RCAP

A RESOURCE FOR SMALL UTILITIES

The Role Mapping Serves

FOR YOUR SMALL, RURAL, OR TRIBAL UTILITY

WE envision

a resilient,

equitable,

and thriving

rural America

Rural Community
Assistance Partnership

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SUMMARY

Technology has advanced in ways that make it much easier for small, rural, and tribal utilities to map their infrastructure, use that location data to quickly and easily organize service delivery, and coordinate operation and maintenance of their infrastructure in an affordable and effective way.

This combination of location data (or spatial data) and information about that location (or attribute data) can be managed in a Geographic Information System (GIS). More affordable and easier to use software and the wide availability of computers and smartphones makes it much, much easier for a small utility to use GIS. This guide provides some of the benefits and considerations of using GIS. Some of those benefits include:

- Accurate locations of infrastructure for quick response in an emergency and efficient repair;
- Resources for more proactively operating and maintaining infrastructure to save dollars and avoid loss of services;
- A central location for information where multiple people can access it at the same time with less risk of losing records through retirement or decay;
- Easy sharing of information with residents and businesses on water quality, costs, services, etc.; and
- The ability to ask "what if" questions of how your system might respond in a disaster, to future population changes, or to other scenarios your community is considering.

When your small system is ready to get started with GIS, RCAP is here to help. Our GIS professionals' job is to help you get what you need to build and run a sustainable GIS program on your own.

RCAP
Rural Community Assistance Partnership

PUBLISHED BY
RCAP Inc.
rcap.org

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RCAP is powered by a dedicated national staff, board, and network of regional partners across the country. Learn more about our people.

The entire contents of this guide are available on the RCAP (Rural Community Assistance Partnership) website at *rcap.org*.

This material is based upon work supported under a grant by the Rural Utilities Service, United States Department of Agriculture. Any opinions, findings, and conclusions or recommendations expressed in this material are solely the responsibility of the authors and do not necessarily represent the official views of the Rural Utilities Service.

RCAP and RCAP staff have used ESRI and ESRI software products to provide GIS technical assistance to rural and tribal communities. This Guidebook is based on our experience, which includes using ESRI. Readers will see multiple references to ESRI throughout the Guidebook. Those references are not an endorsement of ESRI or a recommendation that anyone use ESRI. They are examples of how RCAP has used GIS to successfully support communities.

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INTRODUCTION

Utilities face a range of pressures including aging infrastructure, the COVID-19 pandemic, employee retirement and turnover, and more frequent natural disasters. Digital workflows, especially digital mapping through GIS (Geographic Information Systems), can help many small, rural and tribal utilities prepare for and face these and future challenges.

Many small rural utilities still rely on paper utility maps and field operation workflows (see Figure 1). These traditional paper-based workflows often result in inefficiencies such as lack of access to accurate and up-to-date paper maps, weathered/aged paper, redundant data entry, and illegible handwriting and can lead to the inability to meet regulatory requirements. Paper maps and workflows also make it more difficult to overcome industry challenges and are costlier to operate.

The benefits of digital transformation are well-known and include reduction in operational costs, better record-keeping and engagement, smarter asset management decisions, better regulatory compliance, and higher customer satisfaction. GIS bridges the transition from paper to digital mapping. The use of GIS strengthens your organization with digital solutions that increase efficiency and provide insight for decision-makers.

Throughout this guidebook, blue and green boxes appear that identify tools, resources, and background available to help you lead your water and/or wastewater utility more effectively.

This guide serves to provide knowledge about the benefits and practical applications of mapping, especially GIS, to all staff within a utility that provides water and/or wastewater services to its customers. Each utility is different, but GIS is flexible enough to serve an array of different purposes at different scales.

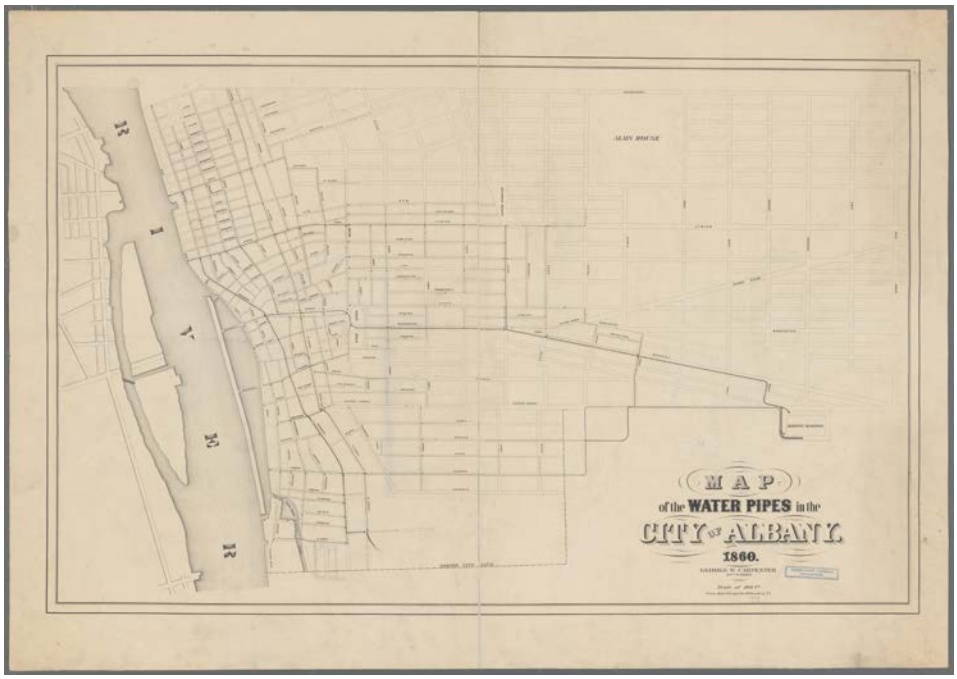


FIGURE 1—HISTORIC WATER DISTRIBUTION MAP

A map of Albany drinking water lines drawn in 1860. It is not uncommon for distribution line records in small communities to look like this one: outdated and too abstract to give accurate dig and maintenance information. Footnote: Lionel Pincus and Princess Firyal Map Division, The New York Public Library. (1860).

RESOURCES FOR ASSET MANAGEMENT

GIS is one tool in a utility's broader approach to asset management – a framework to help utilities provide the desired level of service at the lowest life cycle cost. The framework consists of five core concepts: Asset Inventory, Level of Service, Criticality, Life Cycle Costing, and Long-Term Funding. GIS provides an accurate location for assets and allows utilities to associate information such as infrastructure age and condition with that location data. RCAP has produced several resources to help small systems with their asset management. Also, the Environmental Finance Centers provide an Asset Management Switchboard[1] at *swefcamswitchboard.unm.edu*.

1 SOUTHWEST ENVIRONMENTAL FINANCE CENTER (N.D.). ASSET MANAGEMENT SWITCHBOARD. RETRIEVED AUGUST 23, 2022 FROM SWEFCAMSWITCHBOARD.UNM.EDU/AM/.

A geographic information system (GIS) is a system that creates, manages, analyzes, and maps data. GIS connects data to a map, integrating location data—where things are—with all types of descriptive information: for example, the material, condition, and age of infrastructure, contact information for the homes and businesses served by a connection, or whether homes are in a floodway or fire risk zone. This provides a foundation for mapping and analysis that is used in science and every industry. GIS helps users understand patterns, relationships, and geographic context. The benefits of GIS include improved communication and efficiency as well as better management and decision making.[2]

There are numerous ways in which GIS might help your utility organize and manage maintenance and operations tasks, create reports to support asset management and capital improvement plans, enhance accessibility of data and data sharing, prepare for and respond to emergencies, and organize information for record-keeping and communication purposes.

Engaging Technical Assistance Providers

Navigating through the components and training required for a robust GIS mapping program may seem daunting. As a result, you may wish to engage the services of a technical assistance provider (TAP) who has experience working with similar utilities. Small utilities may be able to receive free technical assistance from the Rural Community Assistance Partnership (RCAP, which produced this guide) and other organizations, and there are also consultants for hire for most areas of utility operations, finance, and management. The inside back cover of this guide provides information about RCAP's national network of nonprofit organizations that are working to ensure that rural, small, and tribal communities throughout the United States have access to safe drinking water and sanitary waste disposal.

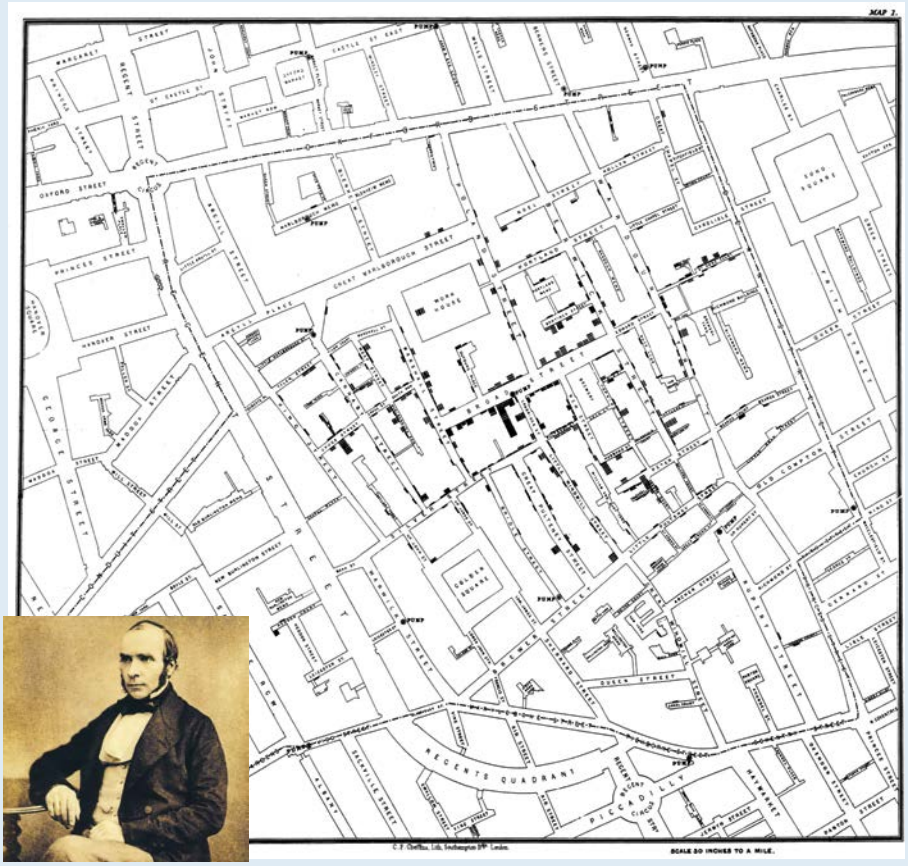
TAPs have an array of ideas and experience from working with multiple water and wastewater systems. They often have more time to invest in analyses and evaluations than utility staff and boards may have on their own. Funding agencies tend to look more favorably on applications from water and wastewater systems that have engaged with TAPs. Your customers may be more accepting of your actions as a board when they are proposed by a neutral, third-party expert rather than from utility or municipal staff.

If you decide to engage the expertise of a TAP, it is important to find one who can best assist your community. Find out what services the TAP can offer you and ensure that they are familiar with the regulations in your state, territory, or Tribal nation. It is a good idea to ask for references from systems that have worked with a TAP previously that are similar to you in size, demographics, and/or ownership.

MAPPING REVEALS IMPACTFUL INFORMATION

HOW MAPPING CHOLERA CLUSTERS SAVED LIVES

One of the biggest improvements in global life expectancy, and the more common use of wastewater treatment, started with a map in 1854. Cholera hit the city of London, England. British physician, John Snow, began mapping outbreak locations, roads, property boundaries, and water lines, as seen in the image below. When he added these features to a map, something interesting happened.



Many people thought the disease was propagating through the air. However, Dr. Snow's map illustrated how Cholera cases were commonly found along the water line and centered around a water pump.[3] That map led to investments in wastewater infrastructure and clean drinking water and was the beginning of epidemiology: the study of the spread of disease. Snow's spatial analysis[4] demonstrated that GIS is a problem-solving tool. He put geographic layers on a paper map and made a life-saving discovery.[5]

2 ESRI (N.D.). WHAT IS GIS?. RETRIEVED AUGUST 22, 2022, FROM ESRI.COM/EN-US/WHAT-IS-GIS/OVERVIEW.
3 PARKES, EA. (2013). MODE OF COMMUNICATION OF CHOLERA. BY JOHN SNOW, MD: SECOND EDITION – LONDON, 1855, PP 162. INTERNATIONAL JOURNAL OF EPIDEMIOLOGY, VOL. 42, PP. 1543–1552. RETRIEVED FROM *ACADEMIC.OUP.COM/IJE/ARTICLE/42/6/1543/740472.*
4 GISGEOGRAPHY. (2022). THE POWER OF SPATIAL ANALYSIS: PATTERNS IN GEOGRAPHY. RETRIEVED FROM *GISGEOGRAPHY.COM/SPATIAL-ANALYSIS/.*
5 ESRI. (2019). GETTING STARTED WITH DIGITAL TRANSFORMATION USING ARCGIS: A GUIDE FOR SMALL AND RURAL WATER UTILITIES. AN ESRI WHITE PAPER. RETRIEVED FROM *ESRI.COM/CONTENT/DAM/ESRISITES/EN-US/MEDIA/PDF/GETTING-STARTED-WITH-DIGITAL-TRANSFORMATION.PDF.*

CHAPTER ONE

What is GIS and why should my utility care?

What is GIS?

Geographic Information Systems (GIS) in its simplest form is a tool that incorporates geographical features with tabular data to map, analyze, and collaborate. The pivotal piece of this technology is Geography – meaning that the data is spatial. Spatial means occupying a physical space on earth. Spatial data usually is accompanied with tabular data known as attribute data. Attribute data is defined as additional information about a spatial feature. An example of this would be a water valve. The actual location of the water valve is the spatial data. Additional data such as valve manufacturer, type of valve, date the valve was installed, number of turns to open, would make up the attribute data. It is the partnership of these two data types that enables GIS to be such an effective tool through spatial analysis. To obtain the spatial location of the water valve, GPS (Global Positioning System) technology is used in conjunction with GIS software (see Figure 2).

Why GIS?

GIS technology has been around for many years, yet there are many who are unfamiliar with this tool, especially rural communities that face a variety of obstacles to obtaining and utilizing GIS. It seems unobtainable to some rural utilities for many reasons, cost being the most decisive factor. Other reasons include staffing, outdated computer systems or weak internet connection, and the lack of knowledge of GIS and its myriad benefits. These obstacles can appear daunting at first, but there are resources available to overcome the obstacles and reap the benefits of GIS.

The benefits of utility GIS are numerous and include:

- Known locations of infrastructure components;
- Baseline for Asset Management;
- Single data repository which leads to improved data collection and records management;
- Increased operational efficiency among workforces;
- Improved proactive operations through efficient work order management procedures;
- Decreased reactive operations;
- Quicker emergency responses, with mobile maps showing locations in the field;
- Meeting regulatory compliance reporting; and
- Transparency to the community and utility/community leaders.

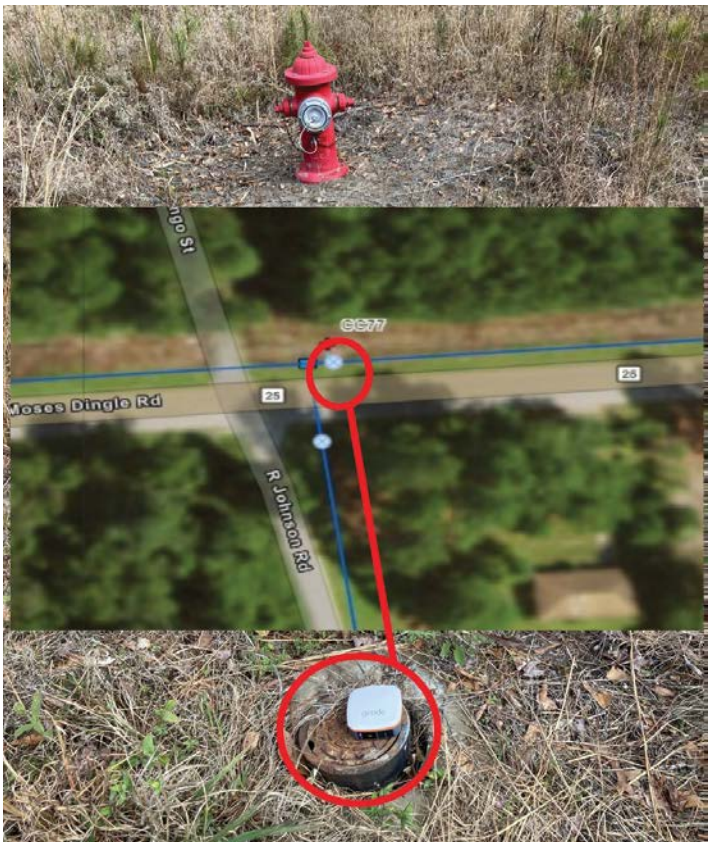


FIGURE 2—GPS DATA COLLECTION POINTS FOR A WATER UTILITY

RCAP photo showing a water valve being located using GPS technology. The circled point on the distribution map reveals an image of the water valve in real time during the data collection process which will remain as an attachment for the water valve in the digital GIS.

Benefits of adopting GIS for your utility

GIS can offer a whole range of benefits for your system no matter what your size or capacity. Benefits can range from basic maps that simply show the location of a single asset type like fire hydrants, to showing all your assets with inspection and condition information.

Reference map

One of the most common benefits gained from mapping your system is an up to date, accurate reference map of the utility. These maps show the location of utility assets and can be used to better respond to emergencies, training new staff, capital improvement projects, and much more.

Another process that can be added to a reference map through GIS is including asset information for each individual point on the map. This information can include condition, date installed, maintenance history, cost to replace, and estimated useful life. By inspecting the assets and including this information in your GIS map, a system can begin developing a quality asset management plan. This will allow systems to move away from reactive maintenance and into predictive and proactive maintenance. Including this information in your map also allows you to have a comprehensive asset inventory which is the base for your asset management program (see Figure 3).

Database for multiple facets of a community

Using GIS in your community is not limited to just one area of the community. Commonly it is used in the utility world helping water, wastewater, stormwater, and electric or gas utilities. But it can also be used to show and catalog other community assets. For instance, a community can create a GIS layer showing where the library, parks, or trails are located. Some communities have even mapped their cemeteries to assist in finding a specific tomb stone.

Prioritizing which actions to take where

GIS can also help a community prioritize investments using multiple kinds of spatial information and attribute data together. For example, a community used GIS to map illegal dumping site locations relative to sensitive habitat and drinking water areas. Those maps helped prioritize cleanup efforts where they would have the most impact on healthy people and healthy habitat.

Mapping with many layers

In GIS, the term "layers" is used to separate each set of data used in a map. With GIS, a community can incorporate multiple layers into a single map to gain additional insight and information into what is being mapped. Each layer added can reveal new patterns or be used to answer different questions. Layers can also be turned "on" or "off". For example, fire hydrants, meters, or shut off valves would each be individual layers. This allows the community to view each asset on its own or all of them together (see Figure 4).

Other ways to map with many layers is to incorporate data from outside sources. This could be adding the county assessor's parcel layer to view property lines, or right of way information. Many counties and states have data sources that can be easily accessed by the GIS user. Additionally, there are hidden gold mines of free GIS data sources such at ArcGIS Hub[7] or your state's GIS library.

Probably the most common example of adding additional layers is adding an imagery layer to your map. This can either be satellite

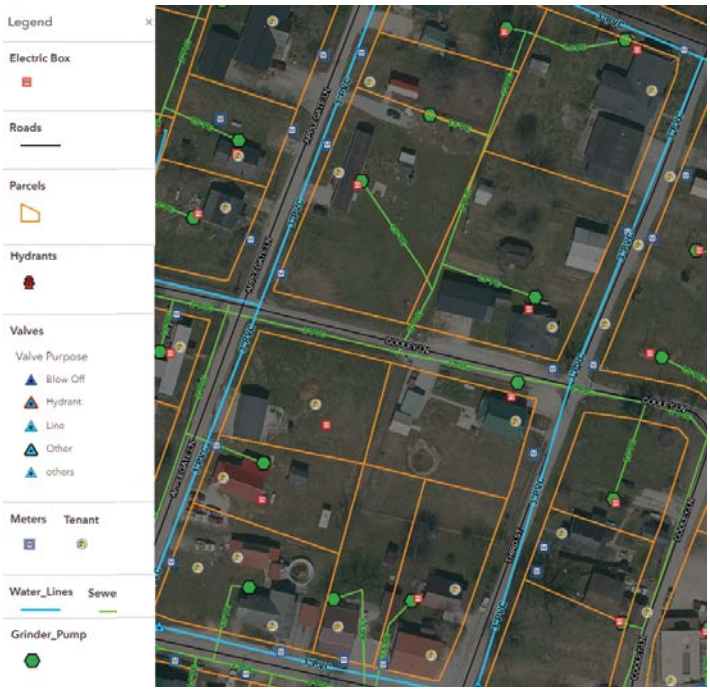


FIGURE 3—AERIAL IMAGERY DISPLAYING A WATER DISTRIBUTION SYSTEM

Example of GIS Water and Sewer Utility Map overlayed on Aerial Imagery with Roads and Parcel Property Data Boundaries

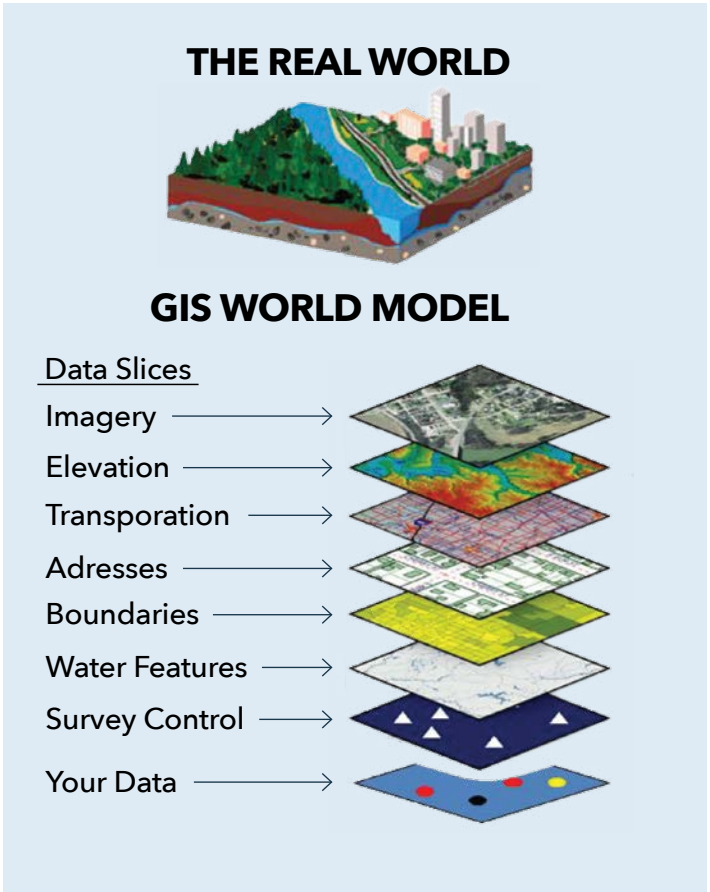


FIGURE 4—ILLUSTRATING THE REAL WORLD BROKEN OUT INTO VARIOUS LAYERS AS DEFINED IN GIS

7 ESRI. (N.D.). ARCGIS HUB. RETRIEVED AUGUST 22, 2022 FROM HTTPS://HUB.ARCGIS.COM/SEARCH.

and/or aerial imagery that can illustrate in detail what the surrounding area looks like.

Moving to digital

Using GIS to assist your water or wastewater system's digital transformation can have a major benefit for the operations, maintenance, and management of the system. With GIS maps, systems gain the ability to add detailed asset information to physical locations on a map. Digital or paper forms can be scanned and attached to these same physical points assisting in documentation storage and security. Maps can be viewed in the field on a tablet or cell phone with GPS location enabled to improve response times. Applications like ArcGIS Field Maps can even collect data in the field using a phone or tablet (see Figure 5).

COMMON, PUBLICLY AVAILABLE IMAGERY LAYERS

Detailed satellite and/or aerial imagery is now widely available, and often free. Some of the common sources of imagery include:

Sentinels Open Access Hub
scihub.copernicus.eu/dhus

NASA's Earthdata Search
search.earthdata.nasa.gov

Global land cover data sources
gisgeography.com/free-global-land-cover-land-use-data

Aerial imagery can also be navigated in several places online, including Google Maps, Google Earth, and ESRI's Living Atlas as examples.

FIGURE 5—DAMAGED PAPER AS-BUILT MAPS CAN BE EASILY DIGITIZED AND ADDED TO ONLINE AND MOBILE DEVICES FOR LIVE UPDATING

CHAPTER TWO

GIS is valuable

GIS is valuable for everybody in the water/wastewater system

GIS has evolved into a spatial asset management system that enables communication and collaboration between all participants in a utility. Whether it be a manager, maintenance worker, water operator, engineer, or even a customer, GIS data can be exchanged and utilized in numerous fashions. Just like how clean drinking water can flow in all directions throughout a distribution system, so can GIS data. The difference between the two is that you can see your GIS asset data at any time and anywhere with a few clicks, versus having to drive there and possibly dig in the ground for that asset information. The practical benefit of using GIS in the utility sector continues to evolve with technological advancements. This is why GIS has resoundingly been recognized as the modern best solution for not only locating assets, but also recording and referencing the volume of data changes that occur with daily operational activities. O&M (Operation & Maintenance) activities can unintentionally cause system design changes, affecting the overall performance and capacity throughout a utility (See Figure 6).

Missing out on the value of GIS as a smaller, rural, or tribal system

"Too much to keep up with" is exactly why even smaller utilities need GIS and why many have started to adapt to learning GIS. Many smaller utility managers only see the additional work and time required to build and run a GIS program, but not the work

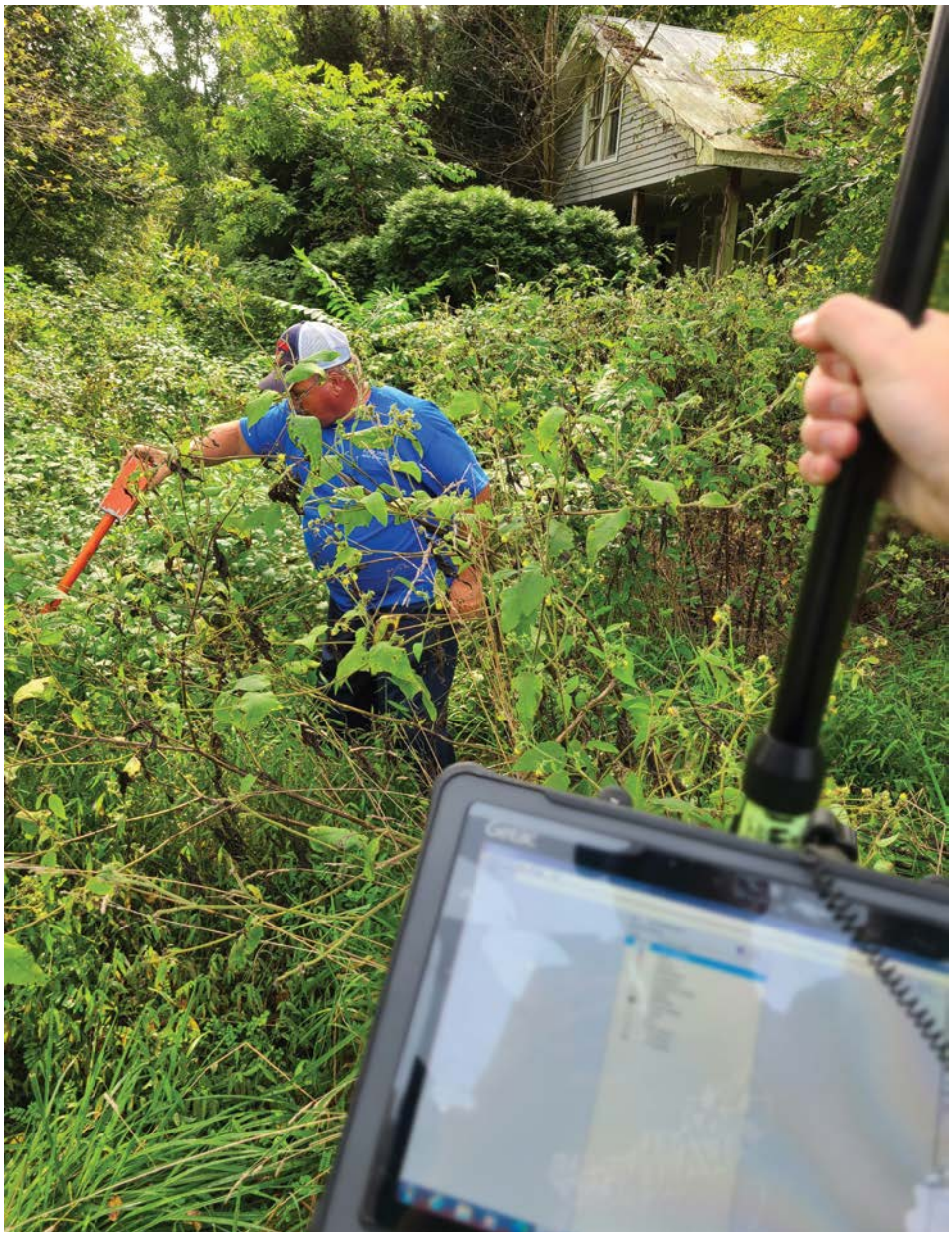


FIGURE 6—WATER DISTRIBUTION OPERATOR USING GIS

Pictured here is a water distribution operator using a metal detector to search for a water service meter. Once found, the GPS coordinates of the meter's location were recorded for quicker locating access in the future. Many utilities are upgrading to radio-read / drive-by meters; therefore, operators visit the location of the meter less frequently. On top of this technological change, more operators than ever are now retiring from the workforce, leaving new utility staff scrambled looking for assets installed by their predecessors. With changing utility environments, it is critical to GPS locate all known utility assets.

and time that they could save in the future. Small utility managers and operators are often accustomed to an insufficient workforce struggling to keep up with the pace of numerous moving parts in their system, which leaves the workforce in many reactive situations to juggle between. A structured, proactive platform like GIS may sound unachievable to maintain. Yet, the further behind a utility gets without investigating situations involving vulnerable assets can lead to severe system failures. That is where GIS plays a role in being able to highlight critical assets, analyze drastic pressure imbalances, and help determine internal and external stresses to the system which can prevent more line breaks from occurring. Plus, once a GIS program is initially configured it is not overwhelming to maintain, and in fact really helps avoid piling up these reactive situations. For example, with proper GIS usage, an operator would not need to wait until a water break surfaces to find a specific water main. With GIS you can eliminate this problem by both recording and referencing that water line or water leak's location with photos, coordinates, and text descriptions straight from your phone or tablet to make better educated responses in future incidents.

Unfortunately, many smaller rural and Tribal systems have not had the proper exposure to the full scope of modern GIS capabilities; nor have they been provided with the proper technical assistance needed to support a small-scale utility GIS program sustainably. Fortunately, GIS has evolved in its software capabilities, ease of use, and customizability for smaller utilities along with allowing collaboration from outside parties like RCAP to help assist with creating a sustainable GIS program. The evolving GIS software programs support more simplified data usage workflows without compromising the quality of the data. GPS collection, handling GIS data, and generating robust analytical results can now be completed in less time than ever. These capabilities along with GIS being able to work with real-time online, cloud-based data servers have allowed nonprofits like RCAP to provide technical outreach to the smallest, most remote water and wastewater utilities.

"GIS ain't built for us small town water and wastewater utilities. There is already too much to keep up with." –A system manager's perspective in the past that now has shifted to actively using GIS alongside with the RCAP network today.

Role of GIS based on your responsibilities

Not everyone in a utility needs to know everything about GIS. Managers/Mayors/Supervisors can shape what kinds of information they need to make good decisions. Operators use the GIS data to quickly locate assets, and they help collect and enter data. Clerks, IT, Finance, and Administrative staff can use the GIS maps to talk with customers and connect all the different kinds of data the small town or tribe holds. A small system's consultants and contractors can use GIS to do faster, better construction and provide good technical assistance. Customers can look at GIS maps to understand their own connections to the system.

Table 1, on the next page, describes some of these roles, the potential benefit of using GIS for each., and some typical responsibilities.

RCAP has had adequate experience with small to medium sized utilities to recognize the variation in management style, system design, and workforce, along with each utility's capabilities. "One shoe fits all" is not the answer with GIS. In fact, within the RCAP network, GIS staff have taken additional steps to allow customizability for utilities needs based on current circumstances where GIS solutions can help.

RCAP can use system design records, operator maintenance logs, photos, and then feed all this data into GIS applications to reflect current system conditions. The GIS tools that RCAP equips a system with are typically determined by the current condition of the system broadly defined by a technical, managerial and financial (TMF) assessment along with what data is available in geographic format. Ultimately, the vitality of a GIS system is determined by the utility's current capacity, willingness, and goals communicated across staff of all roles. Once goals, permission, roles, and all that other business is established, that yellow light turns to green; GIS is ready to go.

Understanding your system design: Watching vulnerabilities and prioritizing improvements based on operation & maintenance activity using GIS.

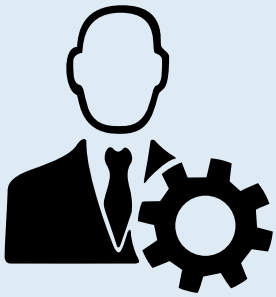
To understand your system design fully and leverage GIS to its full potential:

- GPS record your assets with mapping grade accuracy or above for locating purposes;
- Properly document operations and maintenance activities for assets with assigned unique IDs;
- Use external data from local, state, and federal GIS mapping sources such as imagery, roads; and
- Conduct system analysis by leveraging data statistics such as pressure capacity ratings in water assets in GIS custom applications that can perform calculations to improve system design.

These actions are exactly what many larger utilities have had years of experience doing in one collaborative, centralized geographic platform. This has allowed those larger utilities to shift from a reactive to proactive management style while many smaller systems still struggle because they lack the tools like GIS to effectively manage and communicate between staff about their aging system. Smaller systems typically face lower budget levels to have the equipment and technical capabilities and training to facilitate specialized work needed for proactive investigations on their system's condition. The minor repairs and replacements that do not get addressed or investigated typically result in larger and more frequent main breaks and a staggering service line leak log to keep up with. Aging infrastructure amplifies these issues and can create a critical state of havoc where uneven pressure points worsen throughout a system.

Earlier in the introduction of this chapter, we highlighted how GIS can be used for digitally recording water breaks, but this is just one of many operations that can be digitally recorded. For example, small utilities can utilize GIS with a maintenance/replacement program for gate valves. Instead of waiting to fix or replace the valve once it is broken, GIS allows for proactive analysis and exercising valves before they break. This also helps determine the criticality of that valve if it were to fail in the future. GIS can easily identify critical valves with specialized symbology to make the icons appear

TABLE 1—GIS ROLES WITH BENEFITS AND RESPONSIBILITIES

KEY MANAGEMENT AREA	BENEFITS OF USING GIS	TYPICAL RESPONSIBILITIES USING GIS
 **ROLE 1** **MANAGER/MAYOR/ SUPERVISOR** Calling the shots based on the data given.	**MONITORING DATA** looking at operations, newly installed lines/repaired existing lines, and monitoring analytics like pressure reading capacities. **LEVERAGING DATA FOR PLANNING** creating asset management programs/developing long term replacement strategies. **STAYING IN COMPLIANCE** communicating system goals and needs between local & state officials. **SUPPORTING GRANT APPLICATIONS** leveraging state revolving funds (SRF) and other infrastructure dollars with data gathered from GIS.	Typically involved in the preliminary work for GIS (research, data acquisition, past records, decision-making), and getting approval from the board. The structuring of the system's asset management program and identifying where daily efforts can be infused with GIS. Managing GIS licenses/permissions for employees with technical assistance provided by RCAP or others.
 **ROLE 2A** **OPERATOR/MAINTENANCE/ FIELD** Locating and maintaining assets throughout system.	**QUICKLY LOCATING ASSETS** saves time and reduces stress when needing to work quickly. Imagine when there is a severe water break happening and the operator cannot locate the main line gate valve to isolate that part of the system. Or the fire truck that drove on top of a valve during a fire and frantically trying to locate it for them. **RECORDING OPERATION AND MAINTENANCE ACTIVITIES** by specific location to reference in the future.	Typically involved in the preliminary work for GIS (e.g., marking assets in the field). Can also be involved with on-going GPS, locating assets whether existing or newly installed ones. Taking photos of O&M activity and entering in any supporting data.
 **ROLE 2B** **ADMINISTRATOR/CLERK/ IT TECH DEPT/FINANCE** Sort data and organize; fix tabular inaccuracies from the field.	**HAVING ACCESS TO A DIGITAL WEB MAP** for internal office staff whether billing, admin, or IT staff can be beneficial in many less obvious ways. **COMMUNICATING INFORMATION** for dialogues with customers such as where their curb stop or meter service box is instead of having to call up the field worker or manager that may or may not know right off the top of their head where that particular meter is located. **CONSUMING GIS SPATIAL INFORMATION** like the parcel property boundaries and existing waterline data to determine if a customer is eligible for utility services. This can also be used to determine roughly how many miles of line would be needed to connect a new customer, and to more accurately estimate the costs involved.	Typically involved in gathering preliminary GIS data such as meter billing records, rates, maintenance reports, and any other data that could be consumed on a digital map. Sometimes reaching out to external agencies. Any data can be routinely loaded in to be used by management and field workers. Creating Asset ID name scheme method to match up GIS with asset management software. Fixing data inaccuracies from field worker observations by using internal records typically involving customers and service connection assets like water meters.

KEY MANAGEMENT AREA	BENEFITS OF USING GIS	TYPICAL RESPONSIBILITIES USING GIS
 **ROLE 3** **EXTERNAL USER/ENGINEER/ ENVIRONMENTAL CONSULTANT/ GIS CONSULTANT/ OTHER UTILITY DISTRICT** Provide assessments utilizing existing or creating new GIS data for projects or improving daily operational work.	**HELPING FACILITATE CONSTRUCTION WORK** by leveraging existing GIS data that may or may not have had to be GPS collected; reducing overall work. **SUPPORTING GIS DATA** from operation and maintenance also helps determine the best design solution for the given project with the many parameters such as failing gate valves that exist in the system.	The range of responsibilities will vary based on how involved the third party is with the project. Typically involves loading in existing GIS data collected by consultant/ engineer or creating new GIS data to highlight project plans.
 **ROLE 4** **Customer** Provide feedback to utilities, an extra set of eyes. Communicate data back to customers with free public web maps.	**CAN ACCESS GIS INFORMATION** to understand the current state of the water quality in their system and be alerted when there are system outages. **LOOK TO THE UTILITY COVERAGE MAP** to see if new customers could receive service, and existing customers might look to GIS to understand the risk of them having lead or copper lines or fittings.	A customer typically has no responsibilities involved with GIS mapping but could have experience using a public LEAD & COPPER service line replacement digital map.

differently on the map. This is especially helpful during distressful times like during an 8" water main break when you need to isolate the main for repair with the least amount of disruption to customers' service. Small systems are also utilizing GIS to improve their hydrant flushing program. They can use GIS to unidirectionally flush hydrants before a customer complaint triggers a conventional flush hydrant. This proactive approach lets a system be used to its full potential with additional pressure instead of resulting in greater wtarer loss and poor water quality.

Leveraging existing resources, knowledge, and data

There are very few barriers for a system looking to implement a GIS program. Software costs have become more affordable, and many systems already have many of the computer and smartphone/tablet devices used to manage and support a GIS program. A cloud-based GIS program like ArcGIS Online allows users to access their data and maps on almost any smartphone or device, laptop, or computer with or without an internet connection. A smartphone can be used by system staff in the field or office to collect GPS data, view maps, and have access to a variety of different GIS applications. These GIS mobile applications have been designed to be used by non-GIS users and only require minimal training. Anyone familiar with digital maps, using a GPS, or even just using Google Maps should quickly become proficient with the basics of GIS mobile applications instead of struggling with paper maps (see Figure 8).

Many systems already have GIS data of their water or wastewater system that may not be currently utilized. Often, engineering companies will have this data, or a system may have collected their own GPS points under previous management. Transferring any existing data into a new program is generally an easy process and can help kick start GIS implementation. Once any existing data is reviewed, system staff can begin filling in any gaps or expanding upon the current data.

It is common that a system may not have any GIS data or even accurate maps. Most of the institutional knowledge may just reside with an experienced operator or manager. Extracting that information and transferring it to a system like GIS is a great way to build a data legacy at the system and avoid losing critical information if the

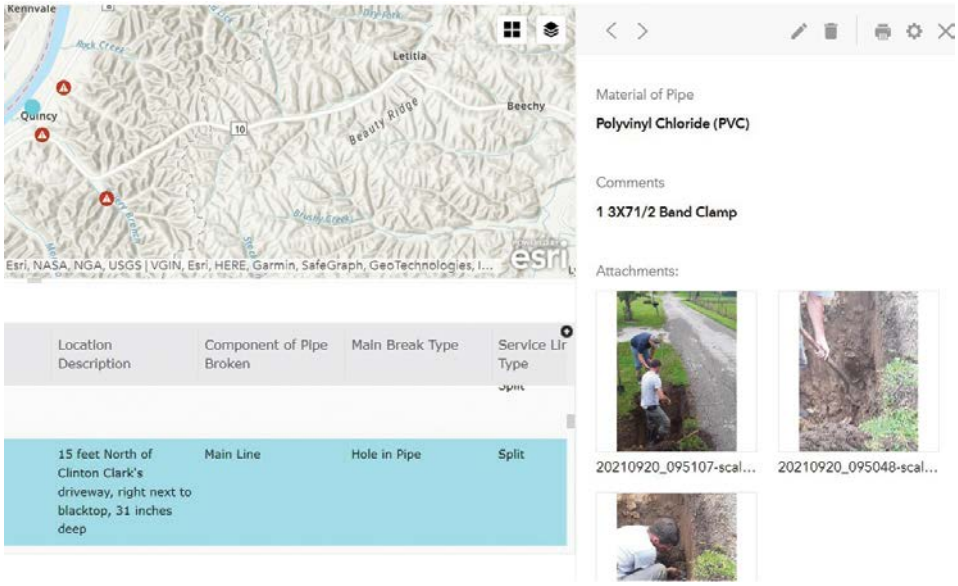


FIGURE 7—USING GIS TO DETECT AND REPAIR LEAKS IN GARRISON, KENTUCKY

Garrison Water District uses GIS to identify, locate, and document repaired water leaks and sewer line maintenance in its system. The project involved first constructing the GIS map by drawing water lines, GPS collecting point data such as meters, hydrants, and valves. Then, the manager wanted to take the next step with GIS to digitally record operation and maintenance activity such as water main/service line repairs using the Survey123 GIS application. This data was moved into reports created by Survey123 and ArcGIS Online web maps to communicate to water board members the need for replacing aging infrastructure as well as allow distribution operators to reference past maintenance records to better prioritize future water line or sewer line replacements.

FIGURE 8—WATER OPERATOR STRUGGLING TO INTERPRET A PAPER MAP IN THE FIELD

CONTRIBUTING TO THE LIVING ATLAS

LOTS OF EXCITING DATA AVAILABLE FOR UTILITIES PROVIDED BY LOCAL, STATE, FEDERAL, AND COMMERCIAL PARTNERS.

WHAT CONTENT CAN YOU CONTRIBUTE?

Imagery–current and high resolution

Elevation–3 meter Digital Elevation Model or better

Urban Systems and Observatory–city-based themes

Oceans–bathymetry and places

Hydrography–streams, watersheds, and elevations

Demographics–lifestyle and business data

Basemap layers–Reference features

3D (coming soon)–Structures, zoning, and trees

FIGURE 9—LIVING ATLAS OF THE WORLD DATA EXAMPLES

GIS Data from public entities and open-source data is becoming more accessible with ESRI's Living Atlas. While you can contribute your own data, there is already lots of local, state, and federal data to consume for no additional cost with an ArcGIS Online user license.

FIGURE 10—BOARD MEMBERS APPROVING A GIS NEEDS ASSESSMENT

knowledgeable staff member would retire or leave the system.

Quick access to an expansive amount of new, online, up-to-date GIS data

GIS has become an extremely popular and increasingly common tool across every industry. The GIS community and major GIS software companies, such as ESRI, share GIS data and maps that are publicly available for GIS professionals to use. For example, a quick search of the ESRI Living Atlas of the World reveals layers showing USA Wildfires, Active Hurricanes, Traffic Maps, and a variety of imagery and base maps, that are readily available and free for a GIS user.[8] The 'Living Atlas' and ESRI's 'ArcGIS Online' contain thousands of publicly available GIS layers that can be added to your GIS maps. Government and state agencies, universities, and many other organizations host GIS data hubs that contain a vast amount of information and data that is readily available to the public. For example, the US Census Bureau provides access to an enormous amount of demographic data that may be useful to understand your customer base or be used in grant applications. Sometimes a quick Google search is all you need to find the data you need.

Sharing and securing data capabilities

GIS data, maps, and applications can easily be shared securely with internal and external stakeholders. A system may choose to share their GIS products with their administrative employees, operators, management, and board, as well as outside entities such as their engineer, consultants, or local municipality or county officials. This GIS data sharing can be real-time with ArcGIS services to be fully updated, or it can be routinely made available offline for download.

Alternatively, each of these outside entities could also share relevant GIS information independently with the system. For example, county GIS offices are usually willing to share GIS data that could be useful to your system such as soil and elevation data, or parcel and municipal boundaries. Towns and Tribes may also have agreements in place to ensure data can be shared quickly with neighboring

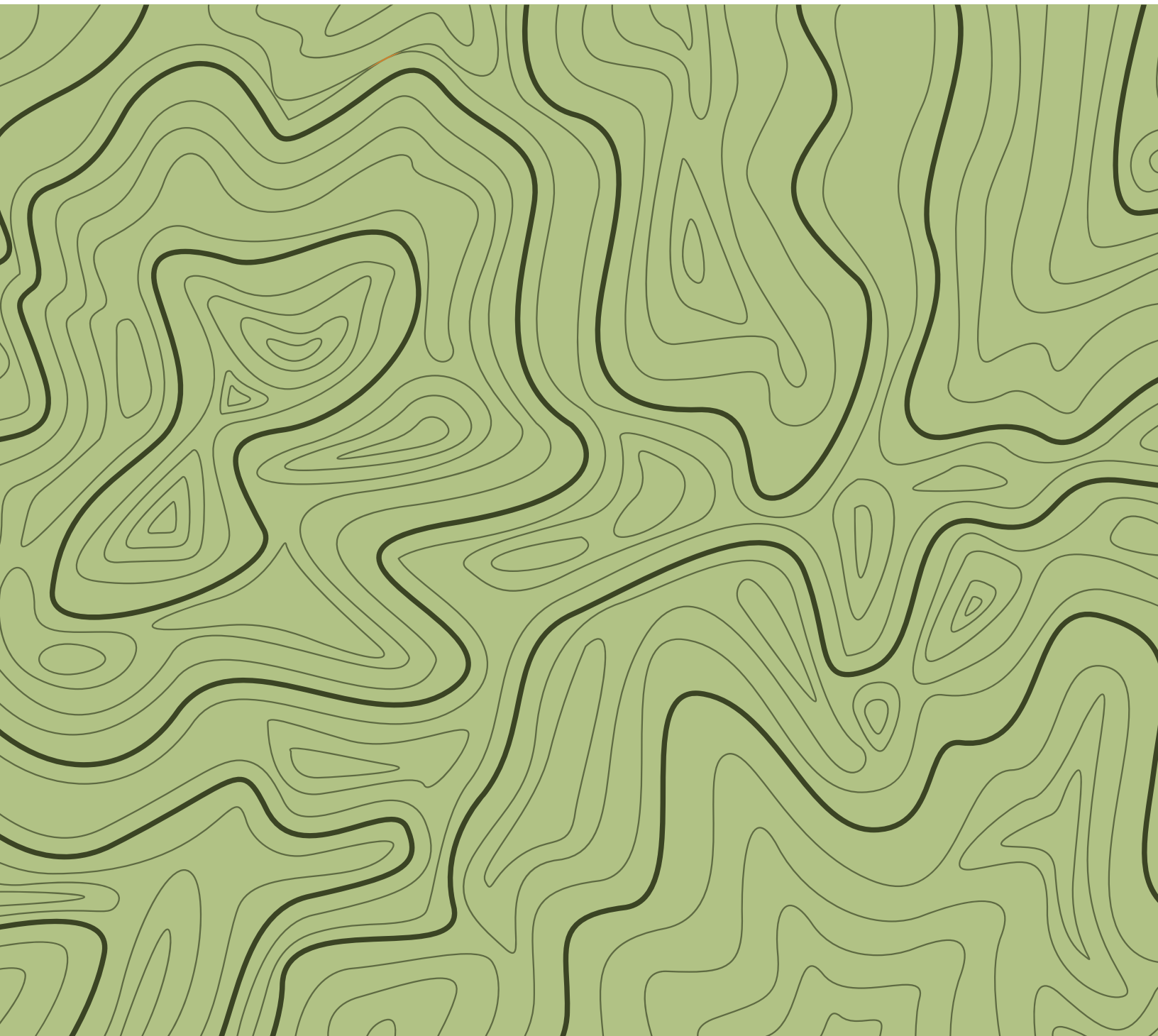
8 ESRI. (N.D.). ARCGIS LIVING ATLAS OF THE WORLD. RETRIEVED AUGUST 22, 2022 FROM HTTPS://LIVINGATLAS.ARCGIS.COM/.

communities in the event of an emergency. There are a multitude of ways an organization could structure their GIS sharing. A system may want to limit visibility of sensitive information on a public map they host on their website (e.g., archeological sites or customer contact information) or filter some data on a map for their Boards (see Figure 10). The sharing of your maps and data can be customized to best service your system needs in concerns of privacy, security, and transparency.

Any remaining excuses, finger pointing, or the blame game? It is time to get started with GIS and put all that in the rearview for the viability of your system's health.

It is easy to point fingers and whip up excuses when current management and staff are dealing with legacy problems that may be rooted in past poor maintenance practices, lack of documentation to understand the operations that were conducted, and/or having little spare time to investigate. The system design may also be faulty in its creation by small, extinct engineering firms. Regardless, these reasons are exactly why GIS is invaluable and needed more than ever at small utilities in "turning the wheel" to take action documenting their systems with their own hands.

If the water system has newer management and/or board members, there is a golden opportunity to implement GIS. Many utility staff members, no matter their years of experience or role, can and have recognized the importance of good documentation by using GIS. Whether having a GIS program is valuable is not much of a debate, but the viability of the GIS program is dependent on many moving parts, just like a utility.



CHAPTER THREE

GIS is practical

We now know that GIS facilitates immediate access to both real-time data and to lifetime records of your system. With GIS, not only can you get the same information as hundreds of paper as-built drawings in one easy to use interface, you also do not have to worry about data loss due to decay, an emergency event, an office move, or any other of the many risks to which records are subject. Additionally, with GIS, your organization can instantly share information between and across departments, and that information can be accessed by multiple users at any time from any device, making it easy to communicate effectively and keep up with the needs of your community. Digitized information and GIS have unparalleled capabilities to help with your small system's Asset Management, Data Collection, Operations Management, and much more!

Asset management

Asset management is the coordinated activity of an organization to evaluate the costs and benefits of its assets over their lifecycle. It often begins with identifying a communal need, then planning to meet that need by acquiring the proper tools and assets, and finally developing a plan to maintain the usefulness and benefits of these assets for as long as possible while minimizing risk. Accurate location information is vital to efficiently complete many of the commonplace tasks of asset management, and it assists in better decision-making. It is important to understand where your assets are located and what the nearest influences on your assets may be for current and future system planning. Every asset has a location, and every location has a story to tell.

The backbone of a GIS-driven asset management plan is the interactive asset map. This map can show all the assets in a system, or just a category of assets (separated out into "layers"), or just a single asset or set of assets that is selected by the user. For example, Figure 11 depicts a small section of pipe. The window within the image depicts a data table that displays all known information about that pipe. The data table is displayed by simply clicking on the pipe section, the asset. Although this community has a smaller water system, it has thousands of individual assets. In order to properly plan for the lifecycle of each of these assets, information on condition, material, etc. must be collected and easily retrieved. Georeferencing every piece of information allows users to organize their assets and inventory much more easily, which improves the quality of your data for your Asset Management plan.

GIS can also aid in getting more accurate measurement information than as-builts, help stakeholders visualize and understand the system as a whole, and be used to model potential capital improvements in order to project future costs. The advanced analytical power of GIS provides insights that help with planning and design to maximize the effectiveness of the present system, and help you get the most out of future upgrades.

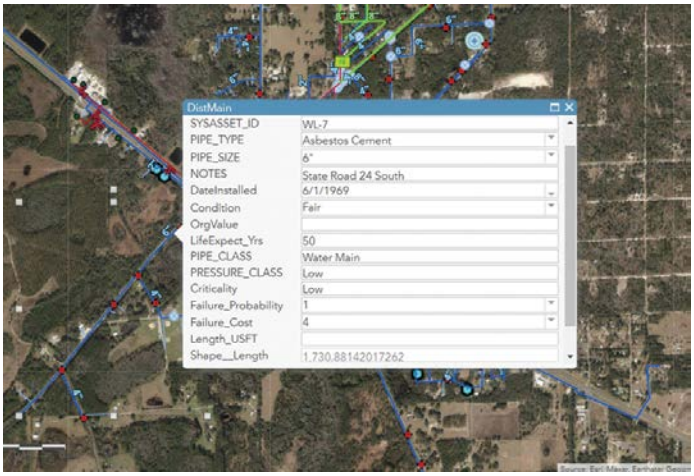


FIGURE 11—A SMALL SOUTHEASTERN WATER SYSTEM'S ASSET TABLE
For a section of water main, showing attribute data for the section of water main selected.

FIGURE 12—SURVEY 1,2,3
Applications like ESRI's Survey 1,2,3, and its many different features make real time data capture simple.

Real time data

One of the most important features of GIS is its capability to enable mobile workers to easily capture asset location, status, details, photos, and notes right from their laptop, smartphone, or satellite receiver. This information can be instantly added to your digital system map and is easily incorporated with traditional data like capital plans and as-builts. This complete picture of your system supports up-to-the-minute accuracy that can be accessed by anyone on your team. This shared information will help you to more efficiently and effectively respond when unexpected events arise, and help you save time and money.

One very useful new aspect of GIS technology is the ability to use survey forms to collect data in the field (see Figure 12). These digital forms are similar to standard paper forms for field workers. For instance, just like a paperwork order form, a digital form might include space for information like the date, the name of who filed the work order, when the work order should be addressed, the location (which will be available on a digital map), and the problem or type of work that needs to be performed. Products for mobile applications are available that have tons of pre-built data collection forms that make setting up your utility GIS survey easy, but survey data collection can be incorporated into any GIS operation in a simple spreadsheet. This data can be tailored to your system's needs and helps you to best leverage the knowledge and skills of your workforce.

Operations management

The goal of operations and maintenance management is to make information easily actionable, and easy to communicate to employees, administrators, and stakeholders. GIS software makes it easy to receive requests for service, assign teams to fulfill a work order, and analyze information on the costs and locations of work over a month or year. This is all possible while reducing the amount of time needed to fill out paperwork. In order to maintain high levels of service and to create an accurate operations budget, there is nothing so important as having a reliable work order system and records. GIS software can serve as an excellent work order management tool, especially for smaller systems.

Your GIS can also help you gain foundational insights through real-time dashboards that show leaders the status of all the many operations within your water and wastewater system to help them make

FIGURE 13—WORKFORCE

ArcGIS Workforce is a mobile app solution that uses the power of location to coordinate your field workforce. It integrates work management to reduce reliance on paper and provides everyone with access to the authoritative data they need.

A WORK ORDER PROCESS ON GIS SOFTWARE MIGHT LOOK SOMETHING LIKE THIS:

1. A customer or an employee encounters a maintenance or service issue in the field. They open a GIS-connected form application like Survey123, and fill out a work order request form, which is customizable to suit your work order needs, and can include photo collection.

2. On the administrator's computer, a notice comes up on the dashboard that a work order request has been submitted. The administrator then locates the newly submitted survey on the map, clicks on it, then determines whether the work order request requires the deployment of a field operator.

3. If the request does require the deployment of a field operator, and the administrator is using ESRI, they can create a new task in the Workforce application, which is used to manage tasks for teams of employees. Otherwise, they can simply deploy the field operator to the location associated with the work order request form. The operator, on their Field Maps or Workforce application, can find the location of the request on their phone.

4. Once they have completed the work order task, or determined that a different action is required, the field operator changes the status of the job in Survey123 or Workforce. They can include information like how long the task took to complete, and what equipment or materials costs were associated with completing the task.

5. The work order request changes status on the dashboard of the administrator.

6. At the end of the month, quarter, or year, the administrator can generate a report based on the information collected in Survey123. They can do this visually, on a map, to describe, for instance, on which water or sewer line the highest number of work orders were fulfilled. They can also run a report in a traditional spreadsheet format, since all the data collected in Survey 123 is recorded in a spreadsheet (called a "related table") that can be exported to MS Excel, or similar spreadsheet software, and analyzed from there. This might be most useful for answering questions like how many total hours have been spent on maintenance.

FIGURE 14—EXAMPLE COMMUNITY DASHBOARD
An ESRI dashboard example depicting service requests during a catastrophic event in Southeastern USA.

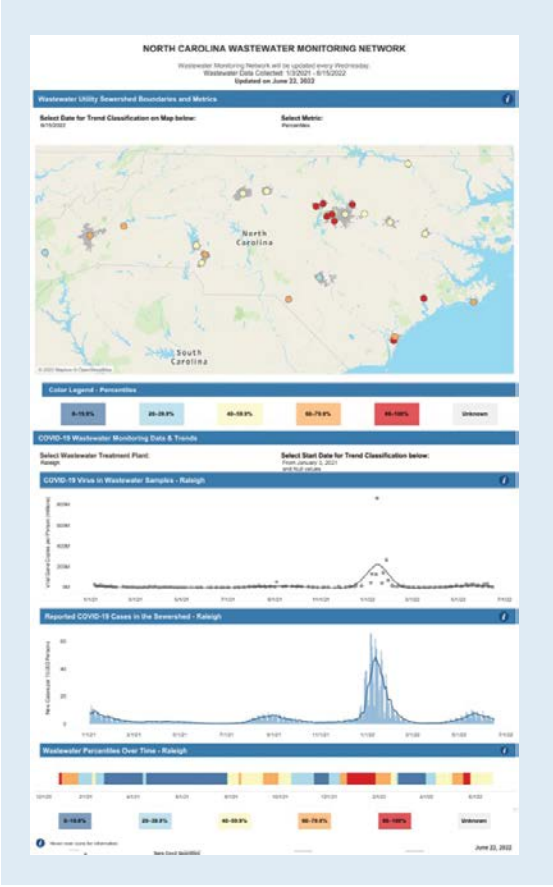


FIGURE 15—TO VIEW THE LIVE DASHBOARD, ENTER THE FOLLOWING URL INTO YOUR BROWSER: HTTPS://COVID19.NCDHHS.GOV/DASHBOARD/WASTEWATER-MONITORING
The following dashboard represents how communities across the nation now use GIS to monitor local wastewater for the occurrence of diseases and health threats like polio, hepatitis, opioid use, antibiotic resistance, and recently, COVID-19. According to the CDC, there are more than 700 wastewater sampling sites in the US currently testing for viral shedding for the SARS-CoV-2 virus that causes COVID-19. Those sites are distributed across nearly 75% of the nation's states and territories, monitoring the waste of approximately 30% of the U.S. population. A single wastewater sample can holistically represent the entire community. In this scenerio, Dashboards act as a tool to display GIS content that provides a snapshot of the spread of disease much faster than contact tracing and the gathering of health records, giving public health officials more lead time for making effective, lifesaving decisions.

well-informed decisions. With the implementation and use of executive dashboards, you can see what is happening throughout your system in real time, including the amount of maintenance work being done, how the work is distributed, and where employees are (see Figure 14). You can also see how employees are accomplishing the work so you can recommend improvements in work protocols to improve productivity.

Security

Security equipment and procedures are increasingly commonplace aspects of water and wastewater systems' operation management. These likely include signage, fencing, security cameras, gates and/or locks, as well as regular checks on the condition of water or wastewater department property. Security equipment can and should be integrated into any map of department assets, and security equipment maintenance can be easily integrated into a GIS software-based operations and maintenance system. Regular security checks can also be easily managed with GIS software, with information about security concerns tied to spatial data so that responses can be timely and accurate.

GIS in the field

GIS software can facilitate your water and wastewater system's operation management by helping you to solicit information about your system from the public too. For instance, many systems engage public participation in reporting Sanitary Sewer Overflows (SSOs). SSO reporting from the public is a crucial step in submitting accurate performance reports to the Environmental Protection Agency (EPA) and to your state's regulatory/primacy agency. By tying each public report to accurate, visual, spatial information you can also help your system identify maintenance, capital improvement, and expansion needs. Using tools like ESRI's Survey123, your system can easily and quickly release downloadable apps for the public to use while moving around your community. For example, if a resident happens upon an SSO event, they can report that event from their smartphone in real time. Back at your administrative office, ESRI's Dashboard will notify you of the report that your resident has submitted, and you can review it. This report will be automatically mapped, so that it will be clear if multiple reports are reported in the same area. You can also create maps and spreadsheet-based reports that will help you analyze information that has been submitted over time. These same tools can, of course, be used to solicit other kinds of information, like loss of service, or places where there are standing water pools in drainage ditches or public places.

CHAPTER FOUR

The myths of GIS

At this point, you might be thinking, "GIS sounds great, but it's not going to work because x, y, z." There are many myths about GIS such as it is too expensive or too time-consuming. You may think it is only for experts, or that you do not have the budget like larger cities do, and therefore, cannot use it in your system. These myths are rarely true; GIS is feasible for small, rural and Tribal communities.

Here is why:

Myth #1

GIS is too expensive

When you think about implementing GIS, the cost immediately comes to mind. Small systems may worry that the available tools and applications will never fit their budgets. While it is true that in the past GIS was quite expensive, it is not necessarily the case today. There are plenty of different types of software, tools, and devices that can fit any budget.

ESRI is the major company providing GIS software, and they have developed options for many different user levels. A user can access online mapping for, in many cases, less than one thousand dollars annually, and you get access to loads of information and mapping capabilities. ArcGIS Pro is great for desktops and offers the ability for more complex data analysis and operations, but if you want to save money, it is possible to operate solely through the ArcGIS Online environment.

ArcGIS Online uses the cloud, so you can log in to any web browser and create maps without the need for a desktop application or server. Also, it will automatically store and update any data collected in the field. ArcGIS Online's associated applications are compatible with most smart devices.

Furthermore, equipment does not have to be outrageously expensive. You could invest in a basic handheld GPS unit like the Bad Elf GNSS Surveyor (see Figure 16), a tripod of some sort, and a smart device, and that is all you need to do most things you require. For some location projects, with less stringent accuracy requirements like mapping an illegal dumpsite, a smartphone's internal GPS could also be accurate enough. You do not need to spend thousands of dollars on survey-grade equipment unless you desire sub-meter accuracy. The more expensive equipment also generally requires more training to operate due to its complexity, so for most, that route is unnecessary.

There are engineering firms that can provide GIS services, but they can also be expensive. And many times, systems do not end up with as much access to their data. RCAP staff can easily offer total assistance for the system and user including long-term support and mapping management.

THE PROS AND CONS OF "OPEN SOURCE" GIS

There are other "Open-Source" GIS options such as QGIS (*qgis.org*) or Open Street Maps (*openstreetmap.org*). However, in comparison to ESRI products, they have not been developed as extensively, do not offer the same level of support, and do not get updated as frequently, so we do not generally recommend them. Employees with GIS experience are usually trained with ESRI products, so using an Open-Source option could require a higher amount of time for training staff.

FIGURE 16—BAD ELF GNSS SURVEYOR UNIT AND AN EXAMPLE OF HOW IT IS USED IN THE FIELD[9]

9 BAD ELF (N.D.). RETRIEVED AUGUST 22, 2022 FROM HTTPS://BAD-ELF.COM/COLLECTIONS/BLUETOOTH-GPS/PRODUCTS/BE-GPS-3300.

RCAP regions can act as a host for your data, giving you complete access without the worry about data storage. Also, they often have more grants available to them, which can potentially be used to fund a GIS license for a period of time. RCAP believes small, rural and Tribal communities should be self-sustainable by being in full control of their GIS data, so our GIS professionals will do everything possible to help you achieve this goal.

Myth #2

GIS is too time-consuming

Next, you may think GIS is too time-consuming to learn and implement. It can seem confusing for systems to figure out on their own. But creating a GIS program will save you time by making it easier to search and update information and improve workflows by making information available instantly all in one place. You may be surprised what resources and information you already have available that can be used to create a GIS program.

There does not need to be a GIS professional on-site, but GIS does require a small learning curve. Luckily, as previously mentioned, our RCAP regional GIS professionals can remove this obstacle by providing direct one-on-one training or refreshers on anything you need to know. This can save you countless hours by walking you through all the steps, so you feel confident managing it on your own. Furthermore, they can point systems in the right direction by offering advice on the appropriate software and equipment. And they may even be able to assist with data collection depending on the situation

Myth #3

GIS is only for experts

Decades ago, GIS used to require a degree and specialized knowledge. This is still the case, but the industry has become more inclusive and tailored to fit all skill levels. Anyone and everyone can learn GIS. It is such a valuable tool for many different situations.

Truthfully, it is all about practice and persistence. The more you practice, the better you will be, and it will become second nature. Most everyday operations that you would be performing in GIS are simply a few clicks on a computer or smart device. The more complex stuff can come later as you get more adept.

And as they say, if at first you do not succeed, try, and try again. There are many courses, videos, and people available to assist in your learning, so you never have to feel lost. RCAP's GIS professionals are only a call or email away.

Myth #4

GIS is only for big cities

Many challenges big cities face, small, rural and Tribal communities face too, especially regarding managing utilities. It is essential for management and planning purposes to have a working system of organization. Infrastructure needs to be updated, fixed, or changed, and GIS is a great way to keep track of all those things. However, GIS is often overlooked because small systems do not realize its advantages, or perhaps do not know it exists. While larger cities may have more options to utilize all GIS capabilities, small systems can benefit from even the most basic GIS functions.

Once you feel comfortable, you can encourage others in your community to become knowledgeable in GIS as well. A lot of resistance in communities comes from a lack of understanding, so the more people who understand the importance of GIS, the better a community will be. Maps are a wonderful way to make this connection.

Myth #5

GIS is only a fad

Lastly, some may think GIS is pointless because it is just another technology that will quickly become obsolete. This is untrue. GIS has been used for decades in the geospatial industry and is continuing to quickly expand to countless other industries (remember the early uses in London to map cholera and the modern uses to trace COVID-19). It is extremely versatile in its uses. There are always new applications and tools being created. Drones, 3D imagery, and AI (Artificial Intelligence) are just some of the new technologies being used in the industry to offer better solutions (see Figure 17) for jobs such as locating lead service lines or reducing flood risks. In short, it is only up from here.

Consider this: the new workforce of young adults has never been taught how to read paper maps. They come out of high school not knowing North is up on a paper map, their phone or GPS turns and orientates digital maps for them. They use their phones for everything including navigation. They will be more comfortable with digital data points on a phone or tablet than pins stuck on a paper map. The migration of utility data from analog to digital will help those new staff in the field. The new crop of utility staff has the workforce numbers in their favor right now as older workers leave the workforce. Before we jump into chapter five, we wanted to showcase a case study from the Rural Community Assistance Corporation (RCAC) that highlights the importance of GIS work in the field.

FIGURE 17—DRONE MAPPING USED FOR AGRICULTURAL ANALYSIS IN MIDWEST USA.[10]

10 ESRI. (N.D.). ESRI DRONE MAPPING. RETRIEVED AUGUST 22, 2022 FROM HTTPS://MICROCAD3D.COM/ESRI-DRONE-MAPPING/.

Mapping Septic Systems on the Tule River Reservation

Working with tribal members to locate systems and improve wastewater management.

Zane Mortensen, Technical Assistance Provider, Rural Community Assistance Corporation (RCAC)

According to the U.S. Environmental Protection Agency (EPA), more than 60 million people across the country are served by septic systems. Septic systems treat household wastewater before it is drained into the soil, and, in some cases, into surface water.

Technical assistance providers (TAPs) like myself primarily work in small, rural communities that may not have as many resources as larger communities when it comes to wastewater treatment and disposal. Many can't afford the high rates for centralized sewer systems, so they use septic systems. Although these communities have had septic systems for years, they may not have had the opportunity to learn how to maintain them properly.

Geographic information system (GIS) mapping is proving an effective tool in water and wastewater management, and it has been particularly helpful in locating septic systems. Such was the case on the Tule River Reservation, located in Tulare County, California. The community is in the Sierra Nevada foothills, with more than 1,000 tribal members living on the Reservation. Tule River Indian Tribe of California members are descendants of the original San Joaquin Valley inhabitants.

GIS Mapping Facilitates Connections to New System

The Tule River Indian Tribe was in the process of locating many aging individual septic systems that had reached the end of their lifespan. The average lifespan of a septic system ranges from 15 to 40 years. Contaminant and, particularly concerning, fecal coliform, were leaching into the Tule River downstream.

COURTESY OF SEVENTYFOUR ON ADOBE STOCK

MAP: GENERATED BY DARCY BOSTIC; USING CATALOG.DATA.GOV

Tule River Reservation, California

Ways to properly maintain a home septic system include

- Inspect and pump the system regularly
- Dispose of waste properly by not dumping anything in the sink or toilet, including grease, pharmaceuticals, chemicals, wipes, or diapers
- Use water efficiently, since all water that goes down the drain ends up in the home's septic system
- Properly maintain the drain field where contaminants are removed from the liquid

Fortunately, the community has a new, larger wastewater treatment system that treats wastewater from homes. It is a membrane bioreactor, which combines a membrane filter with a biological process to treat the wastewater. This community system was constructed about four years ago, but it has taken time to connect individual homes to it. Individual septic systems were, of course, scattered around the reservation. To perform maintenance and possibly interconnect these homes served by failing septic systems to the new more centralized system, the Tribe needed an accurate way to locate them.

The Rural Community Assistance Corporation (RCAC) has long history of working with the Tule River Tribe and, over time, we have built a strong relationship. So, when they were looking for a way to map the existing septic systems, Tribal staff contacted the RCAC to help. The Tribe had been working for about four years to locate all the old septic systems, and my GIS expertise would help to move the project forward and hopefully get it to the finish line.

> **I worked alongside Tribal members, going door to door to ask if homeowners knew the location of their septic systems.**

Over several months, I worked alongside Tribal members, going door to door to ask if homeowners knew the location of their septic systems. After getting permission from each homeowner to access their property, I used a Trimble GPS unit to identify the location of each septic tank and notate that on the system. Afterward, I entered the data into a GIS mapping system.

During the project period, I visited the Reservation for three to four days at a time. Once I had downloaded the information, it was easy for me to use that data to create a map. Working with Tribal members, I was able to map the septic systems for more than 200 homes.

Upgrades and Maintenance Planned for Old Systems

When the map was completed, the Tribe set to work connecting those homes to the larger system and, as of summer 2021, all but about 60 homes had been connected to the centralized community treatment system. Some homes are very remote and located up in the rocky, mountainous area, so it would be too expensive to connect them to the community system. Those homes will be upgrading their septic systems, and the Tribe will create a plan to ensure the systems are properly maintained.

Strong Relationships Support Access

I completed most of the mapping during the COVID-19 pandemic. That meant following local travel and safety guidelines and RCAC's strict travel policy, which includes masking, contact tracing, and, in some cases, travelling in separate vehicles. At certain periods during the pandemic, I had to go through a community checkpoint. But because I had established good communication with the Tribe, they knew when I would arrive and could grant me access.

Throughout the process, the Tribal community members were friendly and accommodating. The homeowners were my greatest resource throughout the project.

CHAPTER FIVE

GIS Is Obtainable

GIS can be obtainable for your utility with proper guidance. RCAP's Technical Assistance Providers can help you develop a more comprehensive plan.

Planning for GIS

Below is not an exhaustive list of questions, but a start to realizing the importance of developing a plan customized to your utility's GIS needs. To dive deeper into each of the questions in the following tables, the utility is encouraged to ask for assistance from a TAP to review the answers and offer more in-depth guidance. This will ensure the utility has covered all of the necessary workflows to be prepared for a sound and sustainable GIS platform.

TABLE 2—GETTING READY FOR GIS

	YES	NO
Do we have an inventory of our system's assets?		
Do we have any maps or documents that would make the process easier?		
Do we have anything already in digital format?		
Does anyone have experience with GIS?		
If we have no experience, do we have staff who would be willing to learn GIS?		
Do we have necessary equipment such as GPS, smart devices, computers, etc.?		
Do we think we can realistically do this ourselves?		
Have we contacted an RCAP technical assistance provider to discuss a GIS plan?		

TABLE 3—PLANNING FOR GIS

	NOTES
Who is going to be viewing or using this information? Operators, clerks, board members, outside companies, customers?	
What are we going to be using GIS for?	
What data, layers, attributes, or features would we like to see in our GIS?	
Do we want to use GIS as a desktop application or are we more interested in the online route?	

IN CLOSING

Utilities should implement patience and seek assistance

Our goal at RCAP is to provide a GIS service with customizable solutions that will not compromise the vitality and sustainability of a GIS program due to the system's present technical, managerial or financial capacities. Also, RCAP wants to improve daily work and long-term planning for utilities in all shapes and sizes, no matter the age or current condition of the system. That way all utilities, especially the small, disadvantaged ones, can be equipped with the proper tools to have a fighting chance at not only having an up-to-date GIS map for locating assets, but also a robust functioning geographic information system (see Figure 18) that utility workers of all backgrounds can pour data into and get usable information back out. As technology moves forward, and GIS applications become more user-friendly and practical, smaller utilities should no longer be left behind because they do not have the technical knowledge to get started.

Instituting best practices and moving towards becoming a highly efficient and effective utility takes time, resources, and expertise. Every one of the best practices described in each of the chapters could easily have its own guidebook describing the necessary steps to achieve it! Many utility leaders step into situations where the challenges seem numerous and daunting because systems have been mismanaged in the past. Do not despair! You can improve the efficiency and effectiveness of your utility over time and taking steps towards any of the best practices outlined here will help. Have patience and remain committed to the process. Most of all, do not feel like you have to undertake this work alone. Utilize existing printed and electronic resources and call on technical assistance providers to help.

RCAP PROVIDING SOLUTIONS TO RURAL COMMUNITIES

RCAP's Managerial and Financial Hub is a one-stop shop for small water systems. The hub contains information about RCAP's upcoming finance and management trainings. In addition, there are links to resources on finance and management topics from RCAP, EPA, and other leading organizations. To access this valuable resource enter the following url into your browser: *rcap.org/managerialfinancialhub*

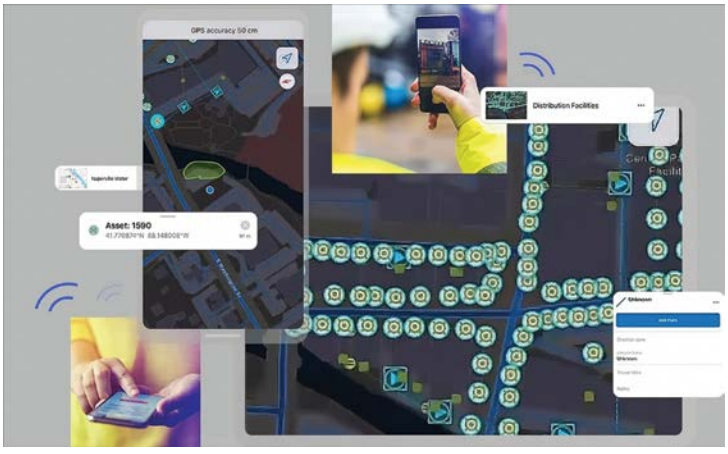
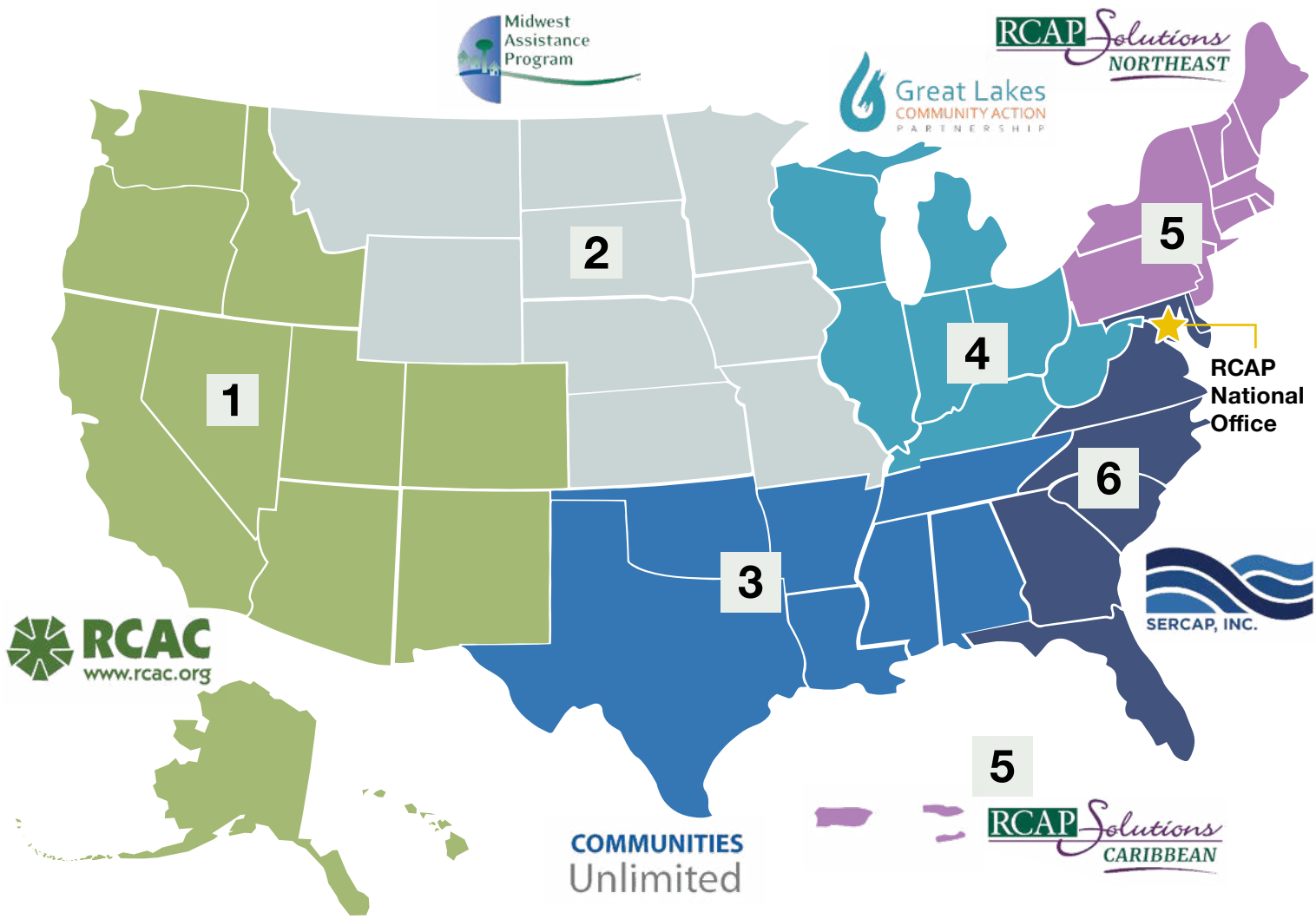


FIGURE 18—ESRI FIELD OPERATIONS [11]

11 HTTPS://WWW.ESRI.COM/EN-US/ARCGIS/PRODUCTS/ARCGIS-FIELD-MAPS/OVERVIEW



Rural Community Assistance Partnership

We envision a resilient, equitable and thriving rural America.

The Rural Community Assistance Partnership (RCAP) is a national network of nonprofit organizations that works with rural communities across the country to elevate rural voices and build local capacity to improve quality of life, starting at the tap. Through RCAP's regional partners, more than 300 technical assistance providers (TAPs) support communities in building their own capacity through technical assistance and training focused on access to safe drinking water, sanitary wastewater, solid waste, and economic development. RCAP works across every U.S. state, the U.S. territories, and tribal land

To learn more, visit **rcap.org**.

1. Western RCAP
Rural Community Assistance Corporation (RCAC)
916.447.2854
rcac.org

2. Midwestern RCAP
Midwest Assistance Program (MAP)
660.562.2575
map-inc.org

3. Southern RCAP
Communities Unlimited (CU)
479.443.2700
communitiesu.org

4. Great Lakes RCAP
Great Lakes Community Action Partnership (GLCAP)
800.775.9767
glcap.org

5. Northeastern and Caribbean RCAP
RCAP Solutions
800.488.1969
rcapsolutions.org

6. Southeastern RCAP
Southeast Rural Community Assistance Project (SERCAP)
866.928.3731
sercap.org

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