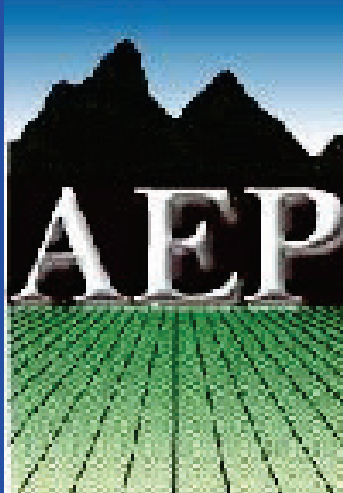


REMOTE SENSING & GIS FOR ENVIRONMENTAL APPLICATIONS

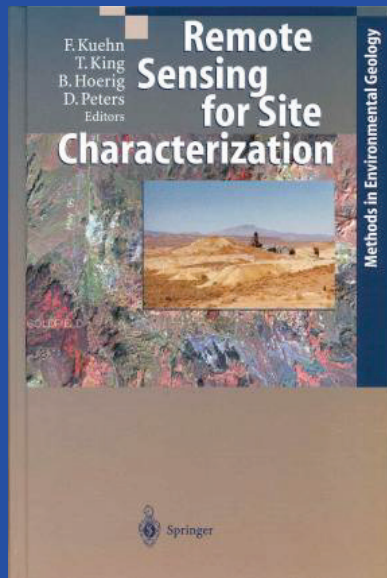


Jim Ellis



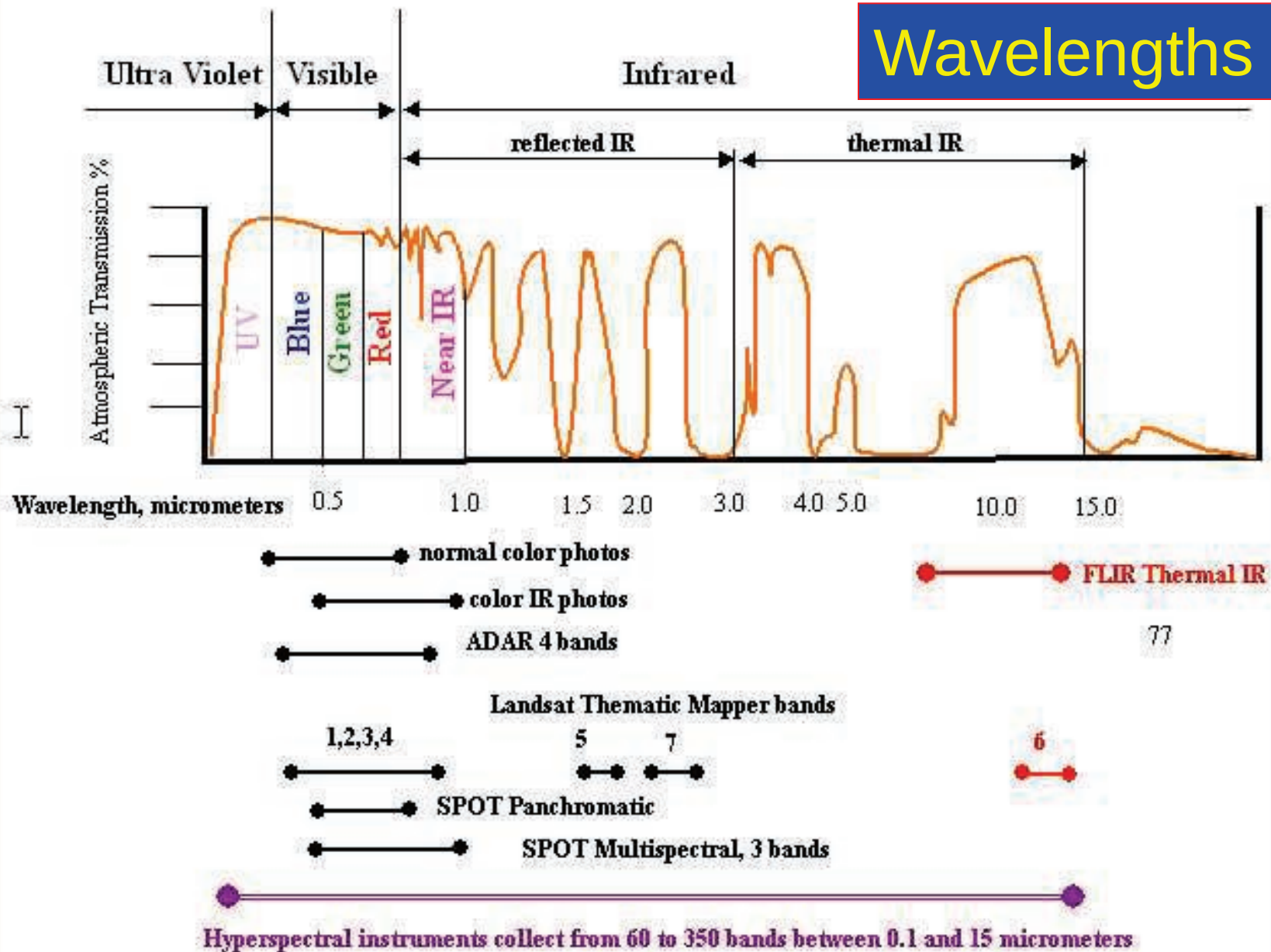
TOPICS

- TECHNOLOGY OVERVIEW
- BASELINE & DATABASE
- MAPS & VEGETATION VIGOR
- CHANGE DETECTION
- DISTURBED SOILS
- THERMAL
- DETECTING OIL
- DEM's FOR DRAINAGE



TECHNOLOGY OVERVIEW

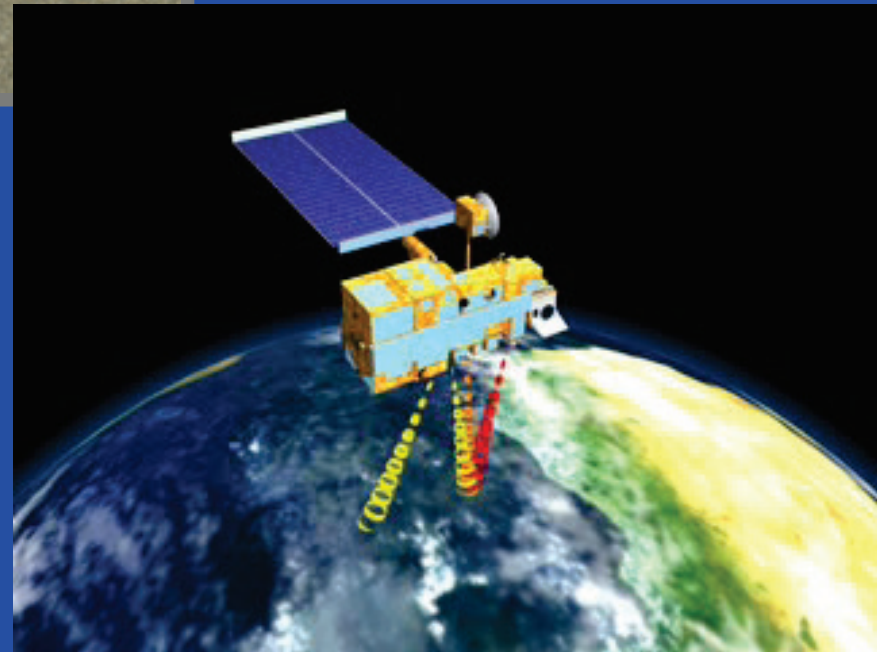
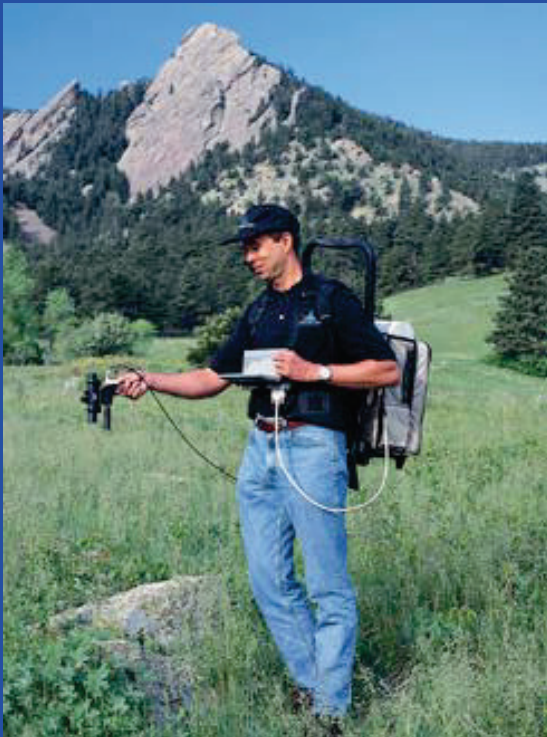
Wavelengths





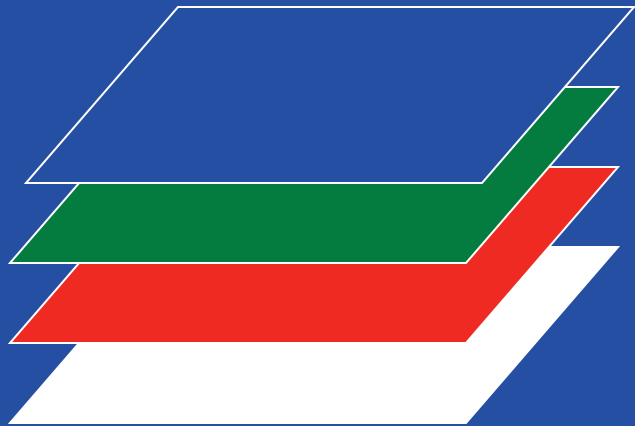
REMOTE SENSING TECHNOLOGY

- Lab
- Ground
- Airborne
- Satellite

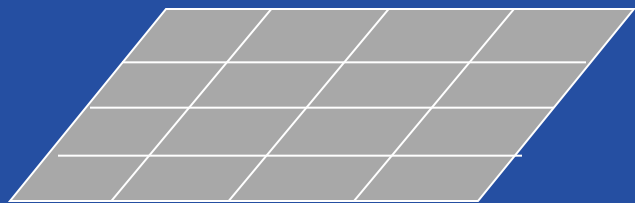




HIGH RESOLUTION SATELLITE IMAGERY



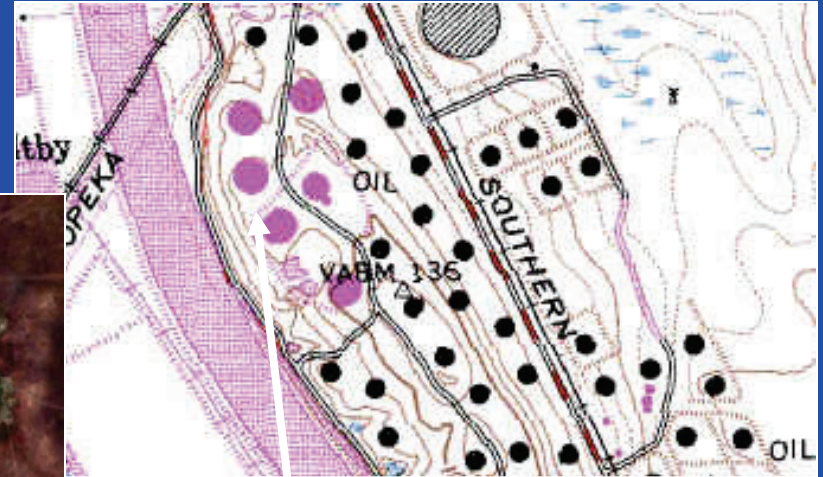
Reflected blue, green, red, and near-IR light are collected as four separate B&W images. This “multispectral” sensor has **8' (2.6 m)** ground resolution. Used for generating natural color and color-infrared images and for classification and vegetation vigor/stress maps.



High resolution, panchromatic B&W image collected with **2' (0.65 m)** ground resolution. Can be used alone or fused with coarser multispectral color bands.

A TANK FARM IN NORTHERN CALIFORNIA

USGS 1:24,000
Topo Map (right)



The Same Storage Tank

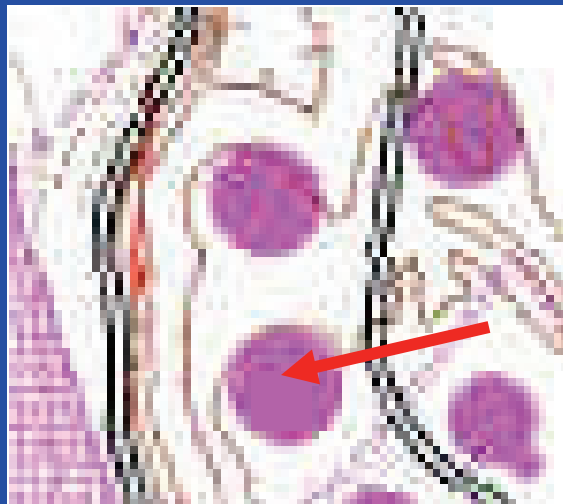
Natural Color (above) and
Color Infrared (right) - 8'
(2.6 m) spatial resolution
(pixels)



CLOSE-UP OF TANKS

A. USGS Topo Map

A.



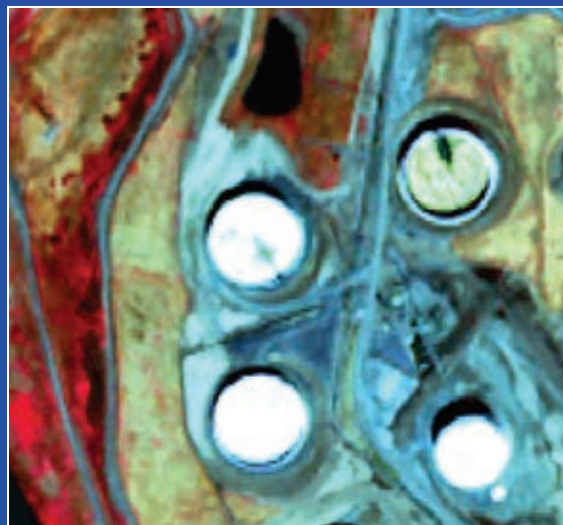
B. 8'/2.6m Color

B.



C. 8'/2.6m CIR

C.



D. 2'/0.65m pan

D.

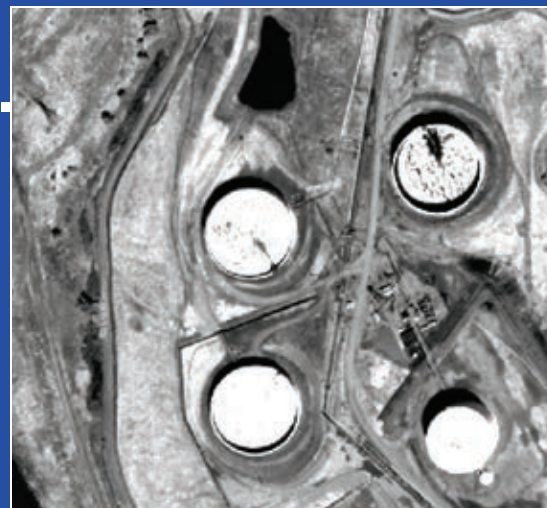


IMAGE FUSION



8'/2.6m color



2'/0.65m B&W

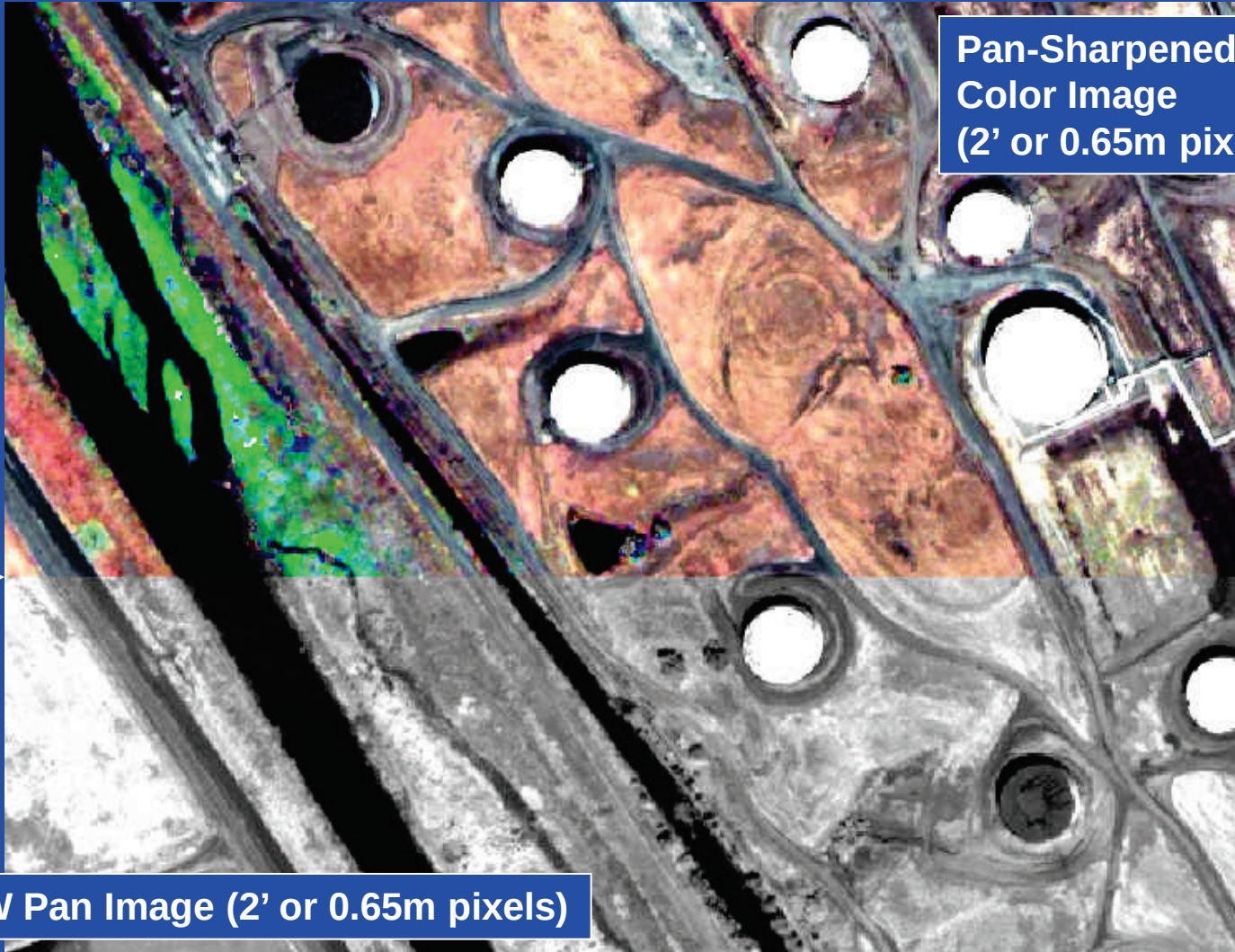


2'/0.65m color

Merging color image (8') with high-resolution pan (B&W, 2' image) to generate color image with 2'/0.65m pixels

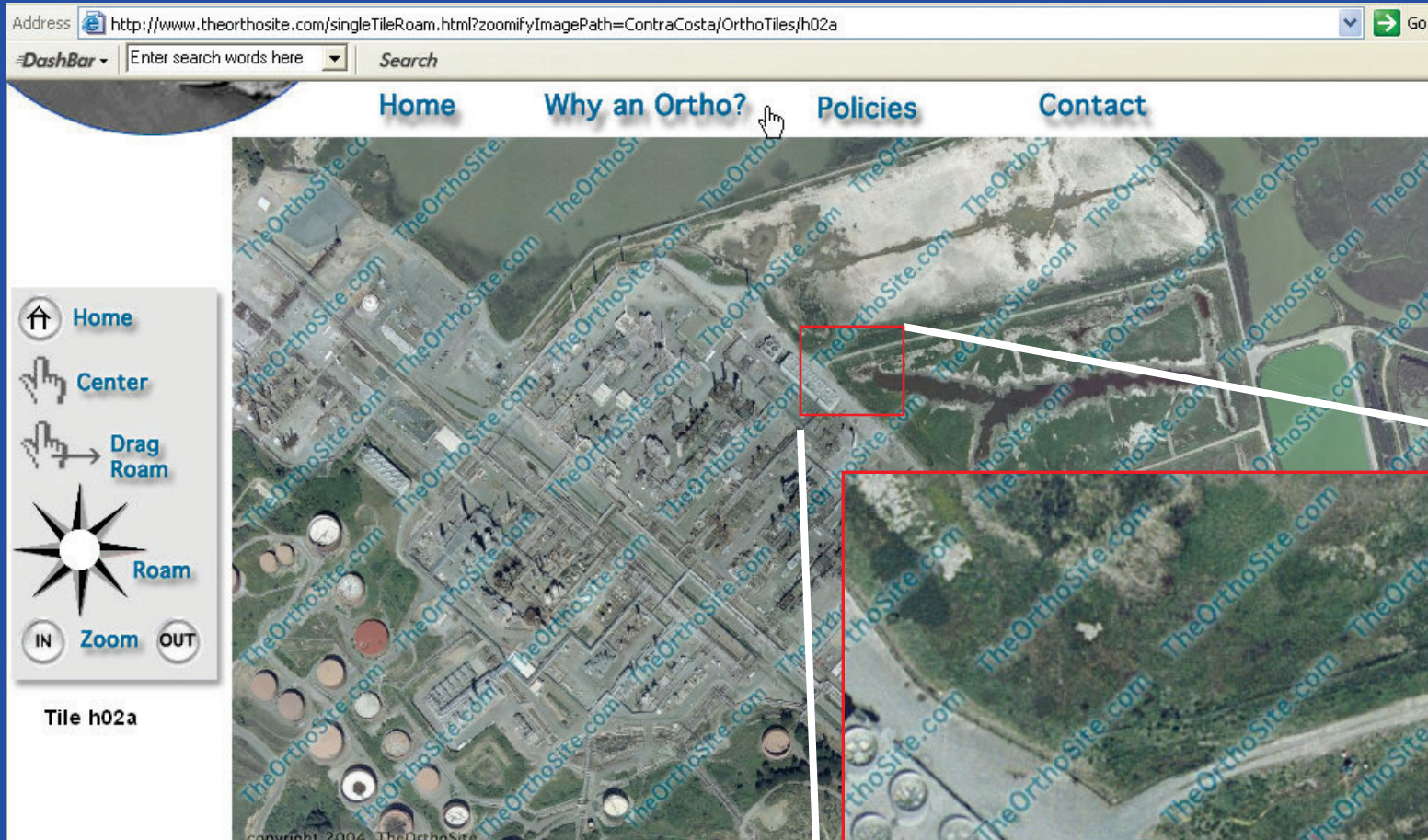
IMAGE FUSION

Pan-Sharpened Natural
Color Image
(2' or 0.65m pixels)



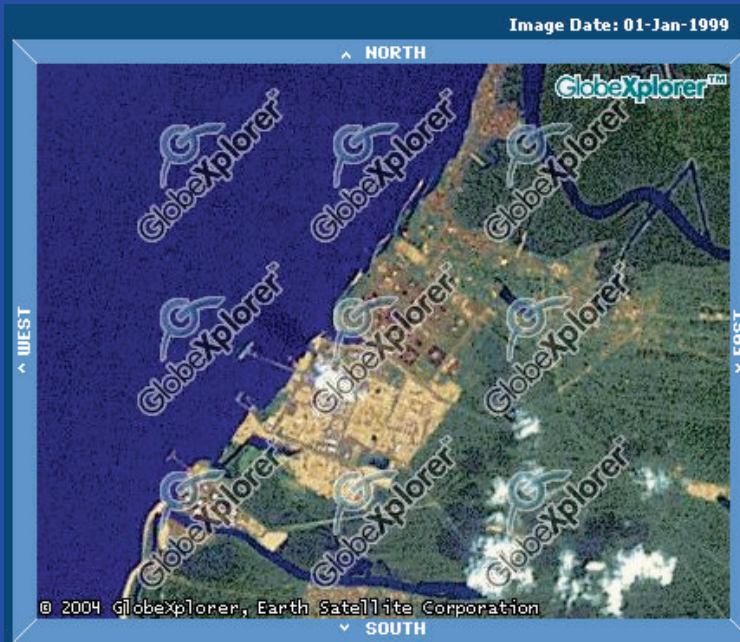
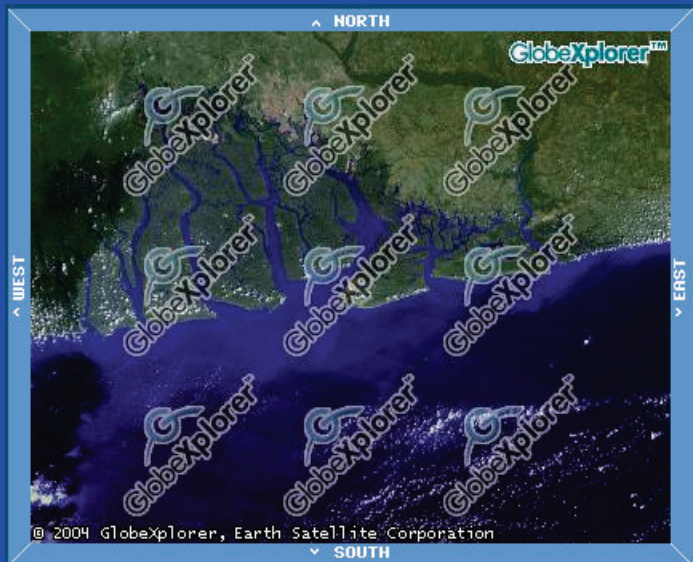
B&W Pan Image (2' or 0.65m pixels)

BASELINE & DATABASE



ONLINE IMAGERY TO START MAPPING & A BASELINE

Summer 2004 aerial photography



[GET HELP](#) [view demo](#)

ORDER CENTER

Order unwatermarked **Digital Downloads** and **Hardcopy Prints**:

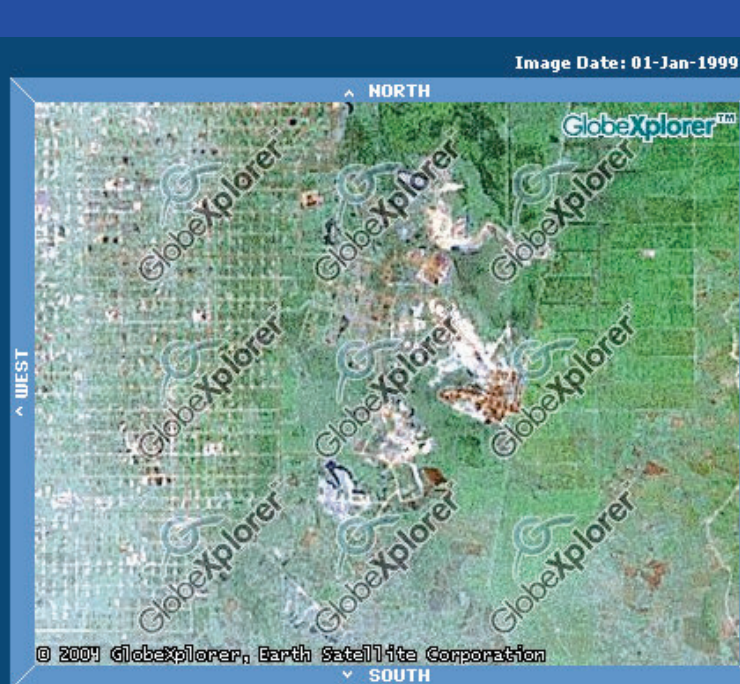
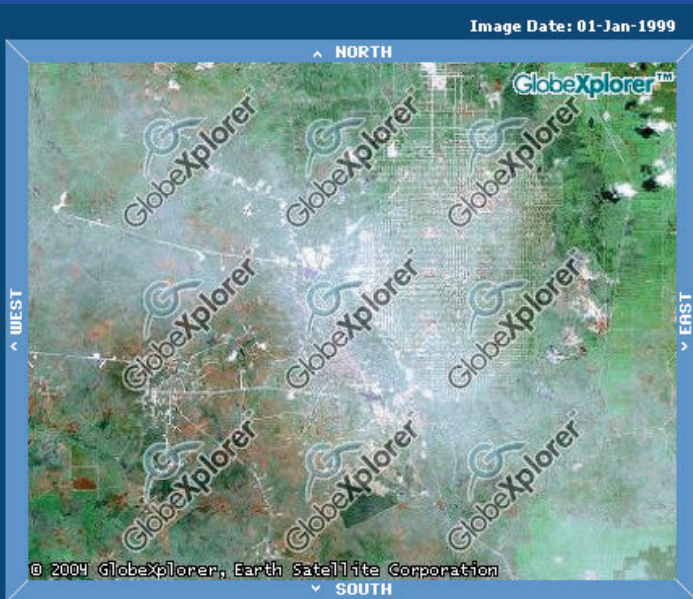
Print Prices

8"x10" print	\$19.95
11"x14" print	\$29.95
16"x20" print	\$59.95
20"x30" print	\$79.95
Large Digital Download	\$34.95

 **order files or prints**

[sample digital download](#)

OR USE ONLINE SATELLITE IMAGERY TO START A BASELINE...



[GET HELP](#) [view demo](#)

ORDER CENTER

Order unwatermarked **Digital Downloads** and **Hardcopy Prints**:

Print Prices

8"x10" print	\$19.95
11"x14" print	\$29.95
16"x20" print	\$59.95
20"x30" print	\$79.95
Large Digital Download	\$34.95

 **order files or prints**

[sample digital download](#)

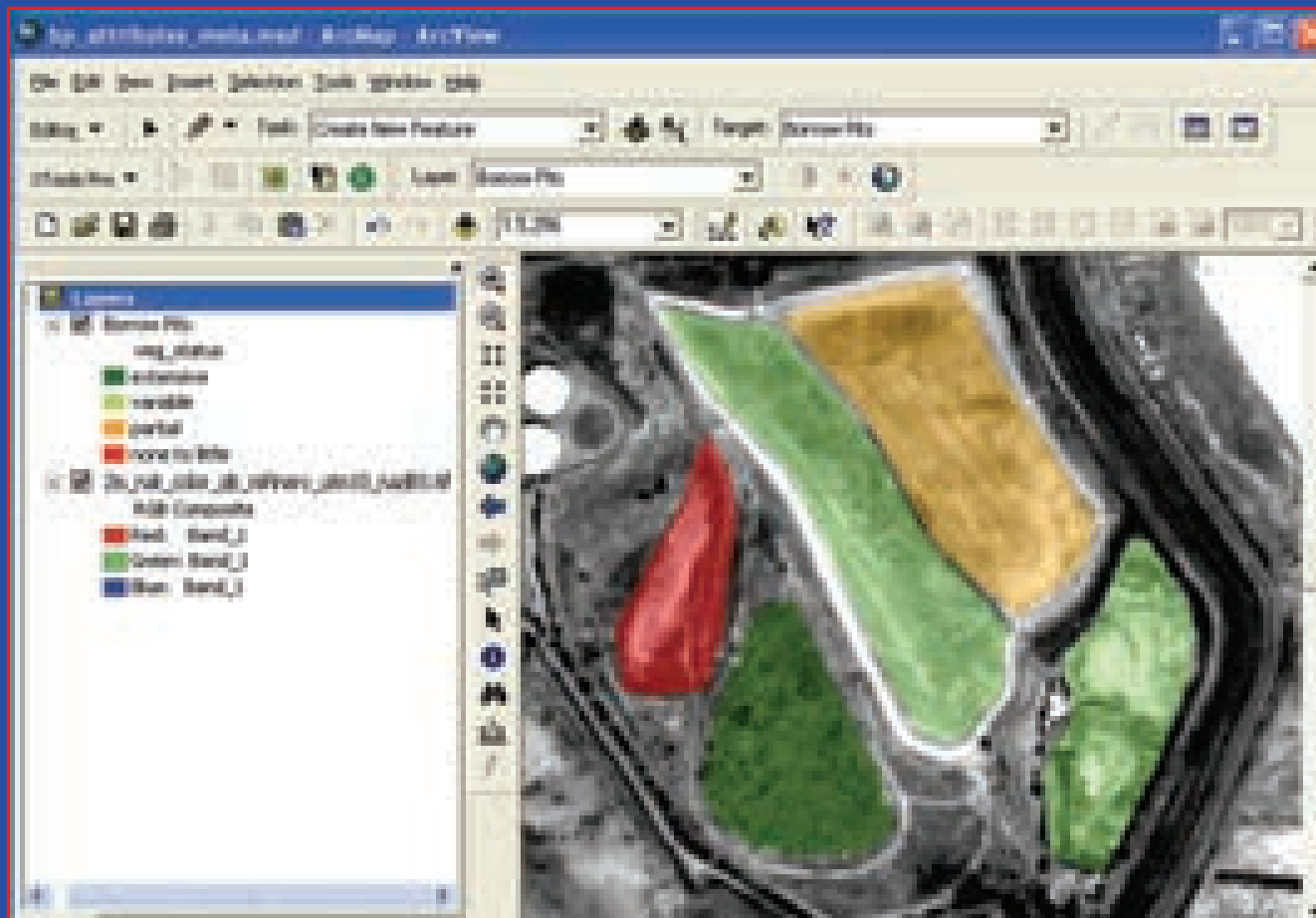
BUILDING A GIS & DATABASE



2.6 meter
satellite imagery

Heads - Up
Interpreting



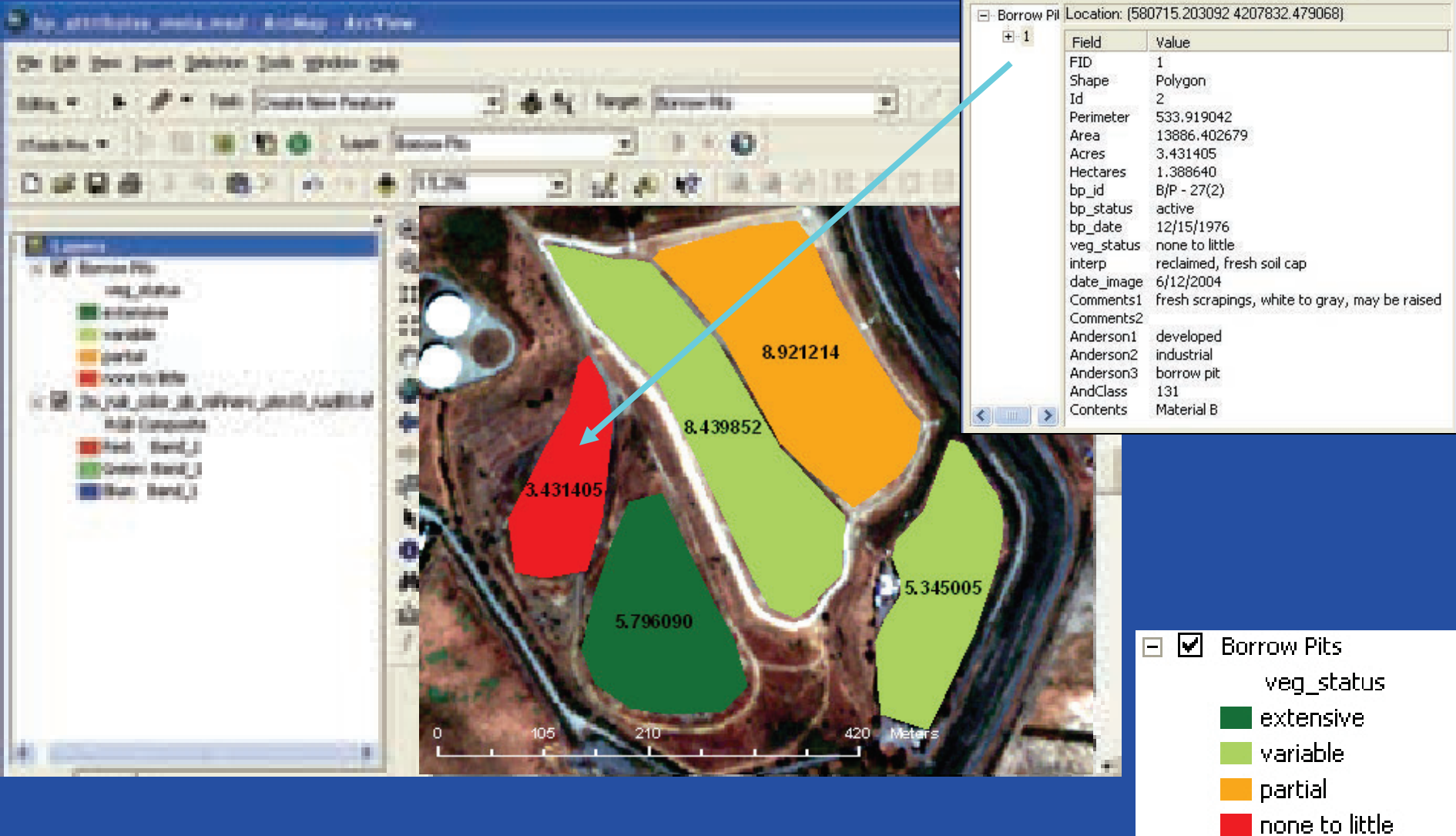


BUILDING ATTRIBUTE TABLES WHILE MAPPING IN GIS

Attributes of Borrow Pits

	FID	Shape	Id	Perimeter	Area	Acres	Hectares	bp_id	Contents	bp_status	bp_date	veg_status	interp	
	0	Polygon	1	609.37639	23455.945395	5.796090	2.345595	B/P - 25	Material A	reclaimed	10/1/1985	extensive	inactive, vegetated	
	1	Polygon	2	533.91904	13886.402679	3.431405	1.388640	B/P - 27(2)	Material B	active	12/15/1976	none to little	reclaimed, fresh soil cap	
	2	Polygon	3	1006.7951	34154.868175	8.439852	3.415487	B/P - 27 (2)	Material C	active	3/15/1988	variable	inactive, vegetation 70%	
	3	Polygon		date_image	Comments1			Comments2			Anderson1	Anderson2	Anderson3	AndClass
	4	Polygon		6/12/2004	site covered with shrubs, no disturbance						developed	industrial	borrow pit	131
				6/12/2004	fresh scrapings, white to gray, may be raised						developed	industrial	borrow pit	131
				6/12/2004	SE portion may be disturbed, veg cover NW						developed	industrial	borrow pit	131
				6/12/2004	Long scraps seen, veg thin and sparse			SE has least vegetation			developed	industrial	borrow pit	131
				6/12/2004	vegetation looks mature, but disturbed zones			NE and center of S disturbed., ponded water maybe			developed	industrial	borrow pit	131

QUERYING THE DATABASE



The screenshot displays a GIS application interface. The main map shows several colored polygons representing borrow pits, each labeled with a numerical value. A red arrow points from the 'Identify Results' window to a red polygon on the map.

Identify Results

Layers: Borrow Pits

Borrow Pit Location: (580715.203092 4207832.479068)

Field	Value
FID	1
Shape	Polygon
Id	2
Perimeter	533.919042
Area	13886.402679
Acres	3.431405
Hectares	1.388640
bp_id	B/P - 27(2)
bp_status	active
bp_date	12/15/1976
veg_status	none to little
interp	reclaimed, fresh soil cap
date_image	6/12/2004
Comments1	fresh scrapings, white to gray, may be raised
Comments2	
Anderson1	developed
Anderson2	industrial
Anderson3	borrow pit
AndClass	131
Contents	Material B

Borrow Pits

veg_status

- extensive
- variable
- partial
- none to little

Map values: 3.431405, 8.439852, 8.921214, 5.796090, 5.345005

Scale: 0 105 210 420 Meters

METADATA FOR THE DATABASE

Editing 'Borrow Pits'

Identification | Data Quality | Data Organization | Spatial Reference | Entity Attribute | Distribution | Metadata Reference

General | Contact | Citation | Time Period | Status | Spatial Domain | Keywords | Browse Graphic | Security | Cross Reference

Description

Abstract: This is a shapefile of borrow pits in an industrial site as interpreted from DigitalGlobe Quickbird images. The borrow pits have different levels of vegetation cover. The imagery was acquired on 12 June 2004 by DigitalGlobe.

Purpose: This GIS map provides the acreage and vegetation cover status, along with interpreted conditions, of borrow pits in the area. It has been joined with the company's database on borrow pits.

Language: en

Supplemental Information: The image base should be orthorectified photo-identifiable ground control sites

Access Constraints: Company Z data

Use Constraints: Company Z data

Data Set Credit: The image was processed by Ellis Ge

Native Data Set Environment: Microsoft Windows 2000 Version 5.1

Native Data Set Format: Shapefile

Editing 'Borrow Pits'

Identification | **Data Quality** | Data Organization | Spatial Reference | Entity Attribute | Distribution | Metadata Reference

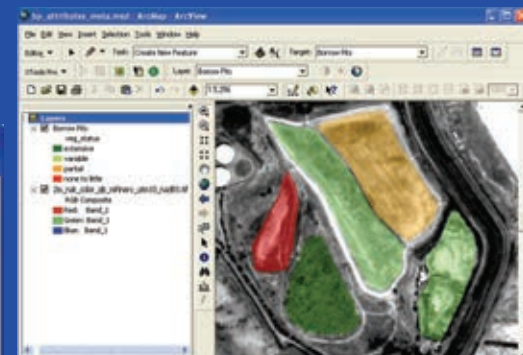
General | Attribute Accuracy | Positional Accuracy | Source Information | Process Information

Process Description: The interpretation was done in a heads-up mode using ArcGIS ArcView rendered as a 1m pan, 1-m fused color, and 4-m natural color map. Company Z's database was displayed as the interpretation was produced.

Process Software and Version:

Process Date: Feb 2004

Process Time:



Editing 'Borrow Pits'

Identification **Data Quality** Data Organization Spatial Reference Entity Attribute Distribution Metadata Reference

General | Attribute Accuracy | Positional Accuracy | Source Information | Process Step |

Process Description: The interpretation was done in a heads-up mode using ArcGIS ArcMap. The georeferenced image was rendered as a 1m pan, 1-m fused color, and 4-m natural color mapping base.
Company Z's database was displayed as the interpretation was proceeding. Acreage was determined with 3-rd

Process Software and Version:

Process Date: Feb 2004

Process Time:

Process Contact: James Ellis [Details...](#)

Source Used Citation Abbreviation:
+ X [Navigation Icons] Source used (+) of 0

Source Produced Citation Abbreviation:
+ X [Navigation Icons] Source Produced (+) of 0

+ X [Navigation Icons] Process Step 1 of 5

Save Cancel Help

Metadata documents
work processes,
accuracy, source,
access, originator,
etc. - good for
Litigation & government

MAPS & VEGETATION VIGOR

IMAGE



Natural Color image of Tank Farm with 8' pixels. Generated from visible bands (reflected red, green, and blue light)

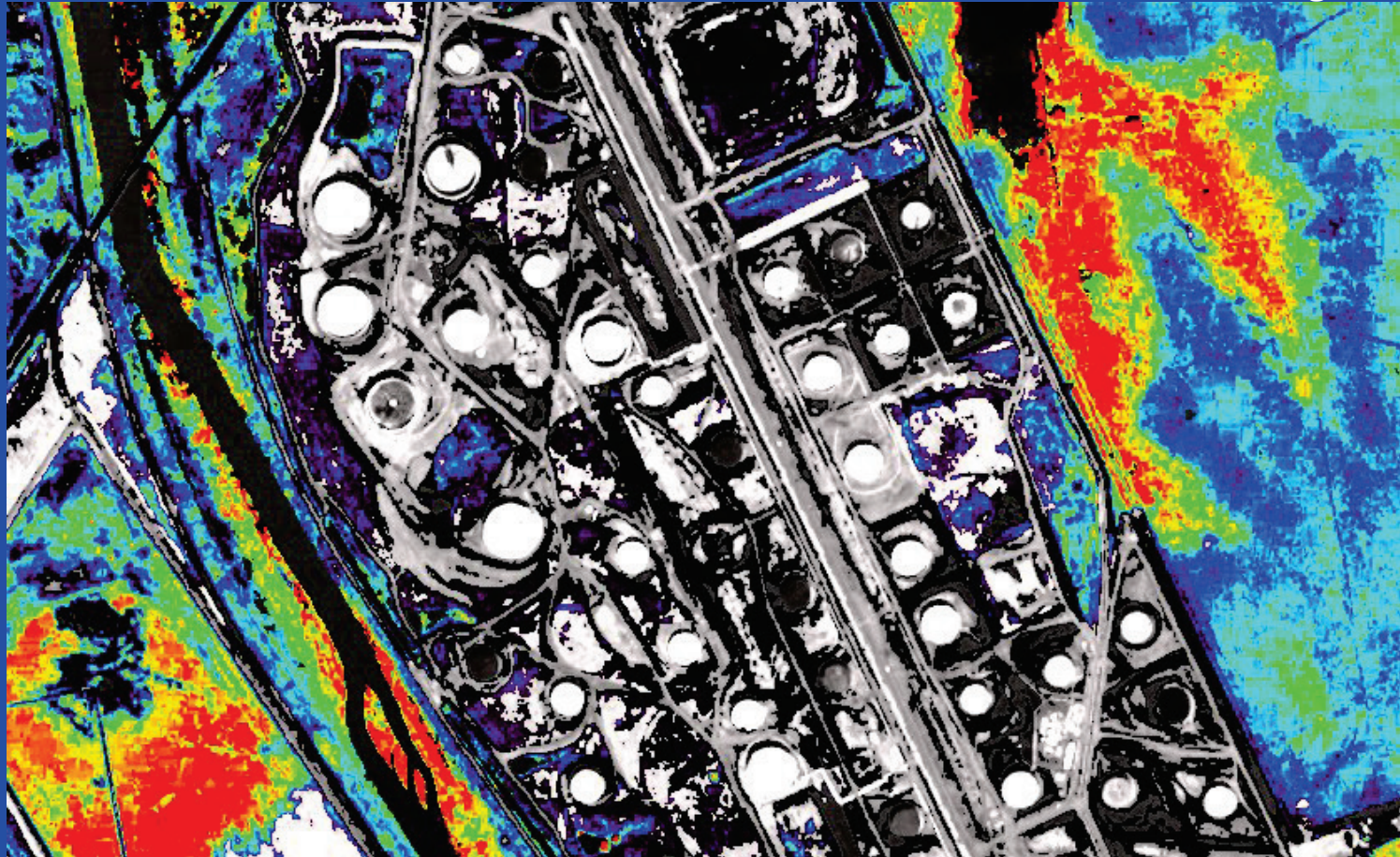
DERIVED MAP FROM IMAGE - LAND USE/LAND COVER & STATISTICS



Supervised classification of DigitalGlobe 8' multispectral bands. Develop statistics and up-to-date environmental basemap

VEGETATION VIGOR MAP

*generated
using NDVI*



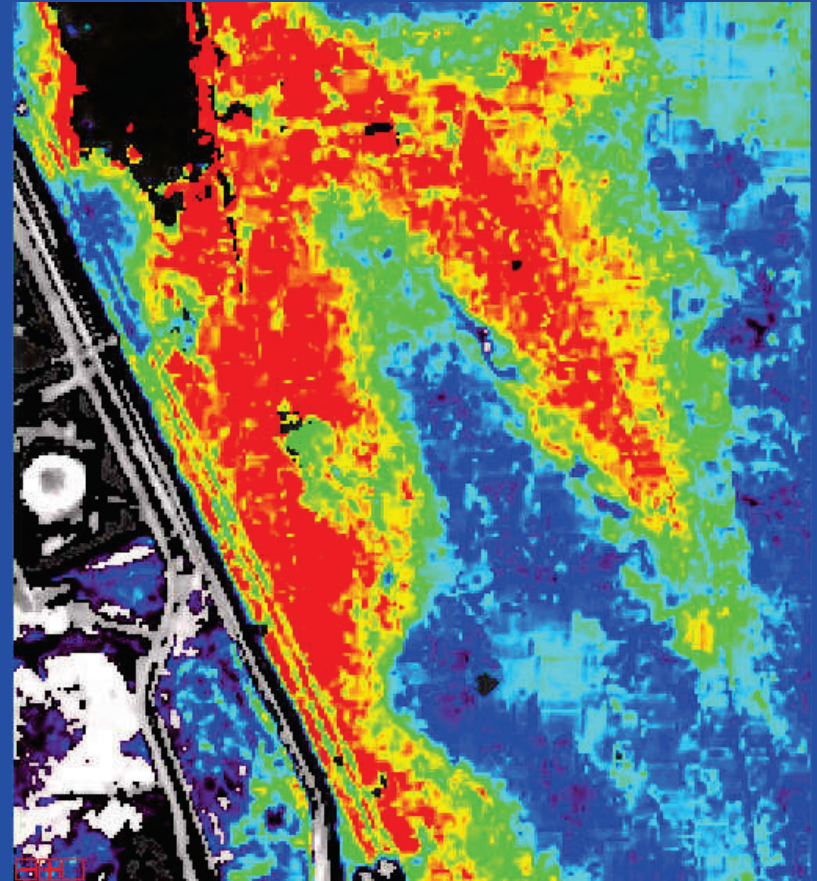
LEAST VIGOROUS  MOST VIGOROUS

Image used as backdrop to map

MAPPING VEGETATION VIGOR/STRESS



Natural Color



LEAST VIGOROUS



MOST VIGOROUS

CHANGE-DETECTION AT SITES

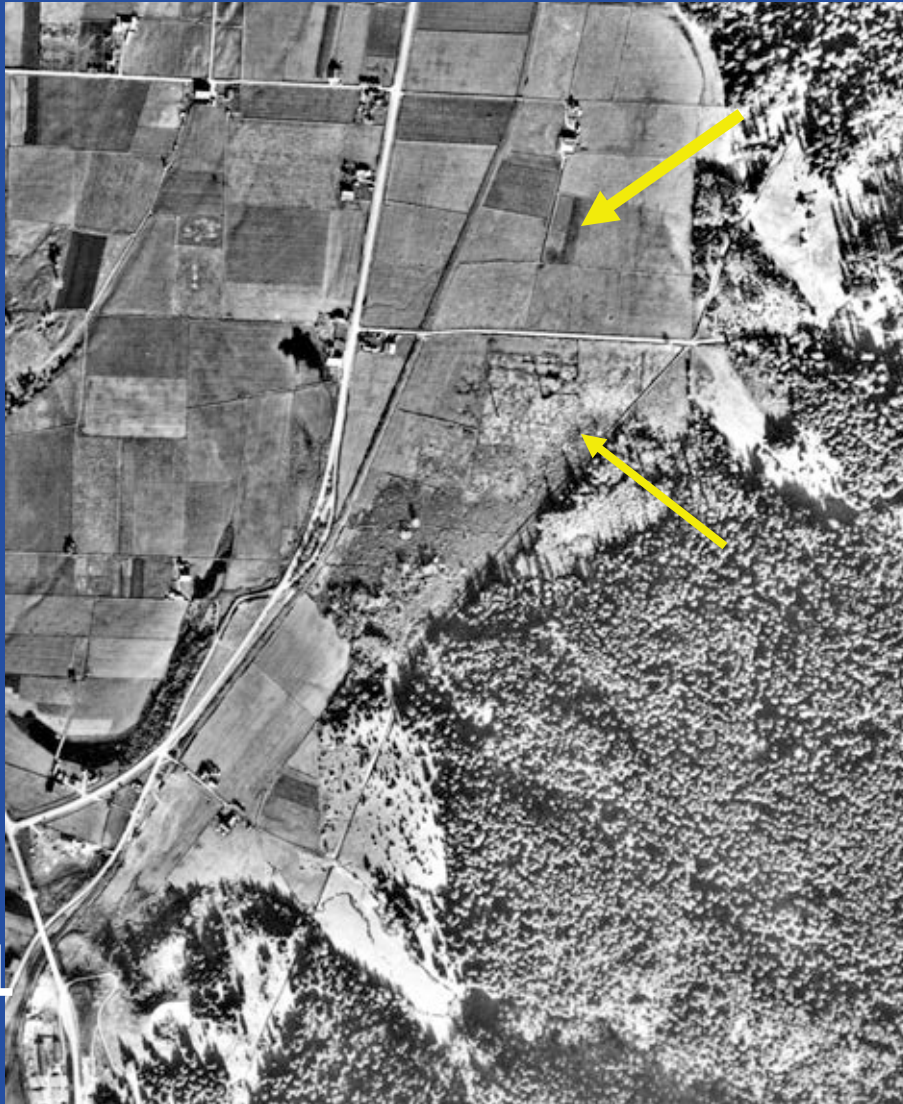
CHANGE DETECTION



1989

**Color IR Photo -
What is previous
land use??**

CHANGE DETECTION



1941

CHANGE DETECTION

1947



CHANGE DETECTION

1958

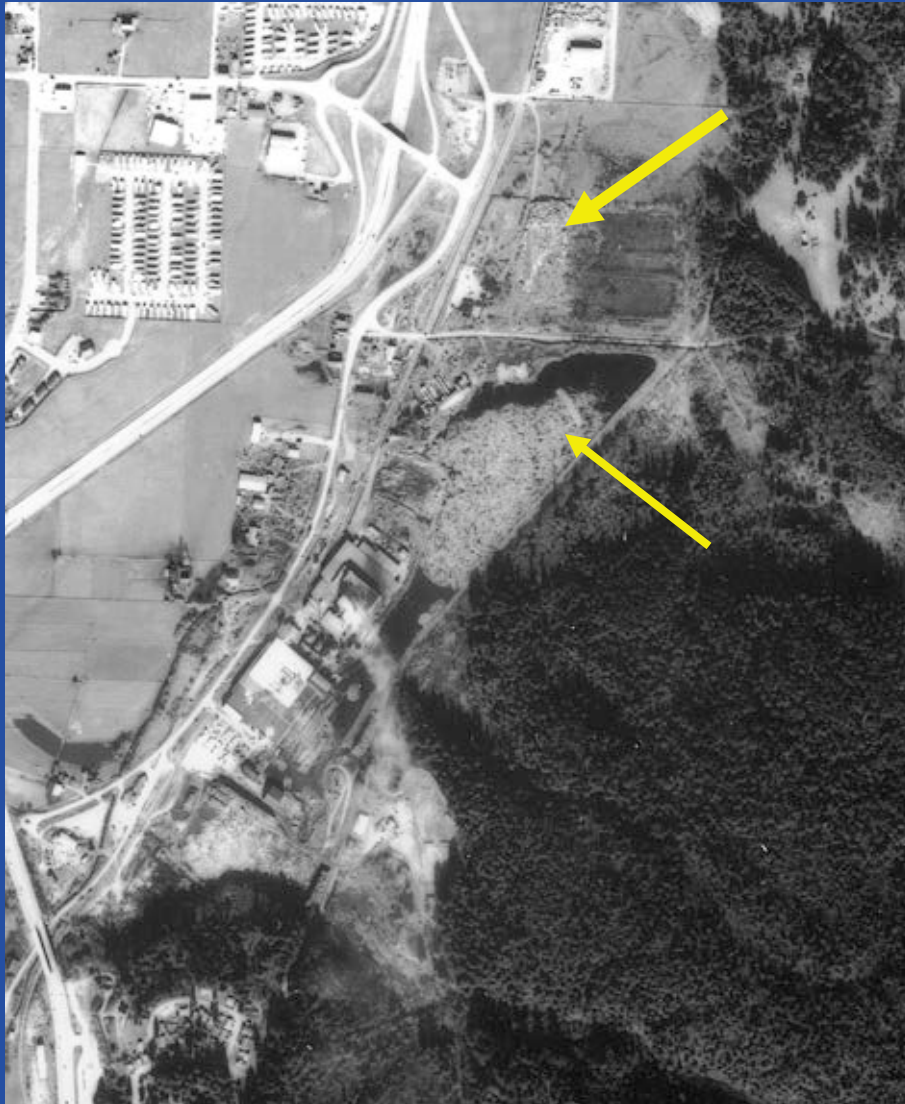


CHANGE DETECTION

1967

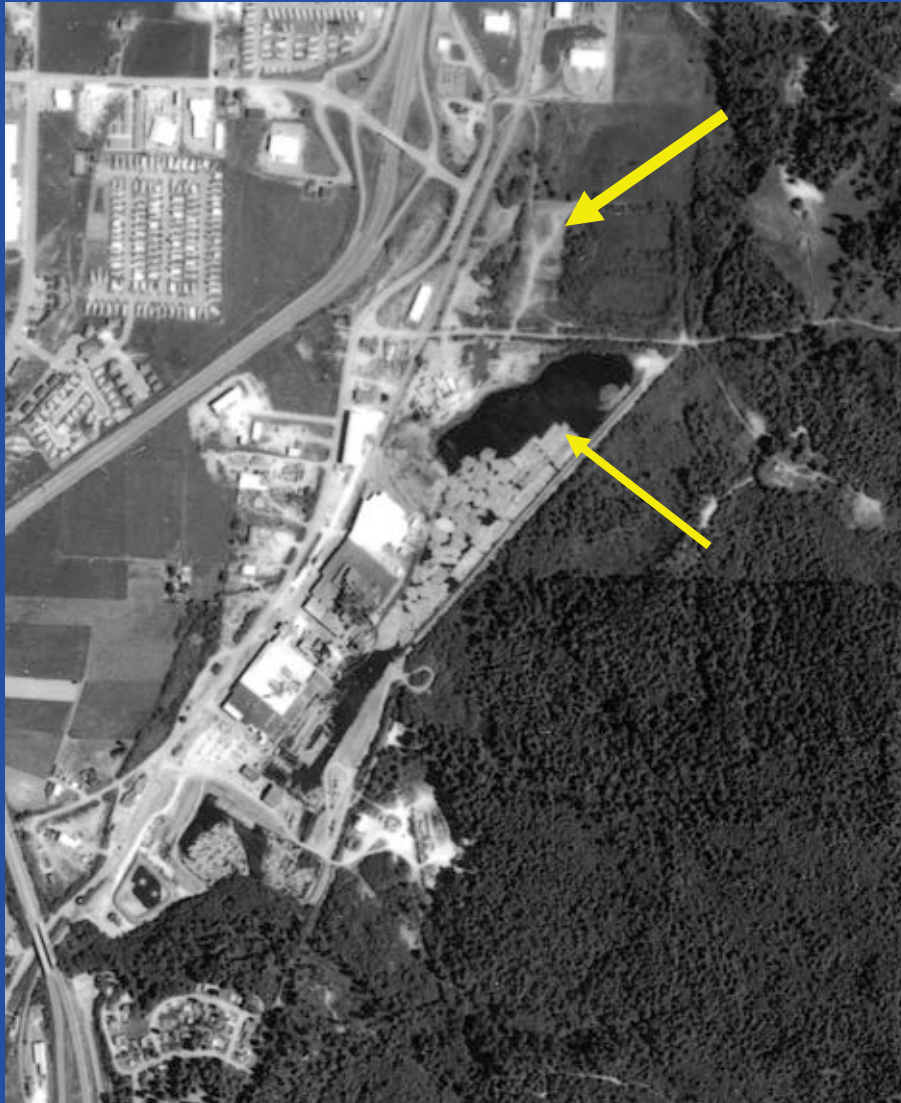


CHANGE DETECTION



1974

CHANGE DETECTION



1979

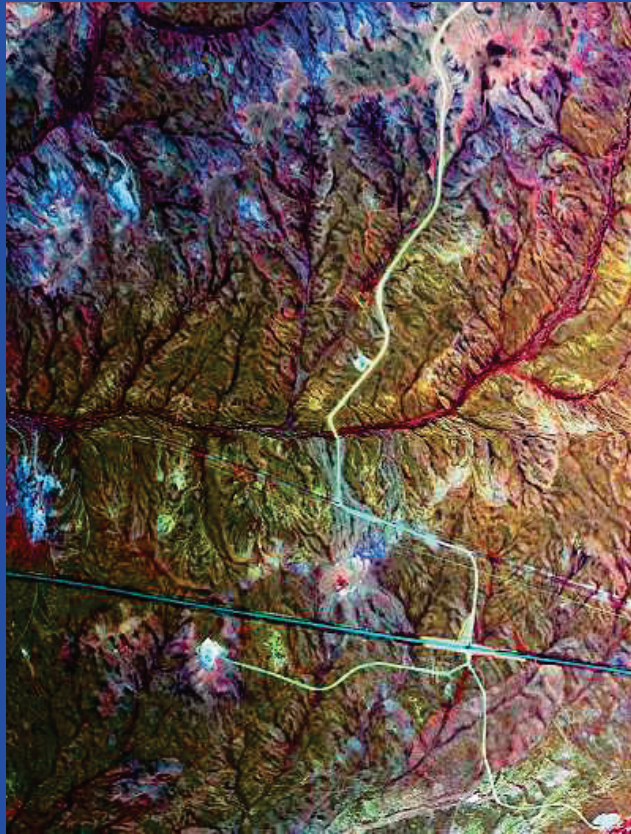
CHANGE DETECTION



1989

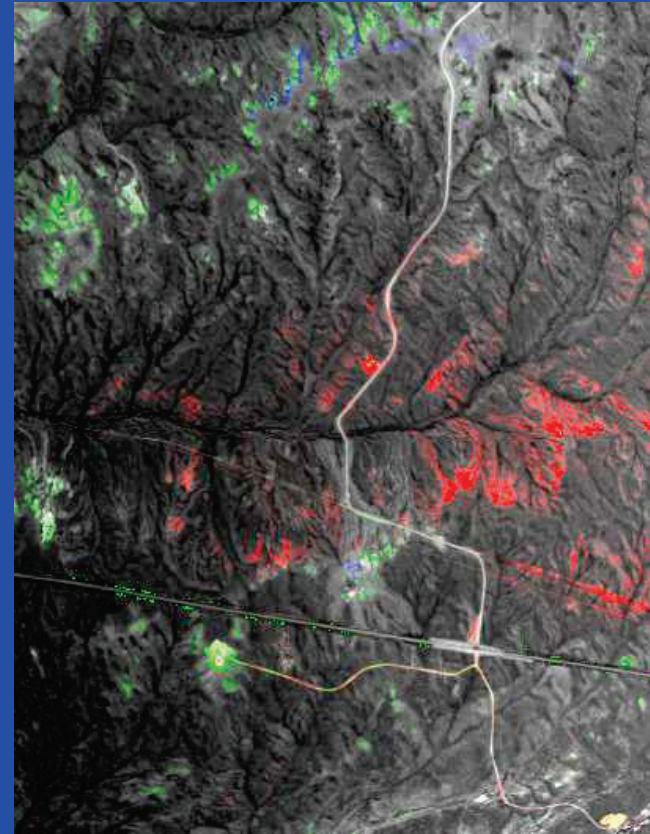
CHARACTERIZING DISTURBED SOILS

AIRBORNE VNIR-SWIR HYPERSPECTRAL IMAGE



Equivalent of TM 4,3,2
(veg is red)

CLAYS & SOILS

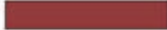


Minerals
kaolinite-smectites (**red**),
montmorillinite-Illites (**green**)
Calcite (**blue**)

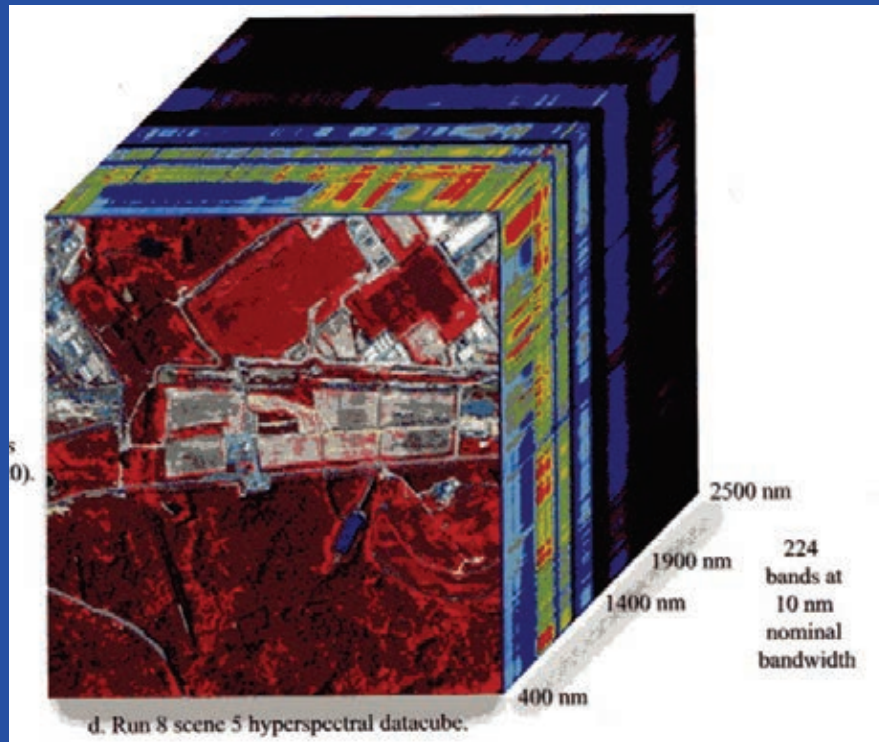
PROBE-1



*Soils Classification
Legend*

	Solidified Material #1
	Solidified Material #2
	Calcite #1
	Calcite #2 (Cement?)
	Swelling Clays (Montmorillinite)
	Fill
	Iron (Hematite)

INDUSTRIAL SITES

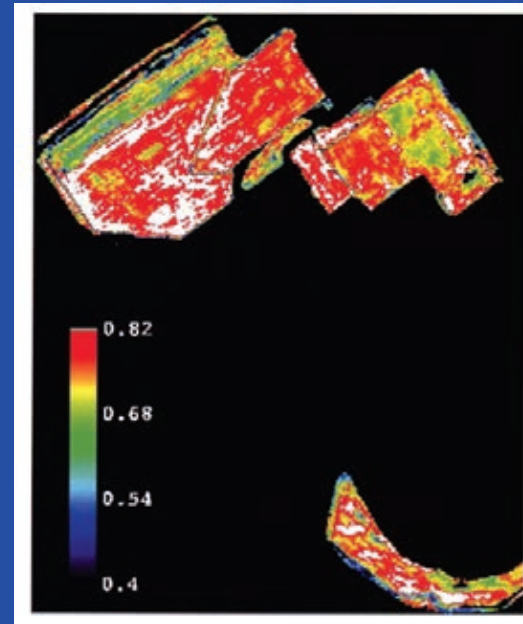


CLAY-CAPPED HAZARDOUS WASTE SITES

HYPERSPECTRAL ANALYSIS

Grass at site taken
to Lab and exposed
to Cu^+

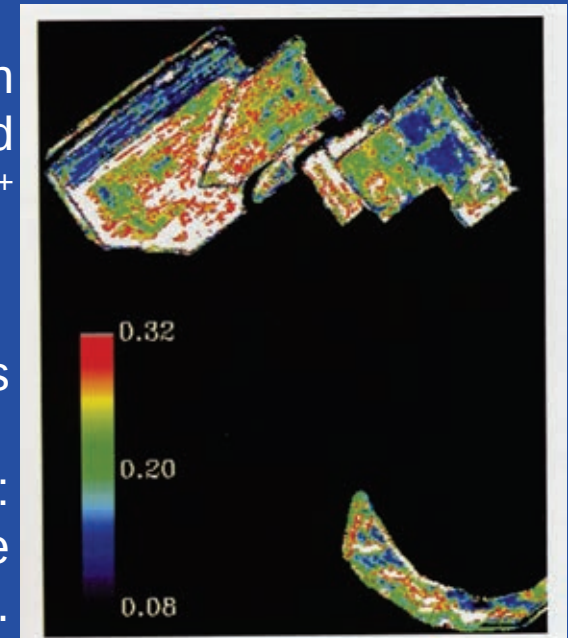
Spectral signature
in lab samples
applied to airborne
Hyperspectral data:
Black to Blue pixels have
 Cu^+ -exposure signature.



Veg Vigor

**Most Vigorous
Vegetation
Red to White**

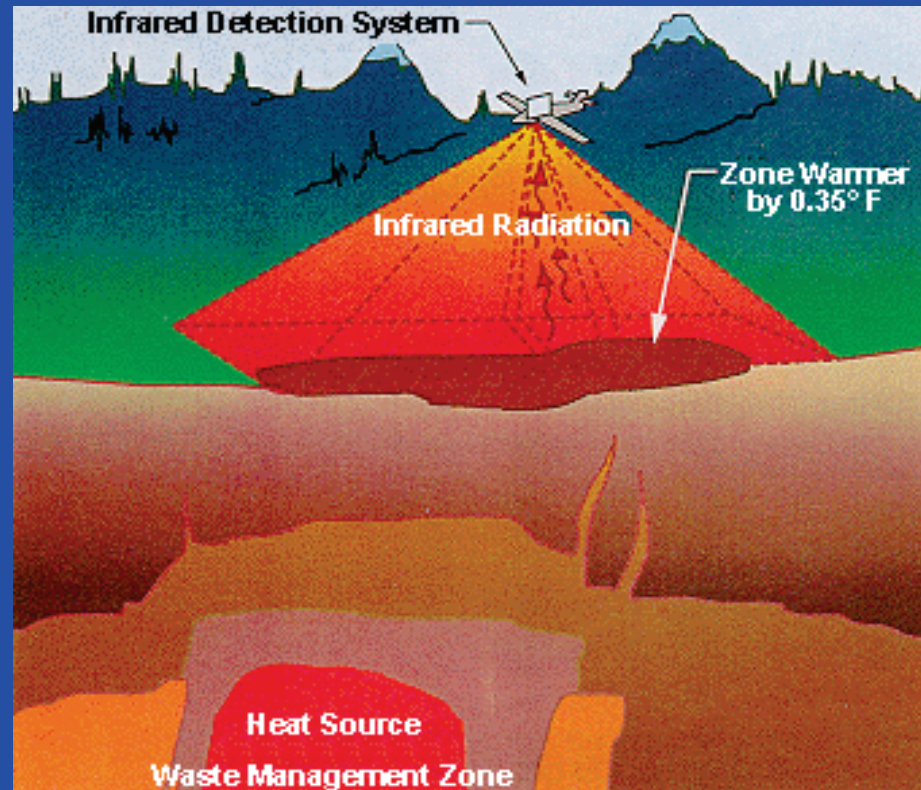
**Stressed
black-blue-
greens**



DETECTING AND MAPPING THERMAL ANOMALIES

OAK RIDGE NATIONAL LAB, TENNESSEE

THERMAL DETECTION



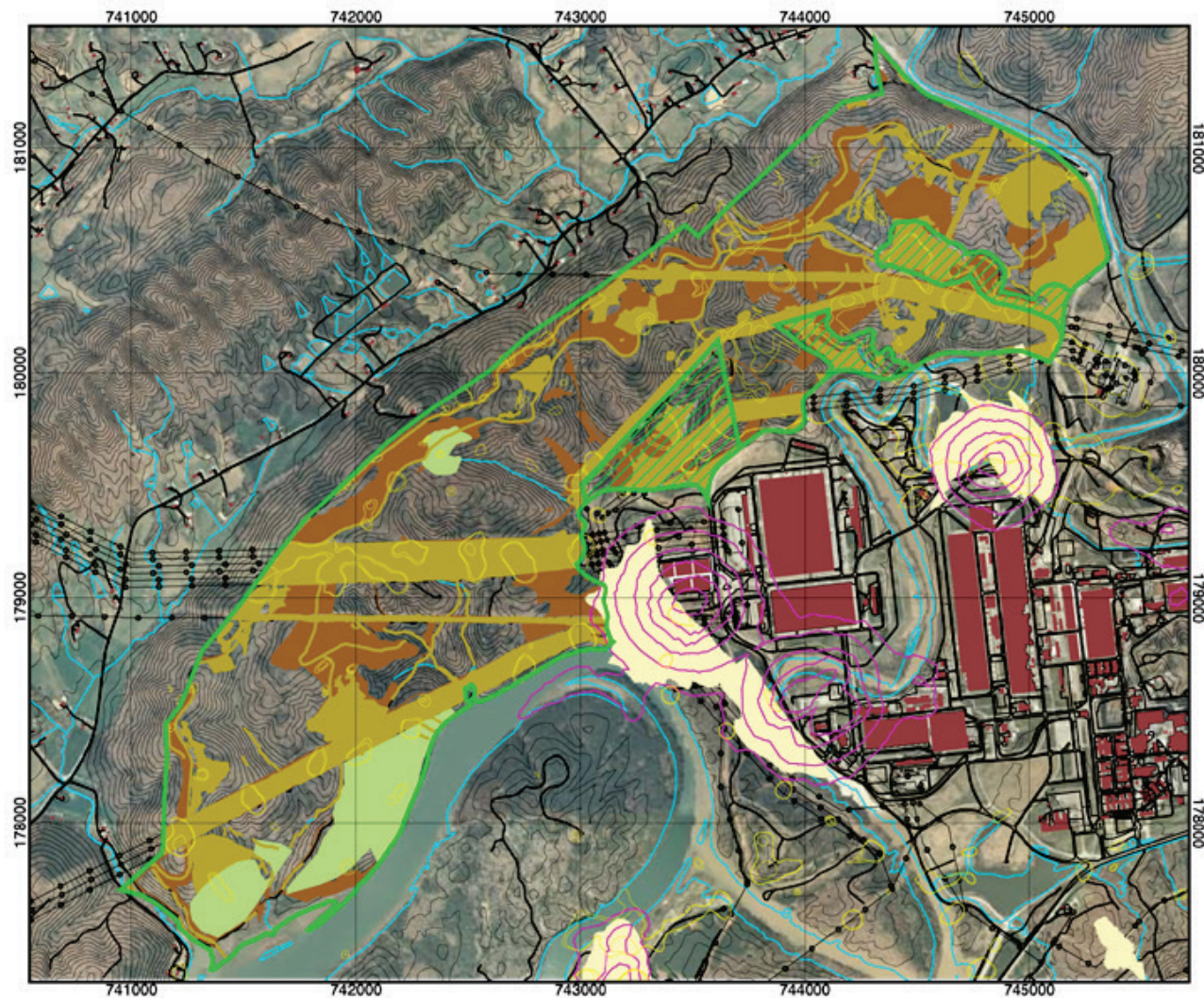


Fig. 6
All Anomalies

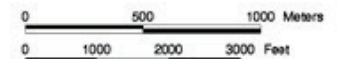
West Black Oak Ridge Study Area

- NDVI Anomaly
- EG&G Gamma Anomaly
- Aerodat Gamma Anomaly
- 10-Ton Magnetic Anomaly
- Landuse/Cover Anomaly
- Thermal Anomaly

Base Data:

- Electrical Lines
- Roads, Parking, and Bridges
- Hydrology
- Buildings
- 20-Foot Elevation Contours
- Study Area Boundary
- Excluded from Study Area
- 1993 Orthophoto

Footprint Reduction Program
Environmental Restoration Division



Tennessee State Plane, NAD83



Anomaly Source: Remote Sensing Program, EM Program
Radon International
Base Source: 1993 Orthophoto Imagery and Planimetric Vectors,
BaseMap and Imagery Project, EM Program
Prepared by: Geographic Information Science and Technology, ORNL
Date prepared: June 23, 1997



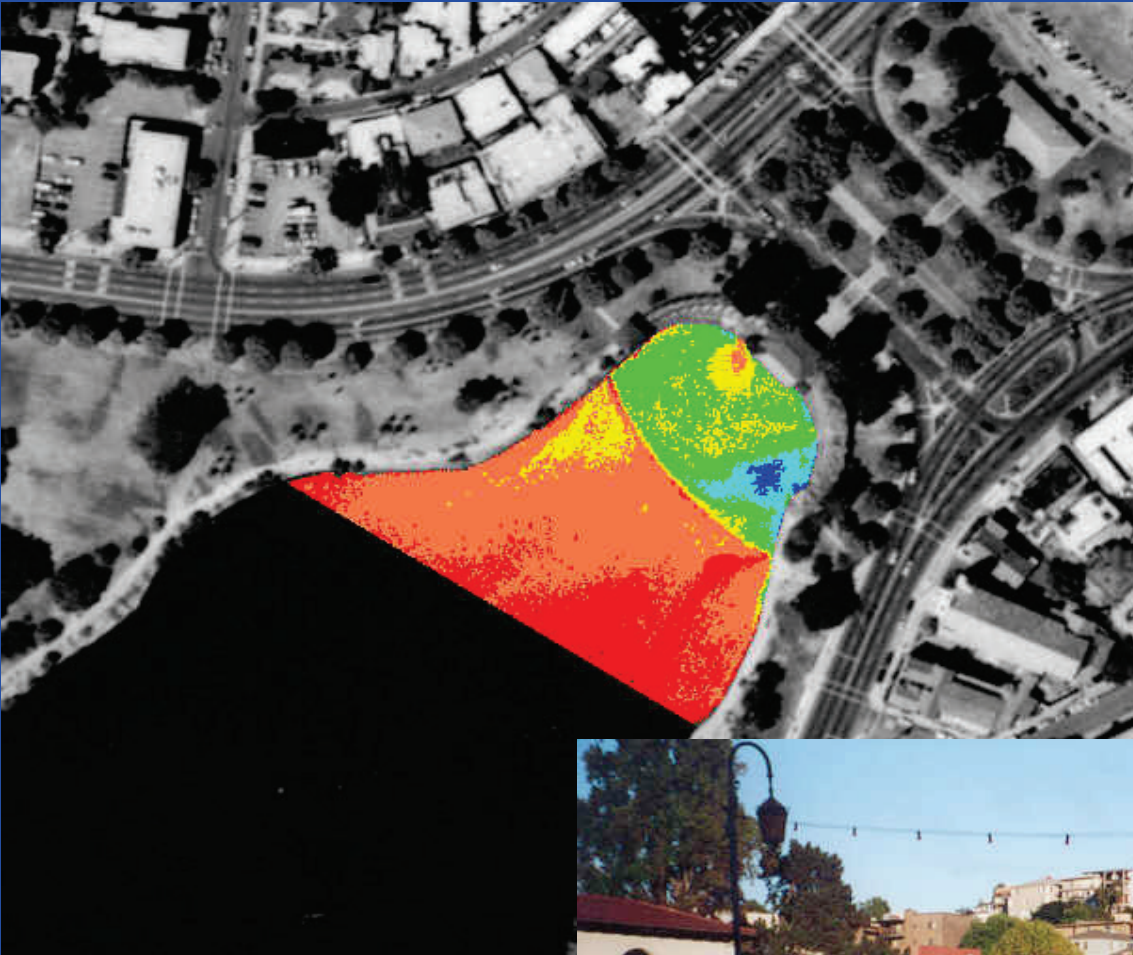
**USING THERMAL FOR
SITES WITH WATER**

THERMAL 7°F/4°C RANGE

RED ~ 66°F/19°C

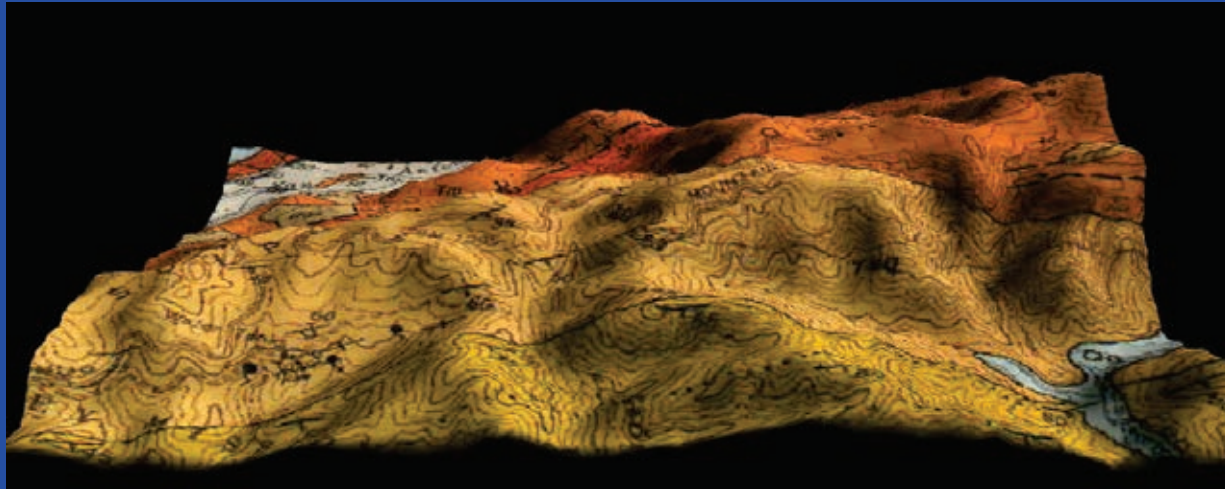
BLUE ~ 59°F/15°C

+/- 3°F/ 2°C



DETECTING AND MAPPING OIL-CONTAMINATED SOILS

AREA IN S. CALIFORNIA WITH MAPPED OIL SEEPS



“Dibblee Oil Seep”

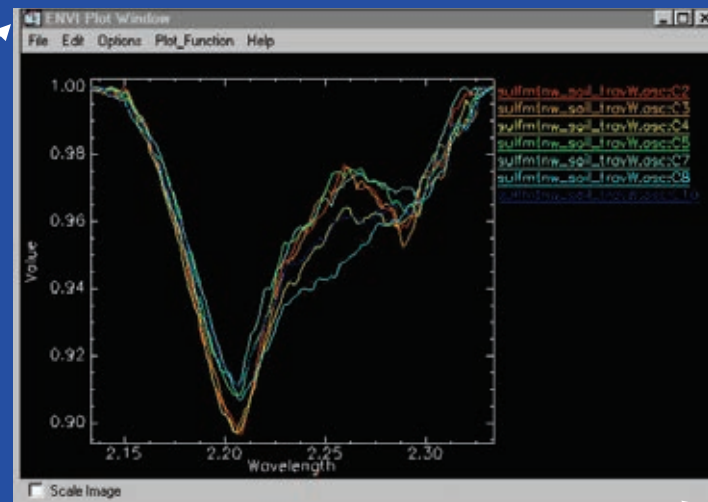
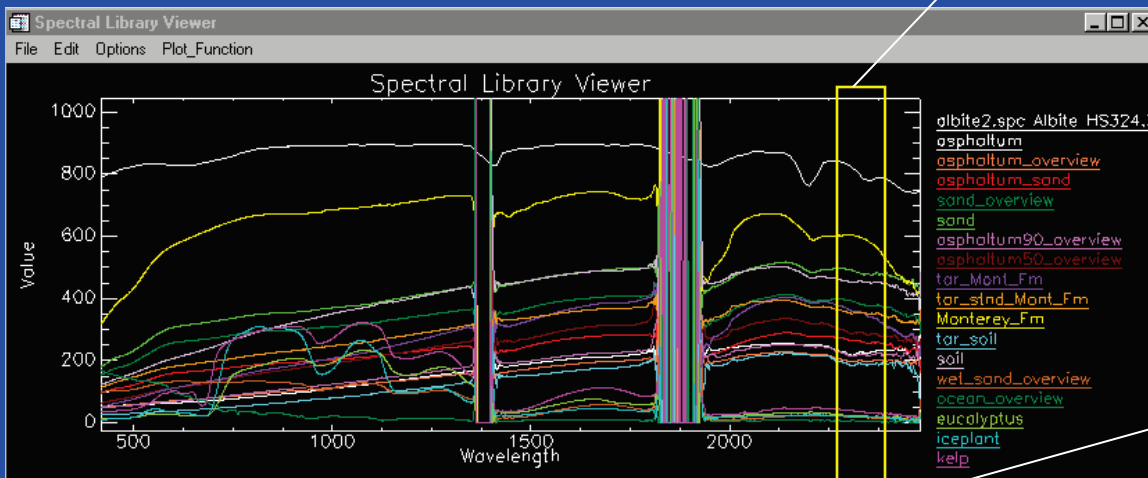


oil seep in road cut - Q river deposit

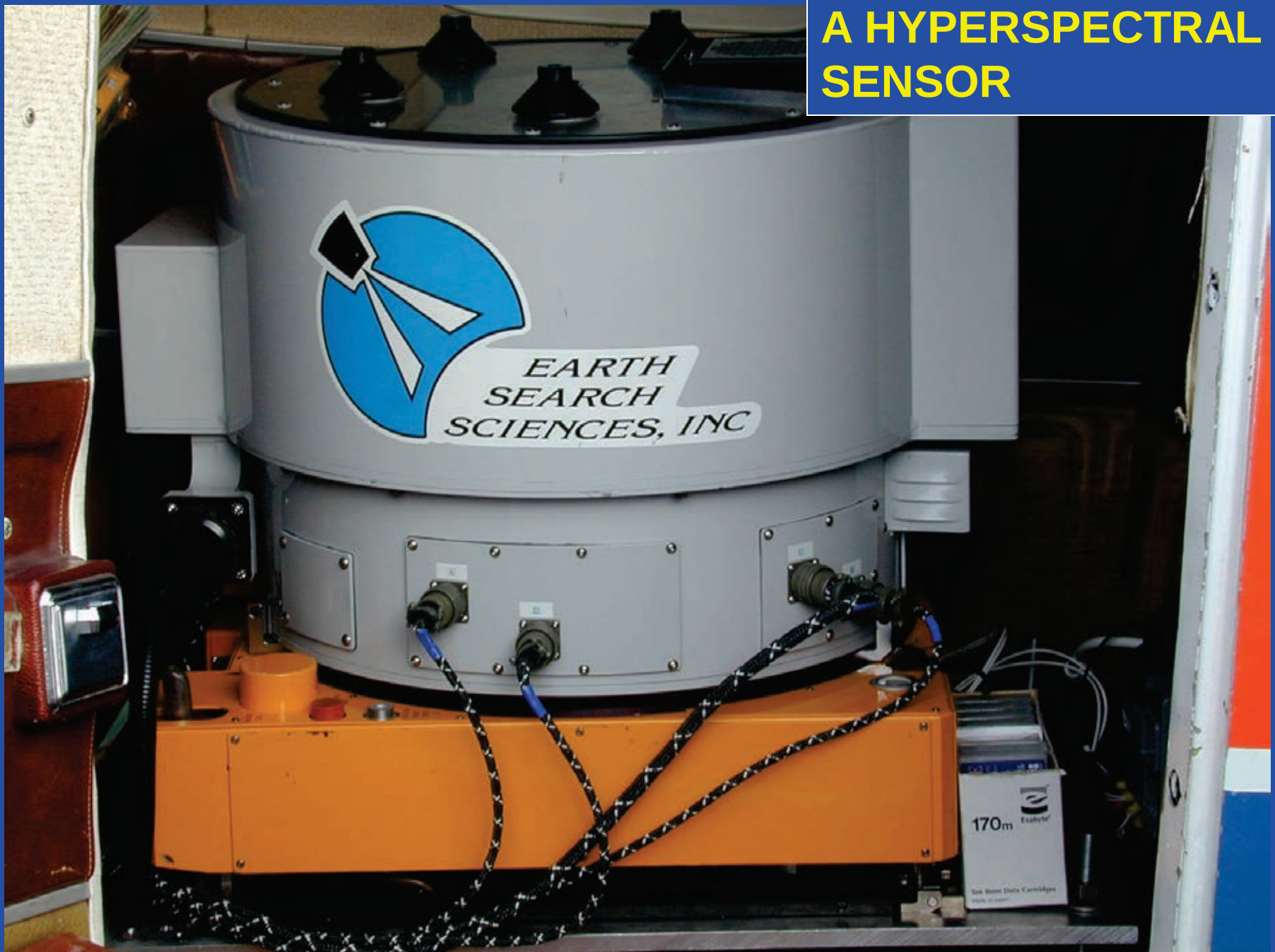
DIBBLEE OIL SEEP

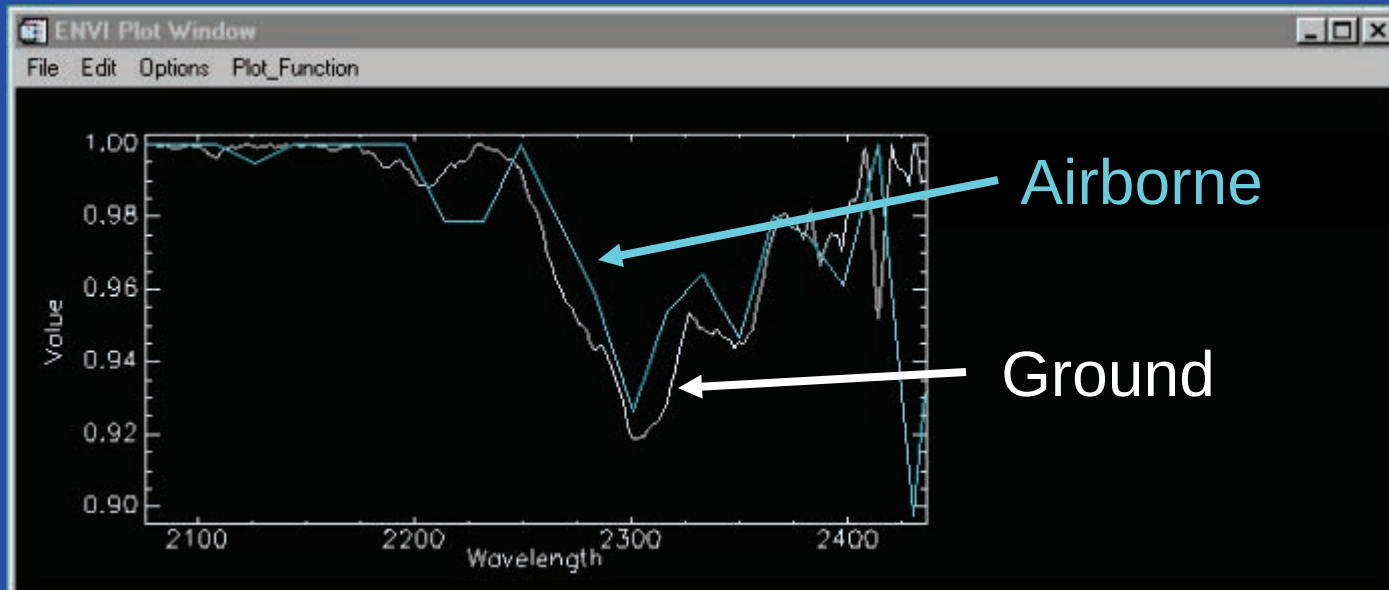
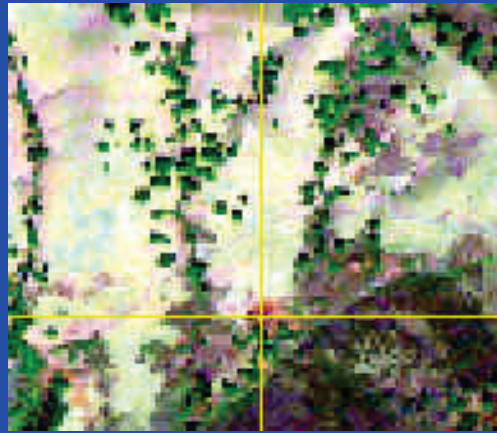


Building an
Oil Spectral
Library Based
on Field
Measurements

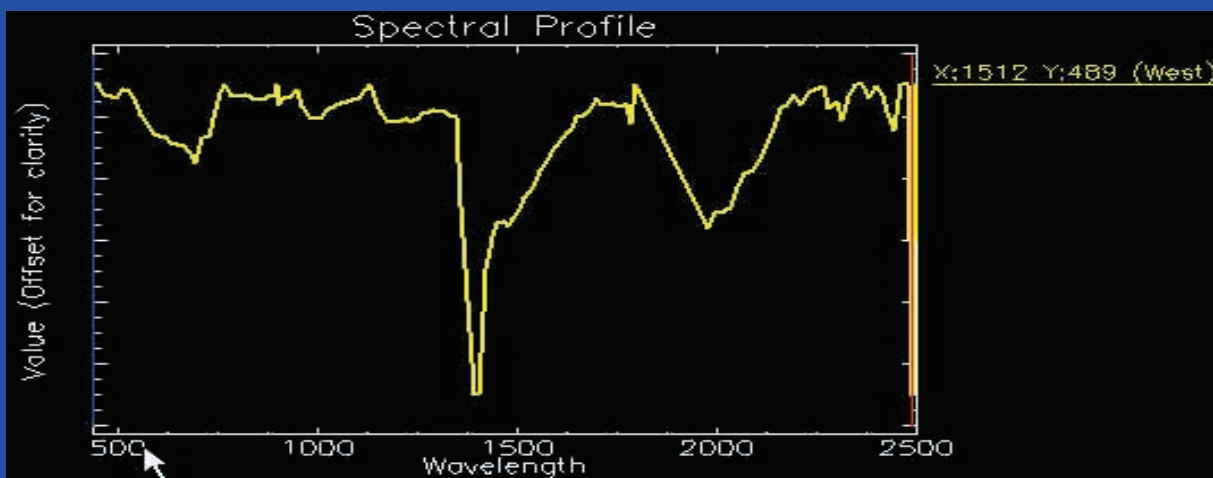
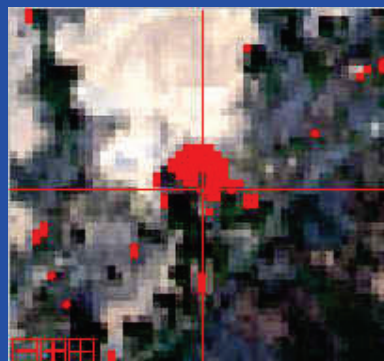
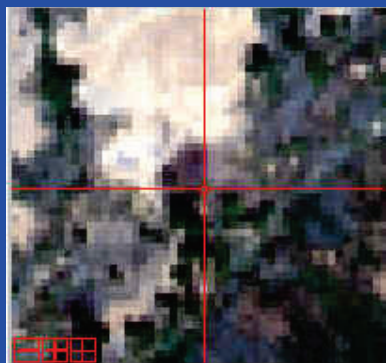


A HYPERSPECTRAL SENSOR





Comparing airborne to ground signature for oil pixel

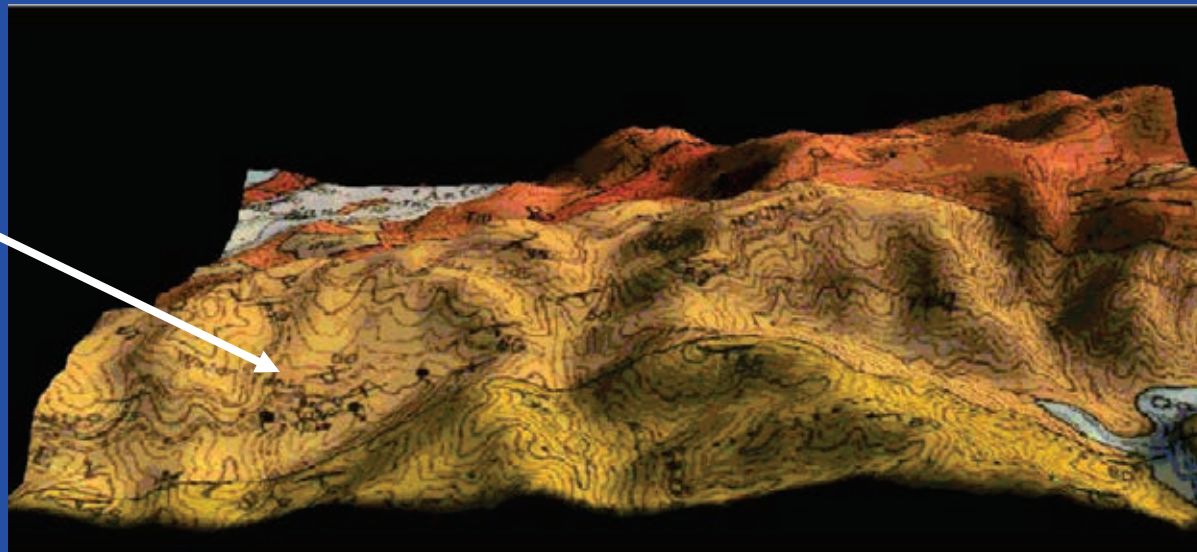


Hydrocarbon Spectral Signature

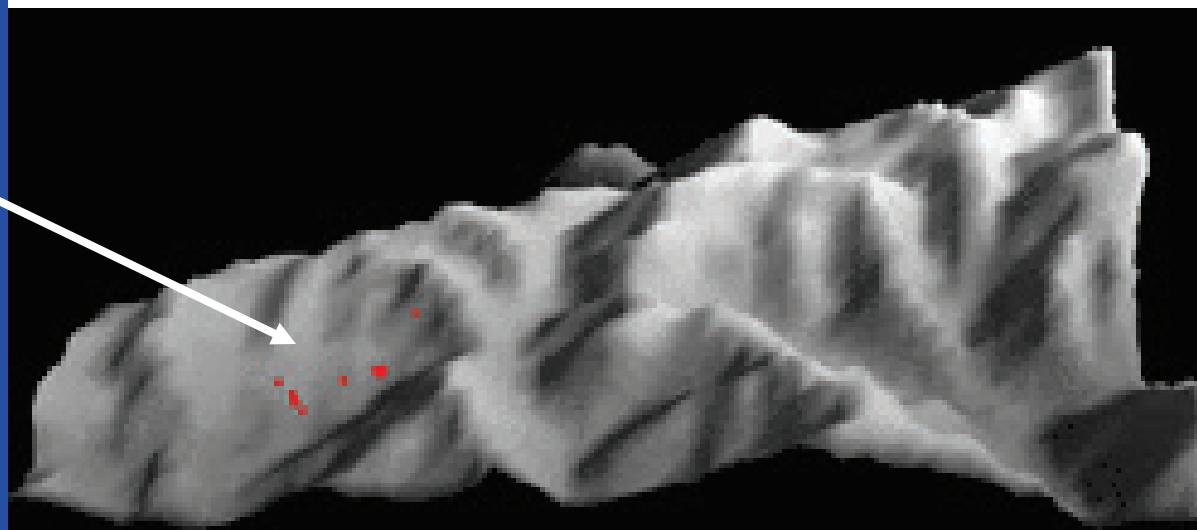
**Extrapolation of
Dibblee oil seep.**

**Spectral signature
from training site
pixel extrapolated to
surrounding area.**

OIL SEEP DETECTION



Before



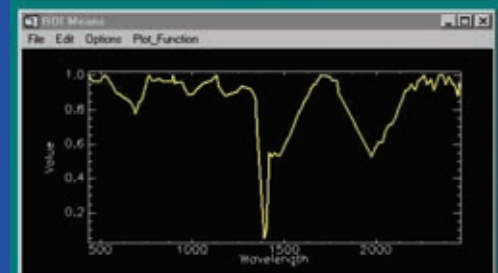
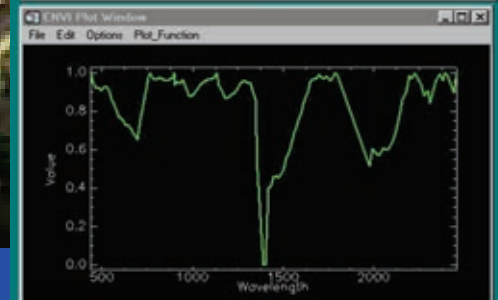
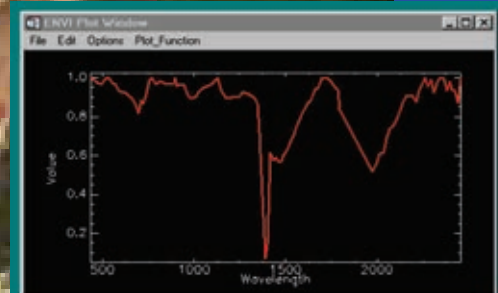
After



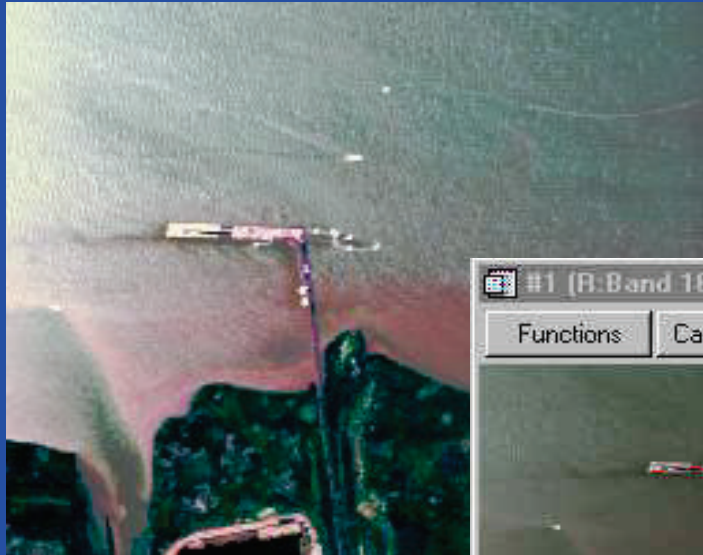
Pumping Facility in terrain characterized by oil seeps....



**Facility has evidence of oil-impacted
soils, roads, and industrial surfaces
(colored red - Spectral Library
on right)**



WHARF - OIL SPILL IN 1992



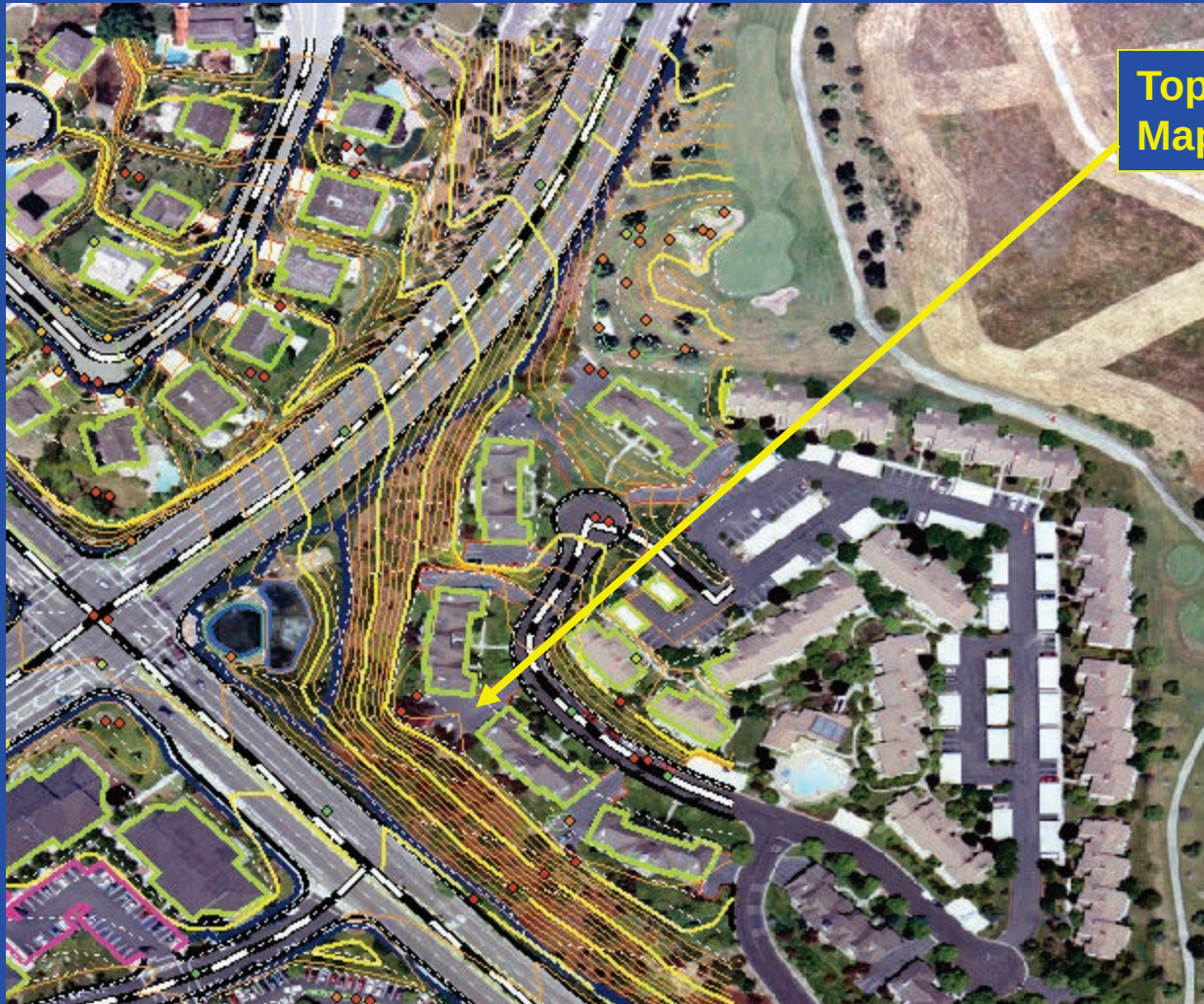
Unique spectral signature for
oil impacted surfaces = red

Classification



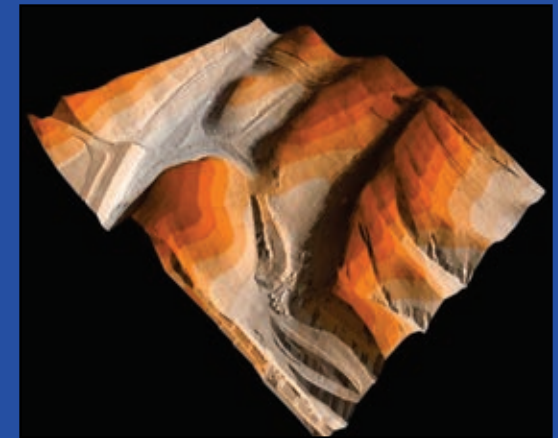
USING DEM's TO MODEL DRAINAGE

DIGITAL ELEVATION MODELS (DEM'S) FROM PHOTOGRAMMETRY AND LIDAR

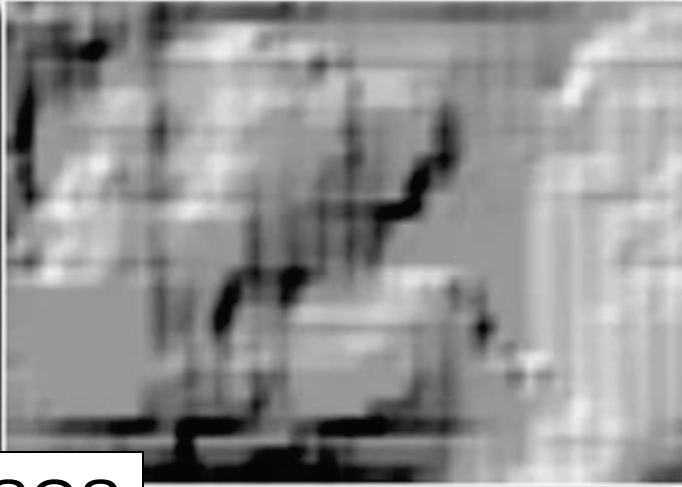


Topographic contours
Mapped by stereo operator

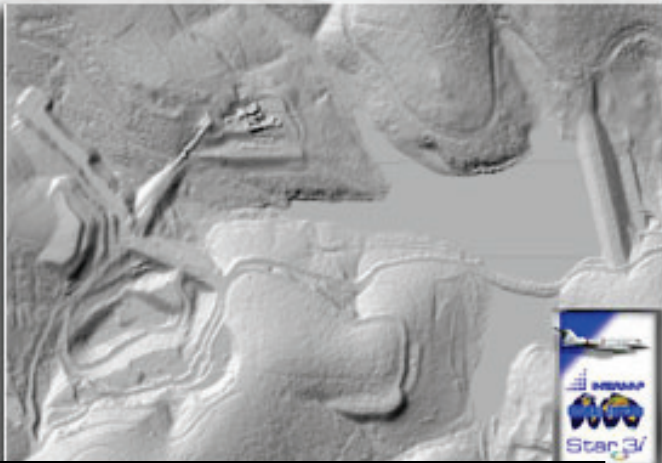
DEM



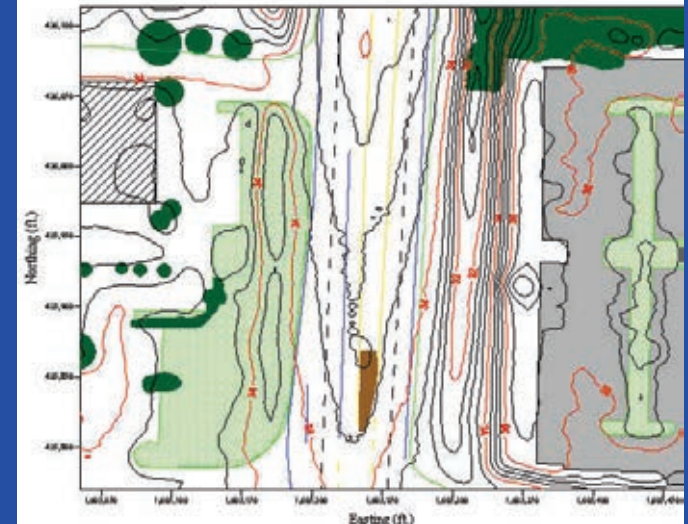
DIGITAL ELEVATION MODELS (DEM'S)



USGS



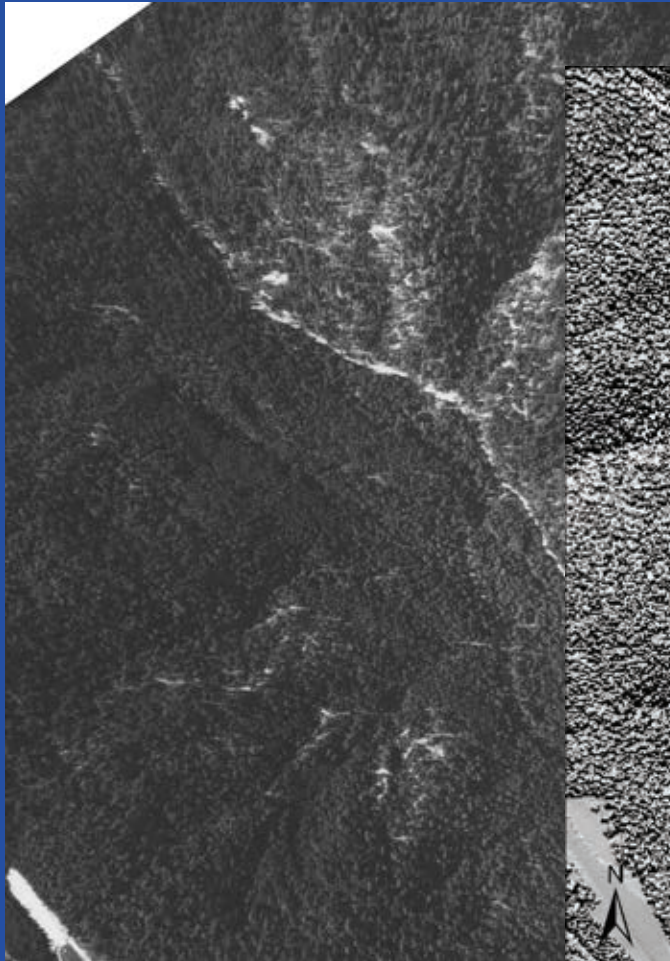
Photogrammetric/LiDAR



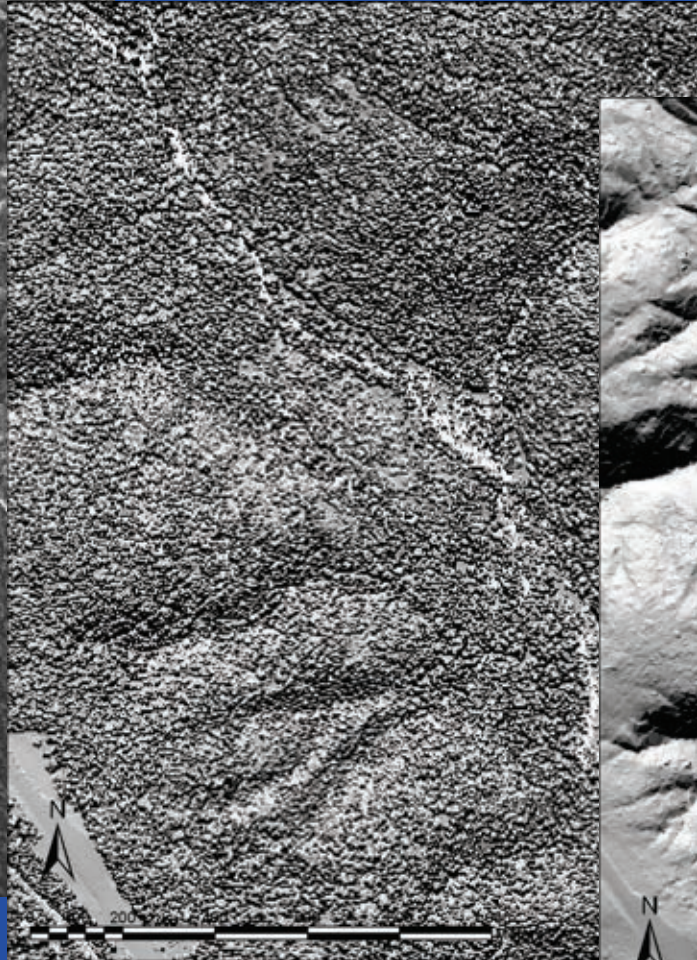
Quality Needed?

DIGITAL ELEVATION MODELS (DEM'S)

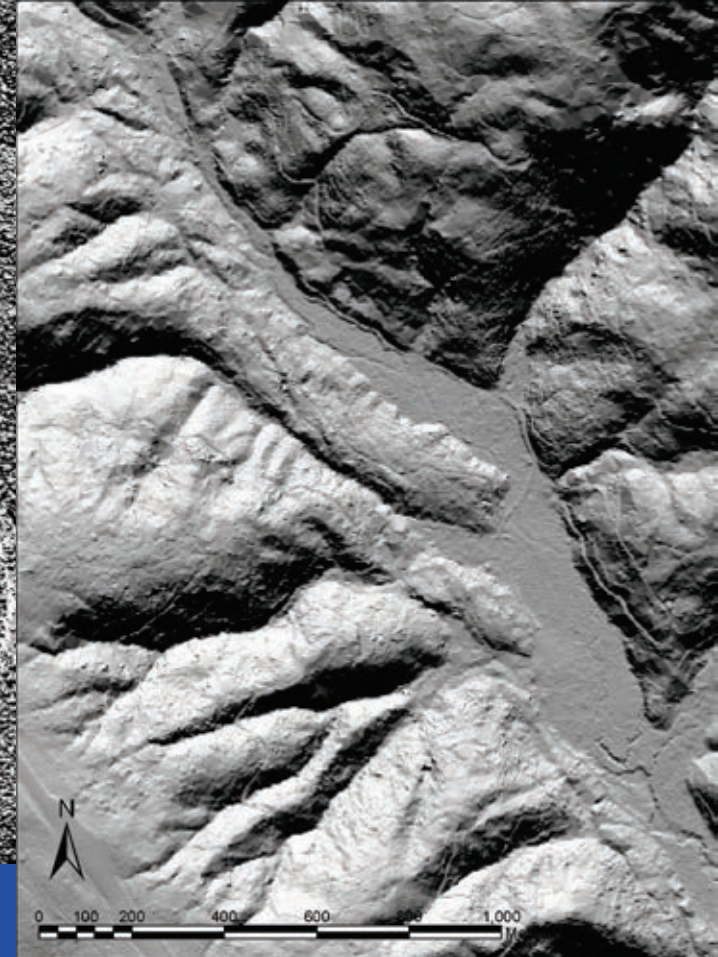
Bare Earth
DEM



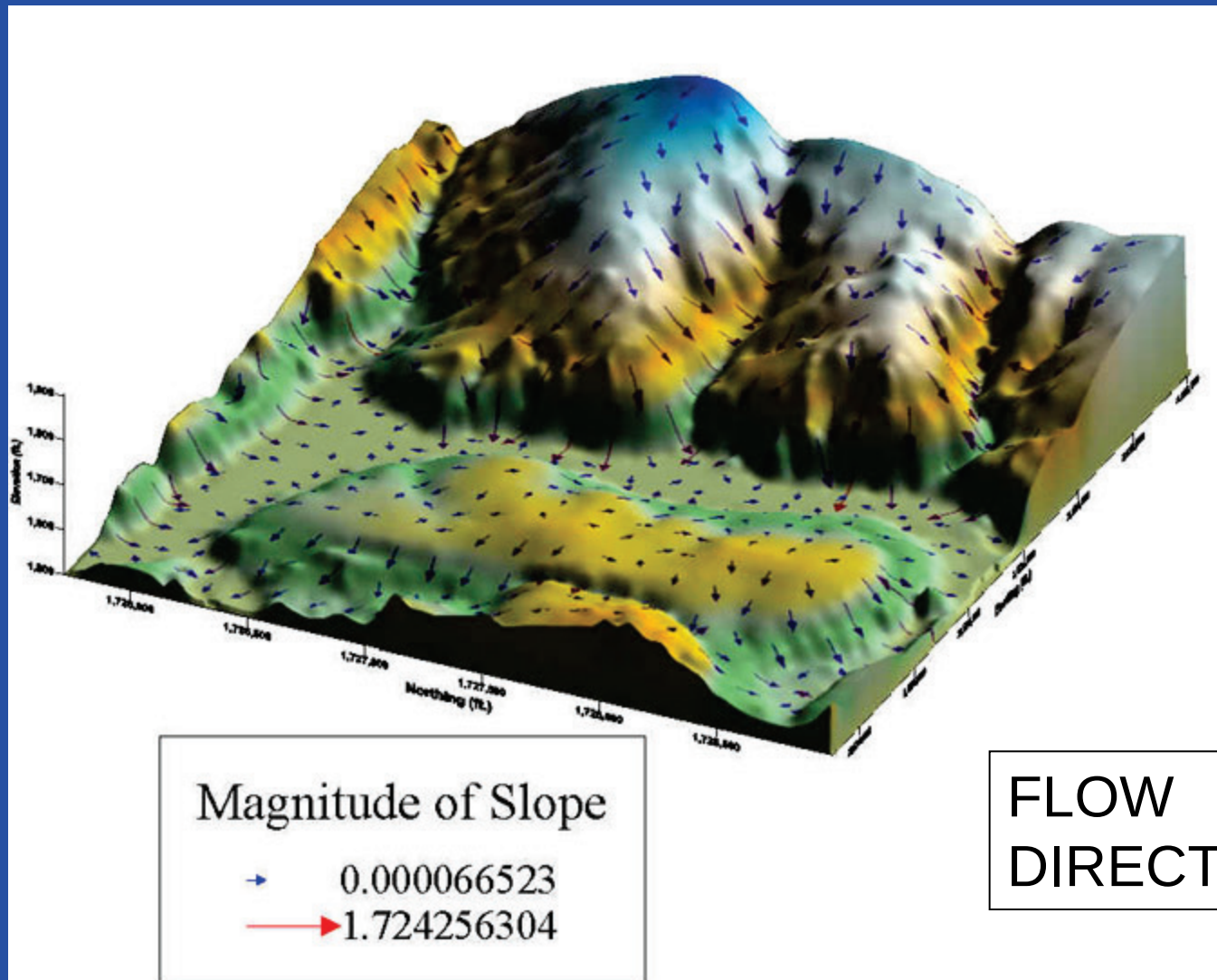
Air Photo
- a forest -



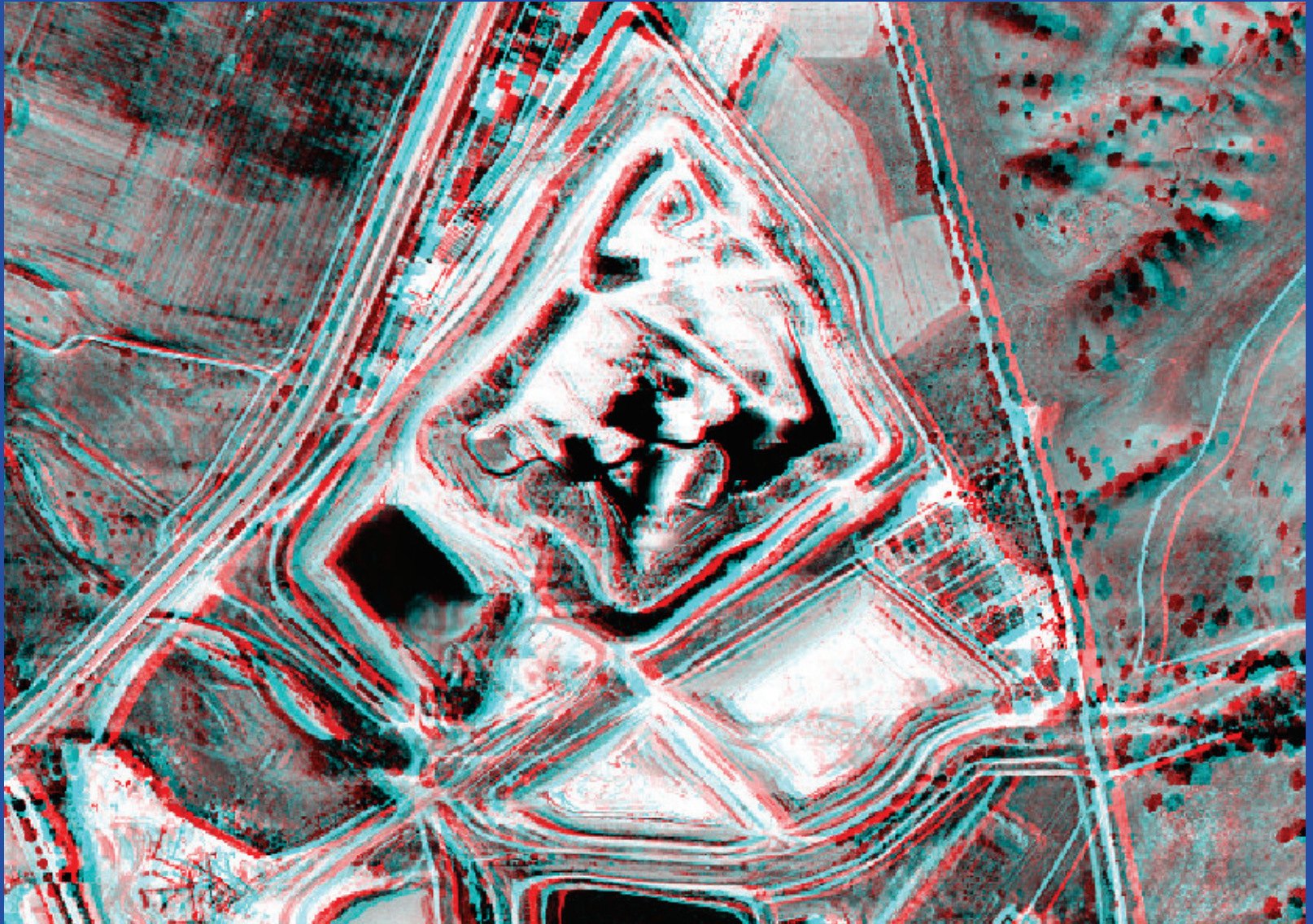
Canopy DEM
from LiDAR



DIGITAL ELEVATION MODELS (DEM'S) - DRAINAGE

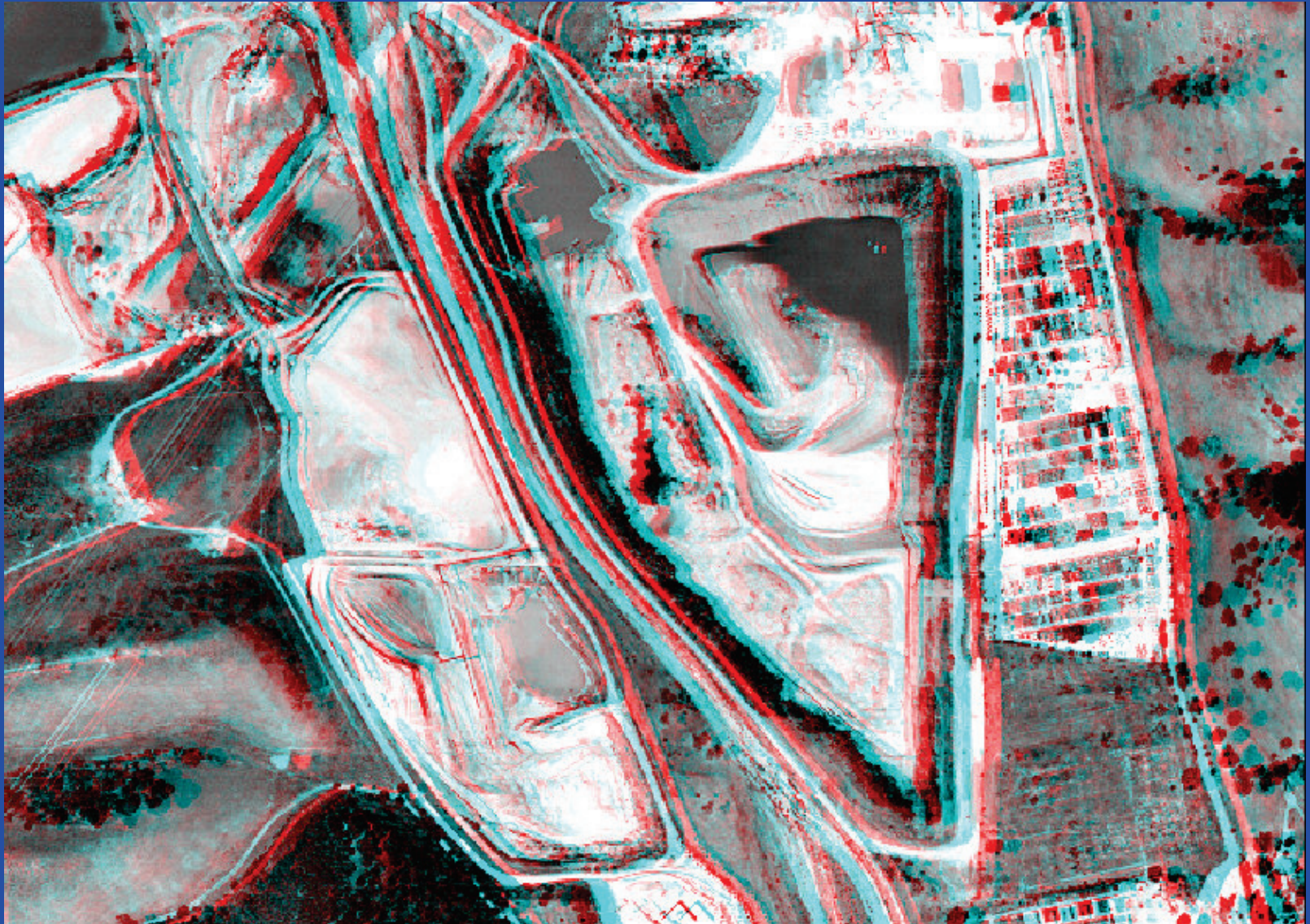


DIGITAL ELEVATION MODELS (DEM'S) - QUALITY?



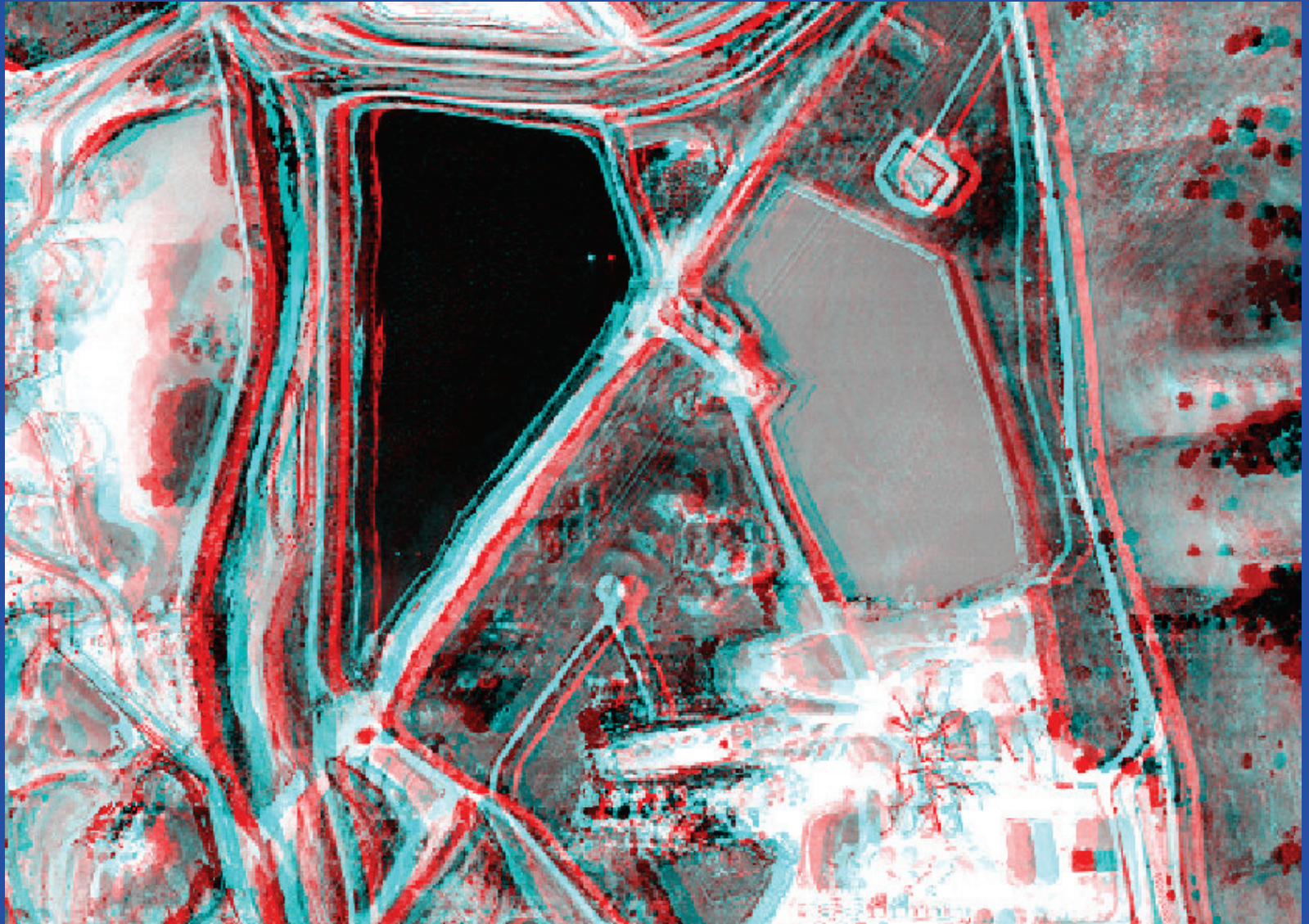
IMAGERY DRAPED OVER DEM

DIGITAL ELEVATION MODELS (DEM'S)



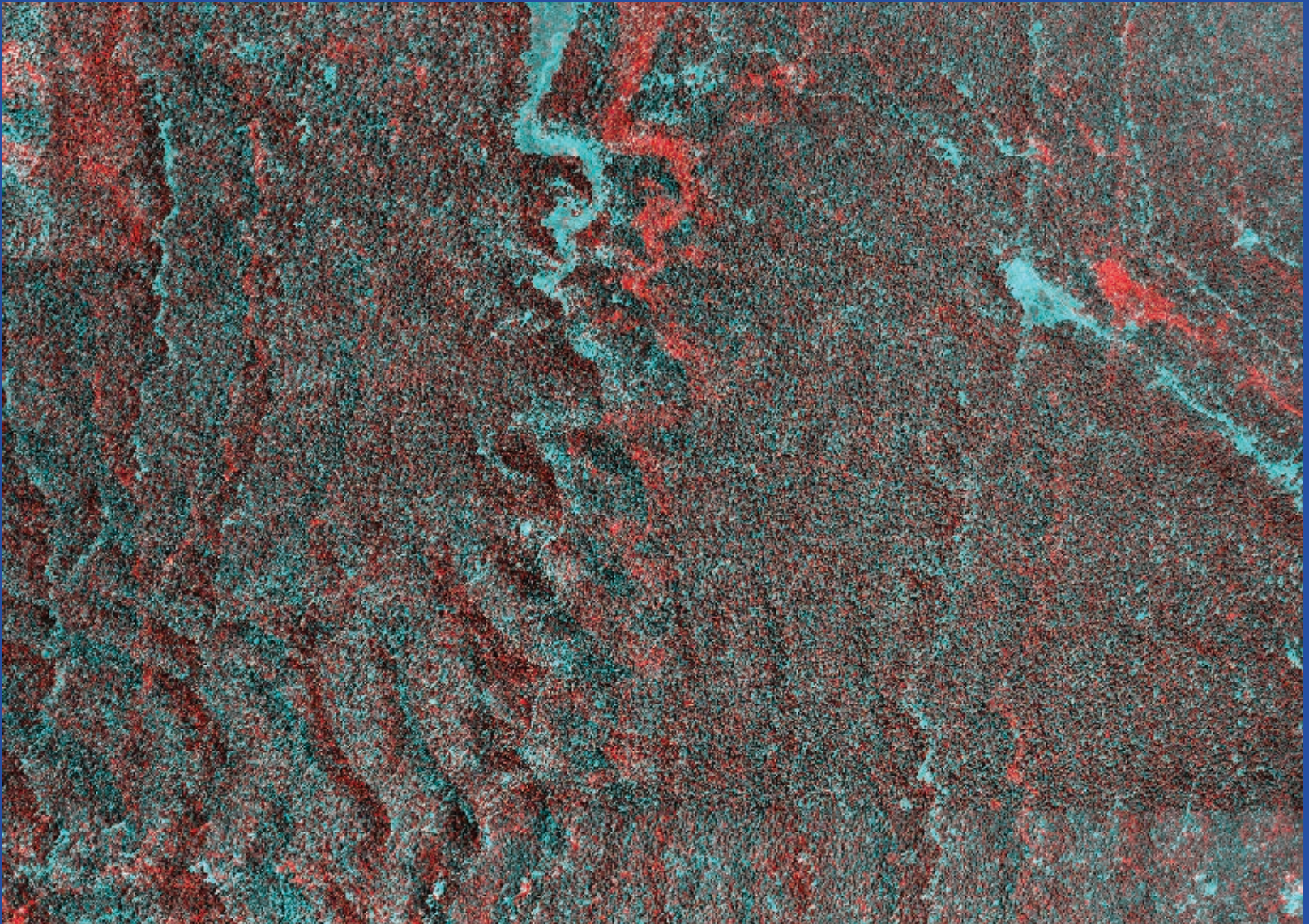
IMAGERY DRAPED OVER DEM

DIGITAL ELEVATION MODELS (DEM'S)



IMAGERY DRAPED OVER DEM

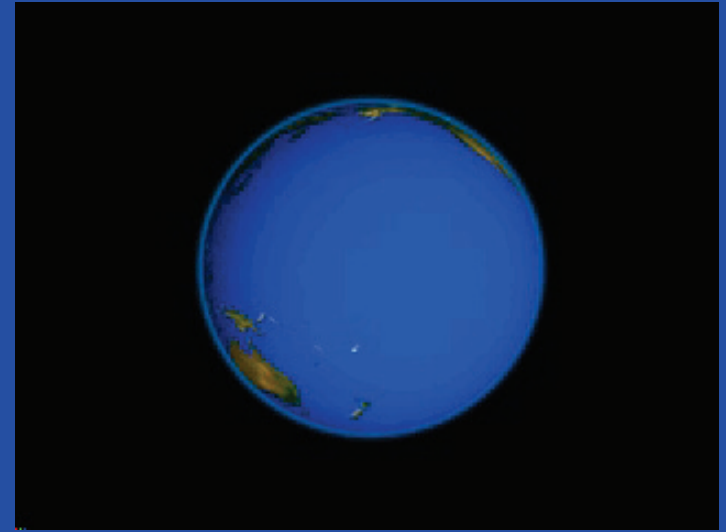
DIGITAL ELEVATION MODELS (DEM'S)



IMAGERY DRAPED OVER DEM

SUMMARY

- Imagery & Derived Maps provide **new** and **unique** information
- Remote Sensing & GIS **will improve** planning, budgeting, field work, presentations, & science.
- **High-value assets** justify better imagery



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Imaging & Mapping Solutions