THREE STEPS TO PRIORITIZE INFRASTRUCTURE INVESTMENT WITH GIS

A Geographic Approach to Building Sustainable Infrastructure

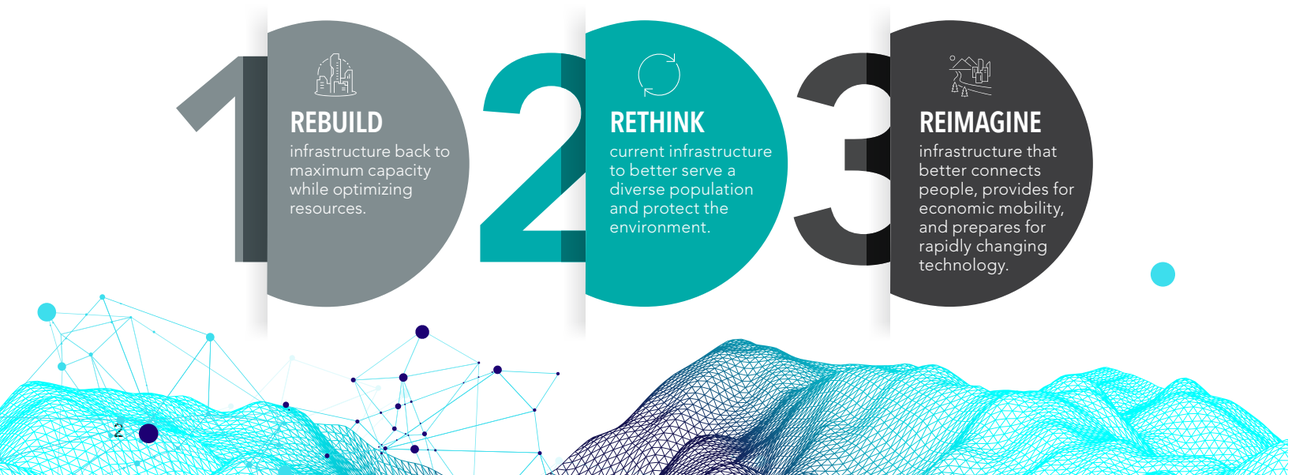
The nation has been placed at an inflection point as to what is the best course for state and local governments to deliver sustainable and resilient infrastructure. Governments, therefore, need to step back and ask themselves, are capital project policies taking us in the right direction? A renewed interest by the federal government is paving the way by offering stimulus funding in programs such as the Coronavirus Aid, Relief, and Economic Security Act (CARES), the American Rescue Plan Act (ARPA), and the Infrastructure Investment and Jobs Act (IIJA). This will require governments to prioritize and coordinate their planning, design, and construction of public works efforts.

Communities are being asked to reevaluate their roads and highways, public transit, airports, water services, electric and gas utilities, open spaces, and broadband needs through a series of lenses that provide greater clarity into how well governments are providing services to the public and businesses. The first lens is racial and social equity. How do leaders course correct decisions that had not considered diversity or provided economic mobility? How can they ensure that community resources benefit the underserved and unserved populations? A second lens that must be included in infrastructure strategy magnifies opportunities to develop climate resilient and adaptive infrastructure. A third lens provides the ability to incorporate smart technology such as sensors, operations dashboards, machine learning, and artificial intelligence to meet future needs head on. These smart technologies will help predict asset life span and provide real-time impacts and usage data in parks, traffic modeling, and transit. The smart lens will help governments adapt to the rise in automated vehicles, drones, electric vehicles, and so much more.

All these lenses have a common denominator that aids in delivering superior planning, prioritization, design, and construction of infrastructure: location analytics and demographic insights in the form of geographic information system (GIS) technology. This geographic approach provides a unique perspective of an individual neighborhood's impacts, based on geocentric design principles, that allows governments to plan capital projects in the context of a digital twin and to monitor patterns such as weather, human movements, and real-time conditions.

Esri, the world leader in GIS, recognizes that, for state and local governments to take bold new approaches to shape the nation's future, they must understand what is in front of them. Through analysis in a real-world setting, they can better decide whether to maintain and build infrastructure in the traditional fashion or shift their approach to create a forward-leaning community.

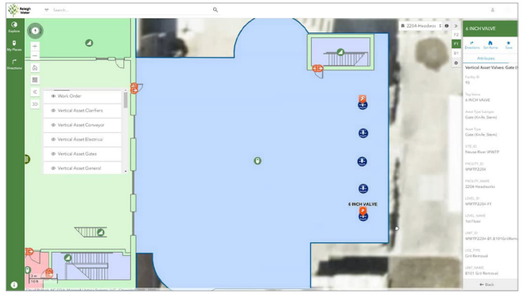
GIS will support future-ready communities by allowing chief information officers, planners, public works and engineering professionals, and others to carry out three necessary steps:



How GIS Is Changing Infrastructure for the Better

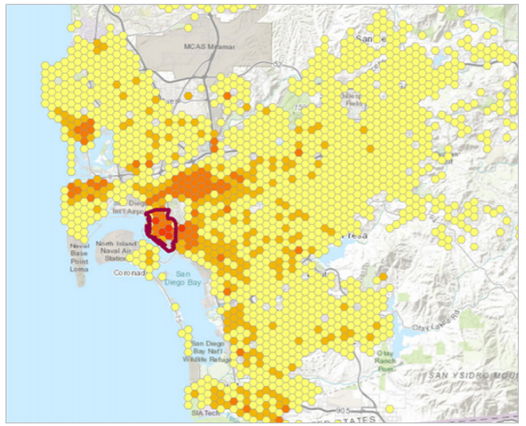
Raleigh Water, North Carolina

Raleigh Water shifted from a tabular inventory of asset types to a detailed inventory of individual assets that are spatially contextualized. New insights—gained from indoor GIS—into the operations of the utility's facilities support budgeting decisions for maintenance and capital improvements.



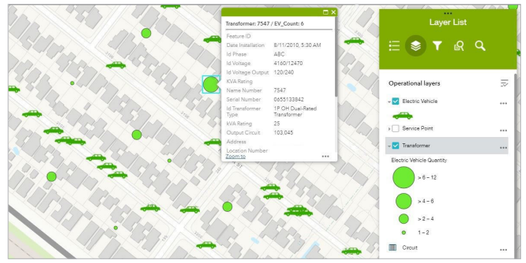
San Diego Association of Governments, California

San Diego Association of Governments (SANDAG) is able to rethink regional planning and transportation projects by using GIS. It enables SANDAG to better understand present conditions and existing stresses on the transportation network, visualize current and future needs of residents and provide them with an open line of communication, and create a suite of transportation alternatives that promote equity.



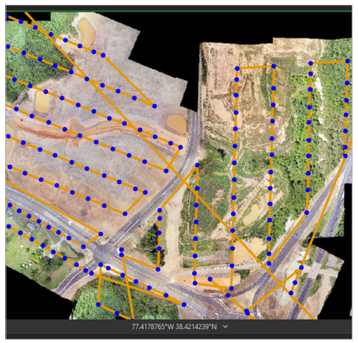
City of Palo Alto, California

With an ambitious goal of reducing greenhouse gas emissions by 80 percent by 2030 and one of the highest adoption rates of electric vehicles (EVs) in a US city, Palo Alto's utility system needs to be ready for EVs in every household. Using GIS, the city is prioritizing where to make service line and utility system upgrades to support additional EV charging stations. Demographic and lifestyle data also helps staff visualize clusters of homes with EVs and evaluate optimal locations for new charging stations.



Stafford County, Virginia

Stafford County, the second-fastest-growing jurisdiction in Virginia, explored the possibilities of drone technology to better foster economic development in the county. Access to drone technology and the unique data that can be captured by drones reduced the number of flyovers necessary to generate imagery required for guiding the construction of the Interstate 95 (I-95) exchange. With a construction project of this magnitude, it was necessary for the county's departments to have current data for decision-making purposes along the way. Having access to data gathered from the drone flyovers enables the GIS team to process its own imagery and makes it easier to schedule time for the drones to fly over the territory and capture needed aerial photography.



GIS Supports Infrastructure Funding through Smarter, Data-Driven Decisions

What will it take to make smarter decisions that will elevate the nation's infrastructures to the next level? First, governments need to know where to make the most strategic investments. GIS allows you to maintain roads, integrate infrastructure with data and sensors, and leverage building information modeling (BIM). Looking at communities in a 3D digital twin will show how infrastructure will fit into the environment.

Location intelligence is essential when laying the foundation for planning and decision-making. To help governments advance the way they manage infrastructure projects and measure their impact, decision-makers need to demonstrate return on investment and share vital information with constituents.

Using GIS technology can help communities better understand where and how they should invest in their transportation, water, sewer, broadband, utilities, and other infrastructure. With GIS, you can see where infrastructure systems are not meeting demand levels or where shifts in demographics are occurring so you can target investments that will deliver the greatest impact.

Technology is advancing the way people think about infrastructure. GIS data and analysis are transforming how current infrastructure is identified so that governments can be more responsive, efficient, transparent, and engaged when rebuilding roads or bridges to adapt to the changing lifestyles and behaviors of the population. Thinking from a GIS perspective first will drive long-term decision-making and planning as the country heads toward a future of better-designed communities gained through location intelligence.

Three Steps to Prioritize Infrastructure Investment with GIS

Approaching infrastructure challenges with GIS allows governments to **rebuild** with priority to maximize investments; **rethink** current infrastructure to address equity needs and changing lifestyles; and **reimagine** their ideas, through technology driven by the Internet of Things (IoT), to prepare their communities for the future.

1 Rebuild

State and local governments have been investing for decades in critical infrastructure for water services, electric and gas utilities, transportation, and broadband networks. Asset management and maintenance for this infrastructure compete with changing demographics, economic swings, service loads, and the extension of these infrastructures. Budgets, materials, and human resources must also be considered.

These competing forces have resulted in infrastructure that is in need of urgent repair, replacement, and modernization. Prioritization of rebuilding must be based on location. The rebuilding of roads and bridges with shifting traffic loads must be analyzed. Addressing deteriorating roads and bridges, removing lead in water, and extending broadband to underserved and unserved communities must be based on where the need is greatest. Overall, consideration must also be placed on where infrastructure needs to be adapted or extended to achieve sustainability and resiliency.

GIS can support the rebuilding process throughout the entire infrastructure life cycle. GIS can be used to plan and redesign infrastructure, collect status of asset conditions, monitor usage, question past practices, schedule logistics and work orders, and engage with the public.

Rebuilding in Action: New England Street Lighting Project Preps Smart Cities

Cities and towns across the East Coast have implemented LED and smart lighting programs for several years. Work to retrofit older, inefficient high-pressure sodium bulbs into streetlights with smart LED bulbs promotes safer driving at night from a less-harsh distribution of light while also significantly reducing CO2 emissions and energy consumption, sometimes up to 75 percent in cities.

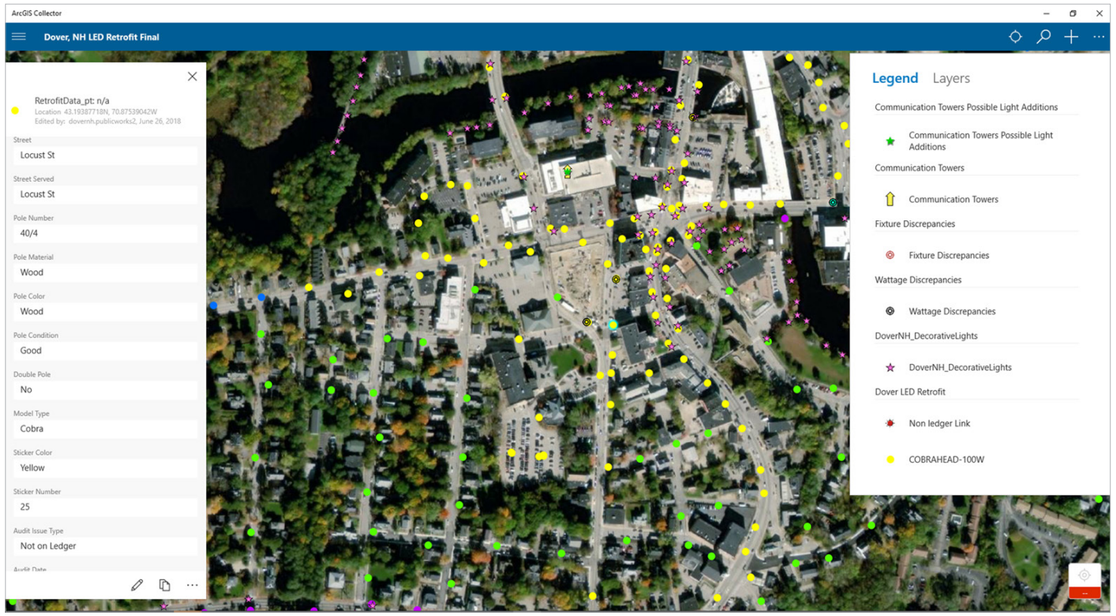
Streetlights are also an important tool in smart community development, in part because they are widespread and strategically located. The myriad of uses for data that could be gathered by the smart streetlights touches virtually every municipal department, from transportation, energy, and wastewater to public safety and recreation.

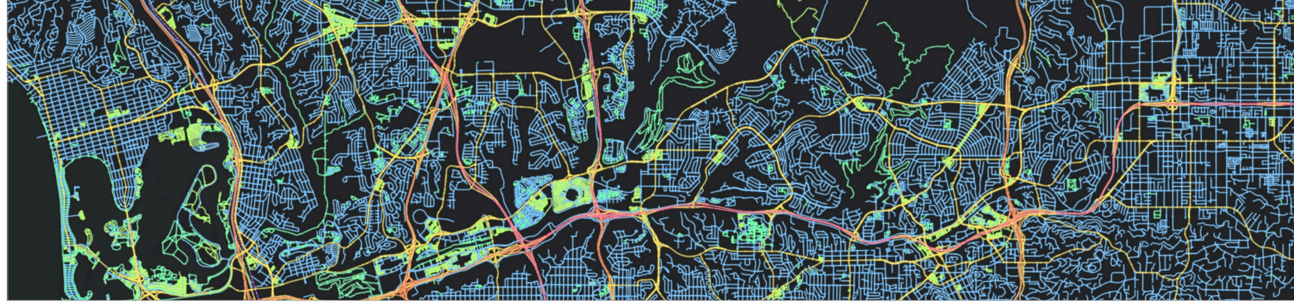
In a project across the New England region, GIS was used to manage the entire process in real time, allowing field auditors to conduct their mobile work and assess progress via dashboards. The information was presented to participating communities for review through a web app. The web app supported an interactive design review process that simplified municipal staff review and comments.

By implementing smart-ready node plug-ins in the LEDs, communities gain valuable capabilities, data, and insight that reaches far beyond lighting. The streetlights' smart nodes are sensors that can be connected and used to build wireless networks.

"GIS technology was critical to the success of these projects in every stage, from data collection and analysis to reporting and stakeholder engagement," said Steve Anderson, GISP, vice president of Technology Services at VHB.

For communities large and small, the first step to retrofitting inefficient streetlights with GIS technology results in a smarter, sustainable, and more resilient future.





2 Rethink

Governments need to rethink how their infrastructure serves the community now and how it will in the future, and not just react and rebuild. They must consider how changing demographics, behaviors, and lifestyles will inevitably shift the way people rely on infrastructure.

For example, does your community continue to build roads because there is an assumption that everyone drives, or are you considering switching to focus on multimodal transportation because Millennials are using public transit and rideshare?

When rethinking infrastructure, communities cannot ignore the importance of addressing equity and inclusion. Data and analysis can help governments better understand their community makeup, identify at-risk populations, and address neighborhoods that lack access to service or are at a disadvantage. Moving forward, all governments recognize that infrastructure investment must incorporate an equity lens.

Rethinking is all about predicting the needs of your community before your infrastructure is unable to meet them—GIS allows you to plan appropriately for the future based on current and future lifestyles of your shifting population.

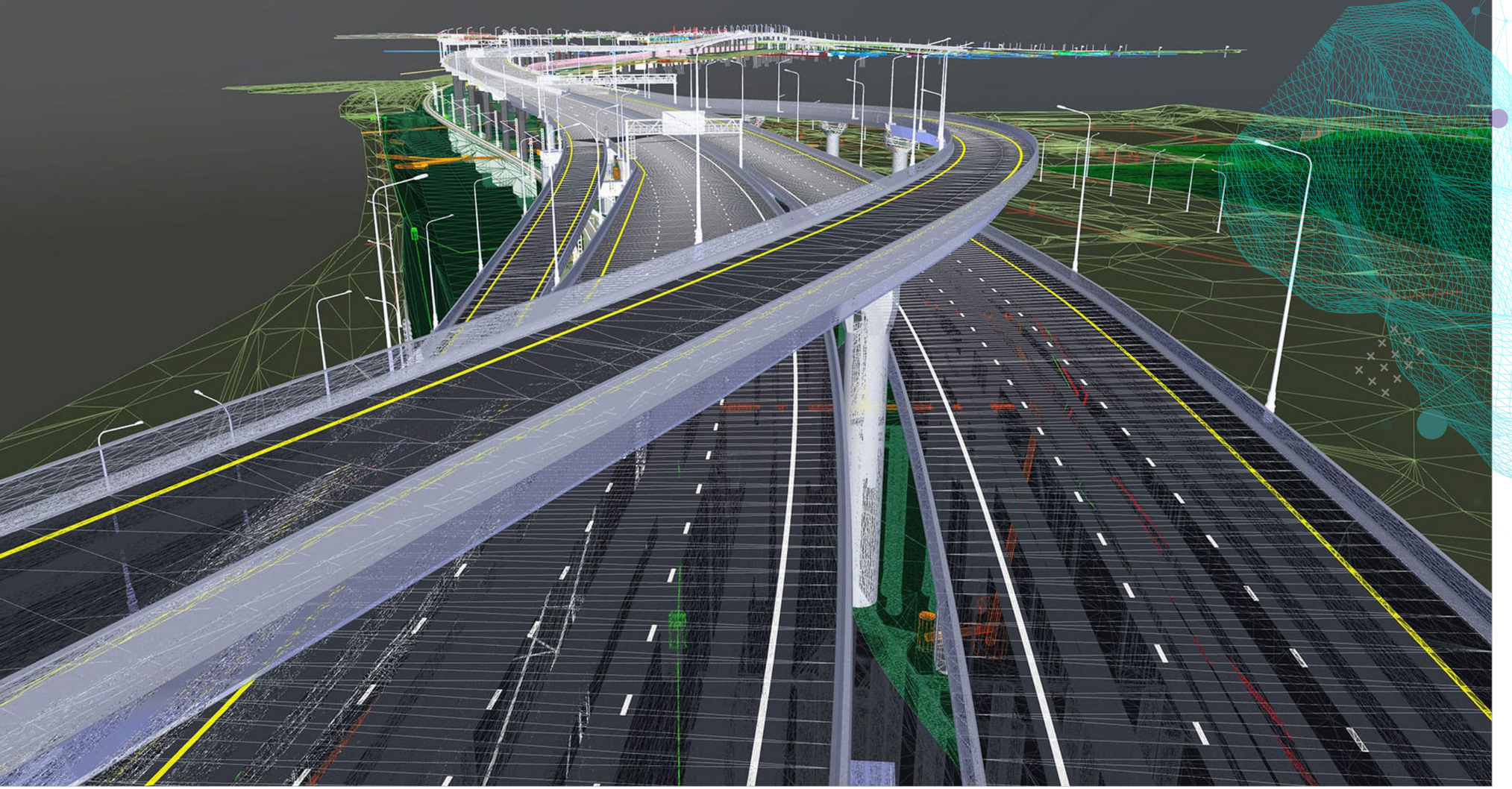
Rethinking in Action: Potter County Identifies Opportunity for Broadband Investment for a More Equitable Future

In Potter County, Pennsylvania, a largely rural community, residents wanted improved access to broadband and cellular service.

To meet residents' demand for high-speed internet service, Potter County leaders used GIS to plan and develop a budget that supported the expansion of broadband coverage. County leaders involved residents, businesses, schools, churches, and neighborhood groups via a survey to gather insight into their broadband concerns and identify where there were gaps. Using the results of the survey, they were able to visualize where current services were located, and which areas needed additional broadband coverage.

By overlaying additional demographic and socioeconomic data, Potter County was able to understand who was affected by service gaps and to make more equitable policy decisions that lead to equal economic opportunity for all.

Today, the county is using this information to negotiate with service providers and prioritize where broadband investment should be made.



3 Reimagine

Technology is rapidly and massively influencing the future of our infrastructure. Sensors, artificial intelligence (AI), drones, driverless cars, 3D, machine learning, and more are affecting everything that is planned and built. The smart cities and communities of the future are getting closer to technological advancement than ever before. Some may even argue they are already there.

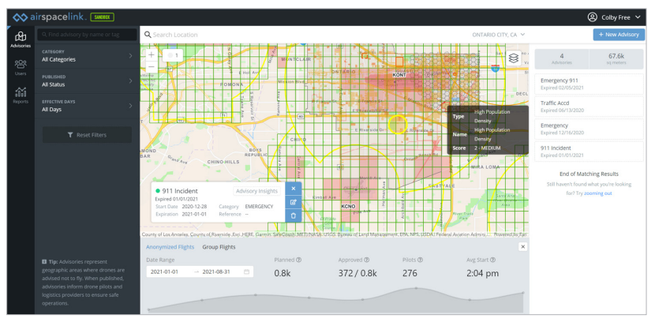
Industry analysts looking at the development of smart communities predict that everything will be "sensorized" to collect data on road conditions, air quality, traffic flows, mobile devices, and constituent feedback. Infrastructure itself will actively collect, store, monitor, and use data. By considering these factors when building and designing new infrastructure, more accurate, data-driven decisions can be made.

Real-time GIS can connect with sensor and streaming data, visualize it, and analyze what should be done next, allowing you to reimagine your infrastructure for the future. Reimagining what's next is the forward-thinking approach governments need to consider when building communities that are ready to support the technology of tomorrow. By promoting real-time decision-making and leveraging the Internet of Things, state and local departments will thrive in a sensor-driven world.

Reimagining in Action: City of Ontario Takes Steps to Be the First Drone-Ready City

The City of Ontario, California, is revolutionizing the way cities of the future will be managed. It has successfully mapped its airways and is able to track drones throughout their flight to ensure safe routes for drone traffic.

The city's work with GIS and Esri partner Airspace Link to map the airwaves and track drone traffic will allow it to have an economic advantage for the introduction of drone delivery services and the integration of drones into supply chains.



How GIS Can Play a Critical Role in Supporting Federal Stimulus Programs

Through federal funding, state and local governments have been afforded an opportunity to create healthier communities, support health equity, and remove barriers to mobility. GIS provided insights to carry the world through a health crisis; now the same technology can provide insights into a resilient recovery. The following are a few of the critical ways your organization can use GIS to align with federal stimulus programs:

Leverage Solutions to Achieve Recovery

Esri has worked toward providing solutions to meet the goals of the national stimulus programs. The pandemic accentuated the need for improvements in health, economic mobility, transportation, broadband, emergency response, housing, and actions addressing homelessness. Applying a geographic approach brings about understanding, providing models and tactics to confront these issues and help make the goals of the recovery programs achievable.

Meet Diversity and Racial Equity Goals

The coronavirus exposed just how deep the need is to address diversity and racial inequities. These gaps pinpointed at-risk populations exactly where they lived, learned, and worked. Access to broadband, health care, and economic mobility requires a lens that can expose inequities based on race, age, gender, language, and more. GIS can provide insights through demographic data, analysis, and operations dashboards to ensure that projects and policies do not leave communities behind and to create the opportunity for all to succeed.

Prioritize Stimulus Funding

The national stimulus programs provide the opportunity to stimulate economies and establish sustainable infrastructure. A geographic approach to prioritizing projects and spending will present insight as to which efforts will have the greatest impacts on communities. Programs to ensure housing affordability, access to broadband, and adequate housing, for example, can be prioritized neighborhood by neighborhood using historical data, residents' input, and long-range forecasting in a map-centric dashboard to meet your goals.

Steps to Using the Geographic Approach to Deliver Infrastructure

Whether you look at addressing infrastructure as crisis response, an opportunity to modernize, an adjustment to equity, climate change sustainability, or a chance to incorporate smart methodologies, a geographic approach will help state and local governments move forward with a data-driven plan. Public works, engineering, transportation, planning, and utilities officials should step back and balance their comprehensive plans to consider rebuild, rethink, and reimagine strategies.

Organizations have derived many quantified returns on investment by utilizing GIS applications in their workflows. The benefits realized by these governments increase as teams ask the question from a perspective of *where*. GIS is made up of two guiding principles. First, GIS is a concept—an acknowledgment that location brings a unique perspective to organizing data and information and applying spatial thinking to provide new insights. The second principle is that GIS is a technology—it allows organizations to build and connect data based on geographic tags and provides a system to apply spatial thinking.

The benefits derived in integrating GIS into your infrastructure planning, design, and asset maintenance can include the following:

- Automating workflows
- Decreasing costs
- Improving efficiency
- Managing resources
- Improving collaboration
- Saving time
- Improving field mobility
- Increasing productivity
- Aiding in budgeting
- Enhancing civic engagement

Thousands of forward-leaning state and local governments have embraced the geographic approach as organizations seek to rethink their strategies regarding service delivery, spatial analytics, and data-driven tools to help them understand the effectiveness of current methods. This rethinking will be derived from modeling their communities in a 3D digital twin. It will draw from real-time information coming from the field, people, vehicles, and sensors in real time. It will allow for adjustments to take place as the impacts of their infrastructure decisions unfold.

Reimagining the nation's water, sewer, transportation, roads, and utilities networks will employ new concepts and technology advancements in designing communities. This involves a deeper examination of the impacts of drone delivery, airspace management, electric vehicles, driverless cars, transit hubs, and increased broadband access to be more economically competitive and more attentive to people's needs. Integrating data from sensors, the Internet of Things, 3D modeling, and building information models into GIS will provide operational awareness and change the way communities grow and thrive.

You can turn to Esri infrastructure, utility, public works, water, broadband, and transportation experts to help guide your knowledge of a geographic approach to building the nation's infrastructure. Backed by ArcGIS® software and industry solutions, you will be able to make sense of it all.

To learn more, visit go.esri.com/infrastructure-steps-gis.

esri | THE SCIENCE OF WHERE®

Esri, the global market leader in geographic information system (GIS) software, location intelligence, and mapping, helps customers unlock the full potential of data to improve operational and business results.

Founded in 1969 in Redlands, California, USA, Esri software is deployed in more than 350,000 organizations globally and in over 200,000 institutions in the Americas, Asia and the Pacific, Europe, Africa, and the Middle East. Esri has partners and local distributors in over 100 countries on six continents, including Fortune 500 companies, government agencies, nonprofits, and universities. With its pioneering commitment to geospatial information technology, Esri engineers the most innovative solutions for digital transformation, the Internet of Things (IoT), and advanced analytics.

Visit us at esri.com.

Contact Esri

380 New York Street
Redlands, California 92373-8100 USA

1 800 447 9778
T 909 793 2853
F 909 793 5953
info@esri.com
esri.com

Offices worldwide
esri.com/locations

Printed in USA

179543
G2210617