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ENABLING RURAL WATER UTILITIES TO CREATE, TRANSFER INFORMATION, AND USE DIGITAL SERVICE AREA BOUNDARIES: YEAR 2 FINAL REPORT

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Enabling Rural Water Utilities to Create, Transfer Information, and Use Digital Service Area Boundaries: Year 2 Final Report

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Abstract

Enabling Rural Water Utilities to Create, Transfer Information, and Use Digital Service Area Boundaries is a project that aims to increase equity by lowering the digital divide for small utilities by providing free, open-source tools that support regional and statewide planning. The project's objectives are to (1) enable water and wastewater utilities to create and maintain digital service area boundaries through the development of an open-source, free technology called **BoundarySync** (formerly ABOUT-US); and (2) create an online tool that spatially links digital service area boundaries with parcel data to better equip small rural utilities to meet new Environmental Protection Agency (EPA) regulatory reporting requirements through the development of the **Lead Service Line Inventory Tool** (LSLIT). The creation of BoundarySync, in combination with LSLIT, will assist small rural utilities in meeting EPA's new reporting requirements and provide more complete information on where lead service lines are likely to exist in their service areas. This information may inform the allocation of federal funding to support lead service line replacement and could help utilities pursue external funding for infrastructure improvements and enhance decision-making. In addition, BoundarySync will provide the state with up-to-date data to support regional and statewide planning.

In Year 1, we developed BoundarySync, a user-friendly tool for the creation and maintenance of digital service area boundaries and assessed how rural utilities could use digital service area boundaries in combination with other data to solve a pressing challenge. Through these engagements, we learned that new EPA rules requiring water utilities to develop lead service line inventories placed a significant burden on rural water utilities which often do not have access to GIS software. In Year 2, we developed the LSLIT to give small rural utilities an easier way to comply with the new rules. Our methods included (1) close collaboration with the North Carolina Rural Water Association (NCRWA) to identify and reach a representative group of users to provide feedback on tool planning and development, (2) engagement with the North Carolina Department of Environmental Quality (NC DEQ) on the future hosting and maintenance of BoundarySync, (3) leveraging additional funding for software development support to ensure that BoundarySync had a modern and intuitive design, (4) working with a Ph.D. student and a postdoc to integrate digital service area boundaries created in BoundarySync with parcel data through LSLIT, and (5) participating in NCRWA conferences and workshops and developing instructional and promotional videos to encourage adoption and use of BoundarySync and LSLIT.

Our results include (1) BoundarySync; (2) engagement with a representative group of water utilities, NCRWA leadership, and NC DEQ in a user-based design process to refine BoundarySync's usability; (3) the Lead Service Line Inventory Tool (LSLIT); (4) engagement with rural water utilities in the planning, development, and continued improvement of LSLIT; (5) a GitHub repository for BoundarySync and LSLIT enabling other states or entities adapt these tools to their needs; (6) two instructional videos (Getting Started in BoundarySyc and Using the Admin Role in BoundarySync) and a promotional video about BoundarySync; and (7) a promotional video that details the challenges rural water utilities face in modernizing their data infrastructure and highlights NCRWA's work.

Through our engagements with North Carolina rural water utilities and partners in other states, we have discovered that there is a great deal of need for these two products not only in North Carolina but in rural areas across the US. As a result, we recommend that in addition to continuing to host, maintain, and promote these two tools in North Carolina we develop a national version of LSLIT and promote the use of LSLIT and BoundarySync throughout the US.

Acknowledgments

We would like to thank the North Carolina Rural Water Association and its members for their close engagement on this project.

Introduction

In Year 1, team partners built on the development of an early-stage, prototype version of BoundarySync created by the Internet of Water (IoW) at Duke with the help of three students in the summer of 2020. The completed BoundarySync tool allows utility managers, or other approved staff, to create or update their digital service area boundaries online without the need for proprietary GIS software or special skills.

The partner team developed an intuitive user interface for editing and creating digital boundaries as well as a system for administrative control. Users can upload and edit existing digital service area boundaries or create their boundaries by drawing them directly in the tool. BoundarySync comes equipped with different base map options including satellite imagery and street maps. Users can also upload an image of their boundary (e.g. pdf, jpeg, png) to use as a guide. Users can adjust the transparency of uploaded images, as well as rotate, scale, and warp these images to align them with the base map.

BoundarySync also enables version control of layers, access control of users who can edit layers, and administrative controls for the managing entity. Users who are assigned the administrator role in BoundarySync can determine which specific users are allowed to view and/or edit boundaries, as well as request edits and approve boundary submissions or updates before changes are finalized. Published boundaries can then be made available for download in GeoJSON, ESRI Shapefile, and GML formats for use by the utility and incorporation into statewide datasets.

BoundarySync is preloaded with the digital service area boundaries created by the earlier collaboration between NC DEQ and Duke University. During this collaboration, NC DEQ provided a list of 614 community and public water systems for the statewide inventory of service area boundaries. Of those, 66 systems (11%) provided GIS shapefiles, 287 (47%) provided pdf maps, 55 (9%) provided images, 125 (20%) were created by the team using municipal boundaries, and 81 (13%) were not created because they were public systems with unclear starting points for creating boundaries. A total of 532 utilities' service area boundaries can now be updated

annually through BoundarySync. Administrators from the 81 systems in this initial list without digital service area boundaries are now able to easily create them using BoundarySync.

The community water systems selected by NC DEQ for the initial collaboration project only included systems that serve over 3,000 people and are therefore required to submit local water supply plans (NC DEQ 2017). These 614 systems are just a small fraction of the 2,000 active community water systems registered in EPA's Safe Drinking Water Information System in North Carolina. The remaining systems are very small, serving fewer than 100 people. BoundarySync enables these small systems to create digital service area boundaries as well. Digital service area boundaries better equip utilities to meet regulatory reporting requirements; pursue external funding for infrastructure improvements; improve emergency preparedness, mitigation, and resilience planning; and make informed decisions.

During Year 1, the IoW team at Duke also collaborated with the NCRWA to identify how the rural water community could use digital service area boundaries to improve water management. In December 2021, the US EPA released new rules requiring water utilities to conduct an inventory of all service line connections to identify the potential presence of lead. Through engagement with our partners at the NCRWA, we learned that this rule placed a significant burden on small rural water utilities that often lack access to GIS software.

In response, we developed the Lead Service Line Inventory Tool (LSLIT) in Year 2. LSLIT overlays digitized service area boundaries with parcel data, including the building age. Boundaries created in BoundarySync are automatically transferred to the Lead Service Line Inventory Tool. Users can select their boundary from a dropdown menu to view a map of all the buildings in their service area. Structures built before the passage of the 1986 amendments to the Safe Drinking Water Act that prohibited the use of lead in public water system service lines are shown in red, and structures built after 1986 are shown in green.

LSLIT also enables utilities to export a spreadsheet of all properties in their service area boundary with additional data including the year constructed, address, and building materials. The spreadsheet is formatted to match the column headings in EPA's lead service line inventory template allowing users to easily pull the data provided by the tool into their inventories. This tool greatly reduces the time commitment needed for utilities that do not currently have GIS capabilities to comply with the new legislation, lowering the burden on small rural utilities.

Methods

Stakeholder Engagement

The IoW team worked with the NCRWA to engage rural water utilities throughout the state in the development of BoundarySync and LSLIT, maximizing the usability and adoption of both tools. NCRWA offers regular workshops to rural water utilities across North Carolina. We shared BoundarySync with 10-15 utilities at two workshops, to get feedback on its usability and functionality. During the workshops, we also explored what types of data would be beneficial to incorporate with their service area boundaries, leading to the development of LSLIT.

We realized early on that rural utility operators were not the right audience for BoundarySync because they do not do the reporting themselves and wouldn't maintain boundaries, nor do they apply for funding. In response, we formulated a group of stakeholders who would be in a better position to give feedback on BoundarySync and inform us about how these boundaries could best be used by rural water utilities. This group consisted of the Director of NCRWA, NCRWA technical assistance staff (circuit riders), and water utility managers identified by NCRWA leadership. This group met regularly to discuss progress on the development of BoundarySync and to provide critical feedback on its usability and functionality. During Year 2, these same stakeholders shaped the development of LSLIT.

Initially, we planned to host a workshop at the 2022 annual NCRWA conference, however, the conference was delayed due to COVID-19. In September 2023, just after the end of the grant period, we attended the NCRWA Leadership Summit. At the Summit, we offered introductory training on BoundarySync and the Lead Service Line Tool and helped utility managers sign up for BoundarySync accounts. The summit allowed our team to promote BoundarySync and LSLIT and offered users who did not participate in the workshops or focus groups the opportunity to provide feedback on both products. Our participation in this event generated a lot of excitement around both tools. The utility managers we spoke to were thrilled to have support with the development of their lead service line inventories with one saying that learning about BoundarySync and LSLIT "made his whole trip worth it." We are continuing to engage with North Carolina utility managers through NCRWA workshops.

Technical Development

During Year 1, we leveraged additional funding to hire a third-party software developer, Azavea Inc., to ensure the development of a modern, intuitive user interface for BoundarySync. Azavea is a software and data analytics company with expertise in the water sector. In collaboration with partners at NCRWA and the IoW team, Azavea developed a BoundarySync prototype, engaged with potential users on the usability and functionality of the tool, and released the finalized BoundarySync tool in December 2022.

LSLIT was built in-house at Duke through a collaboration between Ph.D. student, Spencer Rhea and postdoc, Jordan Clark. LSLIT overlays the BoundarySync service area boundary dataset with parcel data from NC OneMap and disadvantaged communities identified by the Justice40 Initiative. During our engagements with utility managers, we identified gaps in NC OneMap's parcel data. Some counties, particularly small rural counties, did not accurately report their parcel data to NC OneMap. This resulted in errors in the year-built field for structures in these counties. Our team completed an analysis of satellite data to identify the age of all structures in all counties within a 5-year range and integrated this new dataset into LSLIT. This analysis increased the accuracy of the tool from 66% accurate to 99% accurate.

Results

Over the 2-year project period, the Internet of Water team at Duke, in partnership with the NCRWA, NC DEQ, and Azavea:

(1) Completed the development of BoundarySync *(temporary login credentials available upon request)*.
(2) Engaged a representative group of water utilities, NCRWA leadership, and NC DEQ in a user-based design process to refine BoundarySync's usability.
(3) Completed the development of the Lead Service Line Inventory Tool (LSLIT).
(4) Engaged with rural water utilities in the planning, development, and continued improvement of LSLIT.
(5) Made BoundarySync and LSLIT's open-source software code available on GitHub for other states or entities interested in creating and maintaining digital boundaries and/or assisting water utilities in the development of lead service line inventories.
(6) Published two instructional videos (Getting Started in BoundarySyc and Using the Admin Role in BoundarySync) and a promotional video about BoundarySync.
(7) Developed a promotional video that details the challenges rural water utilities face in modernizing their data infrastructure and highlights NCRWA's work.

Discussion

During the project period, the IoW team learned that the NC DEQ began designing an ESRI-based mapping tool for water utilities. Our team, along with the leadership at NCRWA have been in conversation with NC DEQ about the challenges a proprietary software approach presents to smaller, rural water utilities. Both the IoW and NCRWA have recommended to NC DEQ that they consider hosting and maintaining BoundarySync specifically to lower the barrier for smaller, rural water utilities. NC DEQ is currently considering this option.

In the absence of a formal agreement with NC DEQ, our partners at the Lincoln Institute of Land Policy's Center for Geospatial Solutions (CGS) have agreed to host and maintain BoundarySync for North Carolina utilities for free through September 2026. CGS also hosts a free version of BoundarySync that anyone can use, which includes all features except the ability to review and approve boundaries through the admin role. The IoW team at Duke will continue to maintain LSLIT until the due date for submission of lead service line inventories to EPA has passed (October 16, 2024).

The NCRWA has agreed to use its currently existing technical assistance program to aid rural water utilities in using BoundarySync and LSLIT. In addition, the IoW created two instructional videos, available on the IoW website and YouTube channel, that walk utilities through the process of creating and updating their digital boundaries. In addition, members of the CGS and Duke teams are available to offer individualized support for BoundarySync as LSLIT as needed.

Summary

Enabling Rural Water Utilities to Create, Transfer Information, and Use Digital Service Area Boundaries is a project that aimed to increase equity by lowering the digital divide for small utilities by providing free, open-source tools that support regional and statewide planning. In

Year 1 the project team developed BoundarySync an open-source, free technology that enables water and wastewater utilities to create and maintain digital service area boundaries. This tool gives small rural utilities access to technology traditionally only available to large well-resourced utilities. The project team engaged a representative group of water utilities, NCRWA leadership, and NC DEQ in a user-based design process to ensure that the tool is easy to use and meets the needs of our target audience. In Year 2, the project team created a tool that overlays the digital service area boundaries created in BoundarySync with parcel data to assist utilities with the creation of Lead Service Line Inventories required by the Environmental Protection Agency. These two tools enable small utilities to quickly answer pertinent questions and fulfill reporting requirements while providing the state with up-to-date data to support regional and statewide planning.

Conclusions

During the project period, the IoW team learned about the needs and capacity of rural water utilities in North Carolina and the NC DEQ. Despite early expressions of interest, it has been difficult for the NC DEQ to commit to hosting and maintaining BoundarySync long-term. In general, we have learned that it is difficult for state agencies to adopt software products that are not large, proprietary products or add-ons to software the state has already subscribed to. We continue to work with NC DEQ on ensuring the long-term sustainability of BoundarySync in North Carolina but have found an alternative host at the Lincoln Institute's Center for Geospatial Solutions (CGS).

We also learned that small rural water utilities need effective incentives to modernize their processes. Adopting new technology, even if it is free and easy to use, is a challenge for rural water utilities who typically have very small staffs with wide-ranging responsibilities and limited time. Without a clear reason to try something new, most employees will fall back on what they know so as not to risk wasting time learning something new. However, new EPA rules requiring water utilities to develop lead service line inventories provided an incentive. For small utilities that lack access to GIS software, this is an arduous and time-consuming task, especially when employees are already over-tasked.

BoundarySync provides an easy way for these small utilities to digitize their service area boundaries, and LSLIT provides an immediate application of that boundary data to solve a time-sensitive and critical problem. Accurately reporting this information to EPA is critical because it may help to determine how funding for lead service line replacement is allocated. BoundarySync and LSLIT lower the regulatory burden on small rural utilities while helping to ensure that they get the financial support they need to ensure safe drinking water for their communities. In addition to the excitement BoundarySync and LSLIT have generated in North Carolina, other states, including New York and Texas, have already expressed interest in implementing these tools to help small utilities in their states.

Finally, through conversations with the broader Nicolas Institute audience, we have realized that BoundarySync is a tool that is not only transferable nationwide but also to different applications,

such as digitizing irrigation district boundaries. The basic back-end software developed for BoundarySync could be useful to anyone who needs the ability to create or edit polygon-based map layers and export those layers in GeoJSON, ESRI Shapefile, or GML format without a proprietary software subscription. Because we have made the software code available on GitHub, anyone can adapt BoundarySync to their own needs.

Recommendations

After the end of the project period, we recommend that the Duke team and our partners

(1) continue to engage with NC DEQ around long-term maintenance and sustainability of BoundarySync for NC utilities,
(2) ensure maintenance and hosting of BoundarySync at CGS through September 2026,
(3) ensure maintenance and hosting of LSLIT at Duke until after the EPA lead service line inventory submission due date has passed,
(4) continue to promote BoundarySync and LSLIT to NC utilities through NCRWA workshops,
(5) promote the adoption of BoundarySync to other states across the US,
(6) and, develop a national version of LSLIT.

Appendix 1: List of Abbreviations with Definitions

ABOUT-US: A BOundary Update Tool for Utility Services, the former name for the tool now called BoundarySync.

CGS: The Center for Geospatial Solutions at the Lincoln Institute of Land Policy, an IoW Coalition member organization.

ESRI Shapefile: Environmental Systems Research Institute Shapefile, a geospatial vector data format for geographic information system (GIS) software developed by ESRI.

GeoJSON: Geographical JavaScript Object Notation, an open standard format (based on the JSON format) designed for encoding a variety of geographic data structures.

GML: Geography Markup Language, an XML grammar for expressing geographical features.

IoW: the Internet of Water, a project initiated by the Water Policy Program at the Nicolas Institute for Energy, Environment & Sustainability at Duke University.

LSLIT: Lead Service Line Inventory Tool

NC DEQ: the North Carolina Department of Environmental Quality, the lead stewardship agency for the protection of North Carolina's environmental resources.

NCRWA: the North Carolina Rural Water Association, a non-profit organization dedicated to helping our members attain the highest standard in drinking water and wastewater service.

Appendix 2: List of Items Resulting from the Project

BoundarySync: https://boundarysync.internetofwater.app/login
Temporary log-in credentials available upon request

BoundarySync GitHub: https://github.com/azavea/iow-boundary-tool

BoundarySync Instructional Videos:
Getting Started in BoundarySyc: https://youtu.be/txKa9Vn_ixg
Using the Admin Role in BoundarySync: https://youtu.be/nLTXg1GCJLI

BoundarySync Promotional Video: https://www.youtube.com/watch?v=9CD0YYldGoo&t=12s

Lead Service Line Inventory Tool: https://internetofwater.shinyapps.io/iow_lead_dash/

Lead Service Line Inventory Tool GitHub: https://github.com/spencerrhea/iow_lead_dash

NCRWA Promotional Video: https://www.youtube.com/watch?v=vkPNe7BPPoY