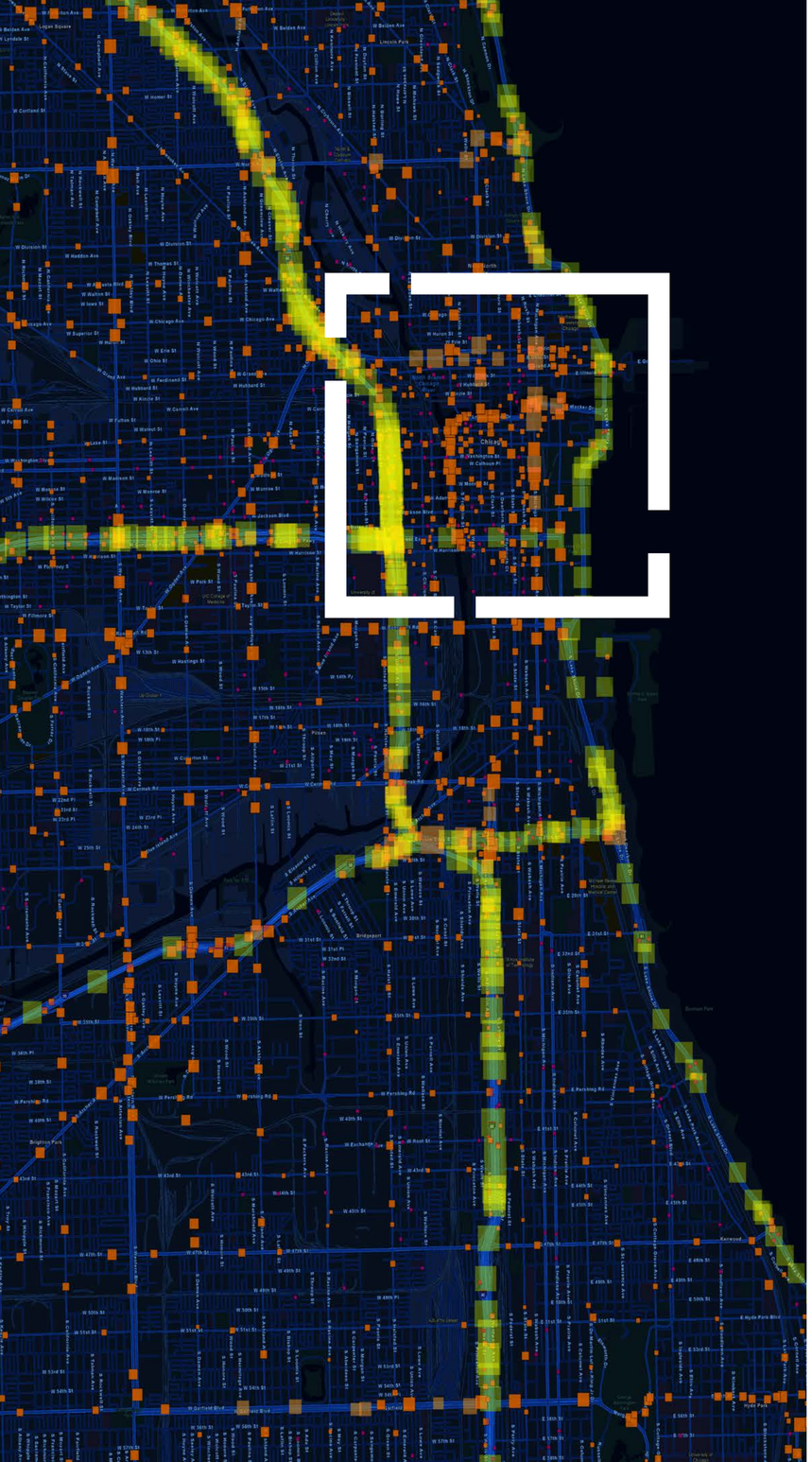
MONITOR CITYWIDE OPERATIONS IN REAL TIME

How a Geographic Approach and Geospatial Technology Can Drive Safety, Equity, and Efficiency



WHAT'S INSIDE

EXECUTIVE SUMMARY: The Need and the Capabilities

The Big Idea

A geographic approach combines data collection, analysis, and sharing to achieve operational intelligence. Around the world, complex organizations are applying geographic information system (GIS) technology, apps, drones, artificial intelligence (AI), machine learning, and the Internet of Things (IoT) to populate a real-time view of assets and people on a shared map. With these tools, organizations gain an edge on complicated challenges because they can see trouble coming and manage decisively around it. For cities, the same tools help deliver services more equitably and more efficiently, with the added benefit of map-based awareness and transparency for all residents and constituents.

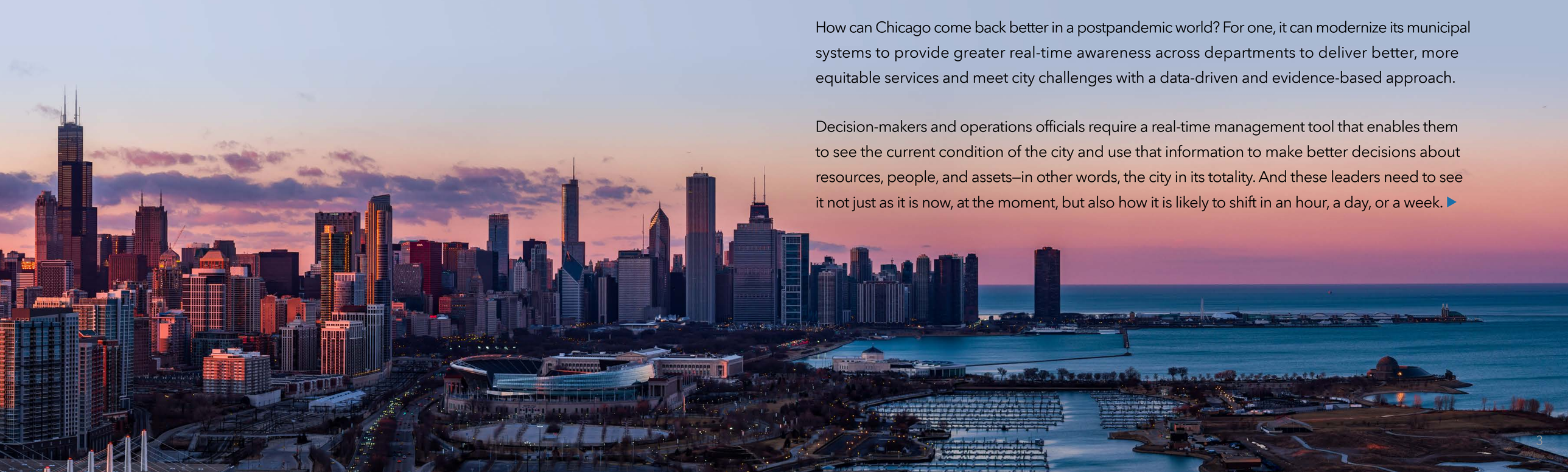
Here's the Why

Chicago, like all cities, is still recovering from the COVID-19 pandemic. As people fled urban centers to escape the virus, it led many people to declare that cities are a thing of the past. But humans are social creatures, and now that health is normalizing, people are coming back to urban settings.

In Chicago, however, the years leading up to the pandemic saw a loss in population. To stem the outflow of people, Chicago can trade on its location advantage and its strengths in transportation, logistics, and food production. The city has strong prospects to close gaps in the supply chain and accelerate the return to manufacturing to mitigate issues of globalization—both pressing national issues in the wake of the lessons learned during the lockdown. And city leaders can spark renewal by thinking about reinvention.

How can Chicago come back better in a postpandemic world? For one, it can modernize its municipal systems to provide greater real-time awareness across departments to deliver better, more equitable services and meet city challenges with a data-driven and evidence-based approach.

Decision-makers and operations officials require a real-time management tool that enables them to see the current condition of the city and use that information to make better decisions about resources, people, and assets—in other words, the city in its totality. And these leaders need to see it not just as it is now, at the moment, but also how it is likely to shift in an hour, a day, or a week. ▶



Here's the How

A geographic approach empowered by modern GIS technology provides a visual means to understand the full context of the city and the way the context affects—and is affected by—the movement of people and assets. Modern GIS is an enterprise technology—as well as a suite of solutions—to address specific workflows and see what's happening across space and time. Managers use GIS to make crucial resource management decisions, acting proactively rather than reactively.

Using GIS technology can accomplish these interwoven objectives, with a portfolio of tightly integrated tools that can achieve several goals simultaneously:

- **Collect, Analyze, Share—**Use purpose-built, location-based apps to collect data and optimize the efficiency of field activities. Then use GIS in the office to store, map, and analyze data points to see challenges in their totality. The data, map products, and analytical results can all be shared internally, across departments, with partners, and pushed back and forth to and from the field.

- **Spatially Enable Operations—**Operational awareness delivered by GIS lets managers see what is happening, track mobile employees, reduce mileage and fuel costs, save time and wear and tear on vehicles, and push routes and directions directly to the field to simplify communications and speed services.

- **Achieve Real-Time Intelligence—**Ingest massive volumes of real-time data feeds and perform fast queries and analysis to understand movement and change. Cities are increasingly constructing digital twins, which combine a 3D model with IoT sensor data to see activity and the workings of the urban environment in real time. This real-time awareness allows users to see such things as bottlenecks in traffic as it changes, where to respond, and where there are service gaps.

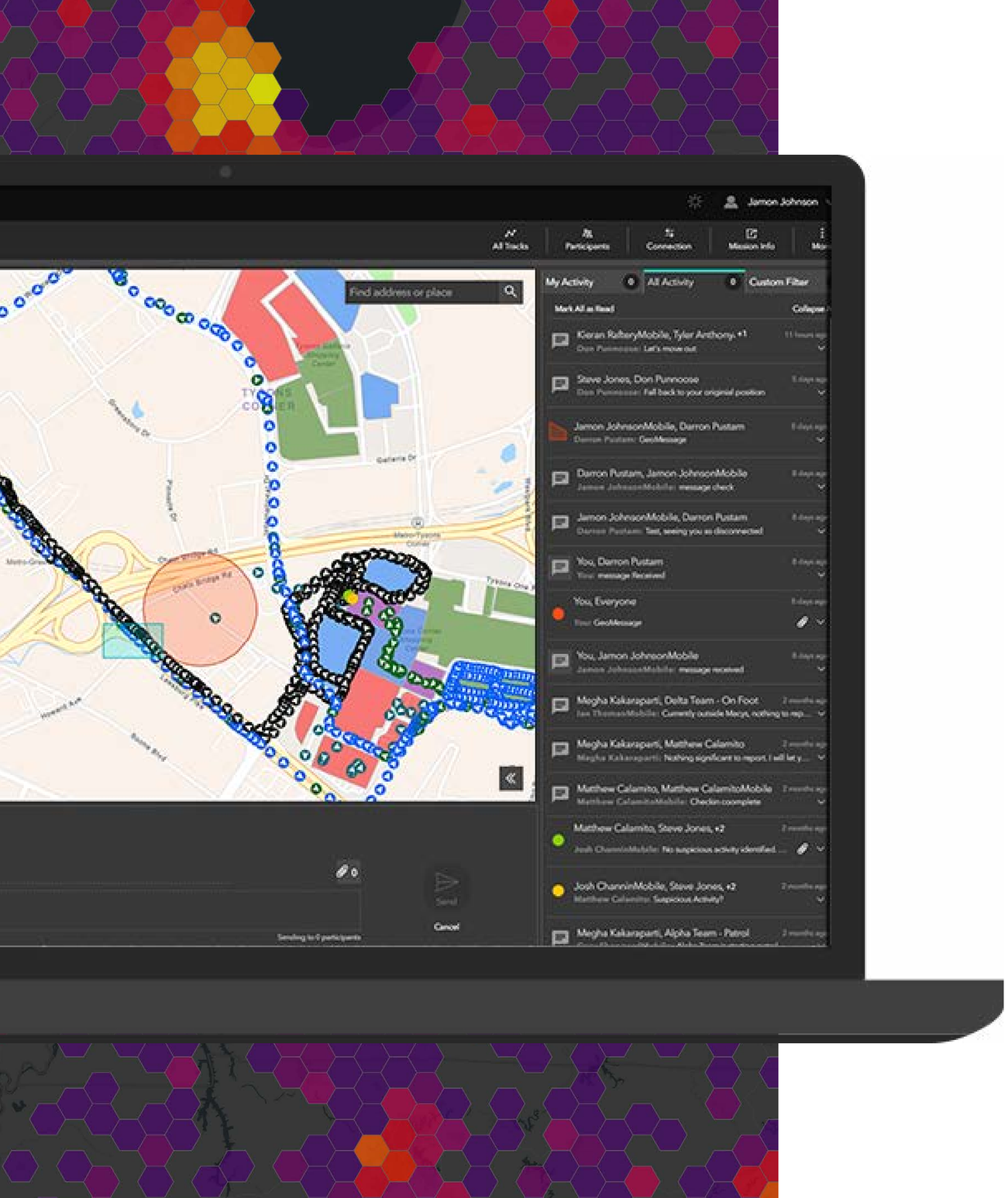
> "We must remember that GIS is not only mapping. That's just a piece of it. It's the data inputs and outputs and the coordination that takes place on the back end that paints the picture and helps us with our decision process."
>
> – Thomas Sivak, Former Deputy Director,
> Chicago Office of Emergency Management and Communications

- **Integrate Important Business Systems—**GIS provides a common meeting ground for other enterprise systems through a powerful factor: location. Through this primary attribute—contained in an estimated 80 percent of all records—relationships and patterns are established, and data from multiple systems can be seen, queried, and acted on. Esri has strong partnerships with providers of foundational enterprise technologies, such as Microsoft, SAP, and Salesforce, adding the power of location intelligence.

- **Really See the Situation, with Great Clarity—**Because GIS contains tools to understand people, places, objects, and processes, it provides unique context. This transparency helps create a smart community. It's about being empowered through our devices, giving everyone faster and better answers, and getting to consensus quickly.

- **Bring Stakeholders Together for Shared Solutions—**By constantly collecting and storing data and providing the means to visualize it on maps, GIS allows decision-makers to note historical patterns and devise solutions. Using machine learning and other AI tools, planners can forecast outcomes. Managers also use GIS to organize people to collect and analyze data around initiatives. GIS workflows underpin good decision-making by helping users analyze the data at hand, target the workforce to take action, and then monitor progress.

GIS manages this level of complexity while bringing visibility to problems and awareness of progress toward the sustainability goals that define a resilient city for the 21st century. ■



SECTION 1

KEEPING PEOPLE AND COMMERCE MOVING

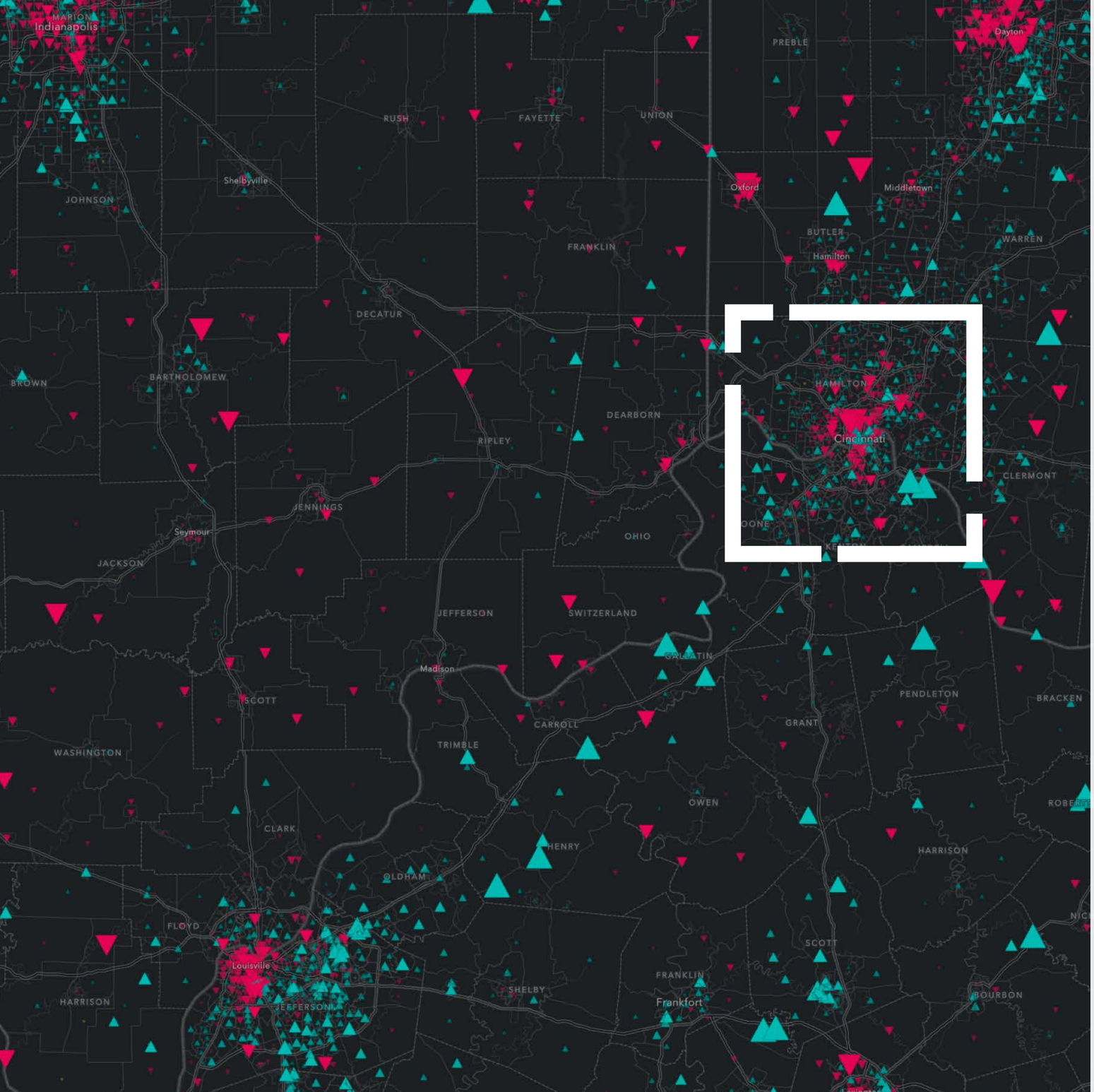
Mapping Chicago's Transit Recovery

An operational intelligence system based on a geographic approach gives city leaders the power of a shared smart map that incorporates the totality of the city's enterprise information.

To manage a city effectively, decision-makers require a data-driven overview of an urban area that is both comprehensive and granular. This perspective became paramount during the pandemic, as all city departments had to adapt to dramatic changes in how they manage staff and deliver services. Dashboards became the norm to track all manner of services, monitor daily operations, and continue to provide exceptional service despite broad changes in cities' ability to deliver services.

Real-time data connects the city's current situation with the events unfolding around it. Seeing business data and status on a map gives officials the confidence they need to make proactive decisions.

A geographic approach and related technologies can aggregate data from disparate sources, while smart maps offer a comprehensive view of what's happening now. Weather reports, incidents, construction activity—it all comes together to provide full awareness of current conditions and ways to improve them. With access to historical data, trends and patterns can be uncovered to guide decisions. Armed with location intelligence, management can proceed at peak performance levels and achieve service excellence. ▶



Section 1 (continued)

GeoAI, or geospatial artificial intelligence, programs help fill in data gaps and automate analytics to tease out information from dataflows. Using deep learning models, GeoAI performs three crucial functions. It sorts through large image caches, recognizing and categorizing the depicted objects by using pattern detection algorithms; discerns change and trends amid enormous amounts of data; and makes authoritative predictions based on current conditions compared to historical data.

GeoAI allows cities to be even more proactive. Just as deep learning programs can recognize shapes and objects, GeoAI can also sense patterns in the data that are not otherwise apparent. This kind of analysis gives operational leaders advance warning of unfolding events.

A deep learning program can even leverage historical data to help users make informed predictions. The system can integrate data from remote sensors around the city, leveraging big data and IoT to improve resource management as part of a smart-city approach. ■

CASE STUDY

Regional Transportation Authority of Northeastern Illinois

Mapping Chicago's Transit Recovery

The Situation: After months of pandemic lockdown that precipitated a dramatic drop in ridership, the Regional Transportation Authority (RTA) of Northeastern Illinois needed to examine routes and schedules to accommodate returning riders. For RTA, that meant strategizing with the Chicago Transit Authority (CTA), Metra, and Pace Suburban Bus (the service boards) to communicate with each other and with riders to get the second-largest public transit system in the country rolling again.

The Challenge: Sharing data across entities about the current state of usage was needed to make plans that fit Chicago's transit-dependent residents. The approach was not just to plan a return to full schedules but also to make a plan that fits the needs of those that would be entirely without mobility options if the area's trains and buses no longer served their communities. ▶

Northeastern Illinois (continued)

The Solution: In response to COVID 19, the team at RTA had launched the COVID-19 Transit Dashboard as a way to easily share daily and monthly data with public officials at the local and state levels. This detailed report of ridership provided important input on who was being served and who was still utilizing the city's transit services. Next, the team used GIS to identify the locations of people and businesses still in need of transportation, analyzing social vulnerability and the essential workers that rely on transit to reach their vital jobs.

The Result: RTA's COVID 19 dashboard provided ridership data to stakeholders, city leaders, and the public. And the easy access to the information increased RTA's ability to communicate and adapt to the rapidly changing conditions. As a result, all stakeholders felt included in the planning process and more confident that their needs were foremost as the transit agency adapted to returning demand. ■

SECTION 2

FUSING DATA AND DELIVERING SERVICES ACROSS DEPARTMENTS

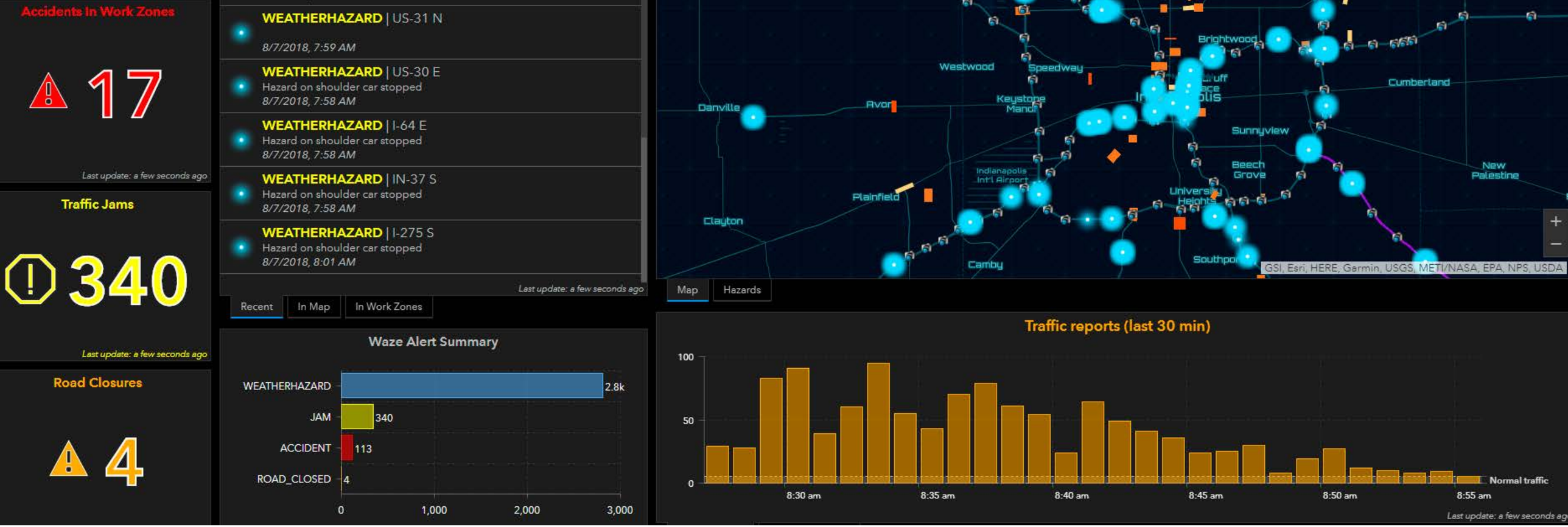
A fusion center powered by geospatial technology provides a way to synthesize information coming in from the field. Managers at the center can gain a holistic view of the situation, making changes and adjustments as necessary. Instead of a department-by-department capability to see just what one group is doing, a fusion center for a city combines all inputs for increased situational awareness and improved collaboration.

All manner of movement can be tracked—including cars, commercial vehicles, mass transit, pedestrians, and cyclists. Add to that the work being done to deliver city services. Combined, the fusion center constitutes the ever-changing context of the city.

The concept of the fusion center is familiar to law enforcement agencies, especially when monitoring large events. It's larger than an Emergency Operations Center, because it's about the flow of all relevant incident and condition information across all agencies—federal, state, and local.

The product these centers fuse is intelligence. Fusion centers allow key operators and decision-makers to establish connections and change plans as necessary.

A modern GIS, which realistically models physical space, creates a unique operational intelligence environment. The fusion center, powered by GIS, takes the system to a new level of everyday utility. ▶



Section 2 (continued)

With cloud-native capabilities that gather IoT data and put it in geographic context in near real time, important decisions can be made with minimal delay and maximal intelligence. The flexibility of the cloud ensures that the system flexes and grows, keeping information flowing regardless of data volume.

A GIS-enabled fusion center can gather data from different devices, process it, and project it onto easily read maps, where patterns and bottlenecks emerge in near real time.

True operational awareness requires many stakeholders operating in concert. A fusion center facilitates collaboration and discourages the siloing of data. The GIS program becomes a sort of common meeting ground for information. As map layers, the interconnected nature of datasets emerges.

The modern smart city produces so much data that it can be hard to discern signal from noise. Dashboards integrated with maps allow for numeric and statistical information to be stored and assessed.

When accidents or other events related to public safety occur, managers need an up-to-date picture of the location of workers in the field who can manage the situation at the scene. Virtual fusion centers may not have a single location like their physical counterparts, but they still allow managers to understand the location of those they manage. GIS-generated smart maps facilitate a quick assessment of who is where and where they ought to be to handle any situation. ■

CASE STUDY

Pennsylvania Turnpike Authority

Employing Map-Based Operational Awareness

The Situation: The Pennsylvania Turnpike stretches for over 500 miles across the state, from its border with Ohio to a bridge in New Jersey. It connects Pennsylvania's major metro areas and traverses the Appalachian Mountains, carrying goods to and from America's fifth most populous state.

The Challenge: The Pennsylvania Turnpike Commission and its nearly 2,000 employees have made great strides toward creating a data-driven operation, including extensive use of GIS. The GIS-based efforts began with a web mapping app built by turnpike authorities. Incident data from Pennsylvania State Police, projected onto the map, revealed areas where accidents were more likely to occur. With this early success, officials realized the toolset could do more, and it cemented their desire to apply GIS on an enterprise level. ▶

Pennsylvania (continued)

The Solution: In 2018, the commission launched the GeoAnalytics program to create geography-based projects for its departments. This includes the turnpike's Traffic Operations Center, which monitors all activity on the freeway.

The Result: Dashboards and maps integrate data from several sources, including weather alerts, traffic cameras, and location data automatically transmitted by the commission's vehicle fleet, tracking road condition from sensors on each vehicle.

A partnership with the navigation app Waze gives the center alerts at increased speed, allowing the commission to respond to incidents and accidents. When incidents occur, the information gets automatically routed to the right people, including police, firefighters, paramedics, and towing companies. Location information is also used for traffic management, department reports, various alerts and to improve the data on travel maps.

GIS also helps the commission make improvements that increase safety and the smooth flow of vehicles on the turnpike. For example, information about locations of deer strikes, projected onto the map, allowed officials to note certain hot spots of animal activity and strategize safety measures, including determining the best locations for animal overpasses. ■

SHOWCASE

STATE-LEVEL COORDINATION OF DATA AND MAPS TO ENSURE RAPID EMERGENCY RESPONSE

Rolling Out Next Generation 911– The Illinois State Police

When someone in distress calls 911, the dispatcher and first responder must know where the caller is and how to reach them. The problem is, these questions can be far from clear. Cell phones don't always convey an accurate location, and street addresses don't always match the map.

In Illinois, officials are working to solve this problem by undertaking a statewide modernization effort, Next Generation 911 (NG911), led by the Illinois State Police. NG911 will connect all 911 call centers and use GIS to increase address accuracy, which will improve response times.

Illinois has moved to geospatial routing and delivery of 911 calls. The new GIS solution automates turn-by-turn directions, using critical details to improve location accuracy.

> "First responders will tell you that two minutes is the difference between life and death. That's why we need to make these changes. When NG911 is fully operational, we'll all start reaping the benefits."
>
> – Peter Schoenfield, GIS Analyst, Lake County, Illinois

Modernization will unlock entirely new capabilities to better communicate the nature and location of each call for help–across the whole state of Illinois. ■

SECTION 3

KEEPING DIVERSE COMMUNITIES SAFE

Large urban areas require a way for multiple agencies to work together to ensure the safety and security of residents. Dashboards and apps combine to orient individuals about incidents and for decision-makers to see the situation as a whole. The digital transformation brought about by these tools delivers true operational awareness with many stakeholders operating in concert, from workers in the field to managers monitoring situations from the office.

In simpler times, even before the pandemic forced cities to make tough decisions about how to approach large public gatherings, these events posed a challenge. As the world learns to live with a pandemic that is, hopefully, on the downswing, these challenges have multiplied.

Ensuring the safety of those in attendance at sporting events, parades, and performances is a massive undertaking. It requires the cooperation and buy-in of multiple agencies, often including those under state and federal jurisdiction.

In an important sense, these events are just particularly concentrated versions of urban living. The city's vibrancy flows from the proximity of people.

Whether for special events or just for everyday peacekeeping in the city, different actors must collaborate. GIS holds the foundation for that cooperation.

GIS provides tools to manage individual officer assignments to protect key assets, manage critical incidents, and plan for contingencies.

It serves as a key source of input for the early assessment and ongoing monitoring of and capturing high-resolution and up-to-date images of the event setup so that officers can orient themselves quickly should an incident occur. ▶

Section 3 (continued)

Esri offers solutions that take core geographic approach capabilities and tailor them for special-event and emergency management operations. These solutions provide a way to collaborate in a geographic context to simplify the safety planning and operations workflows. Event information from the incident action plan can be mapped and monitored along with live information such as weather and traffic conditions, field reports, and health and safety hazards.

Special events play an important role in local economies and improve a community's quality of life. Often these events are celebrations of history or heritage that draw people together and instill close community connections. Already, events are drawing crowds that are even larger than before the pandemic put them on pause.

The value of this command and control system extends far beyond events for a city as dynamic as Chicago. Like in other major cities around the world, every day that operational excellence is achieved in Chicago is a special day. ■

CASE STUDY

Cobb County

Securing the World Series with Real-Time Location Technology

The Situation: In 2021, the Atlanta Braves defeated the Houston Astros in the World Series, clinching the title on the road in game six. Back in Georgia, officials in Cobb County knew that if the Braves won, they would need to organize a huge public victory party and parade to help fans celebrate safely.

The Challenge: As soon as game six concluded, Cobb County had no time to waste. Officials had less than 36 hours to plan a party with an estimated 350,000 guests, none of whom could be turned away. The celebration would include a parade through downtown Atlanta, culminating at the Braves' home field, Truist Park. Almost three decades had passed since the previous Braves World Series victory, and that was at a different ballpark. That meant Cobb County had no prior plans from which to draw to deal with safety, crowd control, and general logistics. ▶

Cobb County (continued)

The Solution: During regular season baseball games at Truist Park, Cobb County police had worked with GIS experts to use mapping for crowd control, security, and traffic management. These activities provided a blueprint of sorts for the World Series victory parade. In the hours leading up to the parade, the GIS team worked with the Braves organization, along with state and county officials, to delineate and approve the route. The map—and real-time awareness of progress and officer positioning—helped Cobb County design a route that put the public near players while keeping everyone safe.

The Result: The real test of the system was how it behaved during the parade. GIS maps displayed the location of every officer along the route, giving commanders the power to not only identify their present locations but also where they were needed and could be sent to respond to an emergency. As the parade proceeded, the maps also allowed workers to hasten the road's return to normal by removing the barricades as soon as the parade passed them. Using ArcGIS® Mission, commanders could track the location of officers, redeploying them as needed. This was especially helpful with undercover officers, who could blend in with the crowds and access all the details they needed on their phones without giving themselves away by talking on a radio. ■

New York City Board of Elections

Staying Alert on Election Day

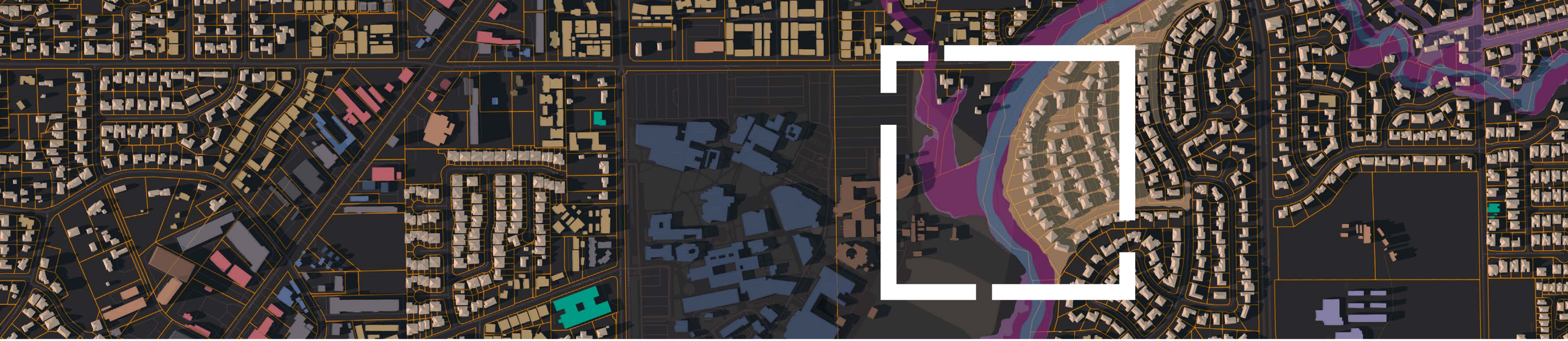
The Situation: The number of registered voters in New York City is larger than any other US city's total population. On Election Day 2016, slightly more than half of them (2.7 million) cast ballots at more than 1,000 polling stations. Two years later, they recorded the highest turnout for a gubernatorial election in 25 years. In the 2020 election, voter turnout in the city increased by 7.5 percent over 2016, and the city added 200 more polling places.

The Challenge: These sorts of numbers make every New York City election a potential logistical nightmare. Given the size of the city's electorate, how smoothly elections run there is often seen as a bellwether for the rest of the nation. Any problems, such as the spate of ballot-scanning machine malfunctions at some polling places in 2018, receive an enormous amount of scrutiny. And as with Election Day anywhere, the city has one chance to get it right.

The Solution: The growing electorate and the ballot-scanning problem in 2018 motivated city election officials to take steps toward greater operational awareness for the 2020 elections. The New York City Board of Elections implemented GIS technology that allowed officials to see the polling sites plotted on smart maps on mobile devices. The solution combined data feeds, predictive analytics, and dynamic maps that allowed officials to detect any unfolding problems as early as possible. ▶

New York (continued)

The Result: The real-time analysis helped ensure that every voter's voice was heard. Freed from the slow process of using paper checklists throughout the day, election officials could concentrate on detecting problems and efficiently troubleshooting them in the moment rather than merely analyzing them postmortem. Rather than waiting for problems to be detected and communicated to the correct people, the system flagged them immediately for all to see. By dividing the city into zones, nearby maintenance crews could be identified and deployed where they were needed so that any problems—from faulty machines to a lack of handicapped access—could be confronted and fixed. The dynamic maps included information regarding traffic patterns and public transportation at any given moment, providing further efficiency in getting the right people where they were needed. The system even included feeds from IoT sensors that provided information on weather conditions and humidity levels, which had been identified as one of the sources of scanning-machine problems in 2018. ■



SECTION 4

PLANNING THE FUTURE WITH A SOLID MODEL OF WHAT EXISTS AND HOW IT OPERATES

Digital twins are virtual representations of the processes, relationships, and behaviors of real-world systems. Virtual 3D models of cities, augmented by local information, provide a means of proposing, understanding, and analyzing development projects and other changes to the urban landscape.

Digital twins reflect the ongoing movement and evolution of real-world assets using feeds from sensors and IoT devices. They can provide a complete dynamic rendering of complex entities, showing how systems function singly and together.

The earliest digital twins grew out of the industrial world. They were ways to keep tabs on the functioning of factories, down to the level of individual machine parts. The goal was not so much to provide real-time monitoring as it was to provide detailed record keeping.

Using digital twins as part of facilities management is a natural outgrowth of these early industrial digital twins. But the capabilities of the technology have expanded so that entire cities can now be modeled—including functions in near real time, using sensors and IoT feeds that provide raw data that can then be contextualized via maps, dashboards, and portals. The same digital twin can provide an ongoing chronicle of what it mirrors while keeping a record of past developments and providing the means to test out future scenarios in a realistic environment.

GIS isn't the only tool for constructing digital twins. However, in the context of a city and its functions, GIS offers clear advantages. Digital twins must process data from disparate sources. Often, the only common attribute the data shares is that it corresponds to events, processes, and relationship with a location component. Where things happen—and how these things affect others that are in the same location—is of paramount importance, and GIS makes these connections.

Just as important is understanding how things in one location affect those in another. In a densely populated city, chain reactions are common. Understanding them and getting out in front of these cascading effects is crucial. This is as true for the traffic on a tarmac or in front of the airport as it is for the traffic patterns that spread out across the city. ■

CASE STUDY

San Francisco International Airport

Utilizing a Dynamic Twin to Transform Operations

The Situation: San Francisco International Airport (SFO) has been a global leader in the adoption of GIS technology. As part of the Federal Aviation Administration's (FAA) ongoing modernization effort, the Next Generation Air Transportation System (NextGen), the nation's airports are required to adopt GIS to gather and share data. SFO has been at the forefront of this modernization. Although the FAA's primary interest in GIS is to manage horizontal infrastructure—runways, taxiways, pavement—SFO saw the results and adopted a vision to expand GIS use to encompass the majority of airport operations.

The Challenge: This desire to expand the use of GIS at SFO reflected an understanding that airports are enormously complex environments. Like cities, they function by means of many systems operating separately while remaining connected to others. The different types of traffic—cars dropping off and picking up passengers; pedestrian foot traffic through the concourses and gates; and, of course, the aircraft that takes on and disembarks passengers—all affect the others. Furthermore, they are all linked to the continued maintenance of the airport's systems—everything from HVAC to elevators to rail links to terminal—that all must be operating to move people and goods efficiently. What SFO wanted was a way to bring all these together into one GIS environment. ▶

"It's about delivering advanced knowledge to the user and the passenger, so they feel more in control of the experience going through the airport."

– Josephine Pofsky, Director of Infrastructure Information Management, San Francisco International Airport

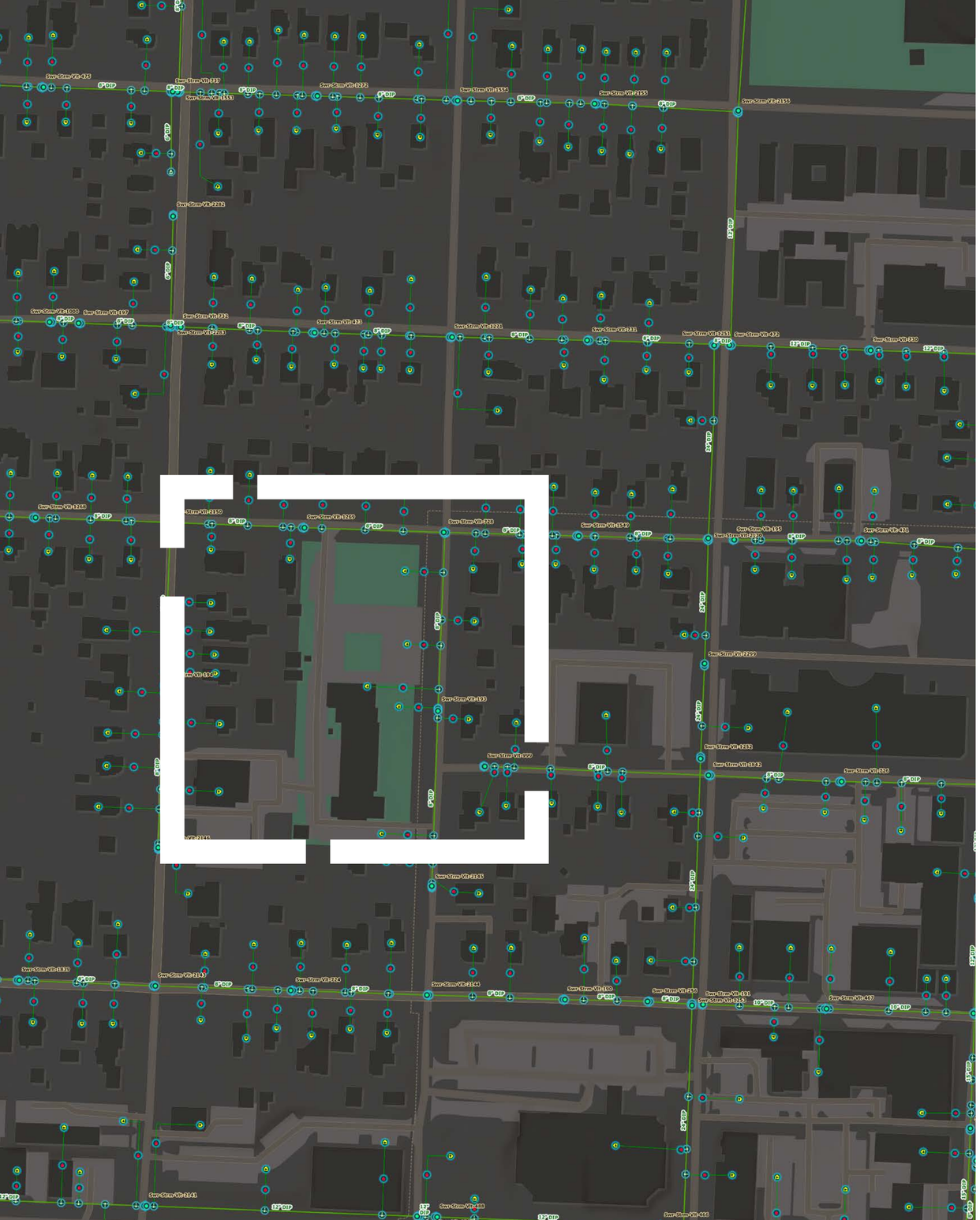
San Francisco (continued)

The Solution: To achieve this kind of integration, SFO used GIS to build a dynamic digital twin that incorporates other technologies such as building information models (BIM) of construction plans and work order management systems that capture maintenance details. SFO's dynamic digital twin reflects the dimensions of both the interior and exterior of airport facilities as well as the activities of most of the airport's assets, providing a constantly updated rendering of spaces and the systems that contribute to their functions. The twin portrays the airport with a great deal of detail, down to the manufacturer and model number of critical components that need regular maintenance, such as lighting and pumps that keep liquids flowing.

The Result: SFO's dynamic twin provides a continuous digital alignment of the virtual and real-world environment—a window into the airport's infrastructure—allowing managers to monitor how components and systems are functioning.

For the retail component of the airport, the space management team uses the tool to find the best location for a kiosk or a specific retailer. This helps in ways that span both day-to-day operations and longer-range planning. Facility personnel use it to plan their days, for example, by seeing which parts need replacing and the best points of entry. The model is tied into the airport's emergency management system so that responders to 911 calls can orient themselves, allowing them to see which doors are automated and which are restricted and require special keys and badges. And the model is available to help visitors navigate through the sprawling facility.

The integration has been integral to pulling off the airport's ambitious and transformative $7 billion renovation, modernizing it through the addition of a new hotel, revamping two terminals, adding parking, and creating tighter transit connections across the region. ■



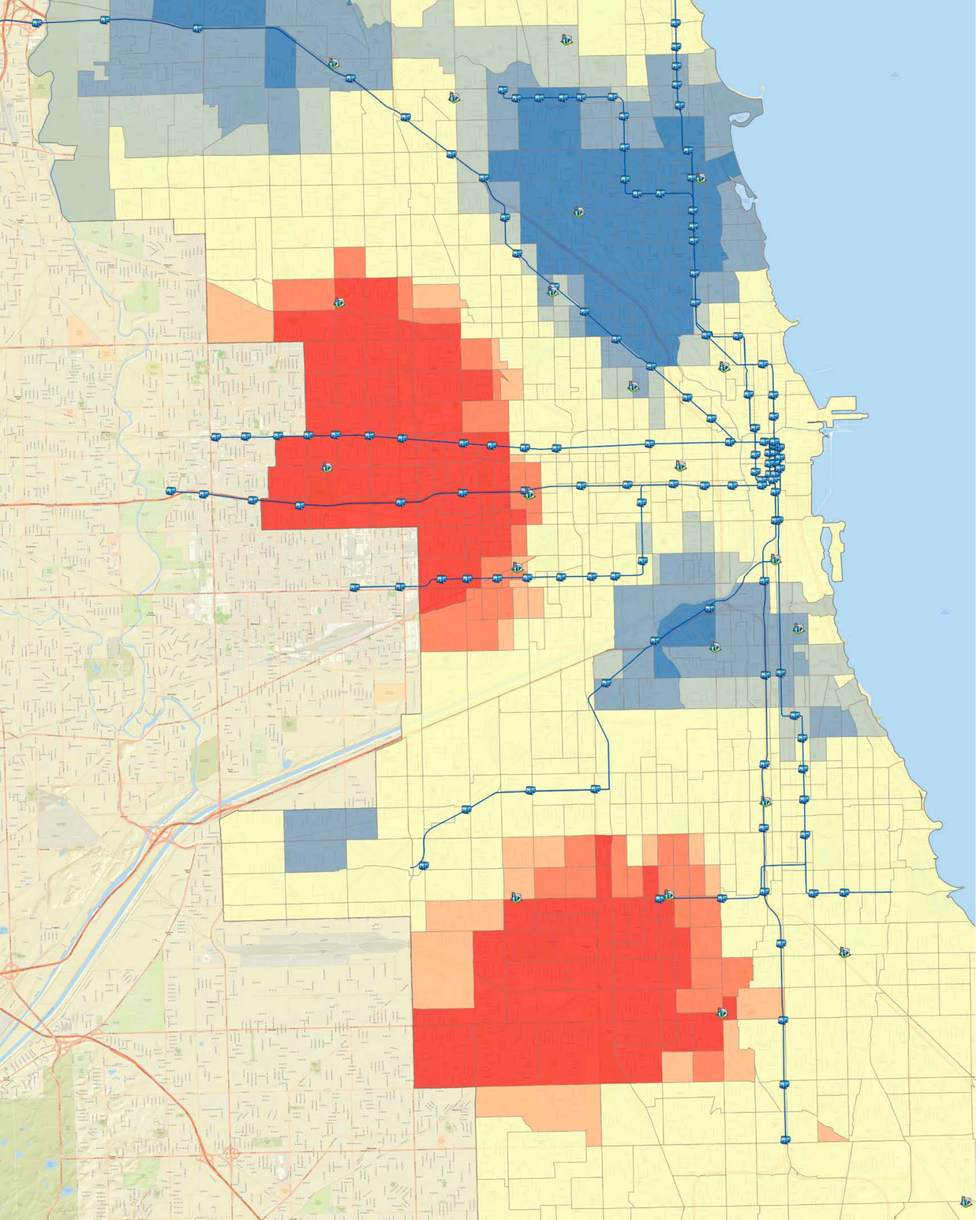
SECTION 5

ACHIEVING LEAPS FORWARD IN INFRASTRUCTURE QUALITY TO ENHANCE LIVABILITY

Chicago may be “the city that works,” but nobody knows more than the city’s municipal managers about how much work goes into keeping the city humming. Maps are a way to manage the city’s complexity, ensuring that the city remains strong and vibrant.

Operational maps help cities maintain and manage the critical infrastructure that keeps a city running, from paving the streets to making sure stormwater doesn’t pool on streets. The same maps and dashboards that serve public works employees can also keep residents aware of current conditions and the status of repairs.

Every city also has individual organizations that manage and maintain their own maps of critical infrastructure: The power company has the electrical lines, the telecommunications companies have details on cellular and broadband coverage, and so on. ▶



Section 5 (continued)

Cities are increasingly coordinating the sharing of maps and taking them to the next level because:

- **Siloed maps have only a limited utility.** A map detailing the location of water pipes is valuable. But when the pipes freeze and need to be repaired, the water company must also ensure that workers won't sever a gas line when they cut into the street.

- **Maps need to be dynamic.** A map of the city's traffic signals, for instance, must portray current conditions within the system, including any intersections that are experiencing service disruptions, so that repair crews can be dispatched. A dynamic map lets relevant agencies make changes remotely, such as changing the timing of signals so that buses on a certain route adhere to posted schedules.

- **Useful maps must also communicate conditions** to the public so that residents have a sense of what is happening in their city.

GIS is a way to facilitate these varied mapping purposes. The same maps used to coordinate work can be stripped down to take out operational details and communicate the status of repairs with Chicagoans. Dashboards provide a way to condense a variety of information for an at-a-glance understanding, with graphs and supplemental details centered around a map. Hub sites are a way to organize information and center actions around initiatives with progress of on-the-ground actions noted on a shared map.

Maps provide a way to bring together all departments to work on the ambitious projects encapsulated in the city's capital improvement program to rehabilitate, upgrade, replace, or construct the city's infrastructure to physically improve and modernize the city for its residents and institutions. ■

CASE STUDY

City of Los Angeles

Cleaning Up Dirty Streets through Comprehensive Open Data Mapping

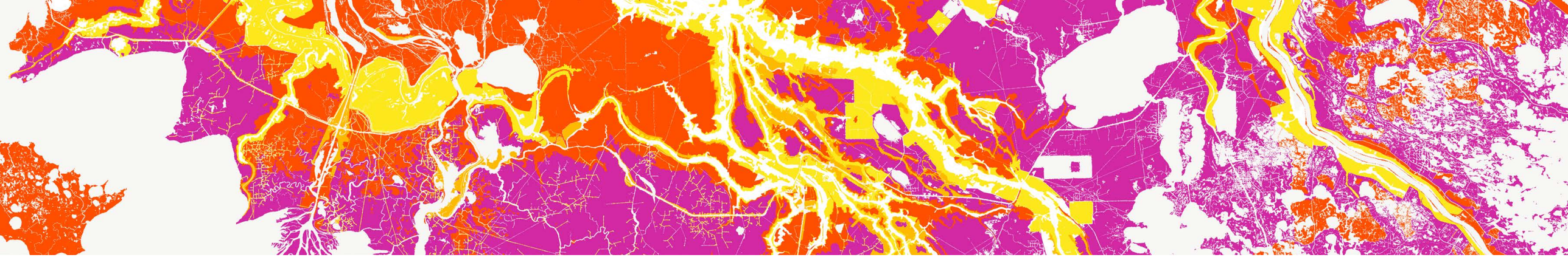
The Situation: Los Angeles needed a data-driven solution to keep streets clean, a responsibility under the purview of the public works department. The city had seen a steady decline in cleanliness because street-cleaning funds had been significantly cut back during the recession of 2009.

The Challenge: Los Angeles has the country's largest street network, with 42,000 blocks and thousands of miles of roads. Due to the city's size, it's difficult to know the conditions on any given block and to prioritize which blocks were most in need of street cleaning.

The Solution: Los Angeles mayor Eric Garcetti launched Clean Streets LA (CSLA), a public-private partnership, with the goal of eliminating dirty streets. One of its major projects is CleanStat, a system of judging each block's cleanliness. Using GIS tools and video capture, crews driving through the city assign cleanliness scores to blocks, adding this information to a map. They can filter the map results by scores to get a sense of the areas where cleaning is most urgently required. This information can then be used to plan the most efficient routes for street cleaners. Through CleanStat, GIS helps staff understand the city and develop a comprehensive method of looking at trends. It's one of many solutions on the city's GeoHub, which combines open access to data and many more tools similar to CleanStat that the city uses to evaluate its challenges. ▶

Los Angeles (continued)

The Result: In the first year after launching CleanStat, the city reduced unclean streets by 82 percent. GIS lends authority to these figures by detailing exactly where work has been performed. The data-driven nature of the map also promotes equity by prioritizing cleaning wherever it is most needed, ensuring that no neighborhood takes precedence over any other. This allows communities to hold the city accountable for providing services that everyone requires. By quantifying service delivery, the city has now shifted to prioritize high-foot-traffic areas, with a pledge to act swiftly to drive out pervasive illegal dumping under freeway off-ramps and make data-driven decisions on where to deploy trash bins in areas with persistent litter. ■



SECTION 6

RESPONDING TO CLIMATE PRESSURES

In the face of increasing impacts from climate change, cities and regions are looking for ways to implement plans that emphasize sustainability and the harmonious integration of green infrastructure to help mitigate the damage from climate extremes, such as increasing storm intensity.

As the authors of the latest exhaustive report from the United Nation's (UN) Intergovernmental Panel on Climate Change have warned, succinctly: **the window is rapidly shrinking** before the planet warms by 1.5 degrees Celsius.

The good news: the world can still get to where it needs to be. With the current tools, the science, and modern GIS, humans can adapt and make the most of their collective efforts to enhance resiliency and reduce the impacts of climate change.

That includes making it easier to process and share massive amounts of information—data collected by field crews, imagery captured by drones and satellites, and monitoring data from IoT sensors—for greater understanding and enhanced collaboration.

Many entities, including the White House, have adopted a hub approach to provide all stakeholders with the latest data and tools for data-driven climate resilience and mitigation plans.

By organizing reliable data and proven solutions in a shared resource, gaps in knowledge will be filled, and all stakeholders will benefit from increased understanding, specific to their needs.

A geographic approach is critical to all five steps of addressing the climate crisis: exploring hazards, assessing vulnerability and risk, investigating options, prioritizing and planning, and taking action.

A hub approach really shines in times of emergency response. A geography-based data portal helps leaders and agencies integrate data, measure change, map environmental health, model impacts, guide resource allocation, and monitor progress.

With a single portal to collectively understand and address climate challenges at both the micro and macro levels, governments and their departments and agencies unlock insight for both near-term and long-term planning and action.

GIS manages this level of complexity while simplifying the communication of crucial information. It affords a dual visibility, illuminating problems and highlighting progress toward resiliency. ■

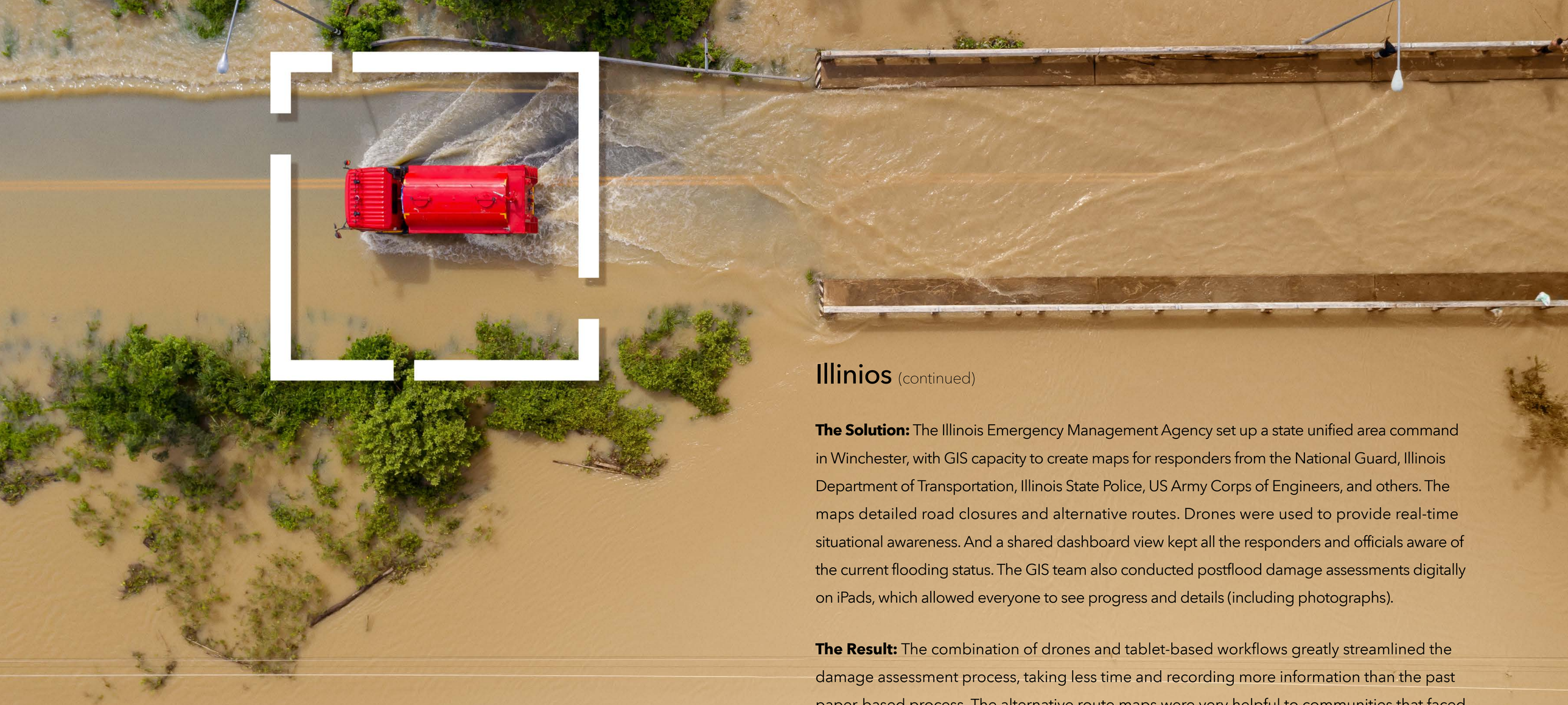
CASE STUDY

ILLINOIS EMERGENCY MANAGEMENT AGENCY

How Technology and GIS aided Response to the Great Flood of 2019

The Situation: It's called the Great Flood of 2019 for a reason. It was the wettest spring on US record, impacting 14 million people as multiple storms hit and rivers overflowed, flooding the Midwest, High Plains, and South from January through June. New high watermark records were set in 42 different locations along the Mississippi River, and the Illinois River just couldn't drain.

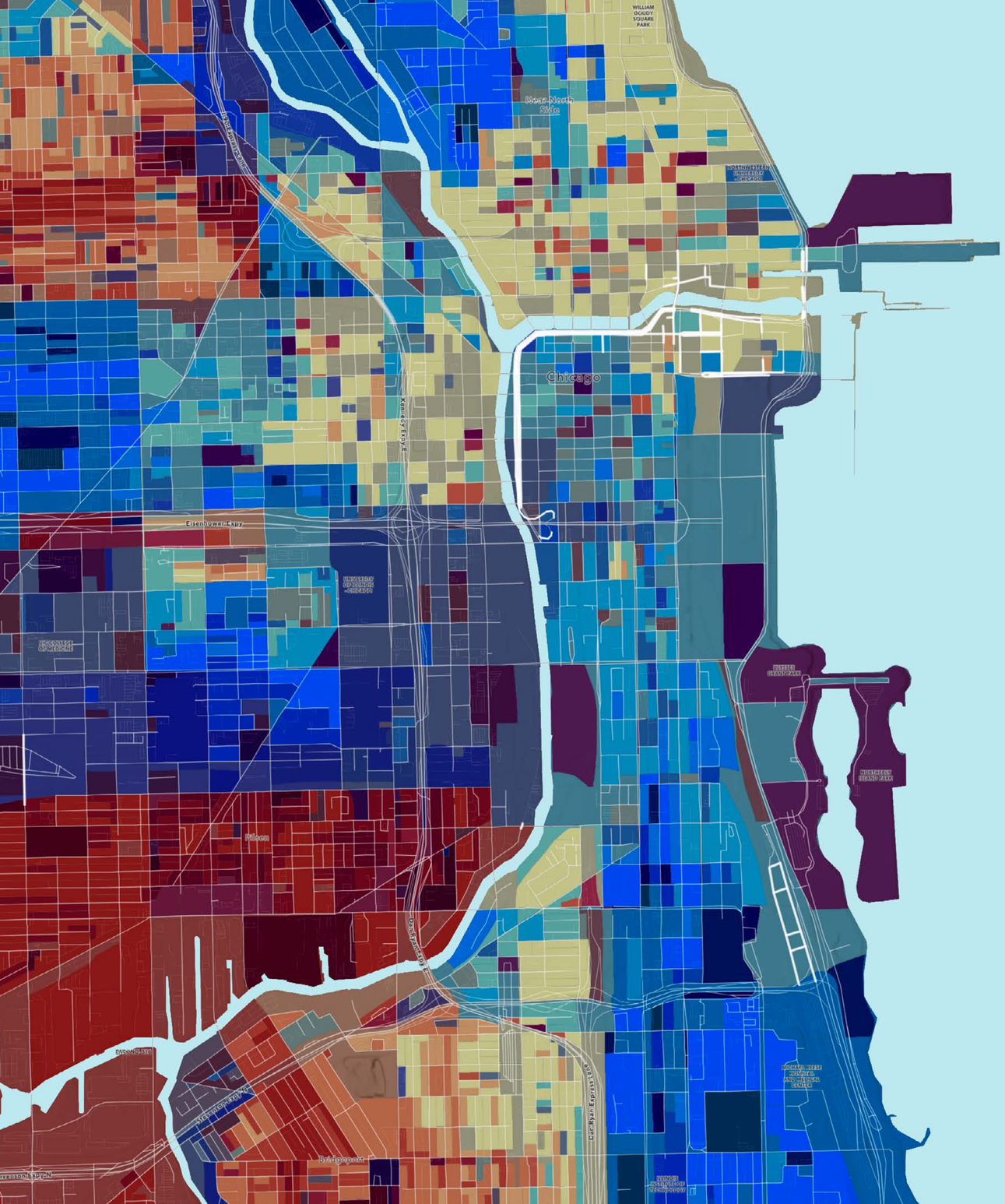
The Challenge: In many of the small communities along the rivers, flooding is a regular occurrence, but not to the extent and duration of these events. Beardstown, Illinois, experienced 176 days of minor and moderate flooding. In nearby Havana, major flooding stretched to 37 days. Local people were busy reinforcing levees while responders struggled to document the impacts and identify areas in need of help. ▶



Illinios (continued)

The Solution: The Illinois Emergency Management Agency set up a state unified area command in Winchester, with GIS capacity to create maps for responders from the National Guard, Illinois Department of Transportation, Illinois State Police, US Army Corps of Engineers, and others. The maps detailed road closures and alternative routes. Drones were used to provide real-time situational awareness. And a shared dashboard view kept all the responders and officials aware of the current flooding status. The GIS team also conducted postflood damage assessments digitally on iPads, which allowed everyone to see progress and details (including photographs).

The Result: The combination of drones and tablet-based workflows greatly streamlined the damage assessment process, taking less time and recording more information than the past paper-based process. The alternative route maps were very helpful to communities that faced hours-long delays and hundreds of miles added to commutes because of road and bridge closures. The real-time awareness from drones helped shore up the most vulnerable levees and speed the evacuation of people when an important levee broke. As high water moved downriver, inundation modeling helped communities there prepare with details on flood extents they could expect. Through flood risk analysis, incident commanders could look at potential outcomes and prioritize the work where it was needed most. ■



SECTION 7

ADDRESSING EQUITY—PROVIDING SERVICES TO EVERYONE

Many cities in the US face ongoing impacts of systemic racism, but not enough have examined the underlying issues. A data-driven approach that reveals trends helps a city achieve its aims of improving equity and inclusivity.

In many ways, geography has been a tool for greater understanding of inequities, but it has also been the means to draw lines that keep communities segregated. A long history of place-based social exclusion, manifested in practices of redlining, created patterns in cities that continue today. The charge now is to address the underlying causes of disproportionate, unfair levels of poverty in communities of color.

Many cities have taken a proactive approach to tackling systemic racial and economic discrimination by examining their own past practices and how they allocate funds and resources to make sure they deliver operational excellence for all people.

Powered by data and a map-based awareness of inequities, activists are also pushing for meaningful reform.

Examining patterns of service delivery often reveals that disadvantaged areas are underinvested in. Reexamining these records has led many cities to prioritize allocations of resources and to improve maintenance to alleviate burdens for communities of color.

Using smart maps powered by a geographic approach and GIS, cities can investigate how current and historical policies and actions have created economic obstacles beyond the control of residents in an affected area. GIS—with its ability to analyze hundreds of layers of factors at once—lets researchers explore data on education achievement, financial status, presence of food insecurity, and many other patterns of inequity that all too often match the old maps that instilled segregation. ▶

Section 7 (continued)

Researching how the demographics of residents affects their success in life provides a first step and is often eye-opening. In Seattle, this research showed that areas with the lowest life expectancy are also the areas with the most people of color. When the COVID-19 pandemic hit, the school districts of Palm Beach, Florida, and Philadelphia, Pennsylvania, used GIS to identify families constrained by the digital divide. The school districts delivered computers and Wi-Fi hot spots to enable disadvantaged kids to take online classes.

Some cities have stood up departments of race and equity that apply an equity lens to every potential project and policy. These departments use maps and spatial analysis because geography helps governments answer one of the most important questions—**Where is the need the greatest?**

All departments and agencies of city government have a role to play by examining the outcomes of their policies, practices, and procedures for underserved communities. GIS can help identify communities in need as well as the actions required to address disparities.

Esri offers tools and data to map and better understand racial inequity to build a more equitable and just world where a person's race or ethnicity does not impact their outcomes. Demographic data and historical resources, such as redlining maps, help locate populations of concern, identify barriers to equality, and support informed and equitable decision-making.

Once initiatives and reallocation strategies have been determined, maps and spatial analysis allow managers to keep track and make meaningful progress.

Equity and social justice are long-term issues—they have persisted for decades, and improvement can only be measured over long time periods. Because of the long timeline, spatial analysis must be executed consistently and with a high degree of precision so it stands the tests of time. ■

CASE STUDY

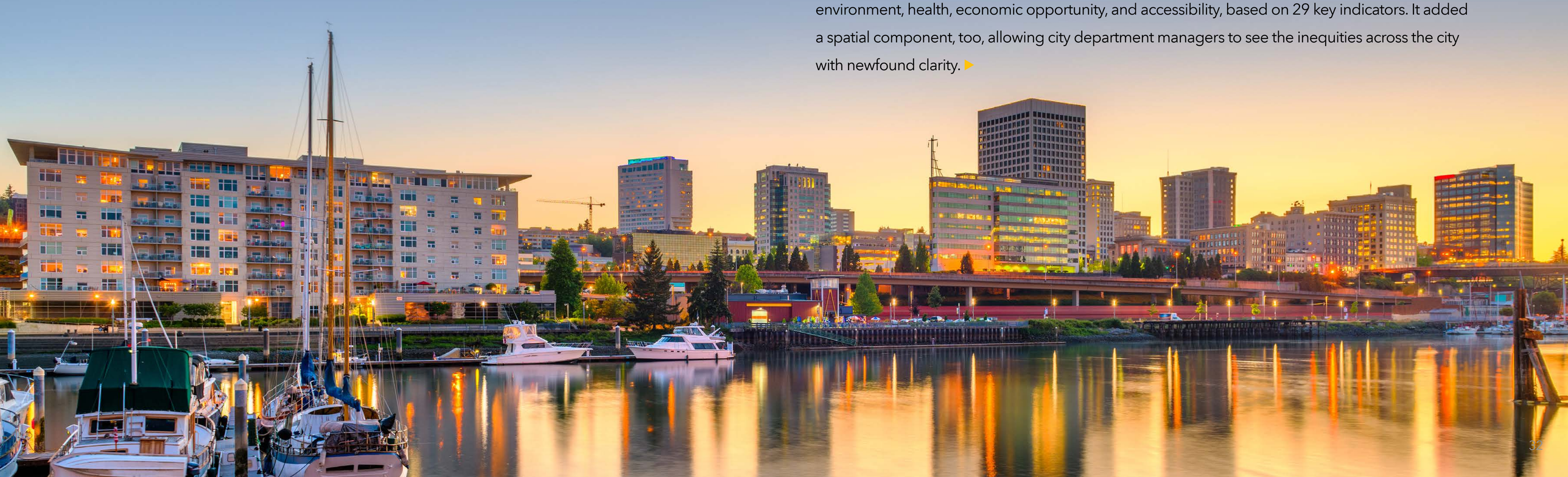
CITY OF TACOMA, WASHINGTON

Becoming an Anti-Racist City: Data-Driven Transformation

The Situation: Like many US cities, Tacoma, Washington, has struggled with how to address systemic racism. Tacoma's mayor, Victoria Woodards, decided that one of her main priorities would be to make Tacoma explicitly antiracist. It was an ambitious goal: how to make Tacoma more equitable to match the diversity of its residents, which are 40 percent Latino, Black, Asian, or Pacific Islander.

The Challenge: Addressing individual instances of racism is one thing—but it's very difficult to take the next steps of examining the underlying reasons. Often a deeply entrenched practice and even racist structures that go way back in the city's history are the cause for inequities to persist.

The Solution: City staff began by doing extensive research about the role specific policies had played in perpetuating inequities. They were then able to quantify the effects of those policies by developing the Tacoma Equity Index, which measures economic problems, housing needs, and social justice issues. Using GIS, the tool examines six inequity categories: livability, education, environment, health, economic opportunity, and accessibility, based on 29 key indicators. It added a spatial component, too, allowing city department managers to see the inequities across the city with newfound clarity. ▶



Tacoma (continued)

The Result: The tool has provided a solid foundation for allocating city investments equitably, from COVID-19 relief to the planting of trees to combat heat islands. The tool allowed Tacoma's city government to see, with empirical precision, the legacy of systemic racism. For instance, the public works department was able to identify specific neighborhoods that have lagged in streetlight repairs, which could correlate to higher incidents of crime at night. In the past, these neighborhoods were often left behind when the city allocated its limited budget. Now, the city could ensure that those neighborhoods are prioritized, providing a definable way to build a more equitable city.

One of the most important applications of the index has been in the effort to improve housing. The Home In Tacoma project used the equity index to prioritize the creation of housing that avoided gentrification. Planners can see how and where to develop affordable housing. Home In Tacoma has helped the city plan for the development of 60,000 new housing units by 2040, primarily within the downtown area and mixed-use centers, and which are geared toward walkability and access to wholesome food. ■

CASE STUDY

California Continuums of Care

How One Powerful App is Changing the Way California Communities Address Homelessness

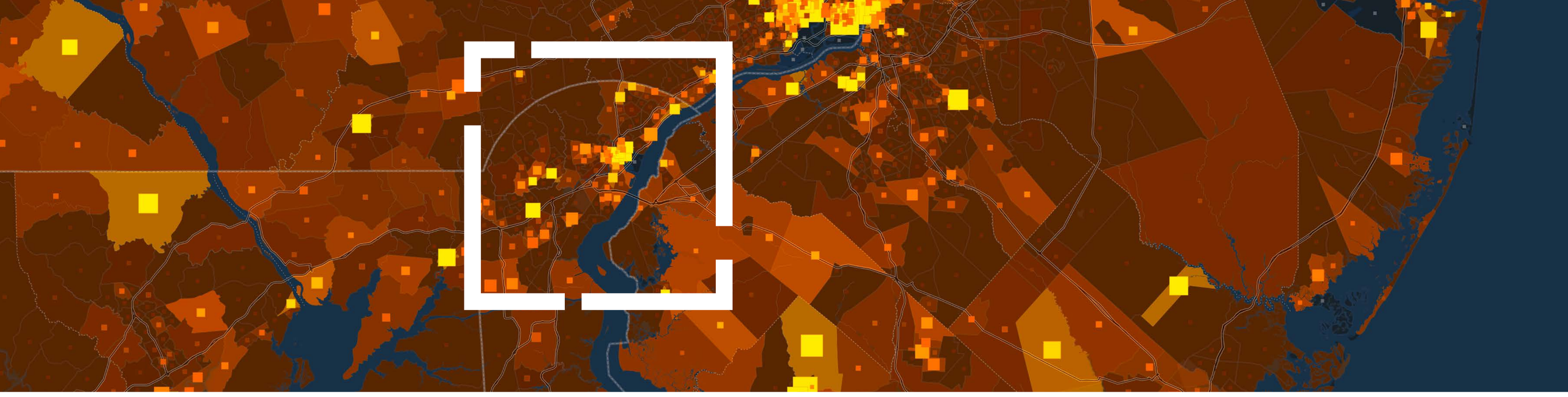
The Situation: The US Department of Housing and Urban Development administers the Continuum of Care program (CoC). The country is divided into discrete CoC areas, each with representatives from state and local governments, nonprofits, health-care providers, and faith-based organizations. Together, these stakeholders are tasked with connecting the unhoused with programs that can help them, emphasizing methods that minimize trauma and maximize self-sufficiency. Every CoC must conduct annual surveys of the unhoused, called Point-in-Time (PIT) counts. These surveys serve a dual purpose, providing a better understanding of the scope of the problem while also offering a framework to discuss solutions. ▶

California (continued)

The Challenge: People experiencing homelessness are difficult to survey with a high degree of accuracy. Since 2019, pandemic mitigation requirements have forced many communities to scale back or suspend PIT counts. PIT counts must be accurate, and they must involve all the stakeholders in a CoC. The challenge is especially pronounced in California, which is divided into 44 CoCs, and where one out of every 250 residents is homeless, forming the largest unhoused population in the country. The state needs to understand the geographic dispersion of these communities, and the local municipalities require suitable methods to understand how their unhoused population corresponds to the greater whole. For example, Los Angeles has nearly one-quarter of the state's homeless, but Santa Cruz County, with a much smaller and less urban population overall, has a much higher homelessness rate.

The Solution: To complete PIT counts, California communities have increasingly adopted technology that improves surveying methods and enhances advanced data analytics. Among the tech enabled, around half of the people doing PIT counts in California now use ArcGIS Survey123.

The Result: Survey123 has helped join the various stakeholders involved in PIT counts, from the individuals in the field gathering data with mobile devices to the offices overseeing the efforts. The software streamlines the entire process by eliminating paperwork, allowing for the gathering and tabulation of results in real time, with no meaningful distinction between data gathering and data processing. PIT counts are better equipped to fulfill their function of helping agencies understand where resources are needed the most. Governments and nonprofits are better equipped to meet the requirements imposed by the CoC program. ▶



The following four ArcGIS products add important real-time perspectives that enhance an organization's situational awareness:

ArcGIS VelocitySM is cloud-native software as a service for ArcGIS Online that allows organizations to ingest data from IoT platforms, message brokers, and third-party APIs. It helps users process, visualize, and analyze real-time data feeds; store them as big data; and perform fast queries and analysis. This capability adds an awareness that brings clarity to essential operational decisions, allows for remote monitoring of important assets, and provides key inputs to achieve predictive maintenance and process optimization.

ArcGIS Field Maps integrates the ability to capture data with easily configured forms; combine position and locations on a map to find assets and plan routes to the work; capture the tracks of field staff, monitor where they are, and analyze where they have been; and improve transparency between the field and office by seeing tasks alongside the location of the workforce.

ArcGIS Mission provides command and control systems to streamline event management for public safety and operations managers while also equipping tactical teams with situational awareness. All key mission data, such as messages, photos, and location tracks, are stored for after-action review and playback. The ArcGIS Mission mapping system supports public safety workflows to secure special events while aligning the efforts of local, state, and federal agencies to act in concert.

ArcGIS HubSM community engagement software provides an easy way to organize people, data, and tools to tackle challenges. Cities, states, and even the White House have applied this framework of tools to take on operational challenges. The suite of products provides a means to share open data, create unlimited outreach efforts, and organize action around initiatives.

Each of these tools speeds an organization's ability to gather data at high volumes to provide context. ■

> "The city is changing all the time, which is why it's important to have access to quality information and current mapping data. A lot of our problems can be solved by mapping to pinpoint the areas of the greatest need and then connecting those areas with resources."
>
> – Eva Pereira, Chief Data Officer, City of Los Angeles

CONCLUSION

As the world's cities begin to rebound from the pandemic, Chicago has an opportunity to reimagine itself to make the most of its location advantage and to grow in ways that enhance livability for all its residents.

As Geoffrey West, a pioneering urban scientist, has discovered, there are fundamental laws of cities related to population size. With simply the number of people in a city, his formula can derive the average income or the size of the sewer system, showing how the number of residents determines infrastructure size and socioeconomic health. When city growth stagnates, an outsize demand for services can lead to accelerating decline.

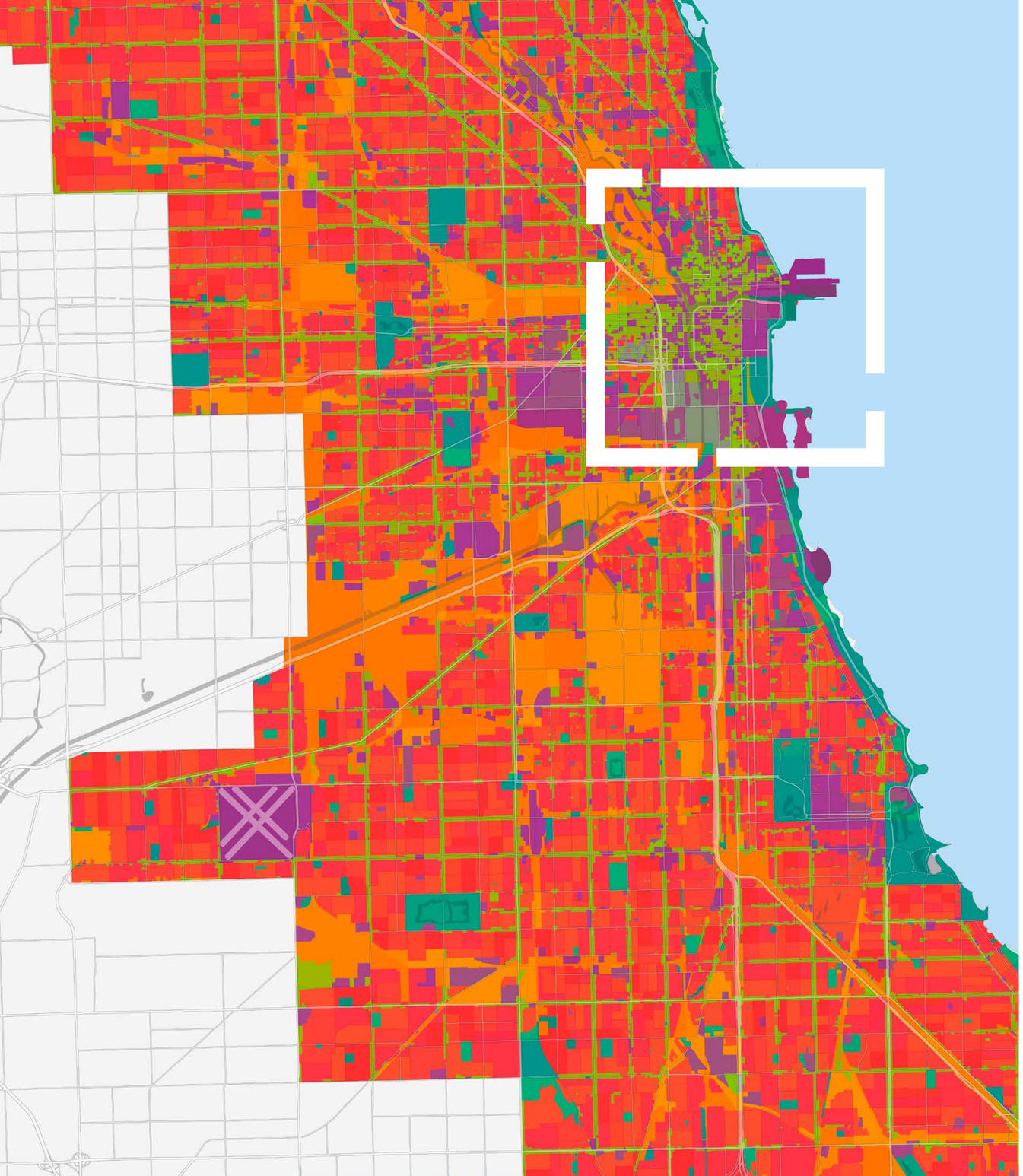
Innovation is the only thing West has found that can arrest this pattern. When smart people come together, they give birth to new companies and new products and replace prior patterns that fueled a city's rise.

Cities, too, are the place to take on new challenges, such as replacing fossil fuels with renewables and clean energy sources.

Rethinking government collaboration, with more streamlined data and data feeds, is how other cities are reinventing themselves. In New York City, a new enterprise approach to GIS is tackling public safety and the city's housing crisis with open data and real-time data streams that put city workers and the public on the same page. In London, the mayor has made congestion and air pollution a priority, with inputs from a network of air sensors on a shared map showing problem areas of the moment. In Los Angeles, the city's GeoHub is an innovation that has fostered greater data-driven decision-making.

A new combination of technologies—cloud, apps, AI, IoT—is speeding the understanding of a city's challenges and fostering swift and meaningful collective action where it's needed most.

Now is the time to modernize. A city like Chicago can parlay its remarkable industrial past and build the urban patterns that are needed for the future. By streamlining government decision-making through a geographic approach, the contextual awareness provided by shared maps and geospatial technology can guide the way. ■



Learn More

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, including Fortune 500 companies, government agencies, nonprofits, and universities. Esri has regional offices, international distributors, and partners providing local support in over 100 countries on six continents. 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.

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