THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR
SMART COLUMBUS

SMART COLUMBUS

City of Columbus

Smart Columbus Automated Vehicle Shuttle Service

Request for Information

The purpose of this Request for Information (RFI) is to solicit feedback and input from consultants and vendors on the deployment of Automated Vehicle (AV) shuttle services in Columbus, Ohio. The objective is to understand AV shuttle capabilities and receive input regarding potential AV routes, not to make a vendor selection. The outcome of the RFI will likely result in one or more Request for Proposals (RFP) that will be published by the City of Columbus or its partners in early 2019. **Responses to the RFI are due by 5:00 PM EST on November 1, 2018**.

For this RFI, the City of Columbus is specifically requesting information only on the questions outlined herein and only for the specific AVs that your organization would consider proposing for this project.

Background

In June 2016, the City of Columbus won the United States Department of Transportation (USDOT) Smart City Challenge. Columbus intends to define what it means to be a "Smart City" and serve as a model for other cities wishing to fully integrate innovative technologies such as automated and connected vehicles into the transportation network. Columbus is acting as a laboratory for Intelligent Transportation Systems (ITS), and it is disseminating lessons learned and best practices to cities across the United States in an effort known as Smart Columbus. The goal of the Smart Columbus project is to connect people by creating opportunity for city residents to better access jobs and services while improving the overall safety and efficiency of the transportation network.

Smart Columbus aims to deploy and evaluate AV shuttles against a series of use cases in pilots commissioned by the City of Columbus, the Ohio State University (OSU), the Columbus Partnership, the Ohio Department of Transportation (ODOT), and DriveOhio. The proposed

technology solution involves vehicles that are level 4 automated, as defined in SAE J3016[1], and preferably electric and connected, serving members of the public on short transit trips typically around a mile.

In May 2018, Governor Kasich signed Executive Order 2018-04K to establish guidelines for testing autonomous vehicles in Ohio.[2] It is expected that any AV deployment in Columbus comply with this Executive Order and meet or exceed its intent where applicable.

Integration with the Smart Columbus Operating System is central to Smart Columbus' vision for facilitating Mobility as a Service[3] and other Smart City applications. The Operating System is a cloud-based, dynamic, governed data delivery platform that is at the heart of the Smart Columbus system. It is designed to ingest and disseminate data from external systems for processing via a microservices architecture in which components of other applications will reside in the Operating System as loosely coupled services. The Operating System also serves as the source for real-time operational data and archived historical data from a combination of data storage sources for use by the City of Columbus and third-party applications and developers. The Operating System is the data platform environment that integrates data and data services from multiple sources, including the planned Smart Columbus projects, traditional transportation data, and data from other community partners. The Operating System embodies open-data and open-source concepts to enable better decision-making and problem solving for all users to support a replicable, extensible, sustainable platform.

Project Scope

The scope of this project is to develop, deploy, and evaluate a series of AV shuttle services to address various transportation needs in the Columbus area. The first use case, a passenger service around the Scioto Mile in Downtown Columbus, was initiated with the release of an RFP on July 2, 2018. Planning for subsequent deployments is underway, though the precise routes and service

[1] SAE International, J3016_201806: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles, revised June 2018, https://www.sae.org/standards/content/j3016_201806/.
[2] The Executive Order can be found here: http://governor.ohio.gov/Portals/0/%21%21%21EO%202018-04K%20%28Signed%205_9_18%29.pdf.
[3] More information on Mobility as a Service, and Columbus's approach, can be found in the Concept of Operations for the Multimodal Trip Planning Application/Common Payment System here: https://smart.columbus.gov/uploadedFiles/Projects/MMTP-CPS%20ConOps%208.30.18.pdf.

areas have not yet been finalized; these decisions are expected to be influenced by the outcomes of this RFI. In general, the intent is to procure turn-key AV shuttle services that operate on public roadways at a frequency deemed necessary to address first-mile/last-mile/only-mile challenges. Human operators are expected to be available onboard each vehicle during operations to monitor the vehicle, explain the technology to passengers, and take control of the operation of the vehicle should the need arise.

Deployed vehicles are also expected to contribute to the region's knowledge base by connecting to the Smart Columbus Operating System. Smart Columbus has a multi-phase vision for enabling integration with the AV shuttle deployments. For the first phase, it is expected that an AV vendor will, in addition to its own services, provide General Transit Feed Specification (GTFS) and GTFS Real Time (GTFS-RT) data to the Operating System to be made available for other applications. Further, the AVs should allow for the capture and archive of onboard sensor data, as well as any incident data, including event logs. In later phases, the intention is to eventually include fleet management for all Smart Columbus transportation providers as a seamless platform in the Operating System.

Project Goals

The Smart Columbus team is interested in deploying AV technology to enhance the mobility of residents and visitors, to evaluate the ability of this technology and associated vehicles to operate on public roadways in Ohio, and to satisfy the specific operating purposes for which each service is intended. Further, the team is interested in better understanding the challenges the potential routes may pose, the infrastructure required to implement and support the operation of this technology, the approach to public adoption, the types and value of data produced, and the benefits derived from the use of AVs. Vehicle performance will be recorded, such as time in service, miles traveled, ridership, high-accuracy positioning, speed, battery/fuel usage, number of and reasons for disengagements, hard braking, evasive maneuvers, and more.

These deployments will benefit the region by demonstrating the potential of this emerging technology to local stakeholders and the public, allowing for an educational experience while also inspiring quicker adoption of future innovations. More broadly, results of this project will be used to inform the following overall goals:

- Better connect the community to jobs and services through first-mile/last-mile/only-mile connections by providing a convenient and reliable transit option.
- Grow COTA ridership by encouraging a modal shift to public transit by increasing the attractiveness and availability of end to end transit options.
- Establish a common data exchange interface that is interoperable across various deployment locations and vehicle vendors.
- Establish a set of procurement guidelines, including demonstrated vehicle performance and data sharing requirements, for both operational and capital projects.
- Develop a set of AV operational testing and evaluation guidelines to benchmark AVs.
- Develop a methodology for evaluating the operational safety of the system in various deployment settings.

Project Schedule

The following table provides the proposed schedule for the second AV shuttle deployment in this series. A possible third deployment may be conducted in parallel. The first deployment is currently in the deployment planning and mobilization stage.

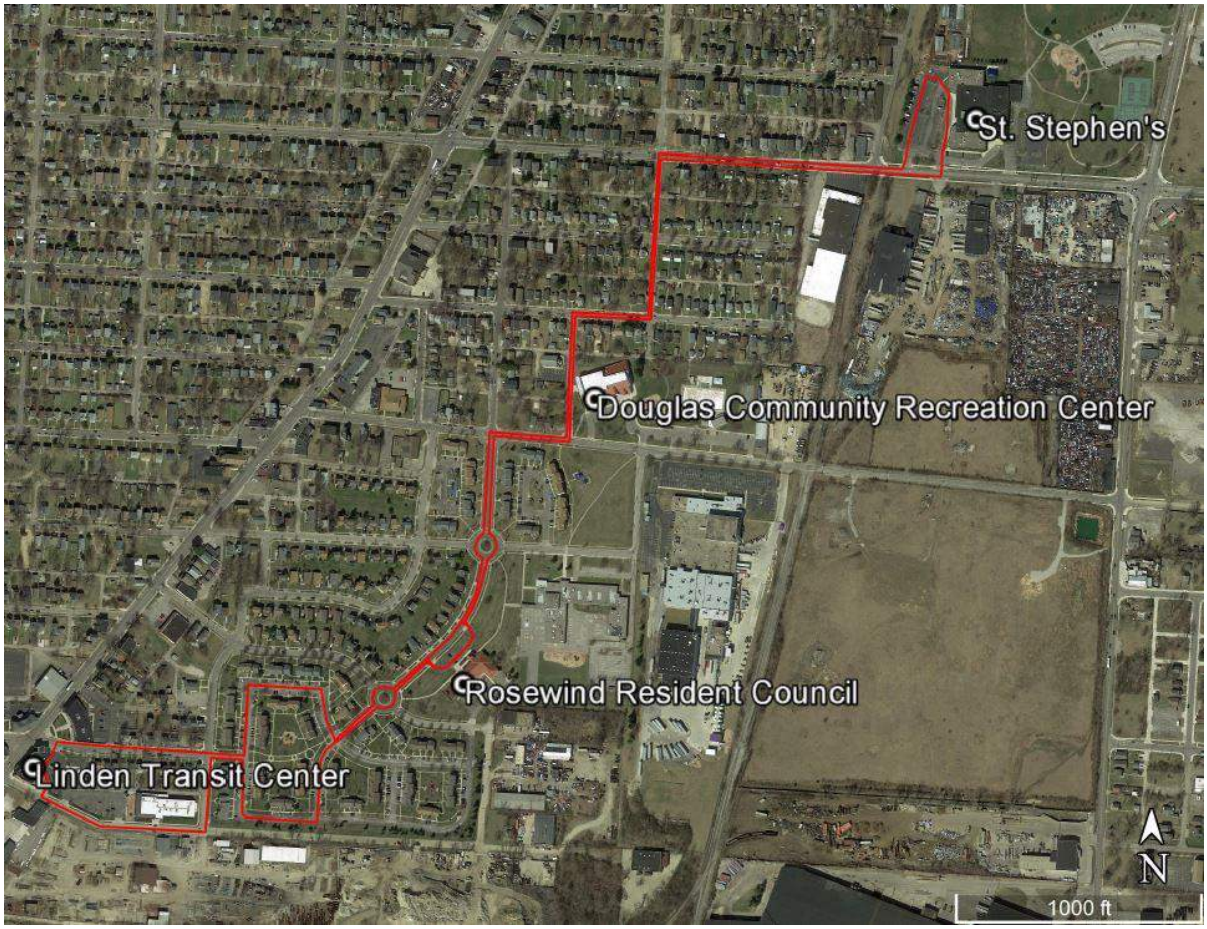
Activity	**Timeline**
Procurement	January 2019 – April 2019
Deployment Planning and Mobilization	May 2019 – September 2019
Vehicle Delivery	September 2019
Minor Infrastructure Enhancements (if needed)	September 2019 – October 2019
Component/System Verification and On-Site Testing	September 2019 – October 2019
Pilot Demonstration Period	November 2019 – November 2020

RFI Questions for Responders

1. The following maps present potential routes where an AV shuttle service would enhance access to transportation and help fill a local need in Columbus. Please review the route maps and provide feedback on whether these alignments would be feasible to serve using your existing technology or proposed technology advancements prior to deployment, and whether you have any specific concerns or suggestions (such as a specific unprotected left turn and whether/how it could be routed out). More detailed maps are included in the appendix.

   Some operating parameters and potential challenges are included but may not envelop all challenges presented on the routes. We encourage you to use any resources at your disposal to inform your response about the routes. The expectation is that high-frequency service, with targeted headways of no more than 10 minutes, will be provided during all service hours in order to enable potential passengers to arrive at a stop and expect a vehicle to come within a reasonable amount of time rather than having to pre-plan their trip. Include any assumptions on operating characteristics, such as hours of operation, layover requirements, fleet size, and headway that would make this type of service possible within your operating constraints.

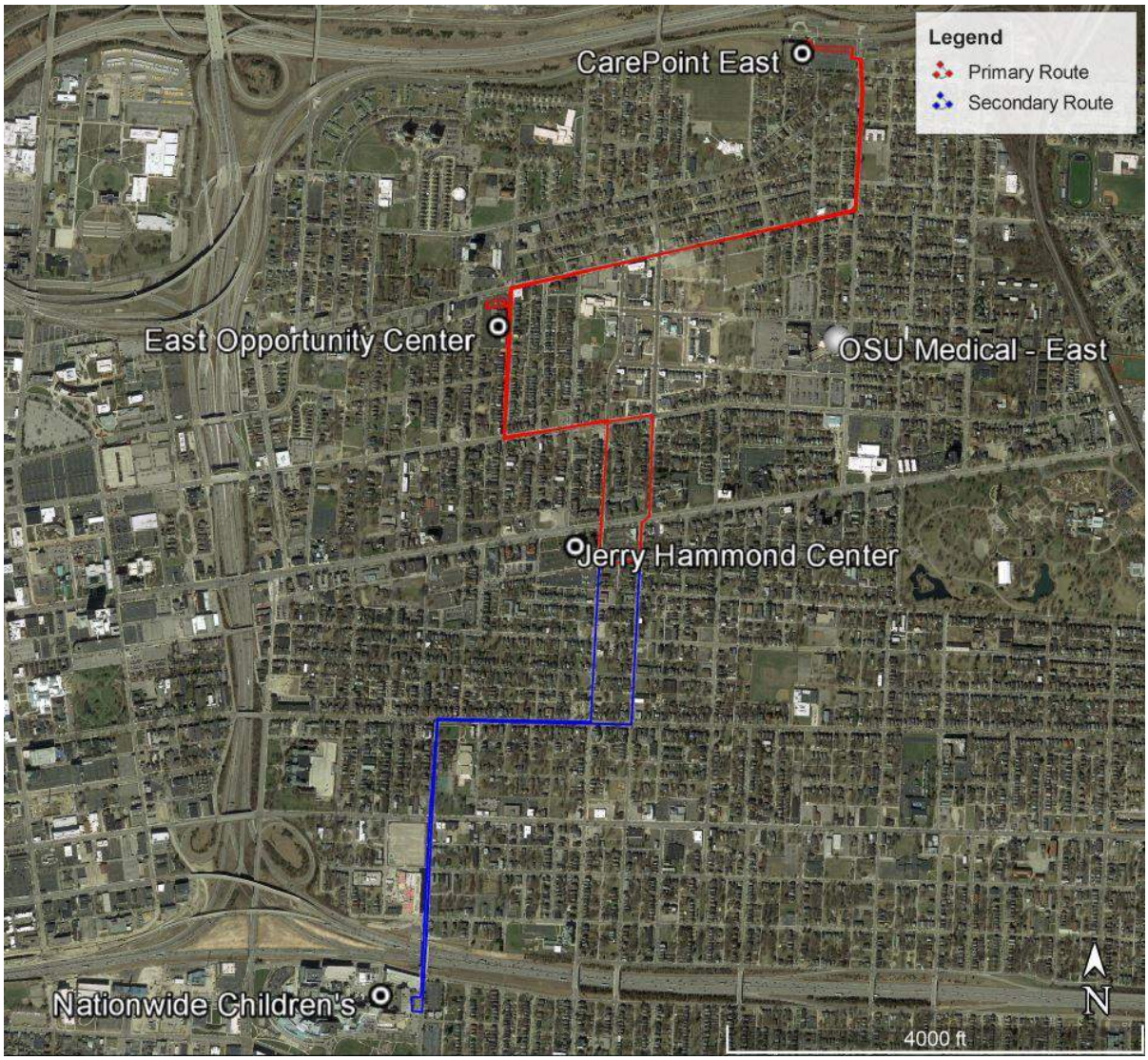
Route 1: St. Stephen's to Linden Transit Center (Round trip distance: 2.7 miles)



This route travels between St. Stephen's Community Center and Linden Transit Center, both of which are designated as Smart Mobility Hubs within the Smart Columbus project portfolio. These Hubs will provide access to resources at chosen areas of community focus, such as transit stops, libraries, and community centers to improve mobility for the surrounding area. Hubs may include features such as real-time information displays; USB charging points; embedded touch screen displays at kiosks with access to trip planning, emergency calling and other applications; and multimodal resources including bike-share racks and car-share parking. The goal with this route is to connect the community center with the CMAX high-frequency bus rapid transit line as well as the neighboring community.

The route has a maximum positive slope of 4.0% and a maximum negative slope of -4.3%. The route travels on some one-way roads and has been designed to minimize the number of left turns. The route encounters on-street parking, roundabouts, a center left-turn lane, a narrow shoulder with no curb, and an intersection crossing from the stopped approach of a two-way stop intersection.

Route 2: Hammond Center to CarePoint East (Round trip distance: primary – 4.0 miles, secondary – 2.3 miles)

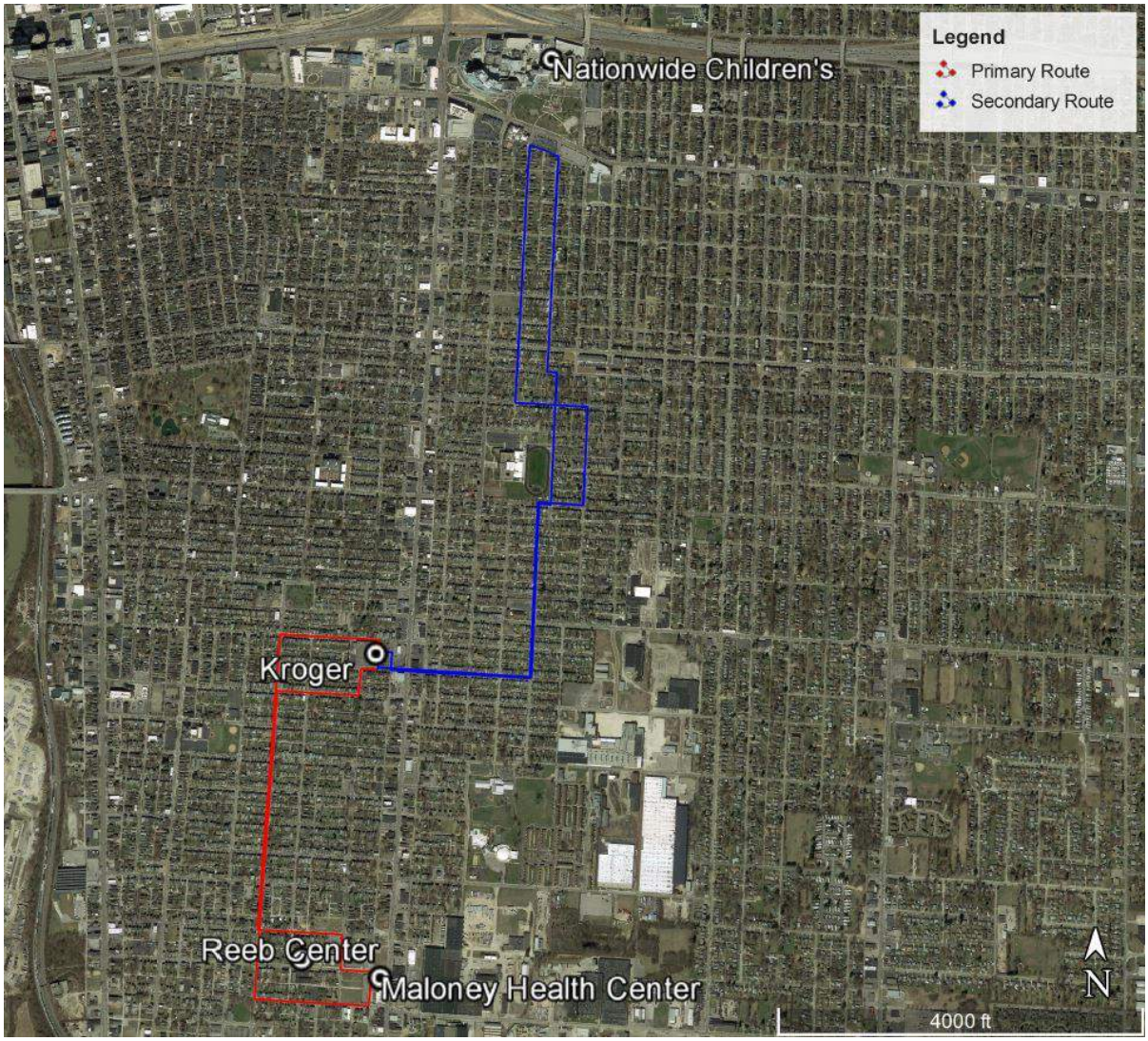


The primary route travels from the Jerry Hammond Center to CarePoint East via the East Opportunity Center. It is expected that a stop near OSU Medical Center – East may be added. The route between the Hammond Center and CarePoint East is easily navigable, with wide-open streets and low volumes of other traffic.

There is also a desire to provide secondary route services to Nationwide Children's Hospital, but the distance may exceed the scope and budget of this program, though that is still under evaluation. The secondary route includes an unprotected left turn, two-way traffic with on street parking on both sides, an unprotected left off of a main road, travel alongside a dedicated bike lane, and the Champion/Broad intersection (which curves for vehicles going straight). Please discuss the ability to complete the primary and secondary routes, both separately and as one route.

The primary route has a maximum positive slope of 3.9% and a maximum negative slope of -3.5%. The secondary route has a maximum positive slope of 10.0% and a maximum negative slope of -9.3%.

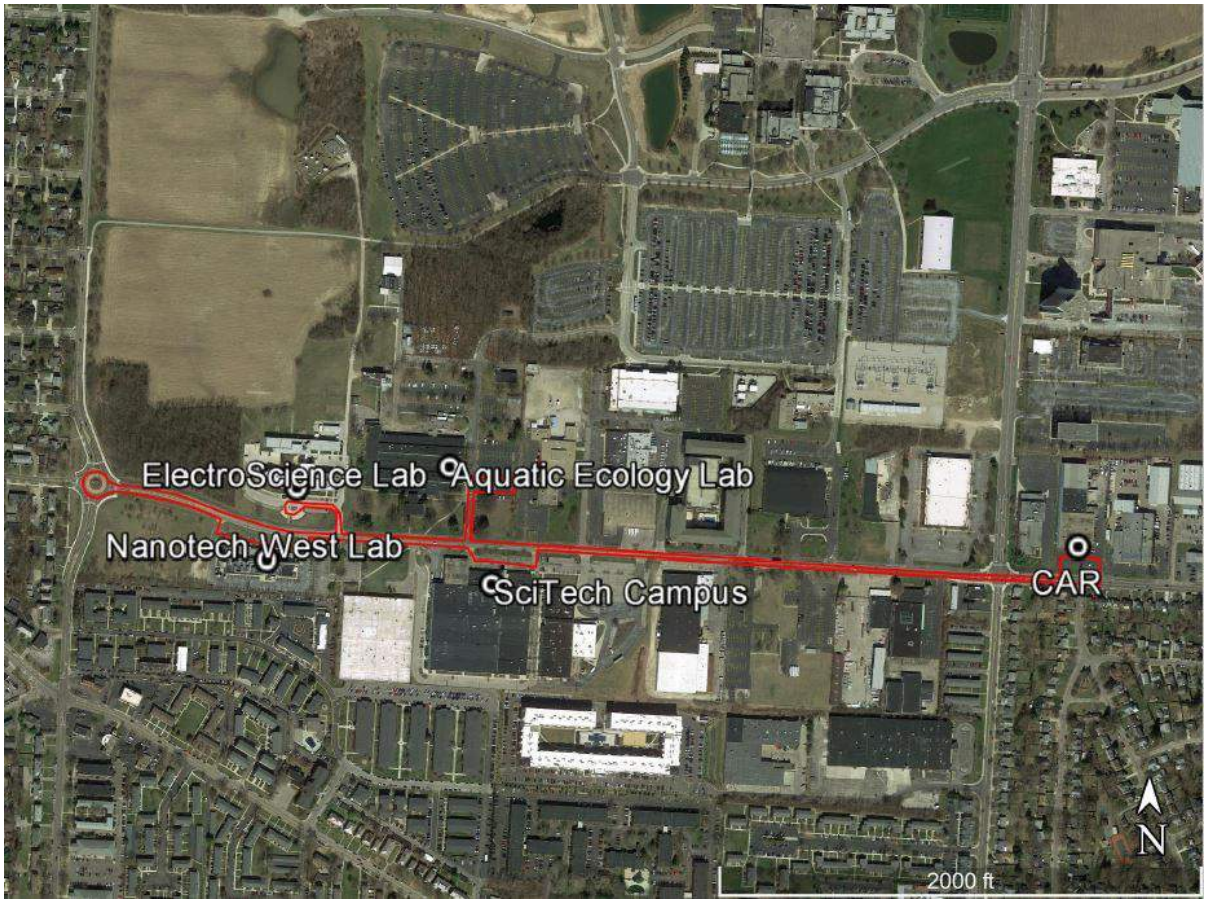
Route 3: Maloney Health Center to Kroger (Round trip distance: primary – 2.4 miles, secondary – 3.4 miles)



This route connects Kroger to the Reeb Avenue Center and the Maloney Health Center, both of which are vital to the neighborhood. The Reeb Center provides job services and other community support. This route contains on-street parking, one-way roadways with parking on both sides, speed bumps within the Kroger parking lot, and uncontrolled pedestrians at Kroger. There is also a desire to provide secondary route services to Nationwide Children's Hospital, but the distance may push the scope and budget limits. The secondary route

contains a cobblestone road with parking on both sides, the crossing of an uncontrolled street (Frebis), a narrow shoulder with no curb, and the use of an alley. Please discuss the ability to complete the primary and secondary routes, both separately and as one route.

Route 4: OSU – Kinnear Road (Round trip distance: 2.0 miles)



This route supports connectivity within the OSU West Campus, between engineering and research buildings. The proposed route travels on Kinnear Road, which currently has a posted speed limit of 35 miles per hour, a roundabout, and a school zone (which lowers the speed limit to 20 mph during certain times of the day). The route has a maximum positive slope of 4.2% and a maximum negative slope of -5.6%.

2. Which of these routes would you like to see as part of an RFP? Why do you prefer these routes?

3. Rather than operating along a fixed route, would it be possible to operate dynamically within a specified area?

    a. If so, how would passenger rides be requested and coordinated? Are the AVs capable of sensing whether a passenger is waiting to board and/or whether a passenger is requesting to alight?

    b. Are these features available to all users, including those without smartphones?

4. Describe your organization's level of interest and role in providing an AV shuttle service as part of the Smart Columbus project. What role do you anticipate the City of Columbus and other Smart Columbus partners to play?

5. Do you have any concerns with the schedule outlined in this RFI, or do you think there would be any benefits to either tightening or extending the schedule?

6. What type and level of support would your organization provide to the Smart Columbus project? (e.g., project managers, trainers, software developers, etc.)

7. How would your organization manage members of the public who choose to ride the AV shuttle or otherwise interact with it in the project area? In what ways can feedback be collected and what can be done to enhance safety?

8. The Smart Columbus project goals and objectives will require the collection of data to measure the performance of the system. Please explain how your organization would support data collection, with a focus on the data suggested in the following table.

Data Type	**Data**
Operational	Real-time vehicle location information
	Trip updates and service alerts
	Ridership
	Actual stop arrival and departure times
	Vehicles miles traveled
	Vehicle hours traveled (hours the vehicle is in service)
	Number of route-trips served
	Duration of each trip

Data Type	Data
	Battery usage (such that it can be associated with weather, temperature, vehicle load, etc.)
	Local roadway traffic volumes, speeds, congestion
Performance	Sensor and other telemetry data
	Navigation variances
	Mechanical data (vehicle condition)
	Hard stops
	Disengagements/interventions by the operator
	Any other logged events
	Conditions driven in (weather, congestion, etc.)
	Incident reports
Communications	Record of operational data exchanged
	Controller Area Network (CAN) bus data
Rider feedback	Rider satisfaction
	Rider acceptance of the technology
	Transfer behavior (to/from COTA)

   a. Can your organization support sharing information and data related to the performance of the proposed solution to support integration to the Smart Columbus program and independent evaluation?

   b. Can your organization support providing data to the Smart Columbus Operating System where it can be accessed by third party users? Do you have any restrictions on the data sets that you would provide?

9. As a result of this project, Smart Columbus intends to define a set of interoperability guidelines for AVs to communicate with infrastructure and a central fleet management system to ensure that various systems deployed throughout the city, state, and nation can be deployed interchangeably. Do you have any suggestions for or concerns with this approach?

10. Discuss any preferred contract type(s) for the execution of an AV shuttle deployment project and the justification for this preference.

11. Did you have any specific concerns with previous RFPs, including ODOT's RFP #505-19: Automated Vehicle Shuttle Service, that made it more difficult to submit a proposal and/or comply with all specified terms?

12. Describe the general specifications of any AVs your organization would consider proposing for this project, including the passenger capacity, external and internal dimensions, maximum safe operating speed on route, required charging time (if applicable), and range.

    a. Within this project's schedule, will these AVs be Americans with Disabilities Act (ADA) accessible, or do you have a plan to ensure ADA accessibility?

    b. Within this project's schedule, will these AVs comply with all applicable Federal Motor Vehicle Safety Standards (FMVSS) or have approval to operate under an exemption to the FMVSS? If not compliant, describe how the items not in compliance are directly related to the full automation capability with no driver. If an exemption is necessary, include whether it has already been approved and whether there is an alternative plan if an exemption is not possible.

    c. Describe the AVs' status with the USDOT National Highway Traffic Safety Administration (NHTSA) 12-point voluntary safety self-assessment[4], including whether the AVs have completed the assessment, whether the assessment has been submitted to NHTSA, and if not, whether there are any plans to do so. Discuss any other safety features you have considered that are not already part of these guidelines.

    d. Within this project's schedule, would you be able to adhere to "Buy America" provisions?

13. Describe any and all infrastructure installations that may be required to support your technology. This may include but is not limited to roadside units that leverage Dedicated Short Range Communications (DSRC), infrastructure-based cameras to monitor signal indications, and real-time kinematic (RTK) antennae.

14. What is the maximum distance from the route that a storage facility should be provided? As part of an RFP, would you require electric vehicle charging stations (or fueling locations, if the AVs are not electric) and storage facilities to be identified or would you be willing to identify facilities?

[4] More information here: https://www.nhtsa.gov/automated-driving-systems/voluntary-safety-self-assessment

a. Identify the power needs for both the charging and storage facility and any other infrastructure that is needed for your solution.

b. As part of an RFP, would you be willing to include the charging and storage facility as part of the package and cost?

c. If the provided vehicle uses gasoline or diesel, would you refuel at a public gas station or prefer a dedicated station?

15. Describe the type of testing that has been conducted with your AVs. What experiences do the AVs have in mixed traffic operations (including crossing high-traffic, high-speed intersections), various weather conditions, and other environments? What precautions were taken during previous tests or deployments?

16. Are there any conditions under which the AVs would not be able to operate and would need to be taken from service (e.g., unfavorable weather, humans manually directing traffic, communication/signal failure, etc.)? If so, please describe the type and level of conditions and the proposed response protocol.

17. Can the AVs be connected to smart infrastructure and send, receive, and respond to messages with other connected vehicles and infrastructure[5]? If so, what types of connected vehicle (CV) applications can the AVs support?

18. Discuss your insurance/liability approach with respect to the proposed solution, including the possibility of cyber security insurance.

19. What is the estimated monthly lease price for a vehicle and what does this include? What are the estimated monthly operating and maintenance costs? Are there any other additional costs we should be aware of?

20. While the service will likely be fare-free during preliminary operations, there may be a desire to test the ability to collect fares onboard and/or via a mobile app. Is this something your

[5] While the AVs are not required to be true CVs, at the very least it is expected that vendors will allow aftermarket safety devices to be installed on their vehicles so that information can be sent to other vehicles in the Smart Columbus CV Environment.

organization's fleet is capable of? Describe the possible options and your thoughts on the feasibility of fare collection as a sustainable revenue model.

21. The outcome of this RFI may result in multiple AV shuttle deployments being pursued in the Columbus area. Considering your current production capacity and other commitments, how many AVs do you estimate you would be able to dedicate to Columbus by late 2019?
22. What level of time and effort (including lead time for route mapping and site assessment) would be required for your AVs to be capable of dynamically switching between different deployment sites in Columbus? Describe the required logistics and process.
23. Are there any additional benefits and challenges that you have determined through your research, testing, and deployments in other cities that were not noted in this RFI?

For additional information, please send a request to Andrew Wolpert, City of Columbus, 170 S. Civic Center Drive, Columbus, OH 43215 or an email to adwolpert@columbus.gov.

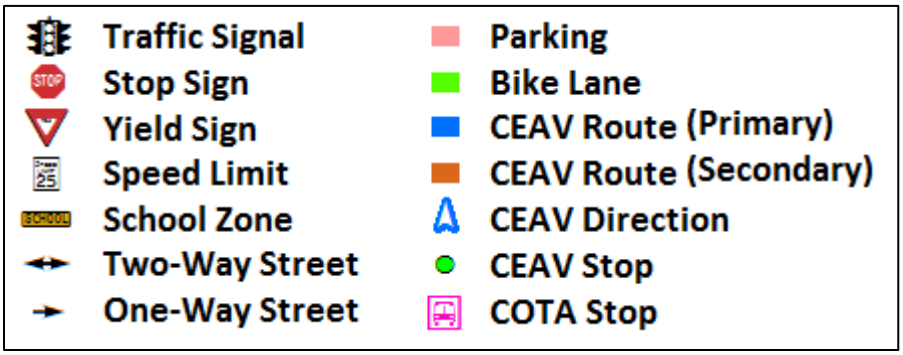
Responses shall be submitted electronically via email to adwolpert@columbus.gov by 5:00 PM EST, November 1, 2018.

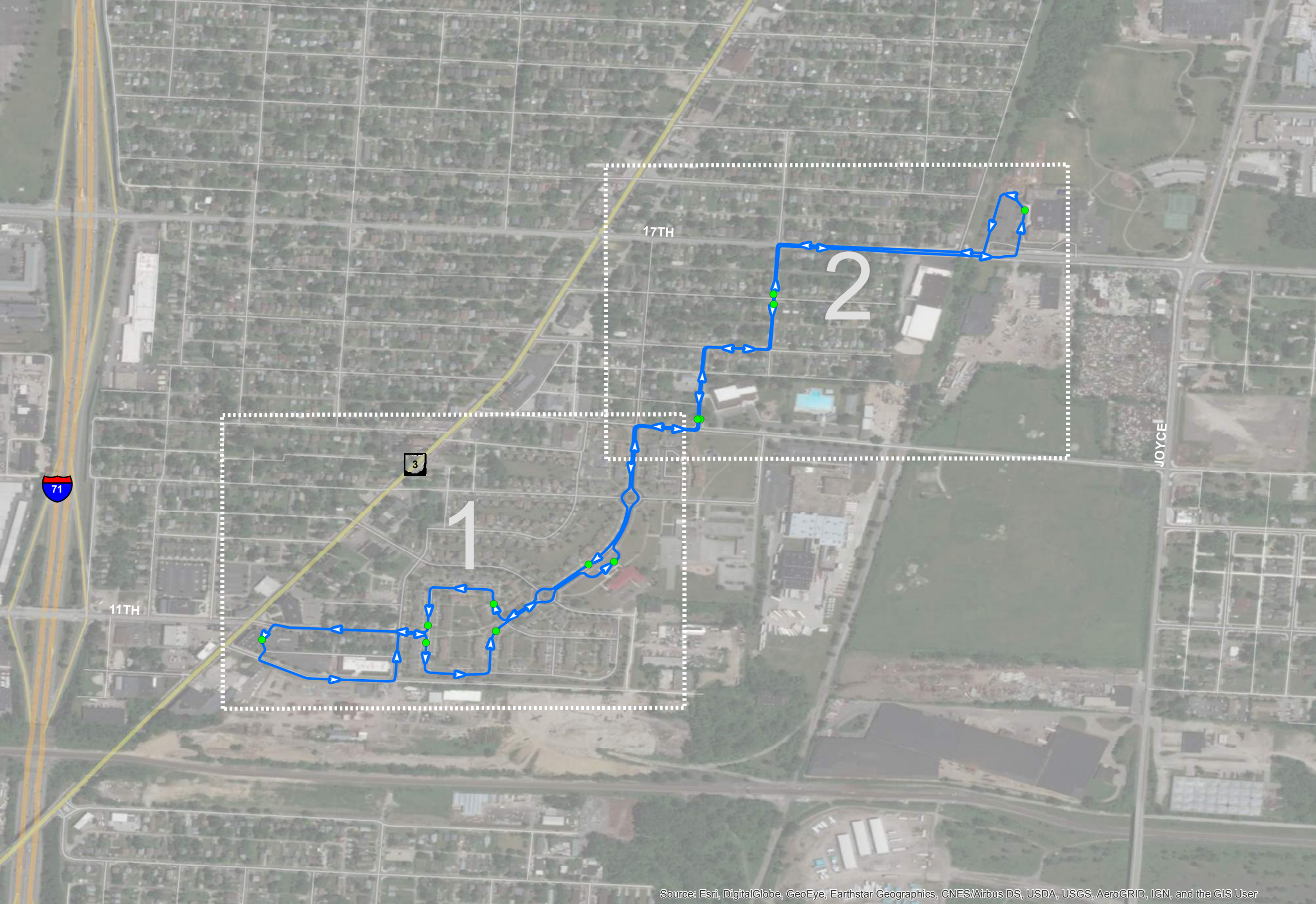
Appendix

Detailed Route Maps

The following pages contain detailed maps of the four proposed routes. For each route, there is a high-level overview followed by more in-depth maps. Route videos have also been uploaded to YouTube at the provided links.

All maps correspond to the following legend.

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

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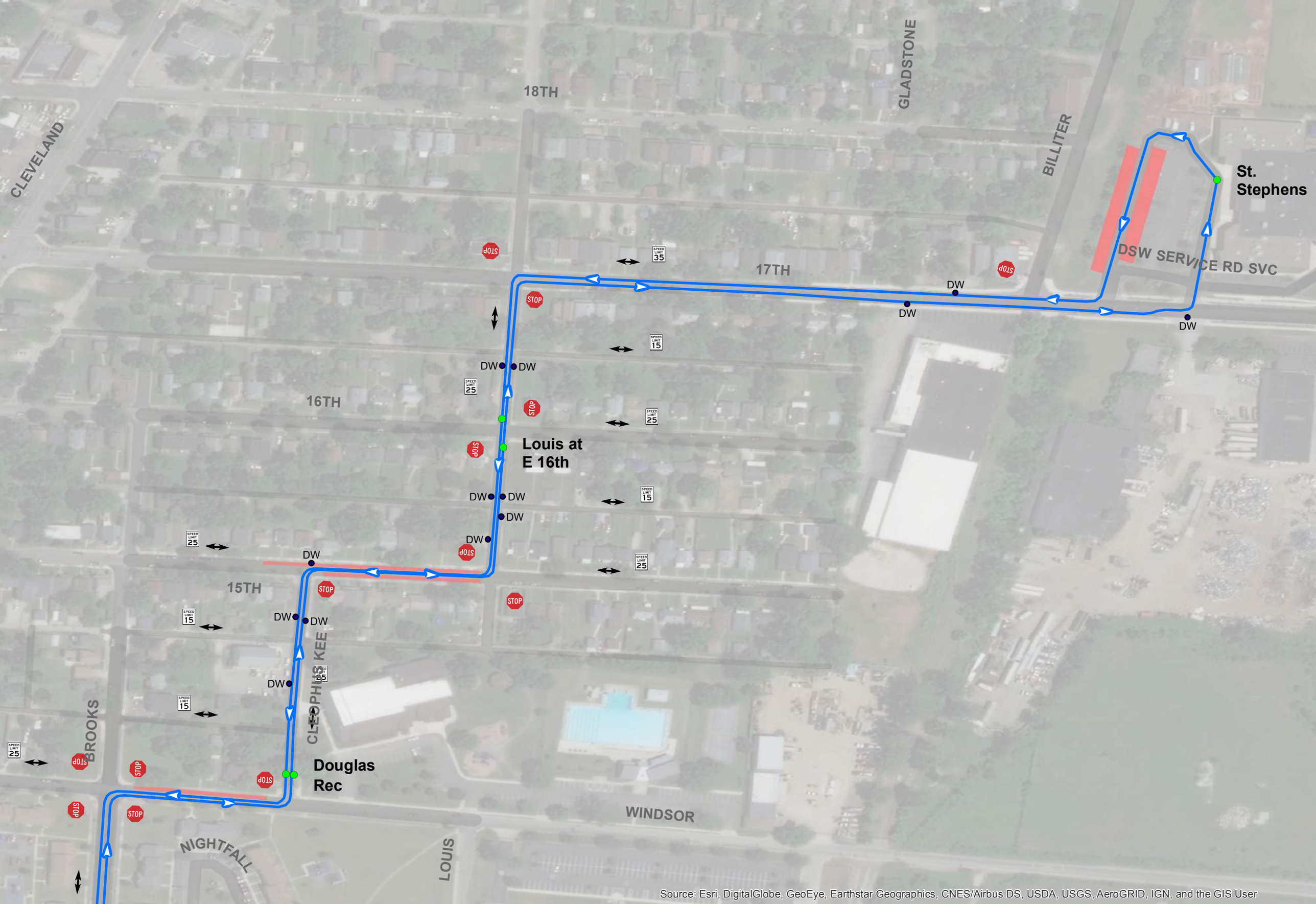
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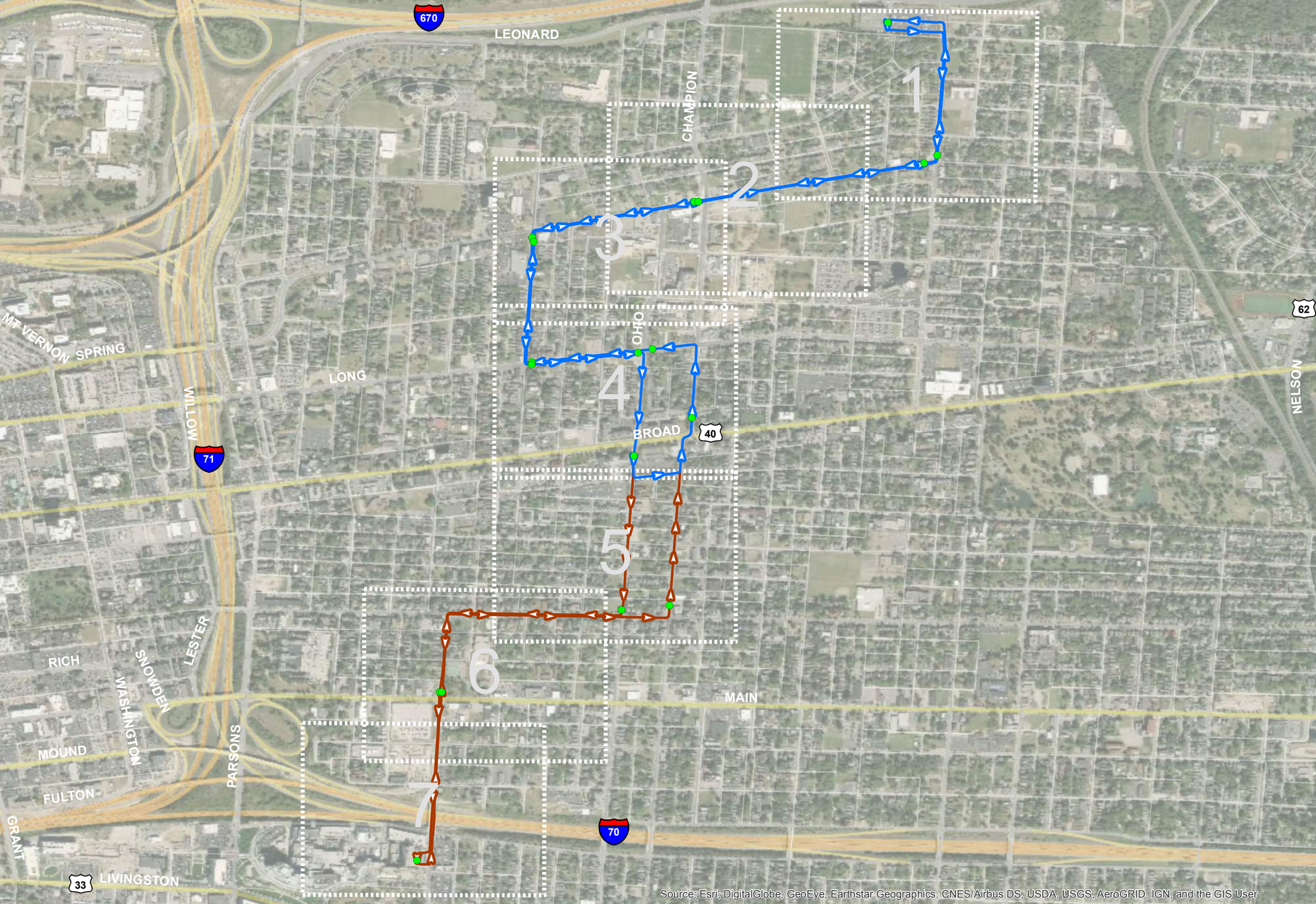
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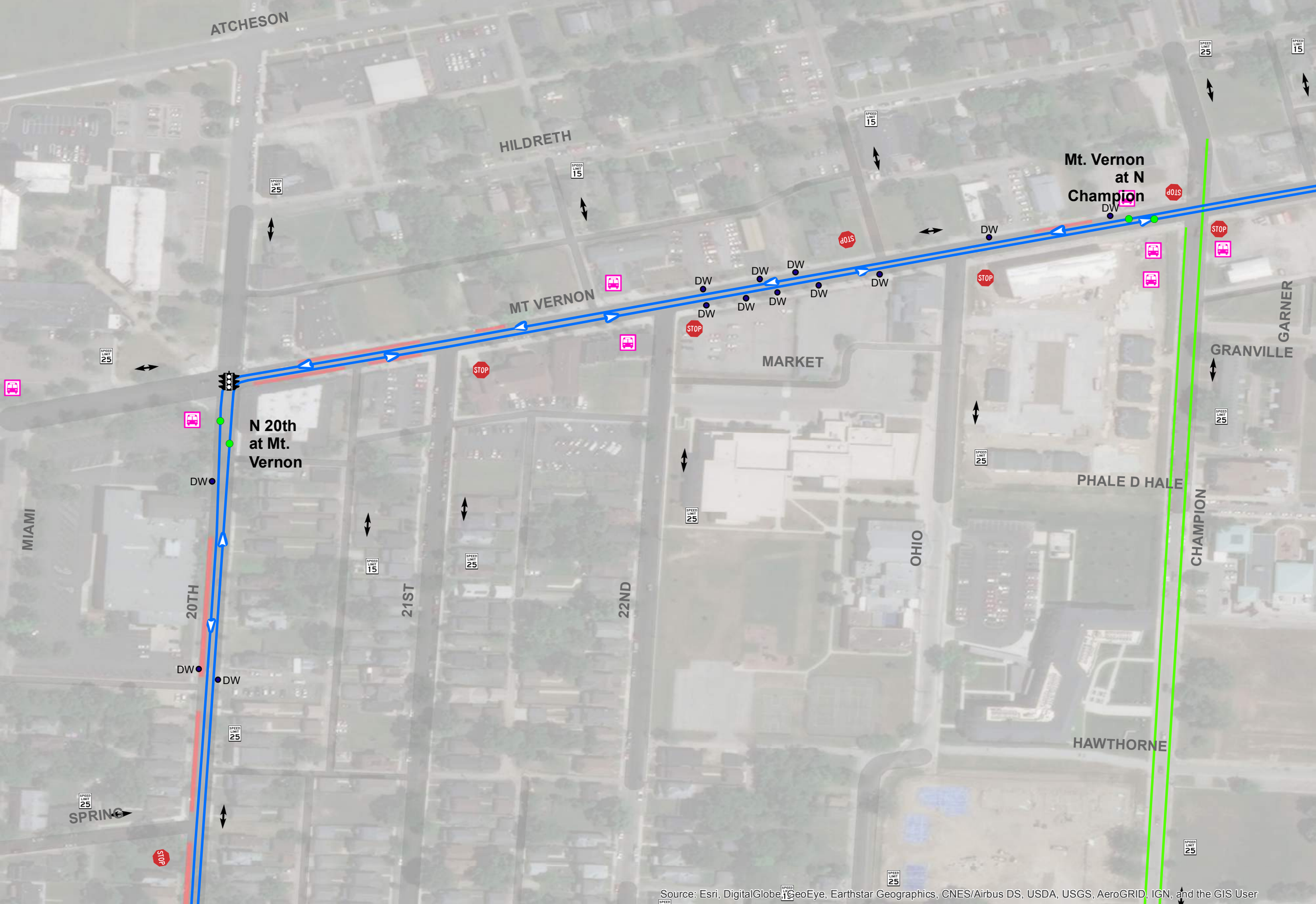
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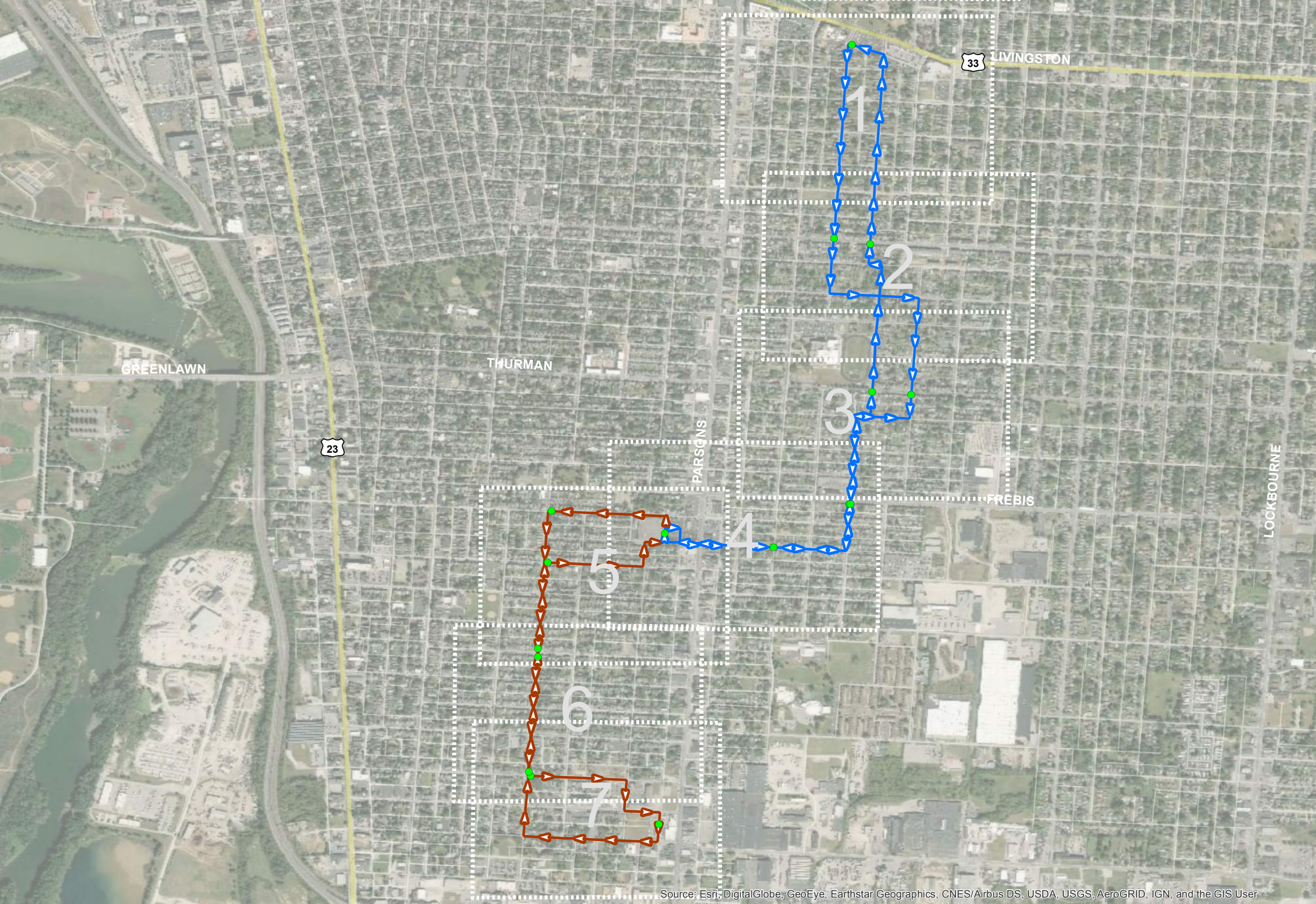
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

Nationwide Children's Hospital

LIVINGSTON

JACKSON

SOUTH

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DENTON

WILL

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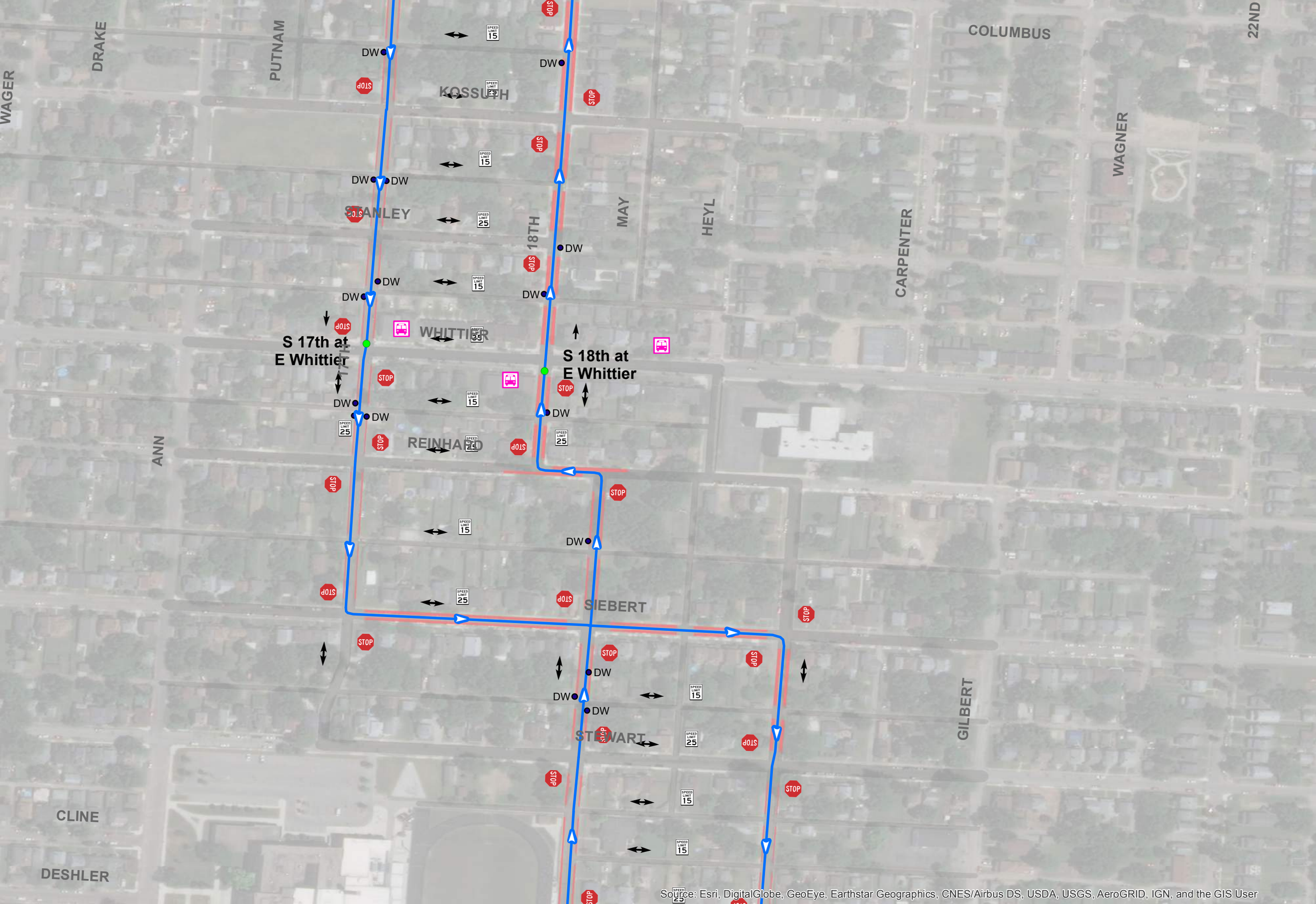
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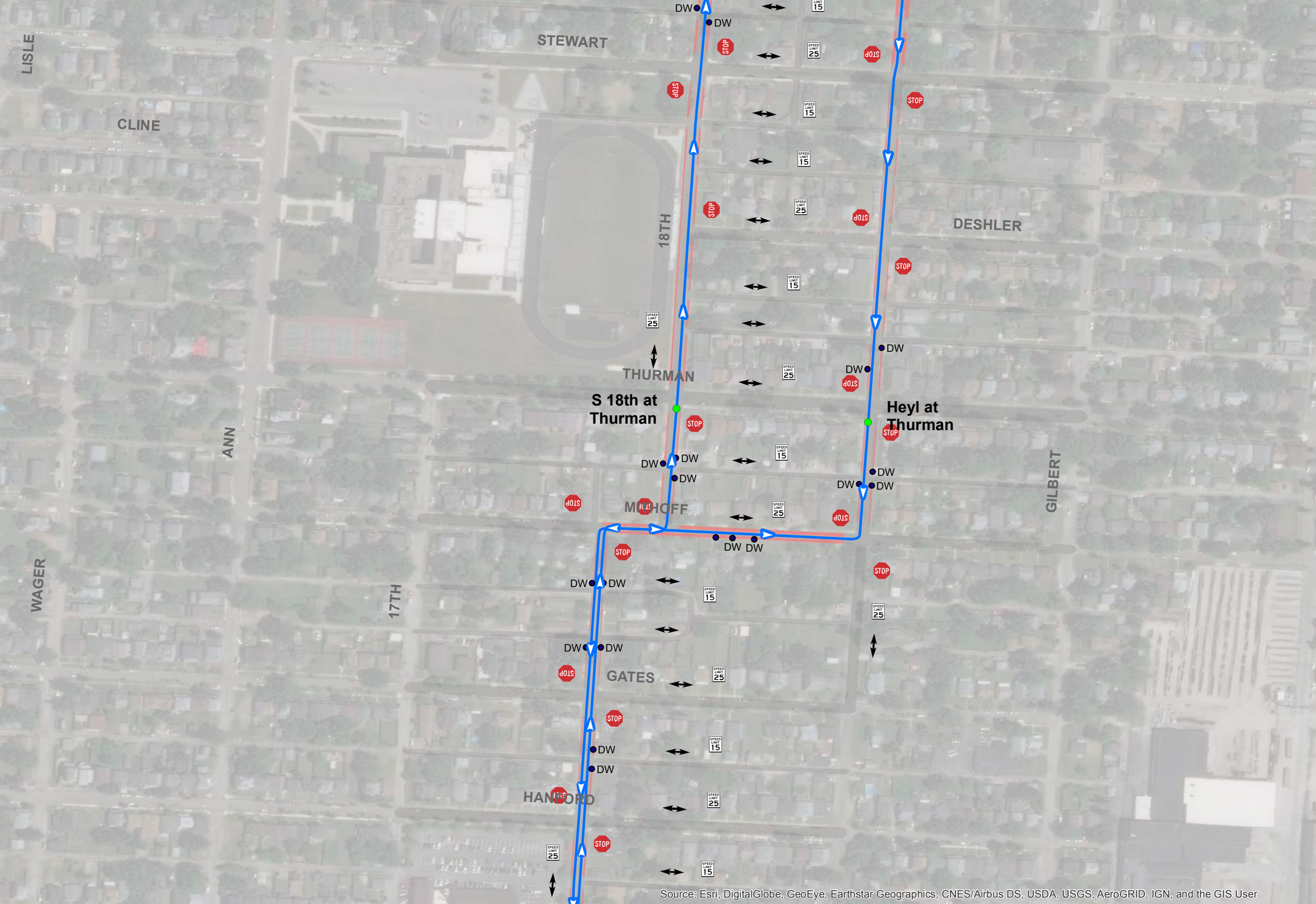
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User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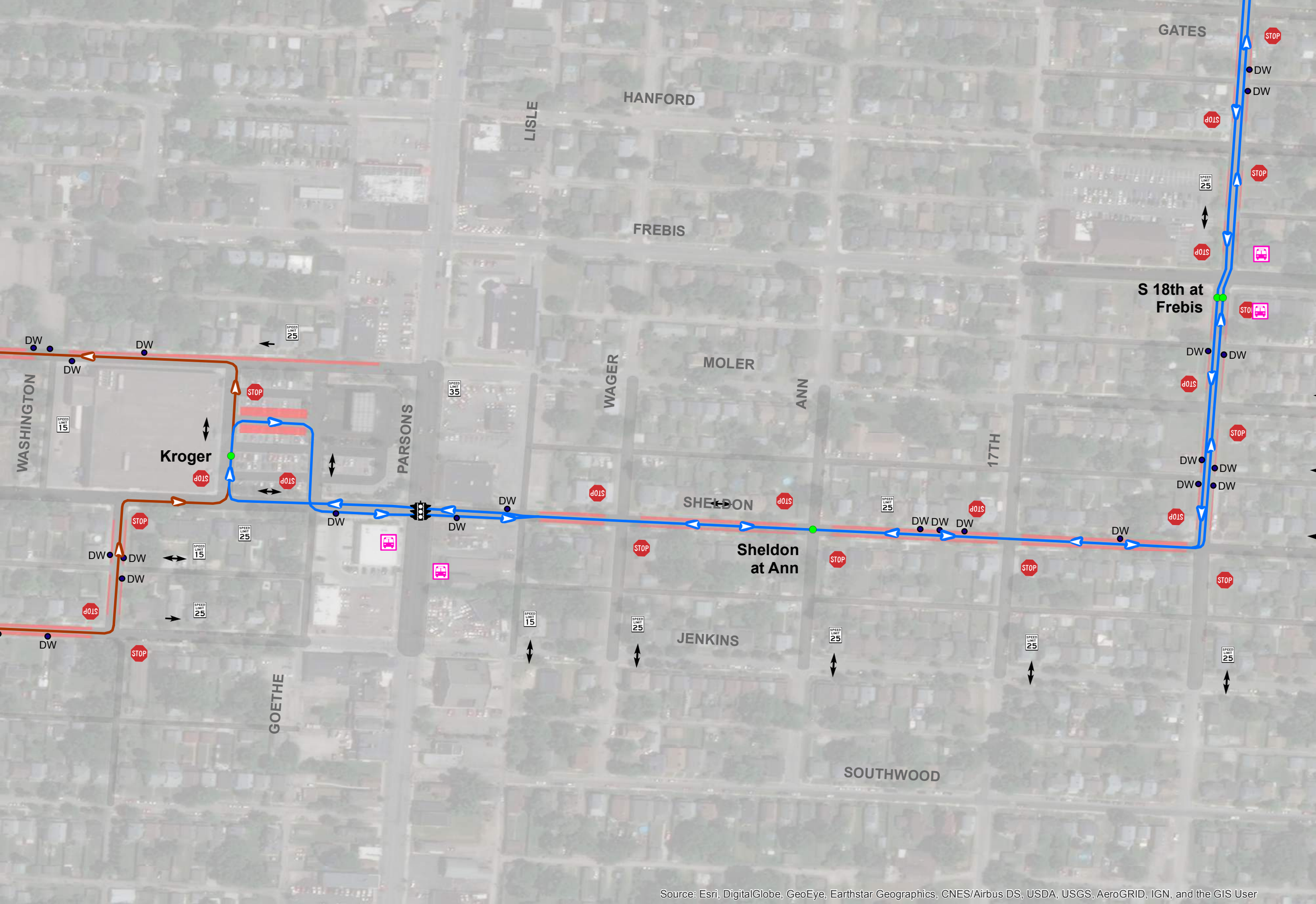

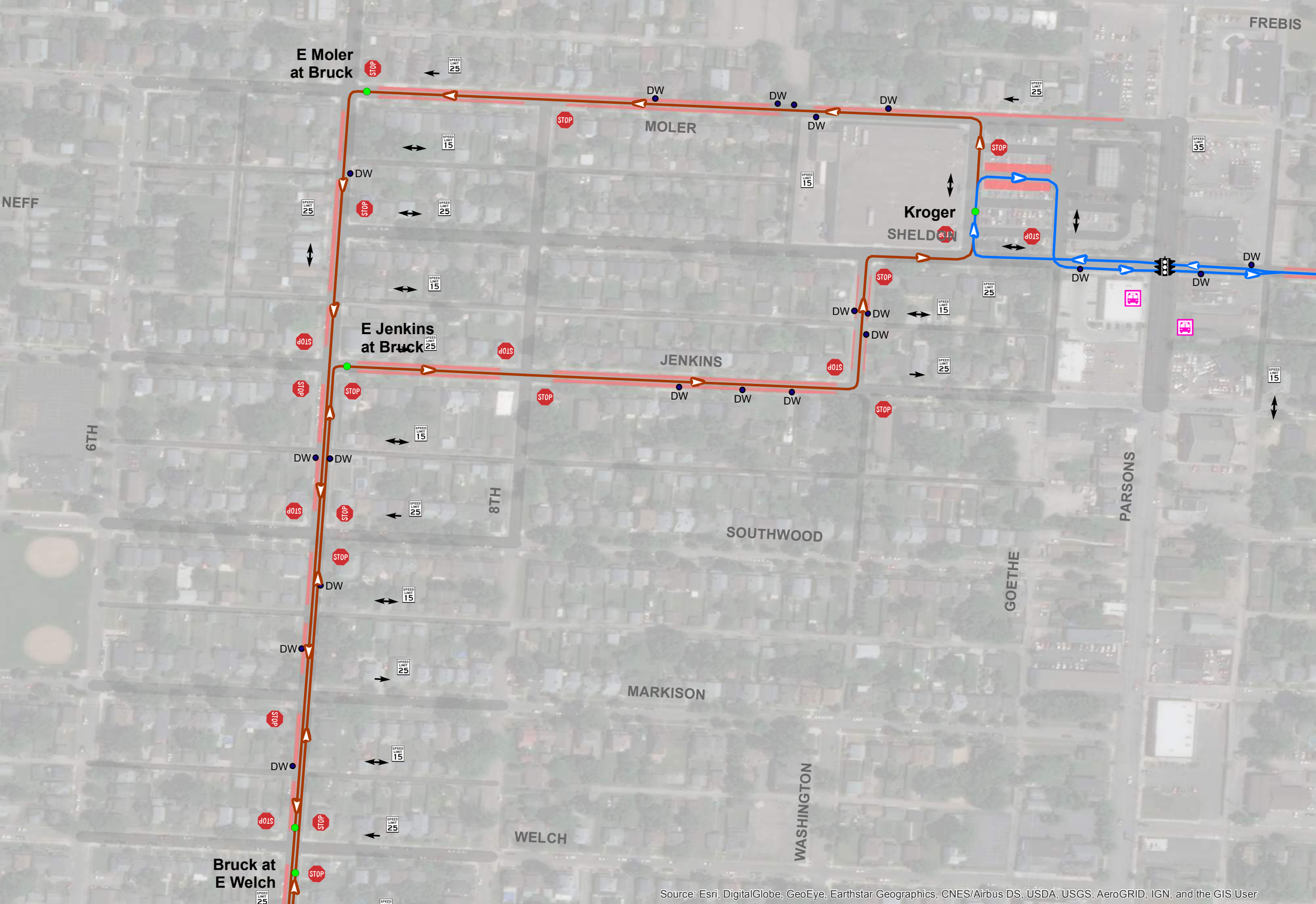
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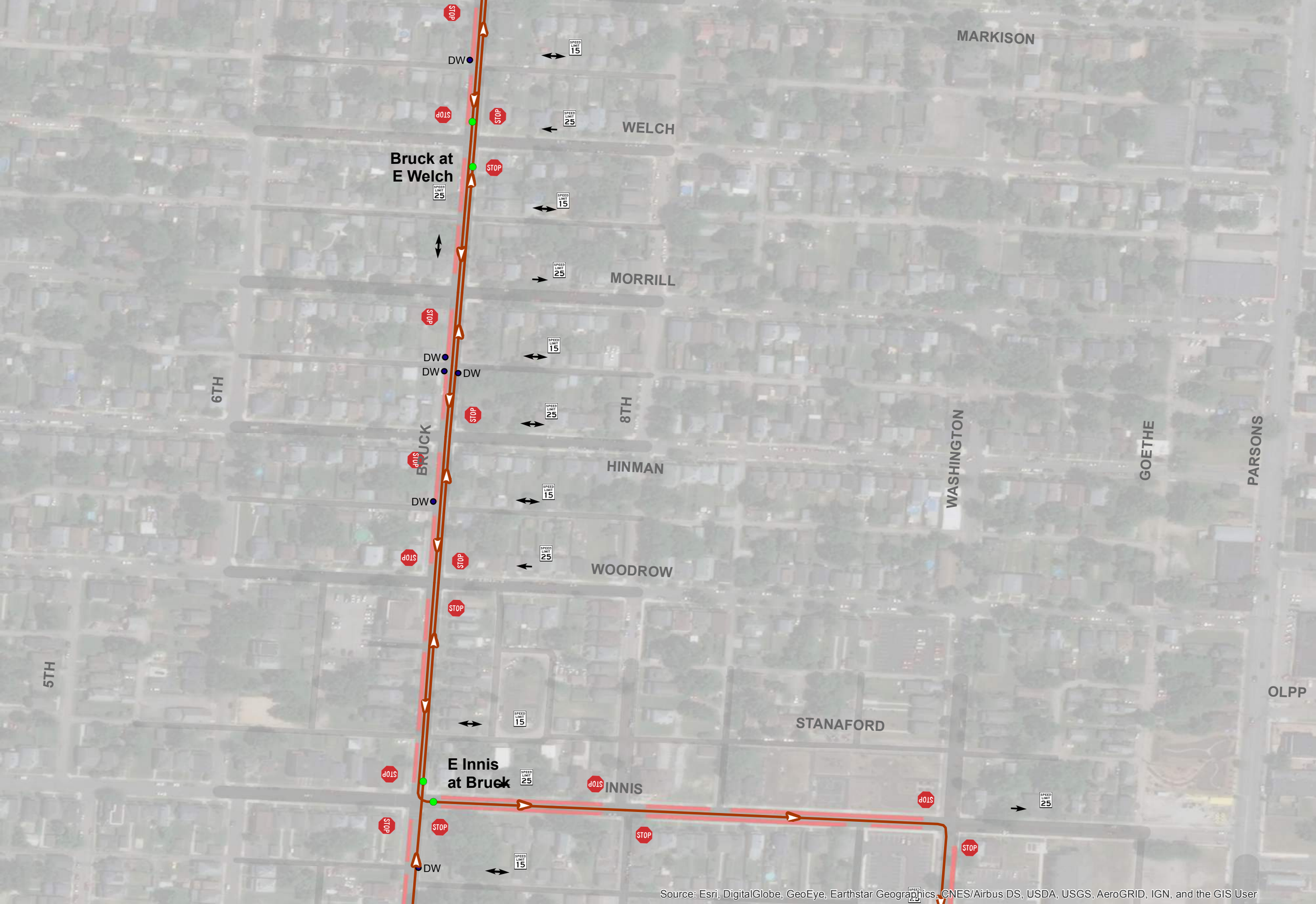
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User


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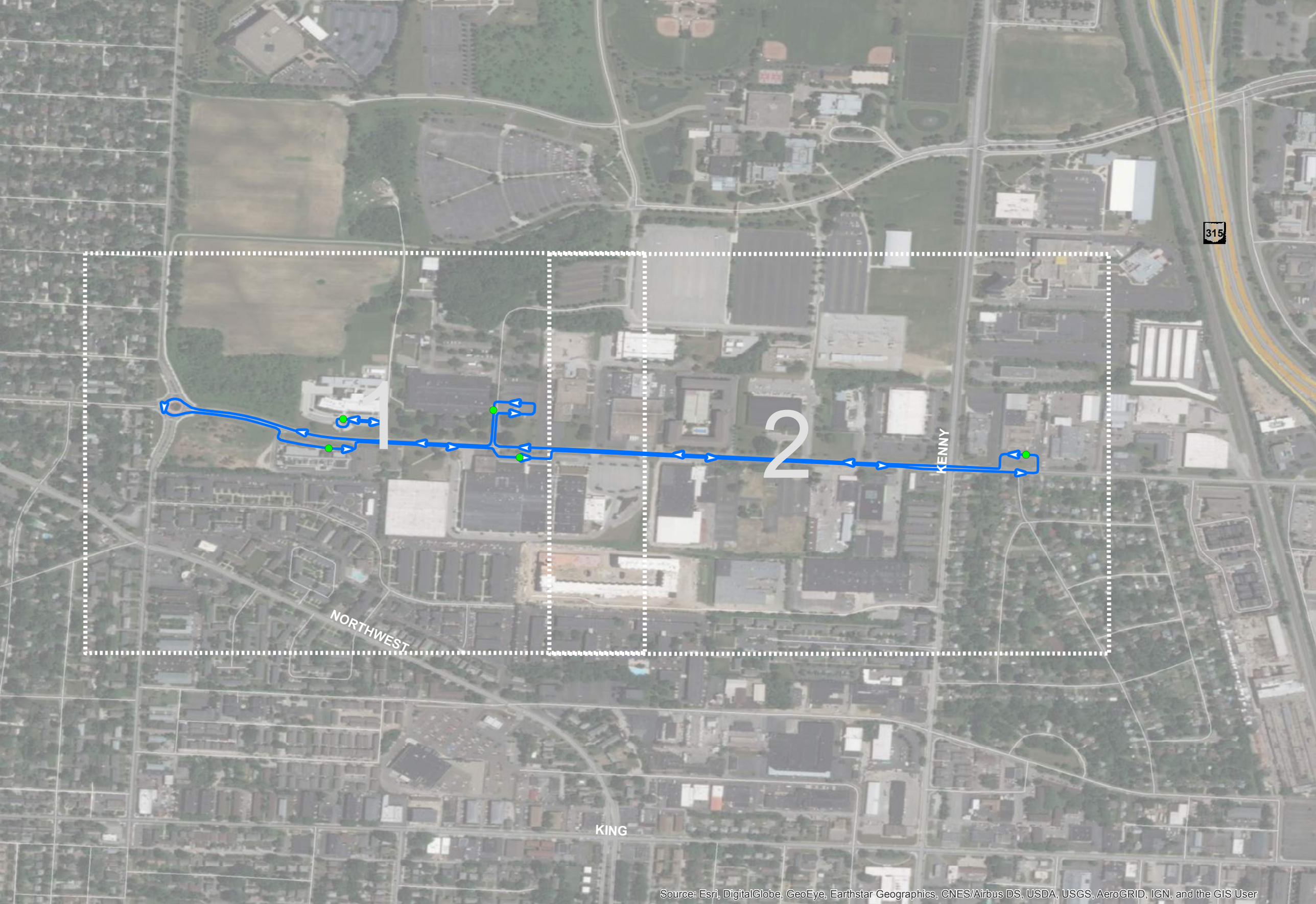
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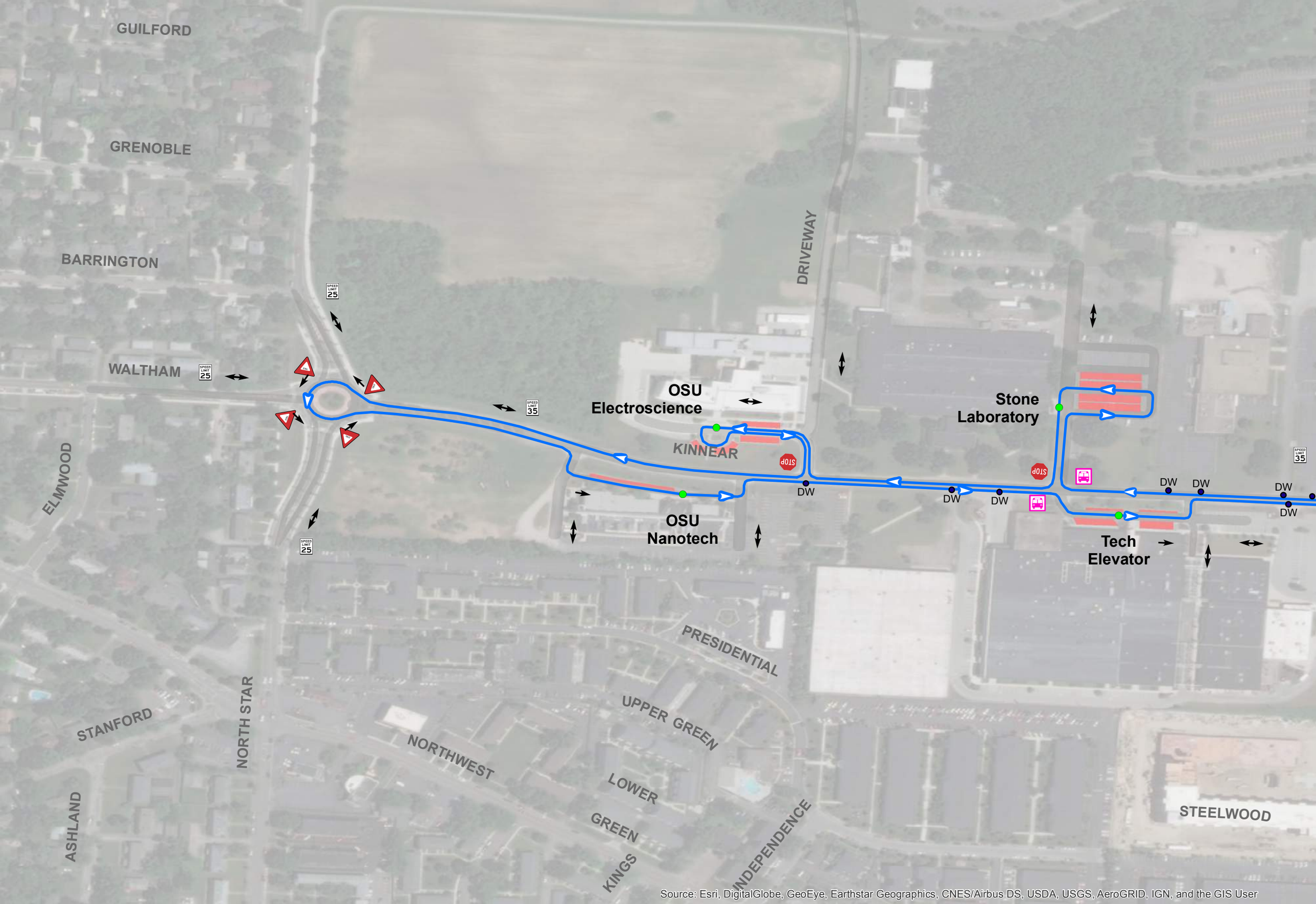
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User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WALTHAM
ELMWOOD
STANFORD
ASHLAND
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UPPER GREEN
LOWER
GREEN
KINGS
INDEPENDENCE
STEELWOOD
KINNEAR
DRIVEWAY
OSU
Electroscience
OSU
Nanotech
Stone
Laboratory
Tech
Elevator
STOP
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User


KENNY
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User