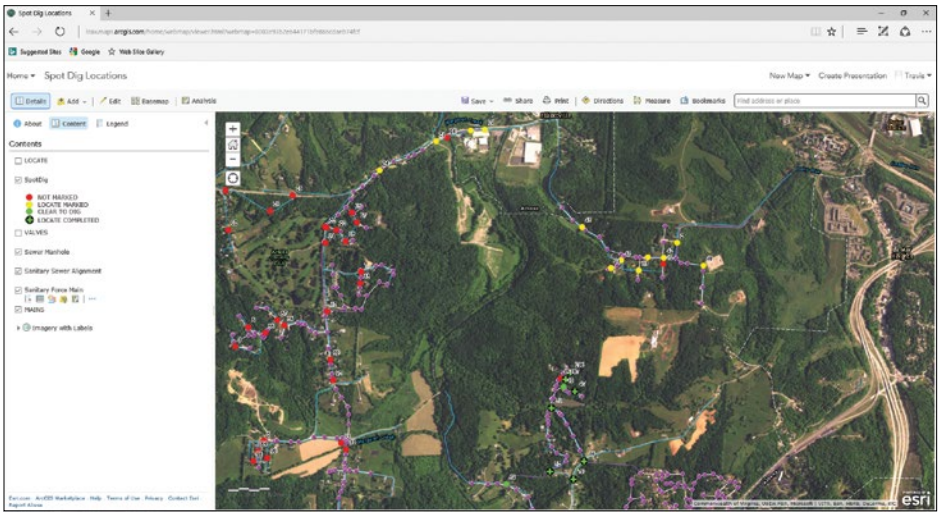
Esri News
for Water & Wastewater
Fall 2016

Rural Water District Gains High Accuracy on a Budget

By Travis Anderson, District Engineer, Le-Ax Water District

When I came to work at Le-Ax Water District in the fall of 2009, staff had just finished gathering GPS points on all the aboveground assets. With Ohio University's Institute of Local Government Administration and Rural Development (ILGARD) providing technical resources, Le-Ax had finally put together all the pieces and had a functioning geographic information system (GIS). From that point on, it was the district's responsibility to maintain it.

The continued task of gathering GPS points was assigned to the maintenance crew. Since they were responsible for installing taps, meters, and valves and making repairs and exposing lines, it made the most sense to have the crew collect the asset locations. Periodically, I would take the handheld GPS unit from the staff and put the new points into ArcMap. The workflow seemed pretty straightforward, but it became apparent fairly quickly that this transition to the district's maintaining the GIS would not be an easy one.



↑ Using Collector for ArcGIS and ArcGIS Online to Keep Multiple Field Crews Aware of Spot Dig Locations in Real Time

↑ Travis Anderson, Le-Ax Water District

The two main problems that came to light were the staff's limited technical knowledge of the equipment/software, and the amount of time the handheld unit needed to acquire accuracy. The first problem was corrected by creating cheat sheets for the staff. If the cheat sheet couldn't answer questions or refresh the memory, a phone call generally would solve the problem. The second problem became a much more contentious issue. As the crew would be ready to backfill a repair, the person responsible for gathering the points would be waiting on the handheld GPS unit to achieve accuracy. Sometimes it would take 20 seconds; sometimes it was minutes. This became really frustrating for everyone.

Le-Ax was definitely at a transition point for gathering field data. When Collector for ArcGIS was released, I knew this would be our next step toward using iPads in the field—I just had to figure out how to use the app. Before coming to

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Esri News for Water & Wastewater is a publication of the Water/Wastewater Group of Esri.

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Le-ax, I knew little about GIS. Everything I have learned has been self-taught. A lot of my knowledge has come from Esri's online communities. A search on Esri's website revealed plenty of dialog between users and Esri support staff that answered many of the questions I had. Online tutorials for Collector provided guidance on creating maps and making them accessible in the Collector app. It was all very simple to figure out. The remaining piece of the puzzle to fully implement Collector was a subscription to ArcGIS Online. Since we already had an ArcGIS for Desktop Basic seat and the yearly maintenance subscription, Esri provided us with one free ArcGIS Online account. After reading the basics on creating online maps and sharing them within our organization, I began uploading our layers and re-creating our desktop GIS in ArcGIS Online. After I understood the concept, it took me about 30 minutes to re-create our desktop GIS as an online version.

Once I created the map, we were able to test the functionality of Collector with our iPad. As a field-specific app, Collector is similar to ArcPad but easier to use. It is very intuitive. A blue circle shows the GPS receiver location, and across the top is a very functional toolbar. To access the layers, you tap the layer symbol and a drop-down list will show the layers contained within the map. You can take a picture by tapping the camera icon on the top toolbar, then point and tap. After you're done, tap the Submit button. Everything will be updated and stored safely in ArcGIS Online. I can't stress enough how easy Collector is to use.

As well-thought-out as Collector is, I still had two major concerns: connectivity and accuracy. Athens County, in southeastern Ohio, is not what you would call a booming metropolis of cellular activity. Sure, along the major highways you may have a data connection, but we are a rural water district. We serve almost 7,000 taps spread out over 500 miles of waterline in four counties. We have waterlines in places where you can't imagine someone having the nerve to drive a track hoe. We have many miles of waterline that are nowhere near a data connection. If Collector was going to work for us, we had to be able to do our work with no connectivity—*offline*.

↑ Arrow 100 GNSS Receiver Mated with an iPad Mini

Having searched the online communities, I knew Esri was working on this feature, but I didn't know how it was going to function. I was worried that the process of going offline would be too specialized for our staff to utilize. It couldn't be something where I was relied on to set up every time someone was going

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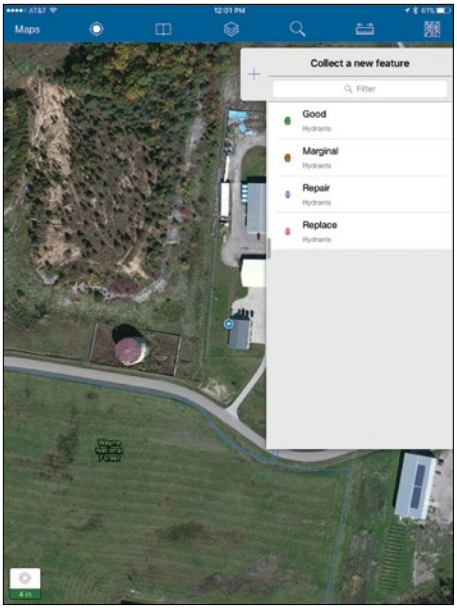
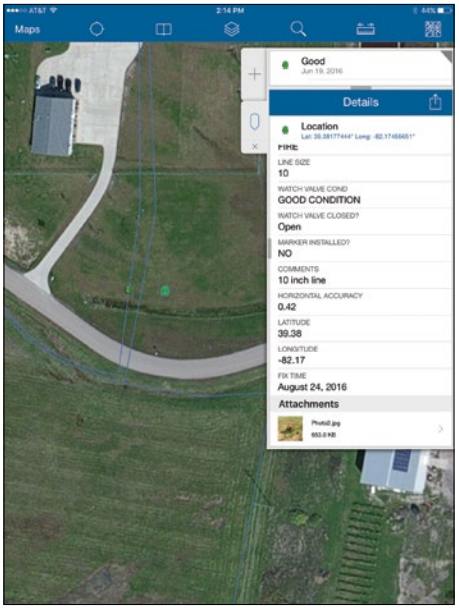


↑ Four-Inch Accuracy with an Arrow 100 Global Navigation Satellite System (GNSS) Receiver Connected to a Real-Time Kinematic (RTK) Network



↑ A Picture of a Hydrant Shown as an Attachment on the Details Panel

↑ Le-Ax Water District Service Area (southeastern Ohio: Athens, Hocking, Meigs, and Vinton Counties)

ArcGIS Helps Kansas City "Keep Out the Rain"

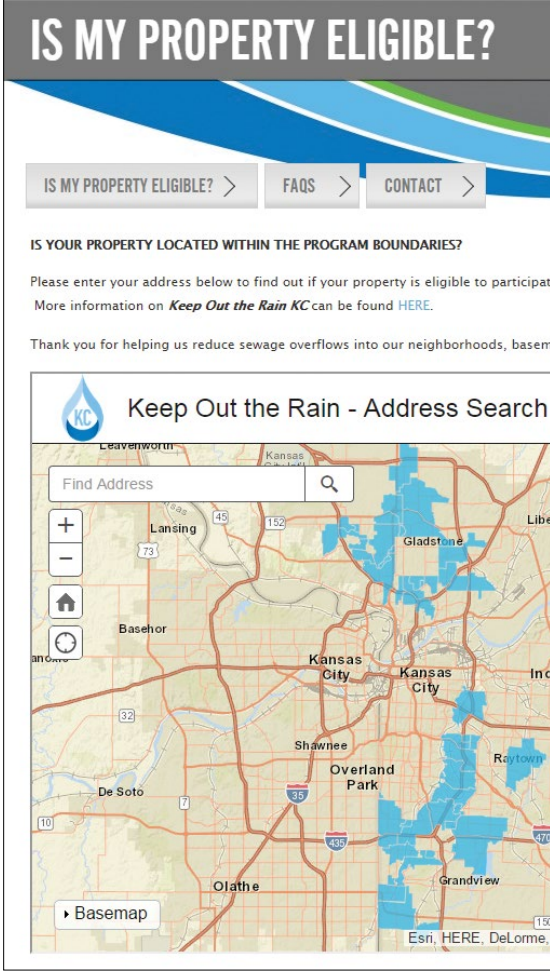
by Brian Parr, Manager, GIS & Data Management Division, Kansas City Water Services

Rain is generally a good thing, but when storm water makes its way into some of Kansas City, Missouri's more than 1,700 miles of separate sewer system, the impacts can be devastating. In Kansas City, excess storm water creates an average of 6.4 billion gallons of wastewater overflow each year.

Kansas City is one of more than 700 communities across the nation that must comply with regulatory standards for wet weather sewer overflows. In 2010, Kansas City entered into a federally mandated agreement with the Environmental Protection Agency (EPA) to reduce sewer overflows by investing in the city's aging sewer infrastructure over a 25-year period. The result is Kansas City's $4.5 billion Overflow Control Program, which will capture and treat 88 percent of combined sewer flows and eliminate sanitary sewer overflows during heavy rainfall.

In an effort to leverage each dollar of the investment, Kansas City is asking homeowners to help reduce the overflow problem by voluntarily disconnecting plumbing connections that are improperly connected to the city's sewer mains. The program, called Keep Out the Rain KC, can help Kansas City save millions of dollars in future capital improvements. Kansas City has initiated this targeted approach because private plumbing connections are believed to contribute to more than half of the rainwater that enters the sewer system.

↑ Collector for ArcGIS displays property status.



↑ An ArcGIS Online web mapping application embedded in the project website is used to determine if an address is eligible for the program and allows property owners to request an evaluation.

"Kansas City is committed to achieving the requirements of the city's federally mandated consent decree in a way that improves neighborhoods and reduces program costs for our residents.

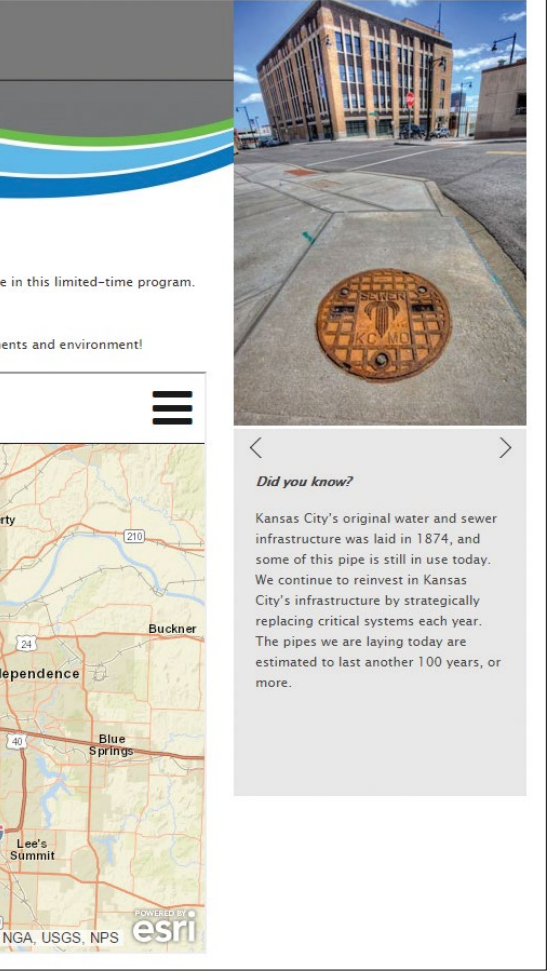
ArcGIS is helping Kansas City to effectively manage the Keep Out the Rain [KC] program and report improvements to the Environmental Protection Agency and to our residents."

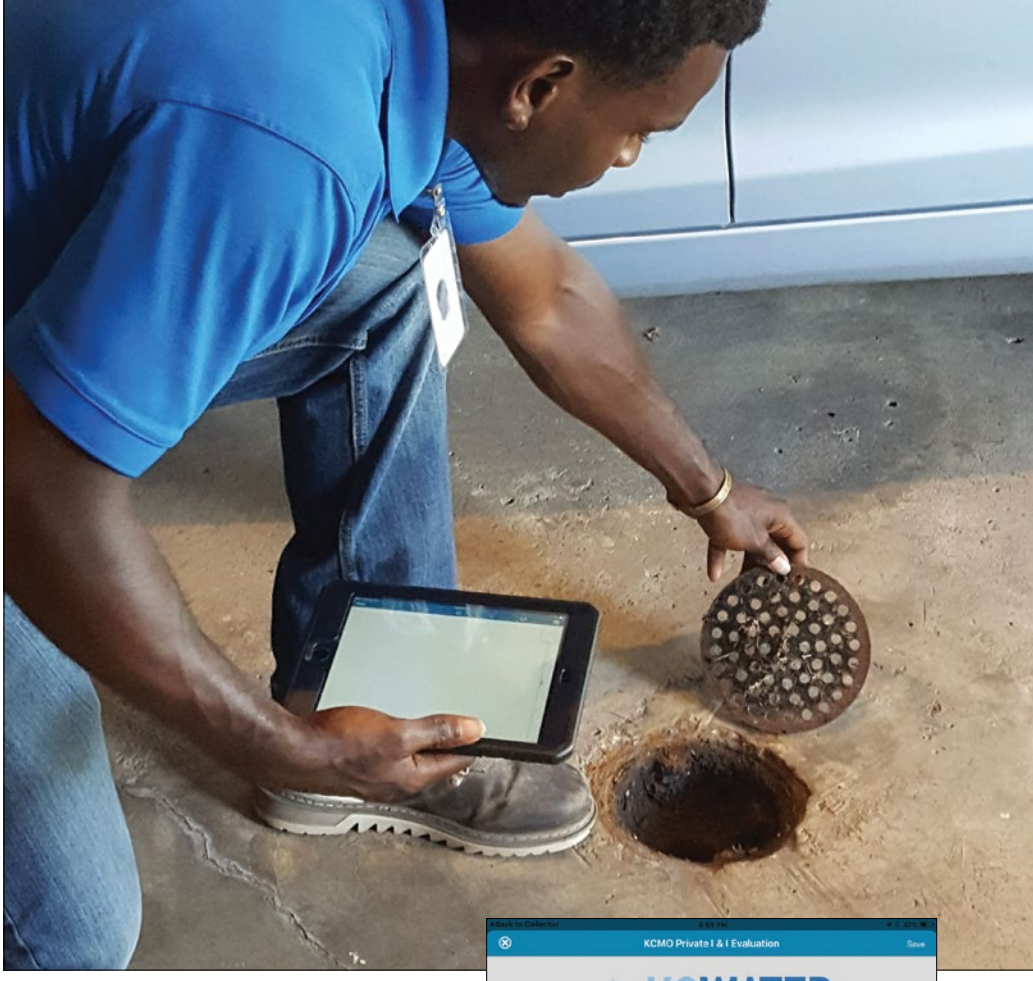
Andy Shively
Chief Engineering Officer
Kansas City Water Services

"Our sewer system is designed to collect and convey wastewater to one of our six wastewater treatment plants," said Andy Shively, chief engineering officer for Kansas City Water Services. "When rainwater gets into the sewer system, it can overwhelm our pipes, which, in turn, can cause overflows and basement backups. Once rainwater enters the sewer system, it must be treated, driving up maintenance and treatment costs."

The ArcGIS platform helps residents and field crews engage with the Keep Out the Rain KC program. It helps Kansas City staff communicate with residents, share large amounts of data, and coordinate and track project teams. Most importantly, ArcGIS helps Kansas City staff analyze the results of the program and report project success.

"Kansas City is committed to achieving the requirements of the city's federally mandated consent decree in a way that improves neighborhoods and reduces program costs for our residents," said Shively. "ArcGIS is helping Kansas City to effectively manage the Keep Out the





↑ Keep Out the Rain KC staff performs an evaluation.

Rain [KC] program and report improvements to the Environmental Protection Agency and to our residents."

To create the Keep Out the Rain KC program, Kansas City first turned to existing GIS data to pinpoint areas where fixing improper plumbing connections on private property might be entering the city's sewer mains. The city found 55,000 properties where simple, cost-effective plumbing corrections could help make a big impact on reducing the city's overflow control issues.

Challenges of the Project and How ArcGIS Has Helped

With 55,000 customers in a project area that spans more than 300 square miles, there are a variety of challenges such as

- Effectively communicating the value of the program to the public and getting a high level of voluntary participation.
- Sharing large amounts of data needed to perform a thorough evaluation with field staff.
- Coordinating and tracking the work being done by a diverse team of city staff and dozens of contractors from many different organizations.
- Analyzing the effectiveness of the program toward its mission of removing rainwater from specific portions of the sewer system.

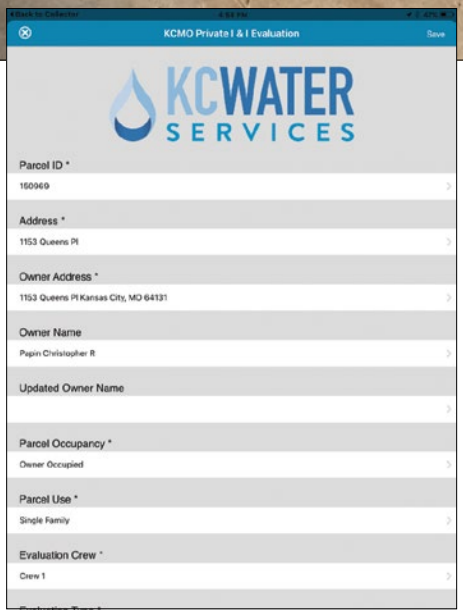
The ArcGIS platform is being used in nearly all aspects of the program including the following:

- Public outreach
- Project coordination
- Data collection and sharing
- Results analysis

Public Outreach

ArcGIS has been used to geographically select from the city's address lists to do targeted mailings notifying property owners about the program in an effort to get them to sign up.

ArcGIS has also been used to help residents determine if their property is eligible for the program. An interactive map embedded in the program website lets property owners search for their address to see if they are within the program area.



↑ Digital evaluation form, built using iFormBuilder, is integrated with the ArcGIS platform.

Project Coordination

ArcGIS was used to subdivide the project area into sections, which helps to evenly

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ArcGIS Helps Kansas City "Keep Out the Rain" continued from page 5

distribute work across the project team and allows program results to be tracked in a much smaller area.

Efficient Data Collection and Data Sharing

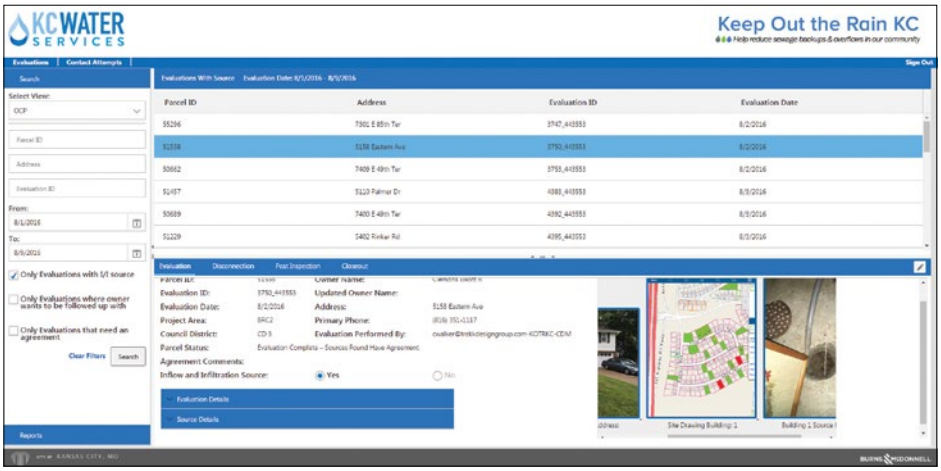
Collector for ArcGIS is being used by the teams in the field performing property evaluations. They can see which properties they are assigned to and determine the status of those properties, such as whether the owners have been contacted, whether an evaluation has been done, and if inflow and infiltration sources were found on the property.

In addition, the application provides the evaluators with a variety of reference information including the following:

- Property owner contact information
- Location of smoke testing observations, which may indicate that there is an inflow and infiltration source on the property
- The locations of wastewater and storm water infrastructure on a given property
- Collector for ArcGIS has also been integrated with smart digital forms built on the iFormBuilder platform developed by Esri partner Zerion Software.

The digital evaluation forms are directly integrated with Collector for ArcGIS. This integration eliminates the need for an evaluator to manually key in property information, such as the parcel ID, owner name, and address, on the evaluation form. This integration increases the quality of the information being collected and makes the evaluation process more efficient.

ArcGIS Online and Microsoft Azure are used to display real-time updates and reporting on the status of the program. Once an evaluation is completed, the information is immediately available in ArcGIS Online and the project dashboard running in Microsoft Azure.



↑ The program dashboard runs on Microsoft Azure.

Analyzing the Results

Using ArcGIS mobile technology and ArcGIS Online allows the project team to see and analyze information in real time. The moment an evaluator completes the work at a property, that information is available for the entire project team to see and analyze.

Having access to information in real time allows the team members to be agile in their approach to the project. Management is able to see what methods have been successful and capitalize on them while working to address any weaknesses.

To make content accessible to all program stakeholders, the program team has incorporated inspection information from ArcGIS into an online dashboard built on the Microsoft Azure platform. The dashboard allows easy access to evaluation information as well as on-demand reports that focus on the program's key performance indicators.

The richness of data being collected in the Keep Out the Rain KC program allows the team to continually improve its approach to accomplishing the project goals.

Quick Results

Within the first three months of the program's start, Keep Out the Rain KC already began meeting its goals:

- More than 6,000 customers contacted
- Approximately 4,000 properties evaluated
- Nearly 400 cost-effective inflow and infiltration sources confirmed
- More than five million gallons per day of rainfall identified to be removed from the system
- An average of 22,000 requests per day on the field staff's online map

Learn More

To learn more about the Keep Out the Rain KC program and ArcGIS implementation, contact Brian Parr, GIS manager at Kansas City, Missouri, Water Services, or Brian Hiller, technology implementation project manager at Burns & McDonnell.

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to an area with no data service. With the release of the Collector update that provided the ability to work offline, Esri couldn't have created it any better. It was basically a two-step process. I showed our staff one time how to use this feature, and no one has had to ask for help since.

My final concern was accuracy. We loved everything about using the iPad with Collector. We had a field-ready tool and app with capabilities that far outweighed the handhelds we had used in previous years. Our staff now could get their email, check weather conditions and receive weather alerts, send pictures back to the office from the field, and opt to use other apps. Also, when a data connection is available, there is nothing like real-time data collection. The user taps the Submit button, and suddenly there's a valve on the map that I'm looking at back in my office. That's pretty spectacular. But even with all these advantages, if we couldn't get to a level of accuracy that would allow us to locate that valve or that waterline one month or five years later, then all this would be for nothing—because that's what this is all about: locating an asset and then being able to get back to that asset based on the GPS data. From the beginning, we knew that we would need an external GPS receiver, and it wasn't going to be an inexpensive purchase. After due diligence on specifications, we chose the submeter performance of the Arrow 100. Before we purchased it, we actually rented the receiver for a couple of days to test it with Collector and the iPad. Three features that sold us on the Arrow 100 were that it was certified by Apple to work with the iPad; it had class 1 Bluetooth transmission (a greater connection range); and beyond the correction service that the receiver provides, it could connect to the Ohio Department of Transportation (ODOT) real-time kinematic (RTK) network and achieve very high accuracy. Coupled with the speed that the receiver would connect to satellites (<60 seconds) and its very quick response to taking points, I felt like we finally had the last piece to our puzzle. The days of waiting 30 seconds to get a point were over. Points now come as fast as you can tap the buttons.

Esri's release of Collector 10.4, which included support for high-accuracy external receivers, put the finishing touches on an already great app. Metadata could now be captured and passed to the attribute table. Being able to see and keep a record of each feature's data accuracy builds confidence in your process and staff. It also allows you to verify the performance of the equipment. If accuracy levels seem off and you look closely at the points on the map, maybe you'll notice the large stand of pine trees that was interfering with the signal—or if, instead, the points are in a wide-open field, you'll know that it's time to check the equipment.

The other feature that proved valuable was the correction profile setting that allows datum transformations. Many counties and states have their data on the state plane coordinate system. Here in Ohio, our department of transportation has its correction service set up on NAD83. In order for me to use that correctly, I need to transform the datum to make sure everything matches. Once you have this set up, the corrections are made on the fly. This allows you to achieve very high-accuracy data collection.

As a final thought, I would be remiss if I didn't mention something about the budget. Everyone has a budget that they would like to stick to. And it's very easy to spend an exorbitant amount of money on items related to GIS and GPS. I did not want to spend a large sum of money on an external receiver just to have it sit on a shelf, like the other two handheld units. So we were cautious and moved slowly. I believe that in the end, we put together a really nice field solution on a pretty decent budget. We could have spent three times as much on a receiver that was supposed to have subfoot performance, but I felt that by collecting 8 cm accuracy online and half-meter accuracy (at the worst) offline, we were in good shape. The assets we look for include a valve box, which is around 9 inches across; a meter pit lid that is 16 inches across; or a waterline trench that's at least 2 feet wide. If we can't find any of those, then there's something wrong with the human locator.

In the end, we invested around $3,700 dollars. We did have the yearly

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"The work Travis has done with Collector is tremendous. It has allowed Le-Ax to easily and economically deploy GPS technology to our field crews. The Esri Collector app, loaded onto our iPads, made operations in the field very straightforward. Nowadays, even if a worker considers himself computer illiterate, I'll bet they own a smartphone. The Esri Collector app turns those employees who can operate a smartphone into a GIS field technician in the simplest of terms. I am excited about the possibilities this will bring Le-Ax but also other water and wastewater operators across the country. I am proud that Travis has been a part of this with Esri and his participation helped in deploying Esri's Collector app."

John Simpson
Le-Ax Water General Manager
Ohio Rural Water Association Board Member, Chairman Membership Committee

High-Precision GNSS Data Collection for Mobile GIS Is Here

Collector for ArcGIS Leaps Ahead with RTK Workflows and Automatic Satellite Metadata Capture

By Matt Alexander, Anatum Field Solutions, LLC

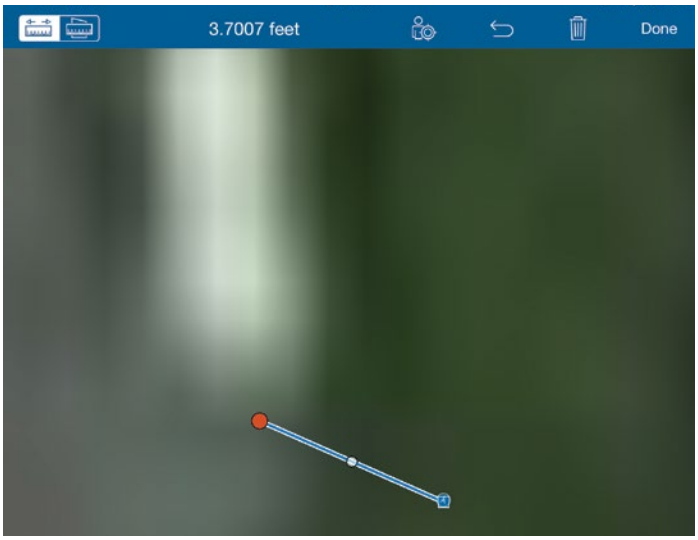
Mobile GIS Workflows Reach Maturity

There are many white papers highlighting the cost-saving benefits of switching from collecting field data using a handheld Global Navigation Satellite System (GNSS) unit running ArcPad software, taking photos with digital cameras, and writing on paper data sheets to the modern workflow of utilizing a mobile GIS solution. As a former project manager of field surveys, I can attest to these budget and time savings, and I can definitively say that ruggedized iPads paired with Eos Arrow GNSS receivers for mobile GIS workflows make for happier field crews.

This mobile GIS workflow uses a tablet or smartphone running Esri's Collector for ArcGIS software paired with an external Bluetooth GNSS receiver to record new field data viewed on a large screen (with aerial imagery easily available), monitor assets, and even capture photos linked directly to each data

← Satellite metadata, including positional information and estimated horizontal and vertical accuracies, can be viewed in a Global Navigation Satellite System (GNSS) receiver's proprietary app but not saved.

↓ A field surveyor is utilizing an Arrow 200 real-time kinematic (RTK) receiver with an iPad and Collector for ArcGIS.



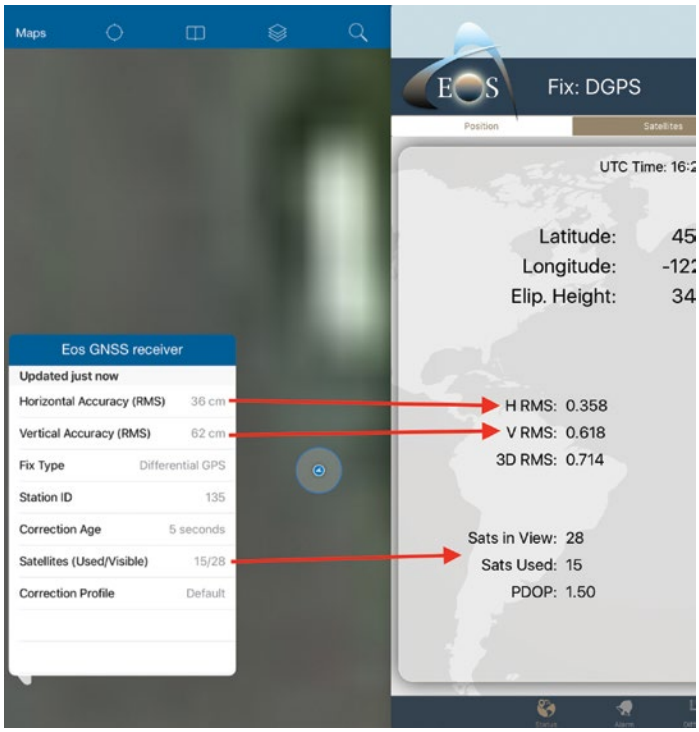
↑ This screen capture shows the positional difference between World Geodetic System 1984 (WGS 84) basemap imagery and a GNSS receiver utilizing RTK corrections in NAD 83. Applying a correction profile in Collector will nullify this positional shift.

point. There is no need for paper data sheets, a digital camera, or a handheld GNSS unit. A mobile GIS system also takes advantage of real-time data transfer from the field for sharing data with coworkers and management via cellular service.

The Missing Piece of Mobile GIS and High-Precision GNSS

What has been lacking from nearly all mobile GIS apps available today is the ability to record the Bluetooth GNSS receiver's metadata with each data point collected. Metadata includes everything from the number of satellites used at the time data was electronically collected to the fix type (GPS, DGPS, RTK Fix/Float) and estimated horizontal and vertical accuracies. This location information can be viewed on a mobile device via the GNSS receiver's proprietary app but not recorded.

The typical workflow for field users has been to flip back and forth between the Collector app and the GNSS receiver's proprietary app to view their estimated accuracy. Estimated accuracy is important to know, since most fieldwork is required to have accuracy levels ranging from submeter and subfoot to centimeter, depending on whether users are delineating a wetland, trying to locate a buried asset, or recording an as-built pipeline before it is covered over. If their particular work requires recorded estimated accuracy values with each point, then they would have had to handwrite the estimated accuracy displayed in the GNSS receiver's proprietary app and then flip back to Collector and collect their data. This workflow is very cumbersome and isn't always accepted by the field surveyor's management or clients. Thus, the problem of not being able to automatically record values like accuracy has forced some people to stick with old software and workflows.



↑ Satellite positional metadata from the GNSS receiver can now be viewed live from within Collector.

Things have been even more cumbersome for workers using real-time kinematic (RTK) equipment for centimeter accuracy data collection with mobile GIS equipment. Standard submeter GNSS receivers utilizing free Satellite-Based Augmentation System (SBAS) Wide Area Augmentation System (WAAS) satellite corrections receive their location coordinates formatted in the World Geodetic System 1984 (WGS 84), and all basemap imagery in mobile GIS apps is in a matching WGS 84 universal transverse Mercator (UTM) format. Thus, when users view their location live on their tablet, they appear to be located on the map at their true location. This is the same default WGS 84 spatial reference system utilized by Collector.

RTK users achieve centimeter-level accuracy by swapping the submeter accuracy SBAS (WAAS) satellite corrections with centimeter corrections from an RTK network that is broadcast over the Internet and consumed through cellular service on their smartphone or tablet. These corrections provide RTK GNSS receivers with the needed accuracy but are broadcast in the North American Datum of 1983 (NAD 83 [2011]), and the basemap imagery displayed in Collector is in WGS 84. Thus, the location of the users and their RTK receiver usually appears on screen to be shifted by about four feet.

Collector to the Rescue

This summer, Esri took a much-anticipated leap forward with its release of Collector 10.4. This update added multiple functions for high-precision GNSS surveying:

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High-Precision GNSS Data Collection for Mobile GIS Is Here continued from page 9

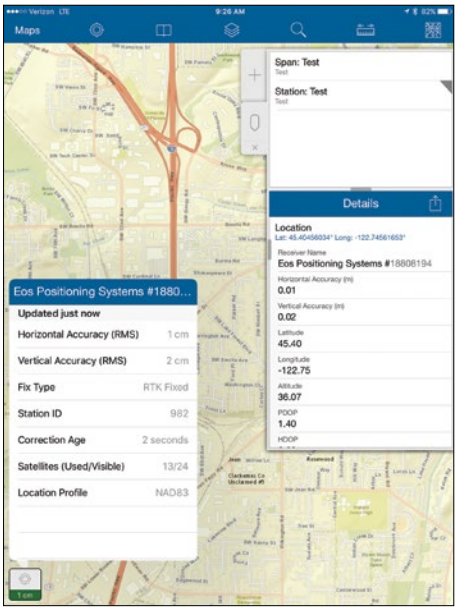
- Ability to connect directly to an external Bluetooth GNSS receiver to view the satellite metadata inside Collector without leaving the app
- Ability to store satellite metadata
- On-the-fly datum transformation for collecting points formatted to user's preferred datum
- Ability to shift the Collector software's map imagery to correctly display user location when utilizing an RTK network sending real-time centimeter corrections in NAD 83

Users of any high-precision submeter, subfoot, or centimeter accuracy GNSS equipment, such as Eos Arrow or Geneq SXBlue, can now view their estimated accuracies and other satellite metadata live from within Collector. This amazing implementation can save immense amounts of time in the field. This function allows the user to remain inside the Collector app all day and avoid flipping back and forth between Collector and the GNSS receiver's proprietary app for viewing satellite metadata. The small green box located at the bottom left of the screen shows the GNSS receiver's estimated horizontal accuracy live. For additional information, the user can tap the green box and view horizontal accuracy, vertical accuracy, fix type, station ID, correction age, the number of satellites, and a correction profile.

Not only does this Collector update allow users to directly connect their Bluetooth GNSS receiver to create a direct line of communication between Collector and the GNSS receiver, it also activates the ability to save the satellite metadata. This is a much-needed addition to the mobile GIS workflow.

Users of submeter GNSS receivers can apply a correction profile to create a datum transformation that will allow their WGS 84 satellite coordinates to be saved in their preferred datum. Thus, users that work with their data in NAD 83 can set their location coordinates inside Collector to be automatically saved in NAD 83 format without having to apply the datum shift back in the office from WGS 84 field-collected data to NAD 83 for use in their GIS.

For RTK users, the new Collector release also includes the ability to set a correction profile to adjust basemap imagery. This allows the user to inform Collector which datum is coming from the GNSS receiver. For example, applying a NAD 83 (2011) datum correction will shift the map imagery to line up with the corrections via the RTK network. This eliminates the usual four-foot shift and



↑ With Collector, data collection forms can now be set up to automatically record the positional metadata with each recorded data point.

shows the user's location on the map to be in the same location as they are in the real world.

In conclusion, the iOS update for Collector 10.4 is an amazing advance toward incorporating high-precision GNSS equipment and data into a mobile GIS workflow.

For more information, contact Matt Alexander at matt@afs-gis.com or visit http://afs-gis.com.

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maintenance subscription for our seat of ArcGIS for Desktop Basic, which afforded us one free account to ArcGIS Online. We used that account to initially test and set up our online maps. We have since acquired a five-seat license for ArcGIS Online, so we can deploy multiple iPads in the field and allow office staff to take advantage of our online maps. The beauty of ArcGIS Online is that all your maps are accessible to anyone within the organization.

We have been thrilled with our entire transition to this new field solution. With its external GNSS support, Collector has made it so easy for us to make this move. If there are other water utilities contemplating going in a direction similar to ours, I would encourage them to do it. Being a member of the Ohio Rural Water Association, I know there are many small water utilities and villages out there that have no idea where to begin with GIS. It can be overwhelming and expensive. But take it from someone who doesn't have a GIS background—this can definitely be done, even on a budget. You don't have to jump in, feet first, and purchase an external GNSS receiver. Simply start with a $400 or $500 tablet, download Collector, and see what you can do with it. You don't have to spend thousands of dollars on consultants. And you don't have to worry about storing and backing up your data. Everything is in place. All the tools are there for you to use. You just need to take the first step.

Join Us in Florida

Esri Will Be Hosting Its Third Annual Water Conference in Orlando, February 7–9

Why Florida?

Florida presents unique challenges for the water industry. The groundwater is so close to the surface that I have often heard the phrase "Surface water is groundwater that you can see." The karst geology adds to this problem. Everything is connected. This has caused great concern regarding water quality and the health of Florida's rich ecosystems. You've probably guessed by now that these water quality concerns have created a diverse regulatory environment.

In addition, water resources and water utilities face challenges surrounding construction, sea level rise, and data collection. Groundwater and tide conditions have to be considered before construction projects can begin. Sea level rise is causing flood inundation and salt water intrusion leading to corrosion. Remote locations, wetlands, sinkholes, and wildlife can make data collection difficult.

I hope you will join us at the conference to find out more about these challenges and experience all that we have to offer. Continuing to improve on previous years' events, we are working to bring you a conference full of useful content, including the following:

- Customer presentations
- Esri technical presentations
- Hands-On Learning Lab
- Data health checks
- Flood symposium
- Tours

New in 2017 will be an EXPO! You asked for it, so we are planning to have Esri partners on-site and available to answer your questions.

See you in Orlando!
David Totman
Industry Manager, Esri
Global Water Practice

2017 Esri Water Conference

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