



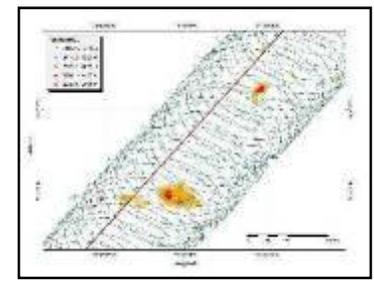
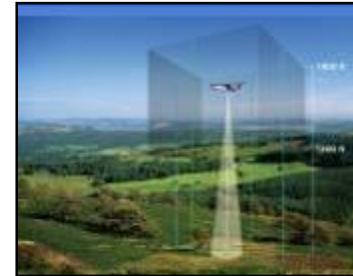
ITT

# ITT Airborne Natural Gas Emission Lidar (ANGEL) Service – DOT/PHMSA Research and Pipeline Leak Detection Results

DOT Web Presentation  
December, 13 2006

Steven Stearns  
ITT Space Systems

*Engineered for life*

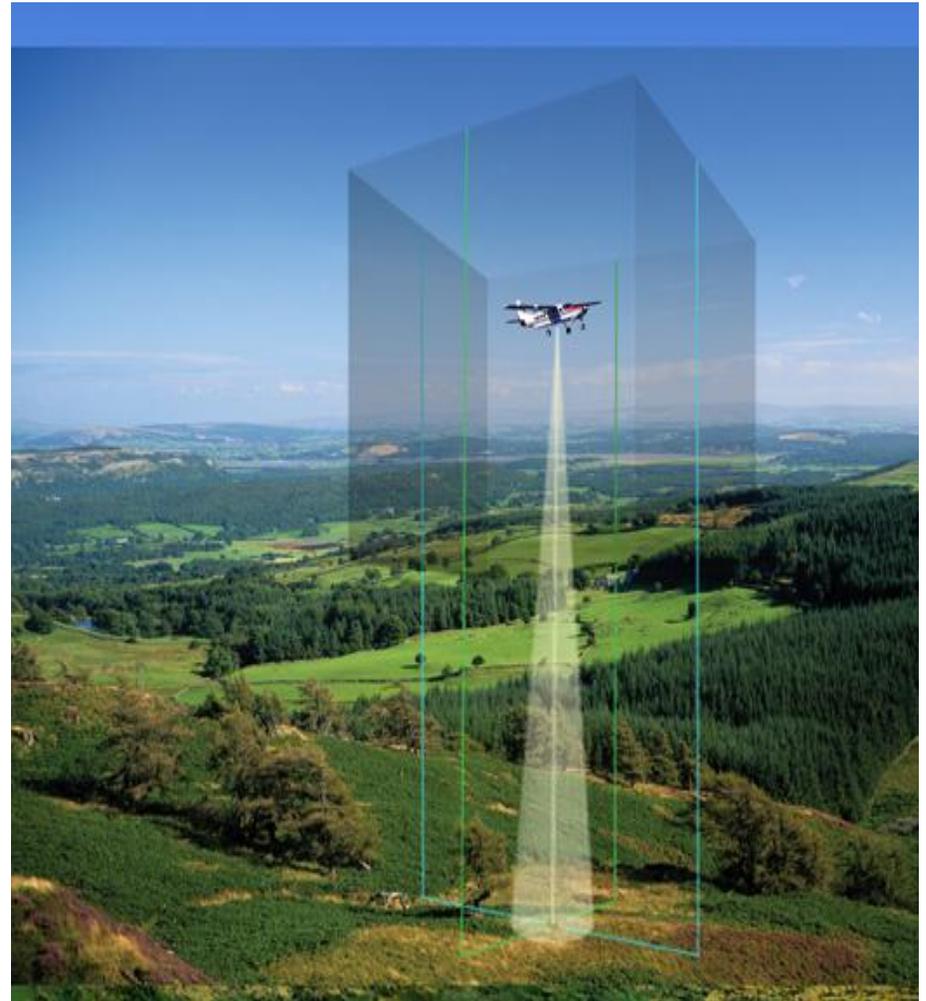


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# ITT ANGEL Service

## Airborne Pipeline Leak Detection and ROW Imaging

- § Airborne Leak Detection and Quantification
- § Hi-resolution Digital Mapping Imagery of Corridor and Facilities
- § Continuous Digital Video
- § Provides GIS-ready datasets



# Recent Accomplishments

## DOT supported R&D

### § **Emergency Response Final Report Submitted to DOT**

- Rapid Flight Planning - 30X improvement
- Real-time (in the air) Data Processing Study
- Rapid Data Processing
- Midwave Infra-red Camera Flight Test

### § **International Pipeline Conference 2006 Calgary** - Presentation of DOT-funded R&D and commercial results

### § **PG&E Partnership** – for Natural Disaster Emergency Response Demonstration in 2007



# ITT ANGEL Service

## Fixed-wing aircraft with three sensors



DIAL  
Sensor

Digital  
Video  
Camera



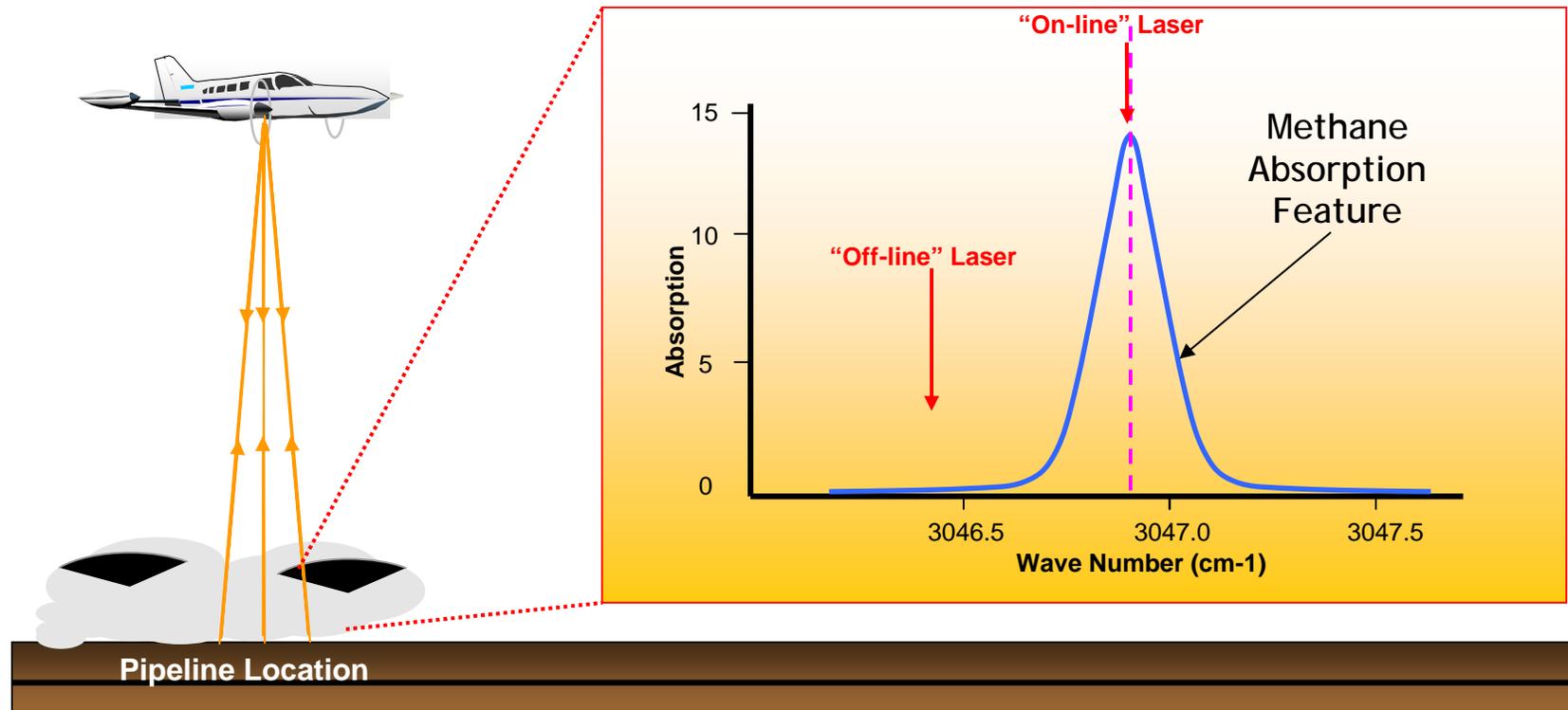
High  
Resolution  
Mapping  
Camera

# ITT ANGEL Service

Hydrocarbon detection and quantification

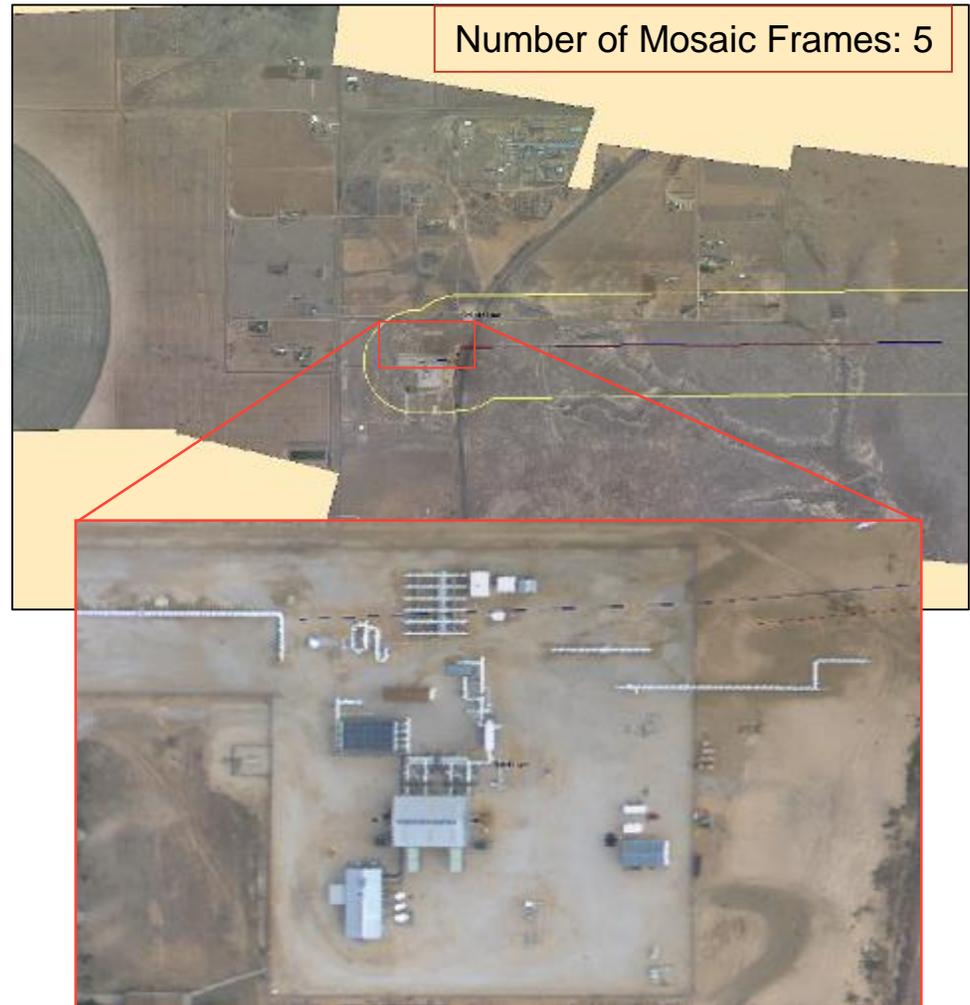
§ Differential Absorption Lidar (DIAL)

§ Active Remote Sensing Technique using IR lasers



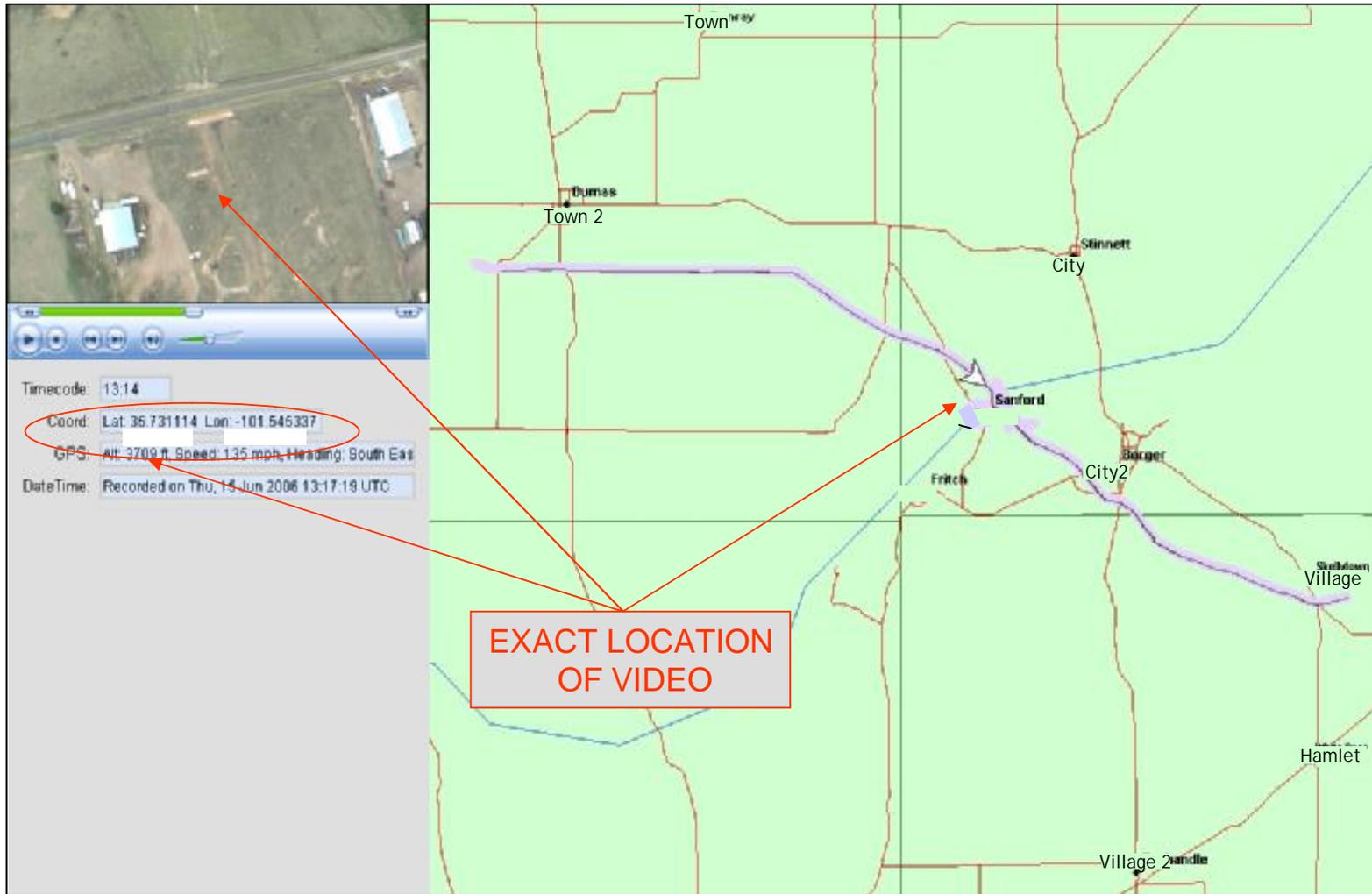
# High-resolution Digital Imagery for GIS Mapping

- § GIS-ready orthorectified and mosaic imagery.
- § Supports alignment sheets, HCA identification, threat identification, site permitting, engineering, and emergency planning.



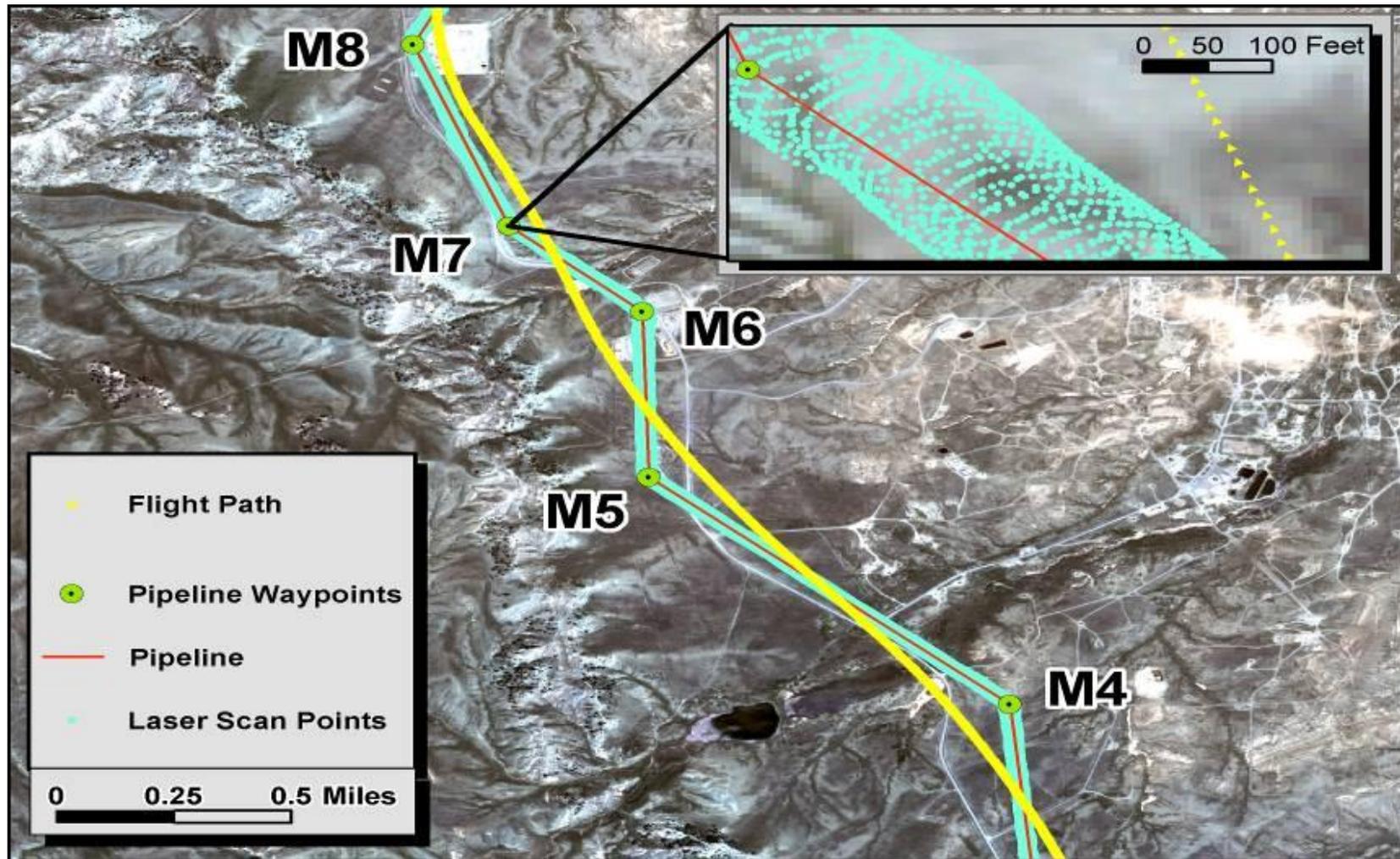
# Airborne Digital Video

Each frame contains GPS position data



# Inspection Utilizes GIS Position of Pipeline

Computer controlled pointing, scanning and tracking system

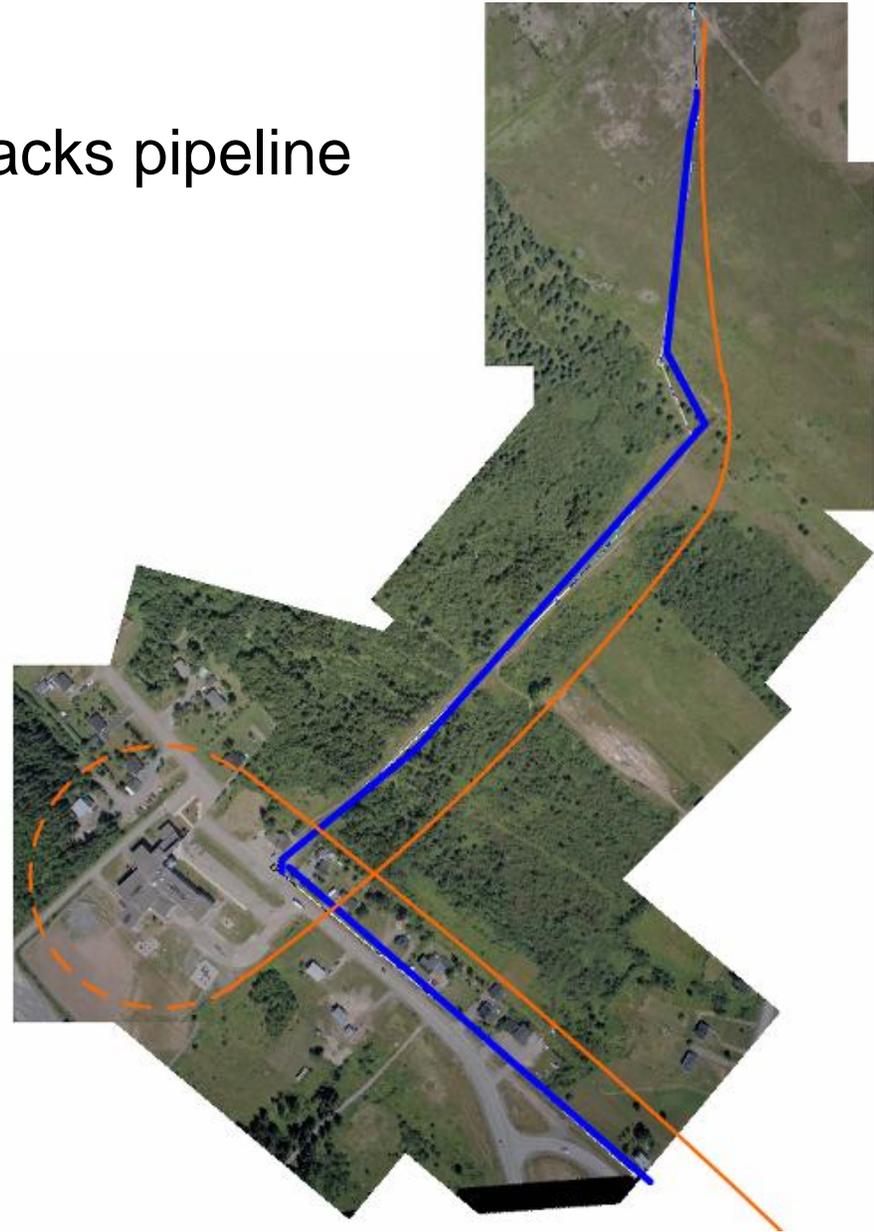


# ITT ANGEL Service

## DIAL sensor automatically tracks pipeline

ANGEL Service requires  
Accurate pipeline position  
data (+/- 25 feet)

**ANGEL flight scenario**  
Image Capture AGL: 308m  
With Return to Target Path  
Pipeline   
Image corridor = 1000"  
Flight line DIAL collect   
Flight line NO DIAL collect 



# DIAL Detection of Methane and Propane Releases Spencerport, NY Test Site



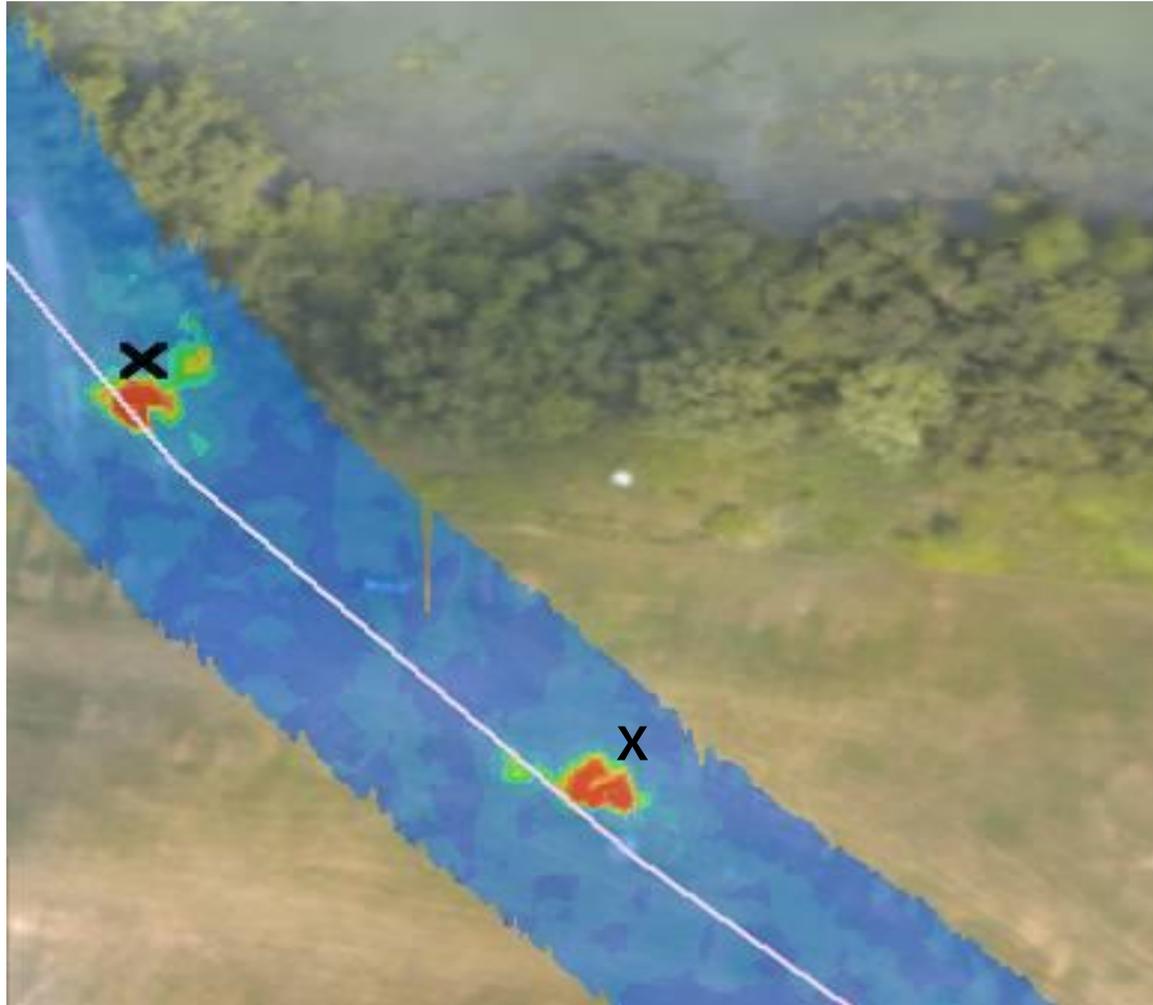
Sand Pit Site



Grass Site

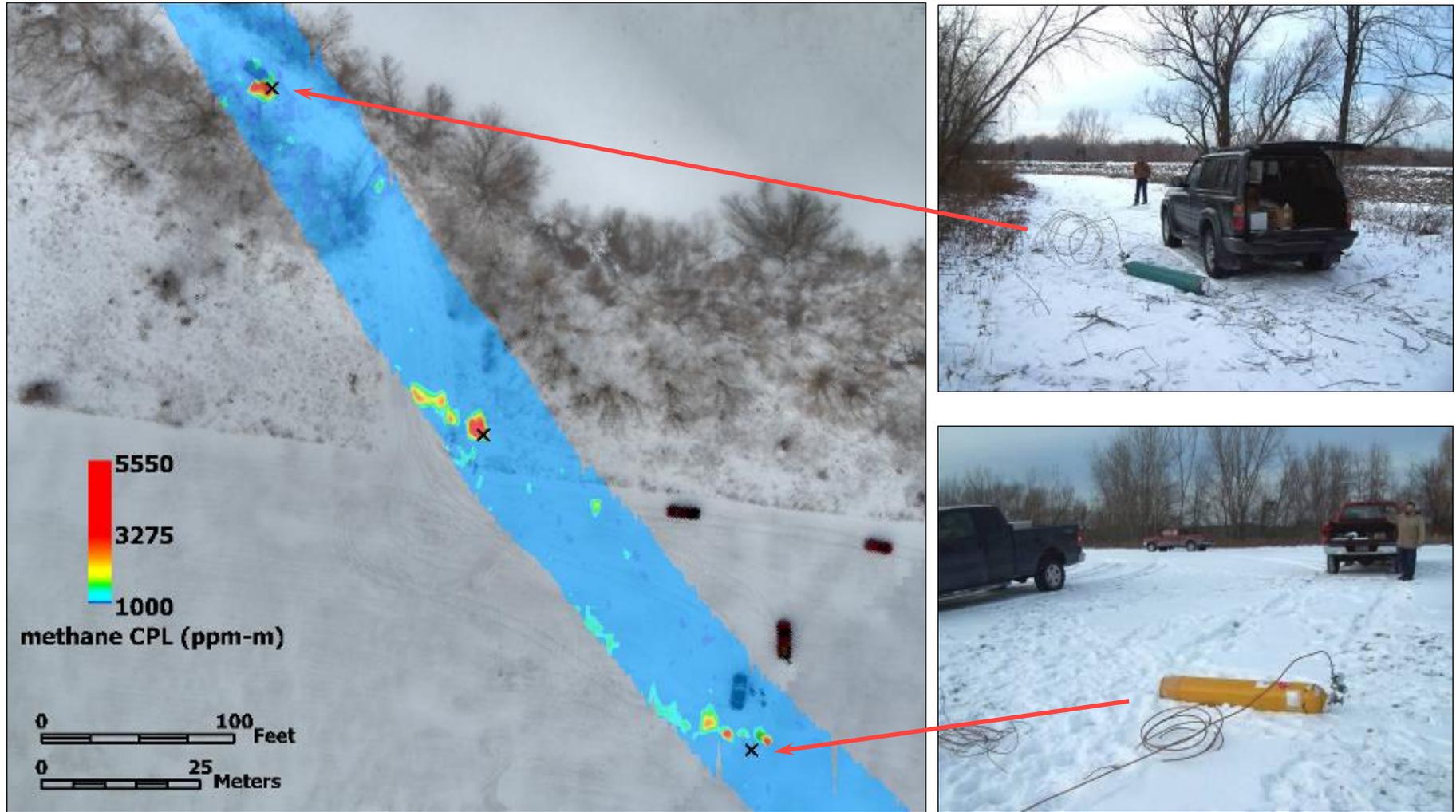
# ITT ANGEL Service remote sensing technology

## Guaranteed Pipeline Centerline Coverage of 99%



# DIAL Methane Detection

## Detection over snow (3 separate 4 scfm releases)

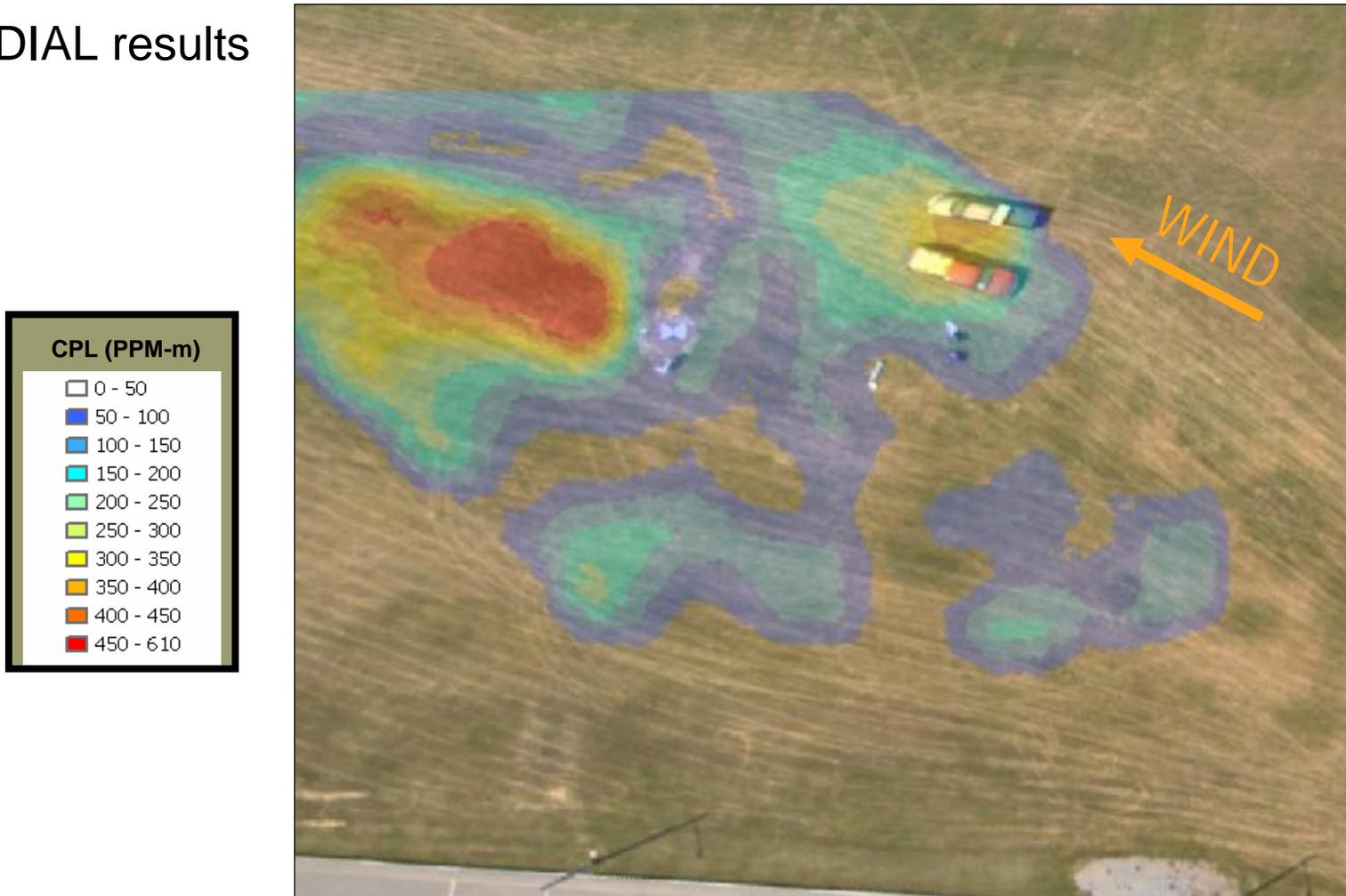


# DIAL Detection and Measurement of Propane Gas Detection over grass – Open field



# DIAL Detection and Measurement of Propane Gas Less than 3 seconds of collection from 1,000' altitude

DIAL results



# DIAL Detection and Measurement of Hydrocarbon Releases

## Field Collection Site: Kingsville, TX



El Paso Production Tank Battery



# DIAL Detection and Measurement of Hydrocarbon Vapors Natural Gas Condensate Tank Farm



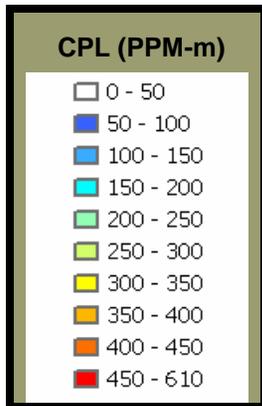
# DIAL Detection and Measurement of Hydrocarbon Vapors Collected from an altitude of 500 feet at 120mph

DIAL Scan  
Pattern shows  
position of  
each laser  
spot



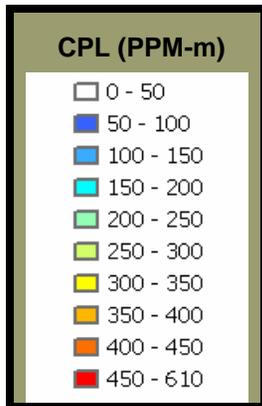
# DIAL Detection and Measurement of Hydrocarbon Vapors Light Crude Tank Farm

Hatches  
CLOSED



# DIAL Detection and Measurement of Hydrocarbon Vapors Light Crude Tank Farm

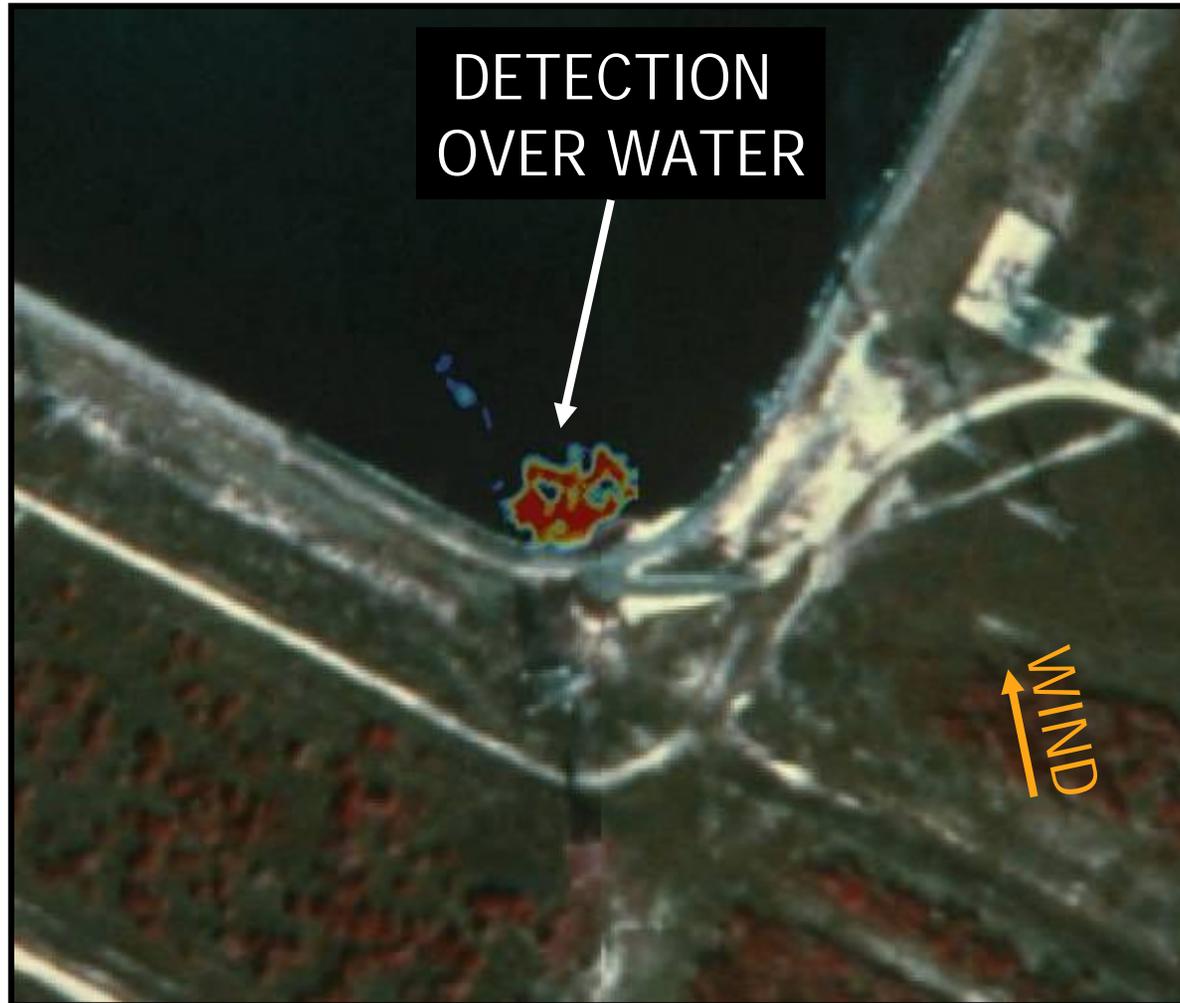
Hatches  
OPEN



# DIAL Detection and Measurement of Hydrocarbon Vapors TAMUCC Gasoline Vapor Release Setup Before Sunrise



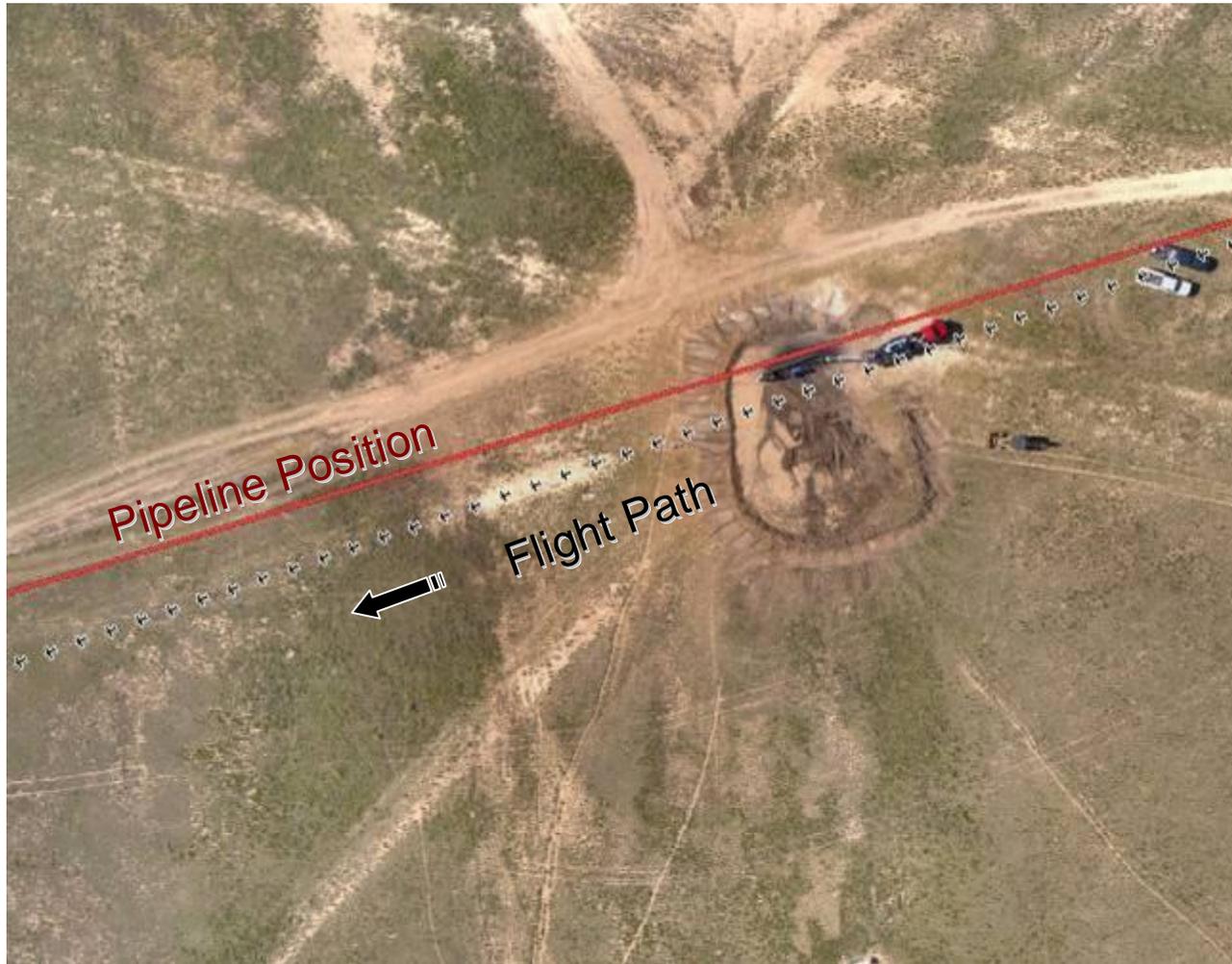
# DIAL Detection and Measurement of Hydrocarbon Vapors TAMUCC Gasoline Vapor Release



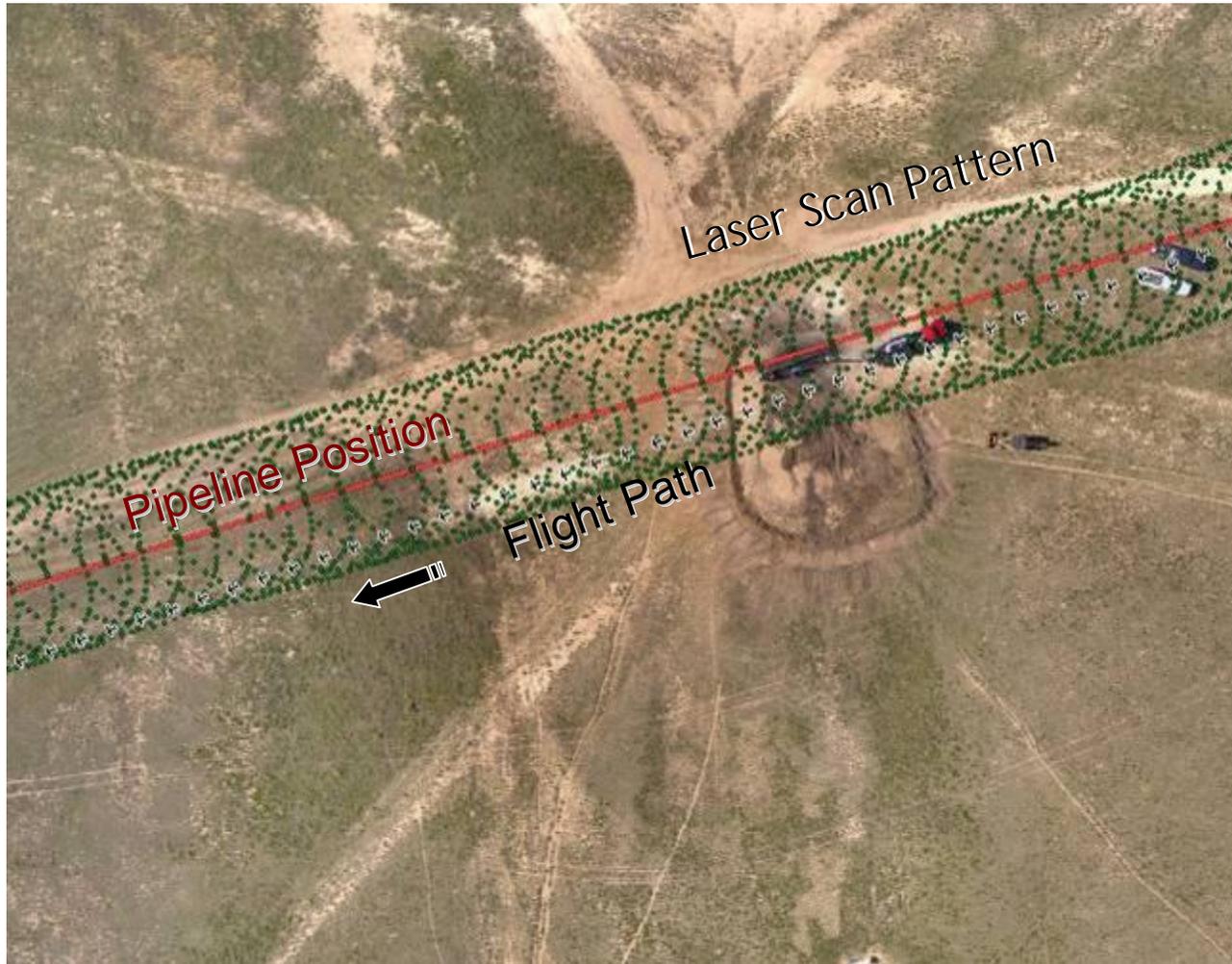
# Commercial ITT ANGEL Service Collection



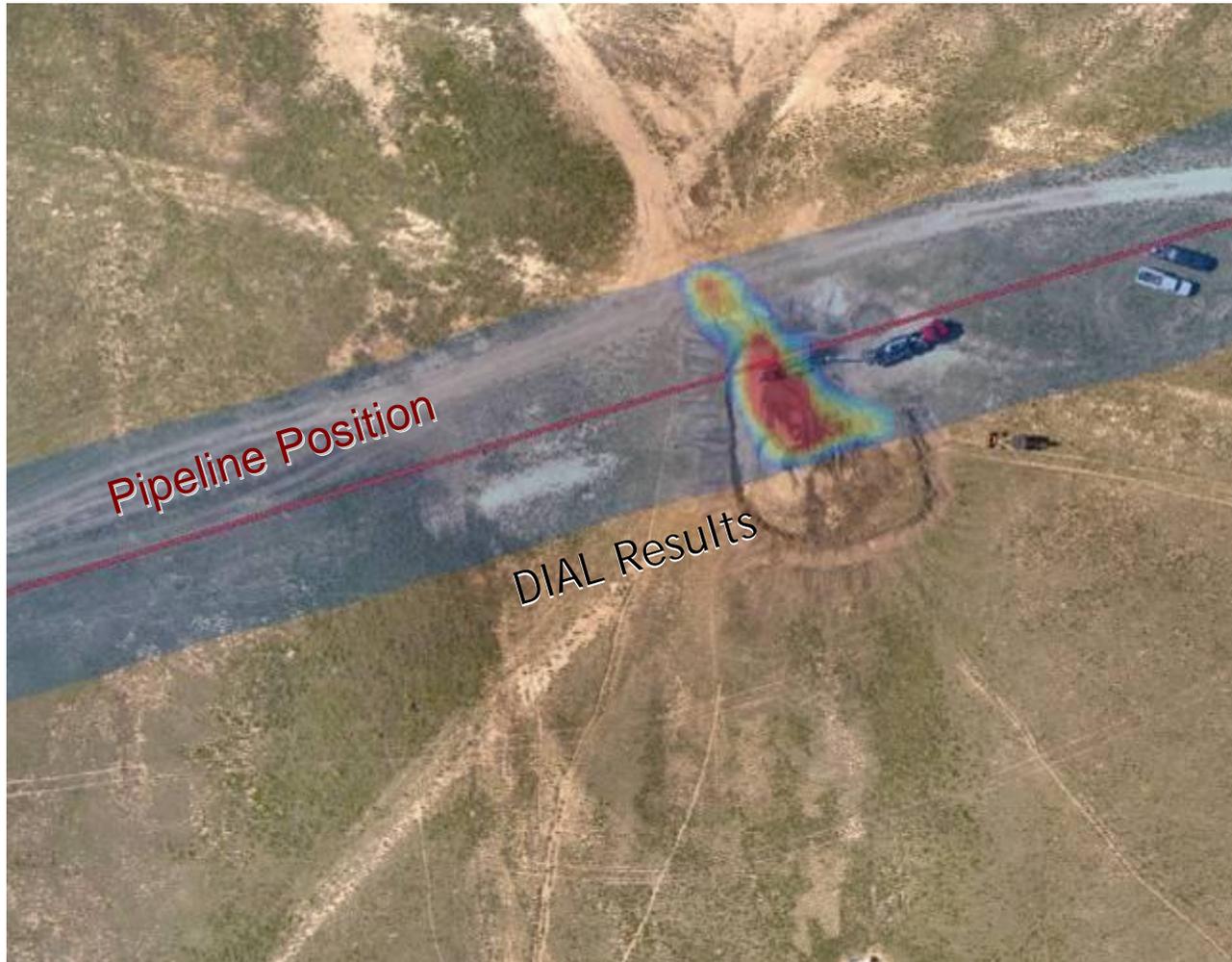
# Commercial ITT ANGEL Service Collection



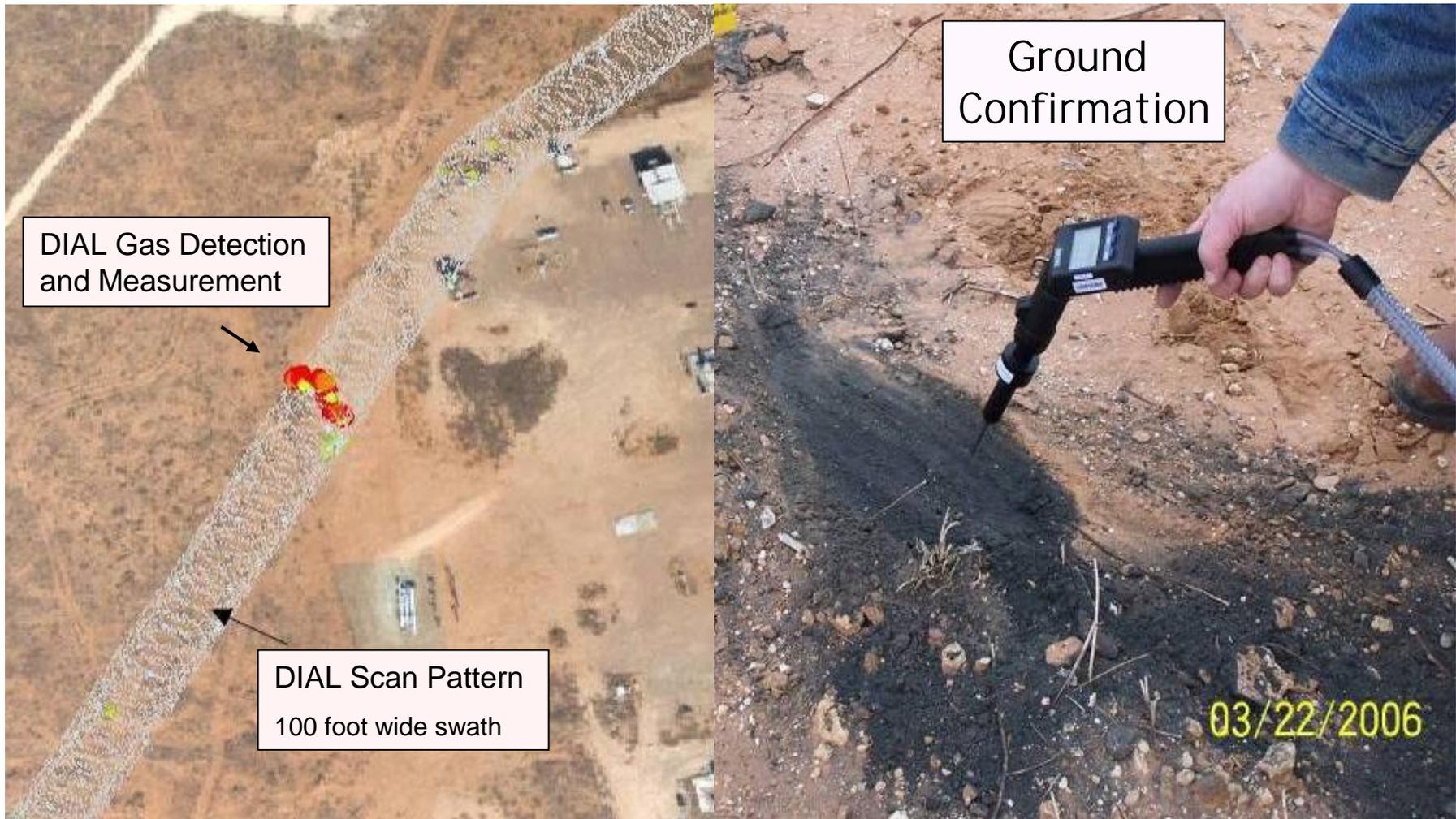
# Commercial ITT ANGEL Service Collection



# Commercial ITT ANGEL Service Collection



# DIAL Detection and Measurement of Natural Gas (Methane) Pipeline Route – Texas



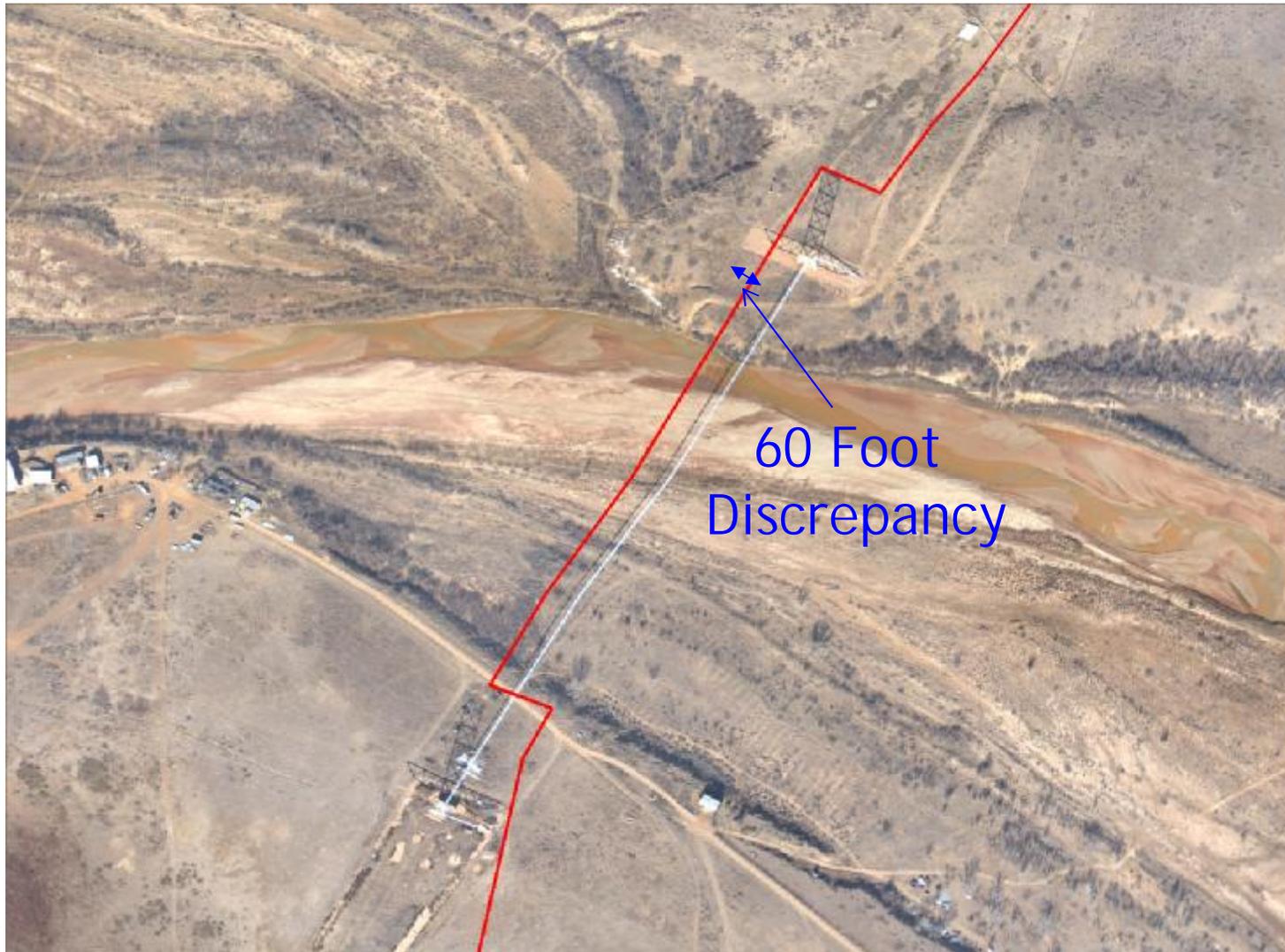
# Commercial ITT ANGEL Service Collection



# Commercial ITT ANGEL Service Collection



# GIS of Pipeline Centerline (+/- 25 feet)



# Rapid Emergency Response For Pipeline Emergencies

§ Contract extension of DOT-HALOS contract DTRS56-04-T-0012

## § Rapid Emergency Response

- Rapid Flight Planning
- Real-Time (in the air) Data Processing Study
- Rapid Data Processing Study
- Mid-wave IR Camera Flight Test

§ Completion: December 31, 2006

# Rapid Emergency Response For Pipeline Emergencies

## § Earthquakes

§ Hurricanes

§ Flooding

§ Landslides

§ Fires

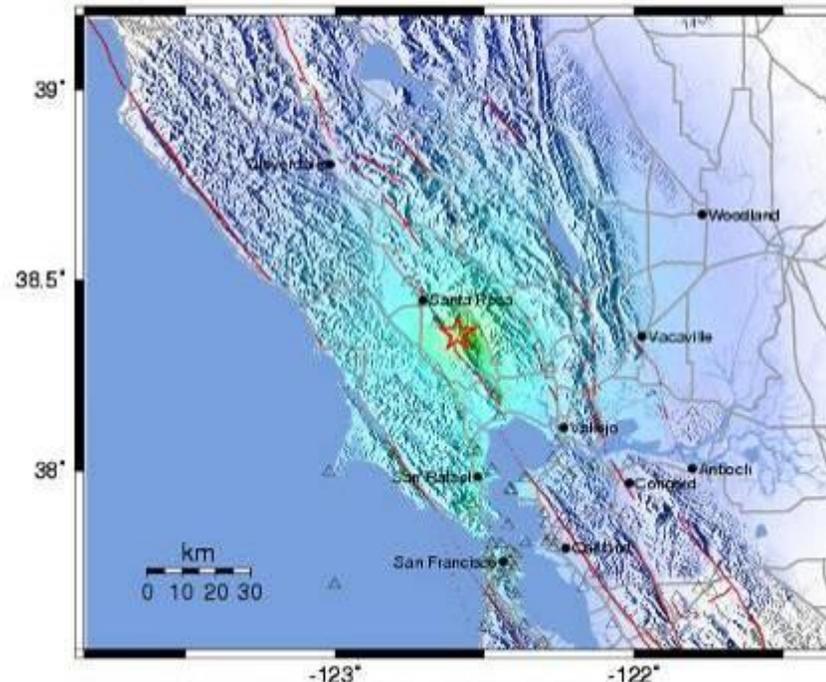
§ Pipeline Rupture

§ Explosions

§ Terrorist Activities

§ Human Error

CISN Rapid Instrumental Intensity Map Epicenter: 6 km W of Glen Ellen, CA  
Wed Aug 2, 2006 09:09:12 PM PDT M 4.4 N38.36 W122.59 Depth: 9.1km ID:40187964



Processed: Wed Aug 23, 2006 09:44:23 AM PDT, -- NOT REVIEWED BY HUMAN

PERCEIVED SHAKING	No felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-18	18-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	Xs

<http://earthquake.usgs.gov/eqcenter/shakemap/>

# Rapid Emergency Response For Pipeline Emergencies

## Seismic Vulnerability and Earthquake Response of the PG&E Gas Transmission System

### Overview

- § 6,136 miles of gas transmission pipelines
- § Gas transmission pipeline system crosses numerous active faults
- § System is exposed to potentially widespread strong ground shaking during future earthquakes
- § Landslide areas



Hitchcock et. al., 2006, GIS-Based Seismic Hazard Mapping for Pipeline Integrity Management, International Pipeline Conference 2006

# ITT ANGEL Service and PHMSA Partnership Conclusions

§ Under contract with the DOT/PHMSA the ITT ANGEL System successfully detected and measured methane, propane, gasoline vapors, and unrefined natural gas condensate vapors.

§ With support from PHMSA, ITT is improving data processing speed to allow the ANGEL Service to be used in Rapid Emergency Response situations such as after a major earthquake or other natural disaster.

§ *Note:* Use of the ANGEL Service requires accurate GIS pipeline data (+/- 25 foot horizontal accuracy)

§ Next Steps – Emergency Response Demonstration 2007





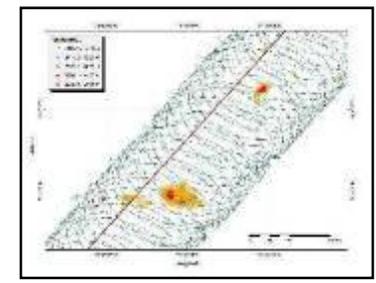
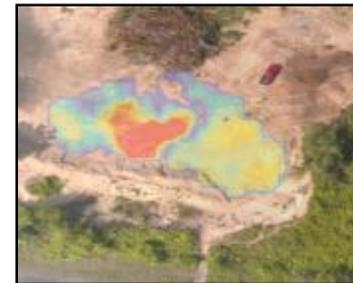
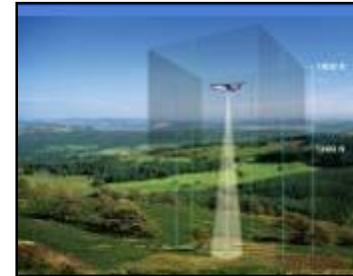
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