Network for Success
Local Programs Workshop
VDOT Virginia Department of Transportation

Designing Today with an Eye on Tomorrow

Breakout Session # 3

September 10,2019
Moderator – Paul Trapp
Director of Infrastructure Services, Timmons Group

Network for Success

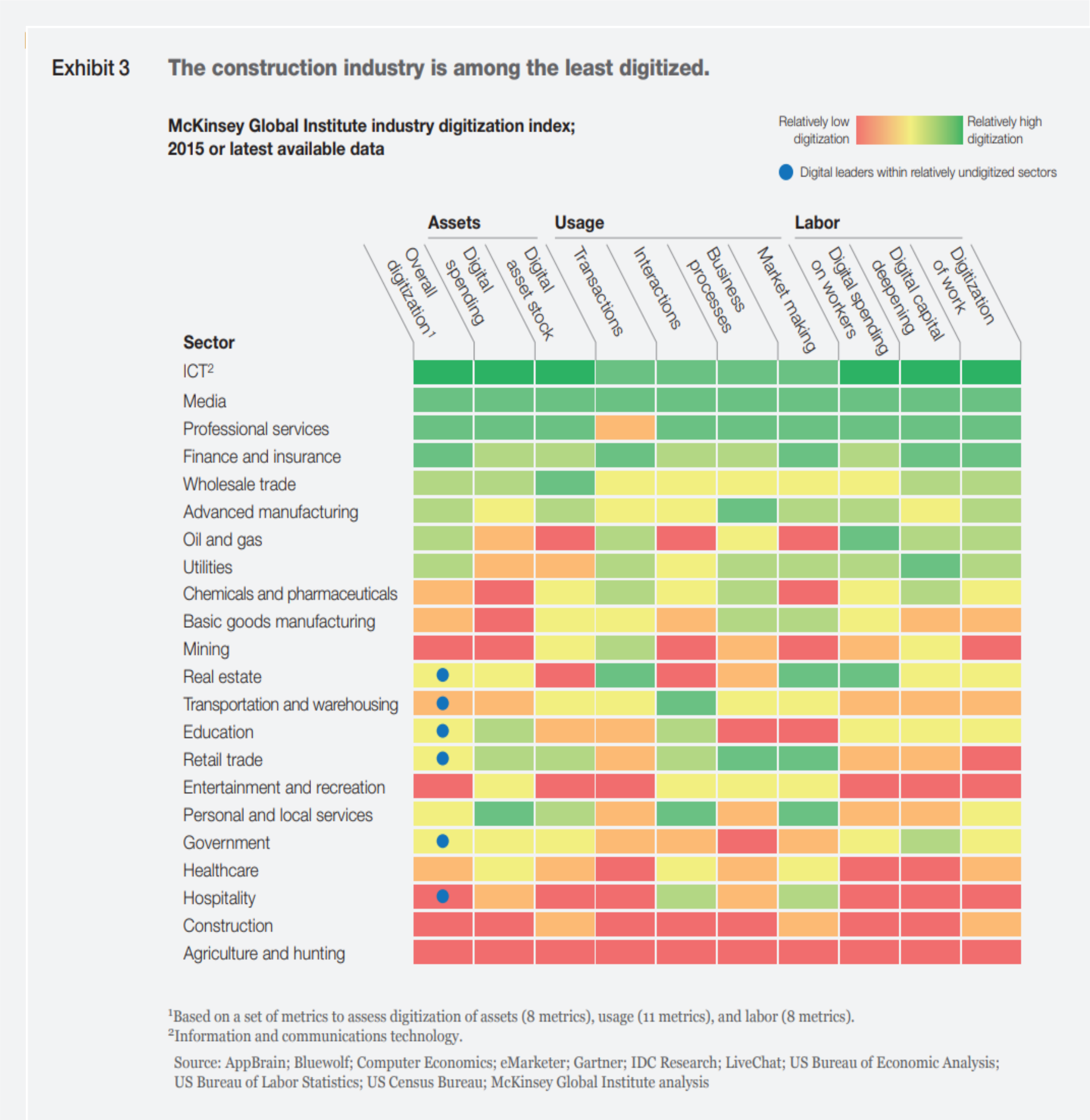
Local Programs Workshop

VDOT Virginia Department of Transportation

Tablet Based Inspection

Ian Millikan, P.E.
Assistant State Construction Engineer
Virginia Department of Transportation

The Construction Industry in a Digital World



Construction Assets

- Overall digitization
- Digital spending
- Digital asset stock

Network for Success
Local Programs Workshop
VDOT

Bringing iPads onto the construction site

Reasons Tablet Based Inspection Makes Sense

- Reduced printing costs
- Immediate access to project documents in a searchable PDF format
    - Plans
    - Contract
    - Reference documents
- Improved collaboration, coordination, and communication
    - Owner to Contractor
    - Field to Office

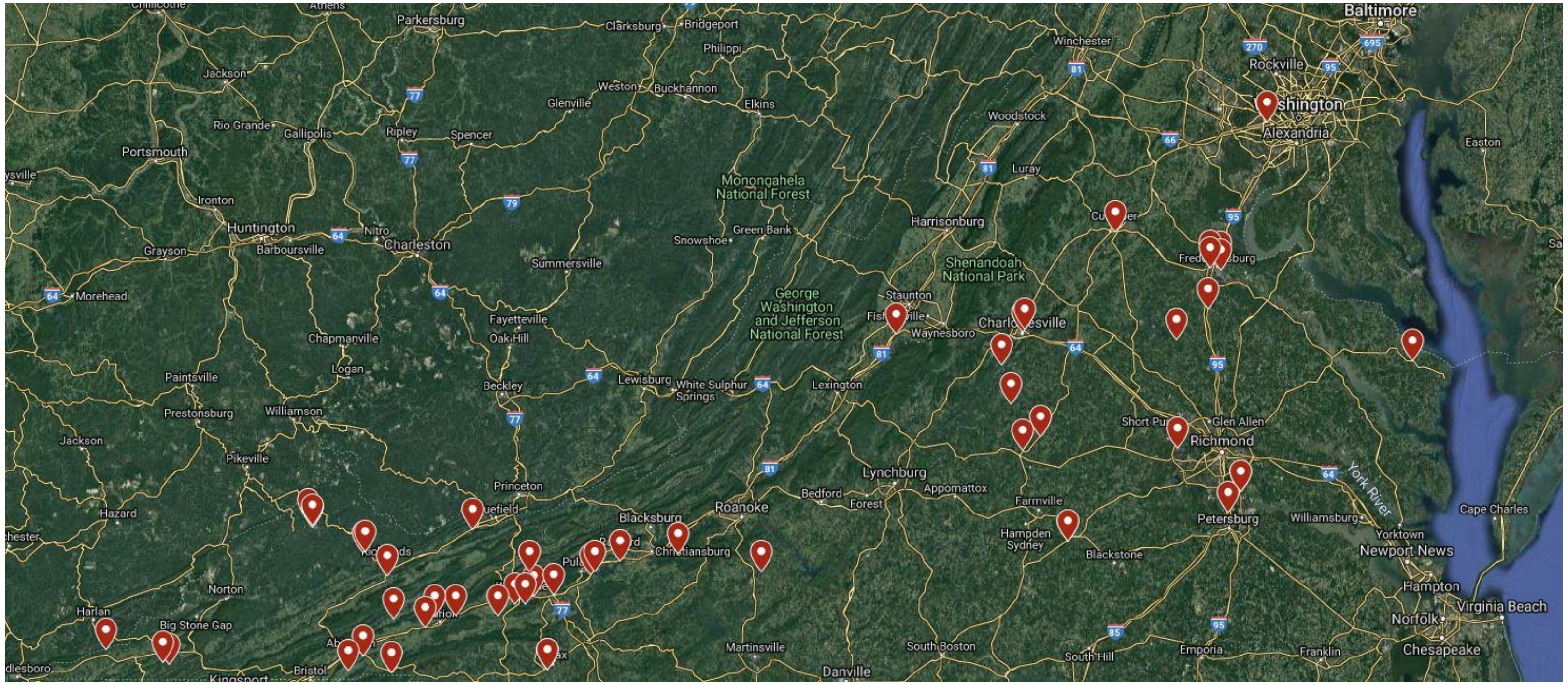
Apps VDOT is testing for Construction Inspection

PlanGrid

HeadLight®

paviasystems

PlanGrid



50

Projects

75

Participants

8

Districts

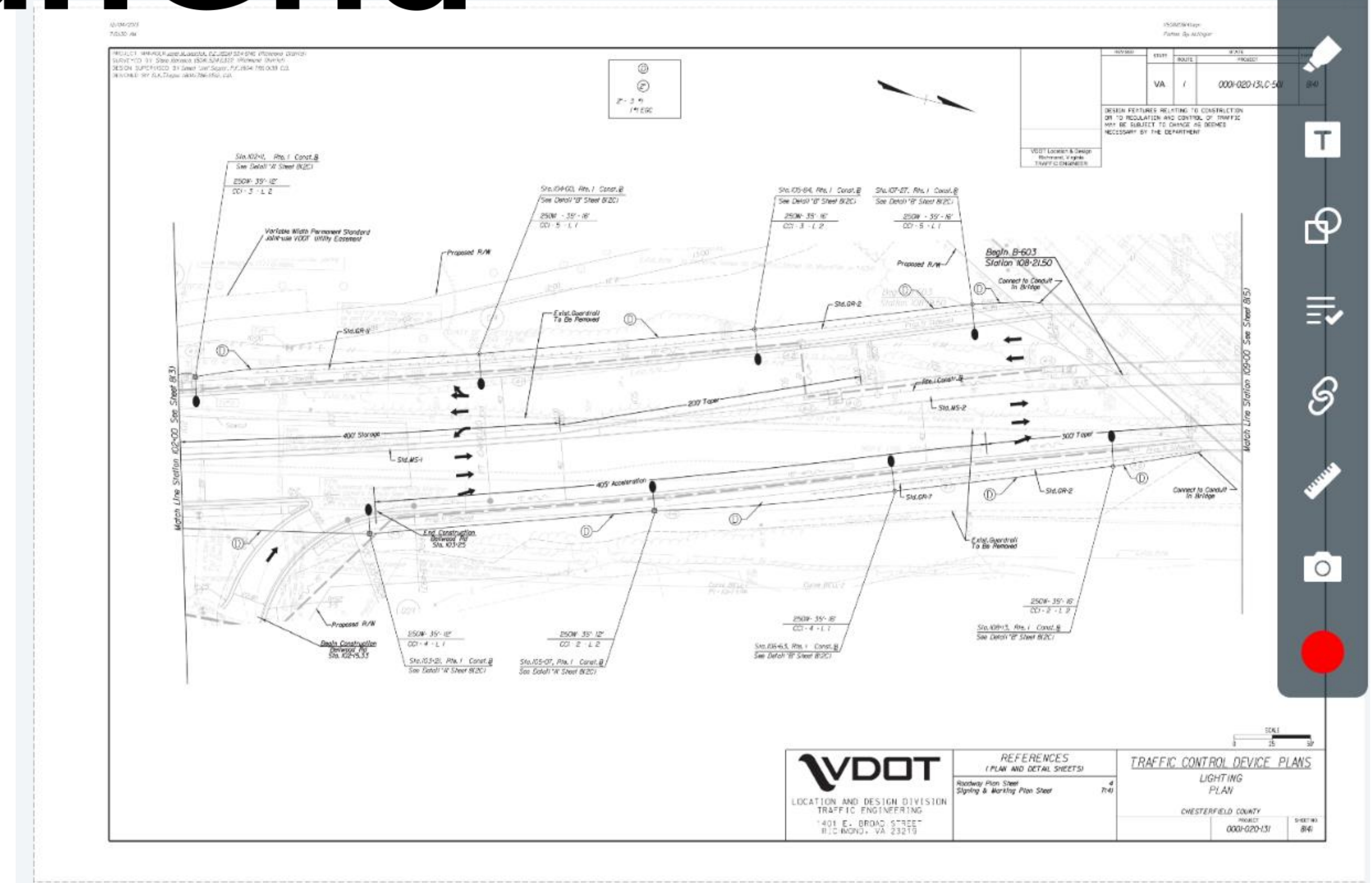
Network for Success
Local Programs Workshop
VDOT Virginia Department of Transportation

PlanGrid

- Review and mark up plans
- Access project documents
- Search and filter plan sheets
- Take progress photos and tag them to the plans
- Identify issues, assign responsible parties, and track resolutions
- Collaborate with design team instantly
- ~~Complete daily diaries~~

PlanGrid

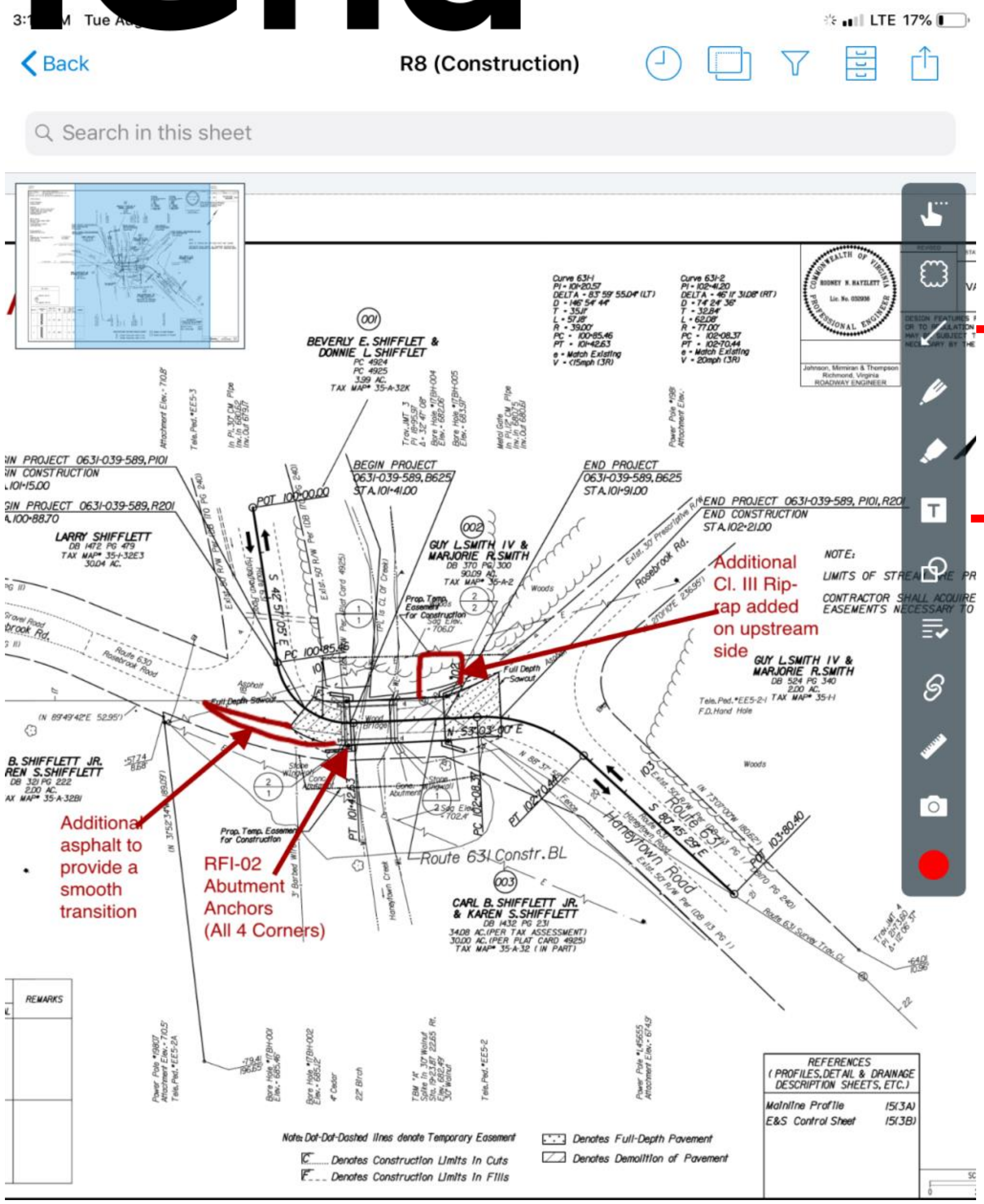
Review and mark up plans



Network for Success
Local Programs Workshop
VDOT

PlanGrid

Review and mark up plans

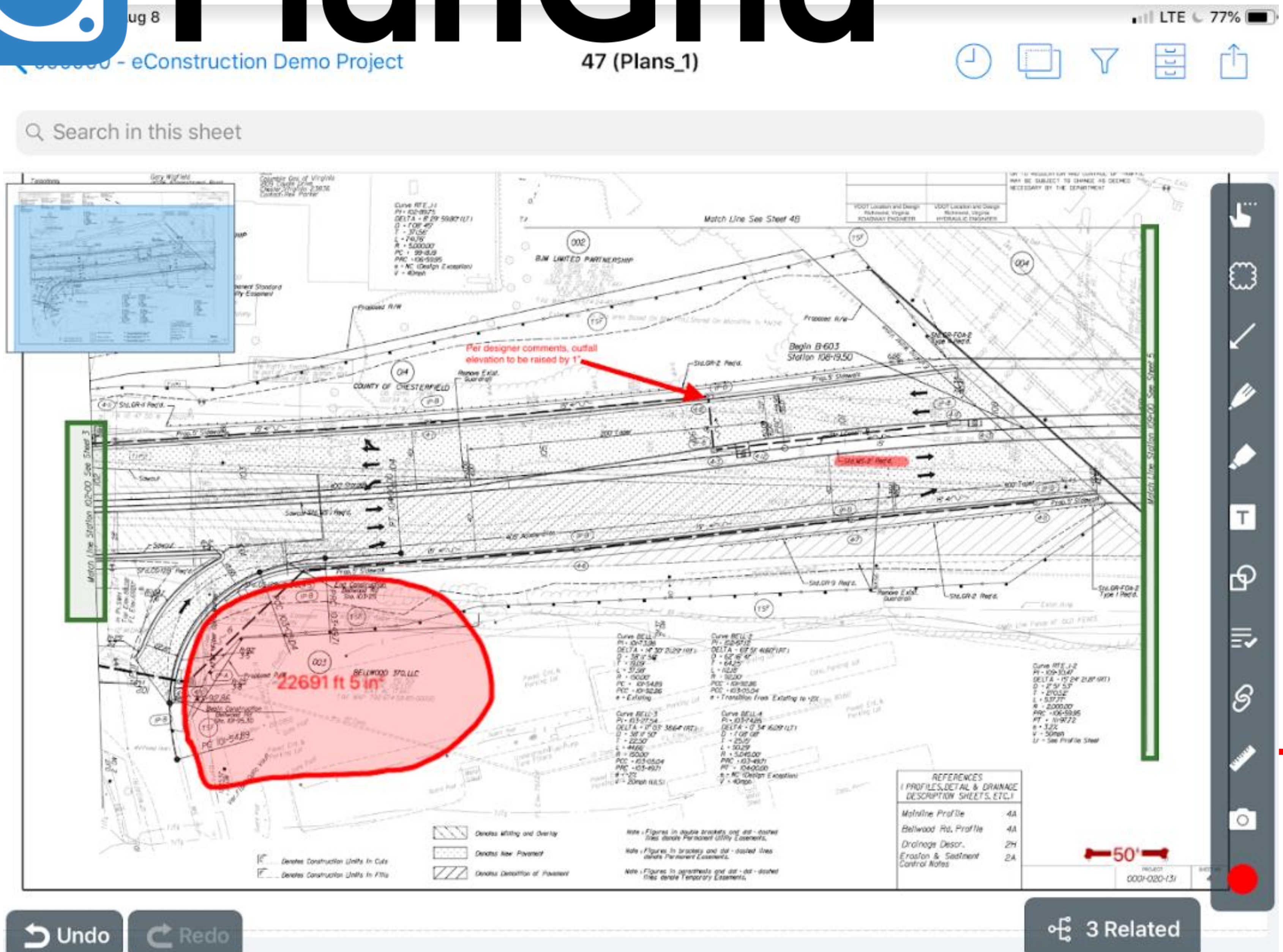


Arrow Tool

Text Tool

PlanGrid

Review and mark up plans

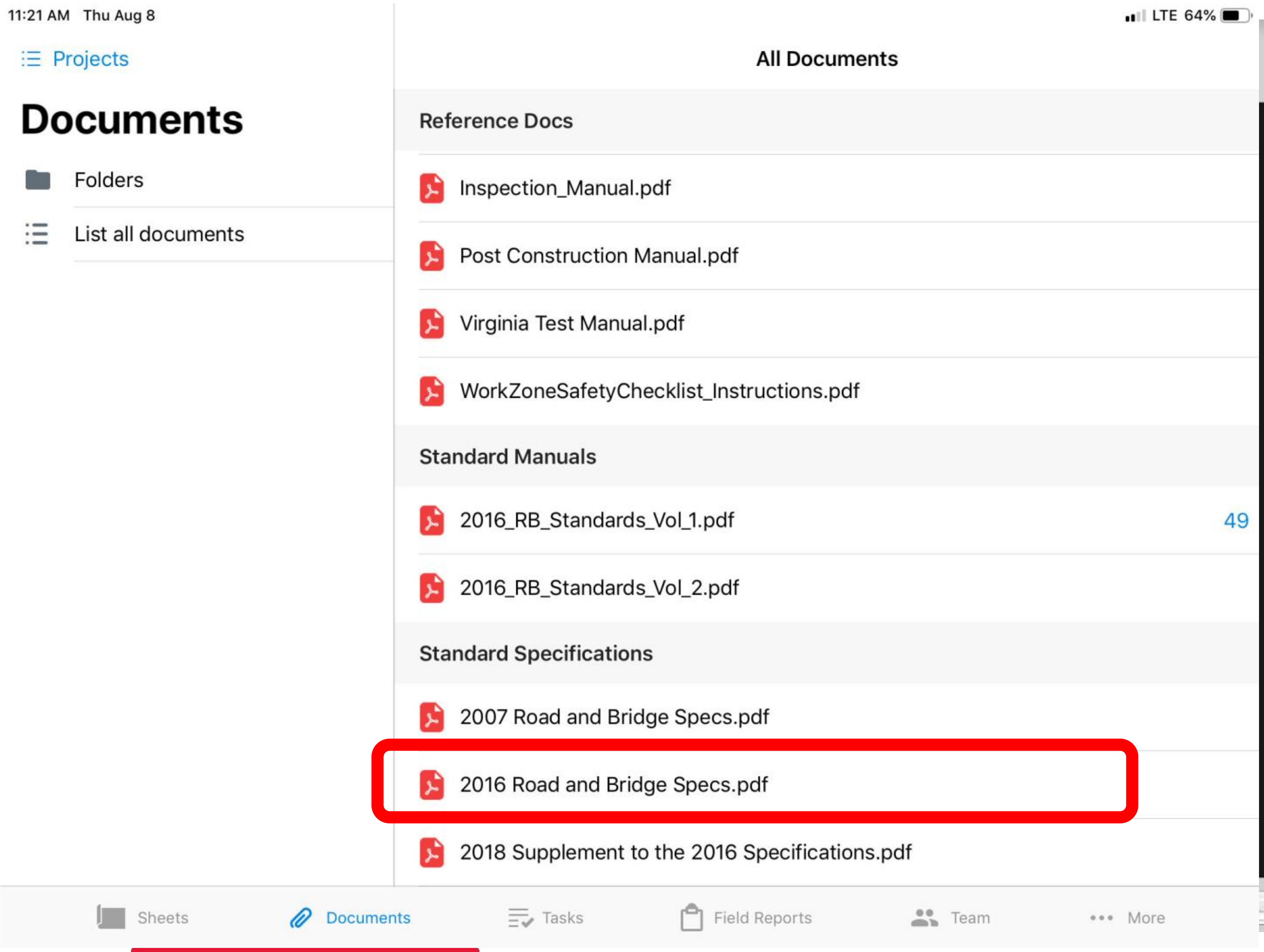


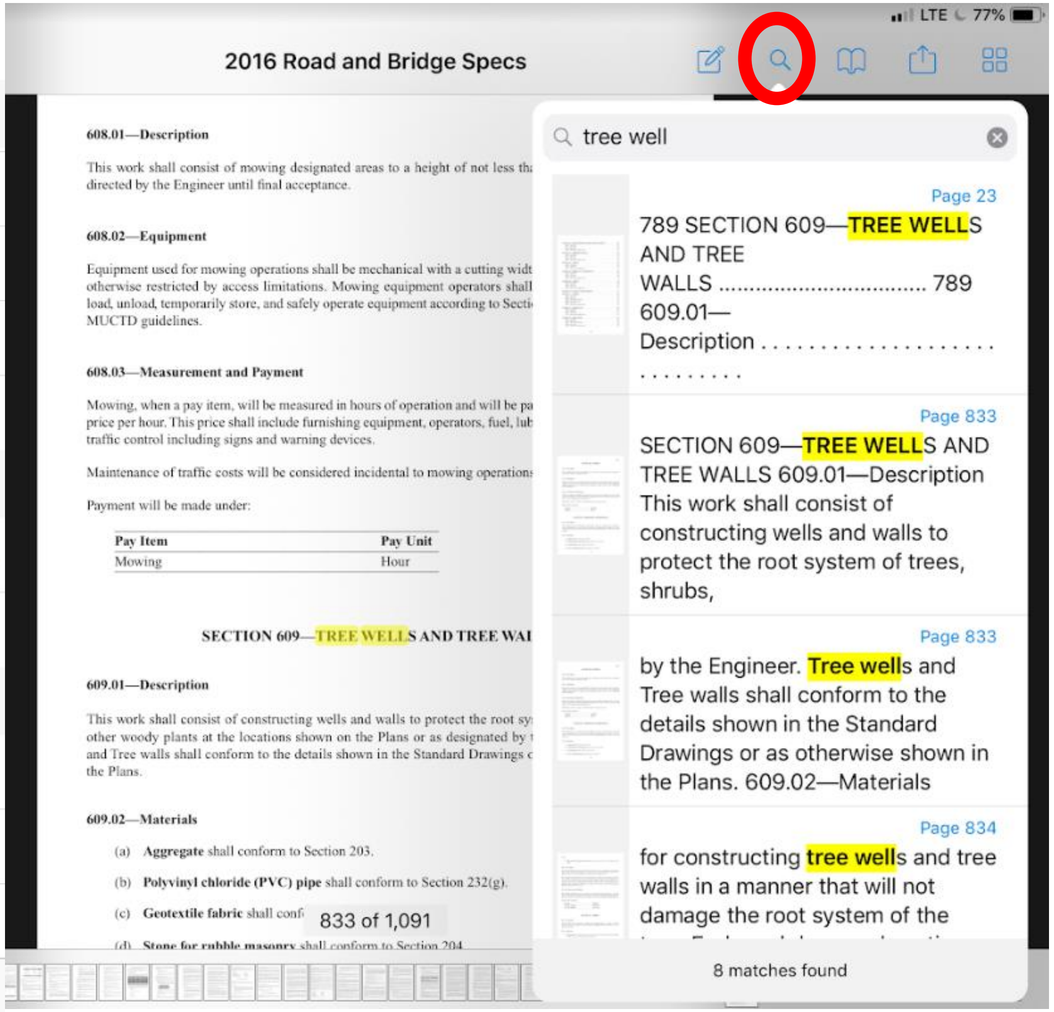
Highlight Tool

Measurement Tool

PlanGrid

Access project documents

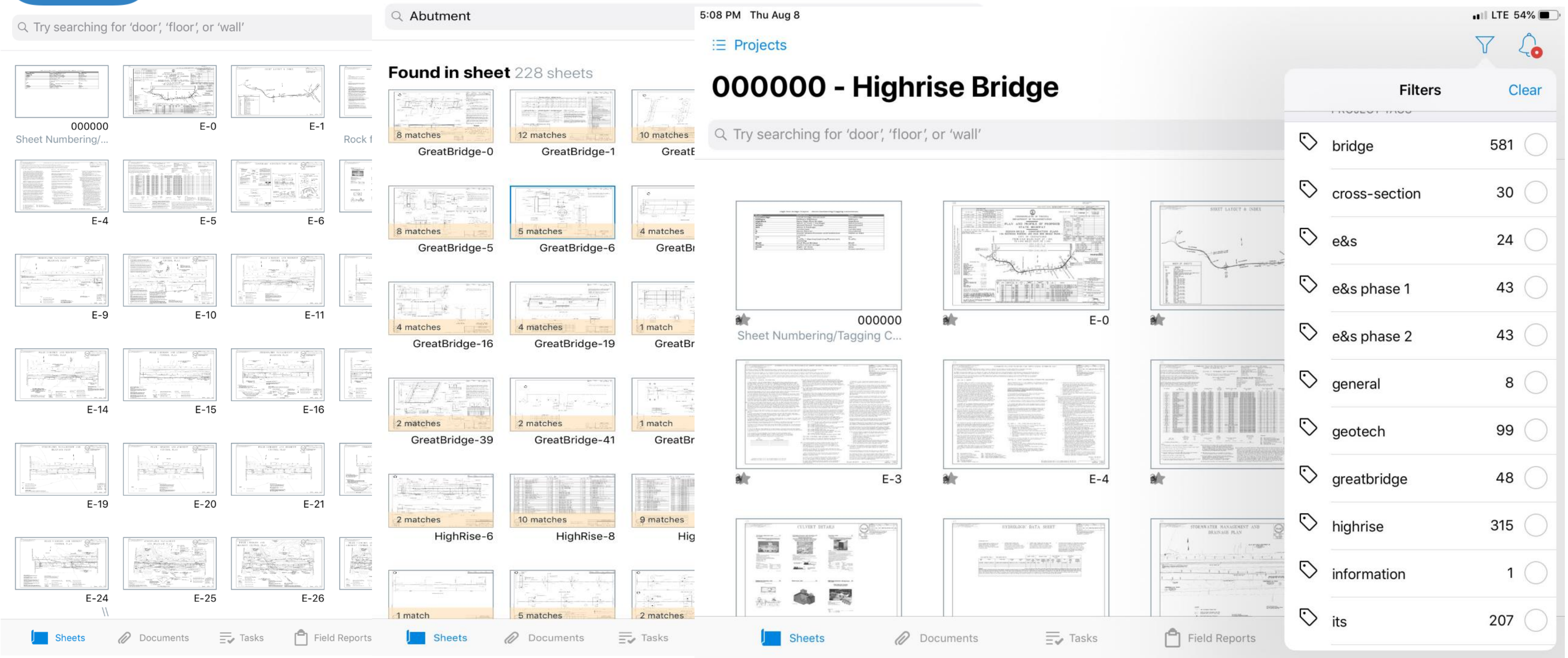




Network for Success
Local Programs Workshop
VDOT

PlanGrid

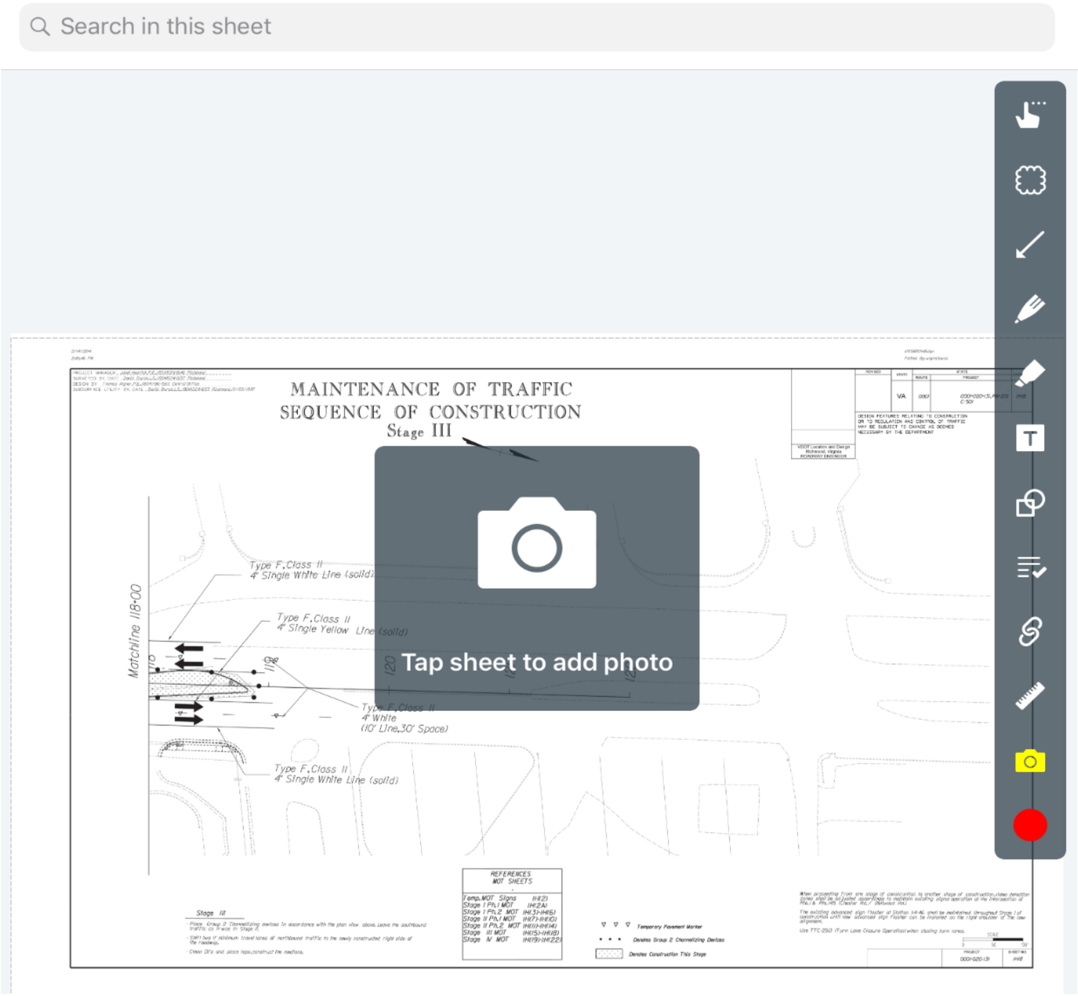
Search and Filter Plan Sheets

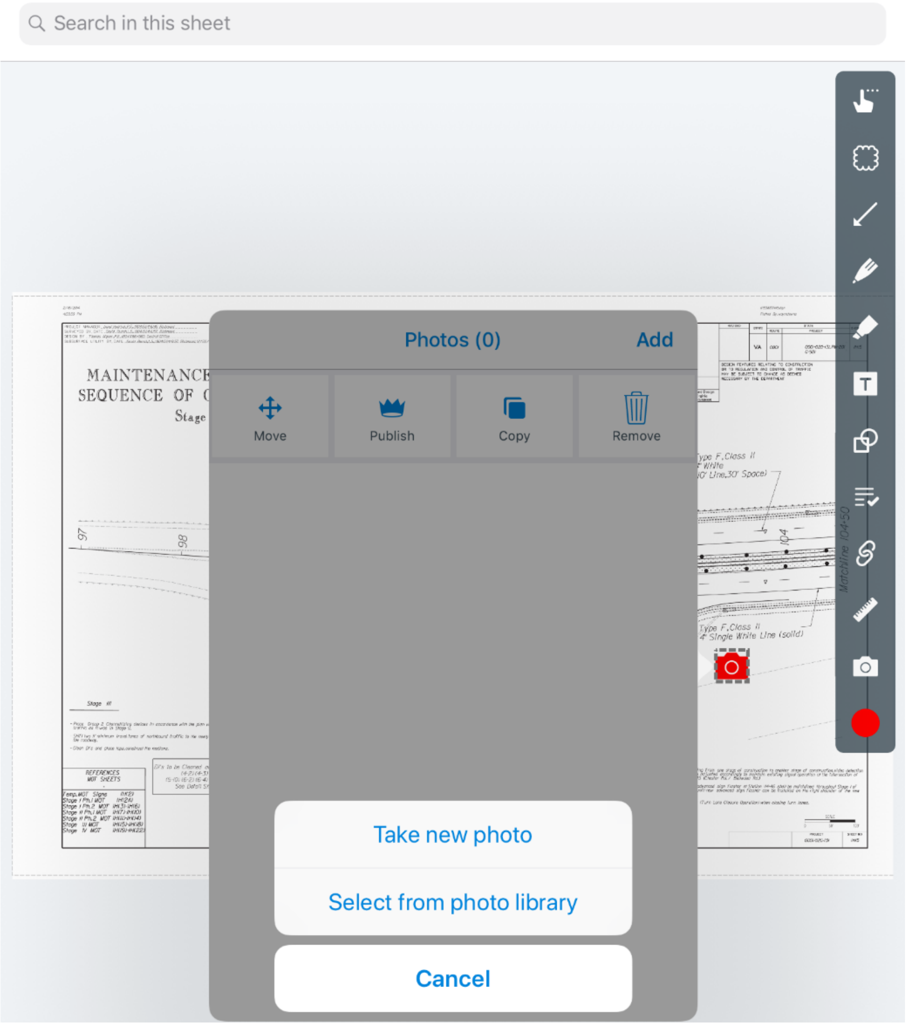


Network for Success
Local Programs Workshop
VDOT

PlanGrid

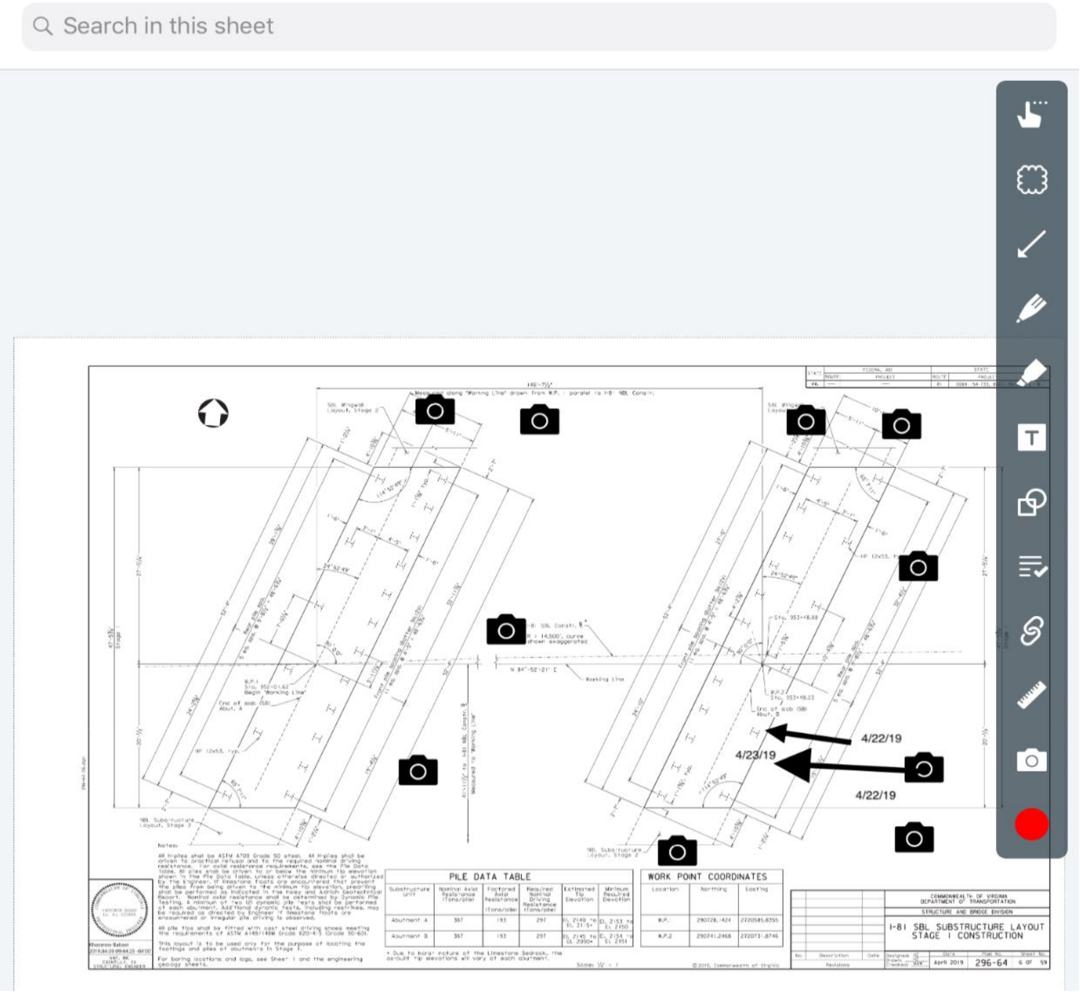
Take progress photos and tag them to the plans

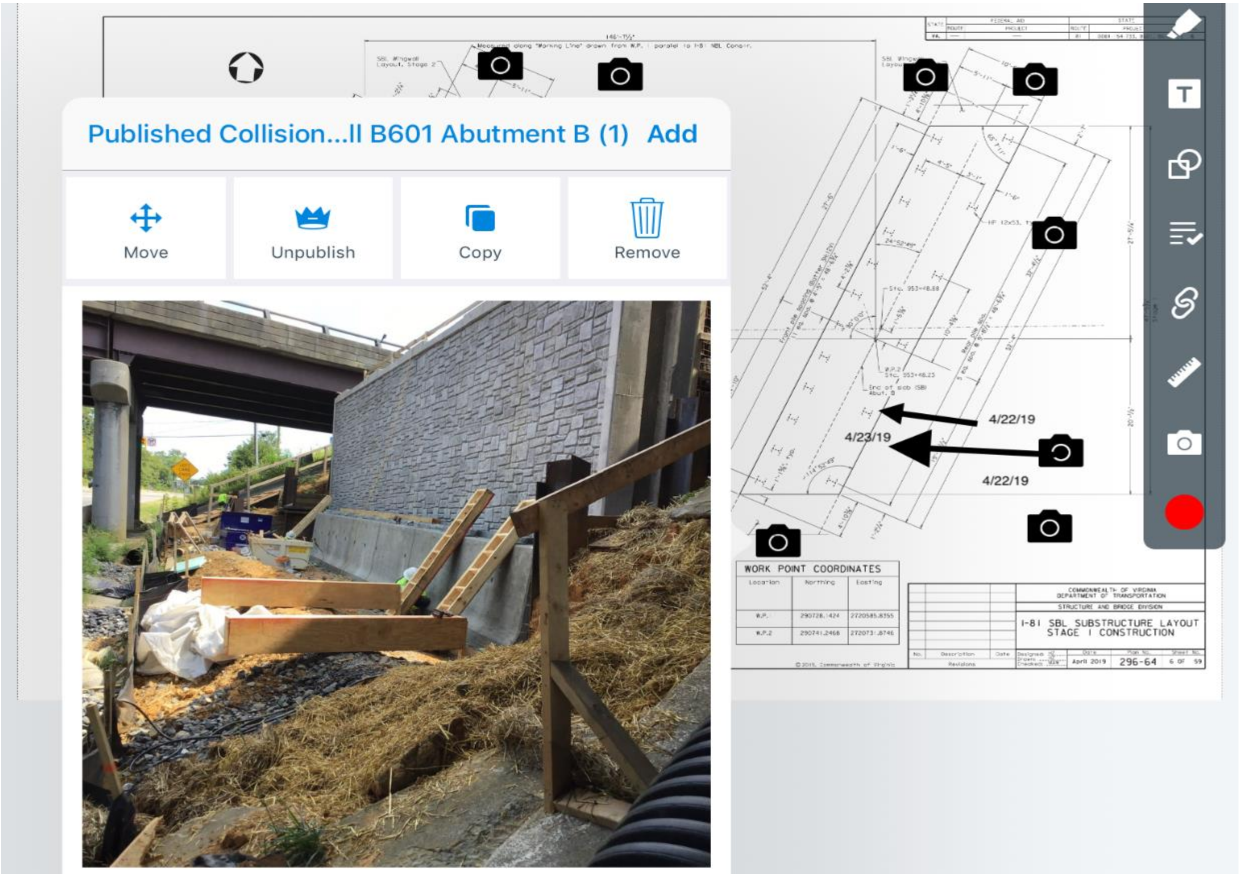




PlanGrid

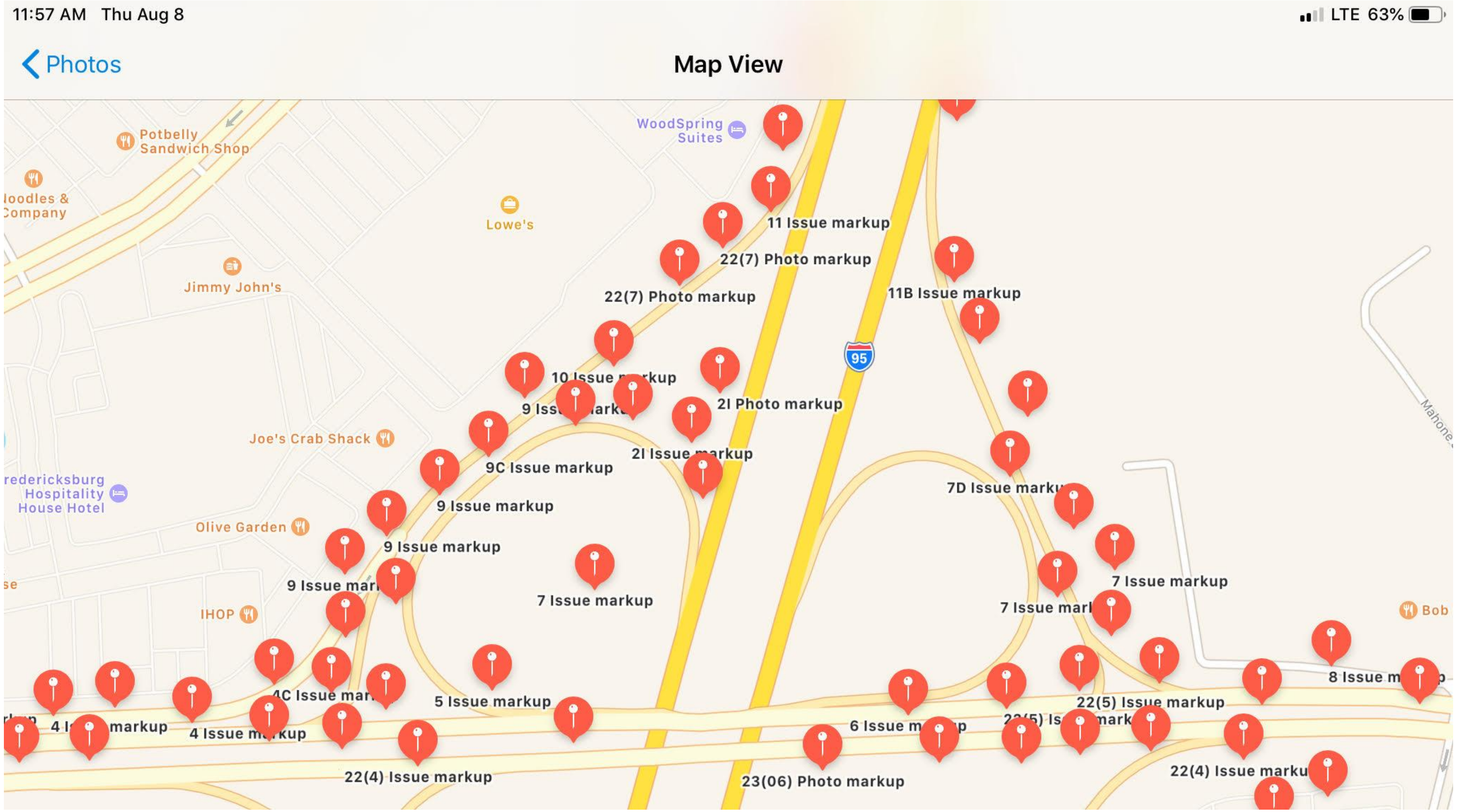
Take progress photos and tag them to the plans





PlanGrid

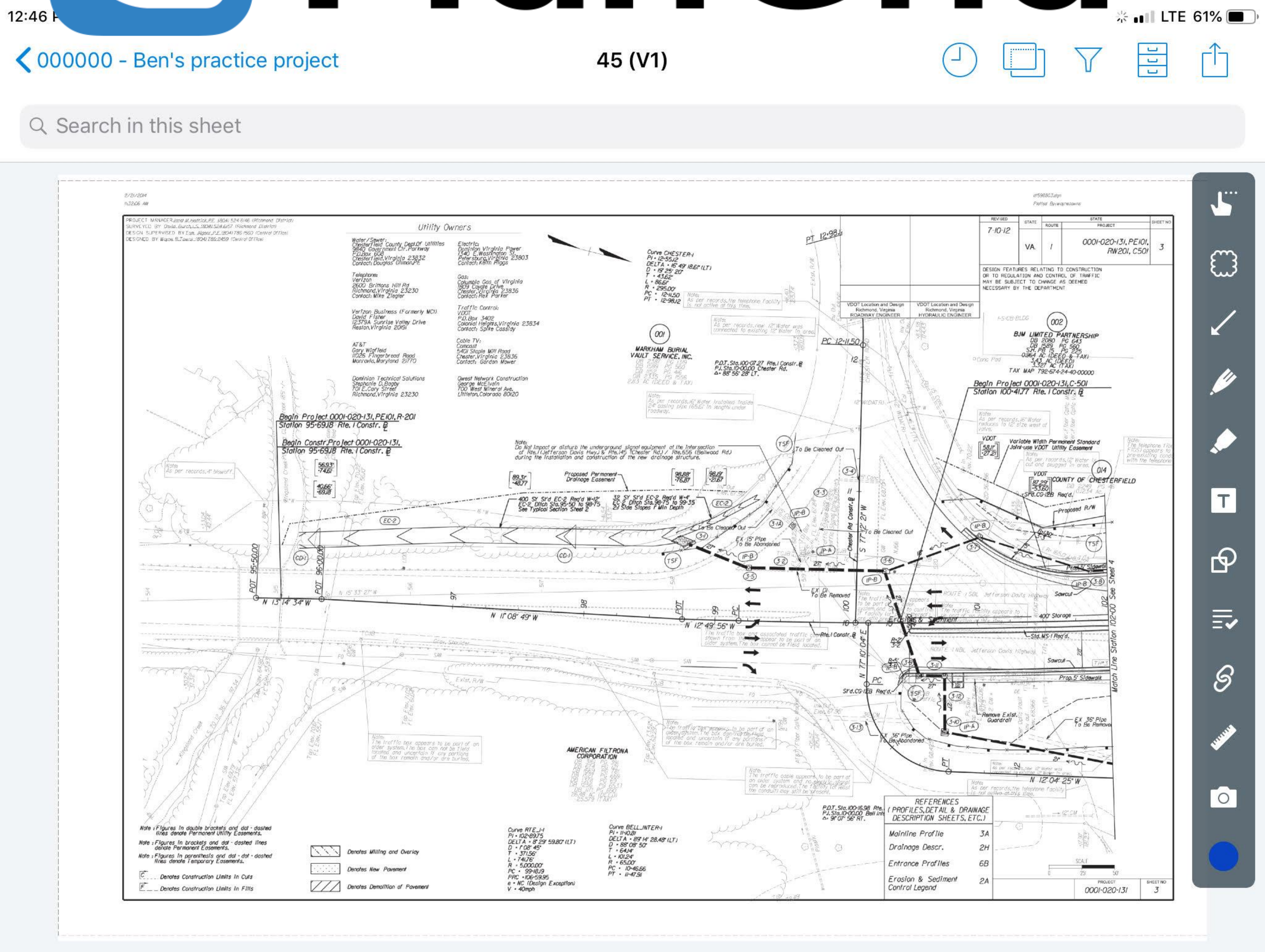
Take progress photos and tag them to the plans

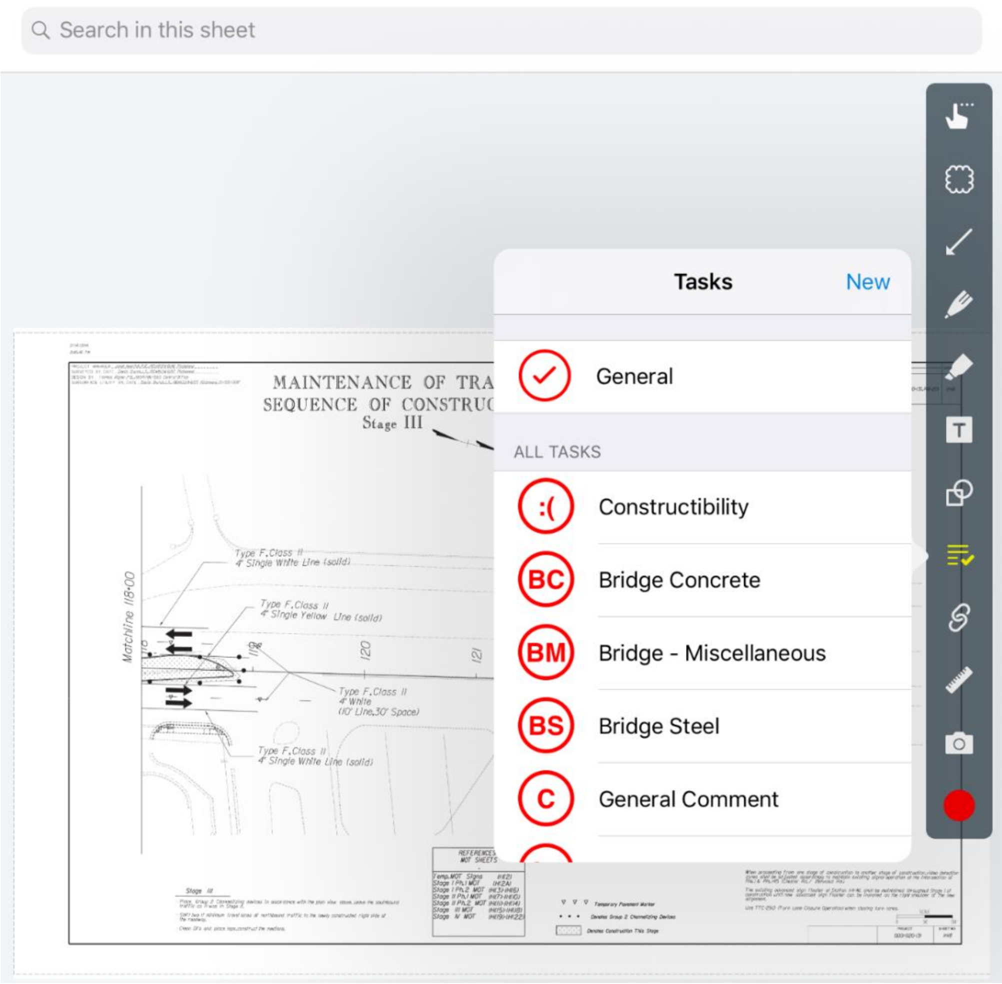


Network for Success
Local Programs Workshop
VDOT

PlanGrid

Identify issues, assign responsible parties, and track resolutions

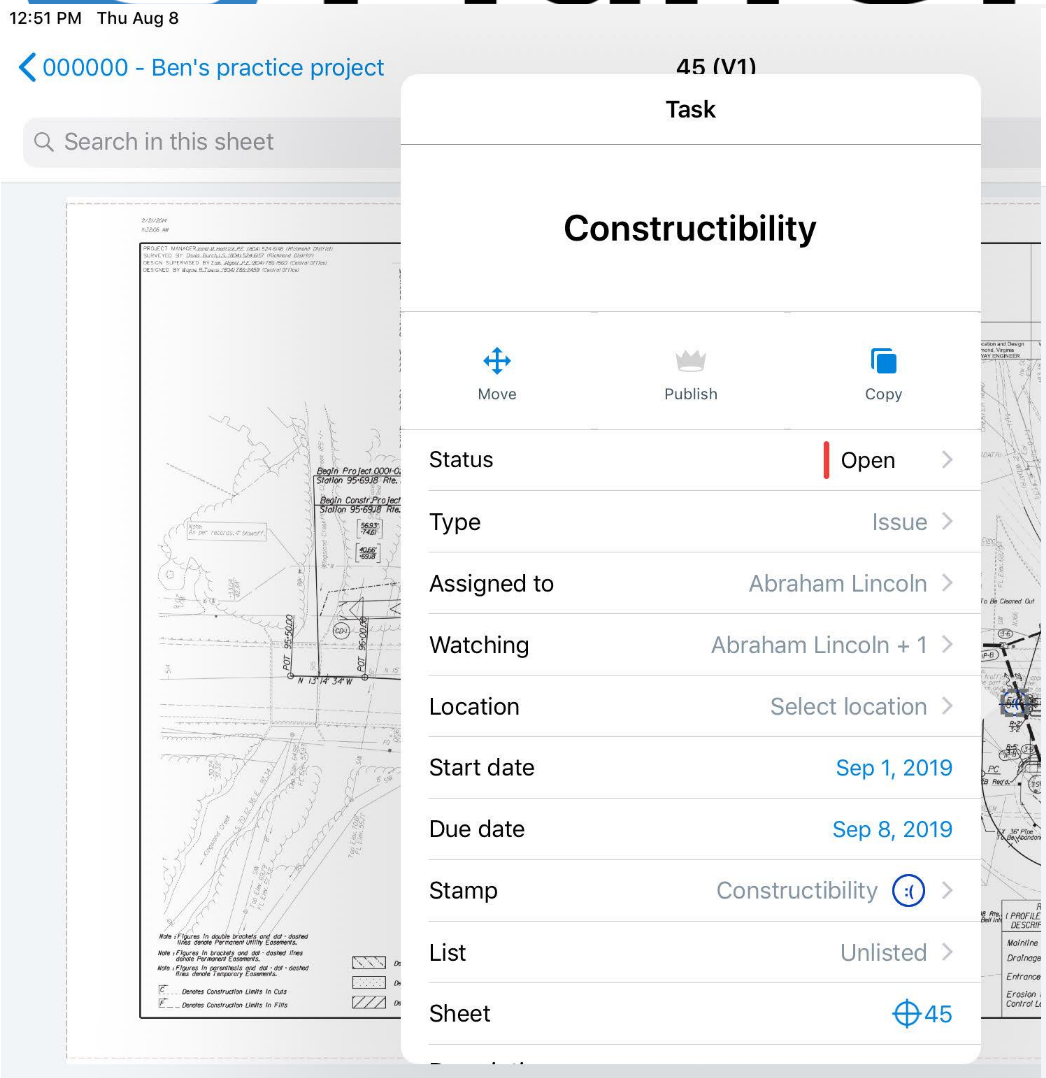


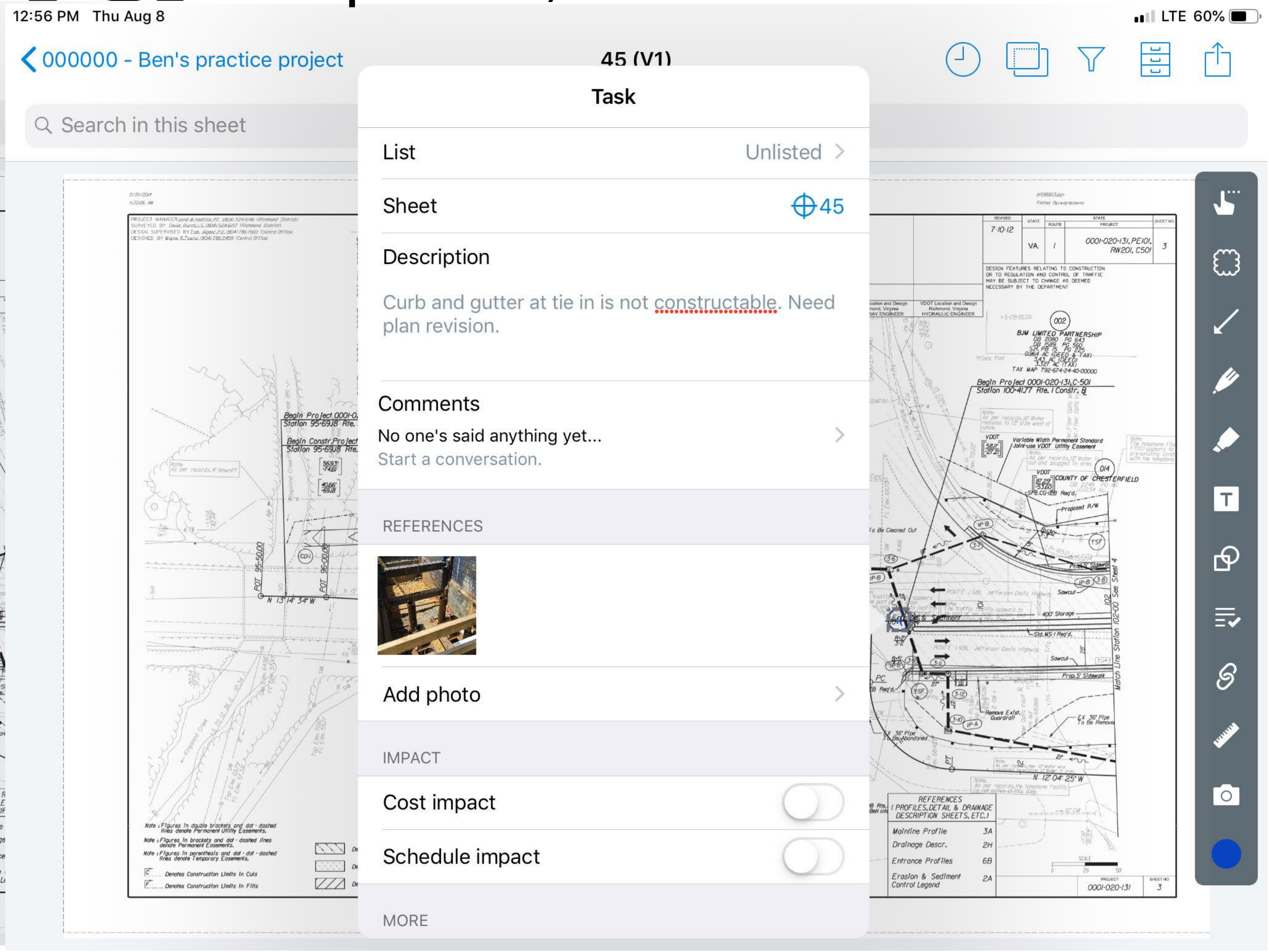


Network for Success
Local Programs Workshop
VDOT

PlanGrid

Identify issues, assign responsible parties, and track resolutions

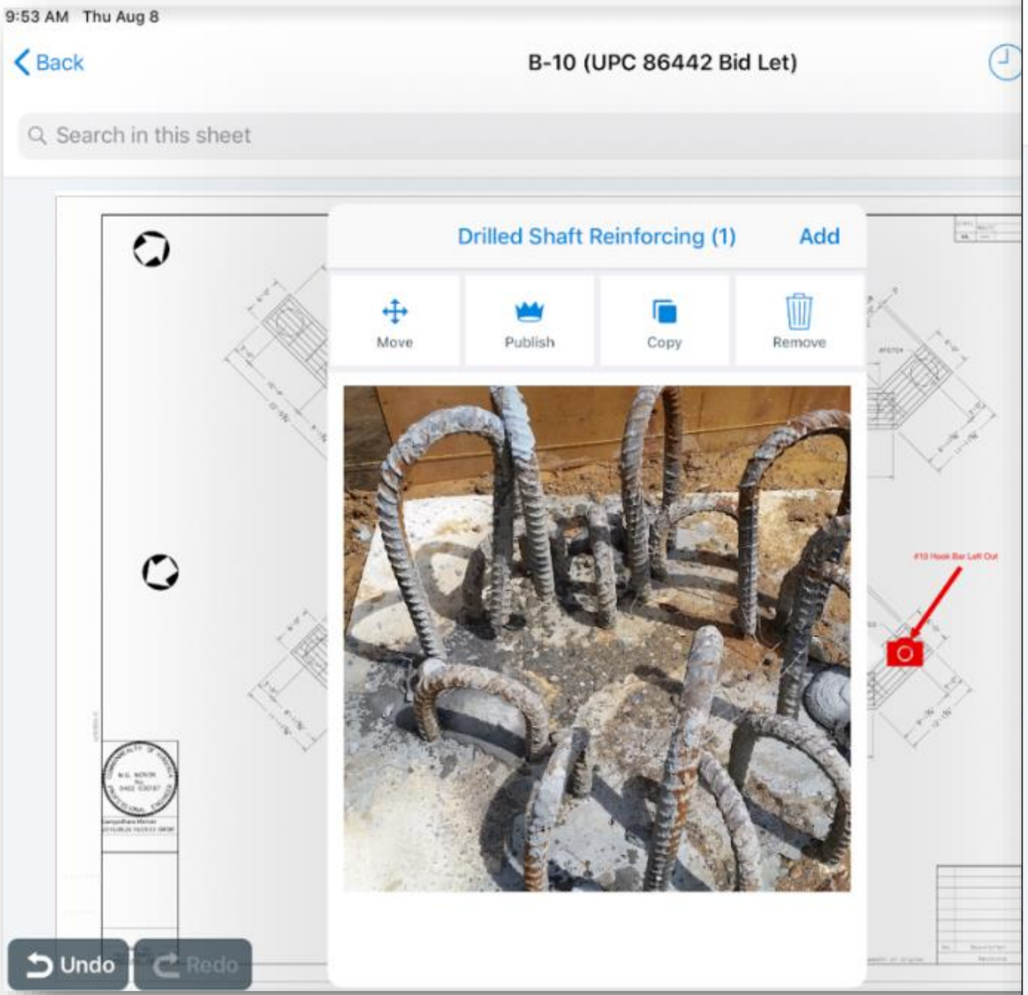


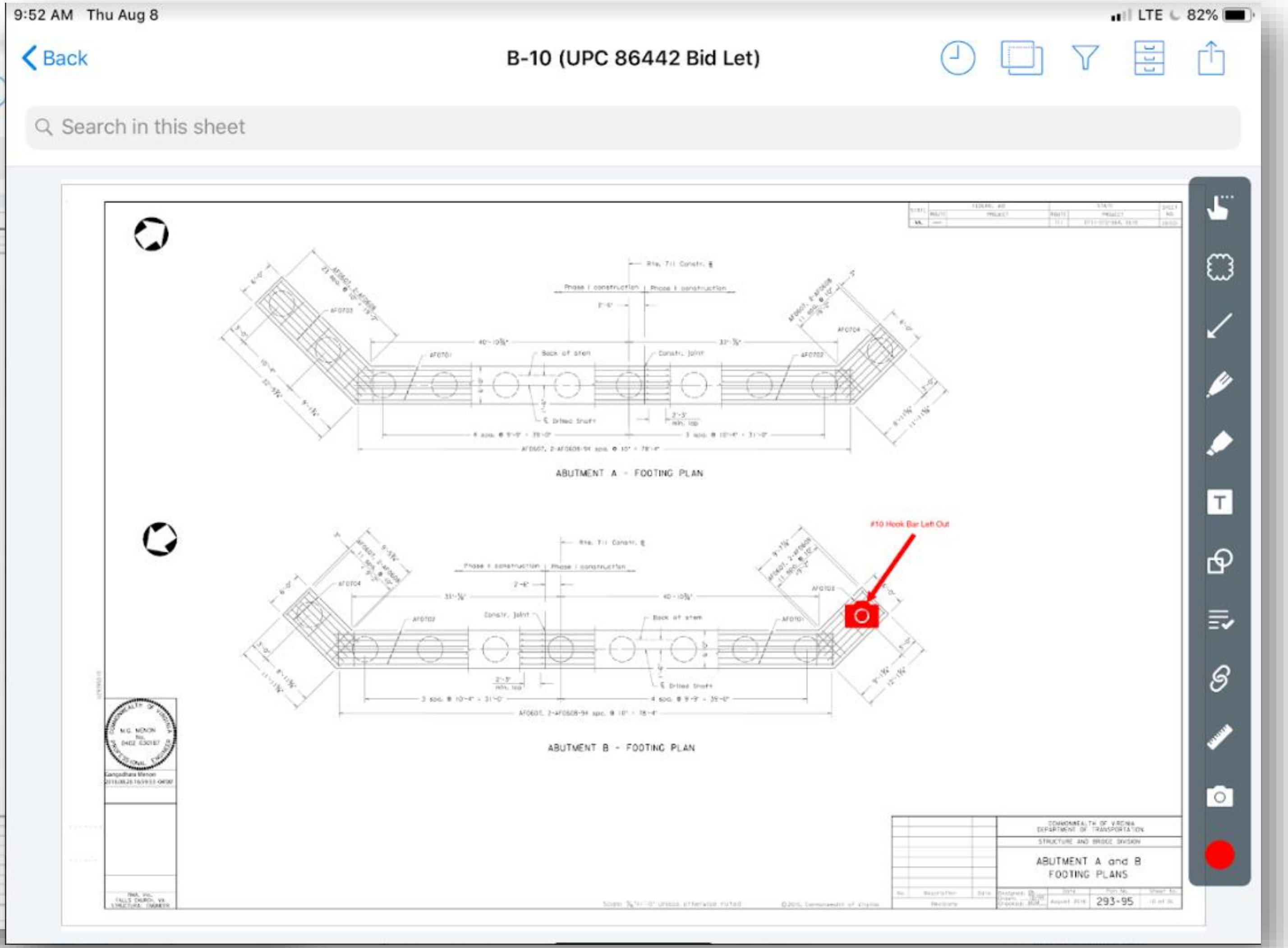


Network for Success
Local Programs Workshop
VDOT

PlanGrid

Collaborate with design team instantly

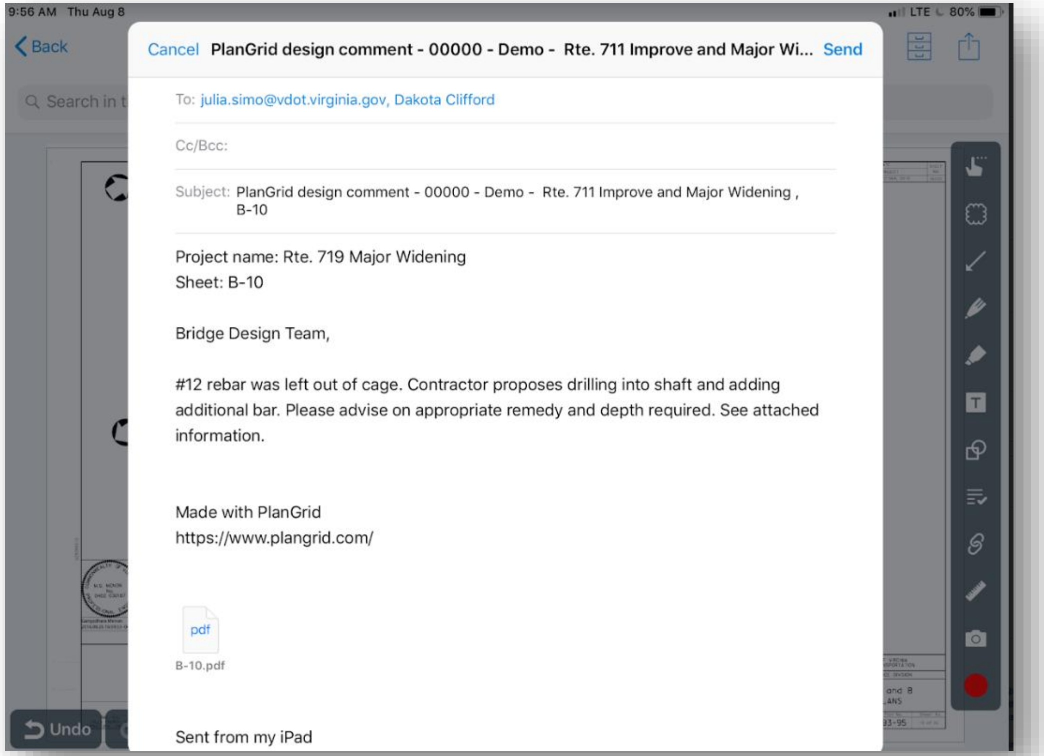




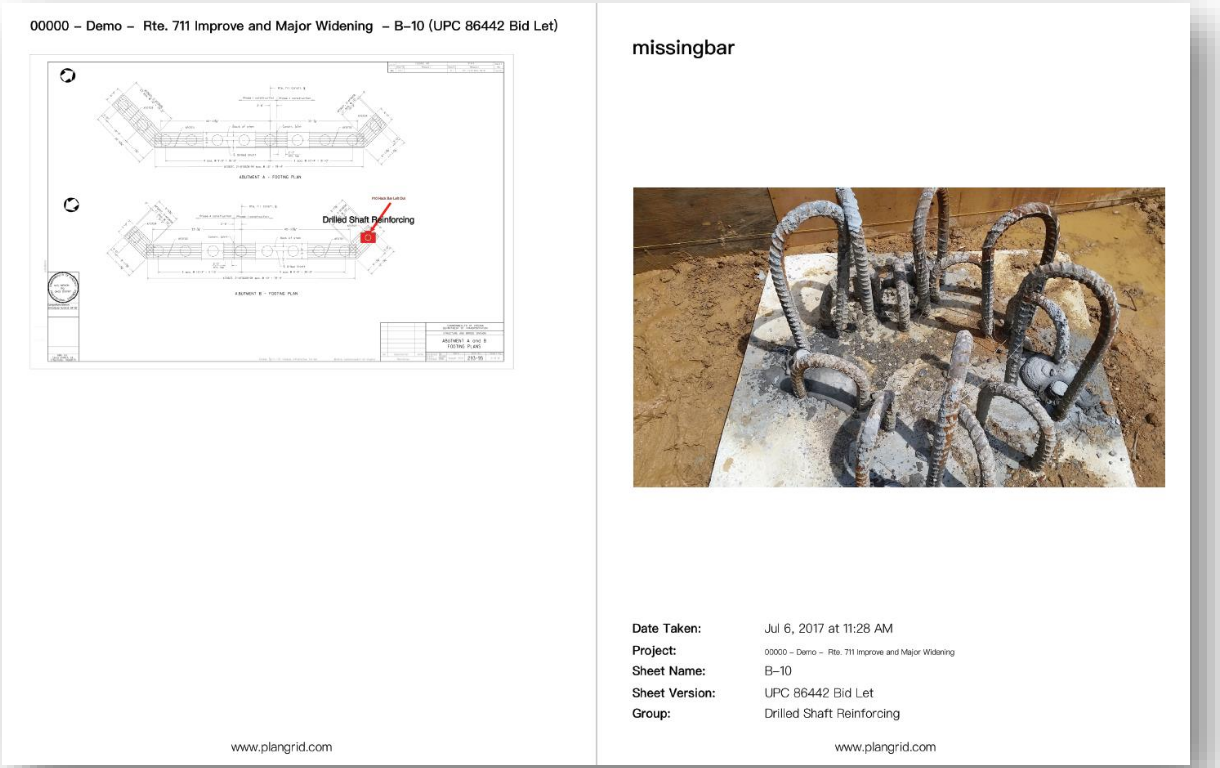
Network for Success
Local Programs Workshop
VDOT

PlanGrid

Collaborate with design team instantly



Email sent directly from PlanGrid



PDF Package generated by PlanGrid.

PlanGrid

Pilot Study Results

94%

Users say PlanGrid makes them more efficient

87%

Users view plans more frequently because of PlanGrid

PlanGrid

Pilot Study Results

3.6

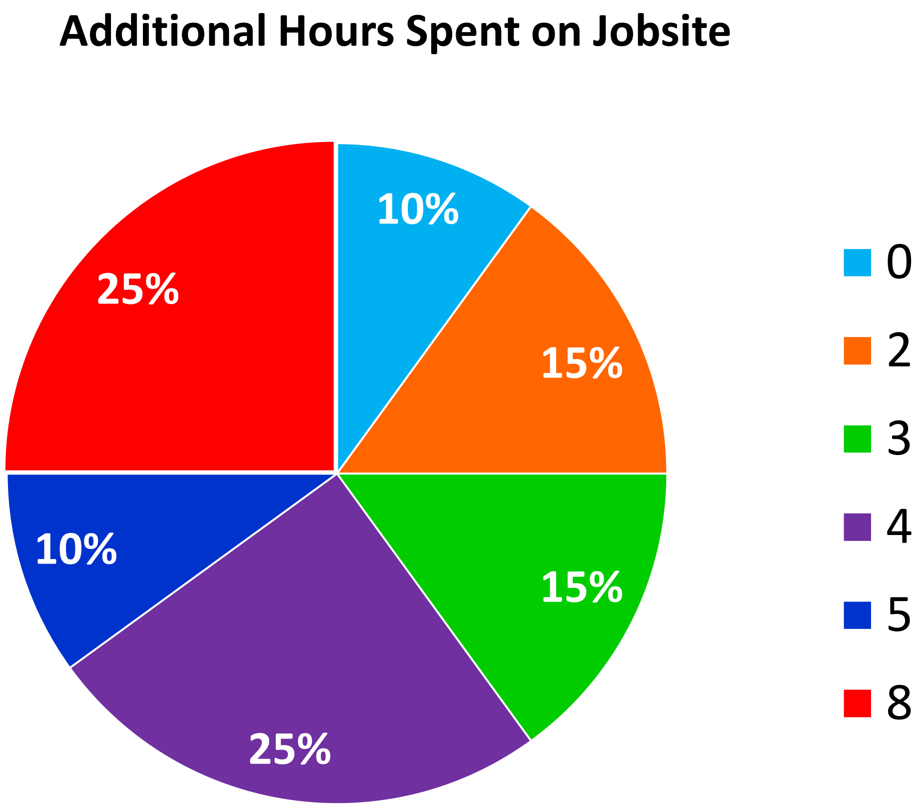
Average Total hours/week saved

4.2

Additional hours/week spent on jobsite by inspectors

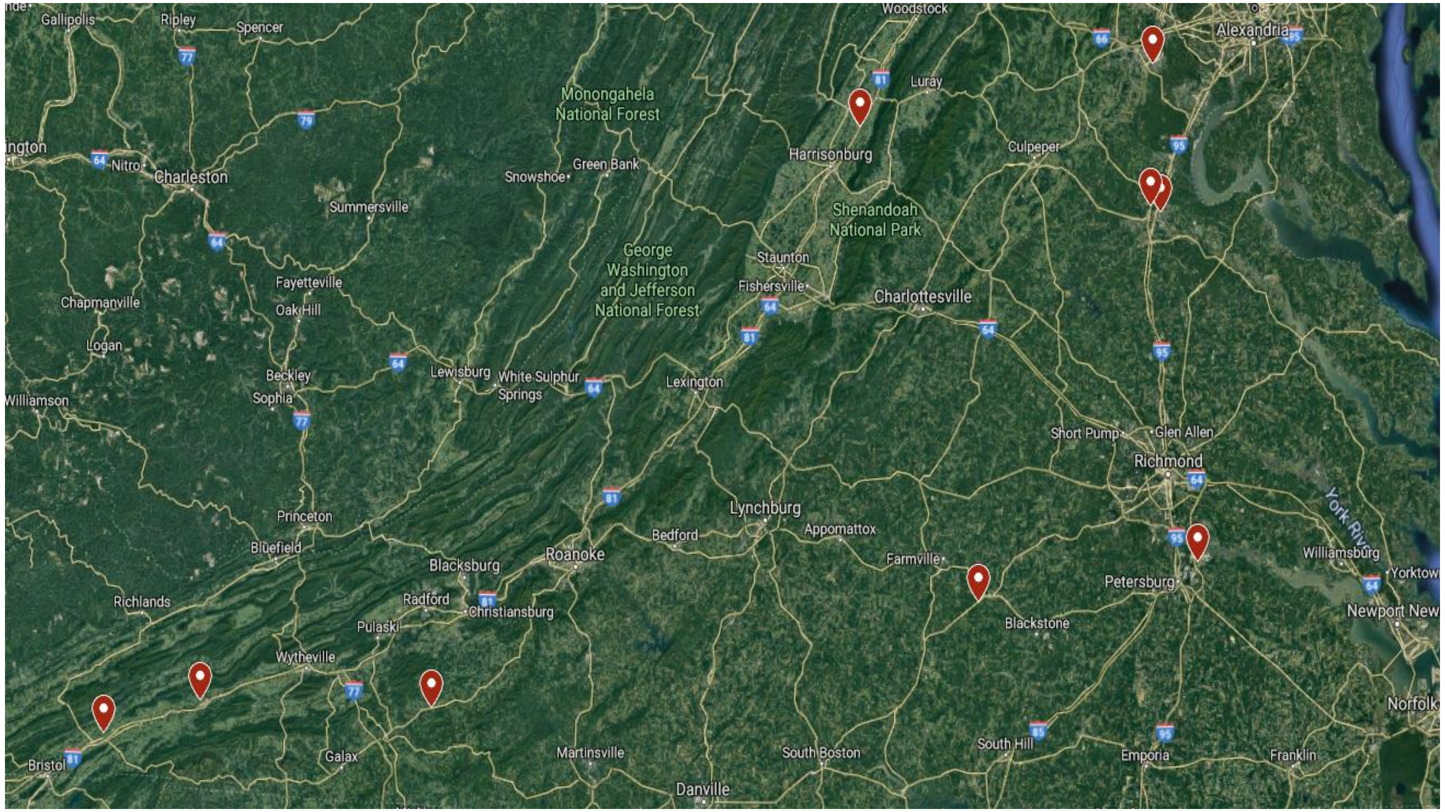
16

Additional photos taken per week per inspector



HEADLIGHT®

paviasystems



8

Districts

9

Projects

45

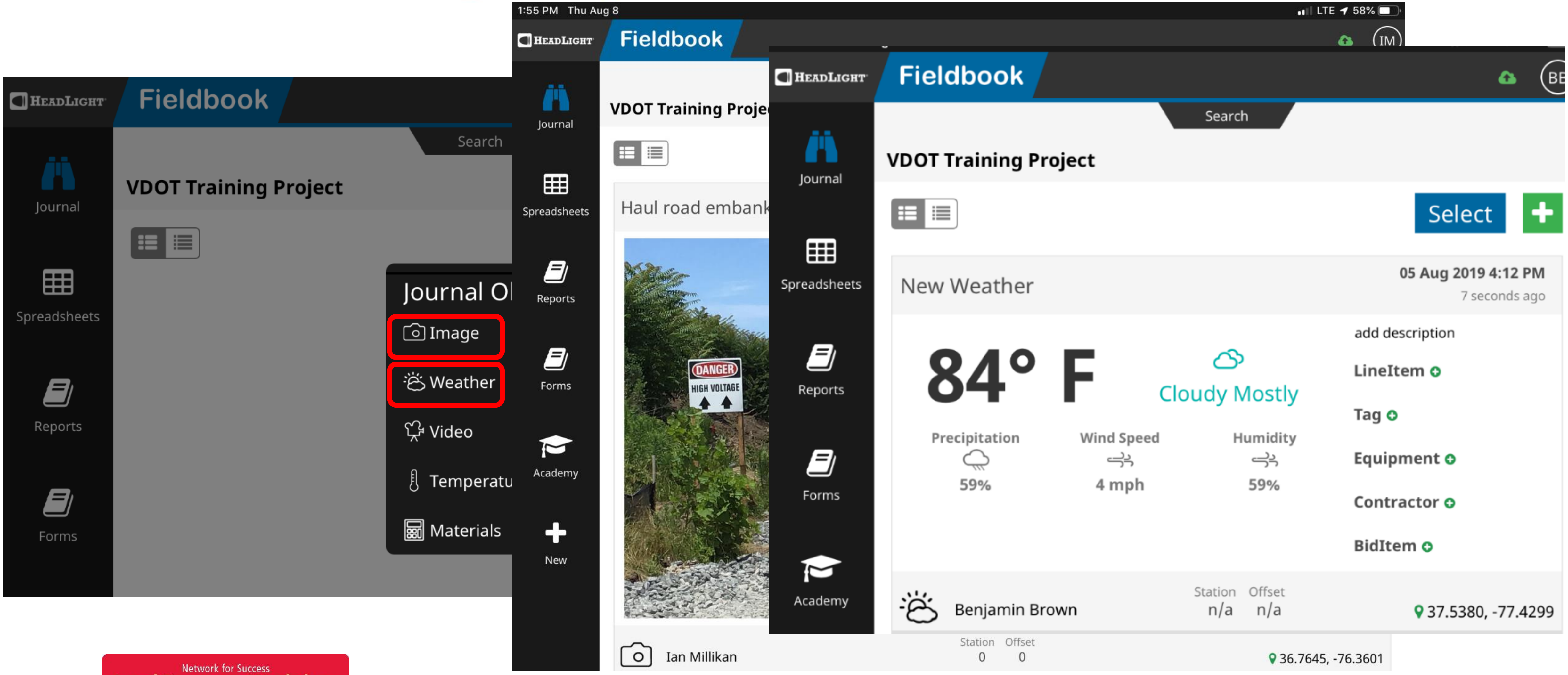
Users

Network for Success
Local Programs Workshop
VDOT

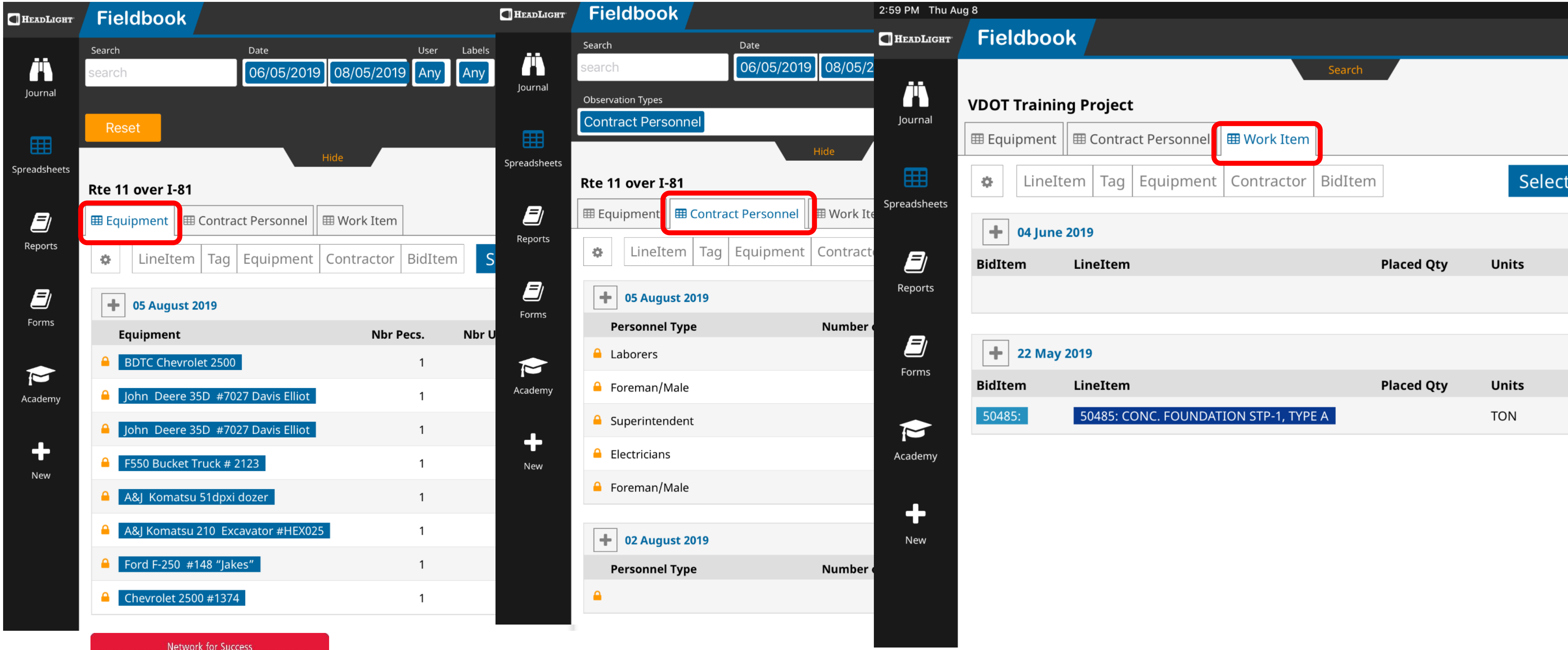
HeadLight®
paviasystems

- Input field observations (weather, work activities, etc.)
- Identify labor, equipment, and materials
- Complete materials testing reports
- Develop daily diaries
- Generate monthly list of completed work items
- Programmatic level reporting

Input field observations



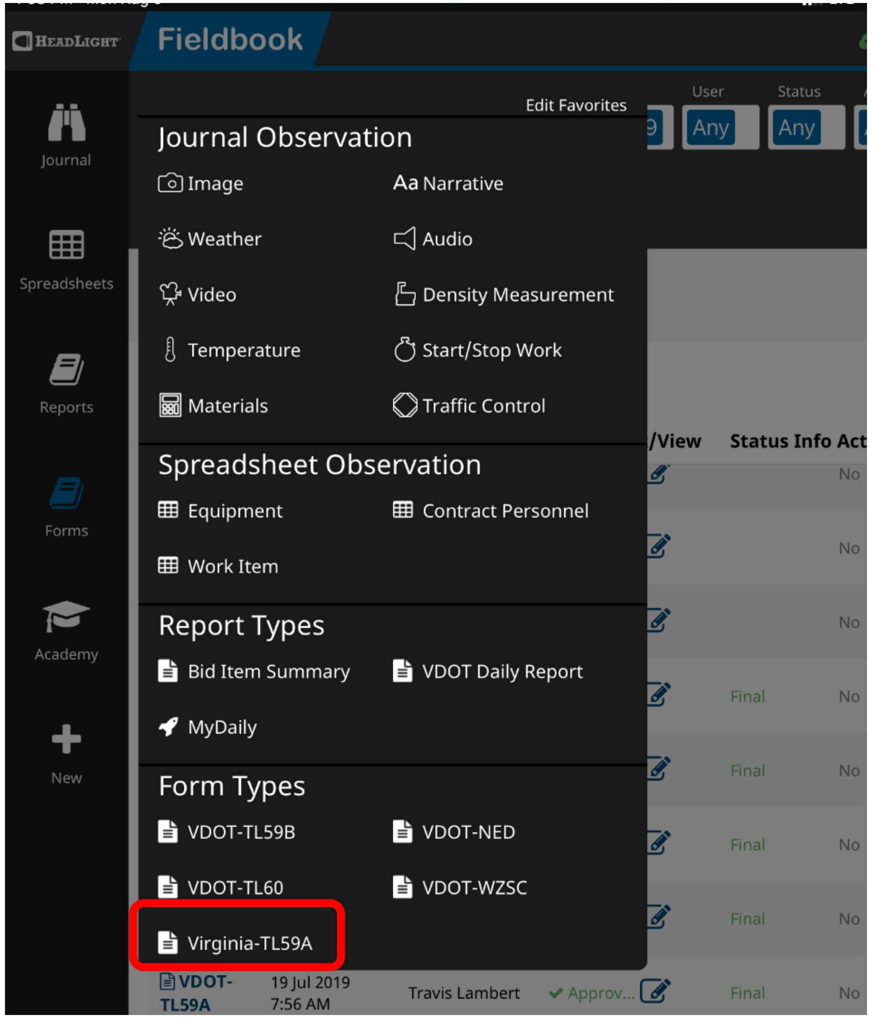
Identify labor, equipment, and materials

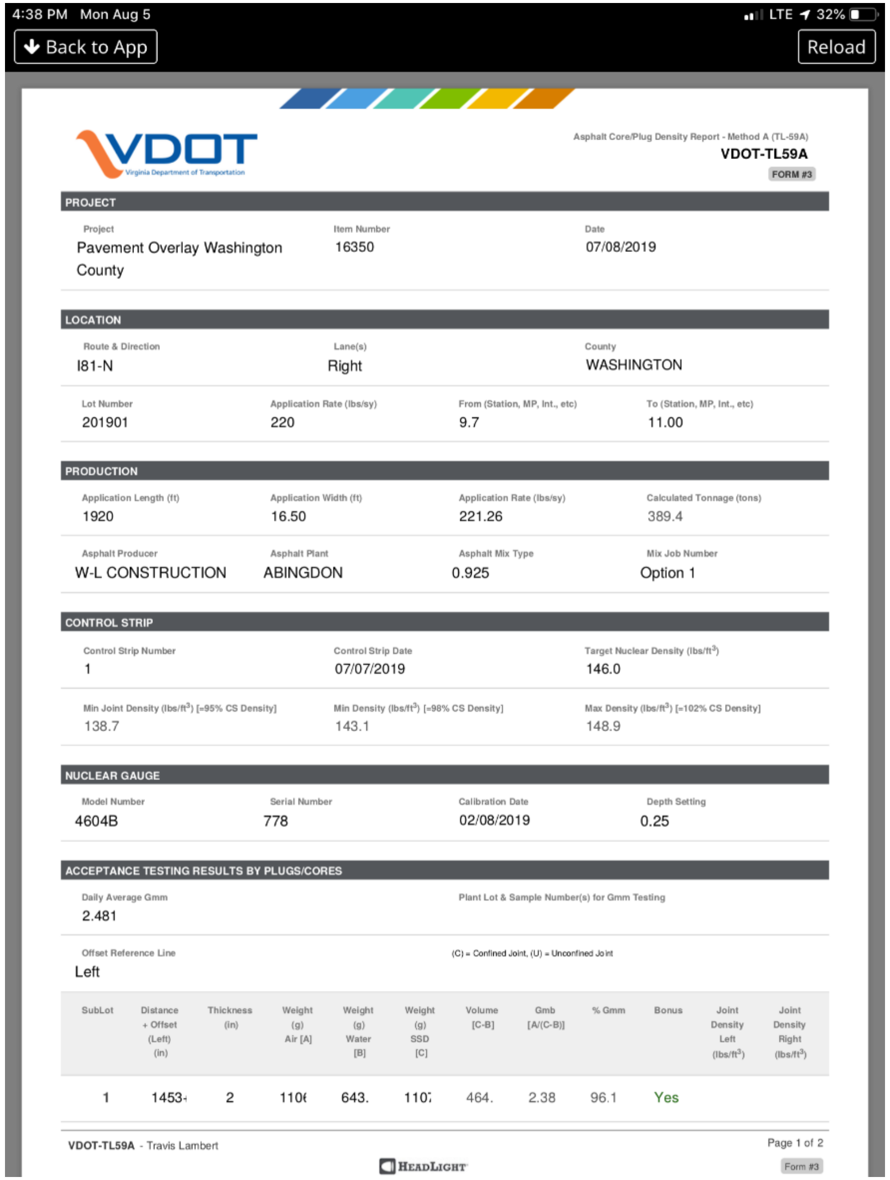


Network for Success
Local Programs Workshop
VDOT

HEADLIGHT®
paviasystems

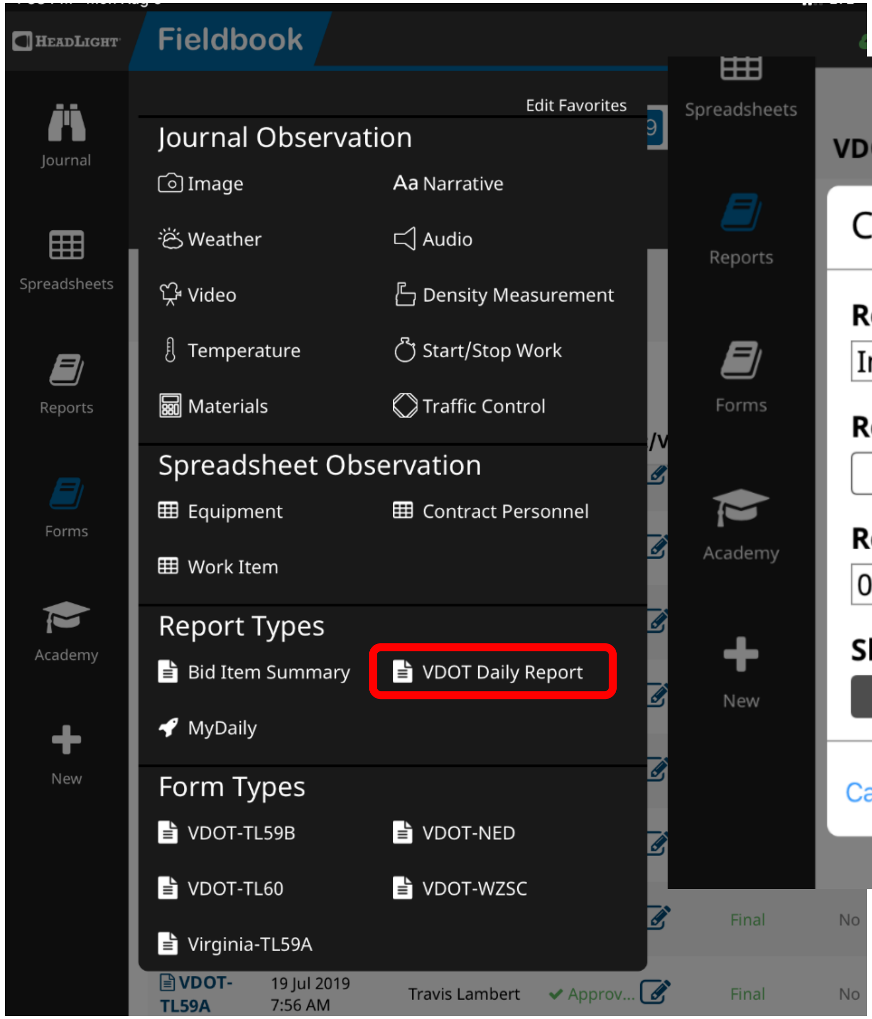
Complete materials testing reports

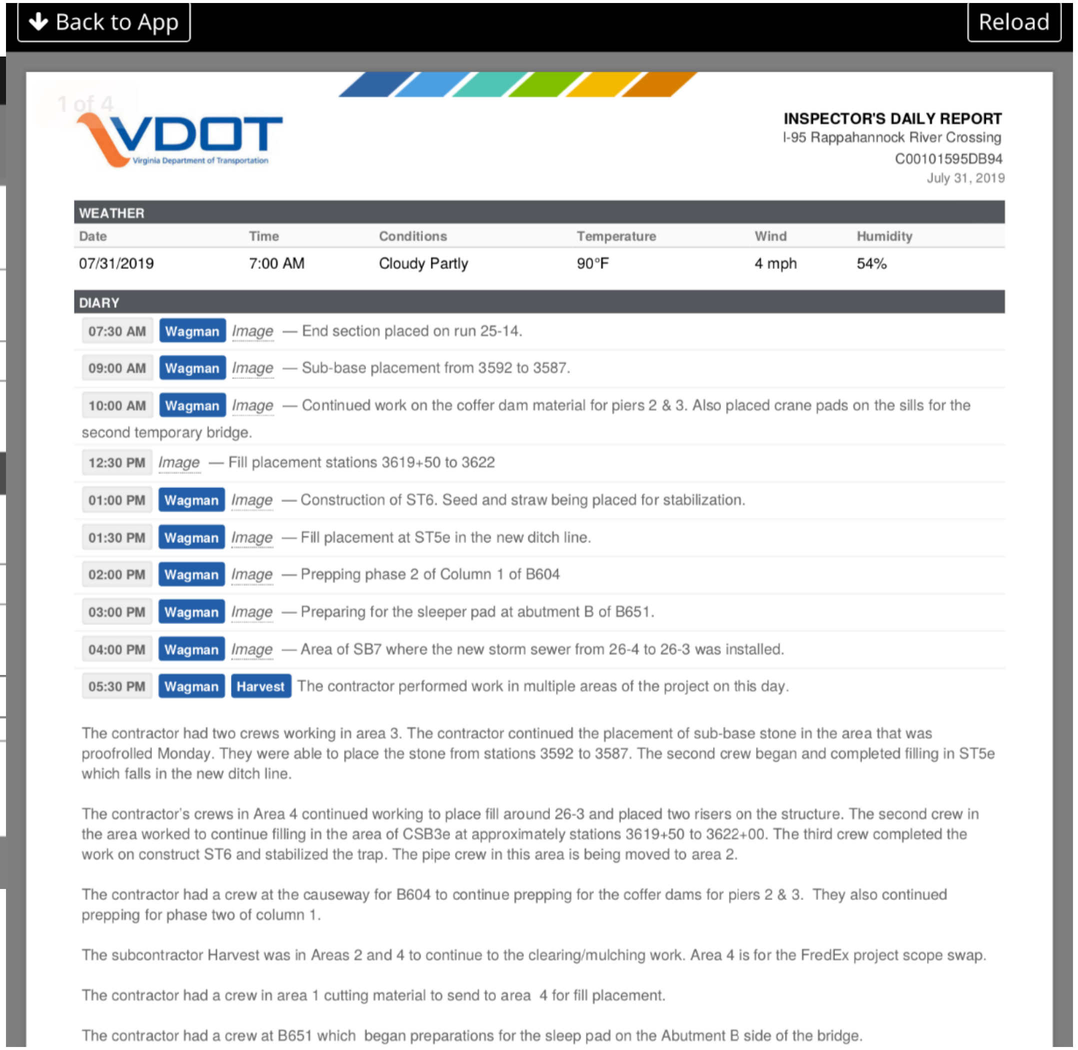




Network for Success
Local Programs Workshop
VDOT

Develop daily diaries





INSPECTOR'S DAILY REPORT
I-95 Rappahannock River Crossing
C00101595DB94
July 31, 2019

WEATHER

Date	Time	Conditions	Temperature	Wind	Humidity
07/31/2019	7:00 AM	Cloudy Partly	90°F	4 mph	54%

DIARY

- 07:30 AM Wagman *Image* — End section placed on run 25-14.
- 09:00 AM Wagman *Image* — Sub-base placement from 3592 to 3587.
- 10:00 AM Wagman *Image* — Continued work on the coffer dam material for piers 2 & 3. Also placed crane pads on the sills for the second temporary bridge.
- 12:30 PM *Image* — Fill placement stations 3619+50 to 3622
- 01:00 PM Wagman *Image* — Construction of ST6. Seed and straw being placed for stabilization.
- 01:30 PM Wagman *Image* — Fill placement at ST5e in the new ditch line.
- 02:00 PM Wagman *Image* — Prepping phase 2 of Column 1 of B604
- 03:00 PM Wagman *Image* — Preparing for the sleeper pad at abutment B of B651.
- 04:00 PM Wagman *Image* — Area of SB7 where the new storm sewer from 26-4 to 26-3 was installed.
- 05:30 PM Wagman Harvest The contractor performed work in multiple areas of the project on this day.

The contractor had two crews working in area 3. The contractor continued the placement of sub-base stone in the area that was proofrolled Monday. They were able to place the stone from stations 3592 to 3587. The second crew began and completed filling in ST5e which falls in the new ditch line.

The contractor's crews in Area 4 continued working to place fill around 26-3 and placed two risers on the structure. The second crew in the area worked to continue filling in the area of CSB3e at approximately stations 3619+50 to 3622+00. The third crew completed the work on construct ST6 and stabilized the trap. The pipe crew in this area is being moved to area 2.

The contractor had a crew at the causeway for B604 to continue prepping for the coffer dams for piers 2 & 3. They also continued prepping for phase two of column 1.

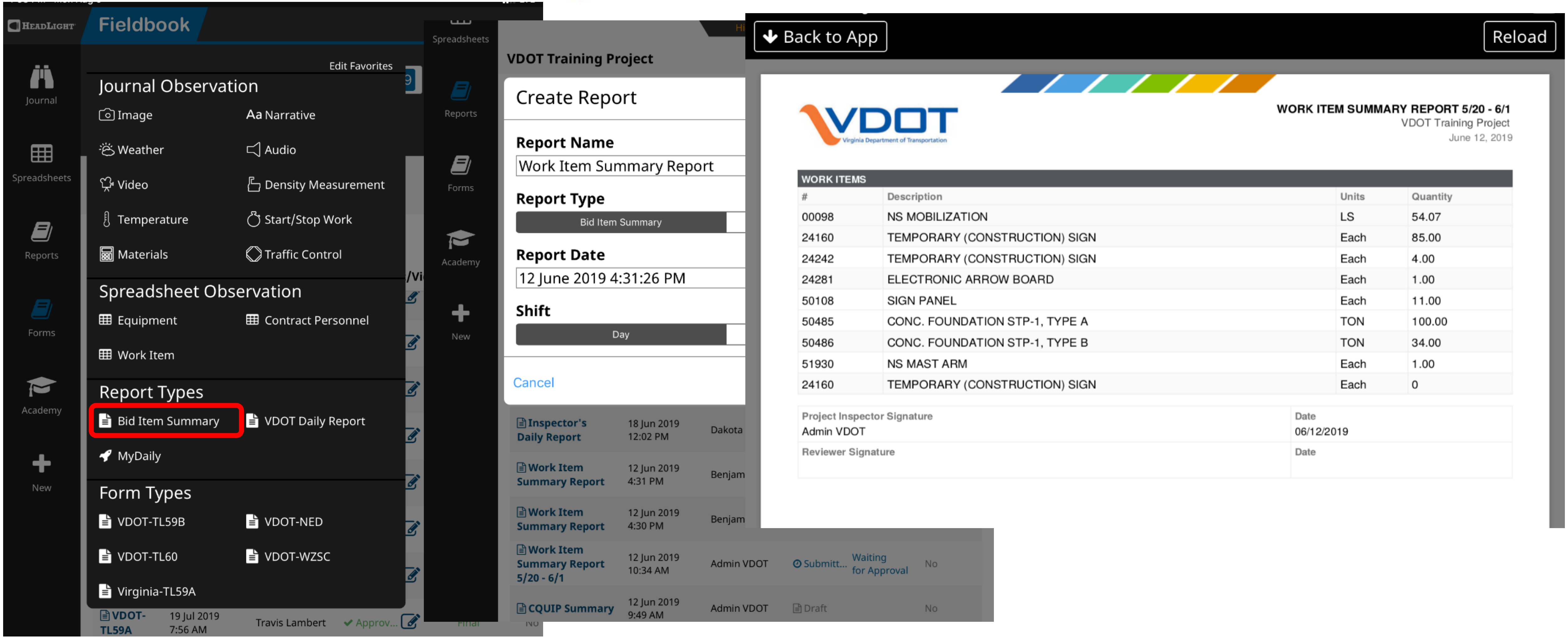
The subcontractor Harvest was in Areas 2 and 4 to continue to the clearing/mulching work. Area 4 is for the FredEx project scope swap.

The contractor had a crew in area 1 cutting material to send to area 4 for fill placement.

The contractor had a crew at B651 which began preparations for the sleep pad on the Abutment B side of the bridge.

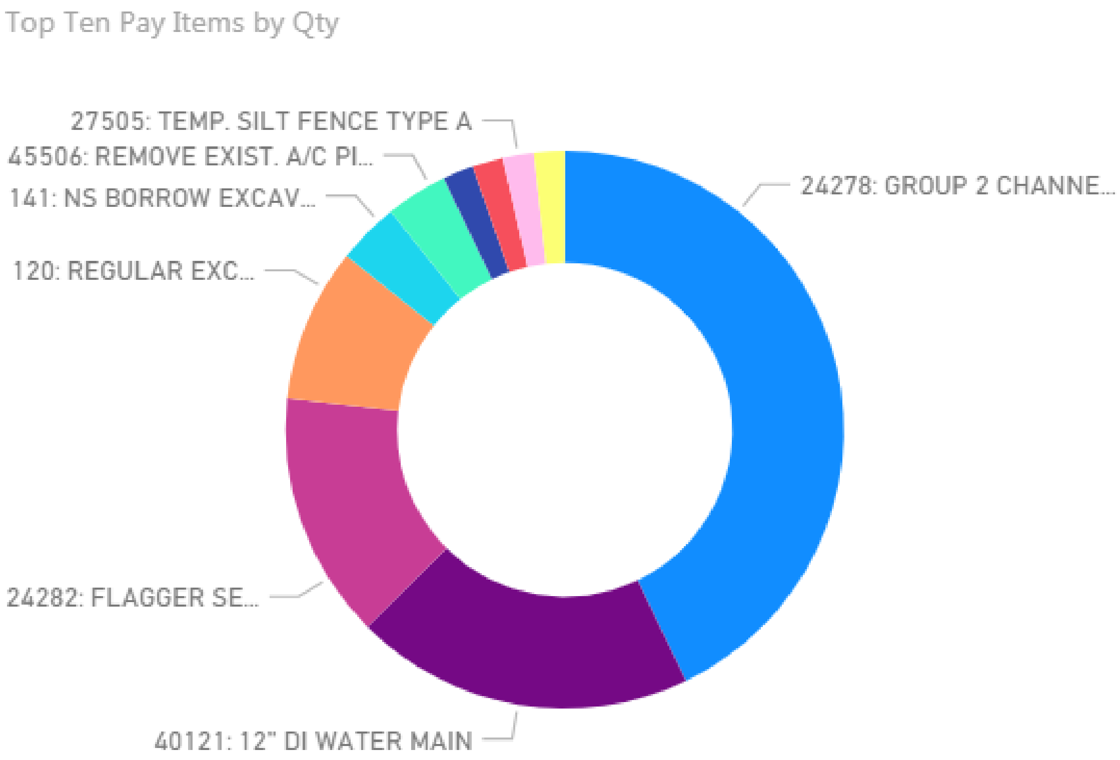
Network for Success
Local Programs Workshop

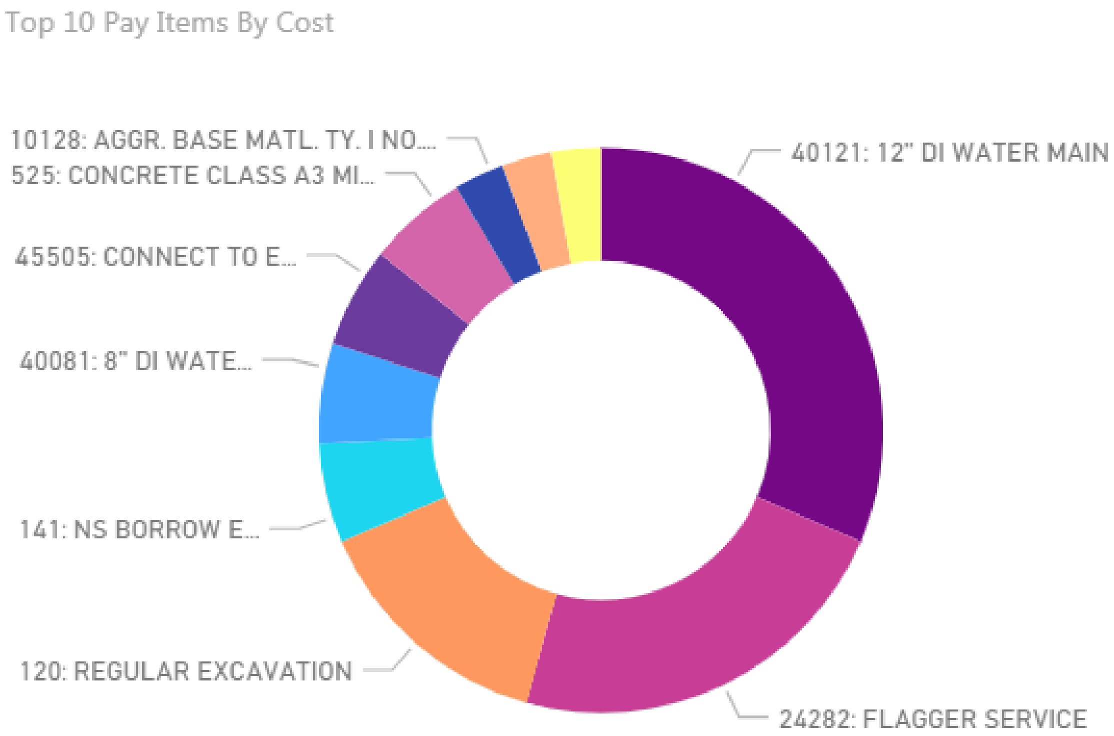
Generate List of completed work items



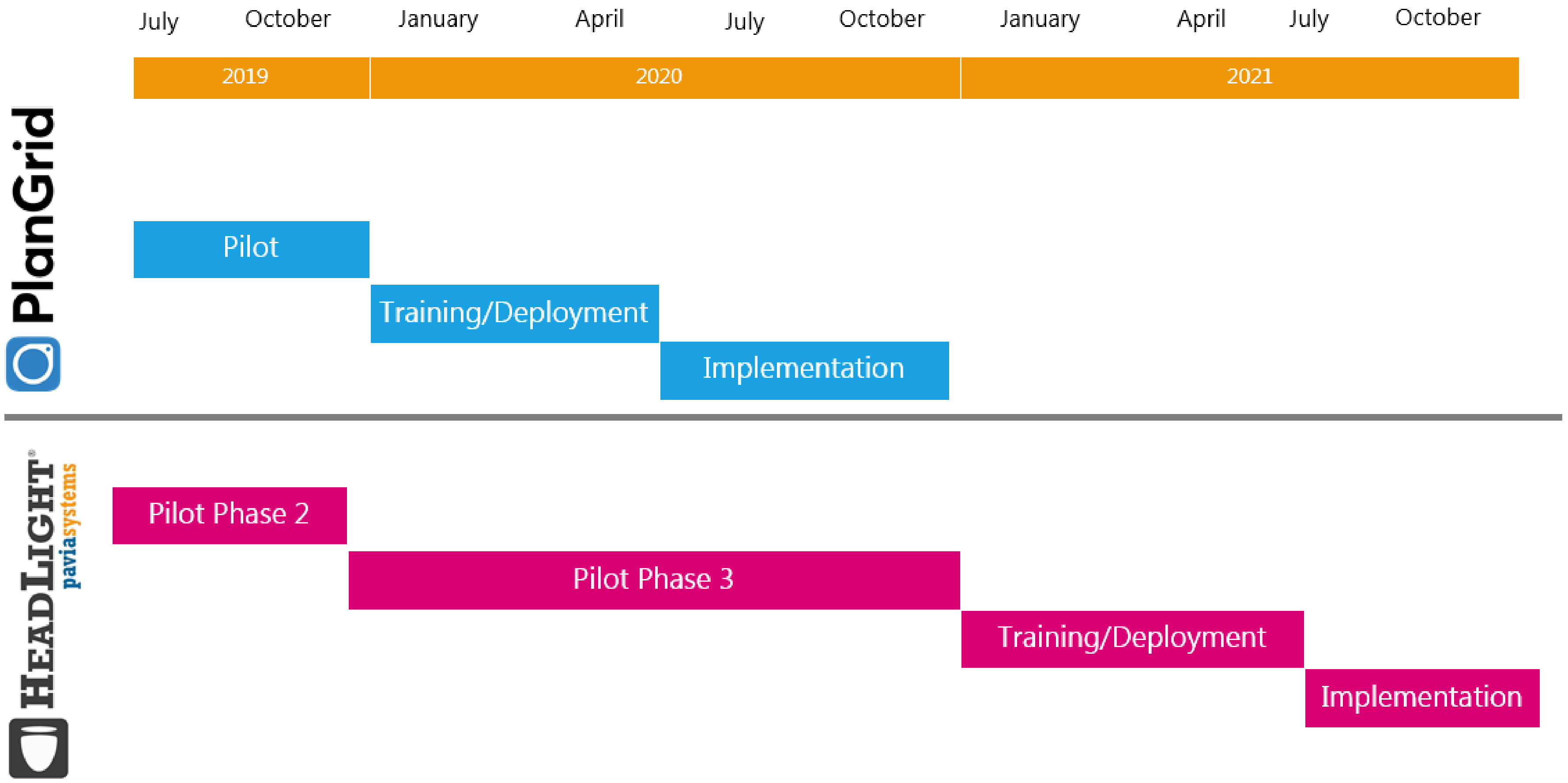
Network for Success
Local Programs Workshop

Programmatic Level Data and Reporting





Implementation Timeline



Contact Information

Ian Millikan, P.E. , PMP, DBIA

Assistant State Construction Engineer

Virginia Department of Transportation

o: 804-786-2045 | c: 804-310-0216

ian.millikan@vdot.virginia.gov

Questions?

Network for Success

Local Programs Workshop

VDOT Virginia Department of Transportation

Unmanned Aerial Systems and their Applications for DOTs and Local Governments

Chris Dodson
Principle-Director of Field Services
Timmons Group

Acronyms and Terms:

- **UAS:** Unmanned Aerial System
- **UAV:** Unmanned Aerial Vehicle
- **AR:** Augmented Reality
- **VR:** Virtual Reality
- **COA**: Certificate of Authorization
- **FAA:** Federal Aviation Administration; U.S. Department of Transportation Agency with the power to regulate and oversee civil aviation
- **LiDAR:** Light Detection and Ranging; remote sensing technology for mapping
- **AWP:** Aerial work platforms; Common method of bridge inspection involving equipment like bucket-trucks, snoopers, lifts, etc.
- **HMD**: A head-mounted display or augmented reality display device
- **Collision/Obstacle Avoidance:** A vision system that allows UASs to detect obstacles and avoid collision.

Figure 1: DJI Matrice 600 field deployment by Timmons Group

Network for Success
Local Programs Workshop
VDOT

Background

- An Unmanned Aerial System (UAS), commonly referred to as a drone, is an aircraft controlled by an operator on the ground.
- The term Unmanned Aerial Vehicle (UAV) has been used interchangeably with UAS.
- The UAS is controlled either autonomously or by a pilot on the ground with a remote control.
- Camera feed can be viewed live from a monitor or through goggles.
- Demand for UASs is growing in both the public and private sectors, with transportation and civil applications growing.

VDOT and LAP Applications

Bridge Inspection[8]:

- UAS technology is a cost-effective and safe approach to the logistical challenges of bridge inspections.
- As technology evolves inspection-specific features are coming into the marketplace that will increase overall effectiveness of bridge inspections.
- UASs with the ability to point the camera upwards and fly without a GPS are ideal for under-bridge inspections.
- Safety risks to both work crew and the traveling public are minimized. Traditional bridge inspection methods require temporary work zones, detouring traffic, and heavy equipment, unlike UAS technology.
- Drones have the capability to be used instead of aerial work platforms, providing significant savings. With drone use there is also reduced or eliminated traffic control and aerial lift costs.

VDOT and LAP Applications

Bridge Inspection:

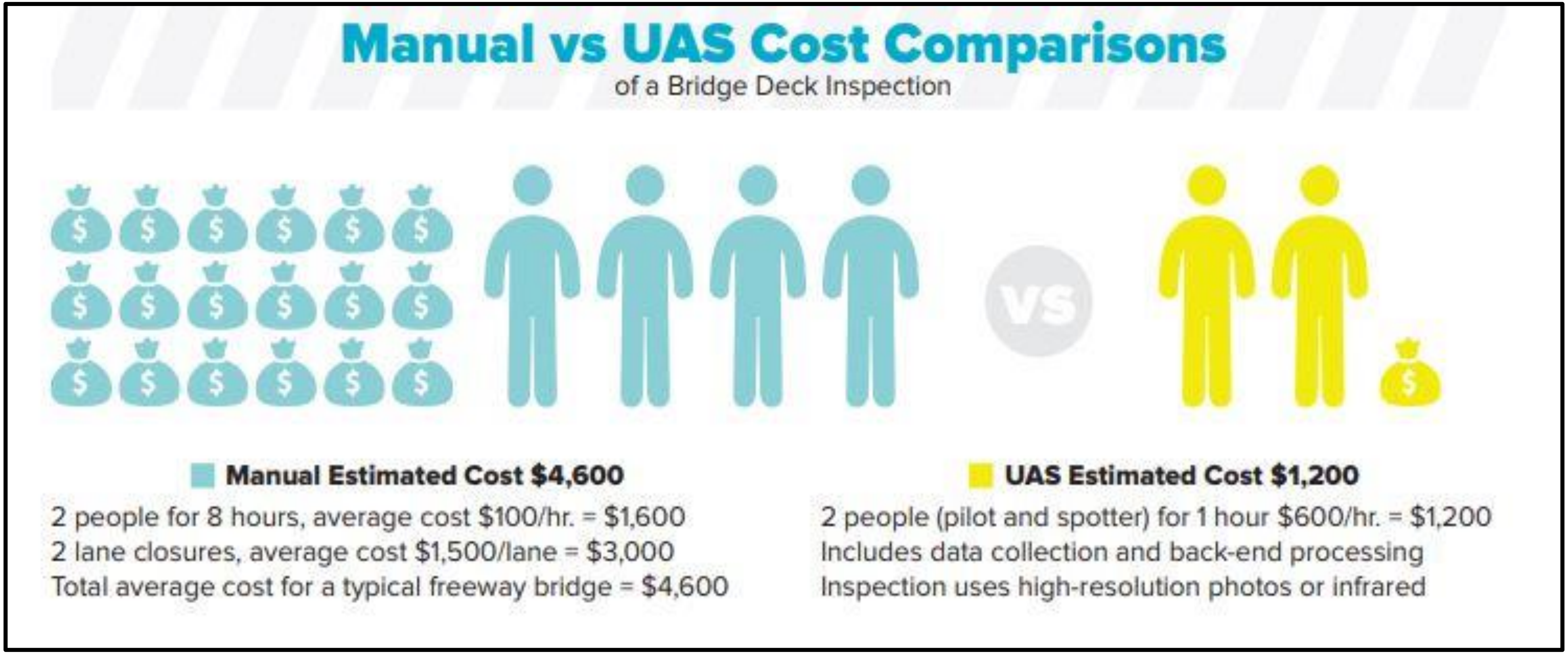


Figure 2: 2019 AASHTO UAS/Drone Survey findings[8].

VDOT and LAP Applications

Bridge Inspection[13]:

- UAS use for routine inspections improves overall quality by obtaining information not readily gathered without costly access methods.
- UASs are commonly equipped with an infrared camera. Infrared images of bridge decks and elements are a common tool to obtain information on concrete delamination.
- Algorithms, once updated, can automatically identify and quantify defects, such as spalls, delamination, and cracks.
- UASs can capture nearby waterway conditions upstream or downstream of the bridge. They can also provide large aerial maps of bank erosion and lateral scour conditions.

VDOT and LAP Applications

Bridge Inspection[2]:

- Pre-inspection planning elements are easily obtained with UAS. Common information gathered includes clearances, rope access anchor points, and general conditions .
- "Digital imagery from flights can be mosaiced, geo-referenced, and converted into 3D point clouds for detailed spatial inventorying."[11]
- Currently Michigan DOT and the Michigan Technological Research Institute are improving upon drone bridge and roadway corridor inspection and capabilities. The new computer systems and algorithms will strengthen the flow of information and help state DOTs make faster decisions regarding transportation infrastructure.

VDOT and LAP Applications

Bat Inventory Inspection:

- U.S. Fish & Wildlife Service and Virginia Dept. of Transportation provide guidelines for visual bat inventory inspections.[20 & 21]
- Visual and infrared inspections for evidence of bat presence are easily conducted with UASs. Bridges spanning wide floodplains provide excellent roosting and food sources. UASs allow for rapid, safe inspections without the need for snooper trucks, lane closures, or inspection personnel contacting bat droppings.[20 & 21]
- New drone designs, such as the DJI Matrice 200 and Parrot Anafi, provide top mounted gimbals and 180° vertical-swivel gimbals that allow for upward-looking inspections below structures.[22-24]

Bridge Inspection

Figure 3: Bridge details taken by Timmons Group with the DJI Phantom 4 Pro UAS.

Bridge Inspection

Figure 4 and 5: Bridge details taken by Timmons Group with the DJI Phantom 4 Pro UAS.

Bridge Inspection-Drone Platforms

Figure 6, 7 and 8: DJI Matrice 200 top mount; Parrot Anafi; Zenmeuse XT-2 IR sensor.[22-24]

VDOT and LAP Applications

Pavement Evaluation:

- UAS payload options allow for a variety of road and bridge surface analyses via remote sensing.
- UASs equipped with an infrared (IR) camera can be utilized to detect subsurface irregularities in asphalt roadways and delaminations in reinforced concrete bridge decking. [25 & 26]
- Heat island effect reduces applicability in urban settings for IR remote sensing accuracy. [25]
- UAS mounted LiDAR can be utilized to measure surface deficiencies, such as potholes, to quickly determine fill quantities needed. 3D surface models can be used to identify areas prone to flooding within a 2cm elevation accuracy. [25]
- Low altitude digital photos are used to rapidly identify surface distress such as potholes, ruts, and washouts, particularly after major storm events. [25]

VDOT and LAP Applications

- **Construction Site Inspection:**
  - UASs can be used as aerial image and data capture devices to inspect and monitor construction and infrastructure projects.[15]
  - UASs can be equipped with radar, infrared, and other technology to enhance surveillance.
  - There is reduced risk to workers when drones can inspect difficult-to-reach locations or hazardous areas such as highway work zones.[4]
  - Construction inspection with UAS allows for the development of terrain models that document the construction process and assist in earthwork quantity measurement.[2]
  - Aerial images produced by UASs can be used to plan the placement of materials, the flow of workers, and to identify potential issues.
  - The faster rate of data collection operations and exact quantity calculations make for accelerated construction.[8]

VDOT and LAP Applications

The following states are examples of DOT programs incorporating UASs.[8]

- **North Carolina:** using UAS to support construction inspections and perform accident scene reconstructions to open travel lanes more quickly.
- **Ohio:** using UAS for construction inspections, traffic monitoring, and emergency response.
- **New Jersey:** using UAS for construction project monitoring, traffic incident and congestions management, structural inspections, aerial 3-D corridor mapping, and emergency response.
- **Washington:** using UAS applications for aerial roadway surveillance and potentially for avalanche control situational awareness.

Construction Site Inspection

Figure 9: Woolridge Road Widening Project, Chesterfield, VA.
Construction monitoring imagery by Timmons Group.

Figure10: Magnolia Green Parkway Extension Project, Chesterfield, VA.
Construction monitoring imagery by Timmons Group.

VDOT and LAP Applications

Roadway Asset Management

- UASs are a low-cost collection method for monitoring roadway conditions and traffic control devices.
- Any images taken with a UAS can help update the DOT GIS database. Aerial images taken by the UAS are beneficial for wetland monitoring and plant classification.[2]
- UASs ability to routinely and consistently map terrain allows problem areas to be isolated before an emergency event occurs.
- In an emergency, UAS technology can quickly survey damage for a more informed recovery operation.
- A study by the Texas A&M Transportation Institute found UASs to be capable of real-time confirmation and monitoring of a traffic incident, real-time monitoring of alternate routes, and real-time monitoring of traffic incident queueing.[14]

VDOT and LAP Applications

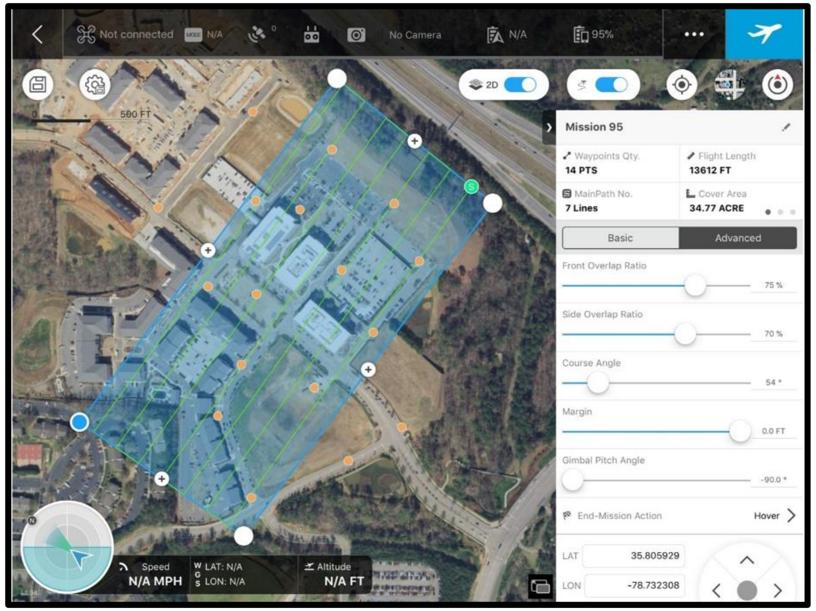
Roadway Asset Management[13]:

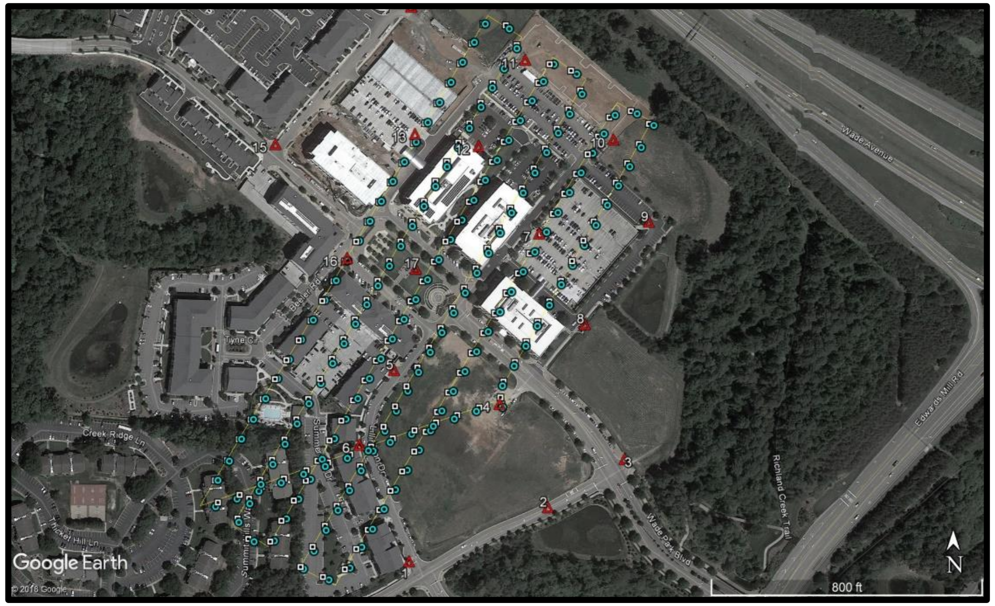
- Pilots can use UAS to assess damage to critical infrastructure and inform recovery plans.
- These operations are more cost-effective and safer than manned aircrafts after a natural disaster or major incident.
- Survey and imagery can be gathered where traditional surveying and mapping practices are unable to access.
- Recorded applications include determining flooding extent and transportation infrastructure impact, general damage assessment, and the monitoring of rising waters.
- There is inherent risk when UASs are flown near inhabited areas, however discussed risk mitigation strategies include parachutes and inflatable wings.

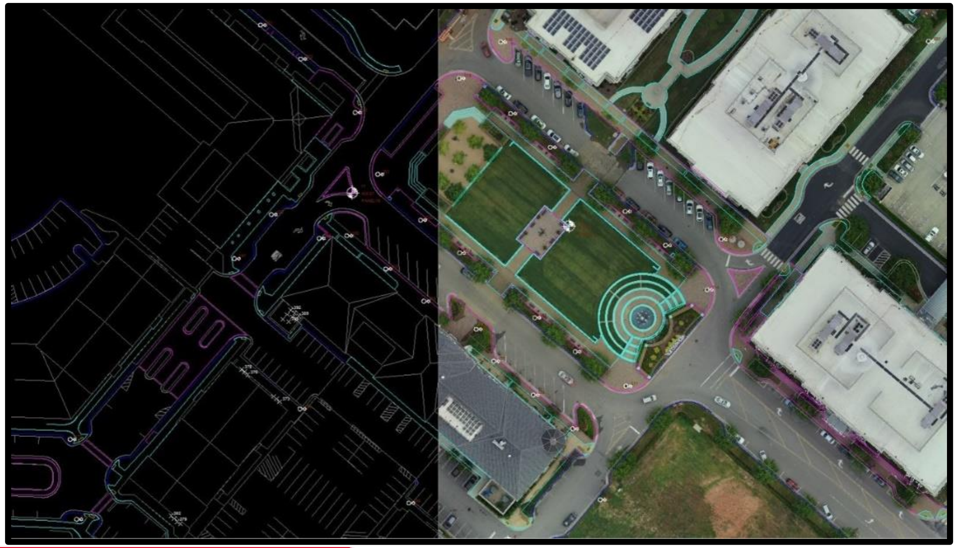
Photogrammetry

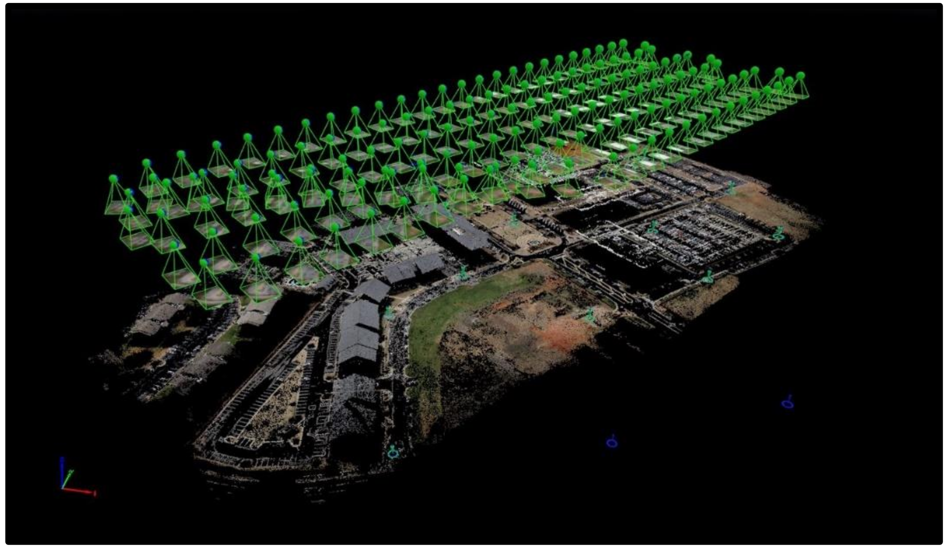
- Photogrammetry is a remote sensing technology that uses georeferenced images to map the earths surface. Photogrammetry is used for terrain and elevation modeling.
- GPS device triggers the camera to take images every X meters based on flight altitude and desired coverage and creates a timestamped GPS file for camera trigger events.
- Ground base station continually logs information to submit to OPUS to gain corrected positioning. [29]
- Images, GPS files, and OPUS correction are post-processed to yield CM level accuracy image geotags.
- PPK GPS can assign geotags of 2 cm accuracy or less to unprocessed images. [30]
- End-result can yield survey grade 1ft contour intervals in open areas.

Photogrammetry Workflow









Network for Success
Local Programs Workshop
VDOT

Light Detection and Ranging (LiDAR)

- LiDAR is remote sensing technology that uses light (laser pulses) to map the earths surface. LiDAR is frequently used for terrain and elevation models.[10]
- LiDAR sensors are often mounted onto a UAS for an all-in-one 3-D mapping device.
- LiDAR sensors can penetrate vegetation and the topography underneath making it useful for generating Digital Terrain Models (DTM).
- Uses for LiDAR include drone collision avoidance, imagery, structural inspections, and night work.
- Aerial LiDAR scanning by UAS is experiencing ongoing growth as manufacturers develop lighter and more affordable versions.[9]

Light Detection and Ranging (LiDAR)

Figure 7: Several models of LiDAR Sensors for UASs.[3]

Augmented Reality (AR) and UAS

- Augmented Reality (AR) is a relatively new technology with diverse applications. AR produces computer generated images over the user's real-world perception. AR systems play a large role in the visualization of 3-D data.[16]
- UAS-AR technology aids in the visualization of both the field environment and virtual construction in site layouts.
- With head mounted displays (HMDs) becoming more light-weight AR applications are open to the outdoors.
- AR systems provide many benefits. Objects can be located with greater speed and accuracy, physical markers can show previously invisible features, and information can be overlaid for comparison.
- AR systems allow for multi-UAV missions where the virtual UAVs interact in real-time.
- Existing applications include heads-up displays in inspection, industrial design, maintenance work, and construction.[19]

Augmented Reality (AR) and UAS

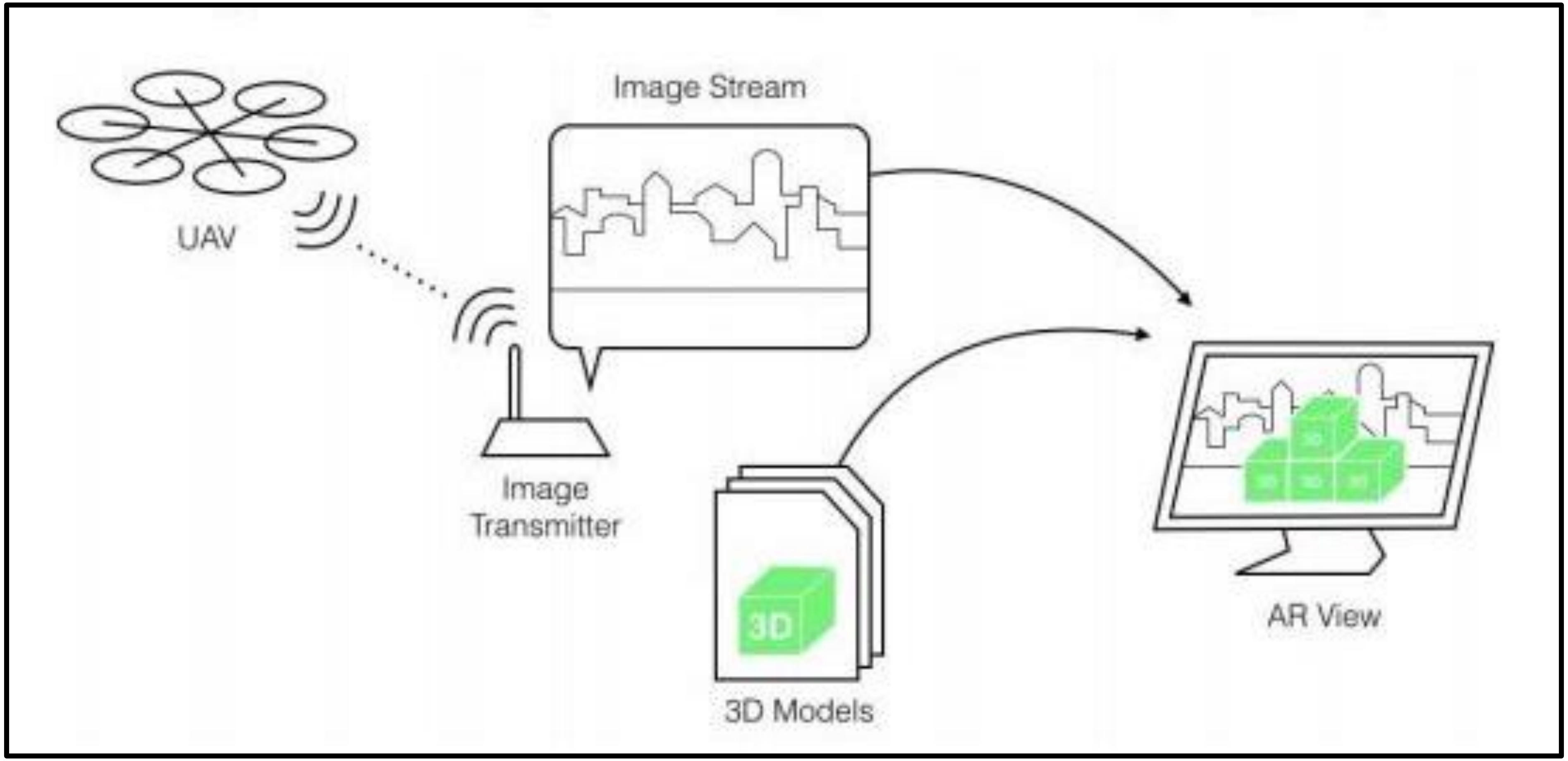


Figure 8: Concept of applying AR on the image stream from UAS.[19]

Differentiating between VR and AR[2]

Fig 8: Visual depiction contrasting VR and AR.[1]

- The fields of AR and VR are collectively referred to as mixed reality.
- AR adds digital elements to a live view. VR is a fully digital experience, shutting out the physical world.
- AR uses clear glasses for immersion, whereas VR uses head-mounted goggles that occlude your vision.
- Using a VR headset linked to a UAS the operator can get a first-person perspective of the flight.
- In short, augmented reality enhances current perception, whereas virtual reality substitutes a simulated reality.
- There is current drive to optimize VR headsets with gesture recognition sensor during flight for more intuitive navigation and exploration.

FAA Commercial Use Guidelines

- Part 107 of FAA standards or the Small Unmanned Aircraft Regulations apply to a wide range of commercial uses with drones less than 55 lbs. in weight.[18]
- The operator must hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person with such certificate.
- sUAS operators must give way and not interfere with manned aircrafts.[6]
- An sUAS may not fly over anyone not directly participating in the operation.
- Minimum weather visibility is three miles from your control station.
- The sUAS must remain within visual line of sight (VLOS).
- Speed must be kept below 400ft AGL (above ground level). The maximum speed is 100 mph (87 knots).
- A waiver is required to operate a drone contrary to the rules in part 107.

FAA Commercial Use Guidelines

Insurance [27 & 28]

- While not mandated by the Federal Aviation Administration, drone liability insurance is a must for risk mitigation.
- Drone insurance comes in two categories: Hull and Liability.
- Hull insurance covers damage to the drone and payloads (sometimes covered under separate Payload insurance).
- Liability insurance covers damages to third parties, both bodily injury and property damage.
- Insurance plans vary due to fleet size, types of sensors and cameras, training and experience of operators (FAA licensure), maintenance and records, safety programs, and operational parameters.
- Typical liability insurance coverage is $1,000,000.

Federal Aviation Administration Integration Pilot Program[7]

- Three state DOTs (Kansas, North Dakota, and North Carolina) are in the UAS Integration Pilot Program, allowing them to fly missions beyond line of sight, at night, and above people.
- This program is helping the USDOT and FAA evaluate operational concepts, address security and privacy risks, and improve communications with local jurisdictions.
- Areas expected to benefit from this program include commerce, agricultural support, infrastructure support, emergency management, and photography.
- The actionable information provided will help in the formation of new rules regarding more complex low-altitude operations.
- Ultimately, a more efficient strategy for overall integration of UASs is being determined.

UAS Data Exchange (LAANC)[17]

- FAA is currently testing the Low Altitude Authorization and Notification Capability (LAANC) as a part of the UAS Data Exchange.
- The system will be deployed initially at nearly 300 air traffic facilities and help support the safe incorporation of drones into airspace.[5]
- LAANC facilitates the sharing of data between the FAA and companies providing LAANC. Companies providing LAANC are known as UAS Service Suppliers (USS).

UAS Data Exchange (LAANC)[17]

- This will ultimately allow for real-time processing of airspace authorization requests for UAS operators. The application and approval process is automated.
- Access to the capability through a USS offers two uses of LAANC:

1. Receive near real-time authorization for operations under 400 ft. in controlled airspace around airports.
2. Submit a "further coordination request" to fly above the designated altitude ceiling up to 400 ft. Approval is coordinated up to 90 days in advance and by the FAA.

LAANC Service Providers

Approved Service Supplier	Part 107 Near – Real Time Authorization	Part 107 Further Coordination	Exception for Recreational Flying/Section 44809
Aeronyde	✓	✓	
Airbus			
AirMap	✓	✓	✓
AiRXOS			
Altitude Angel			
Converge	✓	✓	
DJI			
Harris Corporation			
Kittyhawk	✓	✓	✓
Project Wing			
Skyward	✓	✓	
Thales Group			
UASidekick	✓	✓	✓
Unifly			

✓ = Publicly available service

Figure 9: Various companies in agreement with the FAA to provide LAANC Services.[17]

Concerns of UAS Usage[12]

- **Privacy:** Current regulatory mechanisms involving UAS do not address civil liberties and privacy concerns. Surveillance in the public's opinion has ethical and privacy concerns that must be addressed.
- **Data Protection:** UAS applications can involve highly controlled areas and situations. In addition, the privacy of civilian behavior is impacted.
- **Safety:** There are inherent public safety issues with new technology. In this case accidents and violent usage are of concern. Most UASs have safety features and a lighter weight to reduce damage. Negative effects can also be minimized with a regulatory regime to evaluate drone usage.

State of UAS Operations: AASHTO Survey

- The May 2019 AASHTO UAS/Drone Survey of All 50 State DOTS concluded the following to be the most frequent drone missions by state DOTs.[8]

Top 5 Drone Missions

1. Photo/Video
2. Surveying
3. Infrastructure Inspections
4. Emergency Response/Natural Disasters
5. Public Education and Outreach

State of UAS Operations: AASHTO Survey

- The May 2019 AASHTO UAS/Drone Survey of All 50 State DOTS concluded 36 out of 50 state DOTs (72%) funded centers or programs for drone operations. The previous year only 45% (20 of 44 states) had such operations.[8]
- The survey also found 24 state DOTs to be collaborating with universities on research.
- To keep up with demand 10 state DOTs are training new pilots with the help of academic organizations.

References

1. Barel, A. (2017, August 13). The differences between VR (Virtual reality), AR (Augmented reality) and MR (Mixed reality). Retrieved from https://www.startux.net/the-differences-between-vr-ar-and-mr/
2. Brooks, C., & Cook, S., P.E. (2019, January 16). Implementation of Unmanned Aerial Vehicles (UAVs) for Assessment of Transportation Infrastructure – Phase II. Retrieved July 31, 2019, from https://mtri.org/mdot_uav.html
3. Corrigan, F. (2019, July 01). 12 Top Lidar Sensors For UAVs, Lidar Drones And So Many Great Uses. Retrieved from https://www.dronezon.com/learn-about-drones-quadcopters/best-lidar-sensors-for-drones-great-uses-for-lidar-sensors/
4. Dorsey, A. (2018). Using Drones to Monitor Construction Safety. *Laborers' Health & Safety Fund of North America, 15*(3). Retrieved July 31, 2019, from https://www.lhsfna.org/index.cfm/lifelines/august-2018/using-drones-to-monitor-construction-safety/
5. FAA Begins Drone Airspace Authorization Expansion. (2018, April 30). Retrieved July 31, 2019, from https://www.faa.gov/news/updates/?newsId=90245
6. Fact Sheet – Small Unmanned Aircraft Regulations (Part 107). (2014, September 19). Retrieved July 31, 2019, from https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516
7. Fact Sheet – The UAS Integration Pilot Program and UAS Traffic Management Pilot Program. (2019, April 30). Retrieved July 31, 2019, from https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=23574
8. Gray, J., & Yew, C. (n.d.). Unmanned Aerial Systems (UAS). Retrieved from https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/uas-factsheet.pdf
9. LiDAR Equipped UAVs. (n.d.). Retrieved August 1, 2019, from https://enterprise.dji.com/news/detail/how-lidar-is-revolutionizing-mapping-and-geospatial-data
10. LIDAR scanning - Aerial laser scanning by drone. (n.d.). Retrieved August 1, 2019, from https://www.onyxstar.net/lidar-scanning-aerial-laser-scanning-by-drone/
11. Lovelace, B., & Zink, J. (2015). Unmanned Aerial Vehicle Bridge Inspection Demonstration Project. *Minnesota Department of Transportation: Research Services and Library*. Retrieved July 31, 2019, from http://www.dot.state.mn.us/research/TS/2015/201540.pdf
12. McGuire, M., Rys, M., Ph.D., & Rys, A., Ph.D. (2016). A Study of How Unmanned Aircraft Systems Can Support the Kansas Department of Transportation's Efforts to Improve Efficiency, Safety, and Cost Reduction. *Kansas State University Transportation Center*. Retrieved July 31, 2019, from https://trid.trb.org/view/1420349.
13. Murphy, R. R. (2019). Use of Small Unmanned Aerial Systems For Emergency Management of Flooding. *Federal Highway Administration*. Retrieved from https://www.fhwa.dot.gov/uas/resources/hif19019.pdf.

References

14. Stevens, C. R., Jr., & Blackstock, T. (2017). Demonstration of Unmanned Aircraft Systems Use for Traffic Incident Management (UAS-TIM). *Transportation Policy Research Center*. Retrieved July 31, 2019, from https://static.tti.tamu.edu/tti.tamu.edu/documents/PRC-17-69-F.pdf.
15. Tatum, M. C., & Liu, J. (2017). Unmanned Aircraft System Applications in Construction. *Procedia Engineering, 196*, 167-175. Retrieved July 31, 2019, from https://doi.org/10.1016/j.proeng.2017.07.187.
16. Thomas, B., Piekarski, W., & Gunther, B. (1999). Using Augmented Reality to Visualise Architecture Designs in an Outdoor Environment. *Advanced Computing Research Center*. Retrieved July 31, 2019.
17. UAS Data Exchange (LAANC). (2019, July 22). Retrieved July 31, 2019, from https://www.faa.gov/uas/programs_partnerships/data_exchange/
18. Unmanned Aircraft Systems/Drones. (2019, June 17). Retrieved July 31, 2019, from https://www.state.nj.us/transportation/airwater/aviation/drones.shtm
19. Wen, M., & Kang, S. (2014). Augmented Reality and Unmanned Aerial Vehicle Assist in Construction Management. *ASCE: Computing in Civil and Building Engineering*, 1570-1577. Retrieved July 31, 2019, from http://itc.scix.net/data/works/att/w78-2014-paper-195.pdf
20. U.S. Fish & Wildlife Service Appendix D – Bridge Assessment Guide and Form. (2016, August). Retrieved August 2, 2019, from https://www.fws.gov/midwest/endangered/section7/fhwa/pdf/AppendixD_BridgeAssessmentAugust2016.pdf
21. VDOT Environmental Division – Preliminary Bat Inventory Guidelines for Bridges and Buildings, ver. 3.1.2. Retrieved August 2, 2019, from http://www.virginiadot.org/business/resources/const/VDOTBatInventoryGuidelines.pdf
22. DJI Matrice 200. Retrieved August 2, 2019, from https://www.dji.com/matrice-200-series
23. Parrot Anafi. Retrieved August 2, 2019, from https://www.parrot.com/us/drones/anafi
24. DJI Zenmeuse XT-2. Retrieved August 2, 2019, from https://www.dji.com/zenmuse-xt2
25. Schnebele, E., Tanyu, B.F., Cervone, G., & Waters, N. (2015). Review of remote sensing methodologies for pavement management and assessment. Pennsylvania *State University Center forGeoinformatics and Earth Observation Laboratory*. Retrieved August 2, 2019, from http://geoinf.psu.edu/publications/2015_ETRR_RS-roads_Schnebele.pdf.
26. American Concrete Institute – Thermal detection of Subsurface Delaminations in Reinforced Concrete Decks Using Unmanned Aerial Vehicle. Retrieved August 2, 2019, from https://www.concrete.org/Portals/0/Files/PDF/18-JI-Paper.pdf

References

27. Drone Insurance: A Step-by-Step Guide to Liability & Drone Hull Insurance (2019). Retrieved August 2, 2019, from https://uavcoach.com/drone-insurance-guide/

28. Drone Insurance and Liability Coverage: Do You Need It? (2018, January 17). Retrieved July 31, 2019, from https://blog.dronedeploy.com/drone-insurance-and-liability-coverage-do-you-need-it-b042485c46d5

29. OPUS: Online Positioning User Service (National Geodetic Survey). Retrieved August 23, 2019, from https://www.ngs.noaa.gov/OPUS/about.jsp#about

30. Why use PPK with your Drone (Not RTK) (2018). Retrieved August 23,2019, from https://www.altavian.com/blog/use-ppk-not-rtk

Prepared by C. Dewey and S. Vargo – Timmons Group (2019)

Contact Information

Chris Dodson

Principal - Director of Field Services

Timmons Group

804.200.6438

chris.dodson@timmons.com

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

Questions?

Network for Success
Local Programs Workshop
VDOT Virginia Department of Transportation

Pathways 4 Planning
(P4P)
A map-app for data driven decisions where transportation professionals View, Edit, and Plan

Geraldine S. Jones
Transportation Planning Specialist
VDOT, Transportation Mobility Planning Division
VDOT Central Office

Purpose

To provide an accessible, easy-to-use application for VDOT and VDOT's external business partners including localities, PDC's, MPO's, universities, and consultants to view, manage, edit, and query transportation data in order to plan and make informed funding decisions.

Fund transportation projects that make sense by improving conditions and increasing safety!

P4P Features

- One stop shopping for transportation planning data
- Accessible to external VDOT partners
- Permissions based accounts
- Spatial viewing

- Identify
- Spatial queries
- LRS queries
- Ad hoc queries
- Data Export

Data Categories
Types of data

Static Data

- Maintained outside of the application
- Ideal for data-sets that are not constantly updated
- Ability to link to the LRS
- Examples:
  - National Highway System
  - LRS
  - Jurisdictions

Editable Data

- Maintained inside of the application
- Ideal for data-sets that are updated frequently
- Ability to link to the LRS
- Examples:
  - Access Point Inventory
  - Functional Class Change Status
  - Studies

Metadata

Layer Groups
How the data is organized

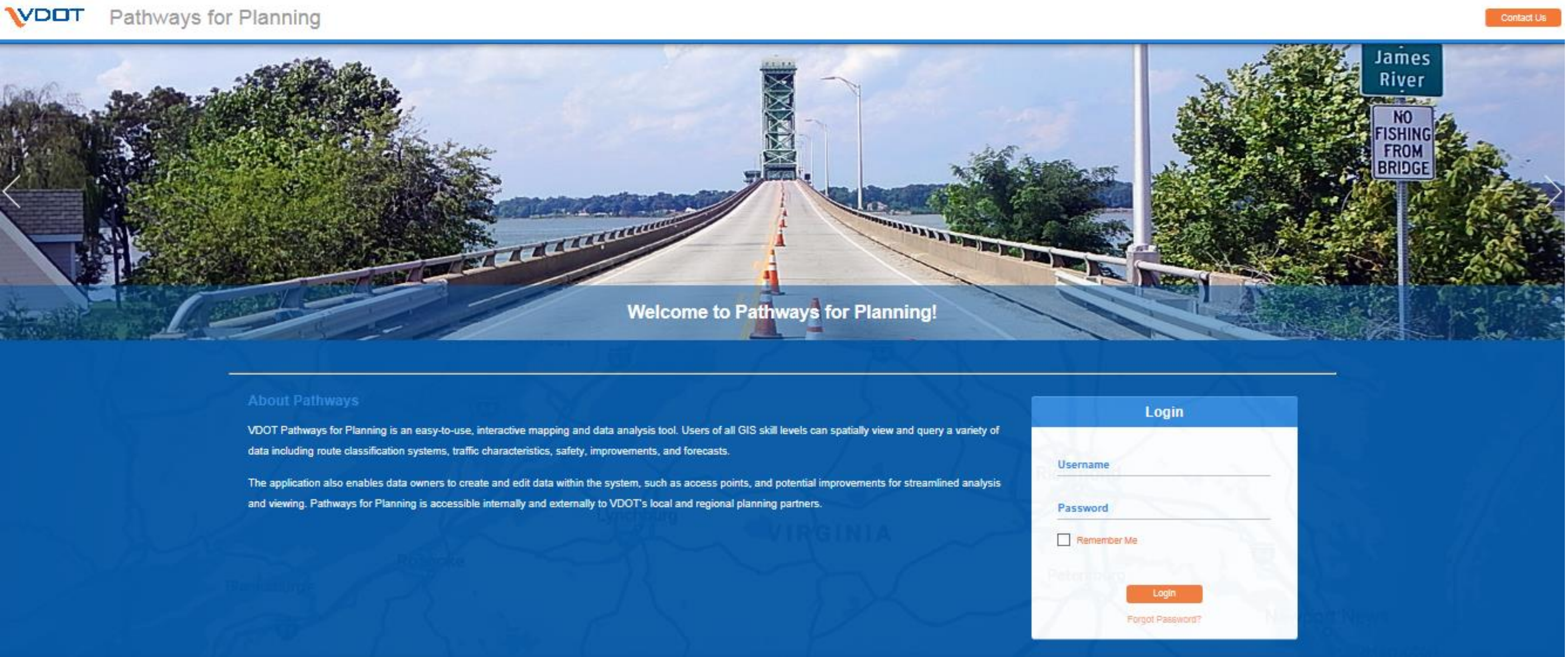
- Freight
- Improvements
- Linear Reference System
- Multimodal
- Political Boundaries
- Route Classification System
- Route Physical Characteristics
- Safety
- Studies and Recommendations
- Traffic Volume, Capacity, and Performance
- VTRANS Needs

Example Use Cases
Questions P4P can answer

- What are the existing road conditions in a corridor being considered for transportation funding applications?
- Where are the PSI intersections and segments in my jurisdiction?
- Number of crashes in an area of interest?
- Number of SMART SCALE applications and projects in each VDOT district?
- Have there been studies performed in a my area of interest?
- What are the preferred recommendations?

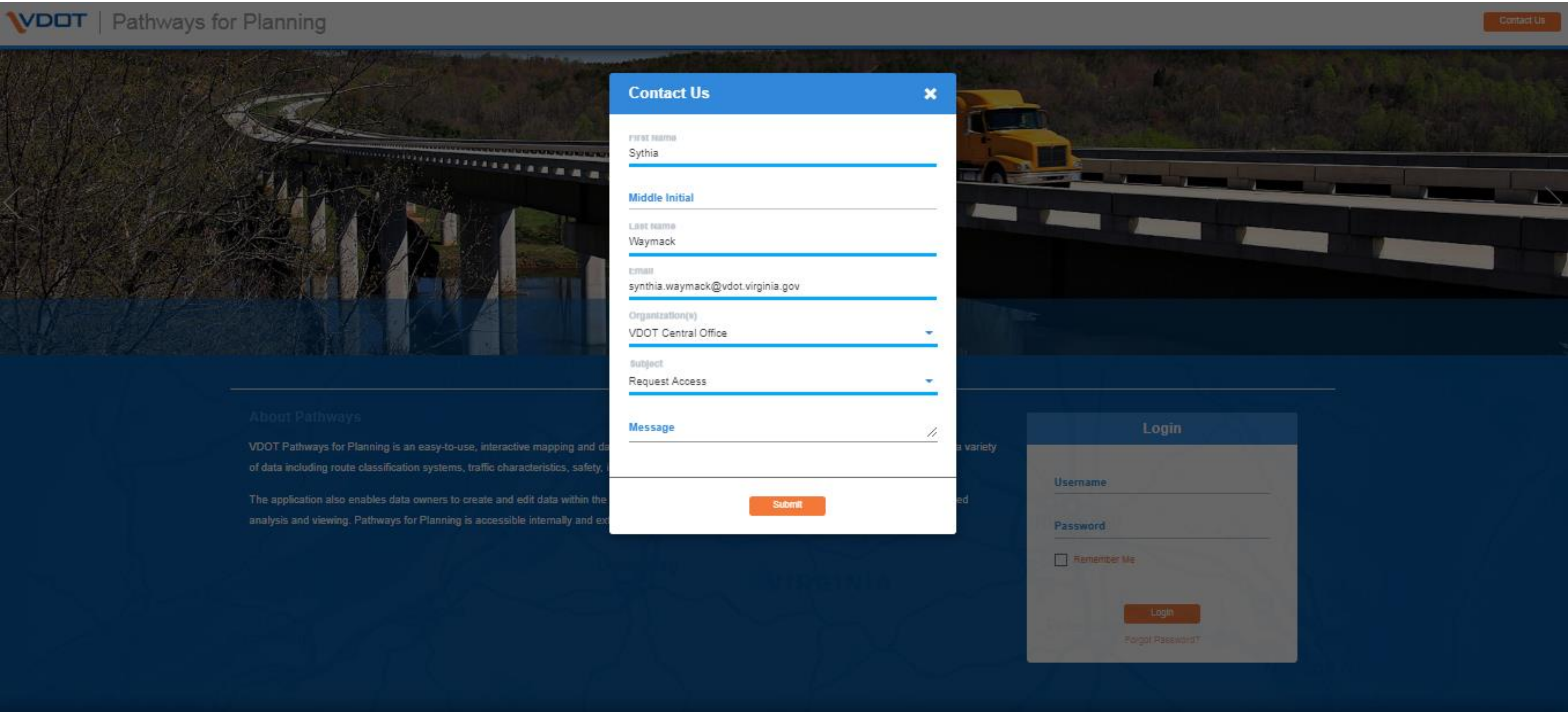
Demo

https://vdotp4p.com

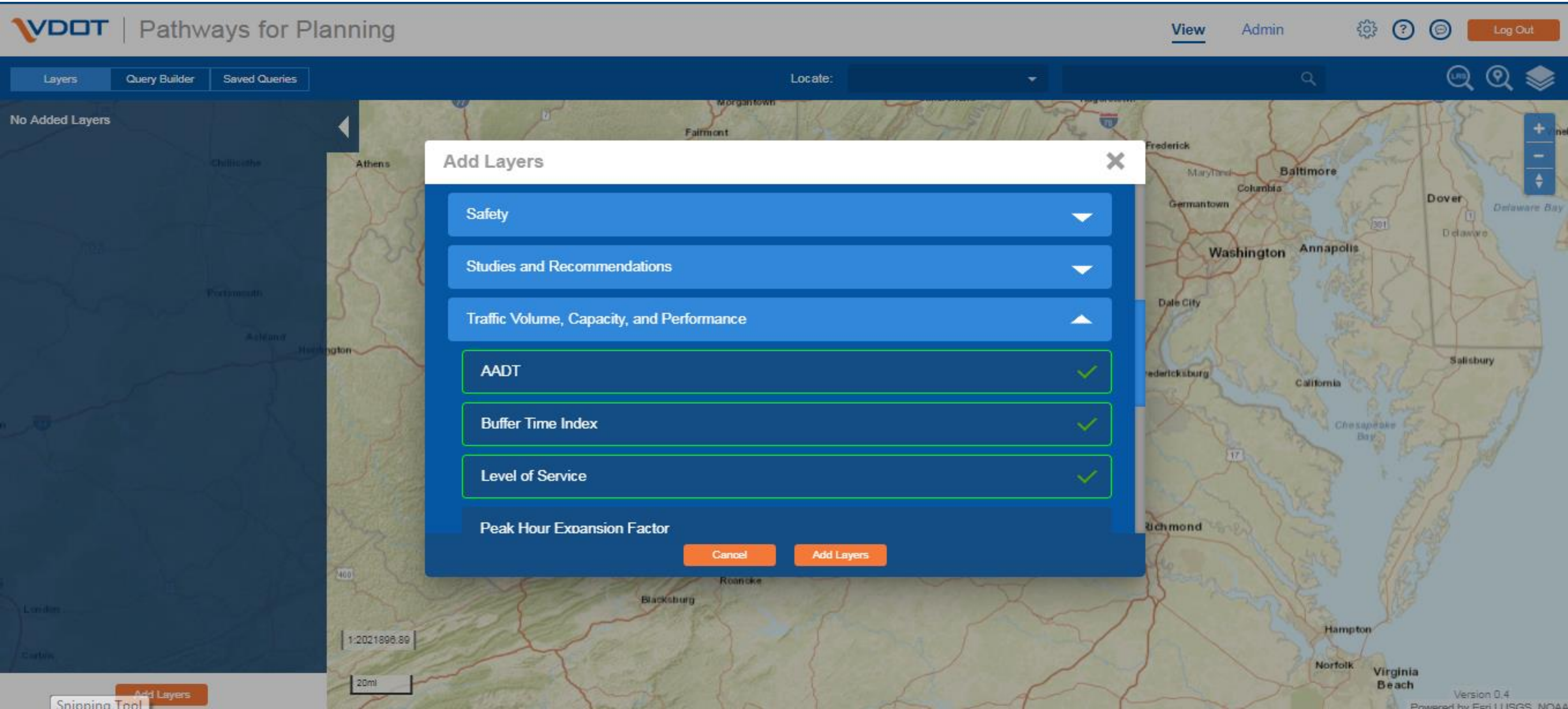


Requesting Access

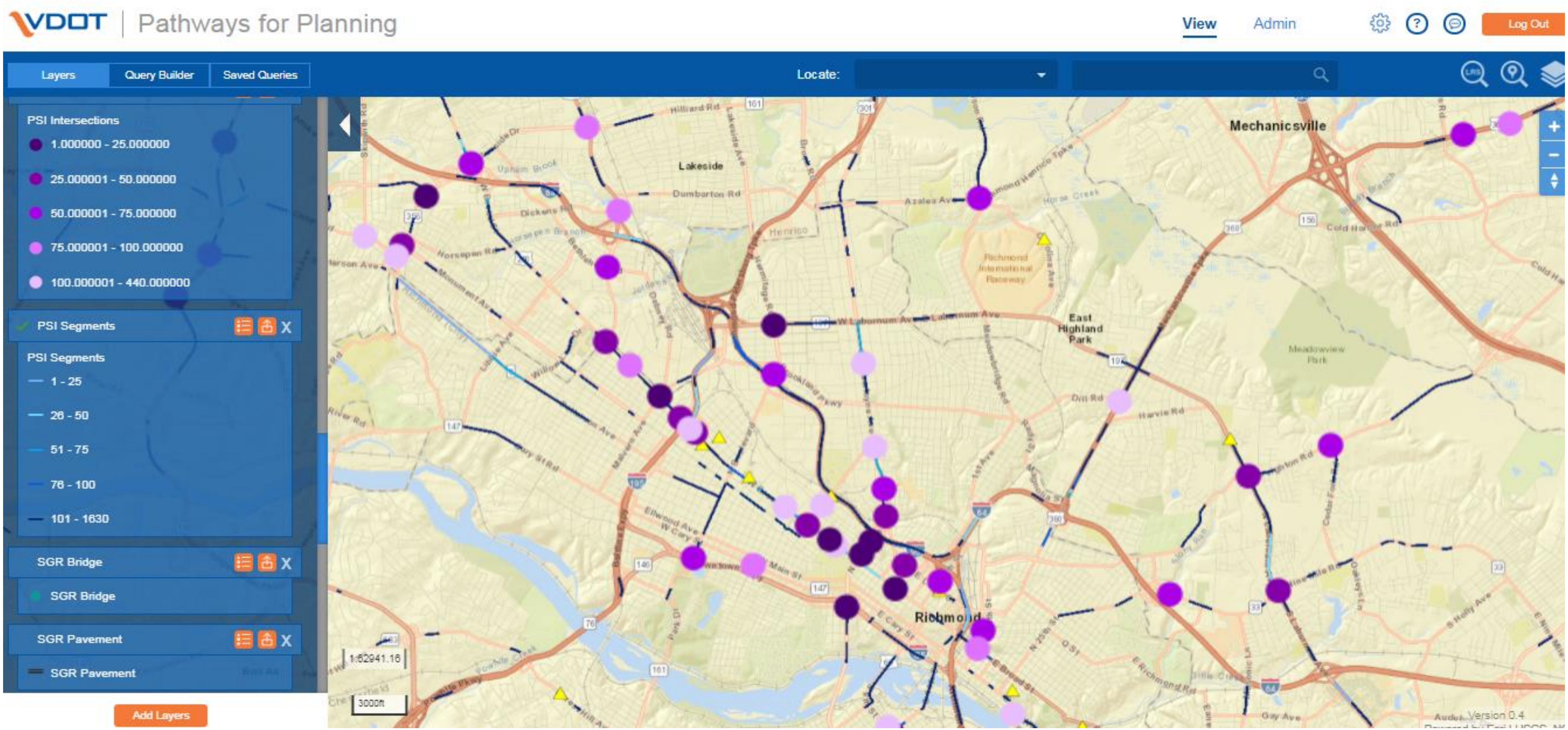
How new users access P4P



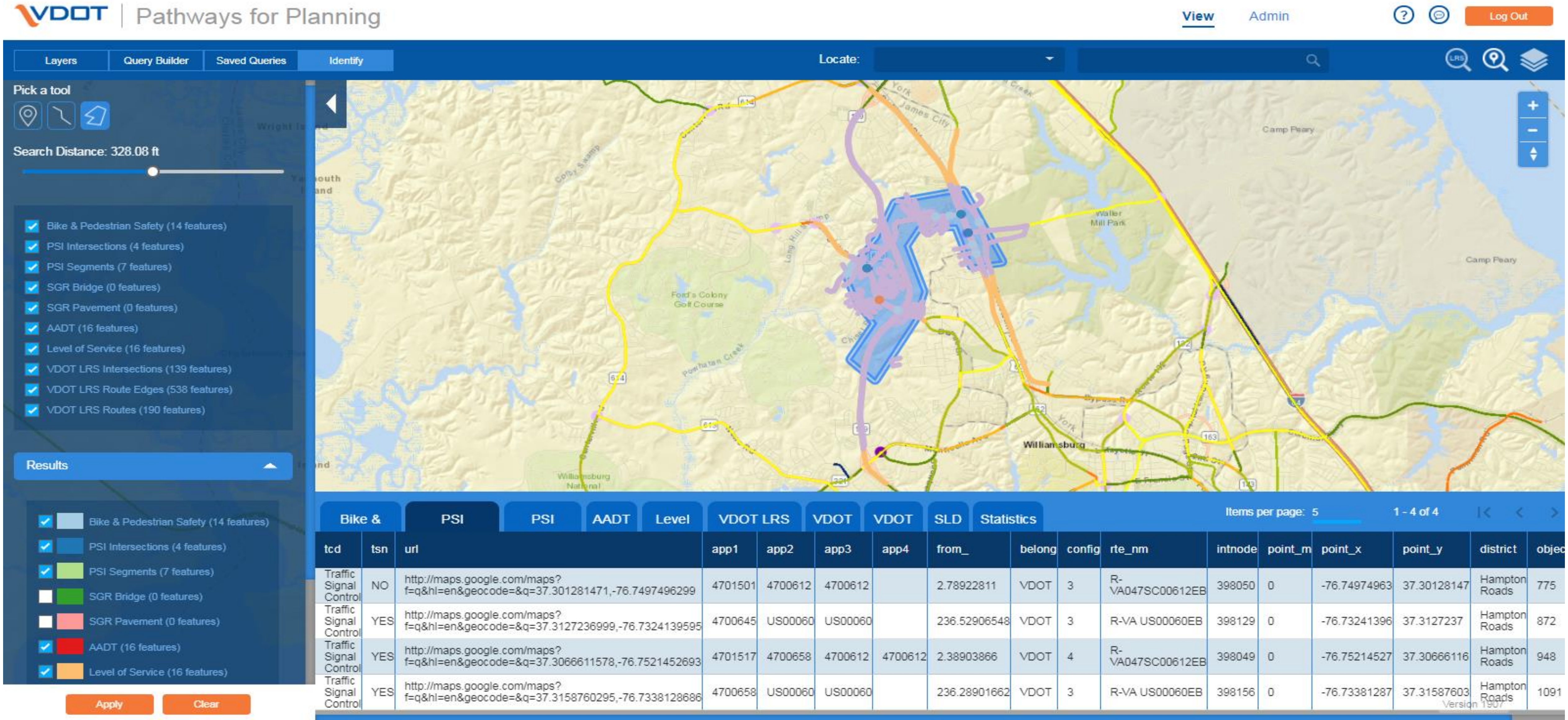
Data Layers
Adding layers to the map view



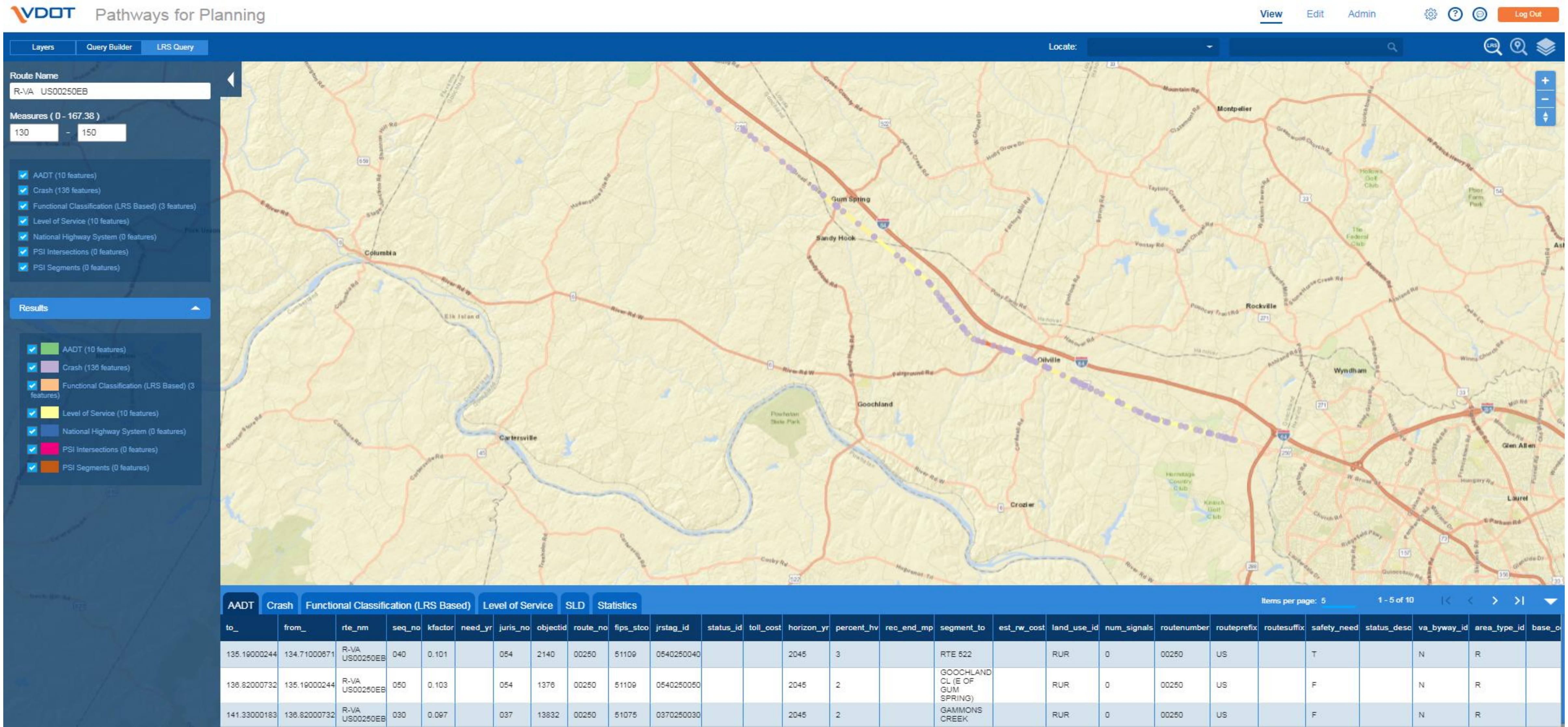
Viewing Data on the Map
Understanding conditions in an area of interest



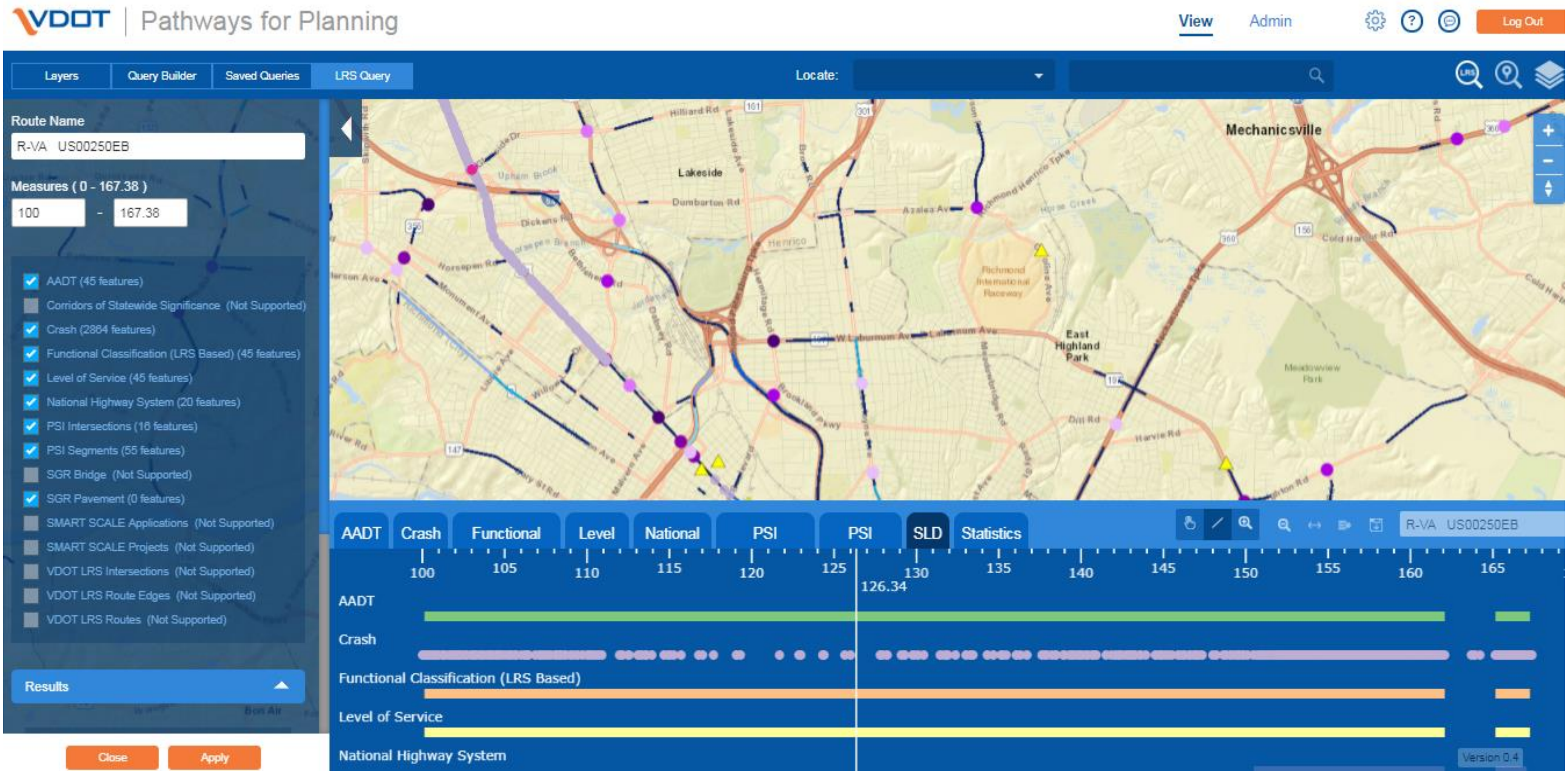
Identify Features
Quick tool to distinguish features and view attribute information



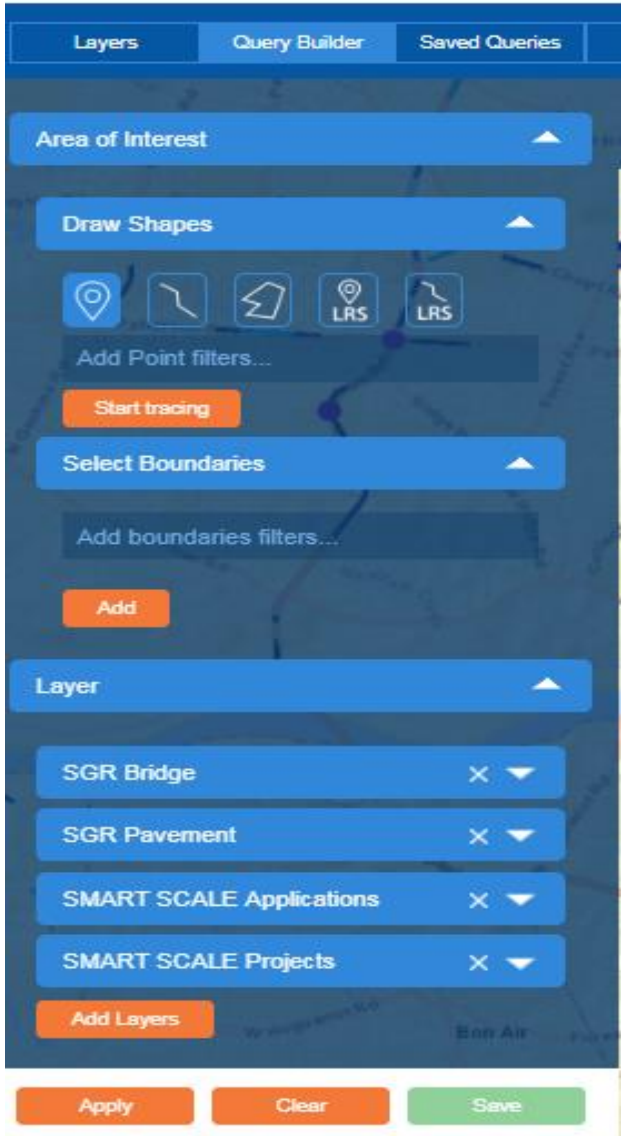
Linear Referencing System (LRS) Query
Existing conditions for 250 EB, measures 130 to 150

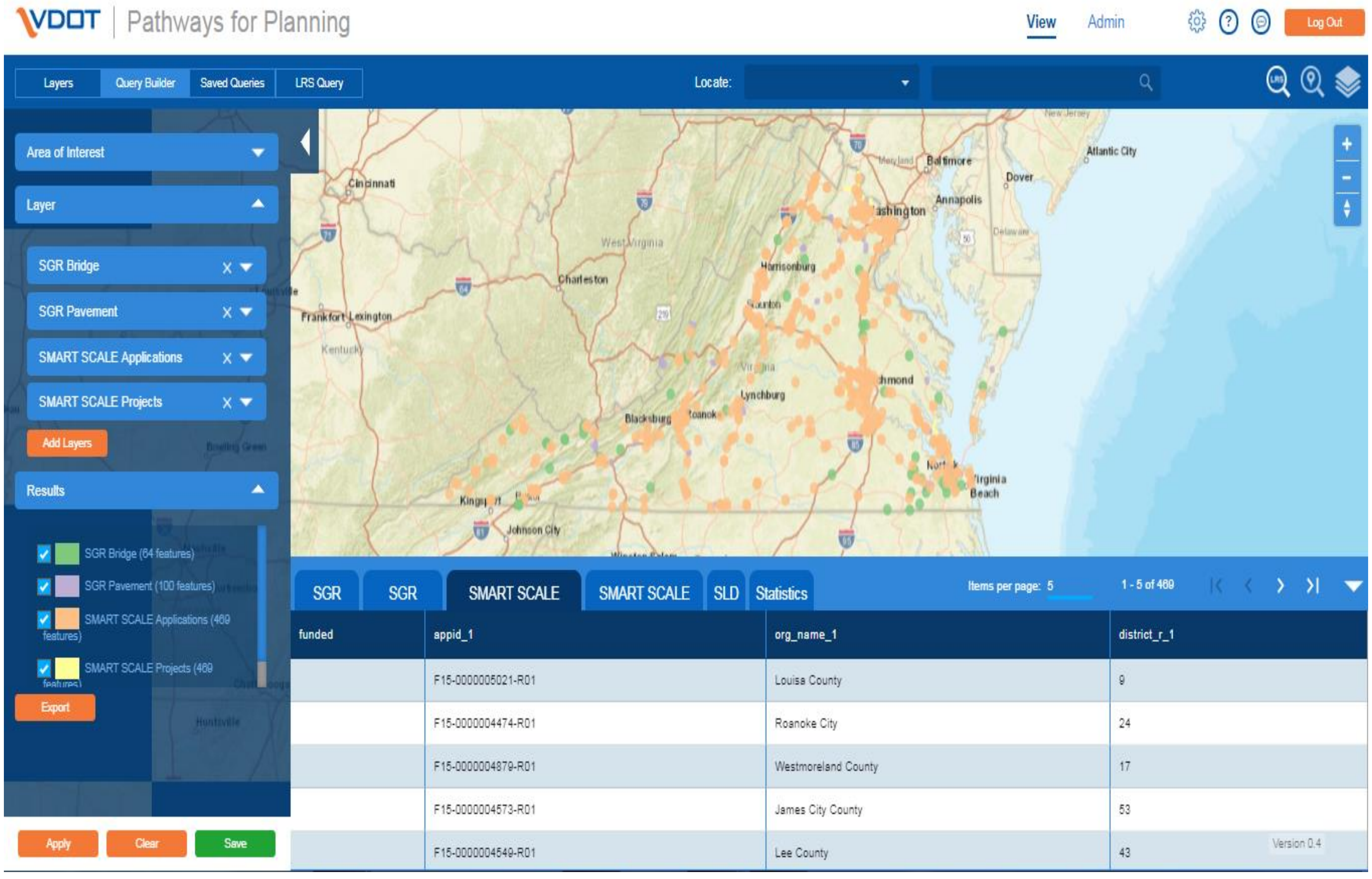


Slide Line Diagram
Concentration of crashes along LRS for 250 EB



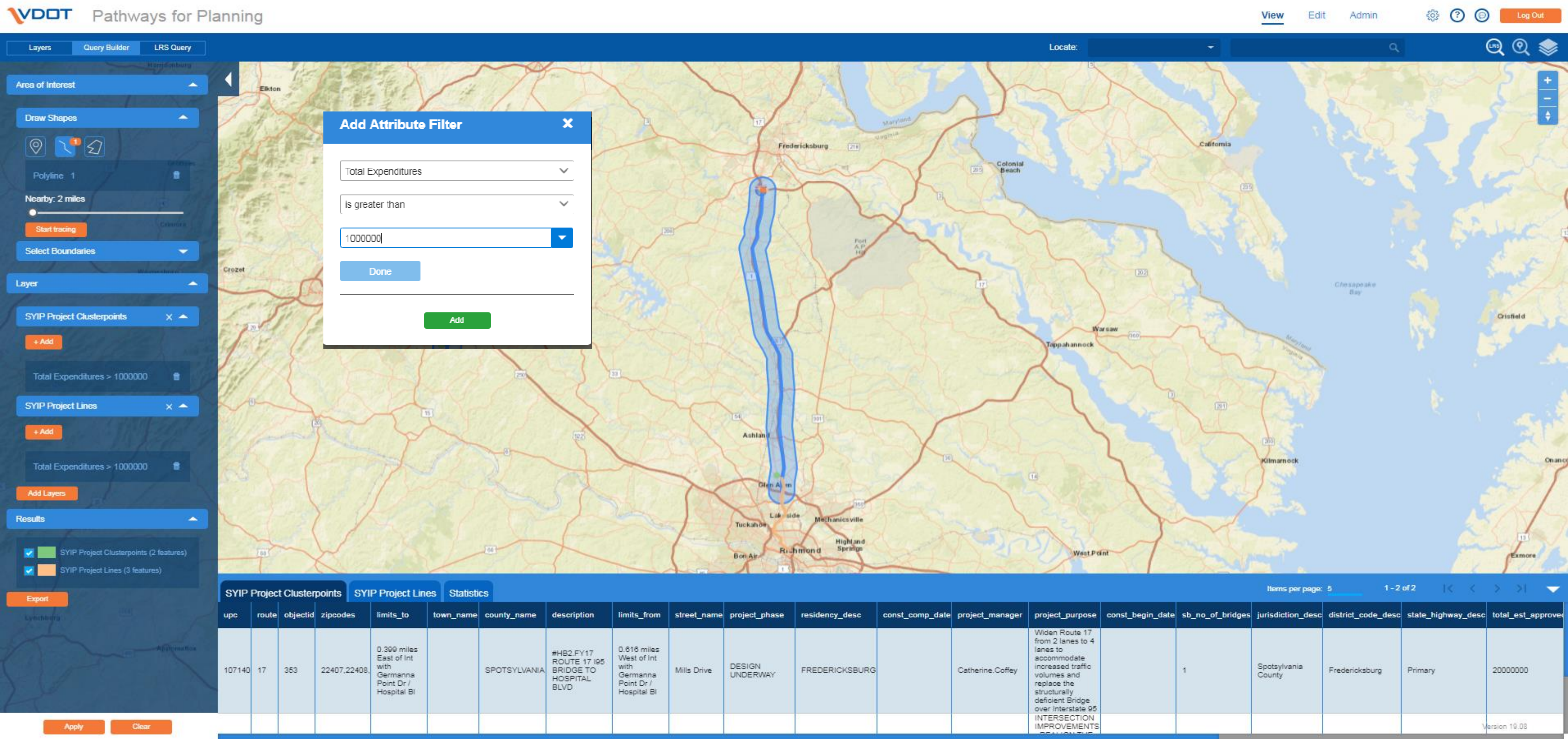
Query Builder
Query non LRS data to view locations of SGR and SMART SCALE projects



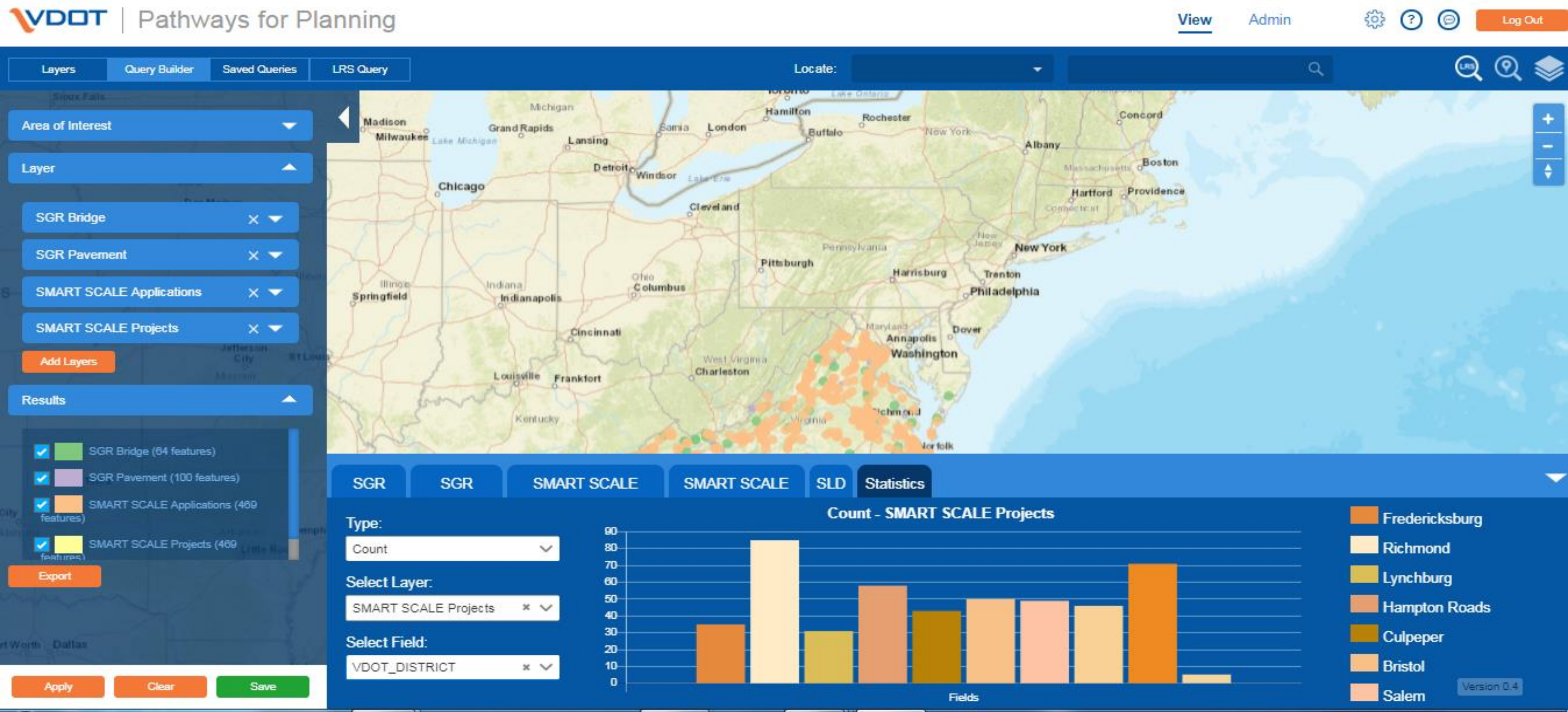


Query Builder

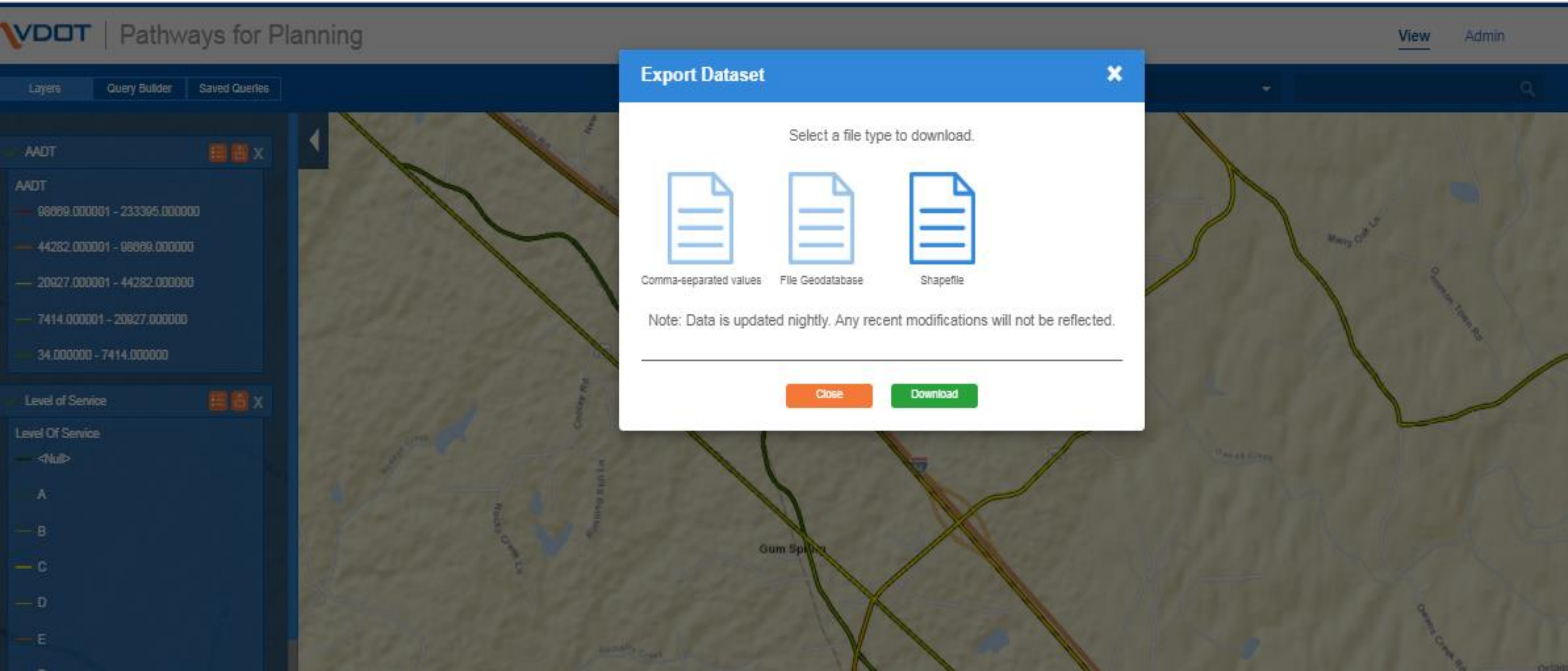
SYIP projects with expenditures greater than $1,000,000



Statistics
Number of SMART SCALE projects by VDOT district



Exporting
Ability to export data as statewide datasets or query results as CSV, Geodatabase, or Shapefile



Moving forward
Monthly Releases

- Finalize requirements
  - Metadata
  - Edit – ability to create and maintain data
  - Plan – store data by relationships
  - Integration with other systems
- Enhancements
- Static data updates

Business Goals
Advancing P4P

- ❑ Define future functional needs
- ❑ Formalize a Change Management Process
- ❑ Engage all business units and planning partners to identify system enhancements
- ❑ Form a User Advisory Committee
- ❑ Select a Steering Committee
- ❑ Governance
- ❑ Training

Contact Information

Geraldine S. Jones
Transportation Mobility Planning Division
Virginia Department of Transporation
geraldine.jones@vdot.virginia.gov

vdotP4P@vdot.virginia.gov

https://vdotP4P.com

Network for Success
Local Programs Workshop
VDOT Virginia Department of Transportation

Questions?

Thank You!