



Unmanned Aerial Vehicles

Establishing A Daily Pipeline Inspection Program in Esterhazy

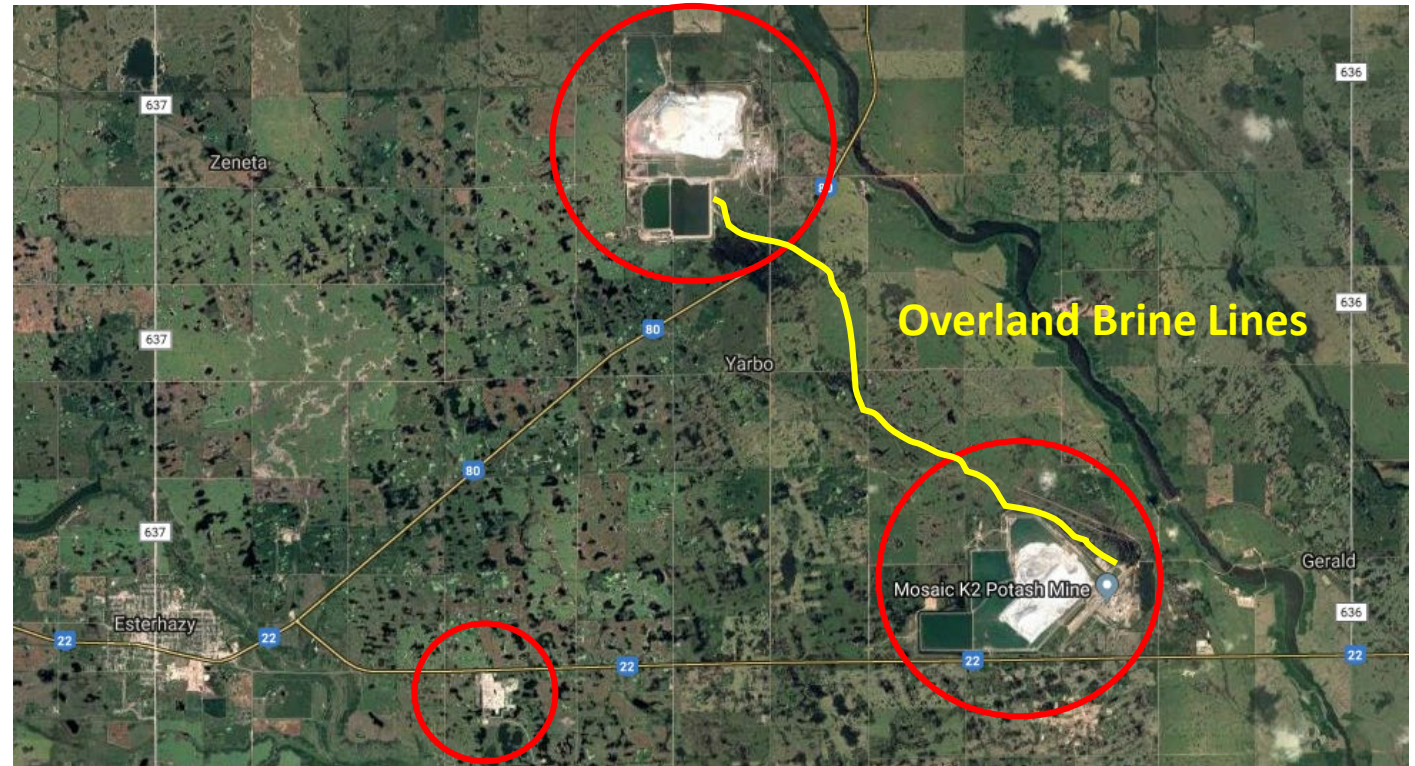
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Mosaic's Environmental Footprint at Esterhazy

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- Esterhazy Operations
 - Three potash mining facilities
 - Overland brine transfer
 - 11 km of brine lines
 - 24 inch 16 inch



Mosaic K1, K2, K3 Potash Mines

Esterhazy Overland Brine Lines



Environmental Controls - Esterhazy Overland Brine Lines

Proactive Controls:

- Visual line inspections (daily)
 - Trained Operators for all inspections
 - Documented procedures in place outlining inspection requirements
 - Drone inspections (new addition)
- Instrumentation
 - Differential flow with automated shutdown
- Operating procedures in place for the overland lines
- Assets are part of the mechanical integrity system

Reactive Controls:

- Emergency procedures
- Emergency response drills

Brine Release Detection Indicators

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- Detecting a salt residue

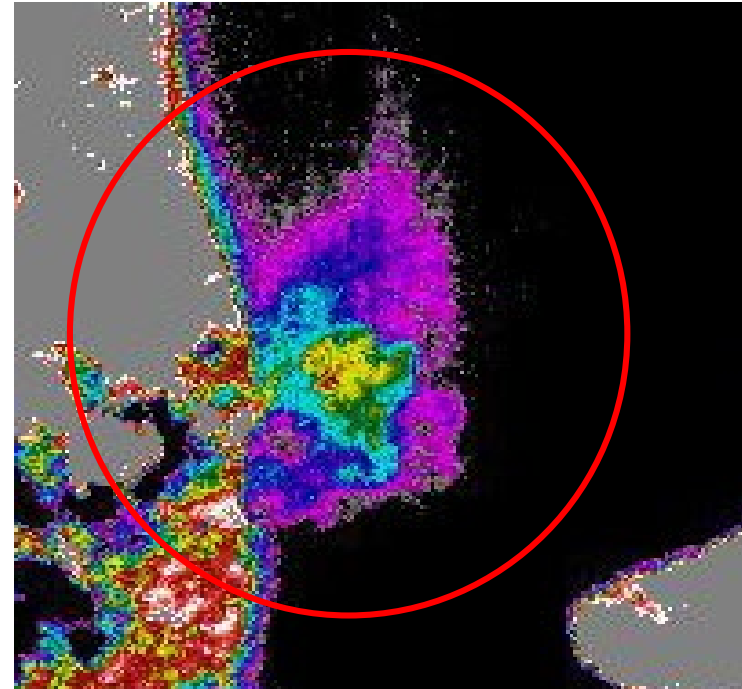
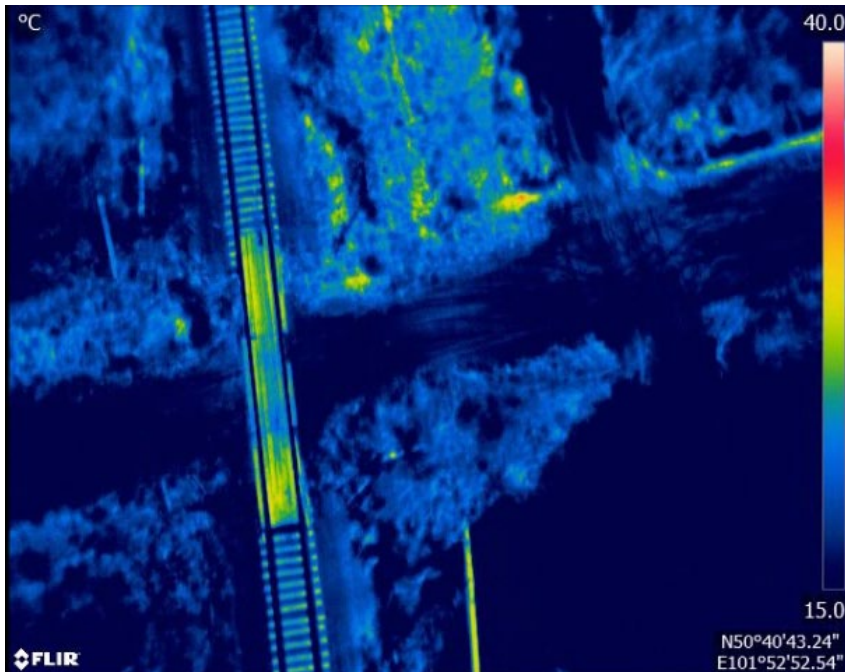


**Visual data of a detected
brine release**

Brine Release Detection Indicators

- Thermal hotspot indicator
- Detecting a difference in temperature between leaking brine and the background
- Looking for a plume like signature
- Vegetation and buried pipeline obscures data

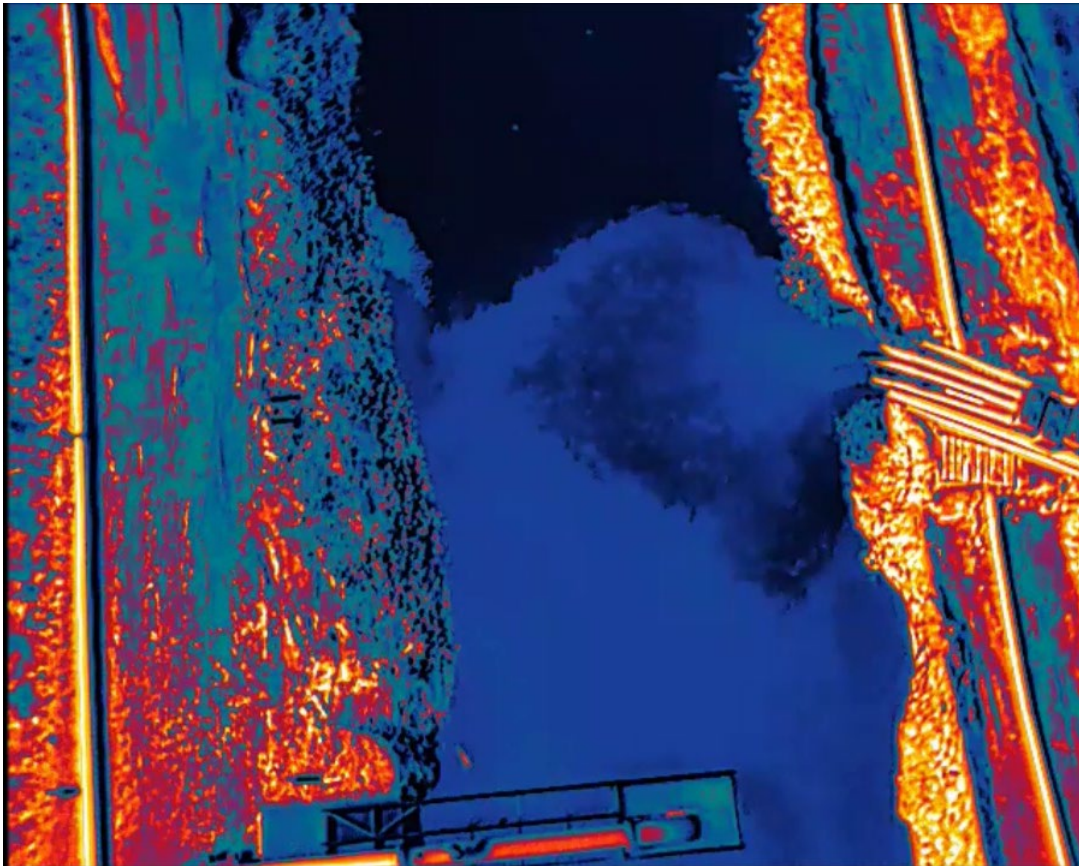
Thermal data



Processed data
from a simulated
pipeline leak

Leak Detection Indicators

- Thermal convection indicator
- Detecting a rapid flow of heat indicates a flow of fluid



Pipeline brine pond
discharge example

Daily Inspection Strategy

- Launch and recover UAV from one location
- Assess the data in real time

Requirements:

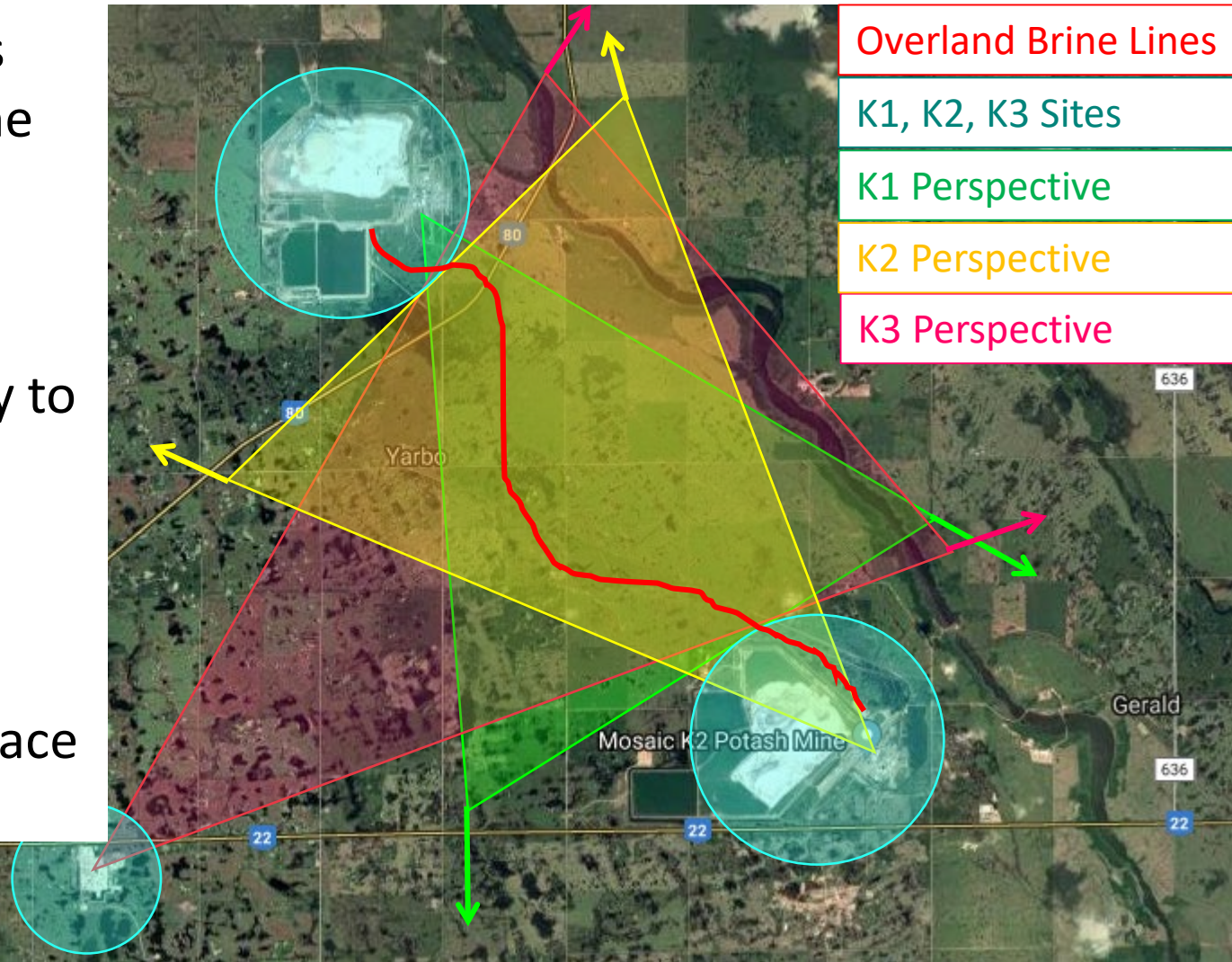
1. Special flight operations certificate (SFOC) approval
2. HD real-time video stream/recording to an employee workstation
3. Long range drone options



1) SFOC Approval Requirements

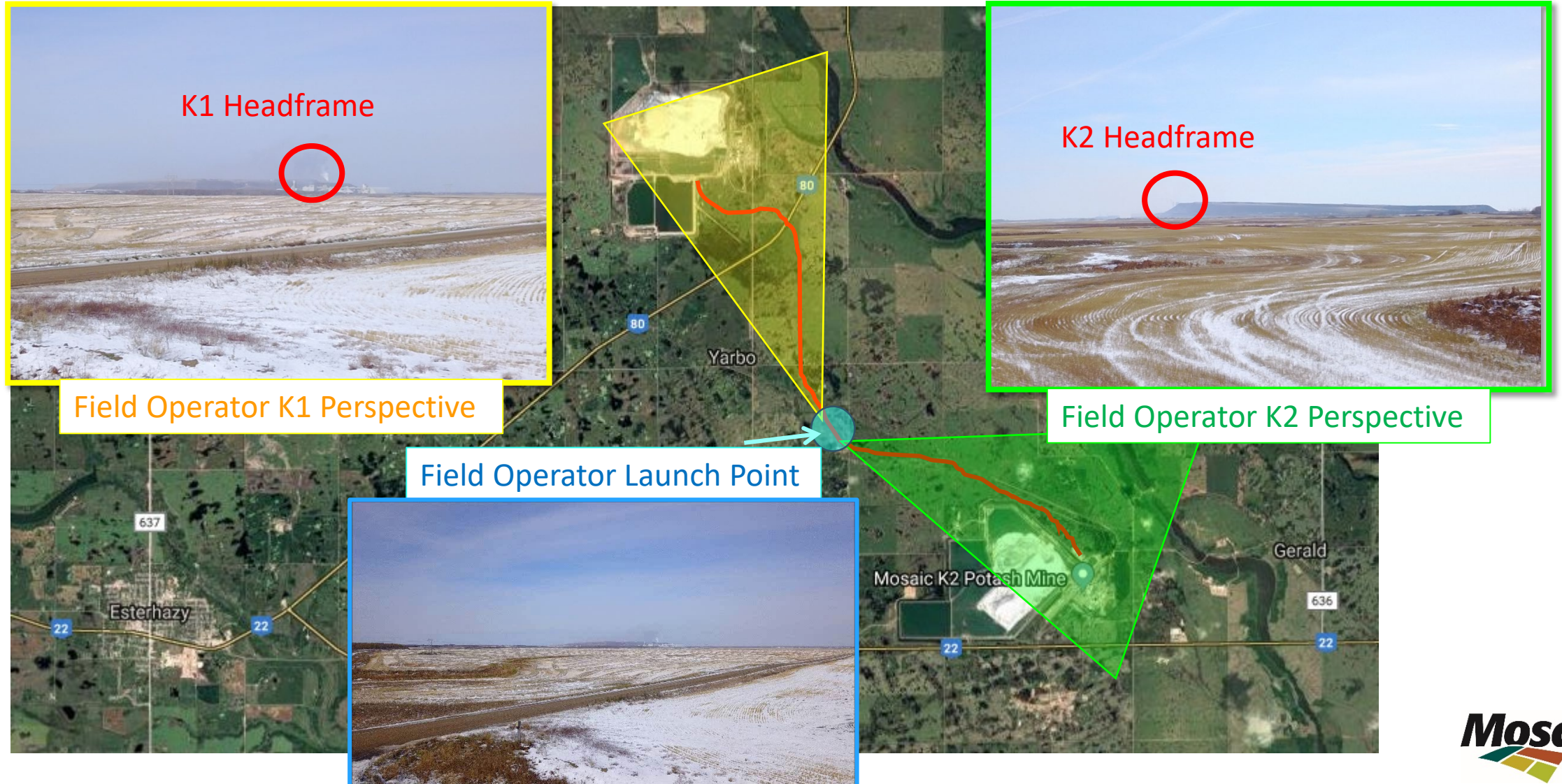
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- Crop spray planes may operate in the area
- Transport Canada requires an approved strategy to detect and avoid other aircraft
- Proposing a 3 camera system to monitor the airspace

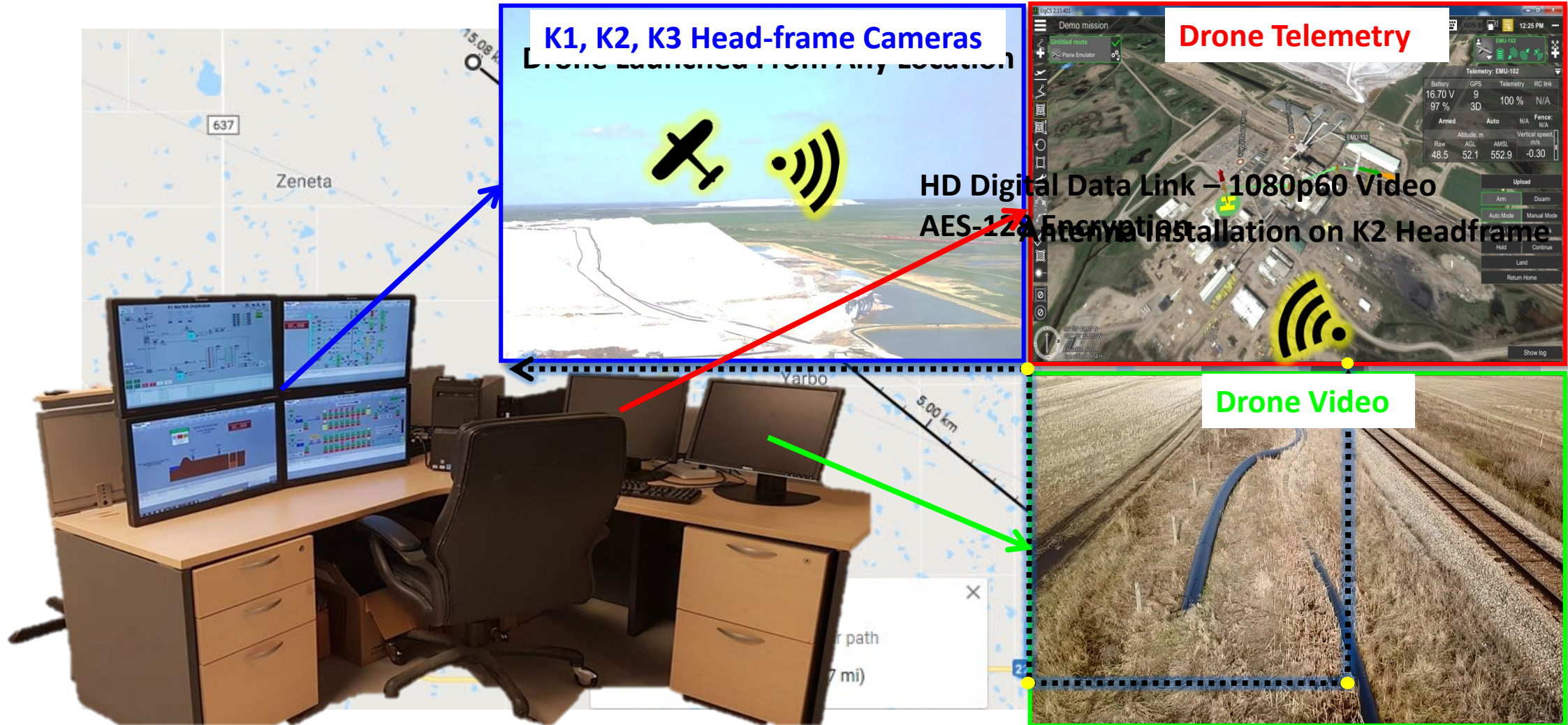


1) SFOC Approval Requirements

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2) HD Real-time Video Streaming Example



3) Long Range Drone Options

Prototype

- 15km low latency digital HD video link
- -40°C specs
- Thermal / visual spectrum payload
- 1hr flight time
- 1.1kg

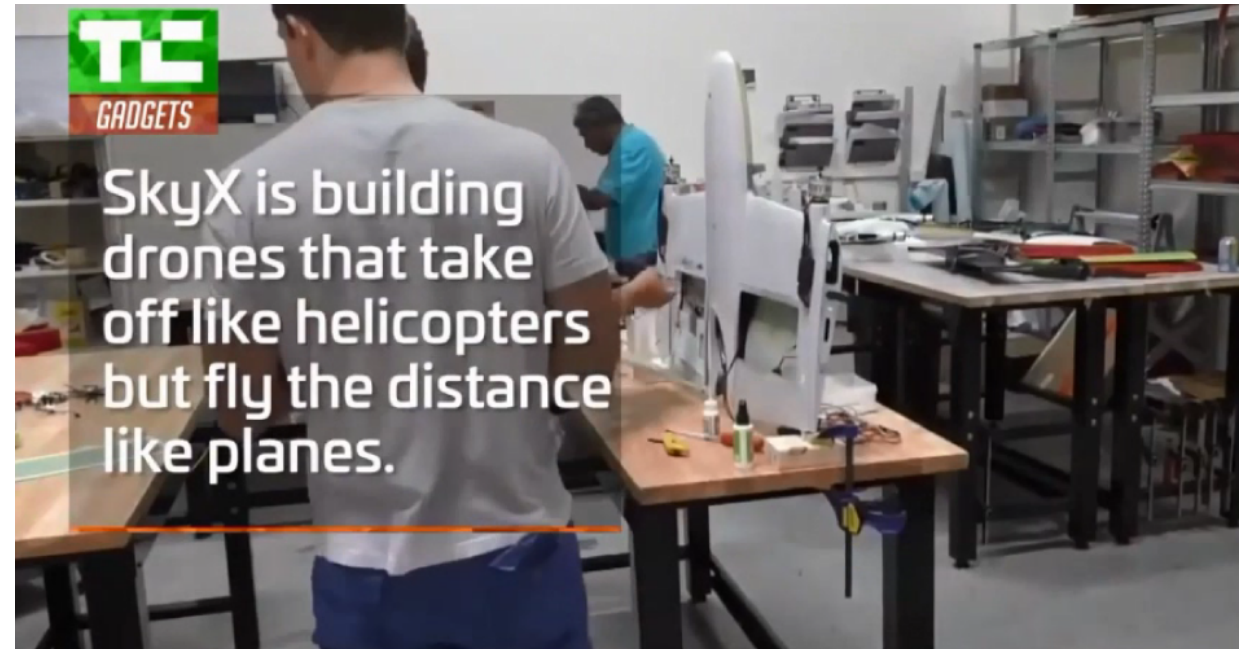


3) Long Range Drone Options

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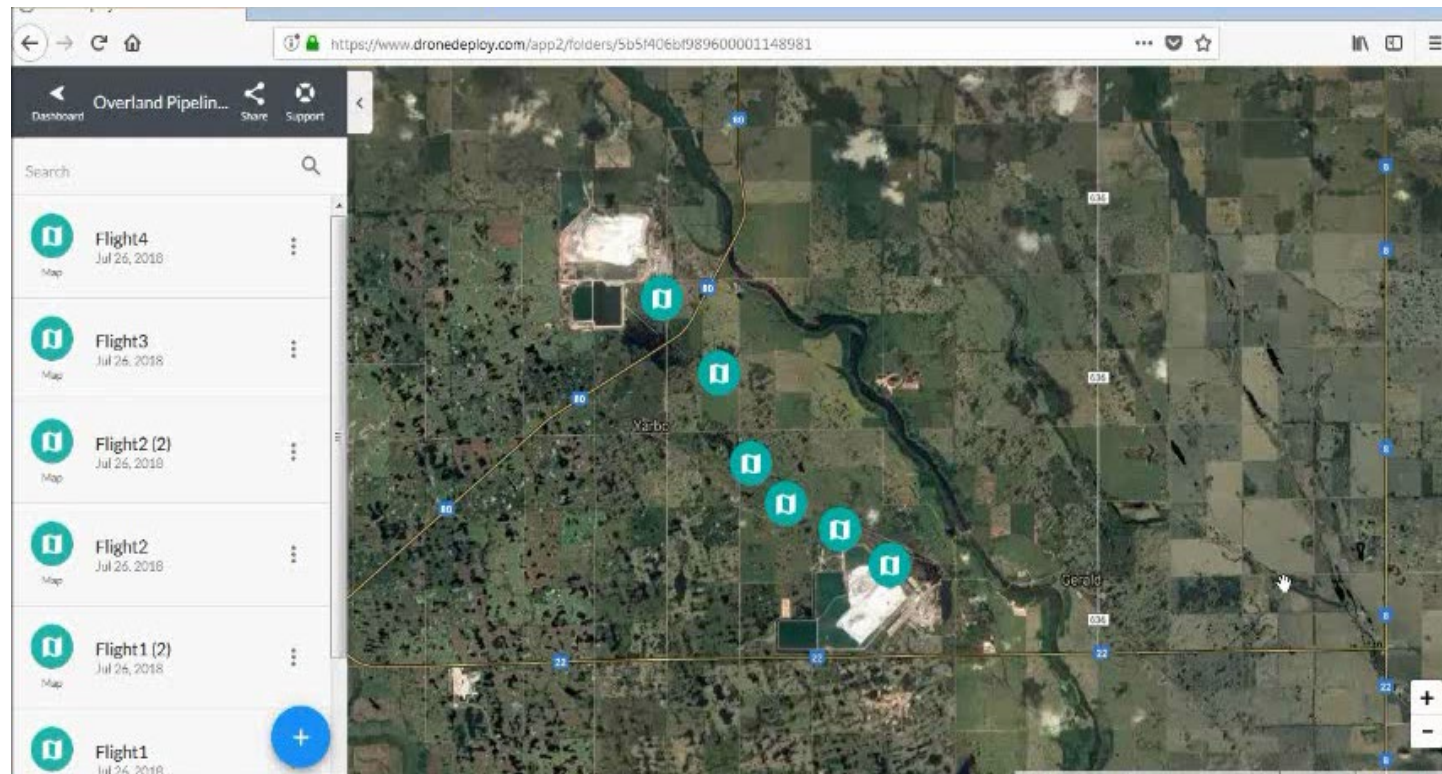
Transport Canada Compliant Aircraft

- SKYX
 - Vertical takeoff / landing
 - Automatic recharge on a charging platform
 - Combines versatility of a multi-rotor with the endurance of a fixed wing drone
- Freya Smartplanes
 - Built for future BVLOS applications
 - Up to 100 minutes of flight time



Pipeline Mapping Option

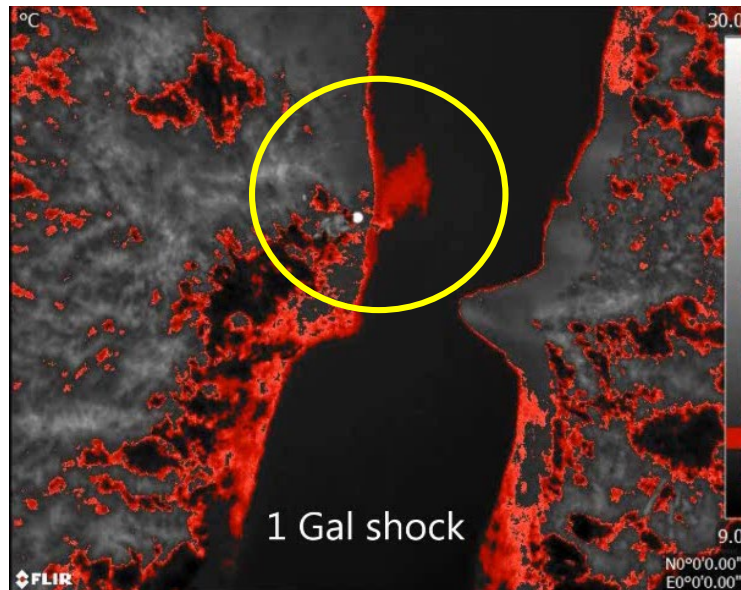
- Processing time required
- View the entire pipeline in software



Drone Deploy software

Future Developments

- Software detection of brine releases



Thermal threshold alarm of a simulated brine leak in water



Visual processing alarm of white pipe sections



