June 8, 2018

Urban and Regional Information Systems Association
ESIG Award Selection Committee
701 Lee Street, Suite 680
Des Plaines, Illinois 60016

Exemplary Systems in Government Award Selection Committee:

I’m extremely proud to authorize this Single Process System nomination for a 2018 URISA ESIG Award. In support of my pride and this nomination, I provide the following background and commentary.

A 1985 hepatitis scare, the absence of accurate records on subsurface infrastructure, and subsequent action by local elected and appointed officials (including my predecessor) led to the creation of a “computer mapping system” to prepare Kenton County for future community challenges.

Today, we and our public-sector partners operate LINK-GIS, one of the nation’s leading GIS systems, recipient of numerous state and international accolades, and provider of a wide-range of geospatial services to a variety of public and private sector users in three counties and 36 cities. PDS functions as managing partner, base mapping provider, and overseer of data usage.

In day-to-day operations, these GIS data and our GIS colleagues:

- Form the foundation upon which PDS’ development-tracking software operates, documenting everything our planning and zoning, infrastructure engineering, and building codes staff pursue;
- Provide the many interactive maps for the community’s online comprehensive plan, making it possible for users to pursue their own analyses of land use issues in the community (see direction2030.org);
- Maintain a highly-accurate accounting of our utility-providing partners’ assets, assuring efficiency and expense controls that benefit their rate payers;
- Serve up address data for emergency dispatch services, protecting the public health, safety, and welfare;
- Update basic elements of property-ownership maps, making it possible for our tax assessing partner to maintain records on which local governments fund their services; and
- Provide a software to which local and state governments and utility providers upload their upcoming right-of-way projects, making it possible for all parties to coordinate their construction/maintenance activities and save money for their tax and rate payers.

These services are notable, fill major needs in our community, and formed the bases for our many awards. They are not, however, unique for the most part.

The initiation of our droneLAB project—a response to ongoing needs of our partners and the subject of this nomination—is an improved government service that makes our partners more efficient and saves money.
PDS’ GIS staff came to me 18 or so months ago with a proposal to provide a cost-efficient way of supplementing aerial images that form the foundation of our GIS system. Their solution was to utilize an unmanned aerial vehicle to secure aerial images that could be processed and uploaded into our system for special projects for which current photography was necessary. I authorized the purchase.

Since then, my GIS staff has:

- earned the federal certification necessary to operate the drone legally;
- flown aerial images during the spring’s flooding along the Ohio River and across its watershed for documentation of damages to FEMA, supporting applications for damage clean-up funds;
- documented the status of a recent grass fire on terrain that complicated emergency services’ efforts, making efficient use of the community’s firefighting personnel and equipment;
- facilitated the re-enactment of a fatal accident, shortening the time necessary for I-71/75 to be closed;
- inventoried open parking spaces across a downtown area at specific times across a day, negating the need for a number of volunteers to take counts at the same approximate times;
- photographed a rural piece of property acquired recently by our local conservancy group, creating a record against which future aerial photography can be compared;
- helped our local water utility to inspect its aerial water storage tanks using the drone in place of having water utility staff pursue the responsibility (see our application for more information on the efficiencies realized);
- inventoried newly-constructed street and curb in residential developments, documenting conditions for future comparisons by PDS engineering staff;
- documented road and traffic conditions to accompany local applications for state and federal improvement funds (played a role in securing approximately $2,050,000 for road/traffic improvements in two communities via a story map with drone footage inserted); and
- deployed Drone2Map for special projects with a plan to investigate community-wide orthophotos.

These examples provide some of the numerous ideas that have presented themselves since we purchased the drone and put it into service. Additional credible ideas seem to occur at least monthly.

I appreciate your attention to our nomination for marrying GIS and drone services to extend our business processes, innovate functions among agencies, and link citizens and services for an even more prosperous community. Please contact me if I can be of assistance.

Dennis Andrew Gordon, FAICP
Executive Director
PDS/LINK-GIS Accomplishments, 1985-2018

Recognition Earned

- ESRI President’s Award, 1992.
- Commonwealth of Kentucky Earth Day Award: Kenton County Brownfields Analysis, 2005.
- ESRI Special Achievements in GIS Award, 2005.
- Ohio-Kentucky-Indiana Regional Council of Governments In Motion Award, Leadership in the Regional GIS Community, 2005.
- Kentucky Association of Mapping Professionals Service to the Mapping Community Award, 2011.
- American Planning Association Kentucky Chapter, Special Merit Award for an Outstanding Comprehensive Plan granted to PDS’ Planning & Zoning and GIS teams, 2015.
- ESRI Map Gallery, Large Format Map: 3rd Place, 2015.
- Kentucky Association of Mapping Professionals Map Gallery, Best Map, 2015.
- ESRI Map Book participant, 2015.
- American Planning Association County Planning Division/National Association of County Planners, Award of Excellence for a Comprehensive Plan granted to PDS’ Planning & Zoning and GIS teams, 2015.
- Kentucky Association of Mapping Professionals Servant Leadership Award, 2016.
- ESRI Map Book participant (two maps published), 2016.
- ESRI Special Achievements in GIS Award, 2017.
- ESRI Map Gallery, Story Map: 2nd place, 2017.
- Kentucky Association of Mapping Professionals Map Gallery, Story Map: 1st Place, 2017.
- ESRI Map Book participant, 2017.

Articles Published


May 29, 2018

Trisha W. Brush
Director of GIS Administration
Northern Kentucky Area Planning Commission
2332 Royal Drive
Fort Mitchell, KY 41017

Re: ESIG Testimonial Letter

To Whom It May Concern:

Campbell County Kentucky is a community bordered by two navigable rivers with numerous watersheds feeding into these rivers. Our topography consists largely of ridges which feed into our streams and creeks. During and following severe weather events including flooding and high winds, we have been challenged with the collecting reliable, efficient, and quick data.

However, recently we have been able to enhance the GIS data gathered a part of the PDSKC/LINK-GIS partnership with drone imagery. This data has proven to be valuable to us on many fronts, including community education, disaster preparedness, disaster assessment, and overall community resiliency.

- Watershed Planning – Understanding our watershed is important from both the management of water quality and quantity. The drone imagery was able enhance a County-wide story map of our watersheds, thereby increasing our community education and management of our flood hazard zones. The County has five (5) FEMA CRS communities, each of these communities receives discounted flood insurance as a result in part of having an intensive understanding and management of development with these watersheds.

- Floodplain Management – Three (3) of our CRS communities experienced notable flooding in the spring of 2018. During the events, drone imagery was used to quickly capture data from areas previously inaccessible during an event. This imagery, combined with LinkGIS mapping and used by the emergency response teams to track and predict the flow of the waters. Following the events this enhanced data was combined with other field data from the fire department, citizen historic data, and active survey work to leverage this as a local match-in-kind for and ongoing USGS Flood Inundation Study.
The USGS team complimented us on the useful detail of the data, stating that this is so rare to get this level of community cooperation. The increased in-kind services resulted an extra $18,000 to the budget. Using the data as our 50/50 match the geographic study area was increased.

We are looking forward to our continued relationship our regional GIS based mapping system (PDSKC/ LINK-GIS) and are pleased to have added drone capabilities to the system.

Sincerely,

Cindy Minter

Cynthia Minter, AICP CFM
Director of Planning & Zoning
May 22, 2018

Trisha W. Brush
Director of GIS Administration
Northern Kentucky Area Planning Commission
2332 Royal Drive
Fort Mitchell, KY 41017

Re: PDS Drone Service

To Whom It May Concern:

On March 19, 2018, several Kenton County Fire Departments responded to a reported grass fire in the area of Pleasure Isle Drive. Upon scene arrival, crews located several brush fires on the hillside from Richardson Road to the neighboring streets of Eagleledge Drive in Erlanger. These initial findings included two large fires on Richardson Road between Old 17 and Shooter’s Supply, approximately halfway up the hill near the railroad tracks. Due to the geographical locations of the various burns it was extremely difficult for responders to access, further evaluate, and extinguish the fires.

During the incident it was decided that PDS should be contacted in reference to obtaining a drone for further scene evaluation, and to assist responders in locating and extinguishing the individual brush fires in the area. The quick response and willingness of PDS to not only respond, but support incident operations, assisted greatly with controlling and safely concluding the incident. Drone footage was essential in allowing Incident Command to determine where best to disperse fire attacks over a large area, all the while incorporating safety and producing specific information to assist in scene control and termination.

The Erlanger Fire/EMS Department wholeheartedly supports the mission of the PDS Drone Service, and plans to incorporate such available resources in a consistent and frequent manner.

Sincerely,

[Signature]
William “Todd” Whitaker
Fire/EMS Chief
Erlanger Fire/EMS Department
June 1, 2018

Urban and Regional Information Systems Association
ESIG Award Selection Committee
701 Lee Street, Suite 680
Des Plaines, Illinois 60016

Re: URISA Testimonial Letter

Dear Exemplary Systems in Government Award Selection Committee:

It is with great pleasure that I submit this testimonial regarding outstanding drone service, as administered by LINK-GIS, in collecting data for the Downtown Fort Mitchell Economic Development Study. This study was undertaken by PDS for the City of Fort Mitchell, Kentucky in February of 2018 and is currently ongoing. A significant component of the study was an analysis of parking demand within the Fort Mitchell Business District.

Assessing parking demand is difficult and existing methodologies for doing so are limited and often criticized for over estimating demand. Historically, parking requirements in the zoning ordinance and estimates from the Institute of Transportation Engineers have been used to evaluate demand. However, these methods do not allow for site specific analysis that shows changes in parking demand throughout the day. PDS wanted a real-time analysis of parking in the area and utilized unmanned aircraft vehicle (UAV) technology for this level of detailed analysis.

The UAV was used to take aerial photos of parking lots in the Fort Mitchell District throughout different peak times of the day. Different businesses have different parking demands—for instance, a bank might be busy during the day whereas a restaurant might have higher demands at night. Utilizing the UAV, the study was able to assess and analyze parking under real-world conditions several times over multiple days. The analysis resulted in findings that were reliable and strengthened the validity of the parking study.

The support of the UAV service offered by LINKGIS had a significant impact on the Downtown Fort Mitchell Economic Development Study and will be used again in future studies that analyze parking and other conditions that need a more real-time evaluation. This study is just one of the ways that PDS staff has found the service invaluable to data collection and analysis. I wholeheartedly offer my sincere support for the program and its benefits.

Sincerely,

James K. Fusz, MCP
Long Range Planning Manager
URISA Exemplary Systems in Government (ESIG) Award Application
Single Use Systems
Planning and Development Services of Kenton County
June 2018

A. System
1. Name of system and ESIG™ category for which you are applying.

Planning and Development Services of Kenton County (PDS) www.pdskc.org and the LINK-GIS partnership www.linkgis.org wishes to make application for the 2018 URISA Exemplary System in Government award in the Single Process Systems. The name of the system is NKYdroneLAB.

2. A letter from the executive administrator authorizing submission of the system application.

Attached is a letter from Dennis Andrew Gordon, FAICP Executive Director of Planning and Development Services of Kenton County, and managing partner of the LINK-GIS partnership. This letter authorizes application for this award.

3. One (1) page, or less, summary of what the system accomplishes and why it is exemplary.

PDS and LINK-GIS introduced drone capabilities to its planning and GIS programs this past year. Unmanned Aerial Vehicles (UAV), or drones, are being rapidly adopted in many industries, including local government. PDS uses drone technology to improve data for various planning studies, to supplement data contained in its GIS, to assist first-responders, and to document current-day conditions on the ground across Kenton and Campbell Counties. The drone services being offered are commercial grade, FAA Part 107 licensed activities.

In its first year, the NKYdroneLAB system has provided technical assistance on a very diverse set of projects in our community.

- **City of Fort Mitchell** – Drone system photography was used in the Fort Mitchell Downtown Economic Development Study to assist with studies of parking lot usage and capacity at different times of day.
- **Campbell County** – Drone system flights contributed to flood response efforts in March 2018 when the Ohio River reached 60.5 feet, its highest flood level in over 20 years. The drone was used to inspect inaccessible houses to determine if they were still occupied and to see if residents required further assistance from first responders. Drone video and photos were used to document community flood levels and cross-referenced to Ohio River gauge levels and time of day to better understand future flood events, response efforts, and to build better community resiliency. These efforts resulted in an increase to the USGS grant budget by $18,000 as part of a 50/50 match for stream mitigation.
- **Kenton County Emergency Management** – The drone system was part of the response to a grass fire in a high-tension power line right of way. Over seven acres burned, including a 2,300-foot stretch of railroad right of way. The drone was used to identify fire hotspots and flare ups. County Emergency Management, Public Works, and 7 fire departments responded. The drone is also on call to assist w/ accident scene reconstruction
- **Northern KY Water District** – Drone system photography was used to conduct water tank inspections (traditional inspections take a two-person crew four hours and requires safety
harness w/tethers to climb to the top of towers). Drone inspections take about 10-15 minutes and are conducted from ground level.

- **Sanitation District No. 1** – Drone system photography was used to conduct pump station inspections near levees during the March 2018 Ohio River flooding. This was to ensure pump stations were on standby if the levee was breached.

- **PDS Infrastructure & Engineering** – Drone system flights used to document and inspect new curb and gutter installations. The drone was also used in 17-acre housing development that requires hilltop removal using ‘cut and fill’ techniques. The drone will document topography changes at this site over time.

- **PDS Long-Range Planning** – Drone system flights were used to capture video for the ‘Kenton Connects’ PSA campaign, a countywide bike and pedestrian transportation plan update.

- **Kenton County Conservation District** – Drone system video and photography was taken at the Morning View Heritage Area as part of its five-year invasive species mitigation and wetland reclamation project work. The drone used to document current ground conditions and identify certain invasive species of plants.

- **Watersheds GIS Story Map projects** – Drone system video and photography was used to capture views of watersheds, waterways, and migratory bird wildlife. Story Maps are media-rich, interactive maps that focus on a single topic or project, in this case watersheds.

- **Technical Assistance to Local Jurisdictions** – Through April 9, 2018, the drone flew 93 flights for 19 projects for local communities. This equates to 95.9 flight miles over 15 hours and six minutes.

In addition to the system projects completed and missions flown, NKYdroneLAB and the PDS GIS team conducted several outreach and education efforts such as GIS Day, conference presentations, and technical presentations at business meetings. These were aimed at making the public and elected officials more aware of how UAVs and drones are changing our approaches to planning, GIS, and other local government responsibilities.

NKYdroneLAB system was recently awarded the Special Merit Award for Outstanding Use of Innovative Technology from American Planning Association Kentucky Chapter (May 2018). NKYdroneLAB delivers exemplary services by contributing to return on investments (ROI) to our communities resulting in efficiencies in workflow, labor costs, and safety. NKYdroneLAB uses innovative solutions that offers a different perspective for governments to improve citizen services.

### 4. Three “user testimonials”.

The following users have submitted testimonials:

- Cindy Minter AICP, Director of Planning and Zoning for Campbell County Fiscal Court
- Todd Whitaker, EMS/Fire Chief for City of Erlanger
- James Fausz AICP, Long Range Planning Manager for Planning and Development Services of Kenton County
B. Jurisdiction

1. **Name of jurisdiction**

Kenton and Campbell Counties of Kentucky

2. **Population served by the organization/agency**

The population of Kenton and Campbell Counties is 271,716
Estimated 2016 US Census Bureau

3. **Annual total budget for jurisdiction**

| Organization                               | Budget  
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<tbody>
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<td>Kenton County Fiscal Court</td>
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4. **Name, title, and address of chief elected and/or appointed official**

Dennis Andrew Gordon, FAICP
Executive Director of the Planning and Development Services of Kenton County
2332 Royal Drive
Fort Mitchell Ky. 41017-2088

5. **Name, title, address, telephone, FAX, and email for contact person for system**

Trisha W. Brush, GISP
Director of GIS Services
2332 Royal Drive
Fort Mitchell Ky. 41017-2088
(859) 331 8987
tbrush@pdskc.org

C. System Design

1. **What motivated the system development?**

PDS and LINK-GIS views the drone system as the future in data collection, emergency services, inspections, imagery, and 3D modelling. Current data collection allows for clearer decision making and more impactful actions.

In 2017, PDS purchased a Yuneec Typhoon H drone. At the same time, Ryan Hermann, Drone Coordinator/Associate GIS Specialist became Part 107 certified by the FAA. The goal of this new system, NKYdroneLAB was to bring future technologies to the counties, cities, and citizens as they join PDS in embracing this innovative industry.

2. **What specific service or services was the system intended to improve?**

The initial intent was to develop a system that could be used by PDS and LINK-GIS to capture images and video of the counties as current as possible. Enrolling these services would enable users to gain unique perspectives, while serving their customers and the public with innovative
decisive decisions. It quickly became obvious that the drone could be utilized in many unforeseen ways. PDS has flown for active shooter preparedness, grass fire reconnaissance, accident reconstruction, invasive species mitigation, water tank inspection, pump station inspections, flood rescue operations, parking lot studies, curb analysis, and contributing to many tales told through story maps by NKYmapLAB.

3. What, if any, unexpected benefits did you achieve?

NKYdroneLAB has benefited from the following unexpected ROI over the past year:

**Safety** – During the assistance with water tank inspections, NKYdroneLAB safely piloted the drone comfortably on the ground. In the past tank inspections requires a team to scale the water tank, over 150ft. This process must be completed once a year for over 20 water tanks.

In the case of grass fire reconnaissance, NKYdroneLAB flew over 7 acres of burned hillside patrolling for hotspots, flare ups, or any sign of danger. The steep terrain made it challenging for fire crew to navigate around the fire. Fire crews had limited access points to the scene, unlike the drone which could cover more ground safely and efficiently.

**Workflow** – In addition to the safety of the tank inspection, time efficiency has also improved. A traditional inspection crew takes two to four hours to complete a single tank inspection. Using the drone for a tank inspection, NKYdroneLAB completed the same task in just fifteen minutes.

Workflow efficiencies were also recognized in the Fort Mitchell Parking Lot Study for Economic Development. Over the course of three days, NKYdroneLAB flew specific timeline flights around downtown Fort Mitchell, capturing parking lot usage. PDS’ planning department now has timestamped imagery to refer to business activity during those dates and times.

**Building Community Relationships** – On November 17th NKYdroneLAB and PDS team coordinated with Kenton County Academy High School for GIS Day. Allowing the best and the brightest Kenton County students to learn and test drone and GIS technology.

The City of Taylor Mill in Kenton County requested NKYdroneLAB to help honor fallen veterans of the Gulf, Afghanistan, and Iraq wars with video and oblique imagery of the GoldStars Tribute Wall. This imagery was used to promote attendance to the event.

4. What system design problems were encountered?

Beginning a new system or incorporating new technology, problems always arise. In the case of NKYdroneLAB four design problems were encountered:

**Batteries** - One of the first issues involved a lack of batteries. Initially, two batteries were provided from the drone purchase allowing for forty minutes of flight time. Quickly realizing battery time would not cover most system flight times, additional batteries and chargers were purchased. The LAB is currently setup to fly for two hours with minimal interruptions.

**Pre-flight checks** – A large hurdle facing the LAB is proximity to the Cincinnati Northern Kentucky Airport (CVG) and Lunken Airport (LUK). CVG is one of the largest airports in the country and is registered as Class B airspace. LUK while only a small municipal airport still has a class D
airspace. Primarily this meant 2/3 of Kenton County was restricted airspace where commercial drone operations could not occur. Knowledge of approved airspace was a time-consuming process and this restriction severely limited capacity to serve the public. However, with the FAA’s new Low Altitude Authorization and Notification Capability (LAANC) program commercial droning is now allowed inside restricted airspace. Simply by using a mobile app it is easy and legal to fly with approval and better serve our community.

Post Processing – There are assumptions that flying the drone is the only task a commercial drone operator performs. This is untrue, most of time spent on projects is actually at the conclusion of the flight. Once a flight is completed it moves to the final step called post processing. Here is where data is downloaded, collected, organized, renamed, edited, and managed to create the final product. Experience has facilitated a more efficient workflow and expedited product deliverables.

Workload – Over the last year, NKYdroneLAB system has completed 22 major projects, over half of which were between January and April 2018. NKYdroneLAB system’s workload has been steadily on the rise since its inauguration. The droneLAB only has one system operator and the pilot has other duties/tasks beyond the LAB. The amount of drone work was not anticipated by the GIS team. A system policy was implemented to ensures that team members are given ample time to properly plan and schedule projects.

6. What differentiates this system from other similar systems?

Our system is unique in the scope of work we conduct. Similar systems typically focus on one aspect of drone data collection, for example real estate photography, surveying, or mapping. NKYdroneLAB offers its service to an array of partners and clients including: planning studies, first responders, cities, utilities, engineering, conservation districts and local government projects. We provide services such as data collection, emergency services reconnaissance, inspections, imagery, and 3D modelling.

D. Implementation

1. What phases did you go through in developing the system?

- August 2016: Team members introduced the idea of drone system technology
  - Discovery of the capabilities of drone systems
  - Research into what is required to operate the system
    - Licensing
    - Insurance
    - Testing
    - Rules and Regulations
- November 2016: Initial plans to creating the system
  - Create a budget
  - Research drone system models and functions to meet partnership needs
- February 2017: Purchased drone system
- May 2017: Acquired Part 107 certification
- May 2017 – Present:
  - Projects for the system as needed
  - Instructional classes
  - Policy and procedures created
Data storage updated to keep up with demand.

2. Were there any modifications to the original system design? Why? What?

NKYdroneLAB is an ever-changing system. In the last twelve months services have increased from simple GIS data collection to many other services as mentioned in this application. To assist in these changes the LAB has incorporated drone system policy and procedures for both normal day to day use as well as emergency services.

**Drone System Policy and Procedure** – This document outlines the rules and guidelines in place to safely and effectively operate the drone under the LINK-GIS partnership. Details include:
- system submission five days prior to any operations;
- all details surrounding the project;
- intended use of the data;
- only a licensed pilot may operate the drone;
- drone system may only be operated in a Right of Way (ROW) or on property where permission has been granted; and
- the system shall not be used for code enforcement, property evaluation or other regulatory investigation.

Having these restrictions in place help alleviate the threat of speculation, increase safety, and create a better workflow to better maintain our operations.

**UAV Disaster/Emergency Protocol** – Similar to the drone system policy, the UAV Disaster Protocol outlines the plan and procedures when an emergency or disaster occurs. This includes: fires, train derailments, accident reconstruction, natural disaster inspections and other occurrences. Disasters tend to be unexpected which gives little time to prepare. The protocol defines response time both during and outside of normal business hours. As well as limitations to usage such as remaining within line of sight of the drone or flying at night.

**E. Organizational Impact**

1. What user community does the system serve and how?

Our user community consists of the two county governments (fiscal courts), 34 cities, emergency management services (fire & police), two utilities (water/sanitation), and three conservation districts.

**County Governments** – The two county governments are made up of sub-areas which include urban, first ring suburban, suburban, and rural landscapes. NKYdroneLAB assists county entities providing data and resources for special projects including: flood, owned asset inspection, landslide recording and detection, new subdivision inspection, bike and pedestrian plan with public safety announcements.

**Cities** – NKYdroneLAB has assisted cities with small area economic study with parking lot restructuring, street and traffic conditions, potential park creation and improvements.
Emergency Management Services (EMS) – Many emergency situations can be aided with aerial imagery. The LAB has assisted EMS with active shooter preparedness footage, grass fire reconnaissance, accident reconstruction, and wellness checks during flooding.

Utilities – Several utility companies have incorporated NKYdroneLAB services into their work plan specifically Northern Kentucky Water District (NKWD) and Sanitation District #1 (SD1). Both companies utilize the LAB for inspection services. 20 water towers dot the rolling hills of Northern Kentucky and must be inspected once a year. It has been found to be safer and faster to inspect towers with the drone system vs a human team. Similarly, SD1 uses NKYdroneLAB for pump station inspections during flooding. As flooding occurs along the Ohio River, pump stations on the levees are used to push water out of low lying areas and back into the river. Inspections of these stations are to make sure the systems were running properly.

Conservation Districts – Northern Kentucky has three conservancy/conservation districts that have used NKYdroneLAB successfully. Projects consist of invasive species mitigation, historic imagery acquisition, eco-tourism awareness through heritage farm tour, agri-tourism awareness and promotion.

2. What are the ultimate decisions/operations/services being affected? If appropriate, provide a few examples including, but not limited to: screen input/output forms, paper products, or other descriptive graphics.

NKYdroneLAB has provided products to improve and empower user agencies from emergency response to economic development. This innovative technology puts data and resources in user’s hands quickly, in order to make critical decisions from a perspective no human can provide. Below are examples demonstrating decisions, operations, and services affected by LAB results.

FEMA / Disaster relief funding – Drone flights contributed to flood response efforts in March 2018 when the Ohio River reached 60.5 feet, its highest flood level in over 20 years. The drone was used to inspect inaccessible houses to determine if they were still occupied and to see if residents required further assistance from first responders. Drone video and photos were used to document community flood levels and cross-referenced to Ohio River gauge levels and time of day to better understand future flood events, response efforts, and to build better community resiliency. During this time, the United States Geological Survey (USGS) was conducting a Flood Inundation Study in which the data captured resulted in an extra $18,000 applied towards the grant.
Street and Traffic Studies – Drone photography was used in the Buttermilk Pike realignment study to assist with review of traffic volume and capacity at different times of day. This high priority intersection clogs during peak travel times creating backups and intersection blockage. Data presented lead to the awarding of $250,000 in design dollars from the governor of Kentucky.

The Stevenson Road project is another example using drone system technology to solve a problem. Stevenson Rd experiences flooding during major rainfall events causing traffic delays, road closures, and street decay. Using drone footage to tell the story of local citizen experiences swayed the Kentucky Transportation Cabinet (KYTC) to allocate $800,000 in design dollars for 2018. In 2019 KYTC budgeted $1,000,000 in improvements for this collector road.
**Active Shooter Preparedness** – LINK-GIS took initiative to use the system in the event of a school active shooter incident. NKYdroneLAB imagery captured all windows, doors, and surrounding areas which first responders can use to make fast and accurate decisions. When the health, safety, and welfare of children are in the balance preparedness allows for speed and precision.

**Water Tank Inspections** – Drone photography was used to conduct water tank inspections (traditional inspections take a two-person crew four hours and requires safety harness w/tethers to climb to the top of towers). Drone inspections take about 10-15 minutes and are conducted from ground level safely.
3. What were the quantitative and qualitative impacts of the system?

Several agencies using the system NKYdroneLAB have seen both quantitative and qualitative measures including but not limited to ROI. Several examples are highlighted below.

**FEMA / Disaster relief funding** – A perfect example of a project experiencing both quantitative and qualitative measures is the Campbell County flooding which occurred in March 2018. *Qualitatively* the USGS complimented on the collaboration on level of detail provided in the drone data. *Quantitatively* this resulted in an $18,000 increase in funding toward the Flood Inundation Study.

**Street and Traffic Studies** – Two excellent projects showcasing *quantitative* results are the street and traffic studies for Buttermilk Pike and Stevenson Rd. These two studies combined produced $1,050,000 in design funding and $1,000,000 in reconstruction.

**Water Tank Inspection** – A smart way to implement the drone system can be proven with the water tank inspection. *Quantitatively* the inspection crew takes four hours to complete an inspection, with 20 water tanks at a cost of $20 an hour, it will take 80 hours and $1600 to complete the process. NKYdroneLAB system can complete the same inspection in 20 minutes. Using the same parameters this amounts to $132 in costs. *Qualitatively* this system keeps all inspectors safely on the ground free from harm in avoidance to being hoisted by guide wires over 150’ in the air improving quality/longevity of life.

**Grass Fire Reconnaissance** – The definition of a *qualitative* impact can be found during the seven-acre grass fire effort. Crew and resources were stretched thin in rough terrain along more than 2,300 feet of railroad battling the blaze. NKYdroneLAB system offered a perspective to easily detect hotspot flair ups, allowing the command center to dispatch resources more effectively. Showing once again how innovation and technology can improve the health, safety, and welfare for the community and emergency responders.

4. What effect has the system had on productivity?

NKYdroneLAB system and drone technologies are changing the way local government is doing business. In the short time of the system’s existence productivity has increased immensely. Agencies using the NKYdroneLAB system experience access to accurate products with quick data turnaround time, which leads to rapid decision making and resource allocation.

5. What, if any, other impacts has the system had?

NKYdroneLAB system has been just as educational as it has been productive. The system has lead to educating the public, elected officials, and partners how to incorporate drones into their work programs.

NKYdroneLAB system has been presented at multiple conferences and workshops including:
- Kentucky Association of Mapping Professionals (KAMP) conferences
- Cincinnati GIS User Group Meetings
- GIS Day 2017 – Kenton County Academy
6. How did the system change the way business is conducted with and/or service delivered to clients? Give specific examples comparing the old way with the new.

Drone technology and innovation are driving the changes in how business is conducted, and service are delivered. Below are several examples showcasing the improved services and business cases the system provides.

**Accident Reconstruction** – Prior to the drone being used, accident reconstruction could take hours with interruptions to traffic and even road closures. For major interstates like I-75/71, which carries hundreds of thousands of cars a day this poses a serious problem. The drone system allows for quick collection of vital information using imagery and video establishing evidence for post scene analysis. Thus, reducing traffic disruptions and road closures allowing for seamless traffic movement.

**Fort Mitchell Downtown Economic Study** – Historically parking lot studies involved interns and team members collecting information on foot. This method of collection can lead to inaccuracies or duplication in counting. Using the drone system data creates a timestamped image of the study area allowing reassessment for accuracy. NKYdroneLAB reduces the work hours from multiple team members down to one analyst.

**Grass Fire** - Before arriving on scene to the seven-acre grass fire, if smoke was detected fire crew would immediate send resources to the smoky area. This was proven ineffective and life threatening. Once the drone was launched it offered perspective to easily detect hotspot flare ups allowing the command center to dispatch resources more effectively. Adding the drone system changed the workflow of the operations while removing risk on loss of life and property.
F. System Resources

1. What are the system's primary hardware components? Give a brief list or description of the hardware configuration supporting the System.

NKYdroneLAB system Hardware
- Yuneec Typhoon H
  - Four Yuneec batteries
  - Chargers and cables
  - ST16 transmitter
  - 32gb micro SD Card
- Dell Precision 7710 Laptop
- Time Warner Cable Internet Service.
- Switched gigabyte network

2. What are the system’s primary software components? Describe the primary software and, if a commercial package, any customizations required for the system.

NKYdroneLAB system software
- ESRI
  - Drone2Map 1.3
  - ArcMap 10.5
- UAVtoolbox
- Adobe suite CS6
  - Video editing
- UAVtoolbox
- VLC Media Player
3. What data does the system work with? List and briefly describe the database(s).

LINK-GIS has a detailed two county data repository compiled of planimetric and topographic updated base maps meeting the National Map Accuracy Standard 1" : 100' (+/- 1ft horizontal; +/- 1ft vertical). NKYdroneLAB system uses base layers stored in a Spatial Database Engine (SDE) including but not limited to: centerlines, parcels, address points, edge of pavement, sidewalks, utilities, topography, and LiDAR to create final products.

4. What staff resources were required to implement the system (i.e., report approximate staff and consultant time as FTE’s)

NKYdroneLAB system consists of one licensed drone operator, a visual observer, and a support team to aid in video and photo editing, project guidelines, and customer service support while out of office.

- Pilot – one full time employee with customer service duties in addition to drone operator.
- Support team – 9 full time employees covering during drone projects.