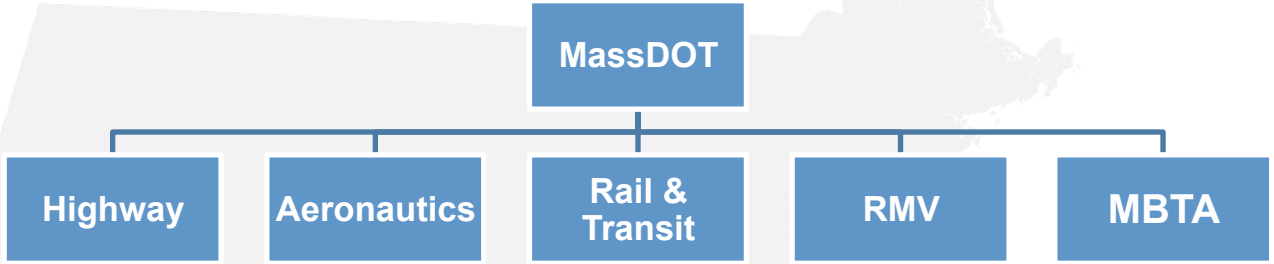
Massachusetts Drone Program:
Expanding Operations Across the Commonwealth

2019 MassDOT Innovation Conference
April 9, 2019

Andrew Mihaley, MassDOT

Massachusetts Department of Transportation (MassDOT)



- November 1, 2009. The Commonwealth integrated its transportation agencies and authorities into a new streamlined Massachusetts Department of Transportation (MassDOT)
- MassDOT is an organization with over 10,000 employees working to simplify and streamline the transportation system while making it more accountable and accessible
- MassDOT Aeronautics is conducting a Unmanned Aerial Vehicle (UAV) pilot program for the use of UAVs in transportation use cases

Statement of Purpose

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- Facilitate the adoption of drones across MassDOT in a manner that is:
  - Safe
  - Cost effective
  - Secure
- Incentivize applied research to enable UAS operations and develop counter-UAS solutions

APPROACH

Agenda

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Developing a Comprehensive Drone Program

Review of Use Cases and UAS Operations

Growing Capability to Support Multi-Modal Needs Across Commonwealth

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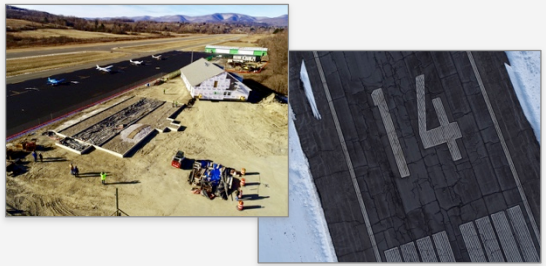
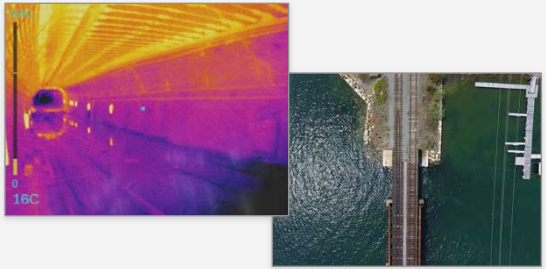
AERONAUTICS

- Runway/taxiway/apron pavement inspection
- General airport inspections
- Obstacle/obstruction analysis to ensure clear approach and departure flight paths



RAIL & TRANSIT/MBTA

- Rail inspection
- Rail obstructions
- 3rd rail inspection
- Tunnel inspection (testing)



HIGHWAY

- Pavement inspection
- Bridge inspection
- Environmental inspection (stormwater management)
- Construction site monitoring
- Incident response
- Asset management

- **Addressing multi-modal needs across MassDOT and the MBTA, and becoming a shared service for Commonwealth agencies**

Deploying UAS Resources for Emergency Response Documentation

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AIRCRAFT ACCIDENTS

- MassDOT Aeronautics state lead accident investigator

PIPELINE FIRES

- Documented damage due to gas fires
- Performed operations in conjunction with NTSB

EXERCISES

- Demonstrated operational integration of UAS and deconfliction with crewed aircraft

- **Working with MEMA and FEMA to support emergency response and to bring capabilities across state lines (UAS and crewed aircraft)**

MassDOT UAS Fleet

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- Fleet selected through evaluation of UAS use cases and analysis of alternatives
- Expanding fleet with new purchases of DJI Mavics and other specialized drones

	 DJI Phantom 4	 DJI Inspire 2	 DJI Matrice 210	 Yuneec H520	 SenseFly ebee	 Delair UX11
# Purchased	5	2	1	1	1	1
Sensors	HD Camera	HD Camera 6K Camera	HD Camera; 30x Optical Zoom; IR (thermal) Camera	HD Camera	S.O.D.A. RGB Sensor[1]	Hi Res, Low/ No Distortion
Features	Familiar to users	Dual Operator Mode	All-weather; Upward Gimbal; Dual Lower Gimbals	All-weather; 6 Rotors; 360° View	RTK/PPK Accuracy[2] 20 mile range	PPK Accuracy[2]; 33 mile range
Flight Time	30 min	27 min	25 min	25 min	50 min	59 min

1: Sensor Optimized for Drone Ops – RGB Broad Color Array
2: Real Time Kinetic/Post Processed Kinetic

Data Pilot General Process

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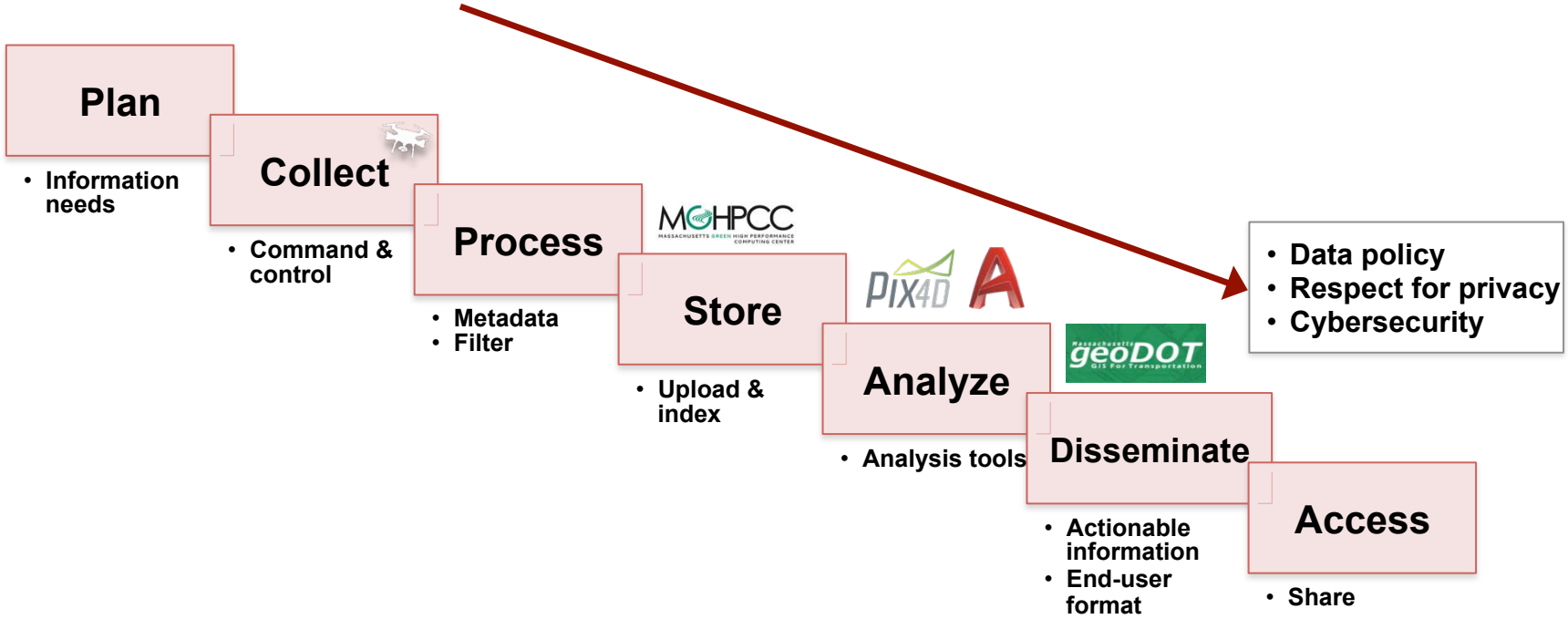

- **Building comprehensive approach to data analytics and security necessary to enable drone benefits and ensure mission success**

Agenda

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Developing a Comprehensive Drone Program

Review of Use Cases and UAS Operations

Comprehensive Approach Allows UAS Support to Expand Across Commonwealth

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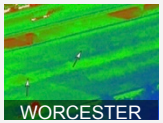
Emergency Response Vigilant Guard Drill

Aeronautics Document Building Move

Highway District 1 Roof Inspection

Highway District 2 Woronocco Bridge

Highway District 2 Agawam Bridge

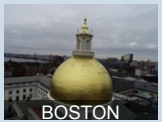


Highway District 3
(L) MassPike Thermal Imaging
(R) Headquarters Construction

Centralized
Distributed

Emergency Response Pipeline Fire

State House Dome



Highway District 6 Comm. Ave. Bridge Replacement

MBTA Subway Drill

Highway District 5 Cohasset Bridge

Highway District 5 I-495 Lobes

Categories of Use Cases and Data Products

USE DATA	DATA PRODUCTS
Public Relations	Imagery & video
Asset management/inspection	Imagery & GIS photomosaics
Construction site monitoring	GIS photomosaics & CAD terrain elevations
Thermal characterization	Infrared imagery & video
Incident/emergency response	Imagery, video & live-streaming video

Documented Replacement of Commonwealth Avenue Bridge

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- Documented progress of Commonwealth Ave Replacement Bridge in downtown Boston
  - Flew 11 missions over 3 weeks: July-August 2018

- Demonstrated Drone Team's capability, and provided valuable lessons learned


CAT

State House Dome Inspection

- State House requested Drone Team support to capture discoloration of dome's gold leaf
- Coordinated with FAA to allow flight close to Boston Logan Airport
- Careful flight planning to ensure safe operations around historic and complex structure

Details

- Flew mission day before Thanksgiving
- Great support from State House authority for access and ground crowd control
- "This gives me what I need" to plan repairs – State House authority representative

Elements of Drone Mission

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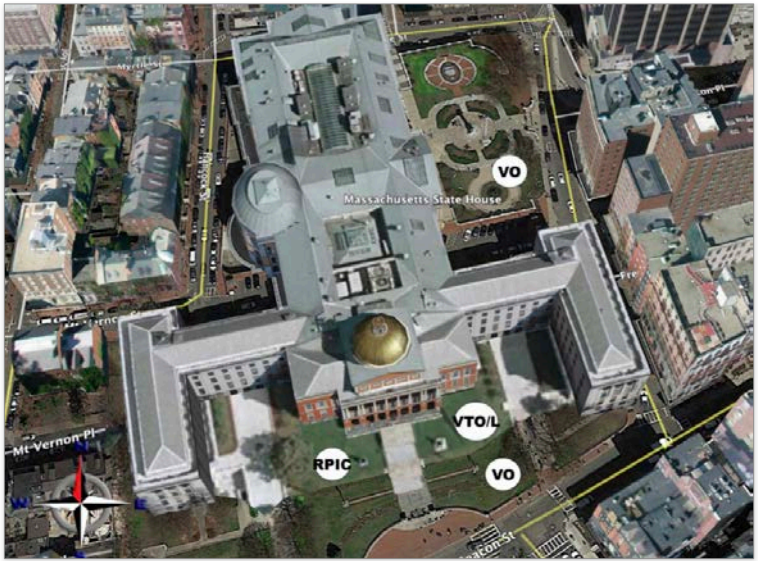
Many elements are required to safely and successfully execute a mission:

- Class B Airspace
- Privacy concerns
- Collision avoidance
- Visual observers
- Stakeholder interaction
- Public safety



Google Earth image showing locations of:

- Remote Pilot-in-Command (RPIC)
- Visual Observers (VO) for safety
- Vertical Take-Off and Landing (VTO/L) location for UAS

State House Dome Video Footage

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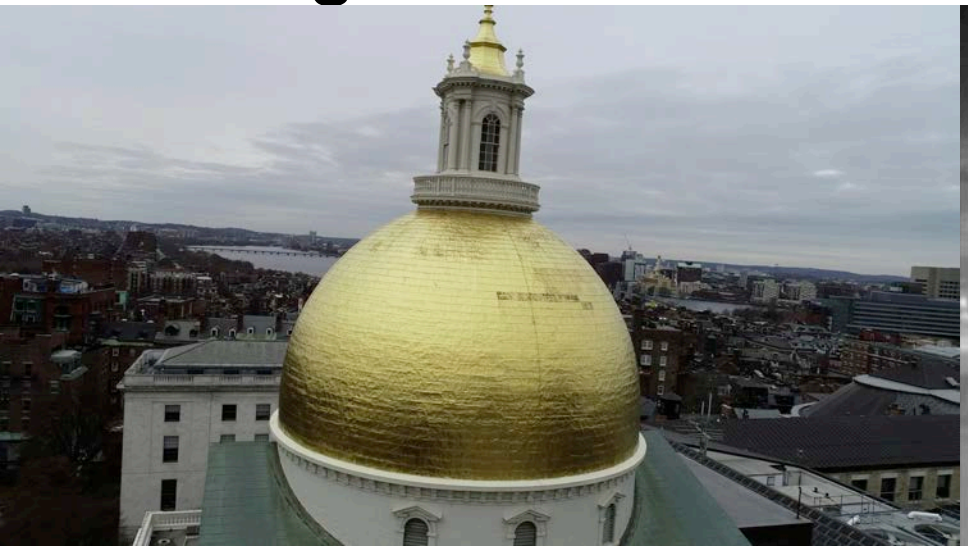

Imagery of damage

IR imagery of damage

State House Dome Inspection
Infrared Sensor

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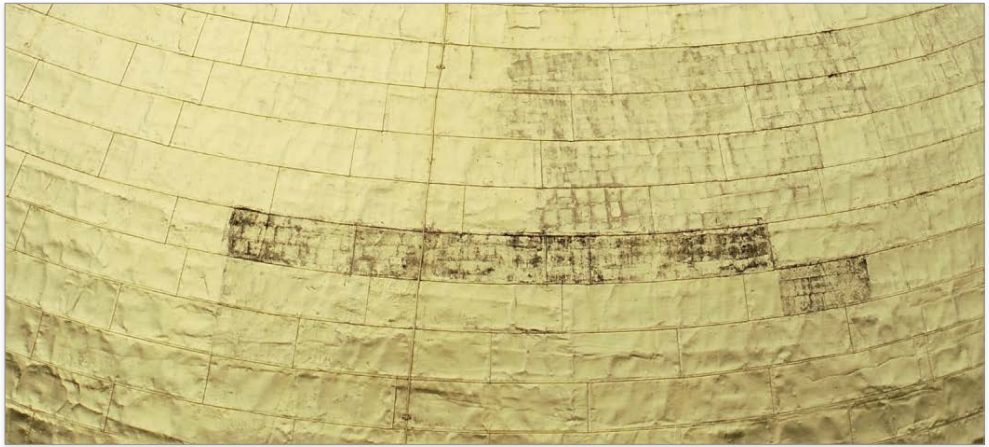
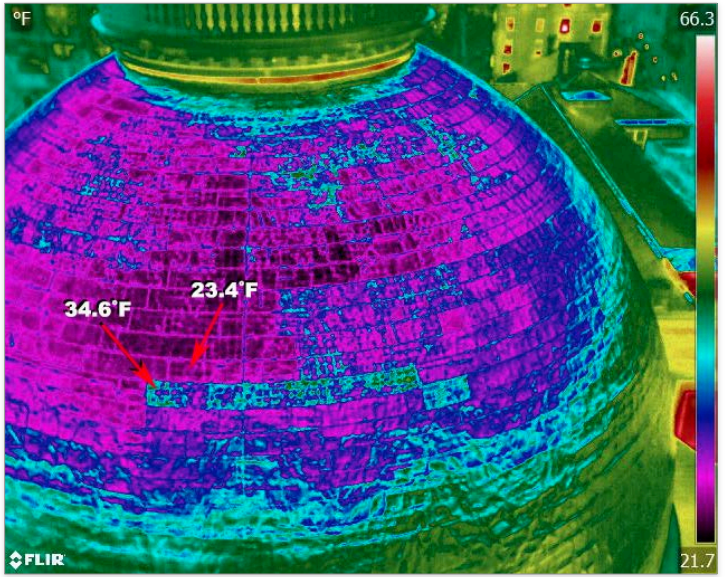
- Demonstrated use of IR (thermal) camera to detect problem area





Successful Use of Drone Data

New Highway District 3 Headquarters

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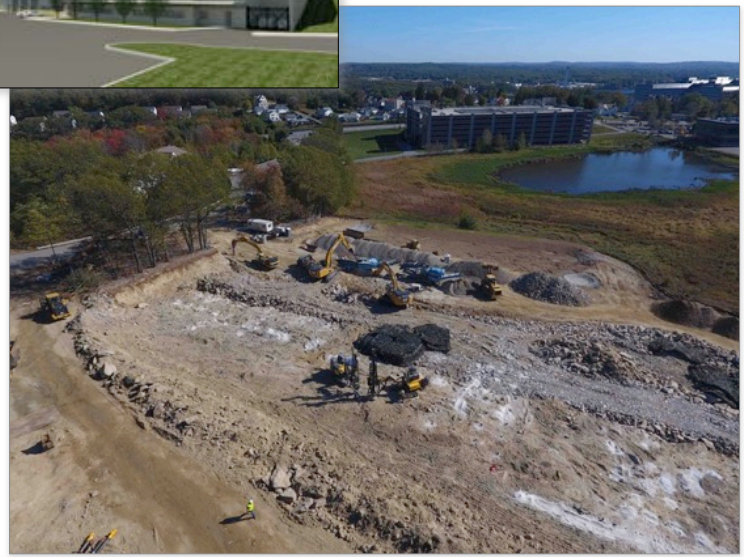
- Difficult site topography created construction challenges
  - Site surface model created using drone mapping tools; used to evaluate site conditions and test ‘fit’

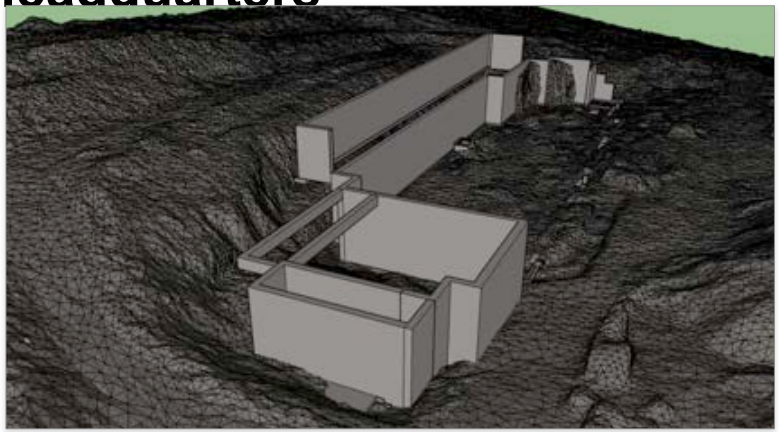


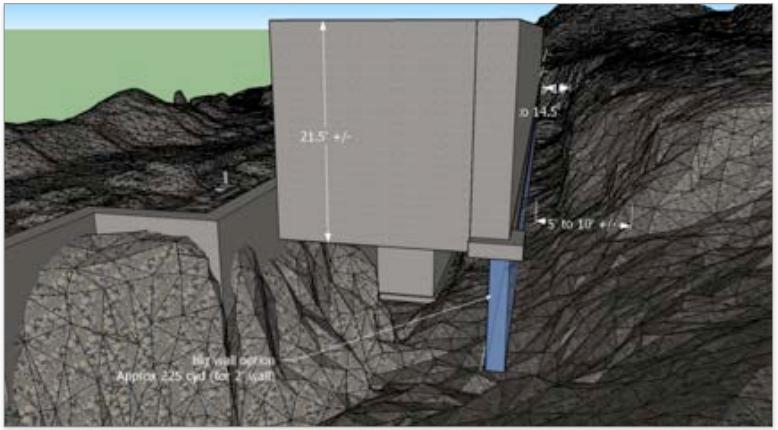
Photomosaics show changes over time

District Application of Drone Data

Construction of Highway District 3 Headquarters

- Combine CAD model of building with terrain model generated from drone data





"The information we received and the processing done by Jason's team allowed us to make construction decisions that would have otherwise cost us significant amounts of time and money."

-- Barry Lorion
District Highway Director, District 3

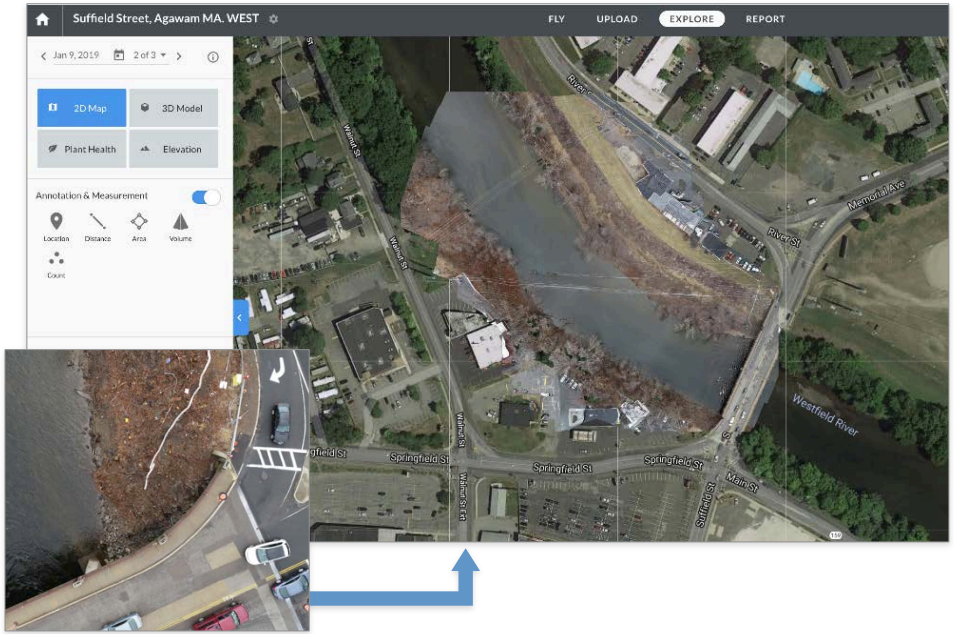
"Use of the drone-derived data revealed $300,000 fill underestimate. Early identification of the gap saved the project money and time."

-- Jason Benoit
Special Projects Manager, District 3

Expanding Use for Environmental Inspection

Agawam Bridge, West Springfield

- Working closely with Highway District personnel for environmental inspection



Details

- Use drones for existing conditions survey of bridge embankments in locations that could be impacted by construction and erosion
- Photo documentation for combined storm water and sewer pipe outlet required before construction
- Grade profile of the West Springfield embankment/flood control levee and coffer dam inspections

Woronocco Bridge

District 2, Westfield River, Russell

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- UAS allowed field engineers to monitor structural condition of abandoned bridge, out of service since 1984
- UAS allows access in complex terrain; inspection of unsafe structure

Airplane Accident Investigation

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- Supporting NTSB by documenting accidents

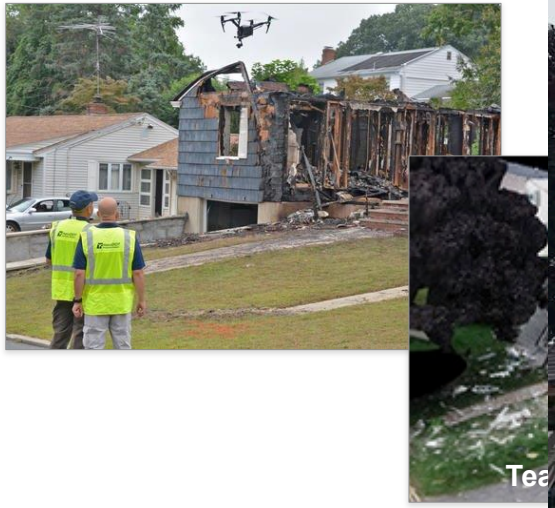
Orange Municipal Airport, Orange, MA (9/26/17)
(Photo courtesy of MassDOT Aeronautics)

Cranland Airport, Hanson, MA (8/24/18)
(Photo courtesy of MassDOT Aeronautics)

Deploying Drones fo
Response

Lawrence Pipeline Fires

- Immediate emergency resp
  locumentation of homes after
  pipeline fires, and for aircra
  - Coordinated with NTSB (le
    e damaged structures
  - All necessary waivers and
    able mission



Details

atched September 14-16 (days
ely after explosions) to provided
coverage and damage
ent of impacted areas

l state and federal coordination

created using drone imagery

transition to scene of aircraft
also coordinating with NTSB

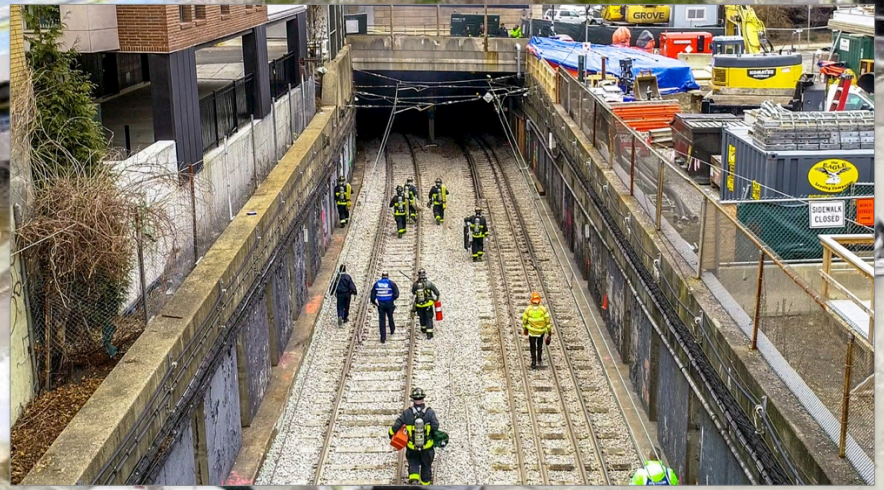
sponse

- Developing concepts of operation to support emergency response
  - Vigilant Guard: multi-agency bi-annual exercise to demonstrate collaboration for a variety of emergency response scenarios: dam damage, stadium attack, and coastline flooding
- Participated in multi-vehicle, multi-mode (manned & unmanned) simultaneous operations

Details

- November 2018
- Deconflicted with multiple other UAS and manned aircraft
- Coordinated with ~25 other agencies
- Identified as key contributor in exercise, and to document activity

MBTA Subway Evacuation Drill



- Support MBTA at Fenway Station for 16 December drill of train derailment
- Provided video for first responders to use to assess evacuation during interagency coordination exercise (MBTA, MBTA Transit Police, Boston EMS, Boston Fire)

Public Relations Documentation

North Adams Airport Building Relocation

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- Documented relocation of existing building for airport manager
- Coordinated with airport manager to allow UAS operations at active airport


Any questions?