
**Alaska Remote UAS Dock Demonstrations (Source: FHWA)**

# UAS Peer-to-Peer Exchange

## Juneau, Alaska

## June 25-26, 2024

U.S. Department of Transportation
Federal Highway Administration

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACUASI | Alaska Center for Unmanned Aircraft Systems Integration |
| Alaska DOT&PF | Alaska Department of Transportation & Public Facilities |
| BVLOS | Beyond Visual Line of Sight |
| Caltrans | California Department of Transportation |
| CFR | Code of Federal Regulations |
| FAA | Federal Aviation Administration |
| FHWA | Federal Highway Administration |
| GIS | Geographic Information System |
| LiDAR | Light Detection and Ranging |
| MassDOT | Massachusetts Department of Transportation |
| MDT | Montana Department of Transportation |
| MDOT | Michigan Department of Transportation |
| ODOT | Ohio Department of Transportation |
| SMART | Strengthening Mobility and Revolutionizing Transportation |
| TxDOT | Texas Department of Transportation |
| UAS | Unmanned Aircraft Systems |
| USC | United States Code |
| WYDOT | Wyoming Department of Transportation |

# INTRODUCTION

As part of the Federal Highway Administration's (FHWA) Support of Unmanned Aircraft Systems (UAS) Deployment Activities, the Alaska Department of Transportation & Public Facilities (Alaska DOT&PF) hosted a peer exchange in Juneau, Alaska, on June 25-26, 2024. Representatives from the Massachusetts Department of Transportation (MassDOT), Michigan Department of Transportation (MDOT), Montana Department of Transportation (MDT), Texas Department of Transportation (TxDOT), Wyoming Department of Transportation (WYDOT), Ohio Department of Transportation (ODOT), University of Alaska, and FHWA Office of Federal Lands Highway were among those in attendance. The goal of the peer exchange was to understand how Alaska DOT&PF has been able to advance UAS operations using remote dock UAS and the benefits of Beyond Visual Line of Sight (BVLOS) operations. Attending State DOTs shared presentations describing how their UAS programs and operations have advanced over time and discussing roadmaps for the future. This report provides an overview and the findings from the various discussions from the peer exchange; the information was up to date at the time of the peer exchange.

# FEDERAL AVIATION ADMINISTRATION REGULATIONS

UAS operators in both the public and private sectors must adhere to statutory and regulatory requirements. Public aircraft operations (including UAS operations) are governed under the statutory requirements for public aircraft established in 49 United States Code (USC) § 40102 and § 40125. Additionally, both public and civil UAS operators may operate under the regulations promulgated by the Federal Aviation Administration (FAA). The provisions of 14 Code of Federal Regulations (CFR) part 107 apply to most operations of UAS weighing less than 55 pounds. Operators of UAS weighing more than 55 pounds may request exemptions to the airworthiness requirements of 14 CFR part 91 pursuant to 49 USC §44807. UAS operators should also be aware of the requirements of the airspace in which they wish to fly as well as the requirements for the remote identification of unmanned aircraft. The FAA provides extensive resources and information to help guide UAS operators in determining which laws, rules, and regulations apply to a particular UAS operation. For more information, please see https://www.faa.gov/uas/.

# UAS DEPLOYMENT ACTIVITIES MATURING

During the initial session of the peer exchange, representatives from the Alaska Division of FHWA welcomed participants to Alaska to engage in conversations regarding advancing UAS operations to increase safety, efficiency, and cost savings. Representatives from Alaska DOT&PF also offered welcoming remarks noting that throughout the peer exchange, the agency planned to share the ways in which advanced UAS operations have improved decision-making with better data, increased time and cost savings, and improved emergency response.

FHWA has funded millions of dollars across numerous, diverse engagements to meet the goals of State Departments of Transportation (DOTs) as they have deployed UAS. Figure 1

summarizes the various UAS outreach activities, level of engagement, and resources that are available to State DOTs.

Over **1,000** participants in UAS-focused webinars

Over **1,100** participants from **38** States and Territories at UAS local and regional workshops

Over **740** participants engaged through UAS Peer Exchanges

Over **20** UAS technical briefs and reports published

**16** free online NHI UAS courses on various applications

**Figure 1. FHWA UAS Deployment Engagement and Resources. (Source: FHWA)**

Additionally, Federal funding that can assist State DOTs with UAS implementation can be accessed through various grant programs including:

- U.S. DOT Strengthening Mobility and Revolutionizing Transportation (SMART) Grant
- FHWA Advanced Digital Construction Management Systems Grant
- FHWA State Transportation Innovation Council Incentive Program
- FHWA Accelerated Innovation Deployment Demonstration Program

As UAS technology continues to improve and become more affordable, State DOTs have continued to increase UAS applications; more than 40 UAS use cases have been identified at State DOTs (Hubbard and Hubbard, 2020).

# UAS STATE OF PLAY – ADVANCED OPERATIONS

The discussion among State DOTs on the UAS current state of play highlighted the significant advancements in UAS applications in recent years, demonstrating their evolution from simple

photo capture to complex remote operations, advanced data analytics, and innovative uses across various departments.

## OVERVIEW OF THE ALASKA CENTER FOR UNMANNED AIRCRAFT SYSTEMS INTEGRATION

A representative from the Alaska Center for Unmanned Aircraft Systems Integration (ACUASI) at the University of Alaska Fairbanks provided an overview of the center's comprehensive program, operations, and role in assisting State DOTs. ACUASI's main objective is to develop a performance-based framework for State, local, Tribal, and territorial government agencies to enable more complex, scalable UAS operations. ACUASI has established Emerging Technology Test Ranges at multiple airports across Alaska that are being used to test various BVLOS operations and operations in extreme cold weather conditions. ACUASI has worked closely with Alaska DOT&PF to implement BVLOS operations with its UAS dock systems. As a member of the FAA UAS Test Site Program, FAA BEYOND Program, and FAA Center of Excellence for UAS, ACUASI is uniquely positioned to help all State DOTs in advancing UAS operations.

## ADVANCING UAS USE CASES

MassDOT's UAS program started small with a handful of UAS operators and has grown to about 40 people engaged in UAS data collection, research and development, and data processing and management—all serving the needs of highway, rail, transit, aeronautics, and emergency management. As MassDOT's UAS program has matured, it has been able to secure a BVLOS waiver for all rail lines in Massachusetts. The main use case is managing vegetation encroachment along rail lines, with inspections conducted weekly to ensure each rail section is examined at least twice a year. Figure 2 shows how UAS can assist in identifying vegetation before it encroaches the rail line so a crew can be sent to mitigate the situation.

**Figure 2. UAS Rail Inspection for Vegetation Encroachment. (Source: MassDOT)**

MassDOT also uses UAS to monitor rail lines that are located against human-made cranberry bogs that are repeatedly flooded to harvest the cranberries. The constant flooding and drainage of these ponds have compromised some of the rail lines as shown in Figure 3.

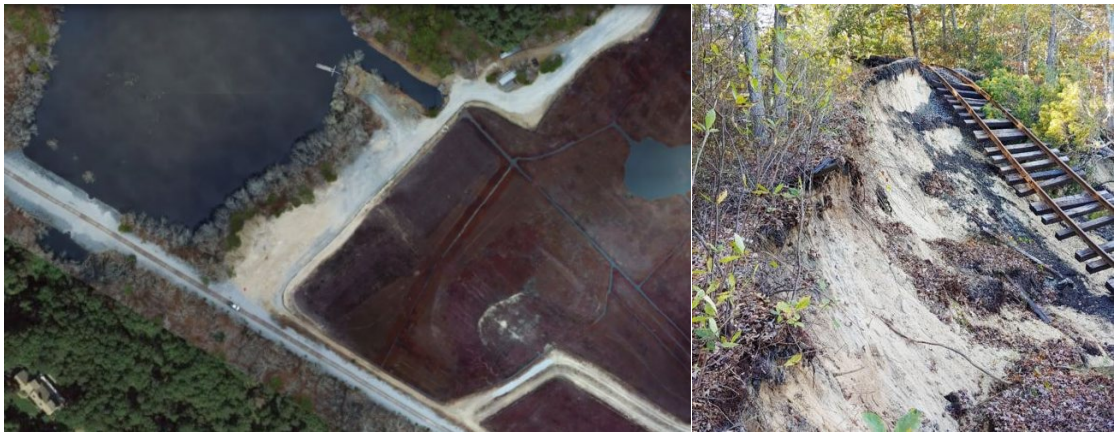

**Figure 3. Cranberry Bogs Compromised Railway. (Source: MassDOT)**

MassDOT shared that it uses UAS for other tasks, for example:

- Conducting initial investigations of incidents like collapsed parking garages.
- Performing runway approach inspections with Light Detection and Ranging (LiDAR) technology to ensure clear approach paths and pavement integrity.
- Mapping accident scenes to support first responders.
- Conducting pre- and post-storm coastal surveys with orthophotography and LiDAR.

California Department of Transportation (Caltrans) has advanced UAS operations and also has a BVLOS waiver. In 2023, Caltrans was awarded a SMART grant to develop a dock-based UAS system featuring solar power, batteries, and remote internet connection. Caltrans has developed permanent and mobile UAS dock systems that are being tested for scalable operations. The agency is also pioneering the use of tethered UAS for construction lighting, replacing up to eight traditional lighting units with a million-lumen system capable of 10 to 12-hour shifts over 20 or more days. This innovation has improved safety by providing even lighting across the work zone and reducing trip hazards on job sites.

### CHALLENGES AND LESSONS IN BVLOS WAIVERS

State DOTs that have obtained BVLOS waivers shared their various challenges and lessons learned during that process. Alaska DOT&PF noted that new or unique use cases can take years to process and receive approval but noted that successful applications often build on existing safety cases. MassDOT shared key lessons including starting with a single use case and gradually expanding. MassDOT also noted that leveraging the expertise and resources of other State DOTs can be very helpful.

Another theme discussed among the State DOTs was the importance of effective communication with the FAA and other stakeholders to clearly agree on safety and performance standards. Communicating effectively with internal and external stakeholders, including the public, is an important component in advancing UAS operations. Alaska DOT&PF explained that communication lessons learned along the way informed its more recent decision to implement better communication systems at UAS dock sites to better inform pilots of UAS activities. Additionally, outreach efforts such as distributing flyers at post offices and brief communications on local radio stations have proven effective in helping the public understand how State DOTs are using UAS.

## BEST PRACTICES FOR UAS PROGRAMS

In a roundtable discussion State DOTs shared experiences on maturing UAS operations from a more general point of view, highlighting lessons learned and best practices.

Many State DOTs began their UAS programs with targeted, low-risk projects to demonstrate value and gain internal support. ODOT started with construction monitoring, identifying it as a low-hanging fruit for the department. TxDOT discussed how one of its initial use cases involved inspecting radio towers, which demonstrated a strong return on investment by quickly paying for the UAS. This initial use case earned TxDOT leadership support because it demonstrated how UAS could be used in other ways to lower costs and increase efficiency.

Representatives from ODOT explained how the success of early projects led to increased interest and excitement among the survey team and other internal divisions. As other divisions explored the various ways UAS could assist in day-to-day operations the ODOT UAS team organically grew and matured. ODOT's UAS team now has a fleet of over 50 UAS platforms used across various divisions, resulting in over 2,000 flights across 700 projects.

## ORGANIZATIONAL STRUCTURES

State DOTs approached the organizational structure of their UAS programs in various ways, and most recognize that the program structure may evolve over time. TxDOT shared how the UAS program was initially established in the Aviation Division, where TxDOT UAS program managers support the program by guiding procurement and facilitating training. However, TxDOT is exploring the potential shift of the program to the Maintenance or Traffic Divisions, either of which may be able to better support future expansion due to the UAS use, budgets, and influence of those divisions. Procurement and training are expected to remain with the Aviation Division.

Other UAS programs grew from different functional departments. Caltrans' use of UAS started with surveying and mapping. As the use of UAS grew across the 12 districts at Caltrans, the need for guiding policies and procedures became apparent. The Division of Aeronautics oversees these policies and procedures, but UAS operations fall to each local district. Alabama DOT has a centralized UAS team that serves all UAS-related needs across the State. To address questions regarding UAS full-time positions and expertise, the Alabama UAS team developed official position descriptions with defined roles such as UAS Pilot Level 1, 2, and 3.

## TRAINING AND STANDARDIZATION

Training and standardization were other factors that emerged in the discussion around the successful implementation of UAS programs. MDT expressed the need for pilot training standardization to assist those who are interested in using UAS throughout the agency. TxDOT shared insight into its training model that trains people on the safe integration of UAS into their operations across all 25 TxDOT districts. TxDOT has a hybrid training model where it has partnered with a community college to assist sending TxDOT personnel through a 10-week course. The 10-week course is broken down into the following sections:

- Three weeks to study the regulations and prepare for the FAA written exam.
- One week to schedule and successfully complete the FAA written exam to become a certified remote pilot.
- One week of in-person training on TxDOT UAS policies and procedures and hands-on flight training that is use case-specific.
- Four weeks of remote learning through self-paced online modules; participants are also issued a training quadcopter to continue practicing flight maneuvers at home.
- One week of in-person training discussing automated operations, waivers, confined space, and other advanced operations. This last week ends with a written exam and practical flight component with TxDOT instructors.

TxDOT noted that the 10-week commitment to become a TxDOT UAS operator requires the division manager's approval for each student. TxDOT also clarified that it does not require its contractors and consultants to complete this 10-week training course; the agency requires consultants and contractors to submit flight plans and adhere to the TxDOT operations manual to foster consistency and safety.

### DATA MANAGEMENT

Another common theme that emerged during the sessions was the challenge of managing the large amounts of data generated by UAS use. Alaska DOT&PF, for instance, has collected more data with UAS in two years than the entire agency had in its history—highlighting the disruptive challenges of UAS technology. Alaska DOT&PF's remote UAS dock systems collect an average of 15 TB (terabytes) of data per year, and these large amounts of data overwhelmed the department's existing Information Technology system. To begin addressing these challenges, Alaska DOT&PF leveraged existing and new third-party systems, combined with internal systems to develop a data management workflow. Figure 4 depicts the agency's remote data workflow from the UAS docks into the department's geographic information system (GIS).

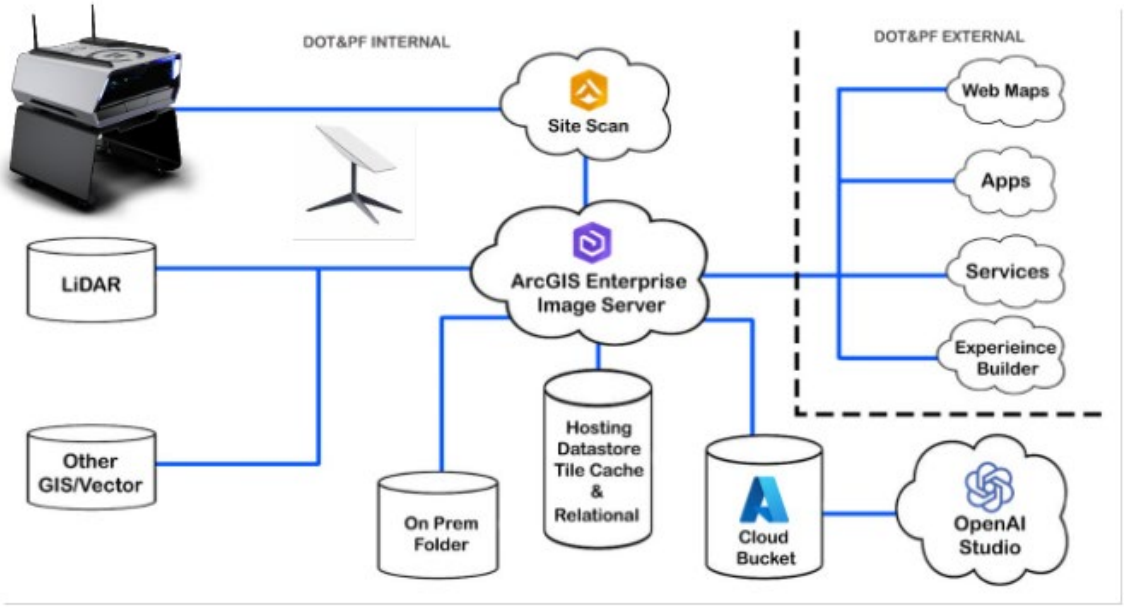


**Figure 4. Alaska DOT&PF Remote Data Workflow to GIS. (Source: Alaska DOT&PF)**

## ALASKA DOT&PF ADVANCED OPERATIONS

As the host State for the peer exchange, representatives from Alaska DOT&PF shared information regarding its use cases across the State. Alaska DOT&PF began using UAS in 2016, and its program continued to grow in terms of how many remote pilots and UAS platforms there are across the various users. Figure 5 depicts the growing list of UAS users in the different divisions and regions of the Alaska DOT&PF.

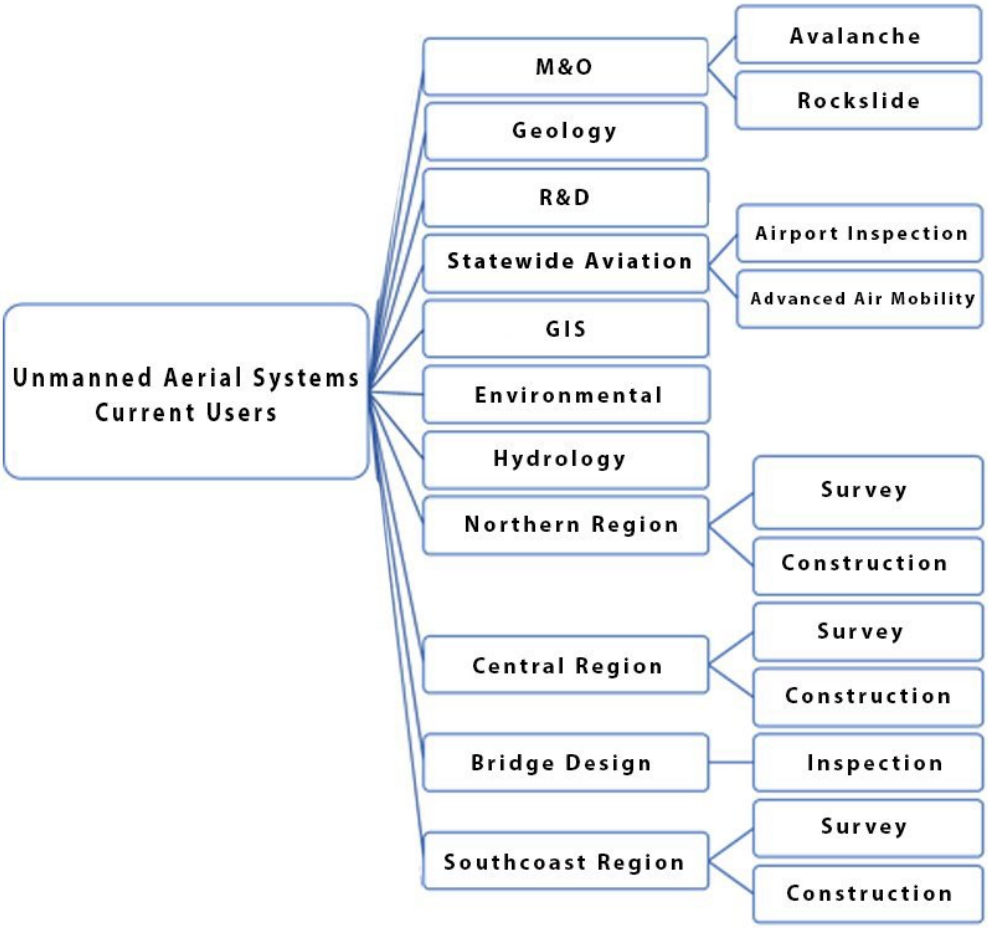


**Figure 5. Alaska DOT&PF Diagram of UAS Users. (Source: Alaska DOT&PF)**

One of the use cases that the Alaska DOT&PF highlighted is its ability to respond to emergencies more quickly and safely. UAS allows for the initial evaluation of transportation assets from a safe distance without putting people in harm's way (Figure 6). UAS also enables the ongoing monitoring of emergency response situations, Alaska DOT&PF shared how they moved a UAS dock system into place to remotely monitor the Dalton Highway washout for 17 days.


**Figure 6. UAS Responding to Earthquake Damaged Road. (Source: Alaska DOT&PF)**

Alaska DOT&PF also assisted in the emergency response for a large and destructive landslide in Wrangell, Alaska. UAS operations allowed the agency to quickly collect, process, and deliver information to the Federal Emergency Management Agency, resulting in a fast turnaround with recovery funds and resources to assist the impacted communities. Alaska DOT&PF noted that countless tests and multiple real-life projects using the UAS remote dock systems have repeatedly demonstrated that this technology is working; some sites have been remotely monitoring for 8 months with no humans physically going to the site.

The peer exchange was hosted in Juneau because it is the only location in the United States that has different types of remote UAS dock systems in operation. As part of the peer exchange, attendees were able to visit the site where these dock systems are installed and used (primarily avalanche mitigation). Figure 7 shows representatives from Alaska DOT&PF explaining how the dock systems work, and that this site was set up to test two different types of UAS dock systems. Alaska DOT&PF representatives talked about how the agency leveraged five different grant programs to assist with funding the UAS dock systems and supporting systems.

**Figure 7. UAS Dock System (on left), Peer Exchange Attendees at Juneau UAS Dock Site (right). (Source: FHWA)**

The remote UAS dock systems in Juneau rest on pallets and have been moved to other locations in the past; however, they are primarily meant to be fixed systems. Alaska DOT&PF uses electric emergency response vehicles as a mobile UAS docking solution. This vehicle (Figure 8) is set up with remote internet and a mounted dock system in the bed of the truck. Because the vehicle is electric, its battery can support these systems for long periods of time.


**Figure 8. Alaska DOT&PF Electric Emergency Response Vehicle with UAS Dock System. (Source: FHWA)**

# CHALLENGES AND NEXT STEPS

State DOTs discussed common challenges such as workforce shortages and software gaps. A common theme on how to meet these challenges was how helpful it is to work together as State DOTs. Alaska DOT&PF shared how it has been able to mature and advance its UAS operations by collaborating with other State DOTs. Representatives from Alaska DOT&PF acknowledged that much of its initial collaboration took place through FHWA UAS peer exchanges or workshops and explained that once those relationships were established with other State DOTs, it was easier to seek help from those State DOT colleagues.

## ADDRESSING TECHNOLOGY AND WORKFORCE GAPS

One of the main challenges raised repeatedly in various panel and round table discussions was the challenge of workforce shortages. MDT shared that turnover of people has been a challenge across the department, and attending State DOTs agreed that everyone is expected to do more with less. UAS are a proven tool that allows State DOTs to perform various tasks more efficiently, and attendees discussed how to leverage technology even more to increase efficiency.

The discussion identified gaps in UAS technology, particularly in software integration and data automation. While hardware capabilities have advanced, software that can seamlessly process

and deliver data is needed to reduce the burden on an already limited workforce. Automation in tasks like traffic cone counting and job site inspections can significantly enhance efficiency, allowing human operators to focus on higher-value activities. Attendees talked about using machine learning and automated systems to use data from a UAS progress mission of a construction site to produce a report on the number and types of equipment, the number of people, and how many were not wearing safety gear properly.

Other challenges expressed were around gaps in technology related to data management, specifically around a lack of a scalable system where data could be easily accessed from a data lake where data from thousands of UAS flights could live and still be accessible. Another data challenge discussed was the difficulty of layering Building Information Modeling, GIS, and capture data. As these data management gaps are closed, the goal is to share data to unite division across a State DOT and increase efficiencies across the entire lifecycle of a project.

### PROGRAM MANAGEMENT

Representatives from MDT discussed the difficulties related to tracking the UAS fleet, the number of UAS pilots, their level of UAS capabilities, software licenses for data processing and the individuals with access, and the level of access. MassDOT representatives identified similar challenges and noted that even when using a software solution to assist, this challenge has been ongoing. State DOTs expressed how helpful a simple solution would be that could meet these needs; noting the need to reduce the knowledge burden associated with much of the software.

## POOLED FUND STUDY – UAS STANDARDIZATION

As UAS deployment activities have matured across the country, State DOTs have recognized and identified the need for UAS standardization. As a result of this identified need, some State DOTs have collaborated to begin a transportation pooled fund study that Alaska DOT&PF is championing. This objective of the project is to create a comprehensive UAS Standards and Specifications guidebook that provides State DOTs with the needed UAS data collection standards and best practices. A stand-alone standards guidebook is envisioned for the following use cases:

- Survey
- Construction
- Bridge Inspections
- As-builts
- Incident Management
- Earth Movement

Additional details regarding the pooled fund study can be found at the following link: Transportation Pooled Fund – Solicitation Details – UAS Standardization.

# CONCLUSION

The peer exchange provided a comprehensive platform for State DOTs to discuss and share advancements, challenges, and best practices related to UAS deployment. Key takeaways from the peer exchange included:

- State DOTs are making progress in leveraging UAS technology to enhance safety, efficiency, and cost savings in transportation operations.
- BVLOS or remote UAS operations have enabled diverse applications of UAS from emergency response and vegetation management to avalanche mitigation and monitoring.
- Alaska DOT&PF demonstrated the successful implementation of remote UAS dock systems and their impact on emergency response and routine monitoring.
- Challenges related to workforce shortages, technology gaps, and program management were discussed, emphasizing the need for ongoing collaboration and advancement of automation, standardization, and training.
- The envisioned transportation pooled fund study for UAS standardization represents a significant step toward potentially creating unified UAS guidelines and best practices that can benefit all State DOTs.

# REFERENCES

Hubbard, S., and B. Hubbard. (2020). A Method for Selecting Strategic Deployment Opportunities for Unmanned Aircraft Systems (UAS) for Transportation Agencies. *Drones*, 4(3): 29. https://doi.org/10.3390/drones4030029