UAV / Remotely Piloted Aircraft Systems (RPAS) Surveying

Presented by:

Moranne McDonnell
Cathy Eden
Cody Purchase

Restoration & Infrastructure Division
TRCA

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PRESENTATION OUTLINE

- What we do at TRCA
- The need to modernize surveying
- Equipment and Software
- Program start up costs
- Comparing traditional surveying to photogrammetry
- Transport Canada rules and regulations
- Steps to fly
- Application examples

TRCA Restoration & Infrastructure Division

- 213 full time staff + approx. 100 contract staff
- $50M in capital and special projects/programs each year
- Erosion hazard monitoring
- Aquatic, flora and fauna monitoring
- Natural channel construction
- Shoreline protection
- Slope stabilization
- Conservation land management
- Trail planning, design and construction
- Aquatic and terrestrial habitat restoration
- Forestry management
- Nursery production
- Archaeology
- Soils management

The Need to Modernize Surveying

Public/client expectations around:

- Using the latest & best technology
- Rapid dissemination of information

More data to collect; less money

- Efficiency is critical

Equipment and Software

DJI Inspire 2
Changeable payload means there is room to grow the program in different directions

Zenmuse X4S
High image quality & stable gimbal means better data acquisition

Pix4D Mapper
Acquisition & processing software with built-in support for DJI Inspire 2

TRCA RPAS COSTS

Hardware and Software Costs	
Inspire 2 UAV/Camera and Kit	$8,450.00
Additional set of batteries	$412.00
Tablet	$1,000.00
Pix 4D Mapper Software	$6,253.00
Laptop	$2,500.00
Software Training	$600.00
Inspire 2 Training	$2,600.00
Administrative Costs	
Transport Canada On-line course-Advanced RPAS	$400.00
25+ hours of staff time in training	
Advanced RPAS Certification Exam	$10.00
Flight Review Certification-Practical	$400.00
Register RPAS with Transport Canada	$5.00
Insurance per year	$3,500.00
Total Start-up Cost (2018)	**$26,130.00**

Additional Growth Costs	
Mavic Pro 2 - RPAS and accessories	$2,500.00
Insurance per year	$3,500.00

Comparing Photogrammetry to Traditional Surveying

	RPAS Photogrammetry	Traditional
Administrative	A lot of administrative prep work	Minimal administrative prep work
Response time	May need to wait for NAV CANADA approvals before survey (can take days)	Can begin surveying immediately
Site conditions	Sites need to be open from above and have adequate lightning	Able to survey around obstacles, under tree canopy, and in water
Safety	Access hazardous areas remotely	Surveyor must traverse hazardous terrain
Survey Data	Large area can be covered, shorter time-line, limited to land survey	Large area, takes much longer but more detail, capable of capturing watercourses
Weather	Weather limited-wind, temperature and precipitation	Only limited by extreme weather
Deliverable	Drawing, orthomosaic, video, photos	Traditional Topographic Drawing

Transport Canada RPAS Rules

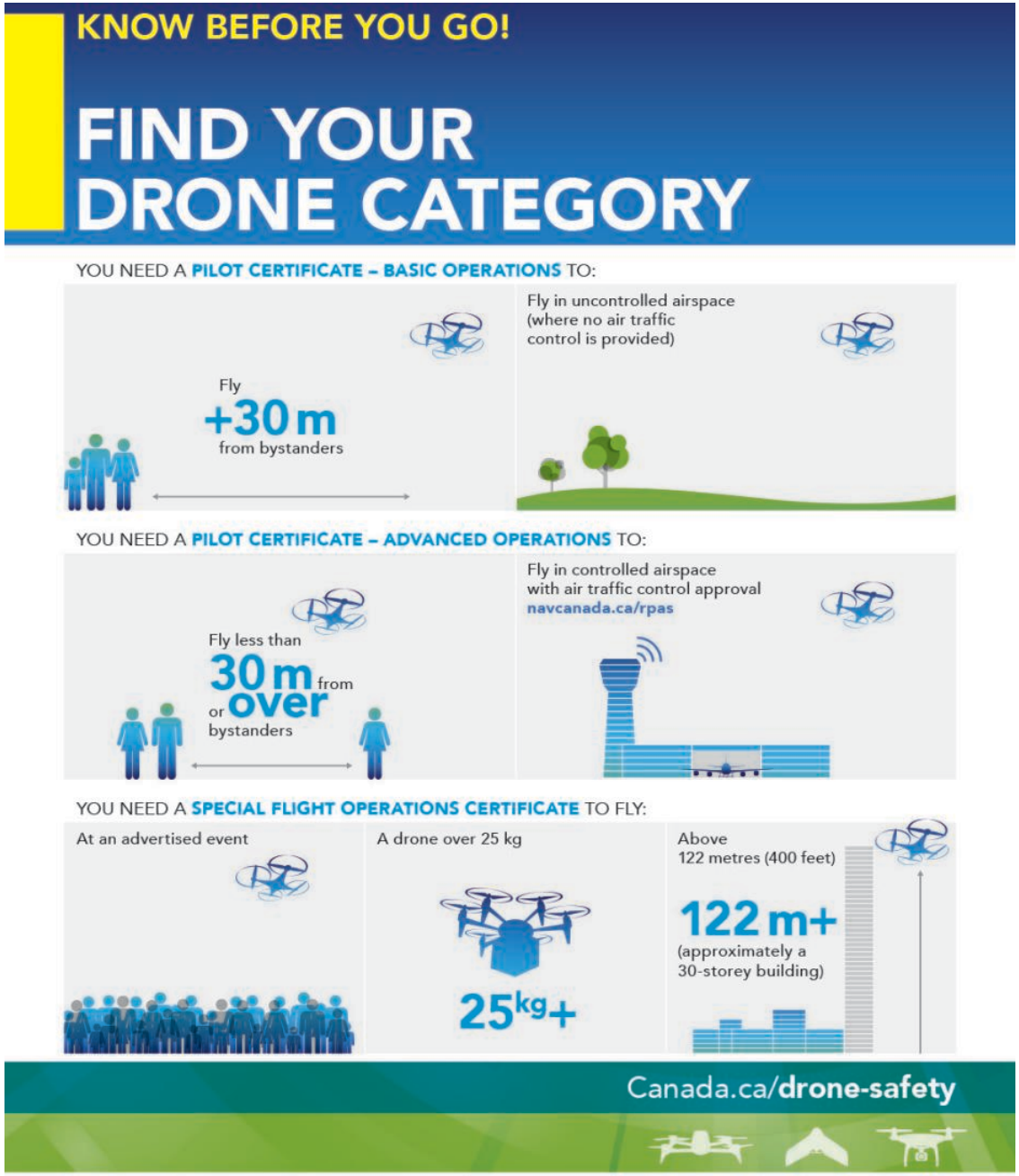


Image source: Transport Canada Drone Safety: https://www.tc.gc.ca/en/services/aviation/images/SM_-_Find_your_drone_category_EN.JPG

Steps to Fly Legally

Training	2 day course / 40+ hour online course
Written Exam	Complete exam for advanced operations with Transport Canada

Knowledge Requirements for Licensing

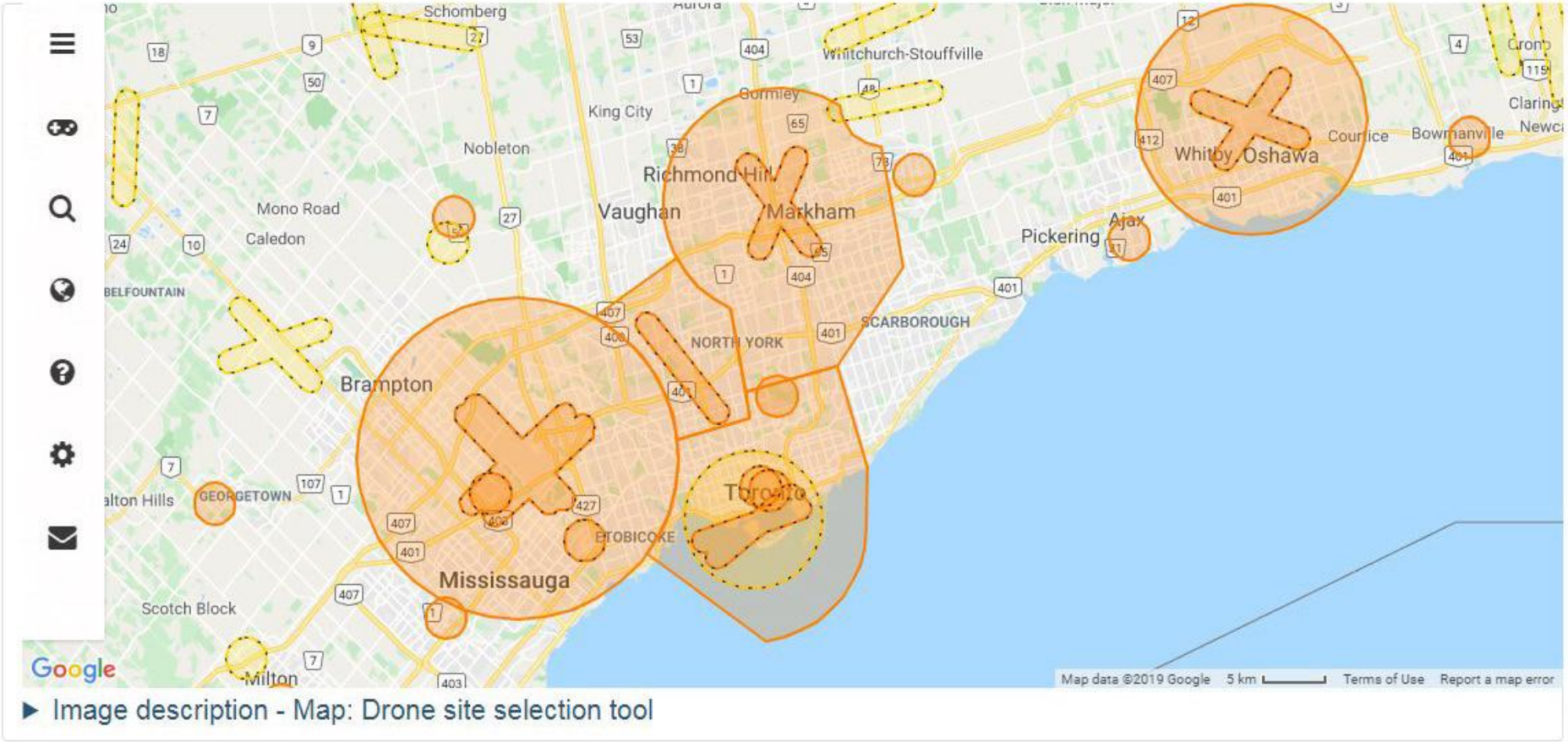
Prospective pilots are tested on the following topics:

- Air law, air traffic rules and procedures
- RPAS airframes, power plants, propulsion, and systems
- Human factors
- Meteorology
- Navigation
- Flight operations (administrative and procedures)
- Theory of flight (physics)
- Radiotelephony

Steps to Fly Legally

Training	2 day course / 40+ hour online course
Written Exam	Complete exam for advanced operations with Transport Canada
Flight Review	Complete flight review with Transport Canada authorized reviewer
Registration	Register and mark RPAS with Transport Canada
Site Check	Check the site and determine airspace restrictions

Site Selection Tool – Do You Need NAV CANADA Approval? https://nrc.canada.ca/en/drone-tool/



▶ Image description - Map: Drone site selection tool

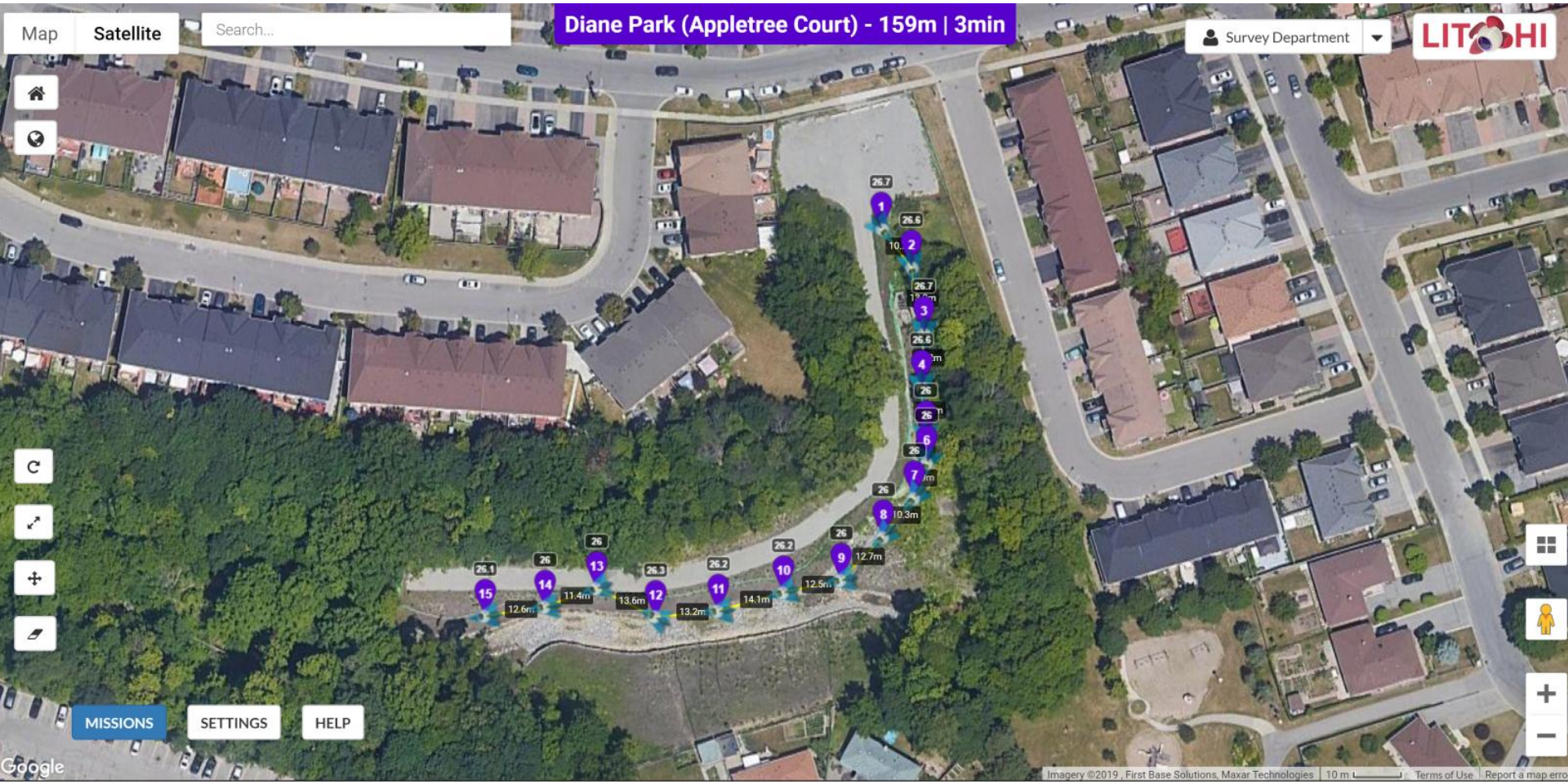
Image source: National Research Council Canada Drone Site Selection Tool:
https://nrc.canada.ca/en/drone-tool/

Steps to Fly Legally

Training	2 day course / 40+ hour online course
Written Exam	Complete exam for advanced operations with Transport Canada
Flight Review	Complete flight review with Transport Canada authorized reviewer
Registration	Register and mark RPAS with Transport Canada
Site Check	Check the site and determine airspace restrictions
Authorization	Submit flight Authorization request to NAV CANADA if applicable
Compliance	Comply with NAV CANADA requirements and approvals and Transport Canada regulations

Traditional Survey Drawing

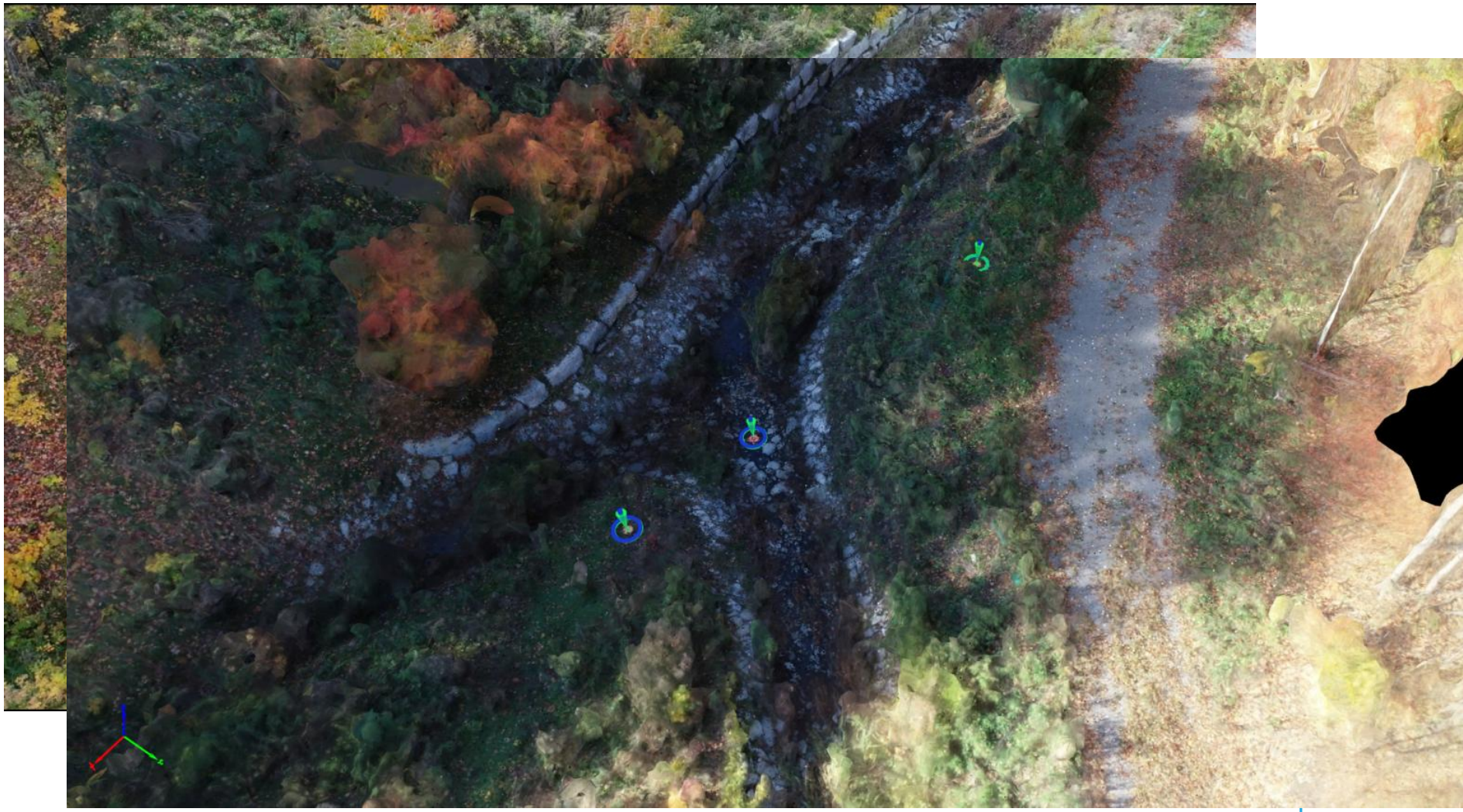
Digital Spatial Model
Photogrammetry



Setting Fixed Monitoring Points

Video footage from waypoint mission

Spatial Model over 4K Video Snapshot



Other Applications for RPAS

- LiDAR data collection
- Measure plant and tree health
- Identify drainage issues and damming
- Monitor flood damage and coastal/river erosion
- Inspect infrastructure and buildings
- Calculate stockpile volumes
- Construction services like site analysis
- Marketing and tourism videos
- Detect presence and temperatures of water and wildlife using heat sensors

Monitoring for Tree Health - Hemlock Wooly Adelgid

Image source (above): Wooly Bully: Monitoring the Impending Woolly Adelgid Infestation

https://earthzine.org/woolly-bully-monitoring-the-impending-hemlock-woolly-adelgid-infestation/

Image source (left): Connecticut Agricultural Research Station, Bugwood.org
https://www.invasive.org/browse/detail.cfm?imgnum=3225077

Monitoring Debris Jams

Flood Monitoring at Rouge Hill National Park

Flood Monitoring at Toronto Island

Video of path washout

Flood Damage to Highland Creek Waterfront Trail

Construction Site Progress Updates

Pix4D Software Uses

3D maps and models
Orthomosaics
Digital elevation models
Contour maps
Thermal map (IR camera ~$14,000)
Agricultural reflectance (multispectral camera ~$5,000)
Agricultural index map (multispectral camera ~$5,000)
Calculate stockpile volumes

QUESTIONS?

Cathy Eden
cathy.eden@trca.ca
416-661-6600 x 5544

Toronto and Region Conservation Authority