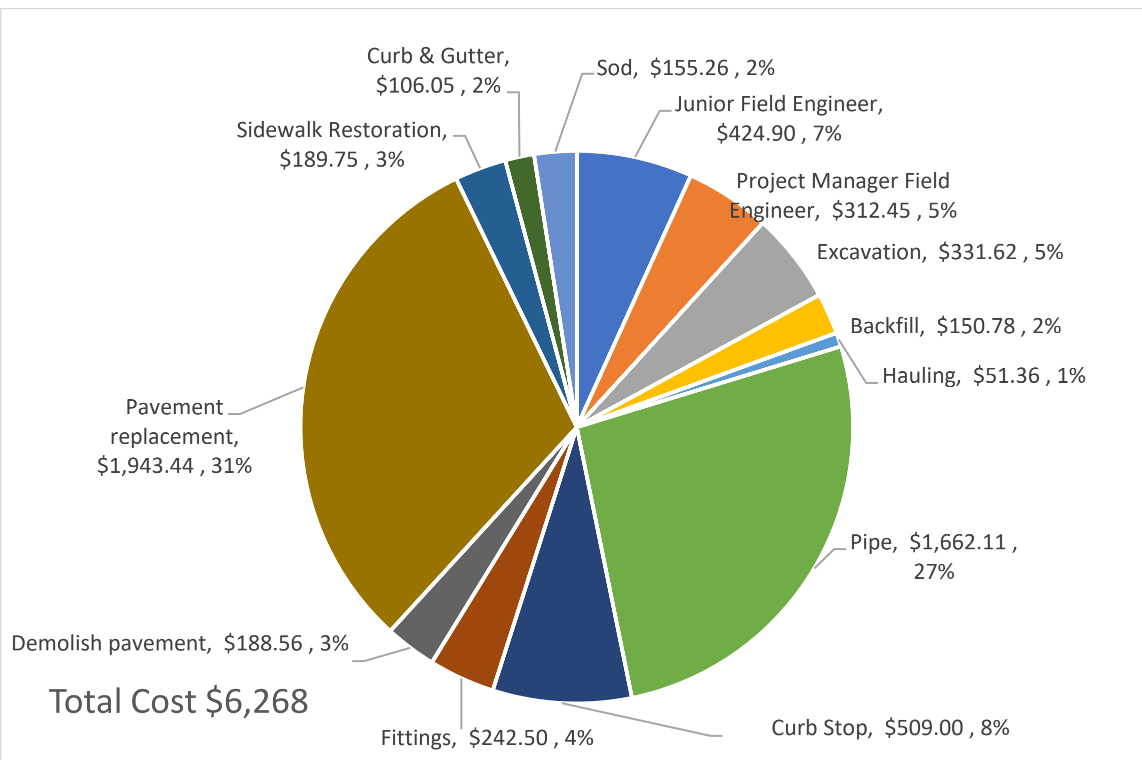

Figure 10: Breakdown of costs (2024$) for low scenario long side, open cut trench copper

The medium and high scenarios of open trench LSLR with copper pipe involving increasingly larger amounts of excavation and pavement restoration result in costs exceeding $10,000 and in the extreme case, more than $33,000 (Table 6). With only 5 replacements happening per week in this high scenario, this cost represents a block with both complex replacements and extra paving requirements. These scenarios demonstrate the need for LSLR approaches that maximize replacements by single work crews while minimizing pavement restoration needs, such as coordination with road paving schedules.

Table 6: Summary of inputs and results for medium and high-cost scenarios

		Value in Scenario	
Item	Unit	Medium Open Cu	High Open Cu
Length of Service Line	LF	71	71
Width of trench	LF	6	6
Depth	LF	6	6
Fittings	EA	2	2
Excavation	CY	94.67	94.67
Backfill	CY	94.67	94.67
New fill material required	CY	0	94.67
Hauling	CY	4.11	141.89
New curb stop	EA	Yes	Yes
New corp stop	EA	Yes	Yes
New water meter	EA	No	Yes
Sod replacement	SF	258	258
Sidewalk restoration	SF	30	30
Curb and gutter restoration	LF	6	264
Pavement demolition	SY	18.67	18.67
Pavement restoration	SY	18.67	410.67
Number of LSLRs per week	EA	10	5
Field staff, junior engineer	FTE	1	1
Field/office staff, project manager	FTE	0.5	0.5
Total Construction Cost (2024$)		**10,703**	**33,408**

It should be noted that these cost estimates represent construction costs only, and do not include ancillary items such as inventories, permits, traffic control, and program management. RS Means does provide estimates for traffic control options, including a flagger for non-intersection low traffic roads ($121.50 per hour), a flasher truck for intersection and medium traffic roads ($189.50 per hour), and police ($247.50 per hour).

Figure 11 summarizes the FLSLR Construction Cost Scenarios detailed in Table 5 and Table 6. The low scenario costs are consistent with the cost estimate range from minimum to 25th percentile by USEPA while the high scenario costs are consistent with the maximum value reported in the literature. Because the high scenario estimate is driven by the high road restoration costs, it would be expected to be found only in a few cases where such restoration is required. The USEPA analysis lists a maximum cost estimate of less than half of the high scenario cost estimate.

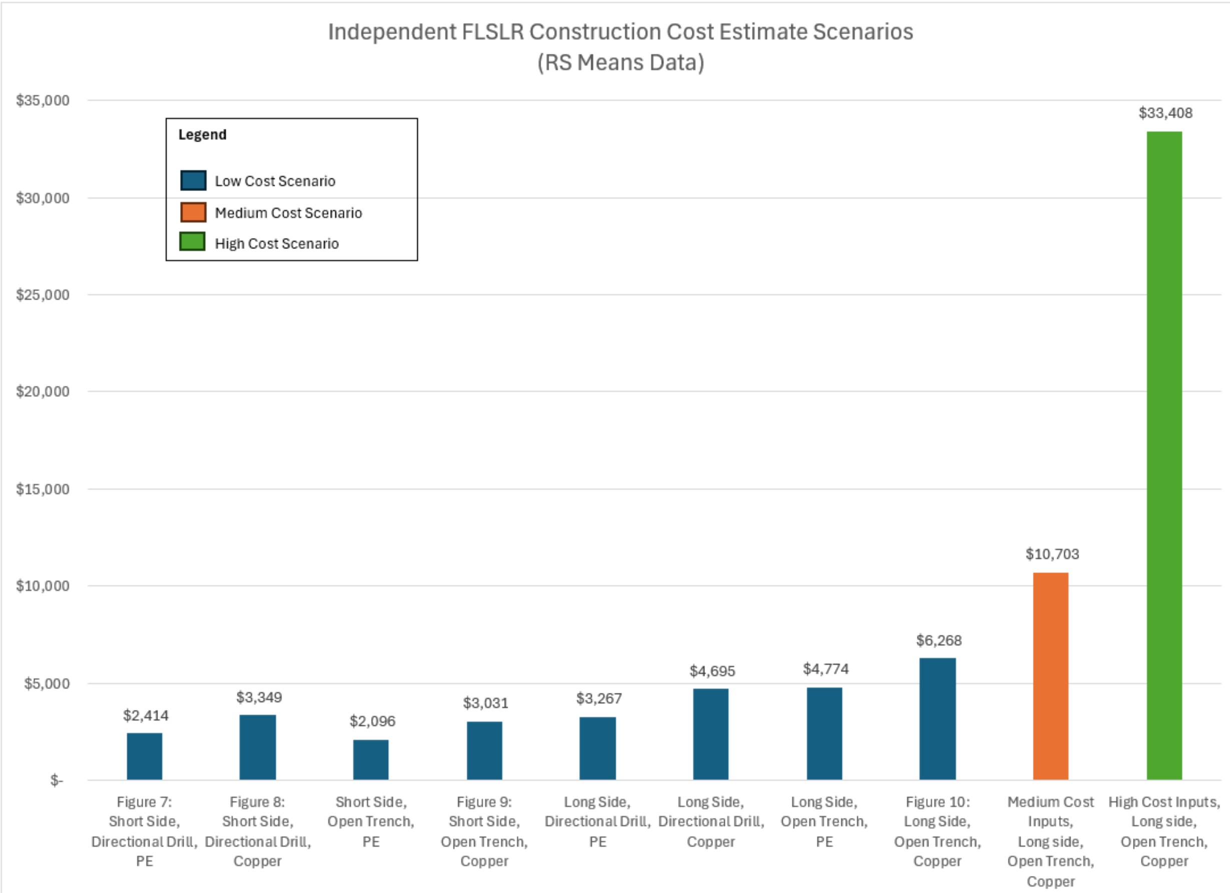

Figure 11: Independent FLSLR Construction Cost Estimate Scenarios

Customer Side Lead Service Line Replacements

In this report, the term "customer side" LSLR refers to replacement of the portion of the service line that runs under private property, regardless of ownership of that portion of the line.

To consider the benchmark costs of customer side LSLR, the low scenario estimates were modified to reflect work in the customer yard only with no restoration of sidewalk or pavement required. A typical length of 30 feet was used. Table 7 summarizes the inputs and results for the customer side replacement scenarios for directional drilling and open cut trenching of both PE and copper pipe. The resulting costs range from $1,748 to $2,915 for straightforward working conditions that do not require extensive restoration.

Table 7: Summary of inputs and results for customer side replacement scenarios

Item	Unit	DD PE	DD Cu	Open PE	Open Cu
Length of Service Line	LF	30	30	30	30
Width of trench	LF	0	0	3	3
Depth	LF	3	3	3	3
Fittings	EA	2	2	2	2
Excavation	CY	1	1	10	10
Backfill	CY	1	1	10	10
New fill material required	CY	0	0	0	0
Hauling	CY	0	0	0	0
New curb stop	EA	Yes	Yes	Yes	Yes
New corp stop	EA	n/a	n/a	n/a	n/a
New water meter	EA	No	No	No	No
Sod replacement	SF	18	18	90	90
Sidewalk restoration	SF	0	0	0	0
Curb and gutter restoration	LF	0	0	0	0
Pavement demolition	SY	0	0	0	0
Pavement restoration	SY	0	0	0	0
Number of LSLRs per week	EA	10	10	10	10
Field staff, junior engineer	FTE	1	1	1	1
Field/office staff, project manager	FTE	0.5	0.5	0.5	0.5
Total Construction Cost (2024$)		**2,160**	**2,915**	**1,748**	**2,503**

For comparison, national home services providers track the costs of water service line replacement across their network of contractors. HomeServe, one such home services provider, reported average customer water service line replacement costs by state ranging from $1,552 to $6,299, adjusted to end of 2023 costs using ENR construction cost index (Schmitz, 2021; ENR, 2024). The median value of these state average costs for all states excluding Alaska and Hawaii is $3,389 based on thousands of individual replacements. These values are slightly higher than the benchmark costs calculated with the RS Means data but are likely to include restoration on customer property which was excluded from the Table 7 calculations.

The average depth of service line was also reported by state in the HomeServe data, which ranged from 2.49 to 8.27 feet reflecting warmer and colder climates, respectively (Schmitz, 2021). Figure 12 plots the relationship between cost of replacement and service line depth from this data set, showing a slight trend (R^2 = 0.46) toward higher cost as depth increases but not a robust relationship.

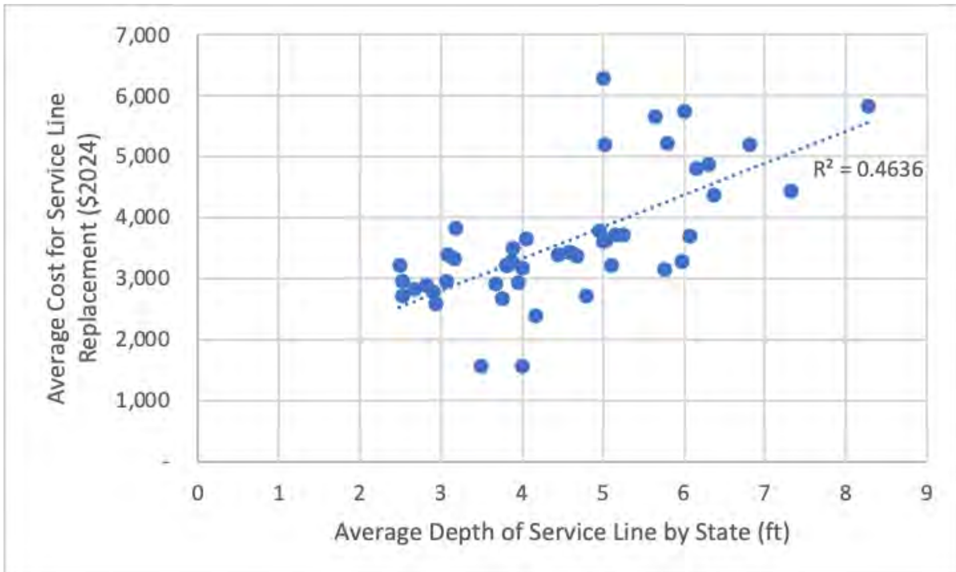

Figure 12: State average cost for customer side water line replacement vs depth of service line (data source: Schmitz, 2021)

HomeAdvisor, a similar home services provider reports an average water service line installation cost of $1,705 (2022$) equivalent to $1,938 (2024$) adjusted using ENR cost indices (Botelho, 2022; ENR, 2024). The HomeAdvisor website offers a summary of 5,163 individual project costs as can be seen in Figure 13, showing that most replacements cost between $646 and $2,816 (year of cost basis unknown).

Figure 13: HomeAdvisor cost summary for water service line replacement (source: HomeAdvisor, 2024).

In contrast, water main side replacements are more likely to affect pavement and sidewalks, resulting in a cost greater than half the cost of a FLSLR. Many of the per-LSLR auxiliary costs would be incurred for customer side or utility side replacements (e.g. outreach, post replacement provisions) the same as for full LSLR. Figure 14 presents a graph of these customer side replacement cost scenarios.

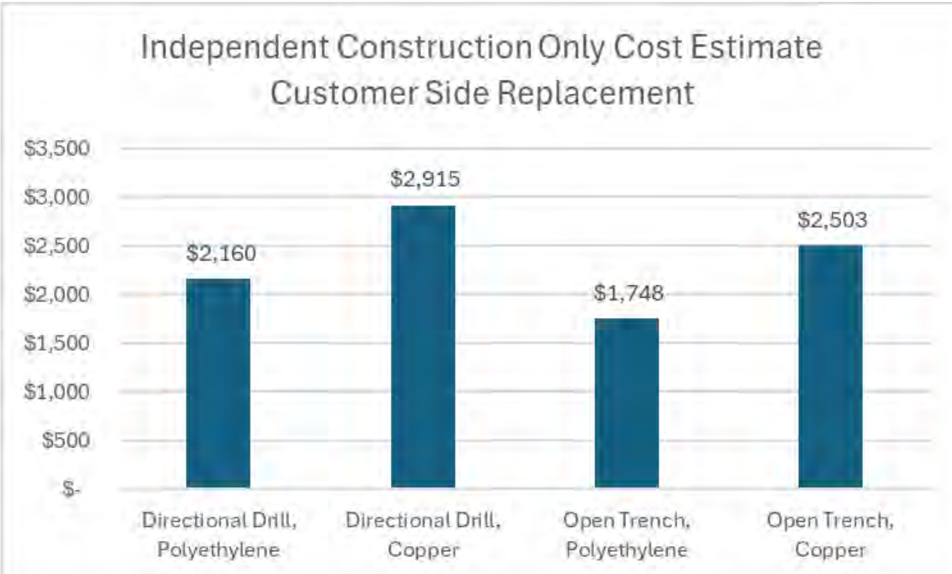

Figure 14: Summary of Customer Side Replacement Construction Cost Scenarios 2024$

Because the costs summarized in Figure 14 are construction costs only, they do not represent equivalent costs to those summarized in USEPA (2023c) that may include some auxiliary costs, summarized in Figure 15. The independent construction cost estimates are consistent with the minimum to median range reported by USEPA (2023c) and are slightly lower but well aligned with the ranges given by national home service providers but are significantly lower than those estimated by CDM Smith (2022).

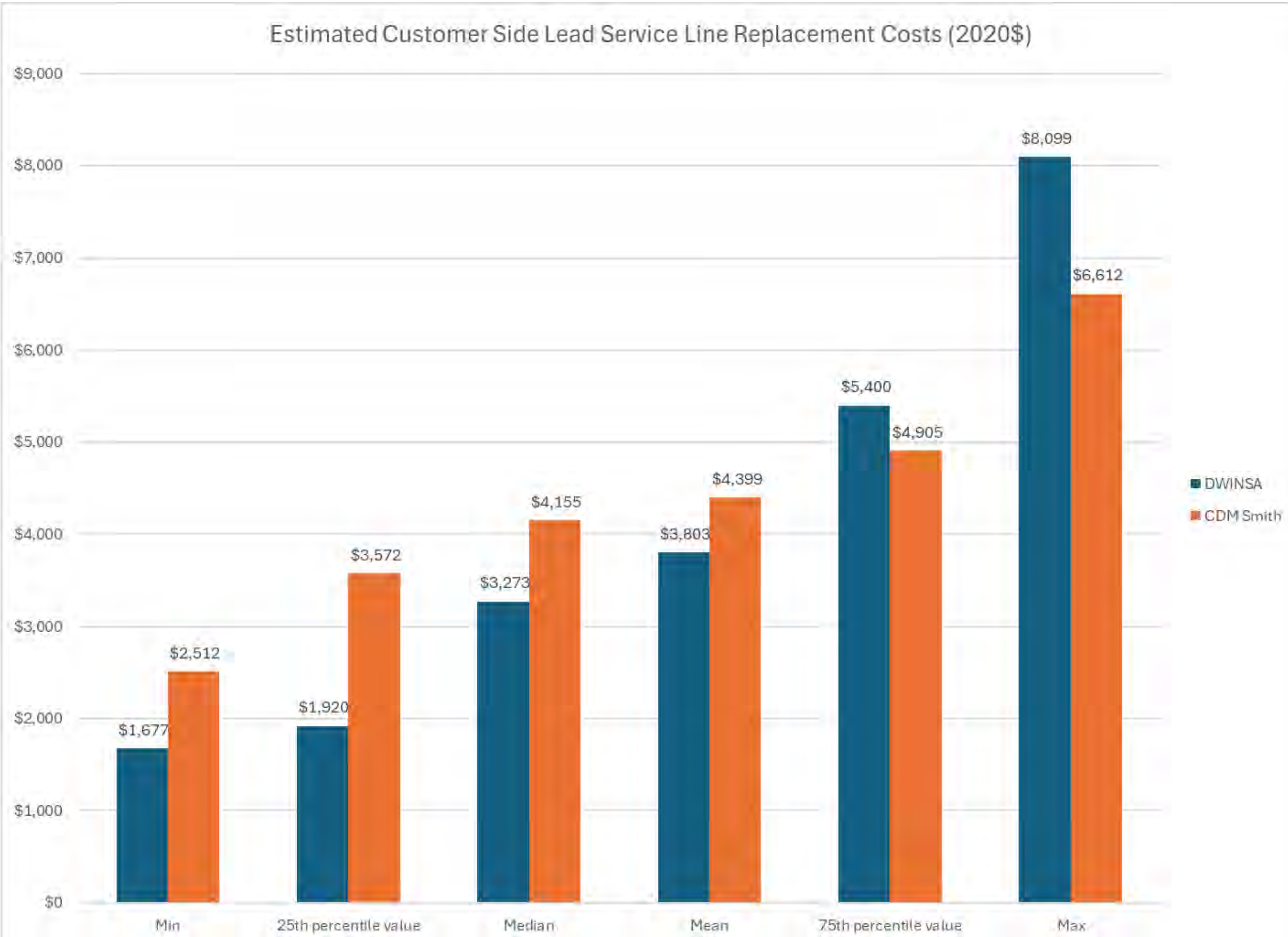

Figure 15: Estimated Customer Side Lead Service Line Replacement Costs 2020$ (Source: USEPA, 2023c; CDM Smith, 2022)

Discussion

This discussion section compares and discusses the results from multiple cost estimates presented in this report, summarizing important takeaways from evaluating the different approaches. It then goes on to discuss the significant cost factors that tend to drive construction and LSLR costs. Finally, the discussion covers LSLR program design considerations that can bring down overall LSLR cost at both the program scale and at the individual replacement scale.

Comparison of cost estimates

Considering the range of data sources and analyses conducted for this report, there is remarkable consistency across the FLSLR cost estimates from the literature, USEPA, and our independent cost estimate using RS Means data, despite the uncertainties introduced by lack of transparency in the inclusion of various auxiliary cost elements. The CDM Smith (2022) average costs are higher than the other data sources, but when the CDM Smith data are adjusted and reanalyzed to avoid selective inclusion of projects and more accurately reflect fixed auxiliary costs they also become more consistent with the other sources. The USEPA estimates are reasonable and the basis for their calculation was clearly presented in the LCRI documentation (USEPA, 2023b; USEPA, 2023c). The findings of this analysis show that very high FLSLR costs are real but outliers occur in very limited circumstances. The majority of FLSLR costs are substantially lower than the maximum and reliably below $10,000. The outlier project costs in CDM Smith (2022) are, in fact, outliers. The data presented in this report demonstrate that there are many ways that costs can be reduced, so the outliers likely represent cases where these methods of reducing costs have not been applied. Although the maximum LSLR cost for the independent literature review is higher than the DWINSA or CDM Smith data, the median and mean FLSLR costs are not.

Although they exclude auxiliary costs, the independent construction cost estimates are consistent with the values reported in the literature and DWINSA. The low scenario costs are consistent with the cost estimate range from minimum to 25th percentile by USEPA while the high scenario costs are consistent with the maximum value reported in the literature. The independent construction cost estimates for customer side LSLRs are also consistent with USEPA estimates, with the independently calculated values aligning with the minimum to median range by USEPA but lower than the CDM Smith (2022) customer side estimates.

LSLR Costs and the LCRI

The LCRI as proposed would require public water systems to replace all LSLs and GRRs within 10 years, with some exceptions. The cost of LSLR includes a wide range of planning, program, and construction tasks. Restoration after LSLR to backfill all excavations, patch any disturbed interior wall, patch disturbed sidewalk and street, and lay grass seed is essential and inherent to any LSLR. However, additional paving and restoration is not compelled by the LCRI. For example, paving an entire street after one or more LSLRs is not an essential cost to obtain the public health benefits of LSLR. Consolidating LSLRs to maximize the benefit of planned paving programs is strongly encouraged as an asset management and customer relations benefit to that community and will also bring down the cost of LSLR when the cost is shared with other capital improvements. Full restoration is encouraged but not required in the LCRI proposal.

Significant Cost Factors

This section discusses factors that influence the overall cost of LSLR in two categories: construction costs and non-construction costs. For non-construction costs, several further cost element categories are presented including engineering services, outreach, permits, internal administration, local policy driven costs, and federal policy driven costs.

Construction costs

Construction costs are difficult to estimate in advance without full knowledge of site conditions, and site conditions can limit options for reducing construction costs. Some construction costs, like paving, may be defined based on local policy requirements rather than site conditions. Working on private property and with buried infrastructure makes this estimation task even more difficult. Numerous predetermined factors affect construction cost including the depth of the water main and service line, the soil type, the need to excavate and restore hard finishes like driveways and sidewalks on private property, the configuration and accessibility of internal plumbing including when homeowners have refinished basements and other modifications. When considering an LSLR program across a utility, different factors will come into play for different areas or individual replacements. In areas with a high density of LSLRs on a given block, the number of pavement excavations may warrant restoration of the full block of pavement.

The largest factor influencing construction costs is the degree of restoration needed and/or required. While it is to be expected that some LSLRs will encounter extensive restoration on public or private property, it would be an overestimate to use these high costs as a basis for modelling national compliance costs for the LCRI.

The cost of the replacement pipe can be a large percentage of the construction cost, especially for copper pipe in cases where restoration costs are low (e.g. 27% of construction cost in Figure 6). Although copper pipe is initially more expensive than PE, it is expected to have a longer service life. Lee and Meehan (2017) found that plastic service lines including PE were most likely to fail after 20 to 40 years in service while copper service lines were most likely to fail after 50 to 60 years. Considering this differential in service life on a 50-year basis, it is plausible that utilities and homeowners may need a second replacement of the PE if that material is used for an LSLR now, effectively doubling the lifecycle cost of a PE service line.

Construction costs are also affected by global market trends and inflation. Copper pipe and tube in particular is expected to be in high demand in the coming decade for applications in plumbing, utilities, devices, heat exchangers, and heat/ventilation. Growth in China, US, Canada, Germany, and Japan is projected to keep global copper pipe demand high and cost of pipe is expected to continue to increase (Global Industry Analysts, 2022). Considering a long side, open trench copper pipe construction cost as shown in Figure 6, an increase in copper pipe cost of 10% would add $166 to the total cost of $6,268, making it $6,434 (an increase of 2.6%). Doubling of the cost of copper for the same scenario would add $1,662 to the total cost, making the total cost $7,930 (an increase of 26.5%).

Non-construction costs

In contrast with construction costs, non-construction costs (also referred to as auxiliary costs) typically depend on program design and local policies. Many of these costs have greater flexibility for change than construction related costs.

Non-construction costs, including engineering support, outreach and working with households, permits, inventories, and internal administrative costs for recordkeeping and compliance with local, state, and federal regulations can have a large impact on overall costs for LSLR programs and these cost elements can explain much of the variability in cost estimates that is seen across the country. These non-construction costs depend heavily on planning decisions for how the program is structured, who will staff the program, and how the water utility interacts with other municipal agencies that set local policies. The extent of these non-construction costs included in overall average LSLR costs in the literature has not been well documented and has hindered the comparison of costs across utilities. Many of the non-construction costs involve hiring of external expertise, especially for smaller utilities without large staff resources to draw upon.

Engineering services may be required to develop standard designs and specifications for LSLR, perform the inventory analysis, and oversee construction. CDM Smith (2022) provided a range of potential engineering services costs from 2% (without construction management) to 20% (including construction management) of total construction cost, with an average of 11%. RS Means provides estimates of engineering services based on a percentage of the total construction cost, as shown in Table 8.

Table 8: Summary of Engineering Fees for Construction Projects (data source: RS Means)

Project Total Construction Cost	Percentage Engineering Fees
For work to $100,000	10
$100,001 to $250,000	9
$250,001 to $1,000,000	6
$1,000,001 to $5,000,000	5
$5,000,001 to $10,000,000	4

However, the engineering design element of overall engineering services for LSLR is fundamentally different from designing traditional water infrastructure projects. Typical water plant or water main design requires highly site-specific detailed drawings. LSLR is fundamentally a simple project based on a standard specification that is repeated over and over at several to thousands of locations. Standard drawings and specifications reflecting the design considerations for the specific utility will be sufficient for the overwhelming majority of LSLRs within a single community water system. It will be rare that site conditions are so unique and complex that a site-specific design will be required for an LSLR. In this case, it is appropriate to include engineering design services in overall LSLR program engineering services with the percentage applied reflecting the overall project magnitude, rather than as a percentage of every LSLR.

Customer outreach, including scheduling appointments, signing forms, getting access to building interiors, and conducting follow up activities, is also often an outsourced activity. The fees for this outreach sometimes are included in the engineering fees or as a separate cost with a defined staff or separate contractor. RS Means reports the cost for educational planning consultants, which would include the outreach type of expertise, as 0.5% to 2.5% of the project total construction cost. For example, Milwaukee Water Works reported that their outreach plan cost $100,000 annually and 1 full-time staff member (Gonda, 2018). For many LSLR projects a fixed cost per replacement would be appropriate, especially when there are fewer than about 1,000 LSLRs involved.

Likewise, it is important to examine the cumulative cost of outreach across an entire LSLR program because at some point there will be economies of scale, similar to the decreasing percentage allocated to engineering fees as the total construction budget increases shown in Table 4. For example, DC Water's allocation of 10% of their LSLR program would have created a budget double the entire water utility's outreach budget to serve only their LSLR program (Betanzo and Attal, 2022).

Household access and coordination has been reported as requiring significant time and cost in completed or ongoing LSLR programs, with some homeowners refusing to participate in the program regardless of financial incentives (Beitsch, 2018). Raising awareness and participation in LSLR programs has been reported as a significant process, even when costs are not borne by the residents/homeowners. Depending on the need to access basements or internal plumbing to perform the LSLR, the time required to set up appointments and reschedule missed appointments can be significant, as is the burden on the resident who may suffer financial consequences to attend such appointments during work hours.

It is important to cross check the cumulative impact of non-construction costs when they are multiplied to scale. At small quantities, applying non-construction costs as a percentage makes sense, especially when that percentage does not add up to a full employee's time. But any time unit costs are multiplied to scale (especially for programs with thousands of replacements) the result should be checked for reasonableness. For example, DC Water's construction management allocation would have provided at least 12 construction inspectors reviewing as few as 3 LSLRs per inspector per construction day (Betanzo and Attal, 2022).

Local policy driven costs

A number of local policies can affect the non-construction costs, including traffic control requirements, permits, plumbing codes and other plumbing requirements.

Maintenance of Traffic

While maintenance of traffic is typical for most water infrastructure projects that require work in public areas, there are varying degrees of additional requirements that individual municipalities have put into place. Basic maintenance of traffic involves placement of cones or barriers to indicate the areas of work to drivers and pedestrians, along with signage and possibly a flagger. Depending on the level of traffic in the work area, more advanced traffic control measures may be required such as temporary street closures (with detours), the use of flasher or signal trucks (which also provide a physical barrier for workers), and police presence with or without flashing lights. These advanced traffic control measures are more expensive than basic ones with average costs (from RS Means) for a flagger for non-intersection low traffic roads of $121.50 per hour, a flasher truck for intersection and medium traffic roads at $189.50 per hour, and police at $247.50 per hour. Some municipalities require police at a large proportion of construction sites (New Jersey American Water, 2023), which increases the non-construction cost of a multi-year program significantly. While public and worker safety should be assured as a priority, there are opportunities to scale the requirements for maintenance of traffic according to the neighborhoods under construction at any given time to reduce the overall costs associated with traffic policies.

Permitting

Permitting procedures and costs vary significantly from municipality to municipality, and requirements are typically set at the local level. Permits are usually an important source for funding municipal inspector positions. It creates an interesting dynamic when another municipal department or public water supply creates the demand for permits and additional municipal staff. Permits and permit fees are important to ensure that all service line replacements are properly completed and recorded. CDM Smith reports a range of $231-$3,400 for the permits necessary for LSLR, resulting in a weighted average of $543 for these fees. Jersey Water Works (2023) reports $100 for a plumbing fee, plus charges ranging from $265 to $790 where road work is necessary.

Plumbing Codes and Requirements

Depending on the local house construction configuration and plumbing codes, an LSLR may require additional work in the interior of the building. For example, LSLRs that connect to a water meter located in the basement of a house may incur higher costs for plumbing work than those that connect to an outdoor water meter. Certified plumbers with an understanding of local codes may be required to perform the LSLR connection. Local codes may also require the use of copper pipe in any piping replacement.

Federal policy driven costs

Federal rule requirements add costs beyond construction costs for LSLR, mainly for development of a service line material inventory and for post-replacement services such as sampling and filters. Many utilities have already started and/or completed their service line inventories (Kutzing *et al*., 2023; Liggett *et al*., 2022). CDM Smith (2022) included a detailed analysis of the cost of developing a service line material inventory using several different methods and projecting example costs for fictional utilities of different sizes. The range of costs reported per service line (SL) evaluated for different methods is large, from $0.10 for historical record review up to $1,140 for sequential water quality sampling and as much as $2,500 for mechanical excavation. Combining these methods into a program for the fictional utilities resulted in a total cost of $42.73 per SL for a utility with 100,000 LSLs to $96.96 per SL for a utility with 5,000 LSLs.

Post-LSLR costs to protect public health are also specified in federal regulations. CDM Smith (2022) provide a range of costs for sampling and filter provision. A single follow-up sample was reported to cost from $20 to $100 per LSLR and a pitcher style filter with 6 months of cartridges was reported to cost approximately $60. Additional outreach to customers affected by LSLRs might also be conducted, with some of those costs potentially included in the LSLR outreach budget.

The vagaries of procurement

The majority of municipal water infrastructure is procured using a low bid system. The efficiency of low-bid procurement versus other procurement options is a continuing field of study in business research around the world, with several other models gaining popularity including design-build and best value options (Gransberg and Ellicott, 1996; Lines *et al*., 2022). In typical low bid procurement, a set of quantities and specifications are provided to bidders and winners are determined from the total cost or from a subset of costs (as specified in the bid documents). Depending on the bid requirements, bidders may be asked to provide a breakdown of certain cost categories or unit costs per item. Bidders are then free to assign their total costs across these categories to develop an advantageous yet competitive bid package. This type of system means that bids can have widely varying line item costs, even when total costs are approximately equal. Large variability can be a reflection of ambiguity in the bid documents in the best case or of gamesmanship by bidders in the worst case.

For example, Table 9 below shows the high degree of variability in bid line items from 5 contractors on the exact same project. In Table 9, for line items with a large difference between the highest and lowest bid on each line item, the highest line-item bid is shaded red and the lowest line-item bid is shaded green. The largest magnitude difference for a single line item is for maintenance of traffic, where this a difference of $315,650 between the highest and lowest bid. However, this is a one-time cost for the entire project. On the other hand, the difference of $3,473 between the highest and lowest bids for a curb stop and box results in a total $1,084,000 difference when multiplied across 312 potential LSLRs. Cost differences at the unit cost scale add up quickly when multiplied across large LSLR projects. Clarity in bid documents, scrutiny of bids, and making bids and final contracts publicly available can help build cost transparency and support better decision making.

Table 9: Five Independent Bids for the Same LSLR Project for the replacement of approximately 312 LSLRs in Benton Harbor, Michigan a Community Water System Serving <10,000 People (Source: City of Benton Harbor, 2021)

	Contractor A	Contractor B	Contractor C	Contractor D	Contractor E
Mobilization	$ 100,000	$ 70,000	$ 65,000	$ 100,000	$ 100,000
maintaining traffic	$ 335,100	$ 25,000	$ 19,450	$ 92,222	$ 53,500
pavement, rem	$ 13	$ 2	$ 25	$ 20	$ 6
sidwalk, rem	$ 12	$ 2	$ 2	$ 7	$ 6
curb and gutter, rem	$ 14	$ 2	$ 5	$ 11	$ 4
aggregate base, 8 inch	$ 8	$ 8	$ 18	$ 19	$ 5
hand patching	$ 296	$ 125	$ 375	$ 185	$ 0
conc pavt, miscillaneous	$ 59	$ 20	$ 61	$ 50	$ 46
curb and gutter, concrete	$ 34	$ 25	$ 28	$ 18	$ 22
driveway	$ 53	$ 20	$ 50	$ 45	$ 44
sidewalk, 4 inch	$ 5	$ 3	$ 5	$ 4	$ 4
slope restoration	$ 8	$ 3	$ 12	$ 7	$ 1
public water service trenchless, per foot	$ 49	$ 80	$ 23	$ 50	$ 29
private water service, trenchless, per foot	$ 33	$ 80	$ 23	$ 50	$ 33
curb stop and box	$ 732	$ 1,800	$ 1,357	$ 1,200	$ 4,205
private service, connection to residence	$ 1,864	$ 1,800	$ 1,050	$ 800	$ 1,500
water service, complete	$ 877	$ 340	$ 229	$ 100	$ 750
Total	**$ 3,211,190**	**$ 3,164,393**	**$ 2,486,044**	**$ 2,599,744**	**$ 3,087,210**
Right of entry form	$ 2,000	$ 300	$ 215	$ 125	$ 250
water service, investigation	$ 500	$ 800	$ 350	$ 1,000	$ 2,000
subbase	$ 53	$ 40	$ 24	$ 15	$ 25
non hazardous contaminated material	$ 70	$ 50	$ 105	$ 150	$ 150
public water service, 1 inch	$ 75	$ 165	$ 34	$ 95	$ 175
public water service 1.5 inch	$ 114	$ 240	$ 45	$ 105	$ 225
public water service 2 in	$ 136	$ 310	$ 70	$ 120	$ 350
water meter replacement	$ 1,024	$ 1,200	$ 425	$ 500	$ 1,000
private service cut and cap	$ 319	$ 1,000	$ 550	$ 1,250	$ 2,700

Note: for emphasis, the highest line-item bid is shaded red and the lowest line-item bid is shaded green.

Program Design Strategies to Reduce Costs

Many decisions go into designing a comprehensive LSLR program. It is this upfront planning (or lack of planning) that sets most of the boundaries around how much LSLR costs within a community. Figure 16 provides an illustration of the upfront planning steps and costs that are needed to make the decisions for an LSLR Program Plan. A conscientious investment in planning can be very effective for controlling costs in the long run.

An inclusive list of the decisions that must be made in designing an LSLR Program Plan can be found in Appendix A. Figure 16 then lists the program scale and construction scale costs that may be part of an LSLR program.

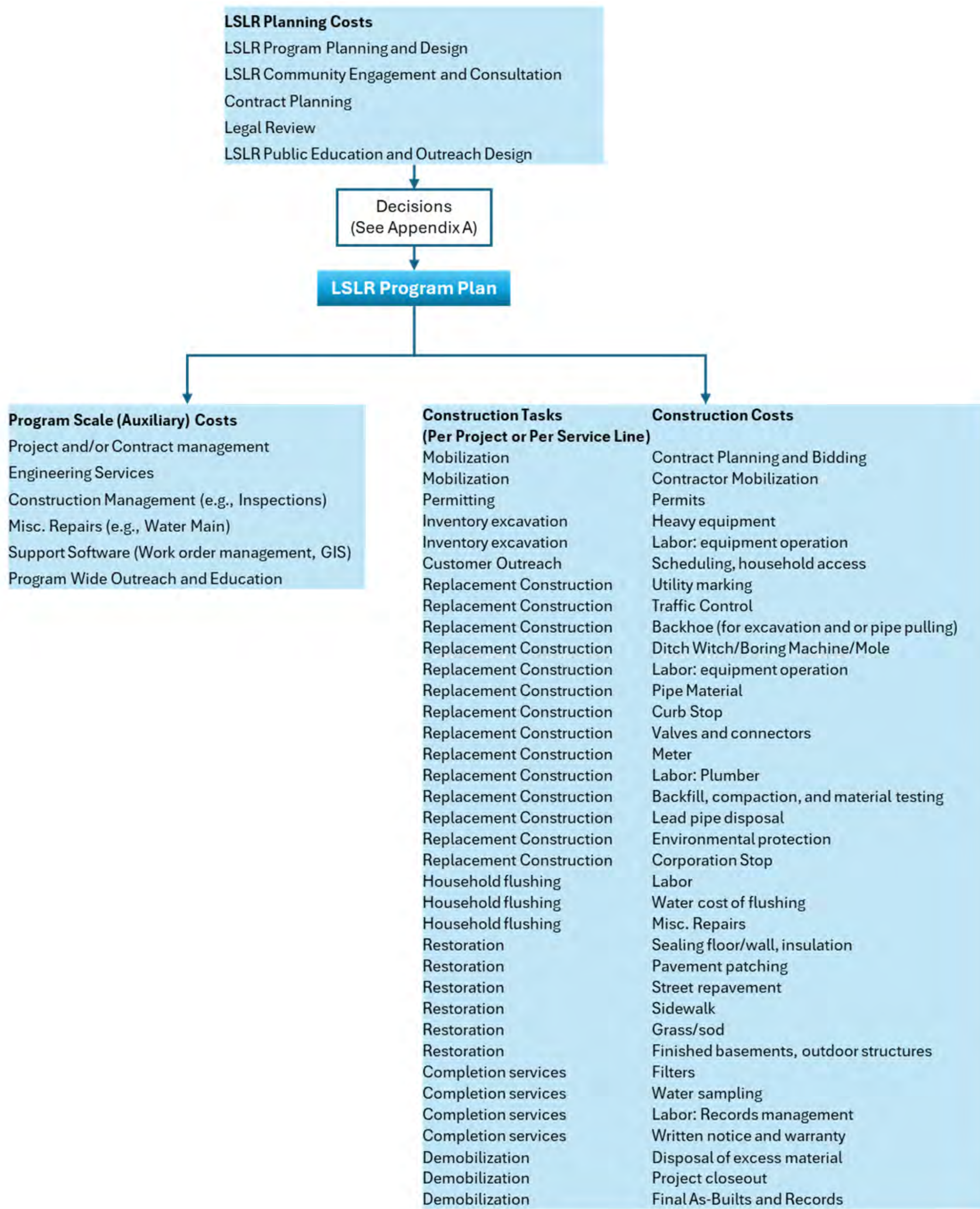

Figure 16: Inclusive List of LSLR Planning Costs, Programmatic Costs, and Construction Costs

The program decisions and opportunities to reduce the overall cost of LSLR are discussed in further detail below. A summary of the key cost reduction strategies is provided in Figure 17.

LSLR through Capital Improvement Planning

Consolidating LSLR programs with other capital improvement programs (CIP) can reduce the cost of LSLR because many of the auxiliary costs are shared with other infrastructure projects and the cost of paving can be split between multiple infrastructure projects. Coordinating LSLR with water main replacement is frequently recommended as a strategy for reducing the cost of LSLR (Betanzo, 2022). However, at least one study found that using asset management plans and CIPs as the only means for achieving LSLR goals can slow LSLR and draw out replacement timelines (Betanzo, 2024). Completing LSLR in tandem with other CIP projects can reduce the cost per LSLR but may draw out the timeline necessary to replace all LSLs because planning decisions are not driven solely based on the presence of LSLs. It is important to balance the priorities of reducing cost per infrastructure project with the public health benefits of removing LSLs as quickly as possible.

An additional consideration for co-locating LSLR with other essential infrastructure projects like sewer line replacement, stormwater management, and street renewal projects is that a management decision must be made to allocate costs to each project. This is an opportunity to improve transparency in project accounting and bidding. A lack of transparency can result in LSLR funds being diverted to co-located non-LSLR infrastructure projects that do not maximize LSLR with LSLR funding. Consolidating infrastructure projects has many benefits and should be accompanied by transparent accounting practices to ensure LSLR funds are preserved for completing LSLRs.

Engage Customers in LSLR Program Planning and Implement Proactive Customer Engagement and Outreach Strategies

Developing LSLR program plans in consultation with community members can identify effective strategies to reach impacted community members. The strategies that will be effective for a municipality or a community within a larger water system can vary greatly. This will be an important step in every community to design a program that meets the unique community needs. This is an important opportunity to engage with the impacted community to identify messages, methods, and approaches that will reach customers and break down any barriers to participation. Hiring trusted community members to perform the outreach may result in faster, more efficient access to customer homes to complete LSLRs. Although community planning and engagement processes present an upfront investment, this extra effort will likely pay dividends for increasing program participation. The Lead Service Line Replacement Collaborative has developed an Equity Toolkit (https://www.lslr-collaborative.org/equity-tools-and-data-sources.html) that describes several strategies and approaches for reaching impacted community members.

Fully Fund LSLR

Many communities have required homeowners to pay to replace the portion of an LSL that runs under private property, and some of those communities have funding assistance available for low-income residents to participate in FLSLR. Substantial paperwork may be required to access funding assistance, continuing to make these programs difficult to access even if assistance resources are available. Programs that require homeowners to pay for LSLR under private property establish a significant barrier to participation and completing LSLR goals. This drives up the cost of outreach as the water utility needs to convince each customer to pay for LSLR. A single block of replacements cannot be completed at once and work ends up scattered across the water utility through a series of expensive one-off replacements.

The increased one-on-one customer contact and unconsolidated replacements slow down the pace of LSLR, which increases the overall cost of LSLR for the entire community (Betanzo and Attal, 2022).

Rather than using LSLR funding to encourage homeowners to pay for replacing the portion of the LSL that runs under their property, the money could be used more directly for public health protection and achieving more LSLRs if the water utility uses funding to pay for FLSLR, including the portion of LSL that runs under private property. Steps that can be taken to fully fund LSLR include using (or where necessary seeking) authority to use water rate revenues for replacement under private property and maximizing use of external funding for replacement under private property.

Adopt Municipal Ordinances that Facilitate FLSLR

Ordinances that mandate participation and authorize access to private property

Newark, NJ and Benton Harbor, MI adopted LSLR mandates that required all building owners to get their LSLs replaced, and authorized the water system to conduct and pay for the full costs of LSLR if the building owners choose not complete LSLR themselves. These mandates reduced the number of residents that refused to participate or did not respond to contact by the water utility or its contractor to replace an LSL at a property. "The Newark City Council passed an ordinance that made it mandatory for property owners to sign up for the program and empowered the City to enter a property to replace an LSL even if the owner did not sign up for the program" (Rebovich, 2020). These ordinances are now options throughout New Jersey, and they greatly reduced the barriers to participation and reduced the costs for convincing building owners to participate. The participation mandates also make it possible for utilities to pursue legal avenues to ensure compliance (Beitsch, 2018).

The complimentary policies of mandating LSLR and providing funding for verification and replacement of all potential LSLs, including those on private property, allow and encourage all residents to readily participate in the program. Once the funding barrier is removed and the mandate for LSLR is established, the program can be further accelerated by an ordinance that authorizes access to private property. These ordinances and funding policies work together to reduce outreach and auxiliary costs for LSLR.

Additional ordinances that facilitate LSLR, and reduce barriers and costs include the following (Jersey Water Works, 2023):

- Requiring replacement upon sale of a property,
- Requiring disclosure of an LSL at the time of sale,
- Requiring replacement upon a new rental lease agreement or new certificate of occupancy,
- Requiring replacement for renewal of a business operating license, and
- Requiring all new plumbing permits to report existing material removed and new material installed.

Hybrid Inventory and LSLR Program

The LCRR and LCRI require development of an LSL Inventory to support an LSLR program. The inventory begins with a records review to understand changes in service line practices over time and to understand the current status of service line recordkeeping. This information is critical for quantifying overall LSLR needs, prioritizing neighborhoods for LSLR, and meeting regulatory requirements. When it comes down to excavating service lines to verify materials, most of the inventory steps duplicate LSLR costs: mobilization, heavy equipment, labor, household access, and record keeping. The initial inventory as required in the LCRR and LCRI provides an important foundation for an effective LSLR program. This initial inventory should be robust enough to identify the areas to work first to remove the most LSLs as soon as possible.

The proposed LCRI would require regular inventory updates and identifying all unknown service lines by the replacement date. However, rather than using limited LSLR funding to complete this inventory work in parallel with LSLR, developing a hybrid inventory/replacement program can reduce costs by digging once and replacing when LSLs are found. Identifying unknown service lines and updating inventories as a separate step from actually replacing LSLs can drive up the overall LSLR cost by duplicating tasks, diverting funding from achieving public health protection, and increasing the overall timeline for replacing all LSLs. Further, replacing LSLs at the time they are discovered via inventory excavation improves public health protection by preventing exposure to lead released from a disturbed LSL that remains in service. Benton Harbor, Michigan and Newark, New Jersey both used this approach. Benton Harbor was able to identify and replace all LSL and GRRs in its system of about 4,500 service lines in about one year (Betanzo *et al.*, 2023).

Consolidating inventory validation and updates with LSLR may add cost in the short term due to excavation of non-lead services that do not require replacement. For water utilities with minimal service line documentation, it may be necessary to excavate every service to verify its composition. Prioritizing simultaneous inventory verification and LSLR may reduce the duplicative cost of completing a standalone service line inventory while improving cost efficiencies and public health protection.

Consolidating Geographies for LSLR

Designing LSLR Programs at the neighborhood scale can bring down the cost of LSLR by consolidating work in a single area, completing more LSLRs and inventory excavations by the same crews on the same workdays.

- This approach ensures economies of scale, especially in comparison to programs where LSLs are replaced as one-off projects, jumping around to different locations where residents identified an LSL for replacement.
- Visiting every known and unknown service line in a neighborhood during a defined project schedule period reduces the cost of multiple mobilizations for a single project area and facilitates the hybrid inventory/replacement strategy.
- Completing all the work at one time reduces the cost of multiple paving projects and provides the opportunity for a full street paving project, if appropriate based on the number of LSLRs and quantity of pavement disturbed, after all service lines are replaced or verified non-lead on a given street.

Betanzo and Attal (2022) estimated that DC Water could save $29 million by consolidating LSLRs at the neighborhood scale. Geographically consolidated LSLR programs can include LSLR associated with Capital Improvement Projects (CIP), typically water main replacement projects, or LSLR within a defined geographic area.

In addition to reducing construction costs, consolidating work in a geographic area also helps reduce outreach and communications costs. Consolidated, obvious construction activity can increase customer awareness because they see and experience evidence of the LSLR program daily while work is ongoing in the neighborhood. This improves the reach and timeliness of neighborhood visibility programs, such as yard signs and neighborhood meetings that might otherwise go unnoticed. With high neighborhood activity increasing conversations and awareness between community members, there may be a reduced need for outreach efforts aimed at convincing customers to participate in the LSLR program.

Grouping Related Replacement Programs and Matching with Appropriate Funding Sources

While the most cost effective LSLR programs will be through neighborhood scale projects, all water utilities have additional LSLR needs that will be completed efficiently at lower cost if a program is ready to meet those needs.

In addition to neighborhood scale CIP projects and consolidated LSLR projects, the two following needs are typically present:

Individual Replacement Program

There will always be a need for individual scale, high priority replacements for a variety of reasons including day care centers, homes where children with Elevated Blood Lead Levels (EBLLs) live, and emergency LSL repairs. There will always be a need to address these types of situations, so it is most efficient for a water utility to build the structure and process for these replacements up front to complete the work efficiently when needed, even though the cost per individual replacement will be greater than geographically consolidated programs. Anticipating this need and identifying appropriate funding sources will reduce the cost difference between the individual replacement program and the geographically consolidated program.

Resident Initiated LSLRs

Building and renovation is typically ongoing in most communities, and when new construction or remodeling happens at a property with an LSL, the builder or owner will want to address this during construction. It will be helpful for processes to be in place so these LSLRs can happen without delay and contribute to meeting the water utility's overall LSLR goals. By having a process in place for these the builder to complete the replacement, it will decrease the number of LSLRs the water utility needs to complete and decrease the overall cost of the LSLR program.

Revisit Paving Policies

Completing all the LSLRs on one street at the same time reduces the cost of multiple pavement patches and provides the opportunity for a full street paving project. Some municipalities have paving requirements, such as Washington, DC where the entire street must be repaved when four or more utility services are replaced (Betanzo and Attal, 2022). This particular policy did not consider the percentage of street disturbed or the length of the block. If Washington, DC was permitted to use the least cost method for every block of LSLRs, selecting between full street replacement and individual site restoration, they could save up to $148 million (Betanzo and Attal, 2022). One strategy for exploring LSLR paving policies to reduce the restoration cost of LSLR would be to evaluate the number of LSLRs per 100 ft of road that should trigger a full street replacement given typical LSL densities and community infrastructure needs.

Revisit Permitting Policies

Because of the repetitive nature of LSLR programs where the same contractor or staff members may be overseeing hundreds if not thousands of LSLRs, there are opportunities to bulk process permits or issue waivers in certain conditions, especially when projects are confined to the same geographic area or types of properties. This can reduce the impact of permit fees on overall LSLR program costs while still ensuring that all appropriate recordkeeping procedures are used. One example of this is Newark, NJ where a batch processing permit option was allowed (Jersey Water Works, 2023).

Another approach would be for the LSLR program to fund dedicated permit staff to ensure sustained and adequate staffing rather than be charged a fee per replacement. When small numbers of permits are processed a fee per permit makes sense, but at scale it may be more cost effective to fund dedicated staff.

Revisit Traffic Control Policies

While public and worker safety should be assured as a priority, there are opportunities to scale the requirements for maintenance of traffic according to the neighborhoods under construction at any given time to reduce the overall costs associated with traffic policies. It is important to review local policies to ensure that the traffic maintenance requirements are appropriate for the work environment. Urban streets will require more advanced measures, whereas residential streets require less intervention. Blanket requirements that do not consider site specific conditions are likely to drive up costs without increasing public health protection.

Contract and Bid Practices to Increase Transparency and Improve Contract Cost Controls

In Newark, to keep prices low, contracts were bid out every other day, by zone or area. This approach allowed each company to sharpen their pencil with each public bid opening, and the prices went down with each bid. Each of the bids was published for 20 days, allowing competing firms to know the prices they would have to beat to win the next contract (Kareem Adeem, Personal Communication, 11/12/21).

Contracting Strategies to Accelerate LSLR Programs

Newark's LSLR program changed considerably after one contractor originally had 9 months to replace 1,000 lines, but they ended up completing *all* lines in the contract in 180 days. This experience led Newark to give contractors requirements to complete 10, 15, or 25 services/day based on company size, not including test pits/potholing. Their timeline per thousand-line contract went from 9 months to 180 days to 120 days. At the peak of their replacement program, 120 LSLs were replaced each day across the city. (Kareem Adeem, Personal Communication, 11/12/21).

To ensure that all LSLs were replaced and there was no incentive to skip potential lead lines, Newark required all inventory potholing at the same time as LSLR. If no lead service line was found, contractors charged $0.01 or $1.00 for the pothole and moved on. If a replacement had to be done, the cost of potholing was rolled up into replacement and not charged as a separate line item. This created all the incentives to find and replace as many LSLs to maximize contractor pay. Newark also added to their contracts the right to terminate a contract for cause if a contractor did not meet their required number of LSLRs per day (Kareem Adeem, Personal Communication, 11/12/21).

Benton Harbor, MI included a $1,000 incentive for each day prior to the mandatory completion date that all contracted LSLs were removed, at a value up to $100,000 (City of Benton Harbor, 2021). This approach can be very effective, but it requires clear contract specifications that all contract requirements are met, and no shortcuts are taken. In this case, comprehensive contract enforcement and recordkeeping are essential if incentives are to be used.

Figure 17: LSLR Program Planning and Implementation Opportunities for Reducing Costs

LSLR Planning Costs	**Opportunities for Reducing Costs**
LSLR Program Planning and Design	Fully fund LSLR; Adopt municipal ordinances to support FLSLR; Revisit local policies
Community Engagement and Consultation	Engage customers in LSLR program planning and implement proactive customer engagement and outreach strategies
Contract Planning	Consolidate contracts by geography or replacement type; increase bid transparency; Completion incentives and termination conditions
Legal Review	Adopt municipal ordinances to support FLSLR
LSLR Public Education and Outreach Design	Consult with community to identify effective outreach strategies; Share information widely

LSLR Program Plan

Program Scale (Auxiliary) Costs
Project and/or Contract management
Engineering Services
Construction Management (e.g., Inspections)
Misc. Repairs (e.g., Water Main)
Support Software (Work order management, GIS)
Program Wide Outreach and Education

Construction Tasks	**Opportunities for Reducing Costs**
Mobilization	Geographic consolidation of projects; group as many replacements and inventory inspections together as possible
Permitting	Batch permit processing, LSLR funded dedicated permit staff
Inventory excavation	Verify all service line materials within a neighborhood while mobilized for LSLR in that location
Customer Outreach	Community engagement to design LSLR Outreach; Hire trusted community members
Replacement Construction	Revisit traffic control policies
Household flushing	
Restoration	Consolidate LSLRs; Revisit local paving policies
Completion services	
Demobilization	

Conclusions

Where present, LSLs are the largest source of lead in drinking water (Sandvig et al., 2008), and they provide a constant risk of exposure to lead even in water systems with corrosion control treatment (USEPA, 2023d). The USEPA's proposed LCRI requirement to remove all LSLs from water systems in the United States (USEPA, 2023d) is an important and effective intervention for reducing and preventing exposure to lead in drinking water.

The purpose of a comprehensive LSLR requirement is to protect public health. In considering LSLR costs, it is important to ensure that three fundamental principles underlie any LSLR program to ensure that it meets the intended purpose:

- Public health protection should be the guiding principle for every LSLR program. Work at every individual home must be conducted in a manner that protects residents and workers.
- LSLR programs must plan for the identification and removal of *all* potential lead and galvanized service lines. If service line material records are incomplete, this likely means every service line will need to be checked individually to verify material during the LSLR program.
- All LSLs should be replaced as quickly and efficiently as possible. The sooner every LSL is removed, the greater the public health benefits and a more equitable outcome is achieved for the entire community.

This report analyzed two different LSLR cost estimates, incorporated an additional literature review, and provided an independent LSLR construction cost estimate based on RS Means data, a widely used industry cost estimating dataset.

1. Overall, there is a large degree of consistency across the USEPA, literature, and independent RS Means construction cost estimates, as can be seen in Figure ES- 2 and Figure ES- 3. The CDM Smith cost estimates as published are higher than the other estimates presented here, but when the CDM Smith data are adjusted to avoid selective inclusion of projects and more accurately reflect fixed auxiliary costs they are also consistent with the other unit cost estimates presented here

2. The DWINSA analysis for the USEPA's LCRI proposal provided more information on inclusion and screening criteria for the DWINSA LSLR cost estimates. This dataset emphasizes the lower to mid-range of cost data that are found in the CDM Smith estimate and is consistent with our analysis of the published literature costs.

3. Our independent cost estimate shows that, in practice, most of the construction costs do not vary substantially. There is a small set of construction conditions that can drive up costs, but as reflected in the literature review cost estimates, these conditions are not experienced in the majority of replacements. Table 5 through Table 7 and Figure 7 through Figure 10 show the relative magnitude of line-item costs in different construction scenarios to assist decision makers in evaluating the reasonableness of LSLR bids for construction projects.

4. The analysis presented here demonstrates that LSLR costs have *not* skyrocketed since USEPA's cost estimates published with the Lead and Copper Rule Revisions in 2020 (USEPA, 2020). The LSLR cost increases documented here reflect nothing substantial beyond inflation.

5. The literature review and cost input tables demonstrate how program design decisions are critical drivers for LSLR costs. These costs are essential to an effective LSLR program, but the costs can have a large variation based on programmatic decisions, or conditions in the LSLR community. This study demonstrates the necessity for good planning and coordination to drive down costs at the unit scale.

6. Figure 16 and Appendix A identify the program decisions and cost inputs that should be considered in the design of an LSLR program. Municipalities and water system decision makers can use these tools to develop their own cost estimates for their specific communities, and they can use the construction cost inputs Table 5 through Table 7 and Figure 7 through Figure 10 to identify where bids are reasonable and where they are not.

7. A large unit cost difference multiplied across hundreds of LSLRs can add up quickly and can result in excessive overall project costs. Clarity in bid documents, scrutiny of bids, and making bids and final contracts publicly available can help build cost transparency and support better decision making.

8. A lack of transparency in bid documents, project reports, and financial accounting can result in LSLR funds being diverted to non-LSLR infrastructure projects that do not maximize LSLR with LSLR funding (e.g., paving, stormwater, sewer line replacement). There is a need for transparency and better data tracking of the different project cost components to ensure that only LSLR is being completed with funding intended for LSLR.

9. Completing LSLR in tandem with other CIP projects can reduce the cost per LSLR but may draw out the timeline necessary to replace all LSLs because planning decisions are not driven solely based on the presence of LSLs. It is important to balance the priorities of reducing cost per infrastructure project with the public health benefits of removing LSLs as quickly as possible.

10. Programs that require homeowners to pay for LSLR under private property slow progress and drive up the unit LSLR cost due to intense one-on-one outreach and one-off replacements being the primary type of LSLR. LSLR funding should be used to maximize the public health protection gained through LSLR.

11. Community members can also use the data presented here as a benchmark for evaluating the cost effectiveness of LSLR projects. They can compare local LSLR project costs to the cost estimates and literature review data presented here to make sure money is spent wisely and efficiently to get the most LSLs removed as quickly as possible to protect public health within their communities.

Finally, it is important to recognize that, as for all water infrastructure needs, LSLR costs will continue to change over time. This cost analysis provides a clear basis for understanding and estimating the current (2024) construction cost of LSLR, and it provides many strategies for controlling LSLR costs. Several water systems with planned LSLR programs, including Cincinnati and Denver found that as they grew and adapted their LSLR programs based on experience they were able to bring down the cost of LSLR over time even as some materials costs increased due to inflation (Moening, 2020; A. Woodrow, personal communication, March 8, 2022). Another example is Milwaukee, WI where they reported replacing 600 LSLs in 2017 at $13,100 each (Gonda, 2018) and a cumulative total of 1,893 replacements from 2017 through 2019 at $10,683 each (Dettmer and Beversdorf, 2019). This documented cost reduction over time further demonstrates the important role of LSLR program planning and adaptation in controlling the cost of LSLR programs and ensuring that LSLR spending results in the most LSLRs possible.

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Appendices

1. Appendix A: Program planning and design decisions that define LSLR program costs
2. Appendix B: Independent Cost Estimate
3. Appendix C: ENR Annual Construction Cost Indices

Appendix A: List of LSLR Planning and Design Decisions that Define LSLR Program Costs

LSLR Program Planning and Management Decisions

- Who will manage the program, staff or consultants?
- How many replacements will be completed each year?
- Do we have/Will we seek a LSLR mandate for our community?
- Will we cover the cost of replacement under private property for all or a subset of customers?
- What funding sources will we use for our LSLR program and what administrative staff do we need to support funding?
- How many different LSLR programs do we need? How many LSLs will be replaced in each?
    - Neighborhood scale
    - Associated with Water Main Replacement or other CIP projects
    - Individual/High priority
    - Customer initiated
- Using what methods and how often will we consult with community on development and progress for the LSLR program?
- What paperwork or documentation will we require from our customers for this program and how will we manage it? (agreements/waivers, financial qualifications for assistance, etc.)
- How will we do large scale community outreach for our LSLR program? How often, using what methods?
- What strategies will we use to reach and access every building that needs an LSLR?
- How many contracts, contract managers, and program managers do we need? How many FTE do we need to staff the program?
- Will we need to develop contractor capacity to meet our replacement goals?
- What software do we need to manage the program? Is this a new expense or can we use a tool we've already licensed?
- How will we capture, maintain, and share our service line inventory?

Construction/LSLR decisions/considerations

Local requirements (program and unit cost drivers)

- What permits are needed? Are there opportunities for bulk permits or waivers?
- Where will we need to plan for traffic control? What opportunities are there to modify requirements to optimize LSLR safely and efficiently?
- What erosion control or dewatering requirements must we comply with?
- What pavement restoration is required? Are there opportunities for modifying requirements to optimize LSLR?
- What lead disposal requirements must we comply with?

Property Scale Decisions (unit cost drivers)

- Will we expose every service to confirm material?
- Will contractor or staff be responsible for getting forms signed, scheduling appointments, and getting access to each building for replacement?
- Will we allow open cut methods? Can we require trenchless in all locations?
- Will we require copper pipe?
- Will we require replacement of curb stop at every property?
- Will we reuse corporation stops or require new ones?
- Do we want to coordinate the LSLR program with a meter replacement program?
- Who will complete flushing after LSLR, staff or contractor? Will we credit the cost of flushing from the resident's water bill?
- What filters will we provide after LSLR? Who will deliver them, staff or contractor?
- Who will conduct sampling after LSLR? Staff or contractor?
- Who will be in charge of record keeping, staff or contractor?

Restoration decisions (unit cost drivers)

- Will we use grass seed or sod for restoration?
- Will we complete exterior restoration under the same or a separate contract from LSLR?
- To what extent will we restore interior property (minimum = sealing wall or floor, and patching insulation)?
- Will pavement restoration happen through the same or a different contract?
- How many LSLRs on a block should be enough to trigger full street repaving?

Appendix B: Independent Cost Estimate Scenarios

Low Scenario, Short DD PE

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
1.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 4.65	$ 3.26	$ 7.91	$ 14.01
40.00	Derived elsewhere	Directional drilling, utility, <4" diameter				L.F.				$ 20.00				$ 800.00									$ 800.00
1.00	312323130100	Backfill, heavy soil, by hand, no compaction	1 Clab	11	0.727	L.C.Y.	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ 88.50
40.00	331413201120	Water supply distribution piping, polyethylene pipe, 160 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	485	0.021	L.F.	$ 0.74	$ 1.55	$ -	$ 2.29	$ 29.60	$ 62.00	$ -	$ 91.60	$ 0.81	$ 2.30	$ -	$ 3.11	$ 32.40	$ 92.00	$ -	$ 124.40	$ 216.00
2.00	331413202240	Water supply distribution piping, fittings polyethylene insert type, nylon, cold water, clamp ring, stainless steel, 160 & 250 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	321	0.031	Ea.	$ 3.82	$ 2.34	$ -	$ 6.16	$ 7.64	$ 4.68	$ -	$ 12.32	$ 4.20	$ 3.48	$ -	$ 7.68	$ 8.40	$ 6.96	$ -	$ 15.36	$ 27.68
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
0.02	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 8.10	$ 1.69	$ 0.22	$ 10.01	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 8.91	$ 2.50	$ 0.24	$ 11.65	$ 21.66
Grand Total														***$ 1,486.03***								***$ 928.17***	***$ 2,414.20***

Low Scenario, Short DD Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
1.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 4.65	$ 3.26	$ 7.91	$ 14.01
40.00		Directional drilling, utility, <4" diameter				L.F.				$ 20.00				$ 800.00									$ 800.00
1.00	312323130100	Backfill, heavy soil, by hand, no compaction	1 Clab	11	0.727	L.C.Y.	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ 88.50
40.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 286.00	$ 134.40	$ -	$ 420.40	$ 7.90	$ 5.00	$ -	$ 12.90	$ 316.00	$ 200.00	$ -	$ 516.00	$ 936.40
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
0.02	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 8.10	$ 1.69	$ 0.22	$ 10.01	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 8.91	$ 2.50	$ 0.24	$ 11.65	$ 21.66
Grand Total														***$ 1,904.41***								***$ 1,445.01***	***$ 3,349.42***

Low Scenario, Short Open PE

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
13.33	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 41.86	$ 39.46	$ 81.31	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 61.98	$ 43.46	$ 105.44	$ 186.75
13.33	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 23.86	$ 12.26	$ 36.12	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 35.32	$ 13.46	$ 48.79	$ 84.91
40.00	331413201120	Water supply distribution piping, polyethylene pipe, 160 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	485	0.021	L.F.	$ 0.74	$ 1.55	$ -	$ 2.29	$ 29.60	$ 62.00	$ -	$ 91.60	$ 0.81	$ 2.30	$ -	$ 3.11	$ 32.40	$ 92.00	$ -	$ 124.40	$ 216.00
2.00	331413202240	Water supply distribution piping, fittings polyethylene insert type, nylon, cold water, clamp ring, stainless steel, 160 & 250 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	321	0.031	Ea.	$ 3.82	$ 2.34	$ -	$ 6.16	$ 7.64	$ 4.68	$ -	$ 12.32	$ 4.20	$ 3.48	$ -	$ 7.68	$ 8.40	$ 6.96	$ -	$ 15.36	$ 27.68
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
15.00	320610100310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 4" thick, excludes base	B24	600	0.04	S.F.	$ 3.41	$ 2.22	$ -	$ 5.63	$ 51.15	$ 33.30	$ -	$ 84.45	$ 3.75	$ 3.27	$ -	$ 7.02	$ 56.25	$ 49.05	$ -	$ 105.30	$ 189.75
0.12	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 54.00	$ 11.28	$ 1.46	$ 66.74	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 59.40	$ 16.68	$ 1.61	$ 77.69	$ 144.43
Grand Total														***$ 903.04***								***$ 1,192.83***	***$ 2,095.87***

Low Scenario, Short Open Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
13.33	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 41.86	$ 39.46	$ 81.31	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 61.98	$ 43.46	$ 105.44	$ 186.75
13.33	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 23.86	$ 12.26	$ 36.12	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 35.32	$ 13.46	$ 48.79	$ 84.91
40.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 286.00	$ 134.40	$ -	$ 420.40	$ 7.90	$ 5.00	$ -	$ 12.90	$ 316.00	$ 200.00	$ -	$ 516.00	$ 936.40
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
15.00	320610100310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 4" thick, excludes base	B24	600	0.04	S.F.	$ 3.41	$ 2.22	$ -	$ 5.63	$ 51.15	$ 33.30	$ -	$ 84.45	$ 3.75	$ 3.27	$ -	$ 7.02	$ 56.25	$ 49.05	$ -	$ 105.30	$ 189.75
0.12	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 54.00	$ 11.28	$ 1.46	$ 66.74	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 59.40	$ 16.68	$ 1.61	$ 77.69	$ 144.43
Grand Total														***$ 1,321.42***								***$ 1,709.67***	***$ 3,031.09***

Low Scenario, Long DD PE

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
1.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 4.65	$ 3.26	$ 7.91	$ 14.01
71.00		Directional drilling, utility, <4" diameter				L.F.				$ 20.00				$ 1,420.00									$ 1,420.00
1.00	312323130100	Backfill, heavy soil, by hand, no compaction	1 Clab	11	0.727	L.C.Y.	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ 88.50
71.00	331413201120	Water supply distribution piping, polyethylene pipe, 160 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	485	0.021	L.F.	$ 0.74	$ 1.55	$ -	$ 2.29	$ 52.54	$ 110.05	$ -	$ 162.59	$ 0.81	$ 2.30	$ -	$ 3.11	$ 57.51	$ 163.30	$ -	$ 220.81	$ 383.40
2.00	331413202240	Water supply distribution piping, fittings polyethylene insert type, nylon, cold water, clamp ring, stainless steel, 160 & 250 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	321	0.031	Ea.	$ 3.82	$ 2.34	$ -	$ 6.16	$ 7.64	$ 4.68	$ -	$ 12.32	$ 4.20	$ 3.48	$ -	$ 7.68	$ 8.40	$ 6.96	$ -	$ 15.36	$ 27.68
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
0.07	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 32.40	$ 6.77	$ 0.88	$ 40.05	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 35.64	$ 10.01	$ 0.96	$ 46.61	$ 86.66
Construction Cost														***$ 2,207.06***								***$ 1,059.54***	***$ 3,266.60***

Low Scenario, Long DD Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
1.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 4.65	$ 3.26	$ 7.91	$ 14.01
71.00		Directional drilling, utility, <4" diameter				L.F.				$ 20.00				$ 1,420.00									$ 1,420.00
1.00	312323130100	Backfill, heavy soil, by hand, no compaction	1 Clab	11	0.727	L.C.Y.	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ 88.50
71.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 507.65	$ 238.56	$ -	$ 746.21	$ 7.90	$ 5.00	$ -	$ 12.90	$ 560.90	$ 355.00	$ -	$ 915.90	$ 1,662.11
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
0.02	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 8.10	$ 1.69	$ 0.22	$ 10.01	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 8.91	$ 2.50	$ 0.24	$ 11.65	$ 21.66
Grand Total														***$ 2,850.22***								***$ 1,844.91***	***$ 4,695.13***

Low Scenario, Long Open PE

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
23.67	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 74.32	$ 70.06	$ 144.39	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 110.07	$ 77.16	$ 187.23	$ 331.62
23.67	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 42.37	$ 21.78	$ 64.15	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 62.73	$ 23.91	$ 86.63	$ 150.78
2.05	312323200024	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 C.Y. truck, cycle 8 miles, 15 MPH, excludes loading equipment	B34A	88	0.091	L.C.Y.	$ -	$ 5.20	$ 5.75	$ 10.95	$ -	$ 10.66	$ 11.79	$ 22.45	$ -	$ 7.75	$ 6.35	$ 14.10	$ -	$ 15.89	$ 13.02	$ 28.91	$ 51.36
71.00	331413201120	Water supply distribution piping, polyethylene pipe, 160 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	485	0.021	L.F.	$ 0.74	$ 1.55	$ -	$ 2.29	$ 52.54	$ 110.05	$ -	$ 162.59	$ 0.81	$ 2.30	$ -	$ 3.11	$ 57.51	$ 163.30	$ -	$ 220.81	$ 383.40
2.00	331413202240	Water supply distribution piping, fittings polyethylene insert type, nylon, cold water, clamp ring, stainless steel, 160 & 250 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	321	0.031	Ea.	$ 3.82	$ 2.34	$ -	$ 6.16	$ 7.64	$ 4.68	$ -	$ 12.32	$ 4.20	$ 3.48	$ -	$ 7.68	$ 8.40	$ 6.96	$ -	$ 15.36	$ 27.68
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
9.33	024113175050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	B38	420	0.095	S.Y.	$ -	$ 5.25	$ 3.41	$ 8.66	$ -	$ 48.98	$ 31.82	$ 80.80	$ -	$ 7.80	$ 3.75	$ 11.55	$ -	$ 72.77	$ 34.99	$ 107.76	$ 188.56
9.33	321216131050	Plant-mix asphalt paving, for highways and large paved areas, pavement replacement over trench, 4" thick, no hauling included	B17C	70	0.686	S.Y.	$ 18.00	$ 37.00	$ 37.50	$ 92.50	$ 167.94	$ 345.21	$ 349.88	$ 863.03	$ 19.80	$ 55.00	$ 41.00	$ 115.80	$ 184.73	$ 513.15	$ 382.53	$ 1,080.41	$ 1,943.44
15.00	320610100310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 4" thick, excludes base	B24	600	0.04	S.F.	$ 3.41	$ 2.22	$ -	$ 5.63	$ 51.15	$ 33.30	$ -	$ 84.45	$ 3.75	$ 3.27	$ -	$ 7.02	$ 56.25	$ 49.05	$ -	$ 105.30	$ 189.75
3.00	321613130404	Cast-in place concrete curbs & gutters, concrete, wood forms, straight, 6" x 18", includes concrete	C2A	500	0.096	L.F.	$ 10.25	$ 5.60	$ -	$ 15.85	$ 30.75	$ 16.80	$ -	$ 47.55	$ 11.25	$ 8.25	$ -	$ 19.50	$ 33.75	$ 24.75	$ -	$ 58.50	$ 106.05
0.13	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 58.05	$ 12.13	$ 1.57	$ 71.75	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 63.86	$ 17.93	$ 1.73	$ 83.51	$ 155.26
Construction Cost														***$ 2,083.98***								***$ 2,690.27***	***$ 4,774.25***

Low Scenario, Long Open Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
23.67	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 74.32	$ 70.06	$ 144.39	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 110.07	$ 77.16	$ 187.23	$ 331.62
23.67	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 42.37	$ 21.78	$ 64.15	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 62.73	$ 23.91	$ 86.63	$ 150.78
2.05	312323200024	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 C.Y. truck, cycle 8 miles, 15 MPH, excludes loading equipment	B34A	88	0.091	L.C.Y.	$ -	$ 5.20	$ 5.75	$ 10.95	$ -	$ 10.66	$ 11.79	$ 22.45	$ -	$ 7.75	$ 6.35	$ 14.10	$ -	$ 15.89	$ 13.02	$ 28.91	$ 51.36
71.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 507.65	$ 238.56	$ -	$ 746.21	$ 7.90	$ 5.00	$ -	$ 12.90	$ 560.90	$ 355.00	$ -	$ 915.90	$ 1,662.11
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
9.33	024113175050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	B38	420	0.095	S.Y.	$ -	$ 5.25	$ 3.41	$ 8.66	$ -	$ 48.98	$ 31.82	$ 80.80	$ -	$ 7.80	$ 3.75	$ 11.55	$ -	$ 72.77	$ 34.99	$ 107.76	$ 188.56
9.33	321216131050	Plant-mix asphalt paving, for highways and large paved areas, pavement replacement over trench, 4" thick, no hauling included	B17C	70	0.686	S.Y.	$ 18.00	$ 37.00	$ 37.50	$ 92.50	$ 167.94	$ 345.21	$ 349.88	$ 863.03	$ 19.80	$ 55.00	$ 41.00	$ 115.80	$ 184.73	$ 513.15	$ 382.53	$ 1,080.41	$ 1,943.44
15.00	320610100310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 4" thick, excludes base	B24	600	0.04	S.F.	$ 3.41	$ 2.22	$ -	$ 5.63	$ 51.15	$ 33.30	$ -	$ 84.45	$ 3.75	$ 3.27	$ -	$ 7.02	$ 56.25	$ 49.05	$ -	$ 105.30	$ 189.75
3.00	321613130404	Cast-in place concrete curbs & gutters, concrete, wood forms, straight, 6" x 18", includes concrete	C2A	500	0.096	L.F.	$ 10.25	$ 5.60	$ -	$ 15.85	$ 30.75	$ 16.80	$ -	$ 47.55	$ 11.25	$ 8.25	$ -	$ 19.50	$ 33.75	$ 24.75	$ -	$ 58.50	$ 106.05
0.13	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 58.05	$ 12.13	$ 1.57	$ 71.75	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 63.86	$ 17.93	$ 1.73	$ 83.51	$ 155.26
Construction Cost														***$ 2,757.18***								***$ 3,510.60***	***$ 6,267.78***

Medium Scenario, Open Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
94.67	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 297.26	$ 280.22	$ 577.49	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 440.22	$ 308.62	$ 748.84	$ 1,326.33
94.67	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 169.46	$ 87.10	$ 256.56	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 250.88	$ 95.62	$ 346.49	$ 603.05
4.11	312323200024	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 C.Y. truck, cycle 8 miles, 15 MPH, excludes loading equipment	B34A	88	0.091	L.C.Y.	$ -	$ 5.20	$ 5.75	$ 10.95	$ -	$ 21.37	$ 23.63	$ 45.00	$ -	$ 7.75	$ 6.35	$ 14.10	$ -	$ 31.85	$ 26.10	$ 57.95	$ 102.95
71.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 507.65	$ 238.56	$ -	$ 746.21	$ 7.90	$ 5.00	$ -	$ 12.90	$ 560.90	$ 355.00	$ -	$ 915.90	$ 1,662.11
1.00	331413457166	Water supply distribution piping, fittings, brass, corporation stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 123.00	$ 37.50	$ -	$ 160.50	$ 123.00	$ 37.50	$ -	$ 160.50	$ 135.00	$ 55.50	$ -	$ 190.50	$ 135.00	$ 55.50	$ -	$ 190.50	$ 351.00
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
18.67	024113175050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	B38	420	0.095	S.Y.	$ -	$ 5.25	$ 3.41	$ 8.66	$ -	$ 98.02	$ 63.66	$ 161.68	$ -	$ 7.80	$ 3.75	$ 11.55	$ -	$ 145.63	$ 70.01	$ 215.64	$ 377.32
18.67	321216131050	Plant-mix asphalt paving, for highways and large paved areas, pavement replacement over trench, 4" thick, no hauling included	B17C	70	0.686	S.Y.	$ 18.00	$ 37.00	$ 37.50	$ 92.50	$ 336.06	$ 690.79	$ 700.13	$ 1,726.98	$ 19.80	$ 55.00	$ 41.00	$ 115.80	$ 369.67	$ 1,026.85	$ 765.47	$ 2,161.99	$ 3,888.97
30.00	320610100310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 4" thick, excludes base	B24	600	0.04	S.F.	$ 3.41	$ 2.22	$ -	$ 5.63	$ 102.30	$ 66.60	$ -	$ 168.90	$ 3.75	$ 3.27	$ -	$ 7.02	$ 112.50	$ 98.10	$ -	$ 210.60	$ 379.50
6.00	321613130404	Cast-in place concrete curbs & gutters, concrete, wood forms, straight, 6" x 18", includes concrete	C2A	500	0.096	L.F.	$ 10.25	$ 5.60	$ -	$ 15.85	$ 61.50	$ 33.60	$ -	$ 95.10	$ 11.25	$ 8.25	$ -	$ 19.50	$ 67.50	$ 49.50	$ -	$ 117.00	$ 212.10
0.26	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 116.10	$ 24.25	$ 3.15	$ 143.50	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 127.71	$ 35.86	$ 3.46	$ 167.03	$ 310.53
Construction Cost														***$ 4,714.32***								***$ 5,988.39***	***$ 10,702.71***

High Scenario, Open Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.20	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 340.00	$ -	$ 340.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 509.80	$ 849.80
0.10	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 250.00	$ -	$ 250.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 374.90	$ 624.90
94.67	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 297.26	$ 280.22	$ 577.49	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 440.22	$ 308.62	$ 748.84	$ 1,326.33
94.67	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 169.46	$ 87.10	$ 256.56	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 250.88	$ 95.62	$ 346.49	$ 603.05
94.67	312323154000	Borrow, common earth, 1 C.Y. bucket, loading and/or spreading, shovel	B12N	840	0.019	B.C.Y.	$ 22.00	$ 1.12	$ 1.69	$ 24.81	$ 2,082.74	$ 106.03	$ 159.99	$ 2,348.76	$ 24.50	$ 1.66	$ 1.86	$ 28.02	$ 2,319.42	$ 157.15	$ 176.09	$ 2,652.65	$ 5,001.41
141.89	312323200024	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 C.Y. truck, cycle 8 miles, 15 MPH, excludes loading equipment	B34A	88	0.091	L.C.Y.	$ -	$ 5.20	$ 5.75	$ 10.95	$ -	$ 737.83	$ 815.87	$ 1,553.70	$ -	$ 7.75	$ 6.35	$ 14.10	$ -	$ 1,099.65	$ 901.00	$ 2,000.65	$ 3,554.35
71.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 507.65	$ 238.56	$ -	$ 746.21	$ 7.90	$ 5.00	$ -	$ 12.90	$ 560.90	$ 355.00	$ -	$ 915.90	$ 1,662.11
1.00	331413457166	Water supply distribution piping, fittings, brass, corporation stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 123.00	$ 37.50	$ -	$ 160.50	$ 123.00	$ 37.50	$ -	$ 160.50	$ 135.00	$ 55.50	$ -	$ 190.50	$ 135.00	$ 55.50	$ -	$ 190.50	$ 351.00
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
18.67	024113175050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	B38	420	0.095	S.Y.	$ -	$ 5.25	$ 3.41	$ 8.66	$ -	$ 98.02	$ 63.66	$ 161.68	$ -	$ 7.80	$ 3.75	$ 11.55	$ -	$ 145.63	$ 70.01	$ 215.64	$ 377.32
410.67	321216130080	Plant-mix asphalt paving, for highways and large paved areas, binder course, 1-1/2" thick, no hauling included	B25	7725	0.011	S.Y.	$ 6.60	$ 0.61	$ 0.42	$ 7.63	$ 2,710.42	$ 250.51	$ 172.48	$ 3,133.41	$ 7.30	$ 0.90	$ 0.46	$ 8.66	$ 2,997.89	$ 369.60	$ 188.91	$ 3,556.40	$ 6,689.81
30.00	320610100310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3,000 psi, 4" thick, excludes base	B24	600	0.04	S.F.	$ 3.41	$ 2.22	$ -	$ 5.63	$ 102.30	$ 66.60	$ -	$ 168.90	$ 3.75	$ 3.27	$ -	$ 7.02	$ 112.50	$ 98.10	$ -	$ 210.60	$ 379.50
264.00	321613130404	Cast-in place concrete curbs & gutters, concrete, wood forms, straight, 6" x 18", includes concrete	C2A	500	0.096	L.F.	$ 10.25	$ 5.60	$ -	$ 15.85	$ 2,706.00	$ 1,478.40	$ -	$ 4,184.40	$ 11.25	$ 8.25	$ -	$ 19.50	$ 2,970.00	$ 2,178.00	$ -	$ 5,148.00	$ 9,332.40
1.00	221119382100	Water supply meter, domestic/commercial, bronze, threaded, to 50 GPM, 1" diameter	1 Plum	12	0.667	Ea.	$ 700.00	$ 50.00	$ -	$ 750.00	$ 700.00	$ 50.00	$ -	$ 750.00	$ 770.00	$ 74.00	$ -	$ 844.00	$ 770.00	$ 74.00	$ -	$ 844.00	$ 1,594.00
0.26	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 116.10	$ 24.25	$ 3.15	$ 143.50	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 127.71	$ 35.86	$ 3.46	$ 167.03	$ 310.53
Construction Cost														***$ 15,112.51***								***$ 18,295.50***	***$ 33,408.01***

Customer Side, DD PE

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
1.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 4.65	$ 3.26	$ 7.91	$ 14.01
30.00	Derived elsewhere	Directional drilling, utility, <4" diameter				L.F.				$ 20.00				$ 600.00									$ 600.00
1.00	312323130100	Backfill, heavy soil, by hand, no compaction	1 Clab	11	0.727	L.C.Y.	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ 88.50
30.00	331413201120	Water supply distribution piping, polyethylene pipe, 160 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	485	0.021	L.F.	$ 0.74	$ 1.55	$ -	$ 2.29	$ 22.20	$ 46.50	$ -	$ 68.70	$ 0.81	$ 2.30	$ -	$ 3.11	$ 24.30	$ 69.00	$ -	$ 93.30	$ 162.00
2.00	331413202240	Water supply distribution piping, fittings polyethylene insert type, nylon, cold water, clamp ring, stainless steel, 160 & 250 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	321	0.031	Ea.	$ 3.82	$ 2.34	$ -	$ 6.16	$ 7.64	$ 4.68	$ -	$ 12.32	$ 4.20	$ 3.48	$ -	$ 7.68	$ 8.40	$ 6.96	$ -	$ 15.36	$ 27.68
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
0.02	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 8.10	$ 1.69	$ 0.22	$ 10.01	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 8.91	$ 2.50	$ 0.24	$ 11.65	$ 21.66
Grand Total														***$ 1,263.13***								***$ 897.07***	***$ 2,160.20***

Customer Side, DD Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
1.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 4.65	$ 3.26	$ 7.91	$ 14.01
30.00		Directional drilling, utility, <4" diameter				L.F.				$ 20.00				$ 600.00									$ 600.00
1.00	312323130100	Backfill, heavy soil, by hand, no compaction	1 Clab	11	0.727	L.C.Y.	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 35.50	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ -	$ 53.00	$ 88.50
30.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 214.50	$ 100.80	$ -	$ 315.30	$ 7.90	$ 5.00	$ -	$ 12.90	$ 237.00	$ 150.00	$ -	$ 387.00	$ 702.30
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
0.02	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 8.10	$ 1.69	$ 0.22	$ 10.01	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 8.91	$ 2.50	$ 0.24	$ 11.65	$ 21.66
Grand Total														***$ 1,599.31***								***$ 1,316.01***	***$ 2,915.32***

Customer Side, Open PE

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
10.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 31.40	$ 29.60	$ 61.00	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 46.50	$ 32.60	$ 79.10	$ 140.10
10.00	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 17.90	$ 9.20	$ 27.10	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 26.50	$ 10.10	$ 36.60	$ 63.70
30.00	331413201120	Water supply distribution piping, polyethylene pipe, 160 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	485	0.021	L.F.	$ 0.74	$ 1.55	$ -	$ 2.29	$ 22.20	$ 46.50	$ -	$ 68.70	$ 0.81	$ 2.30	$ -	$ 3.11	$ 24.30	$ 69.00	$ -	$ 93.30	$ 162.00
2.00	331413202240	Water supply distribution piping, fittings polyethylene insert type, nylon, cold water, clamp ring, stainless steel, 160 & 250 psi, 1" diameter, C901, excludes excavation or backfill	Q1A	321	0.031	Ea.	$ 3.82	$ 2.34	$ -	$ 6.16	$ 7.64	$ 4.68	$ -	$ 12.32	$ 4.20	$ 3.48	$ -	$ 7.68	$ 8.40	$ 6.96	$ -	$ 15.36	$ 27.68
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
0.09	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 40.50	$ 8.46	$ 1.10	$ 50.06	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 44.55	$ 12.51	$ 1.21	$ 58.27	$ 108.33
Grand Total														***$ 749.68***								***$ 998.48***	***$ 1,748.16***

Customer Side, Open Cu

Quantity	LineNumber	Description	Crew	Daily Output	Labor Hours	Unit	Material	Labor	Equipment	Total	Ext. Mat.	Ext. Labor	Ext. Equip.	Ext. Total	Mat. O&P	Labor O&P	Equip. O&P	Total O&P	Ext. Mat. O&P	Ext. Labor O&P	Ext. Equip. O&P	Ext. Total O&P	Grand Total
0.10	013113200100	Field personnel, field engineer, junior engineer		0	0	Week	$ -	$ 1,700.00	$ -	$ 1,700.00	$ -	$ 170.00	$ -	$ 170.00	$ -	$ -	$ -	$ 2,549.00	$ -	$ -	$ -	$ 254.90	$ 424.90
0.05	013113200200	Field personnel, project manager, average		0	0	Week	$ -	$ 2,500.00	$ -	$ 2,500.00	$ -	$ 125.00	$ -	$ 125.00	$ -	$ -	$ -	$ 3,749.00	$ -	$ -	$ -	$ 187.45	$ 312.45
10.00	312316130110	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 4' to 6' deep, excavator, excludes sheeting or dewatering	B12F	300	0.053	B.C.Y.	$ -	$ 3.14	$ 2.96	$ 6.10	$ -	$ 31.40	$ 29.60	$ 61.00	$ -	$ 4.65	$ 3.26	$ 7.91	$ -	$ 46.50	$ 32.60	$ 79.10	$ 140.10
10.00	312316133020	Excavating, trench backfill, 1 C.Y. bucket, minimal haul, front end loader, wheel mounted, excludes dewatering	B10R	400	0.03	L.C.Y.	$ -	$ 1.79	$ 0.92	$ 2.71	$ -	$ 17.90	$ 9.20	$ 27.10	$ -	$ 2.65	$ 1.01	$ 3.66	$ -	$ 26.50	$ 10.10	$ 36.60	$ 63.70
30.00	331413452200	Water supply distribution piping, copper tubing, 20' joints, 1" diameter, type K, excludes excavation or backfill	Q1	320	0.05	L.F.	$ 7.15	$ 3.36	$ -	$ 10.51	$ 214.50	$ 100.80	$ -	$ 315.30	$ 7.90	$ 5.00	$ -	$ 12.90	$ 237.00	$ 150.00	$ -	$ 387.00	$ 702.30
1.00	331413457171	Water supply distribution piping, copper, curb stops, no lead, 1" diameter, excludes excavation or backfill	1 Plum	16	0.5	Ea.	$ 198.00	$ 37.50	$ -	$ 235.50	$ 198.00	$ 37.50	$ -	$ 235.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 218.00	$ 55.50	$ -	$ 273.50	$ 509.00
2.00	221113250130	Elbow, 90 Deg., copper, wrought, copper x copper, 1"	1 Plum	16	0.5	Ea.	$ 13.45	$ 37.50	$ -	$ 50.95	$ 26.90	$ 75.00	$ -	$ 101.90	$ 14.80	$ 55.50	$ -	$ 70.30	$ 29.60	$ 111.00	$ -	$ 140.60	$ 242.50
0.09	329223100020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	B63	22	1.818	M.S.F.	$ 450.00	$ 94.00	$ 12.20	$ 556.20	$ 40.50	$ 8.46	$ 1.10	$ 50.06	$ 495.00	$ 139.00	$ 13.40	$ 647.40	$ 44.55	$ 12.51	$ 1.21	$ 58.27	$ 108.33
Grand Total														***$ 1,085.86***								***$ 1,417.42***	***$ 2,503.28***

Appendix C: ENR Annual Construction Cost Indices

Sources:

- All annual index values shown below are published at: https://www.enr.com/economics/historical_indices/construction_cost_index_history
- All annual index values shown below, from 1999 through 2022, are also included in the LCRI docket in a spreadsheet supporting the LCRI Economic Analysis, which is titled "LSLR Unit Cost Analysis," https://www.regulations.gov/document/EPA-HQ-OW-2022-0801-0521.

Year	Cost Index
2023	13358.05
2022	13006.84
2021	12133
2020	11465.67
2019	11281
2018	11062
2017	10737
2016	10338
2015	10035
2014	9806
2013	9547
2012	9308
2011	9070
2010	8799
2009	8570
2008	8310
2007	7966
2006	7751
2005	7446
2004	7115
2003	6694
2002	6538
2001	6343
2000	6221
1999	6059

From:	Elin Betanzo
To:	EFAB
Subject:	Re: EPA EFAB Water Affordability Public Listening Session - Thank You for Registering!
Date:	Tuesday, February 20, 2024 2:21:50 PM

Thank you so much for the opportunity to speak at your session today.

As I mentioned during my oral comments, I wanted to share another report. Please see the linked report from the National Drinking Water Advisory Council Microbial and Disinfection Byproduct Working Group. Recommendation 7 begins to describe some of the regulatory gaps around wholesale and consecutive drinking water system relationships. This is by no means comprehensive, but I hope it begins to illustrate how public health protection could be weakened in the name of cost savings if consolidation is expanded without addressing these critical gaps.

As I stated during the session:
Specifically, I want to speak about drinking water systems in terms of consolidation. Sharing resources and staff can be a great opportunity for cost savings, but I urge extreme caution when exploring physical consolidation of water systems.

Any consideration of consolidation for small water systems should identify, before anything else, whether the consolidation will be able to maintain or improve public health protection. If this is not the case, consolidation or regionalization should not be considered. I hope EFAB will consider reframing the questions around water system consolidation and regionalization as they currently only consider cost. We should never be considering cost-saving measures solely through a lens of reducing costs. Anything you do in this space needs to clearly identify the necessity of maintaining or improving public health protection while pursuing cost savings.

The NDWAC MDBP Working Group identified several opportunities to improve wholesale/consecutive system relationships to ensure that consecutive systems that would get consolidated are receiving equivalent public health protection and not reduced protection. It is important to address gaps in SDWA regulations and requirements before we expand the number of small water systems that are in wholesale/consecutive system relationships with unclear or incomplete SDWA obligations.

Elin Warn Betanzo
Safe Water Engineering, LLC
@SafeWaterEng, www.safewaterengineering.com
248-326-4339
Schedule a meeting with me using Calendly

From: EFAB <EFAB@epa.gov>

From: Megan Ross
To: EFAB
Subject: Public Listening Session Materials - Water Affordability - February 20
Date: Monday, February 12, 2024 1:45:07 PM
Attachments: image001.png
EPA_EFAB Listening Session Talking Points_SediVision_Megan Ross.docx
Slides with Notes_SediVision.pdf

Good afternoon,

I have signed up to speak at the upcoming public listening session regarding water affordability. I would like to provide you with these supplementary materials in addition to the public comments.

- Attached are the talking points I will be delivering and a PDF copy of the presentation slides. My talking points are abbreviated to meet the 3-minute time allocation.
- The full slides with animation and descriptions can be downloaded from the adobe link below.
- SediVision was also recently selected to pitch our technology at World Water Tech in Los Angeles in October of last year. I have included a link below to a 2-minute clip from that pitch session.

Please let me know if you need any further information. I look forward to participating in the upcoming listening session to demonstrate how our technology can assist utilities with cost savings through assessing grit accumulation in tanks and pipes.

I'm using Adobe Acrobat.
Here's the EPA_EFAB Listening Session_20Feb24.pptx for you to view.

World Water tech pitch: https://www.youtube.com/watch?v=5pN52s-Q95M

Regards,

Megan Ross, PE, ENV SP, *Vice President, SediVision, LLC*
M: (352) 262-9878
2201 Cantu Court Suite 116 | Sarasota, FL 34232
sedivision.com | **ussubmergent.com**

SEDIVISION | U.S. SUBMERGENT TECHNOLOGIES

USST Holdings, LLC

My name is Megan Ross and I am the Vice President of SediVision.

Today I am excited to be here to discuss how our technology can revolutionize wastewater tank asset management and how this can be used to help utilities properly plan and budget, as well as potentially save on costs.

A common problem that affects wastewater utilities throughout the world is Grit Accumulation.

Many utilities have no idea how much grit has accumulated or where it is located and cannot drain their tanks due to limited redundancies and capacity issues from wet weather.

SediVision is a new wastewater imaging and mapping technology that provides complete visibility in wastewater tanks and large diameter pipes and can tell you not only how much grit accumulation you have, but where it is located so that you can manage your assets more cost effectively.

In short lost capacity = lost revenue due to several operational inefficiencies including energy consumption. Aeration accounts for 30-70% of energy consumption and wastewater treatment and grit build up in tanks can increase energy costs and therefore increase your carbon footprint. In one example at a small rural 1.5 mgd facility in Clewiston Florida, we saw cost savings between 1,000 and 2,000 dollars per month simply as a result of removing 400 tons of sand and grit from their tanks. [1.5 mgd]

Slide 6: Case Study: Pinellas County

SediVision has scanned over 160 tanks in 85 facilities across multiple states.

Another case study brings us to a 33 mgd advanced water reclamation facility in southwest Florida that used SediVision on multiple aeration basins to help them put together a 5-year budget for restoring capacity in those treatment tanks.

They are using this information to evaluate a process improvement that would result in a significant reduction in aeration and therefore energy costs.

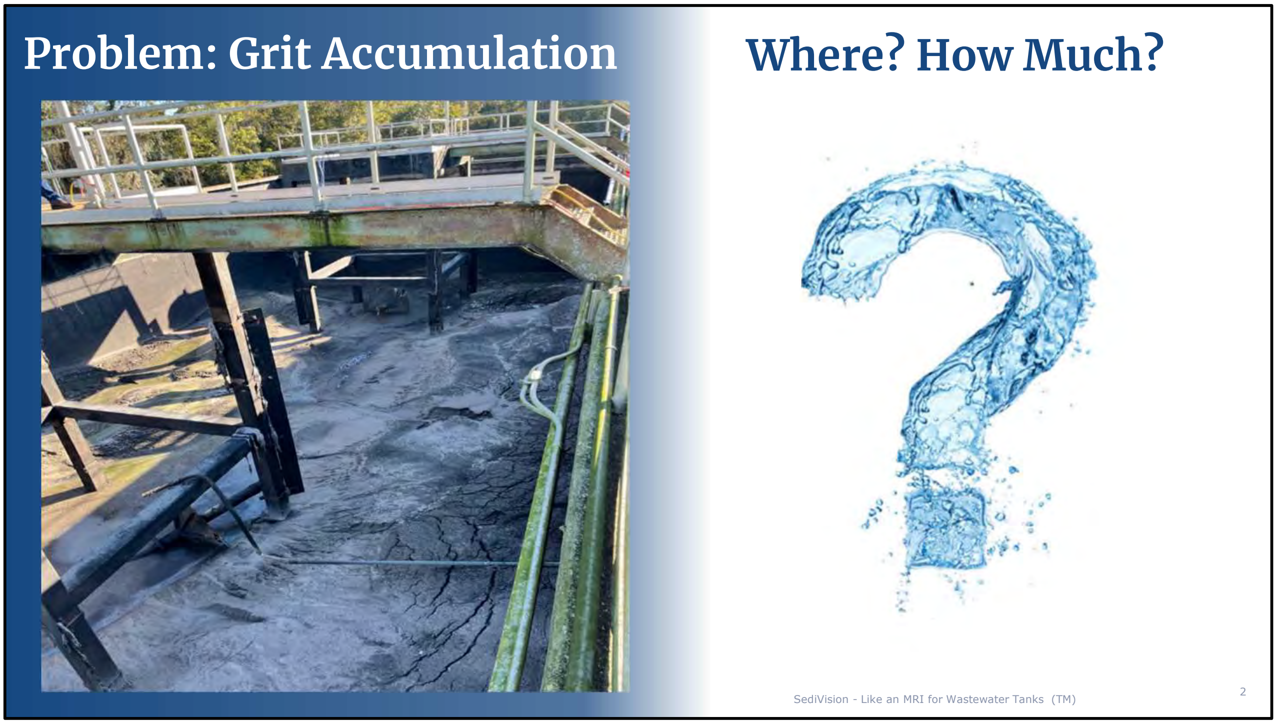
Slide 7: Blacks Ford Case Study

Another case study was at a 6 mgd water reclamation facility in northeast Florida, which was having to double capacity due to growth. Using SediVision Technology enabled them to defer a 6-8 million dollar capital cost that would have been required to install a grit removal system that was not needed and therefore saved the utility that expense.

- With regards to the collection system, we have a case study from Manatee County Florida where they were having sanitary sewer overflow issues due to obstructions in a main trunk line that was going to be very difficult and expensive to bypass
- SediVision technology assessed the pipe and found the targeted areas most in need of cleaning and that were contributing to Sewer Overflows during rain events. This coupled with our specialized online cleaning process allowed them to eliminate this SSO faster and more economically.

I want to thank you for taking the time to listen to how our technology can help utilities with financial planning and cost-savings that could reduce burdens on ratepayers.

My name is Megan Ross and I am the Vice President of SediVision.
Today I am excited to be here to discuss how our technology can revolutionize wastewater tank asset management through providing a non-invasive inspection to determine lost capacity due to grit accumulation. Not unlike how the MRI revolutionized health screenings. And how this can be used to help utilities properly plan and budget, as well as potentially save on costs.

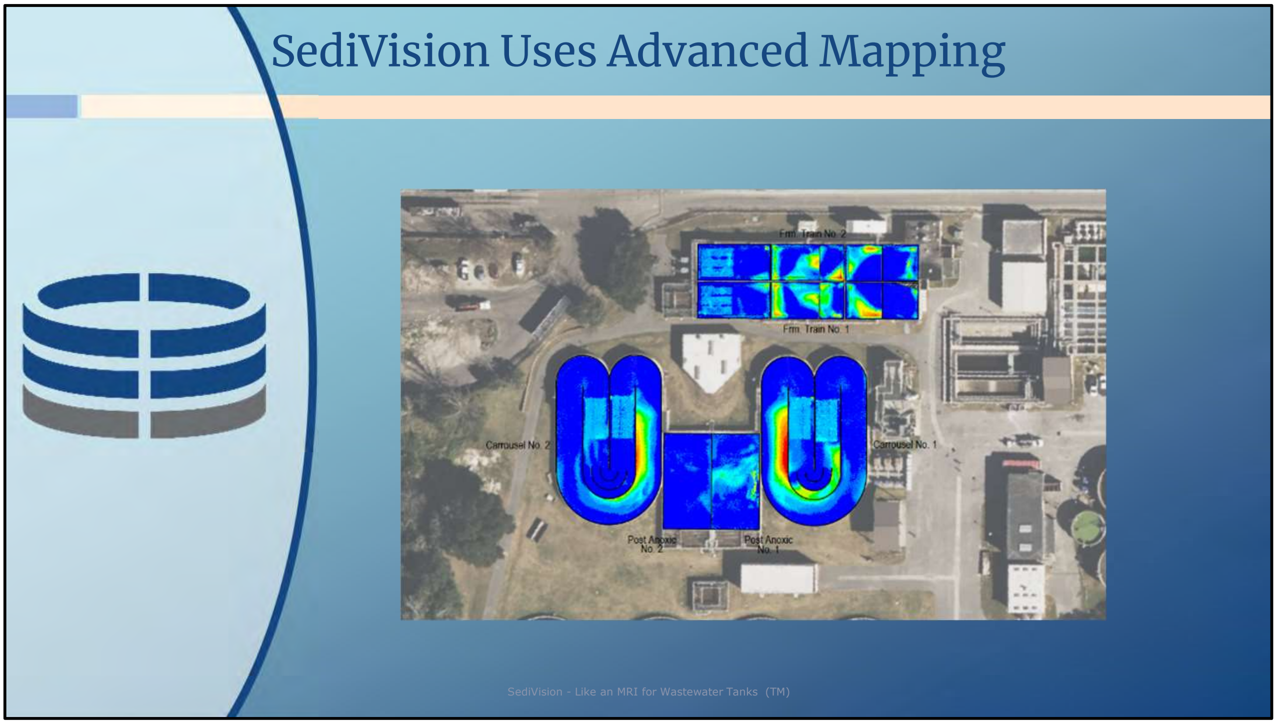


A common problem that affects wastewater utilities throughout the world is Grit Accumulation. The picture on the left is wastewater biological nutrient removal tank that was drained down and found to have 6 feet of grit accumulation in the tank. [Lake City] Many utilities have no idea how much grit has accumulated or where it is located and cannot drain their tanks due to limited redundancies and capacity issues from wet weather. Probes are not accurate, and divers pose a significant safety risk.

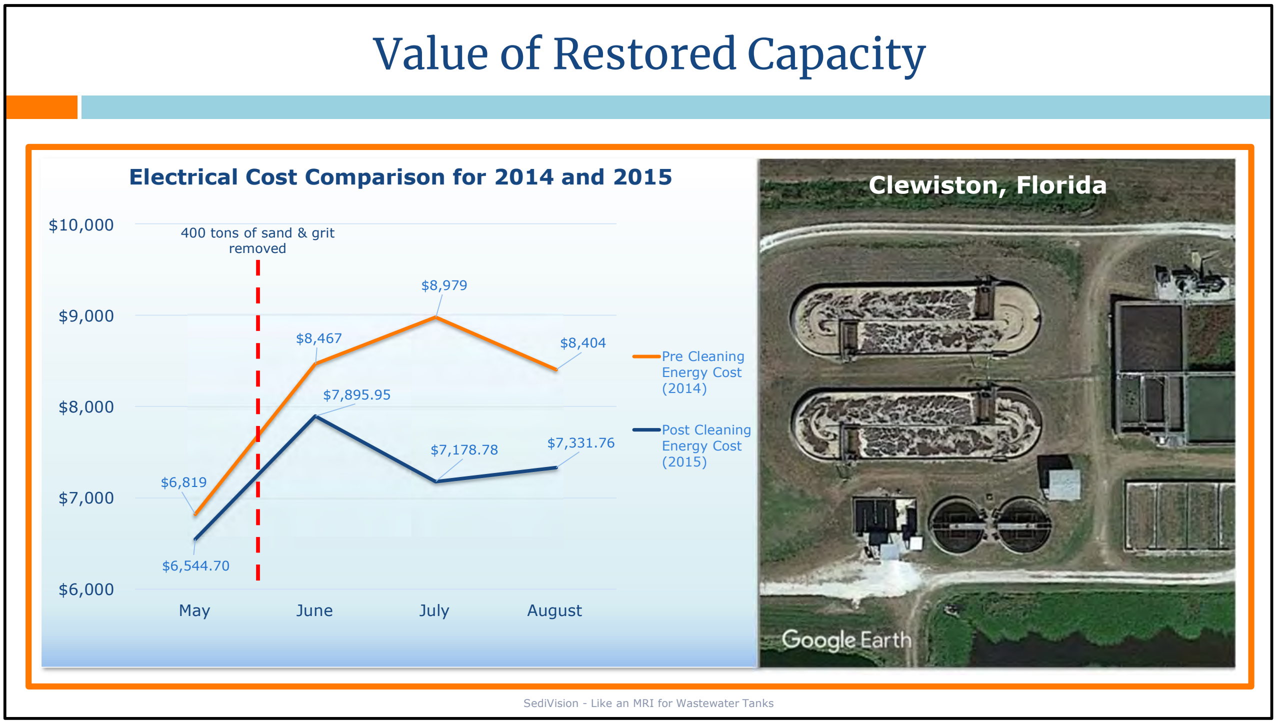
SediVision

Wastewater Imaging and Mapping Technology

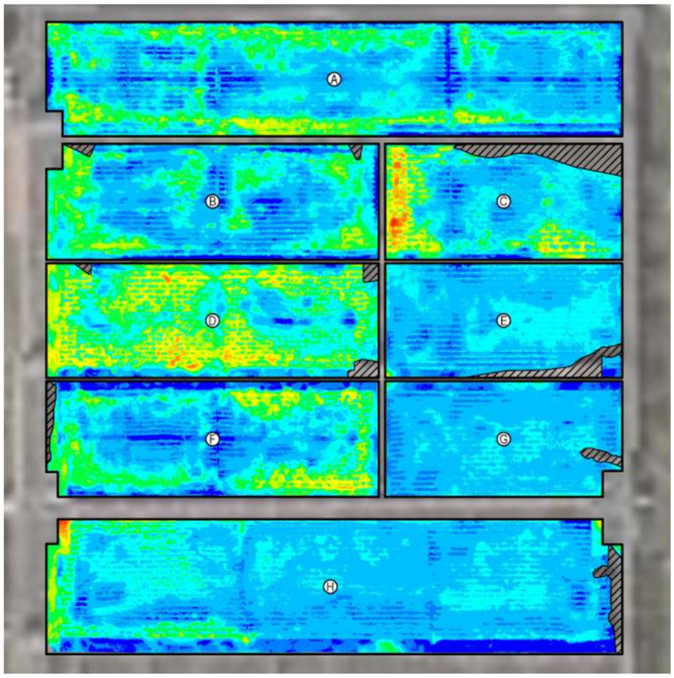
I'd like to introduce SediVision, a wastewater imaging and mapping technology that provides complete visibility in wastewater tanks and can tell you not only how much grit accumulation you have, but where it is located so that you can manage your assets more effectively.



With SediVision, our crew is deployed to your facility with specialized equipment that scans and collects data, the data is then processed by our experts in 3D using GIS, and a complete map of lost capacity in your tanks is generated.



In short lost capacity = lost revenue due to several operational inefficiencies including energy consumption. Aeration accounts for 30-70% of energy consumption in wastewater treatment and grit build up in tanks can increase energy costs and carbon footprint. This example illustrates the cost savings in a small rural facility in Clewiston Florida where they saw between 1,000 and 2,000 dollars in savings per month as a result of cleaning their tanks. [1.5 mgd]



Case Study: 33 MGD

Advanced Water Reclamation Facility, SW Florida

Process Improvement

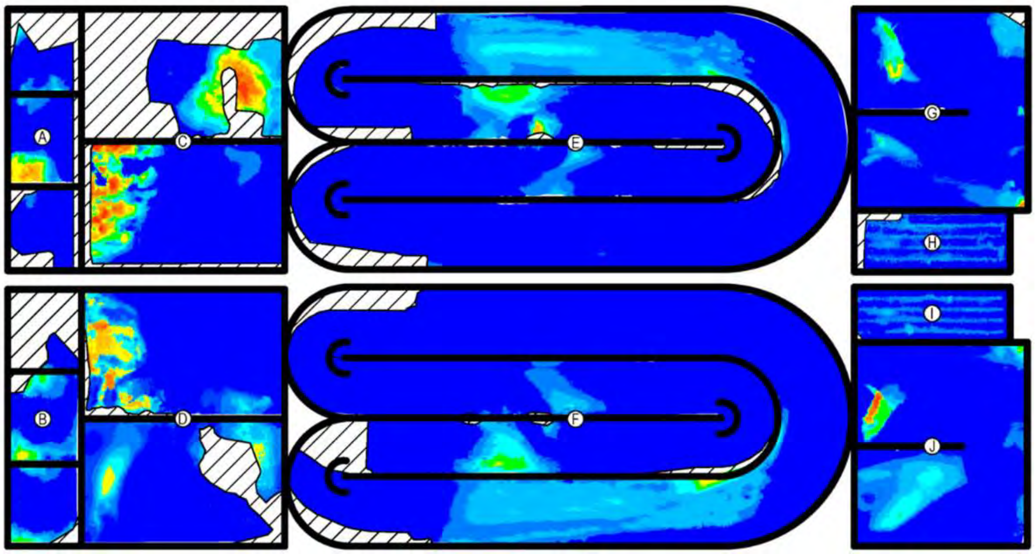
- Budgeting for the next 5 years of restoring capacity
- Improve process to reduce energy & enhance nutrient removal

SediVision has scanned over 160 tanks in 85 facilities across multiple states. I will not take a moment to highlight a few of those case studies.
The first case study brings us to a 33 mgd advanced water reclamation facility in Florida that did an assessment of 70,000 square feet of aeration basins to help them put together a 5-year budget for restoring capacity.
They are also using this information to evaluate a process improvement that would result in a significant reduction in aeration and therefore energy costs.

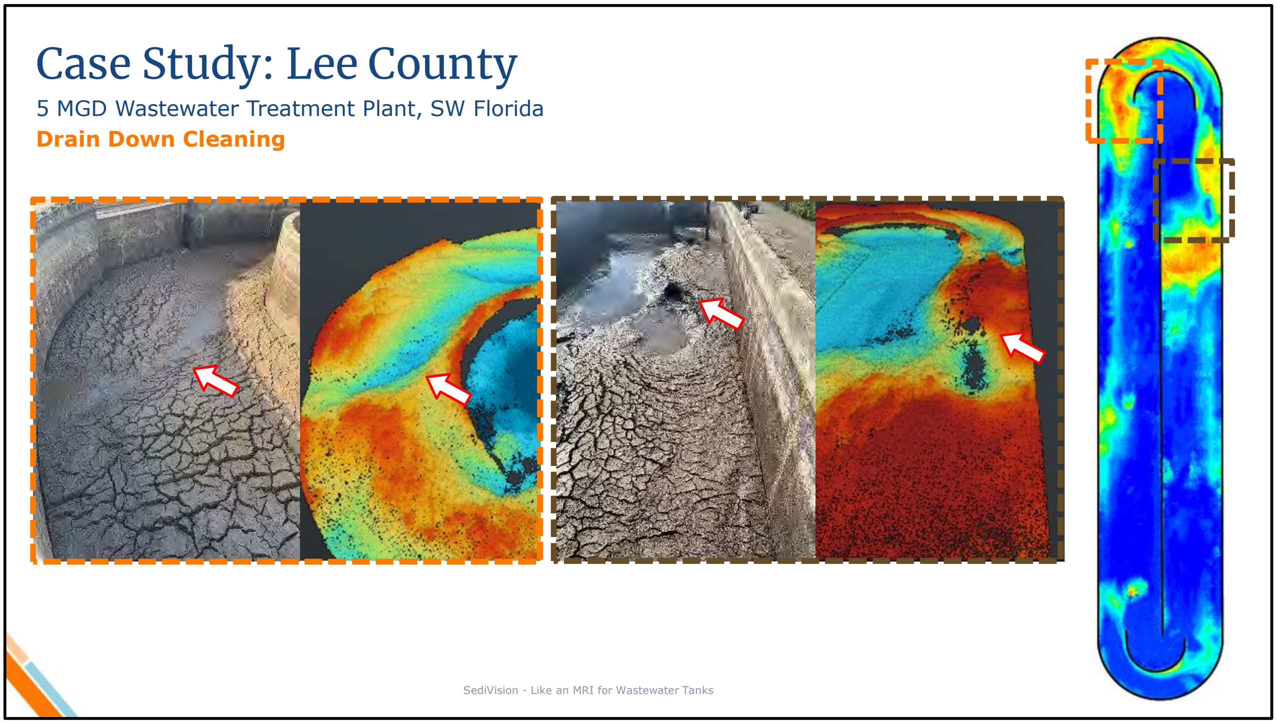
Case Study: 6 MGD

Water Reclamation Facility, NE Florida

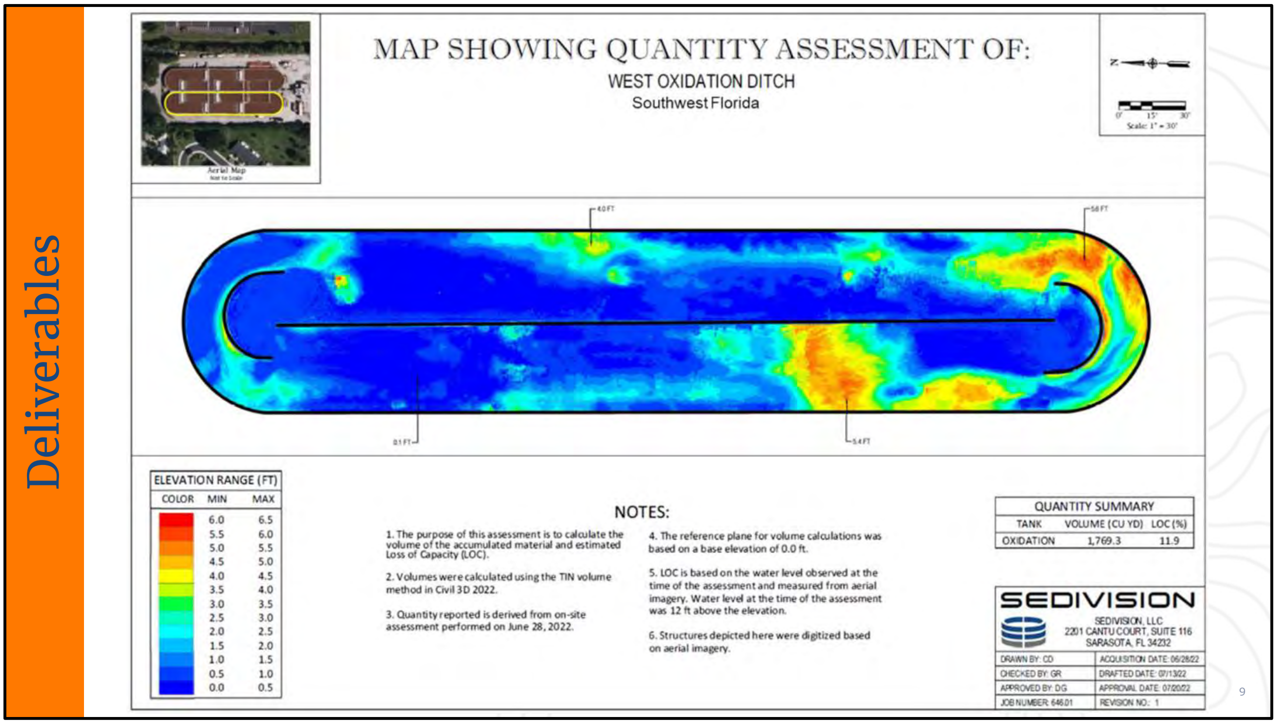
Deferred Capital Expense, $6-8 million



Another case study is a project we did in partnership with Ardurra Engineering. This facility was a 6 mgd water reclamation facility in northeast Florida, which was having to double capacity due to growth, and part of that expansion was evaluating the needs for the addition of a grit removal system that wasn't currently in place. Before installing they wanted to see how the current system was operating with their relatively new collection system. Using SediVision technology, we found that the basin had relatively small amounts of grit accumulation and was operating at only a 2% Loss of Capacity. These results enabled them to make a decision to defer the 6-8 million dollars it would require to install a grit system and therefore save the utility those capital costs.



In a case study of a scan performed in Lee County, in Southwest Florida, we were able to collect photos of drain down comparisons that were captured and enabled us to prove the accuracy and reliability of our technology as you can see here. The data was used to determine a budget for tank cleaning. We also used this study to verify and calibrate our estimates to within 1% accuracy.



The deliverables that SediVision provides to our clients are a set of detailed drawings depicting the imagery and mapping of the scanned tanks along with % of lost capacity in each tank. We can also perform core sampling to get more specific weights estimated that can be used to calculate budgetary costs for removal and disposal.

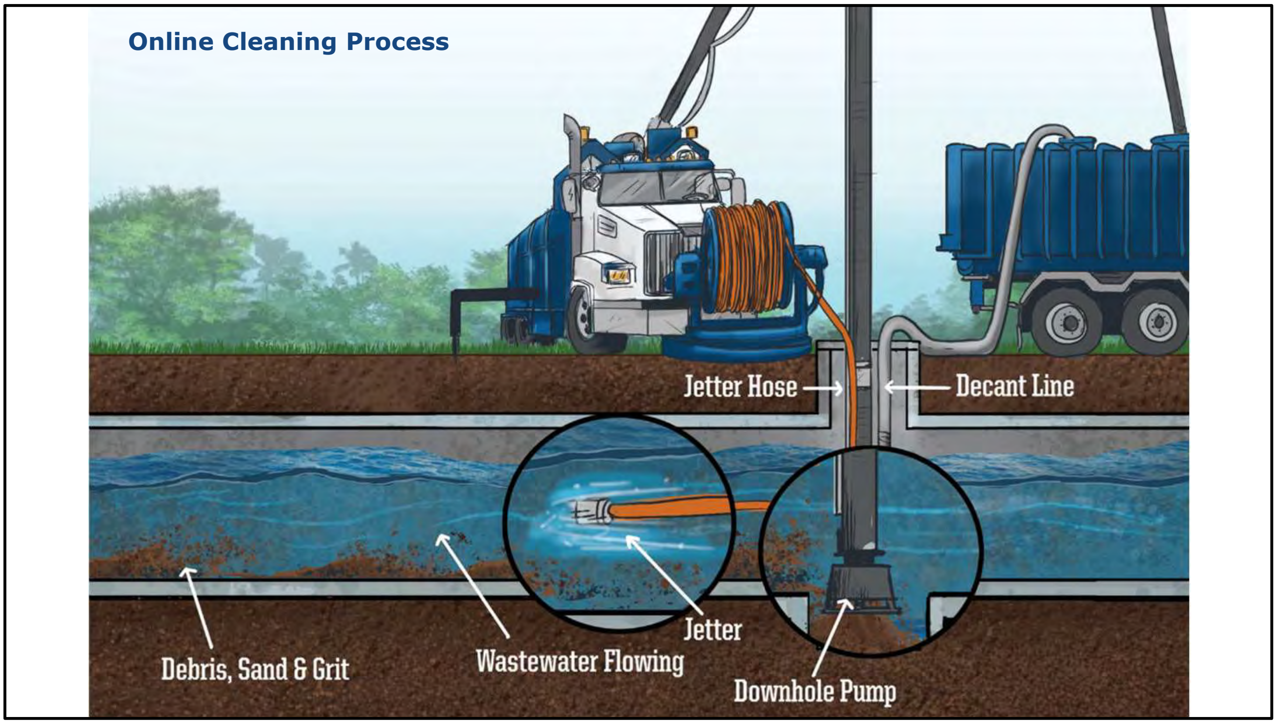
SediVision in Large Diameter Pipe

- Greater than 30”, up to 200” (16.7 ft)
- Empty or partially/fully submerged
- Tethered and up to 1,980 feet
- Online Cleaning Capabilities (no bypass or dewatering)

I would like to now introduce what we call our see, clean, verify process which utilizes sonar technology in fully or partially submerged large diameter gravity sewer pipes to inspect, identify and target areas of grit accumulation.

Typical applications are in 30-to-200-inch diameter pipe and the equipment is tethered at nearly 2,000 feet.

Using this sonar technology in combination with water chemistry and solids analysis, our turnkey approach has demonstrated a rapid solution to inspecting, cleaning, and verifying removal of debris within the pipe.



- After debris is found, an online cleaning truck can be deployed to that can clean manhole to manhole sections

- This slide depicts a typical set up. The process involves use of a jetter hose that is lowered into the pipe that forces material downstream and is collected by a downhole pump

- This is a continuous process where heavy solids will settle in a box and water will be decanted back into the pipe

- This methodology is very rare in that it enables a fully online process so that the system remains in services for the entirety of the cleaning project.

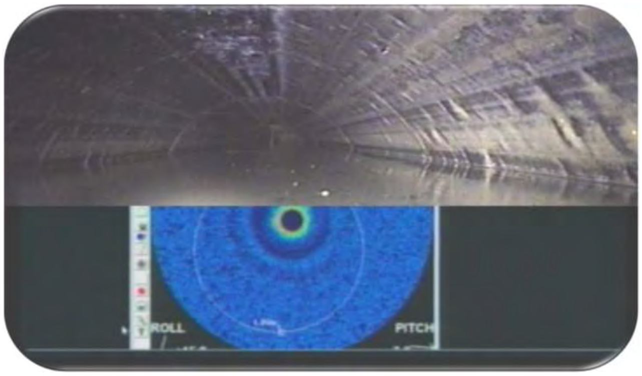
- This can used for improved operation and maintenance reliability, seamlessly eliminating bottlenecks that have been identified due to sand and sediment

- It can also be used in advance of CIPP lining projects which do ultimately require a drain down. However, by employing this method, you can minimize bypass time by performing bulk of the cleaning in advance of the drain down and preparation needed to implement the liner.

Case Study:

Manatee County, SW Florida

Pipe Assessment and Cleaning



- Estimated Cleaning: 12,000 linear ft
- Not in budget
- Main Trunk Line – Difficult to bypass
- Actual Cleaning: 3,500 linear ft of most obstructed sections
- Targeted Cleaning with SediVision – Online
- Cleaning prevented SSO

This is a case study from Manatee County Florida where they were having sanitary sewer overflow issues and estimated that they had 12,000 linear feet of pipe that needed cleaned and that was not in their budget

This involved a main trunk line that was going to be very difficult and expensive to bypass

We assessed this pipe for them and found that there was only 3,500 linear feet of pipe that were most obstructed

Once the scope was narrowed down, this project became very doable, and they utilized online cleaning capabilities to avoid bypassing

Solving the acute problem solved their SSO's almost immediately, so rain events in the past that would cause issues in the past, were no longer a problem

This was proven because the county had installed smart covers that measure flow in relation to hydrographs. They were able to use this information to budget and clean the remainder of the pipe over the next few years

In closing, I want to thank you for taking the time to listen to how our technology can help utilities with financial planning and cost-savings that could reduce burdens on ratepayers.

From:	Chaitovitz, Chuck
To:	EFAB; Johnson, Tara (she/her/hers); ck
Cc:	Merrifield, Trevor
Subject:	written comments
Date:	Tuesday, February 20, 2024 2:11:19 PM
Attachments:	image001.png 240220_EFAB_Comments_USChamber.pdf

Dear Tara and Cynthia:

Hope all is well.

I wanted to express my appreciation for being included in today's important EFAB discussion on water affordability.

As promised here are the Chamber's written comments for your consideration.

We are developing our 2024 water and resilience priorities, including promoting our small and disadvantaged community water funding roadmap, which I will share when ready.

Please let me know if you wish to discuss. Perhaps we can arrange time to follow up during the coming weeks?

Thanks again,

Chuck

Chuck Chaitovitz
Vice President, Environmental Affairs and Sustainability
U.S. Chamber of Commerce
202-463-5316 (Phone)
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U.S. Chamber of Commerce

Statement of the U.S. Chamber of Commerce
Environmental Protection Agency – Environmental Finance Advisory Board
February 20, 2024

My name is Chuck Chaitovitz, and I am Vice President of Environmental Affairs and Sustainability at the U.S. Chamber of Commerce ("Chamber"). On behalf of the Chamber, I want to thank the U.S. Environmental Protection Agency ("EPA" or "Agency") and the Environmental Finance Advisory Board ("EFAB") for convening this important discussion. The Chamber is pleased to provide feedback on your proposed 2024 priorities, including reducing the capital intensity and addressing water infrastructure challenges faced by disadvantaged communities across the nation. Today, I would like to highlight the imperative role of the business community in offering technologies, other innovations, and solutions that lead the development of smart, modern, resilient infrastructure and tackle our shared environmental and economic priorities.

Infrastructure Investment and Jobs Act

The enactment of the Infrastructure Investment and Jobs Act provided transformational $50 billion over five years. EPA was fortunate that the SRF programs were already in place to allocate the funds to the states in a timely manner. I want to commend EPA for its work on that.

However, small and disadvantaged communities often do not have the wherewithal to pursue the needed infrastructure dollars—yet those are the communities who need them most.

Recommendations

You asked for case studies and examples on policies, procurement models, and technologies that might help. The following are several practical and policy suggestions for EFAB and the Agency:

- Provide Congress with the necessary information to demonstrate value to the taxpayers and low-income and disadvantages communities to fund and support the innovative water technology grant program.

- Promote approaches that reduce and spread upfront risk for utilities and households to adopt emerging and advanced technologies that can reduce costs including smart meters, systemwide leak detection, and real time water quality monitoring. We also support integrated planning as an additional mechanism to engage broad stakeholders in this effort.

- Complete EFAB's study of the value and impact of an industrial water reuse tax credit to incentivize businesses to implement water recycling and reuse efforts that decrease the overall costs and stress on watersheds.

- Encourage the Agency to move forward with the proposed water system restructuring rule that would have states explore the readiness and models for regionalization and consolidation, including liability protection for potential good neighbor public and private sector operators. Without coordination among neighboring communities, opportunities to overcome gaps in expertise by sharing experience, best practices, and joint purchasing power are missed. This greatly increases the costs of adoption.

- Continue to expand technical assistance to small and disadvantaged communities to address their challenges and improve access to funding. The Chamber has worked with several key staff at EPA and other interagency colleagues to develop our small and disadvantaged community water funding roadmap, which compiled public and private technical assistance resources to help the most vulnerable communities access IIJA water and resilience funding. I consider this roadmap to be a living document or work in progress, so please send along any additional information that could improve this resource.

- Continue to facilitate interagency coordination through all mechanisms possible. Agencies often indicate that there is much informal discussion among interagency colleagues. I want to underscore the importance of institutionalizing the practices so that they continue from Administration to Administration.

Finally, here are additional issues for your consideration:

1) I have previously raised the importance of public-private partnerships to EFAB as a needed tool to fund and implement water and other environmental projects. EFAB should work with the Agency to highlight how collaboration with private operators is a viable alternative for communities to improve affordability for ratepayers. EFAB should recommend to Congress that private access to the Clean Water SRF—similar to drinking water—would offer critical flexibility to communities.

2) Affordability cannot be discussed without providing solutions to households. As infrastructure improvements with updated technologies are made, costs will go up that will be passed on to customers. The Low-Income House Water Assistance Program provides funds to states and tribes to pay for qualified household water bills. The Chamber supports housing the program at EPA and funding the 40 pilot communities called for by the IIJA.

3) The EFAB should work with the EPA Office of Water regarding properly evaluating the economic impact of regulations, as communities are concerned that EPA is not accurately projecting the financial impact of potential rules (LCRI and PFAS MCL being primary examples).

4) We are now more than two years into IIJA implementation, as such, it is time to start building the case for reauthorization. I urge EFAB to begin evaluating the success and best practices of current execution and to work with the Chamber to educate Congress.

Thank you for your prompt attention to these issues. The business community stands ready to assist you.

WATEREUSE
610 Madison Street, Suite 101, Box 621
Alexandria, VA 22314

February 13, 2024

U.S. Environmental Protection Agency
Environmental Financial Advisory Board
Water Affordability Workgroup

Dear Water Affordability Workgroup,

On behalf of the WateReuse Association (WateReuse), I am pleased to submit our comments regarding the role of water recycling in improving water affordability.

The WateReuse Association is a not-for-profit trade association for water utilities, businesses, non-profit organizations, and research entities that advocate for policies and programs to advance water recycling. WateReuse and its state and regional sections represent nearly 250 water utilities serving over 60 million customers, and over 200 businesses and organizations across the country.

Water recycling programs throughout the nation successfully help mitigate the water supply consequences of climate change, ensure broader water accessibility and affordability, and support economic stability and growth.

Throughout the United States, both arid and water-secure regions of the country continue to grapple with the volatility of climate change impacts, including severe droughts and flooding. Water recycling helps communities build resilient water supplies, maintaining pricing and mitigating rate spikes.

Below are some key examples of water recycling as a mechanism for improving and maintaining water affordability:

- State College, Pennsylvania

  Pennsylvania's University Area Joint Authority, which serves Penn State University and much of the region, recycles approximately 3 MGD of water to ensure a sustainable supply, reducing the burden on the Spring Creek watershed and groundwater sources, and decreasing negative thermal impact on aquatic life. Implementing this program has helped stabilize rates—for the twenty-two years of the program, rates have only increased by 2.7% annually, on par with the average inflation rate.

- New York City, New York

  For New York City, with 42 inches of rain per year, the drivers for water reuse are housing affordability and incrementally avoiding retrofit costs for the existing combined sewer systems, thereby averting rate payer impacts from multibillion tunnel projects. The adoption of onsite water recycling systems by developers eliminates more than 200,000 gallons per day of combined sewer flow and reduces the need for new and expensive sewer infrastructure.

- El Paso, Texas

  El Paso Water is in the final design phase of a 10 MGD advanced water purification facility that will blend and treat recycled water and brackish groundwater to provide a safe and drought-proof supplemental water supply by 2030. The $78 million cost is less expensive and more sustainable than importing additional water from outside the region. The cost of recycled water is $4 per 1,000 gallons to produce locally, compared to $9 per 1,000 gallons to import.

- West Basin, Southern California

  In 2020, West Basin Municipal Water District sold imported water to customer agencies for $1,405 per acre-foot and sold tertiary treated recycled water for between $1,215 - $1,255 per acre-foot. This represents an 11% - 13% discount for irrigation and similar non-potable uses for recycled water. West Basin also produces recycled water with additional levels of treatment. Pricing for this recycled water varies, and in all cases, is less expensive than other options available for the same end uses, including imported or other sources of water with similar levels of purification.

- Eastern Municipal Water District, California

  In 2020, recycled water comprised 35 percent of Eastern Municipal Water District's (EMWD) water supply portfolio. One of the key aspects of EMWD's water reuse program is pricing. In all cases, EMWD's recycled water rates are less than potable supplies purchased from regional sources. For example, for urban irrigation customers, EMWD's recycled water rate is 59% less than comparable potable water, at $556 per acre-foot rather than $1,354 per acre-foot.

Water recycling allows communities to stabilize water supplies and rates throughout the country, particularly amid the challenges of climate change. As demonstrated in these examples, water recycling can be an effective strategy for achieving water affordability. Thank you for considering our views. We also encourage you to read the supplemental document that we have provided, *Access to Safe & Affordable Water*.

Sincerely,

Patricia L. Sinicropi, J.D.
Executive Director

WATEREUSE®

ACCESS TO SAFE & AFFORDABLE WATER:

THE CASE FOR INVESTMENT IN WATER REUSE

THE ONCE AND FUTURE SOLUTION

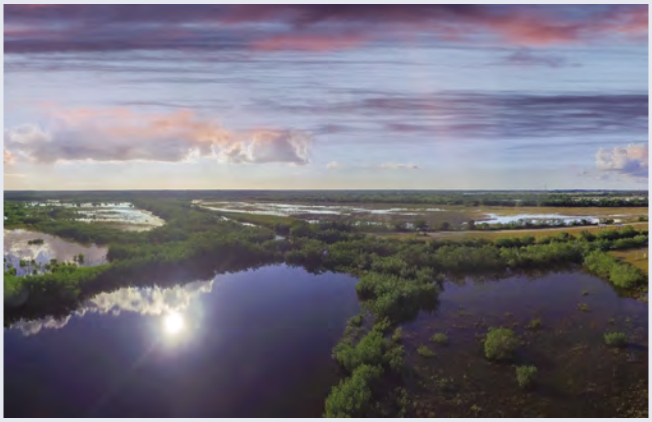
WATER REUSE IS A PRINCIPAL SOLUTION TO THE CHALLENGES OF WATER ACCESS, AFFORDABILITY, AND RESILIENCY.

Policy makers in Washington, D.C., are debating a generational opportunity to invest in water, upgrading infrastructure at a time when extreme weather across the nation is generating more frequent floods and drought. We can learn from hard-won experience on how we can secure water supplies for the future, investing today in water reuse to maintain access to water, and ensure its resiliency and affordability for decades to come. Water recycling programs throughout the nation successfully help mitigate the water supply consequences of climate change, ensure broader water accessibility and affordability, particularly in disadvantaged communities, and support economic stability and growth.

California's experience with climate change provides important lessons. In 1986, the then-modern drought of record in California began and did not end until late 1992. Water resources were depleted, including drastic reductions in reservoir levels, depletion of ground water, private wells going dry and agricultural land idled. One measure was the Oakland Hills fire that was the then-largest fire loss in US history, along with the tragic loss of 25 lives.

Due to changing weather patterns associated with climate change, drought conditions that shocked Californians in 1990 have become both more commonplace and more severe in the three decades since. This pattern is consistent with the "new normal" of climate change: extreme weather measured by more flooding from storms, diminishing mountain snowpack, premature snowmelt, and severe droughts which have lasted for longer periods and affected larger geographic regions.

In contrast to this constraint on water supply, the population of Southern California has increased by nearly 30% since 1990. Economics tells us that increasing demand while decreasing supply will drive up prices—causing hardship particularly for low-income and underserved communities with limited means. Yet California pulled off a miracle with the strategy adopted in the early 1990s that reduced potable water demands and provided new drought-proof supplies. Water providers and the state implemented ambitious policies, public health regulations, and projects to treat wastewater to near potable quality to replenish potable water supplies while advancing diverse non-potable uses to sustainably support economic activity and environmental priorities.



As climate change creates more challenges for water supply, management, and affordability, investment in recycled water is critical to ensuring water is accessible to all Americans.

As the impacts of climate change across the country create more challenges for water supply, management, and affordability, investment in recycled water at the federal level is a critical element in ensuring a national water strategy is affordable and accessible to all Americans.

Water Reuse Ensures Access to Water Supplies at Affordable Rates

Overuse or inconsistent availability of groundwater or surface water can threaten water supply reliability and force communities to seek more costly water supply options. In addition, long-term dependence on limited groundwater has potential irreversible impact on the environment. Groundwater pumping without balanced replenishment, particularly when water levels are low, can cause land subsidence in low-lying areas within an aquifer and reduce flow and storage capacity causing sediment compaction where recharge of the aquifer is no longer possible.

Several factors have accounted for the increase in the use of recycled water over the past 60 years, including quality and safety, availability, and reliability.

In California, water reuse projects by the Eastern Municipal Water District (EMWD) and the Los Angeles County Sanitation Districts (LACSD) that started before the 1990s are delivering essential water supplies today. EMWD's Recycled Water System and Recycled Water Accelerated Retrofit programs have enabled the use of 100 percent of its recycled water for beneficial reuse. With an investment of over $200 million, EMWD's treatment plants recycle 48 million gallons per day (MGD) through a system of storage ponds and tanks—which store 2.3 billion gallons of water—to be used for agriculture, public landscaping, and industrial use. In 2020, recycled water comprised 35 percent of EMWD's water supply portfolio. As the district grows, EMWD is implementing an advanced water purification program to replenish its principal groundwater aquifer.

One of the key beneficial aspects of EMWD's program is pricing. In all cases, EMWD's recycled water rates are less than potable supplies purchased from regional sources. EMWD also prices recycled water based upon each customer's alternate options for water supplies. For example, for urban irrigation customers, EMWD's recycled water rate is 59% less than comparable potable water, at $556 per acre-foot rather than $1,354 per acre-foot. For agricultural customers, EMWD's base recycled rate is $151 per acre-foot.[i] This rate is established based upon these customers' foregoing pumping of groundwater at a comparable cost, and willingness to have annual restrictions on volume and flow rates. The use of recycled versus groundwater allows EMWD to limit overuse in the groundwater basin.

In southeastern Los Angeles County, there is a long history of using recycled water to replenish the Central Basin, which supplies about three million people with about half of their drinking water supply.[ii] In 1962, in collaboration with the Water Replenishment District, LACSD began operating the Whittier Narrows Water Reclamation Plant (WRP), the first water reclamation plant in the world built for the specific purpose of producing recycled water for groundwater replenishment. Since 1962, almost 2.2 million acre-feet of recycled water from that plant and two of LACSD's other plants have replenished groundwater supplies.[iii]

Several factors have accounted for the increase in the use of recycled water as a source of replenishment water over the past 60 years, including the quality and safety of the recycled water, the availability and reliability of the recycled water (especially when compared with imported water during drought conditions), and affordability. The cost of imported water relative to recycled water continued to rise precipitously. In 1981, WRD's cost for imported replenishment water was $67 per acre-foot. Recycled water cost $7 per acre-foot. As of 2019, the price for imported raw water was $820 per acre-foot compared to $65 for tertiary recycled water.

Eastern states are also turning to water recycling to address affordability, accessibility, and economic sustainability challenges. Pennsylvania, while not typically water scarce, experiences dry periods and strains to watersheds and groundwater sources. The University Area Joint Authority, which serves Penn State University and much of the region, recycles approximately 3 MGD of water to ensure a sustainable supply, reducing the burden on the Spring Creek watershed and groundwater sources, and decreasing negative thermal impact on aquatic life. Implementing this program has helped stabilize rates—for the twenty-two years of the program, the rates have increased by 2.7% annually, on par with the average inflation rate.

The common theme among these projects is that well planned and designed investments in water reuse help conserve precious surface and groundwater resources, replenish and sustain critical aquifers, and ensure affordable access to water in regions facing sustained droughts, aquifer depletion, sea level rise, and sometimes all three.

Water Reuse Helps to Mitigate Rate Spikes from Water Scarcity and Aging Infrastructure

Forward thinking communities also use water reuse to avoid potable water rate spikes in low-income communities, which are disproportionally impacted by climate change in water scarce regions. In other regions, water reuse has helped decrease the cost of new infrastructure.

El Paso, Texas, for example, has a population of about 680,000 people and faces declining supplies of surface and groundwater. El Paso Water (EPWater) has engaged in long-term planning and made investments to ensure water demands will be met even in worst-case drought conditions through 2060 and beyond. Since the early 1990s, recycled water has played an important role. And in 2020, the city produced 125,131 acre-feet of potable water, with 40% coming from groundwater sources and 38% from the Rio Grande. More than 8,600 acre-fee per year of recycled water is used for non-potable demands.

EPWater realized that even more needs to be done to ensure water resiliency and economic stability. The agency is in the final design phase of a 10 MGD advanced water purification facility that will blend

Brooklyn's Domino District project is an example of a successful water utility/development partnership. The New York City Department of Environmental Protection offered developers a 25% rate reduction to build non-potable water reuse infrastructure.

and treat recycled water and brackish groundwater to provide a safe and drought-proof supplemental water supply by 2030. The $78 million cost is less expensive and more sustainable than importing additional water from outside the region. The cost of recycled water is $4 per 1,000 gallons to produce locally, compared to $9 per 1,000 gallons to import. Water reuse at $570 per acre-foot is also less expensive than desalination, which would cost El Paso's ratepayers $600 per acre foot.

For El Paso, a city that consistently ranks as one of the most affordable cities in the US, past and current investments in water reuse have reduced the cost of water. EPWater continues to have one of the lowest water rates in Texas, ensuring that El Paso continues to be a thriving and affordable city.

Water reuse is also sustaining economic development and community revitalization in water rich regions struggling with aging water infrastructure. For New York City, with 42 inches of rain per year, the drivers for water reuse are housing affordability and incrementally avoiding retrofit costs for the existing combined sewer systems, thereby averting rate payer impacts from multibillion tunnel projects.

The Domino District project in Brooklyn provides an example of how water utilities can partner with the development community to share in the costs and risks of water infrastructure challenges. The New York

City Department of Environmental Protection (DEP) offered developers a 25% rate reduction to build non-potable water reuse infrastructure. The benefit to DEP and the community is the reduction of more than 200,000 gallons per day of combined sewer flow and the reduced need of new and expensive sewer infrastructure, with corresponding decreases in demand for potable water. The reduction in the water rates also supports developers in keeping their 20% affordable housing commitment.

Water reuse reduces ratepayer costs and provides reliable, environmentally sustainable supplies. This is particularly important for disadvantaged communities throughout the nation that frequently face both water resource and financial challenges.

Water Reuse Supports Economic Stability and Growth

For water scarce regions, water reuse becomes a central component of planning for sustained economic growth in the future. For a smaller town like State College, Pennsylvania, the local utility, University Area Joint Authority (UAJA), distributes 3 MGD of recycled water to customers including for non-environmental purposes such as a car wash, hotel laundry and swimming pool, commercial laundry, and golf course irrigation. During the economic downturn in 2008, the only laundry business to stay open in the region was supplied by UAJA's less expensive recycled water.

Few areas of the world face this challenge more acutely than Southern California. The West Basin Municipal Water District (West Basin) recycles water in partnership with Suez Water Technologies for a cascade of uses that provide economic benefit, including multiple large refineries, urban greenspace watering, industrial cleaning and process water, and recharging aquifers. Not only does reuse provide a reliable source of water to support hundreds of thousands of jobs, but the program conserves enough groundwater and imported water to meet the needs of 80,000 households a year. Importantly, the program is designed to provide key industries a 100% reliable, climate-resilient supply of affordable water in a region prone to extreme drought and water restrictions.

West Basin prices recycled water based upon its end use and coined the term "designer water" to reflect its strategy for providing varying levels of treatment suited to specific needs – be it a refinery, a seawater injection barrier, or a municipal irrigator. As an example, West Basin sold imported treated water in 2020 to its customer agencies for $1,405 per acre-foot. Tertiary treated recycled water, on the other hand, ranged in price from $1,215 to $1,255 per acre-foot, representing a 11% to 13% discount for irrigation and similar non-potable uses.

West Basin also produces recycled water with additional levels of treatment. Pricing for this recycled water varies, and in all cases, is less expensive than other options available for the same end uses, including imported or other sources of water with similar levels of purification. Moreover, recycled water is resilient to drought and is not subject to periodic shortage allocations. The supply reliability and pricing structure provides an important economic foundation for high-water consumption industries.

The capstone of water reuse initiatives in the western US is the Regional Recycled Water Program (RRWP) being developed by the Metropolitan Water District of Southern California (MWD) in partnership with the Los Angeles County Sanitation Districts (LACSD). For this massive $3.4 billion project, which will be the largest potable reuse initiative in the world, LACSD will divert treated wastewater to MWD's advanced water purification facility before water is delivered to industrial users and to replenish groundwater basins, and potentially to augment raw water for potable reuse throughout the region. The majority of the purified recycled water is likely to be used to replenish groundwater basins, which provide about 40% of Southern California's water supply, and which otherwise rely on climate-dependent imported water or local stormwater runoff.

A planning study completed in 2019 analyzed costs for implementation of the project at 168,000 acre-feet per year of production along with various phasing scenarios and determined the unit cost for the project is at $1,752 per acre-foot in 2018 dollars. Based upon MWD's other water supply costs, sales and resulting rates, the study further estimated the fully implemented project would have a $170 per acre-foot, or 16% impact on MWD's rates.

By comparison, the Pacific Institute estimates that ocean desalination on the West Coast of the United States would cost from $1,900 to $3,000 per acre-foot. Similarly, a publication surveying stormwater capture programs projected unit costs in the 25th and 75th percentiles ranging from $334 to $4,911 per acre-foot, with less reliability. Although the investment in RRWP is anticipated to be significant, it provides an important and relatively affordable drought-proof water supply alternative for Southern California's future. The economics are driven by the project's high degree of reliability compared to periodic and more frequent restrictions on imported water supplies impacted by climate change.

For Southern California and other supply-constrained areas, as well as in water rich areas struggling with aging infrastructure, the situation is clear: recycled water investments are inextricably linked to continued economic stability and growth.

CONCLUSION

Recycled water programs are a critical component of America's current and future water resources portfolio. They are helping communities stabilize water rates, sustain economic activity, and address environmental and infrastructure challenges. Moreover, water recycling programs throughout the nation successfully help mitigate the water supply consequences of climate change, ensure broader water accessibility and affordability, particularly in disadvantaged communities, and support economic stability and growth. Investment in recycled water at the federal level is a critical element in our national water strategy.

MOONSHOT MISSIONS

The WateReuse Association thanks George Hawkins and his team at Moonshot Missions for producing this white paper.

i An acre-foot of water equals about 326,000 gallons, or enough water to cover an acre of land 1-foot deep

ii This example is derived from information in Water Replenishment District, "Our Road to Independence" 2019 (available at: https://www.wrd.org/sites/pr/files/Our%20Road%20To%20Water%20Independence%2C%20WRD.pdf).

iii LACSD, 31st Annual Report on Recycled Water Reuse, Fiscal Year 2019-2020, p. 7 (available at: https://www.lacsd.org/civicax/filebank/blobdload.aspx?blobid=23890).

For more information, please contact Greg Fogel, Policy Director, WateReuse Association at gfogel@watereuse.org

From:	Rudolph, Danielle - Xylem
To:	EFAB
Cc:	Braun, Tim - Xylem; Cho, Albert - Xylem
Subject:	Written statement for EFAB listening session
Date:	Monday, February 12, 2024 2:30:58 PM
Attachments:	image001.png casestudy_sso-cso_south-bend_01-26-23_en_us.pdf

EFAB Members –

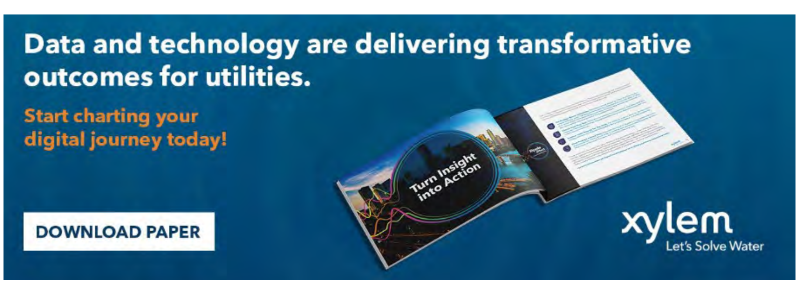
Please find attached a case study for consideration as part of the public listening session scheduled for February 20th. This case example from South Bend, Indiana, demonstrates a successful approach to improve wastewater system performance and reduce the capital intensity of meeting their community's wastewater service needs.

Since implementing its smart sewer program, dry weather overflows have been eliminated and combined sewer overflow volumes have been reduced by 80 percent, or roughly one billion gallons per year. South Bend has also enjoyed approximately $1.5 million in annual operating and maintenance cost savings. In addition, E.coli concentrations in the St. Joseph River have dropped by more than 50 percent on average, improving the water quality. Overall, this real-time decision support system has allowed South Bend to reduce costly traditional gray infrastructure, while improving system performance and capacity utilization, lowering operating costs and delivering environmental gains 10 to 15 years ahead of schedule.

Thank you for your consideration.

Danielle Rudolph

Xylem



Case Study
South Bend, Indiana, United States

City of South Bend

UTILITY REDUCES CSO VOLUME BY 80% AND SAVES $400 MILLION IN CAPEX SPENDING USING "SMART SEWER" TECHNOLOGY

The St. Joseph River has long shaped South Bend's economy, especially during the mid-20th century, when the river was the conduit to heavy industrial development such as Studebaker and the Singer Sewing Company. Despite the demise of heavy industry in the 1960s, the City is still the economic and cultural hub of Northern Indiana, and the St. Joseph River is still the central downtown attraction. Over the past decade, the City's population has started to grow for the first time in 50 years, and the old Studebaker plant and surrounding area is being re-ignited as a technology center to attract new business.

To reduce the 1-2 billion gallons of polluted water dumped in the St. Joseph River annually, and the huge environmental, social, and economic costs associated with the ongoing issue, the City embraced a way to harness intelligent watershed technology to optimize its existing sewer system, without the need to build costly new gray infrastructure.

Challenge

Prior to 2008, virtually every time it rained heavily, the City of South Bend faced sewer overflows into the landmark St. Joseph River because the City`s aging sewer system could not handle the excess discharge, an average of some 1-2 billion gallons annually.

In 2012, the City entered into a consent decree, agreeing to a long-term control plan (LTCP) of their sewer overflow estimated at $713 million in capital improvements plus financing costs. For South Bend, with a population of just over 100,000, this equated to a significant burden per citizen, which is economically unfeasible given that the average annual household income is around $32,000.

Solution

South Bend turned to Xylem for help to solve the overflow problem. In 2008, the City installed and commissioned a real-time monitoring system of more than 120 sensors located throughout the City's urban watershed. After a thorough data review in 2012 the system was expanded with **Xylem Vue powered by GoAigua's SSO/CSO Predicition and Prevention applications**, a real-time decision support system consisting of smart sensors and actuators. Xylem's system enables the

We spent 400 million dollars less than originally estimated, achieving greater environmental benefit and level of service, just by optimizing the existing system in the ground.

Eric Horvath, Director of Public Works for the City of South Bend

Program Highlights

- Estimated $400 million in CapEx savings
- Elimination of dry weather events
- 80% reduction in combined sewer overflow volumes (roughly 1 billion gallons per year)
- Over 50% drop in E. coli concentration (from sewer system) in the St. Joseph River
- $1.5 million per year in operational and maintenance cost savings

network to react to sudden wet weather events to avoid sewer overflows and prevent water pollution by trading available sewer capacity in real time and moving flows to under-utilized parts of the network.

SSO/CSO Predicition and Prevention serves overflow information via SCADA screens to operators, via smartphones and tablets to field staff, and through Web portals jointly developed with the City's engineering staff. A key benefit is that operators have the ability to override the system at any time and take control.

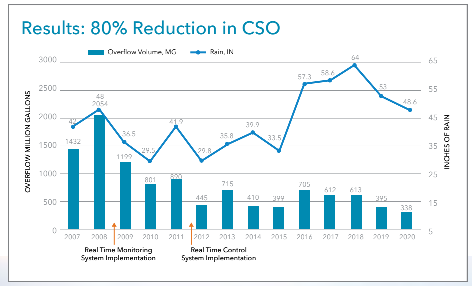
Since 2012, the monitoring sensors (currently 165) and 13 automated gates and valves have eliminated dry weather overflows and reduced combined sewer overflow (CSO) into the St. Joseph River by more than 70 percent.

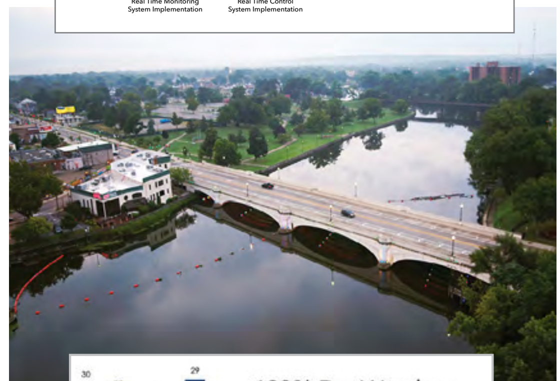
Eric Horvath believes in the benefits of the real-time decision support system approach. In 2021, the Department of Justice and the US Environmental Protection Agency endorsed the City of South Bend's updated long-term control plan requiring 60% less infrastructure investment than originally estimated, saving the City approximately $400 million in capital expenditure spending.

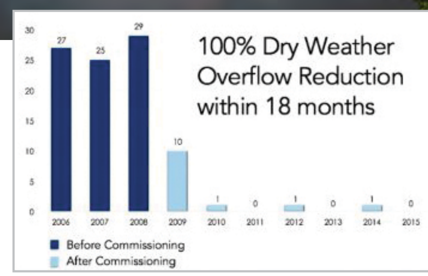
Outcome

Since implementing its smart sewer program, dry weather overflows have been eliminated and **combined sewer overflow volumes have been reduced by 80 percent**, or roughly one billion gallons per year. South Bend has also enjoyed approximately **$1.5 million in annual operating and maintenance cost savings**. In addition, E.coli concentrations in the St. Joseph River have dropped by more than 50 percent on average, improving the water quality.

Overall, this real-time decision support system allowed South Bend to reduce costly traditional gray infrastructure, while improving system performance and capacity utilization, lowering operating costs and delivering environmental gains 10 to 15 years ahead of schedule.







As proof of the environmental gains, residents and tourists are again now fishing for salmon and steelhead in the St. Joseph River without trepidation. Photo: Kieran Fahey, Long Term Control Plan Manager, City of South Bend