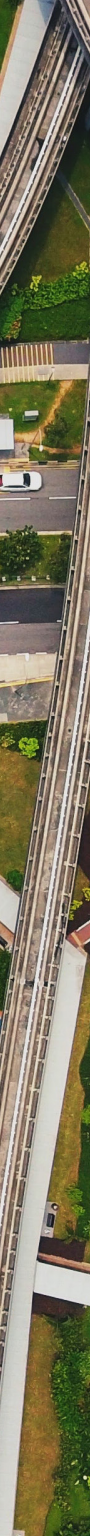


PART 1

PLANNING AND URBAN DESIGN

WITH GIS, STATE AND LOCAL GOVERNMENTS USE location data to plan for and minimize the impacts and stresses of change. GIS helps planners and urban designers create realistic alternatives that include statistical and spatial analyses for comparing the pros and cons of different scenarios. Interactive mapping and 3D visualizations representing accurate urban and rural landscapes are more relatable to government officials, businesses, and residents than static drawings and other highly stylized renderings. By using GIS to visualize and study proposed transit services, compare capital investment options for a downtown area, find the most effective locations for economic development, or simply reevaluate zoning changes, planners take a forward-looking approach to problem-solving, which leads to more confident actions and better outcomes.

Having a location-centered understanding of a community or place allows planners and urban designers to elevate the value of data through mapping and spatial analysis. Issues such as diversity, high residential density, mixed land uses, open space preservation, housing affordability and scarcity, and economic viability can be measured and investigated together against accurate, lifelike

landscapes and neighborhoods. GIS also facilitates open communications with the public, encouraging participation in the planning process and ensuring that transparency and accountability are driving those interactions.

Planners and urban designers use GIS to bridge the divide between what is currently taking place and how people work together to build for the future.

Case studies

Today's state and local government planners are using a mix of digital technologies and strategies to make their communities more sustainable and better places to live. GIS analysis and visualizations help planners and urban designers dig deeper into valuable data and create different scenarios, which can be explored and compared in order to find the best solutions for every project. Using GIS, planners gain a more informed understanding of where negative impacts to the community are reduced and where positive outcomes are most likely.

In the following case studies, city and county planning efforts are highlighted. Planners use GIS to sift through complex data to find the right solutions and to communicate with local officials and the public about what the future might look like.

SHOWING THE COMMUNITY WHAT IS POSSIBLE

Oshkosh, Wisconsin

THE CITY OF OSHKOSH REGULARLY FACES DECISIONS THAT require the community to balance residential and business interests, as well as infrastructure and environmental needs. Elected officials must understand the potential impacts of planning and engineering projects because they're making decisions that affect generations to come, said Kelly Nieforth, the city's economic development services manager. This was especially true when Oshkosh, one of the smallest cities in the nation to boast a Fortune 500 company, overcame initial public disapproval, time constraints, major infrastructure challenges, and more in a quest to retain its largest employer, Oshkosh Corp., and save hundreds of local jobs.

The City of Oshkosh used 3D GIS for planning purposes and for showing the community what's possible. This map is an example of how the city used Esri's CityEngine software to create and share their 3D visualizations.

The city is a longtime user of ArcGIS and Esri tools, especially for planning purposes and for showing the community what's possible, Nieforth said. It's hard for people who aren't in planning or working on projects to visualize that potential. Some people may see only rundown buildings, but others can see a bustling, revitalized area. As part of its proposal to retain Oshkosh Corp. and become the location for the company's new global headquarters, the city used ArcGIS to look at potential sites and settled on offering a portion of the city's municipally owned golf course. Oshkosh also teamed with Esri partner Houseal Lavigne Associates and used CityEngine, an advanced 3D modeling software, to quickly create an interactive and immersive environment for the community and elected officials to weigh in on before proposing that golf course site to Oshkosh Corp. board members. "It helped us put our thoughts in a visual representation" and to have a conversation, Nieforth said.

Not only did the company accept the proposal, but city residents who were initially concerned that a massive office complex would hinder their lakefront views became proponents of the project. In 2018, the city's parks department began work on a plan to turn the portions of the golf course not sold to Oshkosh Corp. into a park. Previously, if people wanted to enjoy the lakefront, they had to pay, said Nieforth, an Oshkosh native. GIS played a vital role in fostering civic engagement and providing an inclusive environment for residents to voice their concerns and to be heard. Nieforth expects that dialogue will continue to flourish as the city looks to tools such as ArcUrban to understand the impacts of zoning codes and to drive conversations with an increasingly informed community.

This story originally appeared as "A 3D Model Provides the Vision to Combat Blight" by Matt Ball, August 30, 2017, on the *Esri Blog*. All images courtesy of the City of Oshkosh unless otherwise noted.

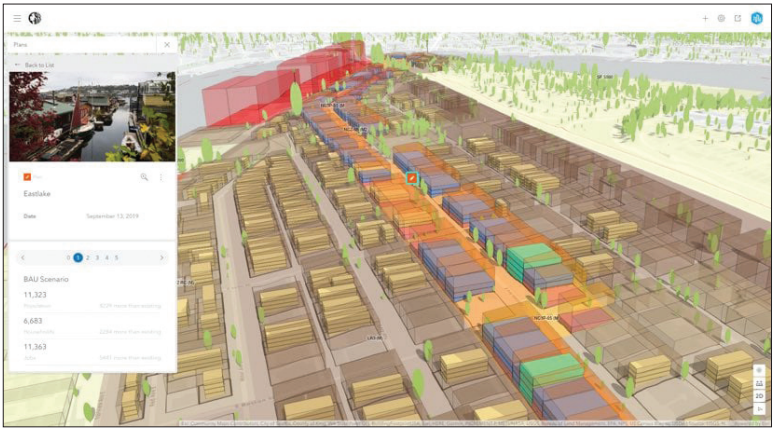
UNDERSTANDING THE IMPACTS OF NEW DEVELOPMENT

Seattle, Washington

WITH THE BOOM OF AMAZON, MICROSOFT, AND THE MANY internet and health care companies that call Seattle home, the city has added 105,000 new residents since 2010 and was the decade's fastest growing US city. Seattle is in the process of updating its 20-year comprehensive plan, which will assess the city's capacity to accommodate that growth. By law, King County is one of several in the state that must determine if they have adequate amounts of residential, commercial, and industrial lands to meet the growth needs. In previous years, planners would use an Access database before plotting that data on a map.

Seattle recently implemented a new building permit system and invested in 3D capabilities to visualize the whole city alongside zoning requirements using ArcGIS Urban software. "For the first time, we are going to use GIS and 3D capabilities to refine our analysis but [also] share it out to the public and to our decision makers," said Jennifer Pettyjohn, a senior planner for the city. "We have quite a large land use code that is a lot of legalese," Pettyjohn said. The city's zoning rules and land-use code are complicated. If printed out, they would create a stack of paper at least 10 inches high. The classifications of zoning codes have all been coded into ArcGIS Urban to improve understanding. The goal is to use the technology to understand where Seattle is now in terms of land use and accommodations for projected growth and to create different scenarios to consider how best to support future residents.

We have had a lot of growth, [and] we expect a lot of growth," Pettyjohn said. "What that means is our planning decisions have



Seattle's zoning rules and land-use code are complicated. If printed out, they would create a stack of paper at least 10 inches high. In this map, the classifications of zoning codes have all been coded into ArcGIS Urban to improve understanding.

to be more transparent. We have to demonstrate that we can look at many different scenarios of how we plan to accommodate the growth." For example, there's a need to understand the impact of new development and what happens to people and jobs when buildings and neighborhoods transform. The impact of gentrification and whether it factors into the growing homelessness problem are of particular concern. Seattle plans to share its technical and methodological advancements with its regional peers to help them compose their buildable lands report. Internally, GIS enables the city to better store its data and provides a single system of record. Not only that, but now planners and developers can turn that data into visualizations. "I've been doing this for 30 years," Pettyjohn said. "I can't believe that I can put out a 3D model on the internet. It's pretty exciting."

This story originally appeared as "Seattle: New Residents, Tech Boom Demand Agile Growth" by Brooks Patrick, February 4, 2020, on the *Esri Blog*. All images courtesy of the City of Seattle unless otherwise noted.

USING GREEN INFRASTRUCTURE TO FUEL SMARTER GROWTH

Richland County, South Carolina

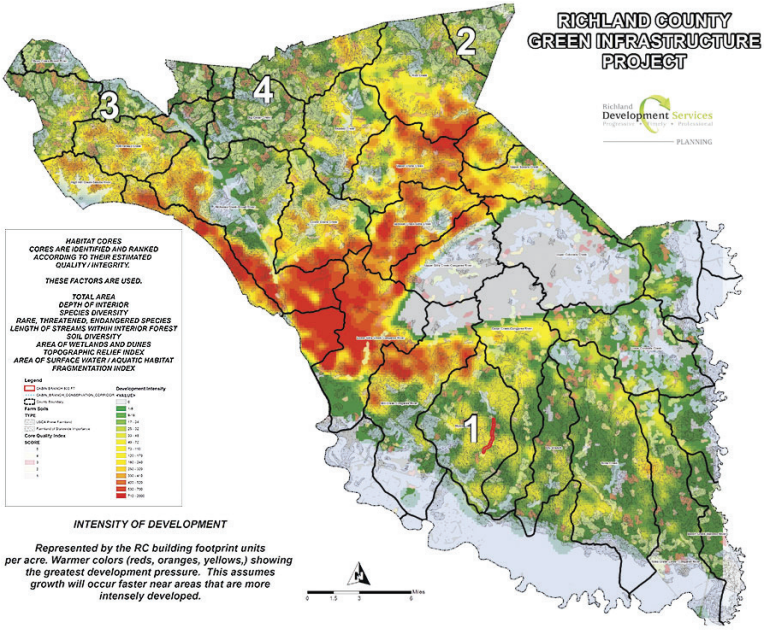
IN 2015, A TWO-DAY STORM CAUSED BY HURRICANE Joaquin swept across South Carolina, leading to devastating flooding, more than a dozen deaths, and the destruction of critical infrastructure. The state recorded $12 billion in losses with up to 160,000 homes damaged.

Richland County was hit worst. This severe weather event dumped two feet of water in some areas of the county, killing nine people and threatening the drinking water. Schools, businesses, and roads remained closed weeks after record rainfall and dam failures occurred.

The historic flood urged decision makers to ask serious questions. Why did flooding occur in this area? What caused the dams to fail? What can we do to prevent this from happening again?

"Flooding is a natural event, but the impacts we experience are caused by humans," said Quinton Epps, director of the Richland County Conservation Department. "We build in the areas that are flood prone. Very often, we change the areas in dramatic ways…that increase flooding impacts. These are things people have known for hundreds of years."

Homes built near bodies of water, for example, are appealing and tend to have higher property values, but they are predisposed to flooding. In Richland County, regulations require developers to build houses that would accommodate the type of flooding that occurs roughly every 100 years, meaning the structures must be built two feet above the base of a potential flood. Although subdivisions



Richland County's planning and development services department used the GIS green infrastructure tool to identify four priority areas in the county that met the criteria of being an intact core, or habitat, at risk of losing its natural assets.

meet current regulations, they are still in danger of being damaged by more severe floods like the county saw in 2015.

As the person in charge of securing properties and funding for conservation efforts, Epps also acquires easements to help avoid disasters like the 2015 flood. He leads projects to connect people with nature as well.

The job is no easy task. Success relies heavily on factors that are out of his control, such as the availability of land, willingness of property owners to sell or donate easements, and political interests that drive funding and development decisions.

After Hurricane Joaquin, Epps advocated to fund easements in flood zones to ensure that the land is never developed. But Richland County allocated its limited grant dollars from the Federal Emergency Management Agency (FEMA) and the US Department of Housing and Urban Development elsewhere—namely, to rebuilding homes and roads.

"The way people look at disaster recovery tells the story of how we don't look at long-term consequences," Epps said. "Do we have money to fix the problems of the last 50 to 100 years of development? No. But we can try to prevent history from repeating itself."

To Epps, most disaster recovery and development strategies focus on rebuilding and extending existing manufactured infrastructure. However, these strategies dismiss a critical component of creating a safe and livable community: green infrastructure.

With Richland County still reeling from the flood, a green infrastructure model could do more than connect people with nature; it could also help win executive buy-in for conservation projects that safeguard wildlife habitats, protect people and property from future harm, and boost the economy. By using GIS to assess all the county's features that the community deems valuable, Richland could explain the importance of green infrastructure in a more scientific way.

"We could provide a rational basis for conservation efforts not tied to politics or opinions," Epps said.

Richland County's planning and development services department used the GIS green infrastructure tool to identify four priority areas in the county that met the criteria of being an intact core, or habitat, at risk of losing its natural assets.

He was inspired to formulate a green infrastructure plan that would enable the county to plan smarter, and he knew one person would be the key to developing the plan—Brenda Carter, GIS

manager for the planning and development services department at Richland County.

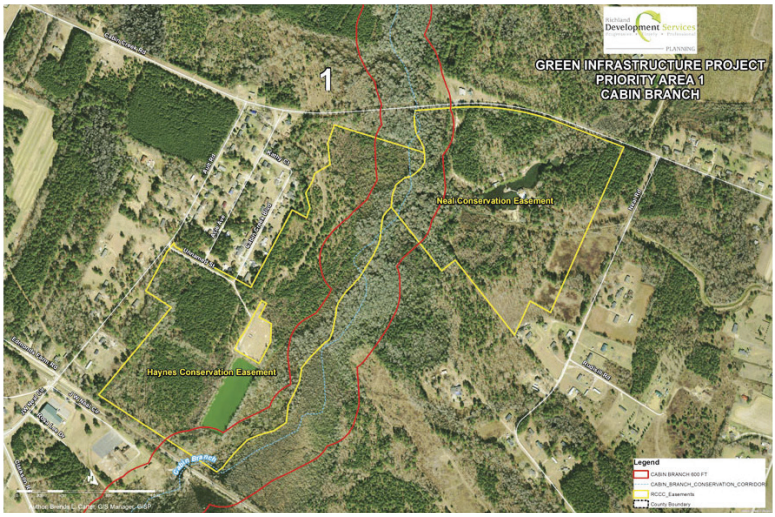
"Reading through everything made me realize that this was something really, really important for all counties and for all people—especially after our county had just suffered a great flood," Carter said. "I started seeing the connections as to why the flood could have happened and why we needed to do something about it."

Thus, the planning and conservation departments formed a partnership to bring green infrastructure planning to Richland County. Carter outlined goals and developed the entire green infrastructure blueprint. She began by identifying four goals:

- Improve water quality by providing a buffer to help prevent runoff and erosion and reduce pollutants.
- Maintain forested land cover to facilitate recharging groundwater aquifers for drinking water.
- Preserve and promote natural resource-based recreation, such as hiking, bird watching, hunting, and fishing.
- Conserve community character and heritage by protecting a historic landscape.

Once Carter had the essential data layers in place—including existing county GIS layers such as conservation easements, address points, and zoning—she used tools from Esri to create asset maps and maps of intact habitats, also referred to as cores. Carter employed spatial analysis using ArcGIS to conduct landscape analyses, assess fragmentation and risks, develop a core quality index, and prioritize opportunities.

"The first step to mapping the intact habitat cores is identifying the location and shape of habitat cores," Carter said. "The second



In this map, green infrastructure analysis shows areas identified as targets for land conservation. Yellow lines show the boundary of the two conservation easement properties, and red lines enclose a riparian area that cuts both easements.

step is ranking the cores based on their ecological integrity using the best available data and science."

With the green infrastructure tool, Carter identified four priority areas in the county that comprise unique rural lands and waters. Each of these locations met the criteria of an intact core at risk of losing its natural assets. As part of the green infrastructure plan, Carter and Epps also identified potential projects to protect the cores—such as purchasing easements to preserve certain streams—and made clear the benefits of implementing them.

"I've been doing environmental work for 30 years," Epps said. "I had a picture of what the green infrastructure model would look like and, in the end, it didn't resemble what I had in mind. But that's what [is] cool—Brenda used scientific data and tools to set the strategy. It's

not just about picking out what we think we should protect; it's scientifically supported."

The task force presented the green infrastructure plan and maps to the Richland County Conservation Commission, a group of 11 members appointed by the county council to implement conservation goals. The commission was impressed.

"Science proved what they were thinking all along," Carter said. "Now they have scientific evidence to prove which areas need protection and restoration."

The team presented the information to the county council as well, to resolve issues with zoning and the county's comprehensive plan. And the county's land administration department rewrote the land development code, keeping the priority cores top of mind.

"We're not going to write code to keep developers from [building new homes]," said Carroll Williamson, land development administrator with Richland County. But the "new codes will guide smarter development that will be better for the land, people's investments, and our county in the future. We used to tell developers that green infrastructure was a 'nice to have' feature. But if we can say scientifically that green infrastructure is critical to our well-being, then it takes on much greater significance."

Moving forward, the team will continue the project and identify additional priority cores throughout the county's council areas. They're excited about the possibilities that the green infrastructure plan can bring to the county, including for the local economy. Helping people—especially county executives and developers—understand the benefits of green infrastructure will be critical.

Epps explains the green infrastructure planning is not simply about conservation but a way to provide a more sustainable and resilient community and to be better prepared for the next extreme flood. For Carter, green infrastructure planning means using her

craft to enhance quality of life for all of Richland County for years to come.

We want to preserve the natural resources that we have in the county so we can protect our quality of life, says Carter. "We want to grow, but we want to have smart growth."

This story originally appeared as "Green Infrastructure Plan Fuels Smarter Growth in Richland County" in the Winter 2017 issue of *ArcNews*. All images courtesy of Richland County unless otherwise noted.

UNCOVERING THE VISUAL PATTERNS OF AFFORDABLE HOUSING

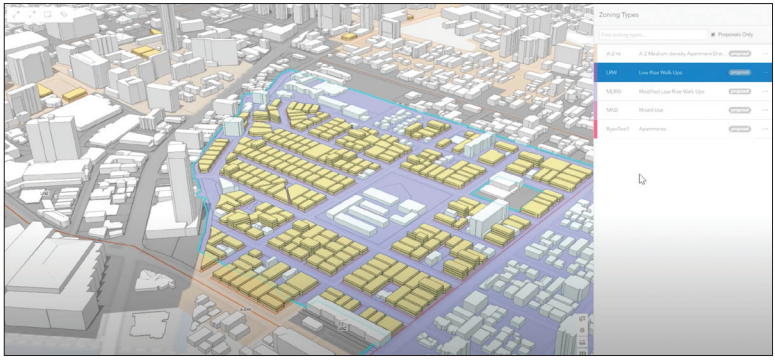
Honolulu, Hawaii

ONLINE HOSTING SITES, SUCH AS AIRBNB AND VRBO, DIDN'T set out to disrupt local real estate markets. However, research shows short-term vacation rentals are becoming a major driver of rising rents and home prices in cities around the world.

In Hawaii, and Honolulu in particular, affordable housing has been hard to find for a long time. To combat this scarcity, and to balance the demands of residents versus tourists, the Hawaii legislature recently passed a bill, awaiting the governor's signature, that requires hosts of short-term rentals to collect and pay lodging taxes. The Honolulu City Council just passed a bill that takes the more severe step of restricting the number of short-term rental units and fining violators up to $10,000 per day.

The state tax could raise considerable revenue as Honolulu is home to 800 legal vacation rentals and an estimated 8,000 illegal units. Restricting the number of short-term rentals should return some of these units to use by locals. To gain an understanding on these changes and how they impact residents, city analysts and planners use GIS technology. In Honolulu, GIS mapping and databases are available through the City and County of Honolulu's Land Information System (HoLIS).

"Honolulu (the City and County of Honolulu) has begun to look at changing the Land Use Ordinance (zoning codes) to address affordability," said Ken Schmidt, GIS administrator for the City and County of Honolulu. "GIS helps quantify how this problem came to be and allows us to visualize ways we might address it."



In this map, Honolulu planners use GIS to visualize a zoning change and the potential impact to the community.

According to a 2015 report, 66,000 housing units will be needed in Hawaii by 2025 to meet demand, with nearly 26,000 of those dwellings required in Honolulu. A number of proposed zoning changes aim to address this looming housing deficit.

Proposals include restrictions on the square footage of residential units to combat monster homes; an easing of height restrictions on low-rise apartments to allow five-story walkups rather than the existing three-story limits; and a proposal allowing homeowners to build and rent accessory dwelling units.

The Honolulu Department of Planning and Permitting used 3D visualization tools to examine and visualize the proposed low-rise apartment zoning change in the neighborhood of Mo'ili'ili. Honolulu worked with Esri, piloting the capabilities of ArcGIS Urban and CityEngine. "We've been working to demonstrate to planners what the changes to our zoning code would look like in 3D," Schmidt said. "Our planners' eyes got really wide when they realized that they could quickly and easily change values in the zoning code and see what the difference in development would be."

Metropolitan Honolulu is the fourth most densely populated area in the US, with traffic that often ranks among the worst in the country. The constraints of the island, with its narrow coastal plains, steep slopes, and cross-island canyon connections cause much of this congestion.

The 20-mile, 21-station Honolulu High-Capacity Transit Corridor Project aims to help alleviate the problem by introducing elevated rail to the region. The rail corridor, under construction now, would move 8,000 people per hour and give Honolulu residents an opportunity to rethink development patterns. The city has already embraced Transit-Oriented Development (TOD) as a strategy to increase the density of housing, jobs, and services around rail stations.

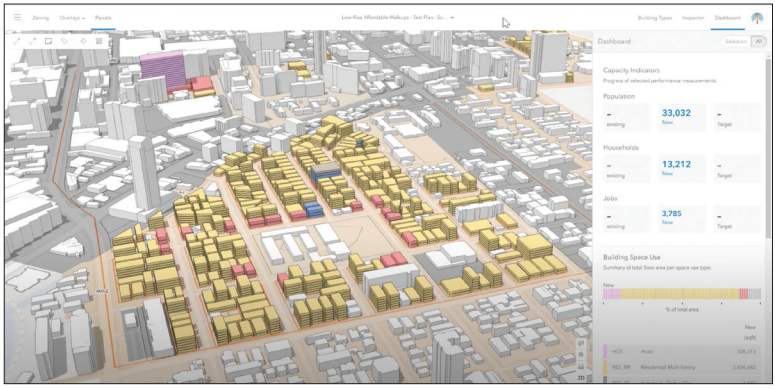
"We've been working with the TOD division to look at changes in zoning laws to provide incentives for development within a half mile of station locations," Schmidt said. Schmidt and his team created a participatory environment that allows government, business, and community stakeholders to visualize TOD redevelopment scenarios and rezoning proposals.

As Honolulu begins the build-out of the new rail line and associated development, officials are looking to improve the city's permitting process. "Anybody who tries to get a building permit usually has some challenges," Schmidt said. "That's primarily due to the amount of volume as we have from 15,000 to 20,000 permit applications per year. Anything we can do to help streamline that process or make it easier is one of our major objectives."

The city was an early permitting innovator with a system called HONLine that allows homeowners to quickly obtain permits for such things as fencing, solar panels, water heater replacements, or other minor upgrades to residential property. "GIS plays an important role because we have to check to see whether that property might be in a flood zone, along a coastline, or how it's zoned," Schmidt

said. "The integration of the permitting system with our GIS was critical in our ability to be able to put those permits online."

Next, Schmidt and his team hope to tackle improved business workflows for new development by incorporating digital building information models (BIM) within GIS as part of the permit review process. Digital BIM files would replace the paper plans in use today. A new all-digital workflow would provide a means to streamline building code assessments and automate the detection and notification of any conflicts.



In this map, planners can model and analyze different scenarios based on building heights and locations.

While ongoing development and redevelopment in Honolulu have considerable impact on the local economy, GIS provides the means to quantify it. "Looking through our data, we can see 0.2 percent of the total number of building permits accounted for more than 10 percent of the total value of all building permits," Schmidt said. "That small number of permits reflects 33 new apartment complexes built in the last year."

The impact of new apartments, on both the affordable housing issue and the overall city economy, is one of the factors driving the city to recently adopt the proposed walk-up apartment zoning change. Many more ideas are coming forth to deal with the state's housing crisis. "A variety of different creative and innovative—and somewhat haphazard—proposals are coming forth," Schmidt said. "Each proposal needs to be analyzed using GIS to see potential impacts and to communicate the results to the public."

This story originally appeared as "Honolulu Planners Visualize Housing Patterns with an Eye on Affordability" by Brooks Patrick, June 25, 2019, on the *Esri Blog*. All images courtesy of the City of Honolulu unless otherwise noted.

GETTING STARTED WITH GIS

ISSUES SUCH AS HOUSING AVAILABILITY, SUSTAINABILITY goals, and economic changes are compelling state, regional, and city governments to better plan for the future. GIS allows planners and design professionals to collaborate across teams using maps, spatial analysis, and 2D and 3D applications. GIS also supports scenario planning and impact assessment.

GIS offers a way to view, analyze, and share planning projects with internal stakeholders, private partners, and the public. With GIS, planners and urban designers can create a detailed, illustrated project, from beginning to end, including the evaluation of different scenarios and spatial measurements of the impacts to the community.

Planners and urban designers can use GIS to see data in new ways, bringing together data from many sources and visualizing all the relevant information in one place. When planners are working with spatial data, they can start asking spatial questions.

How do I use GIS to visualize planning projects?

With GIS, planners and urban designers can create, track, and review development plans with a digital twin (a virtual and editable image) of project areas. The digital twin provides a direct connection between the physical area of the project and all the information, assets, guidelines, and policies within one unified, digital model. For example, building information modeling (BIM), areal and satellite imagery, and 3D information can be incorporated and investigated throughout the project review process, giving planners and developers a common view of development guidelines.

How do I make 3D scenarios a part of the planning process?

GIS enables planners to create, edit, and manage interactive 3D environments. GIS 3D scenarios simulate what proposed planning areas might look like, given different criteria, within the context of the larger picture. With GIS 3D, plans include realistic buildings and structures alongside zoning and land use designations, rights-of-way and setbacks, and details of integrated infrastructure for an all-inclusive view of current or future development efforts. A 3D scenario-driven process makes land-use changes, zoning updates, and evaluation of development proposals faster, which in turn, improves communication and speeds up policy-making decisions.

How does GIS help me guide change and measure impacts?

GIS allows planners and urban designers to directly join essential data from many different sources within planning maps and analysis, including databases and repositories. Factors such as population change, economic growth, and housing availability provide planners with an all-inclusive view of project areas, which leads to a more comprehensive understanding of all the factors affecting a comprehensive planning process. GIS enables spatial measurements and statistics, such as hot-spot analysis and sightline analysis, that help planners guide people through the impacts of proposed changes within and around a project.

How can I use GIS to increase stakeholder participation?

GIS applications increase the reach of planning professionals through sharing interactive, digital maps. Online maps open access to new audiences, often boosting access to key demographic groups and stakeholders. GIS-based applications allow planners to collect online

comments and survey affected populations, as well as clearly communicate development proposals in public and internal meetings and on the web. 3D GIS provides public reviewers and commenters with an interactive view of alternatives that include simulations and analysis of building heights and shadows, distances to stores, and proximity to bus stops, subway or light rail stops, and parking. With location-based visualizations and metrics, residents and business leaders get an inside track on new information affecting their interests, leading to more participation in the planning process.

Using GIS

There are two ways to get started with GIS: hands-on learning and using ArcGIS Solutions.

Hands-on learning

Hands-on learning will strengthen your understanding of GIS and how it can be used to improve planning and urban design. A good place to start is with Learn ArcGIS, an online resource that introduces GIS using real problems and scenarios. Learn ArcGIS lessons will help you understand how planning and 3D maps are represented and learn more about the following:

- ArcGIS Urban and other GIS tools for creating 3D planning maps and analysis, such as creating alternative scenarios by changing zoning and parcel information
- Using GIS to encourage citizen participation in the planning process and improve public service using data from GIS survey forms and public-facing portals such as ArcGIS Hub

- Creating a greenfield plan that helps planners work with land developers, neighboring jurisdictions, and staff to ensure environmental sustainability
- Studying the per capita environmental impacts of industrial facilities and meeting standards for monitoring and regulating the discharge of toxic chemicals into the environment
- Communicating planning initiatives and engaging the public with maps, images, and text that break down the big ideas shaping their communities

Learn about additional GIS resources related to state and local government planning and urban design by visiting the web page for this book at **go.esri.com/bsc-resources**.

ArcGIS Solutions

ArcGIS Solutions is a collection of focused maps and apps that help address challenges in your organization. As part of the Esri Geospatial Cloud, solutions work with your data and are designed to improve operations and gain new insights. For example, you can use one of the following methods:

Create and publish 3D basemaps

Create a collection of high-quality 3D basemaps using existing data such as lidar, building footprints, and underground utilities to use in desktop, mobile, and web mapping applications.

Integrate GIS with capital improvement planning

Make mapping and spatial analysis part of capital improvement planning, including defining projects plans, coordinating project schedules with internal and external agencies, and organizing a

project portfolio that can be shared with the public and other key stakeholders.

Share incentive zones with businesses

Use GIS maps and apps to promote community growth opportunities in targeted areas by sharing incentive zones with business owners and corporations to encourage new businesses or the expansion of existing businesses in a community.

Conduct homeless point-in-time counts

Conduct location-based annual counts of homeless persons who are sheltered in transitional housing, emergency shelters, and safe havens and quickly summarize the extent of homelessness and streamline requests for federal funding.

Takeaways

State and local government planners and urban designers use location data to express the value of what's being planned and drive decision-making through mapping, spatial analysis, and evaluating the impacts on people, businesses, and the environment. By integrating GIS and spatial thinking into comprehensive planning efforts, planners and urban designers take a forward-looking approach to problem-solving, which leads to more confident actions and better outcomes.

In the Oshkosh story, city planners and officials used 3D GIS to overcome initial public disapproval and major infrastructure challenges in order to retain its largest employer and save hundreds of local jobs. In the Seattle story, the city used different GIS-based scenarios to plan for the impact of new development and accommodate the community growth. In the Richland County story, planners and conservationists applied a green infrastructure approach that helped

win executive buy-in for conservation projects that safeguard wildlife habitats, protect people and property from future harm, and boost the economy. Finally, in the Honolulu story, city analysts and planners used GIS to address the inequities of housing scarcity and the city's housing crisis and formulate location-specific zoning changes that streamlined building code assessments by automating the building permit conflict detection and notifications.

This section also provided recommendations for learning and quickly applying GIS tools in planning projects.

Next, you will learn about using GIS to improve the efficiency of daily work and reduce the costs and time needed to perform continuous operations and maintain critical services.