Impact of Geographical Information Systems on Geotechnical Engineering

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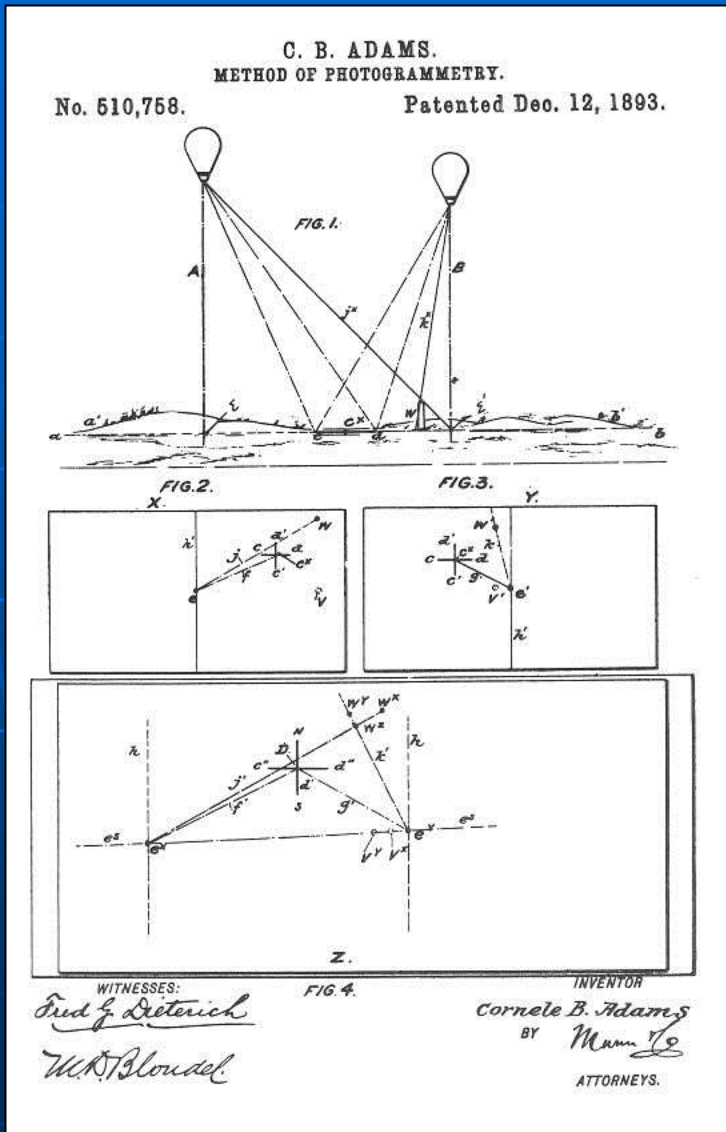
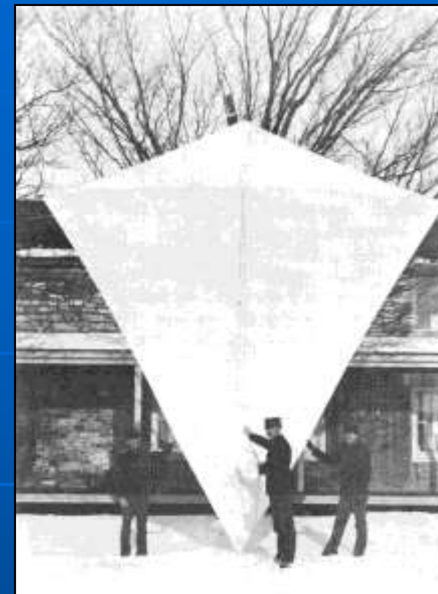
ORIGINS OF REMOTE SENSING



Stereopair Images-1893



Reconnaissance Kite-1895

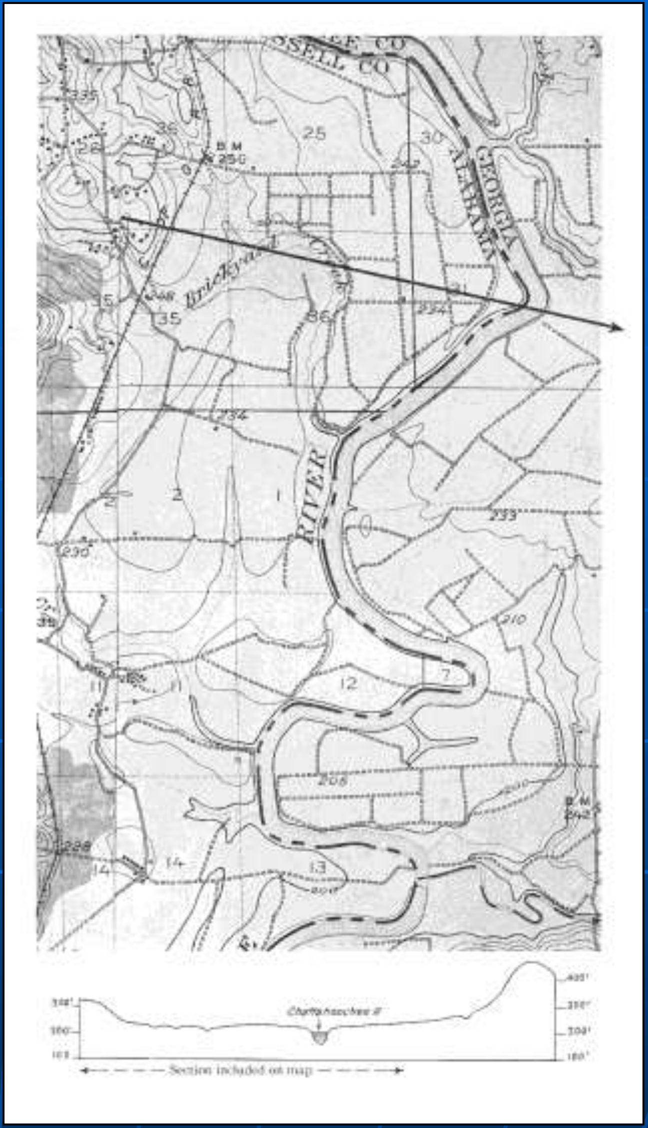
1908

EMERGENCE OF AERIAL PHOTOGRAPHY IN THE 1920s

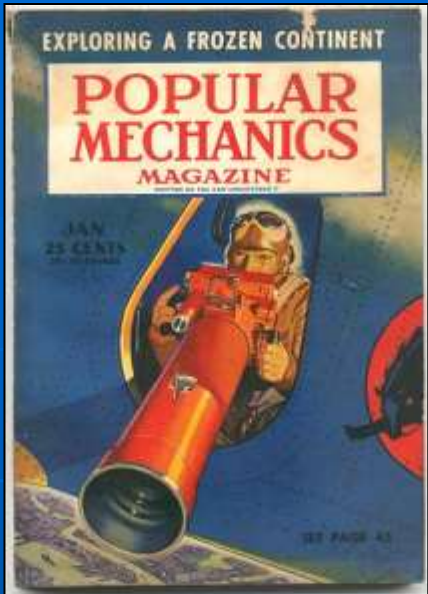
Sherman Fairchild invented an aerial camera with a focal plane shutter in 1920.

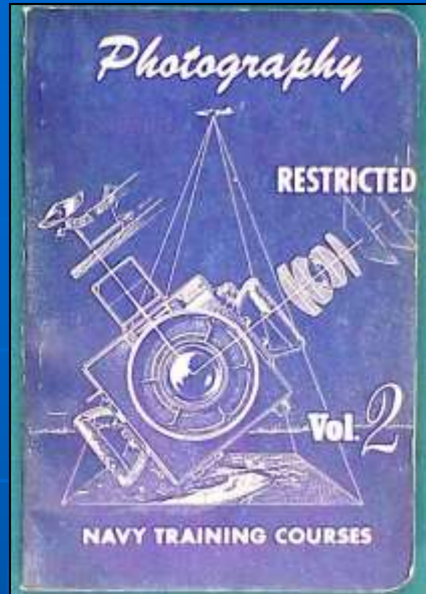
In 1924 Fairchild compiled an exquisite map of New York City's five boroughs using aerial images

He went on to develop aircraft, aerial cameras and aerial photogrammetry firms



Aerial photos allowed new features to be seen or "sensed", which had never been mapped previously. The photo at left was taken in 1922.





During the Second World War (1939-45) aerial camera technology advanced rapidly, becoming a key component in gathering of intelligence, strategic planning, tactical planning and bomb damage assessment. Focal lengths up to 60 inches were employed from altitudes up to 34,000 feet.

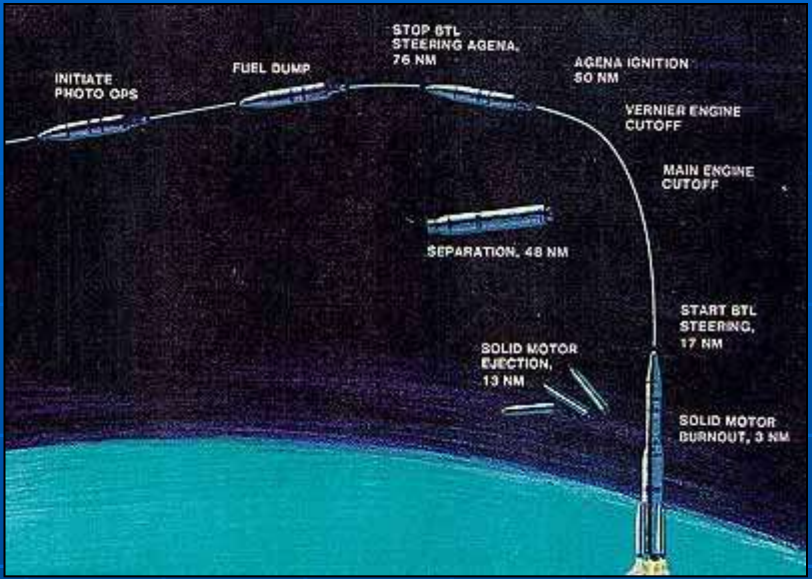
The strategic import of aerial imagery was confirmed through wartime experience. From April to September 1944, 96% of Germany's petroleum, oil and lubricants manufacturing capacity was destroyed; all of it targeted using aerial photography

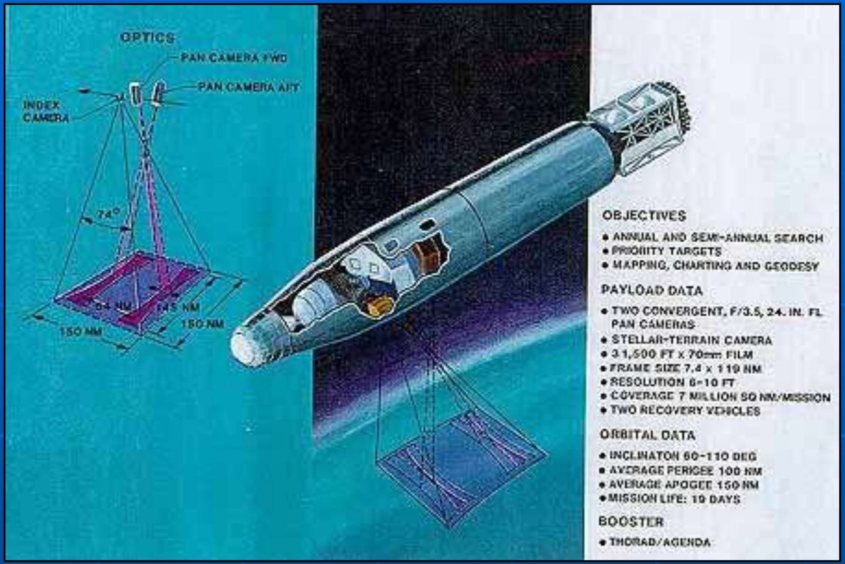
Early in the Cold War manned reconnaissance capability increased markedly; with enormous cameras carried by the RB-36 with a crew of 22 men on 50-hour missions at altitudes above 58,000 feet

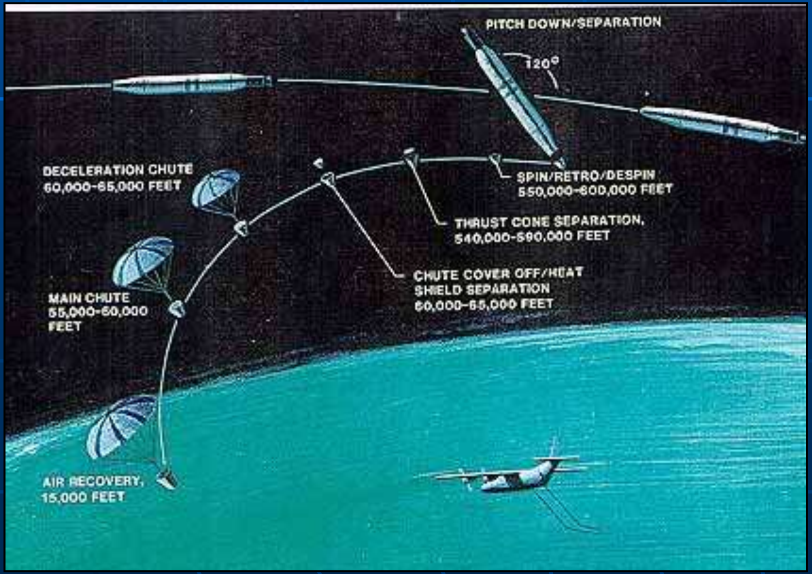
HIGHER AND FASTER

- In 1956 the U-2 spy plane began flying at altitudes between 45,000 and 60,000 feet carrying 72-inch focal length cameras
- Remotely piloted craft began appearing in the 1960s, negating possibility of captured pilots

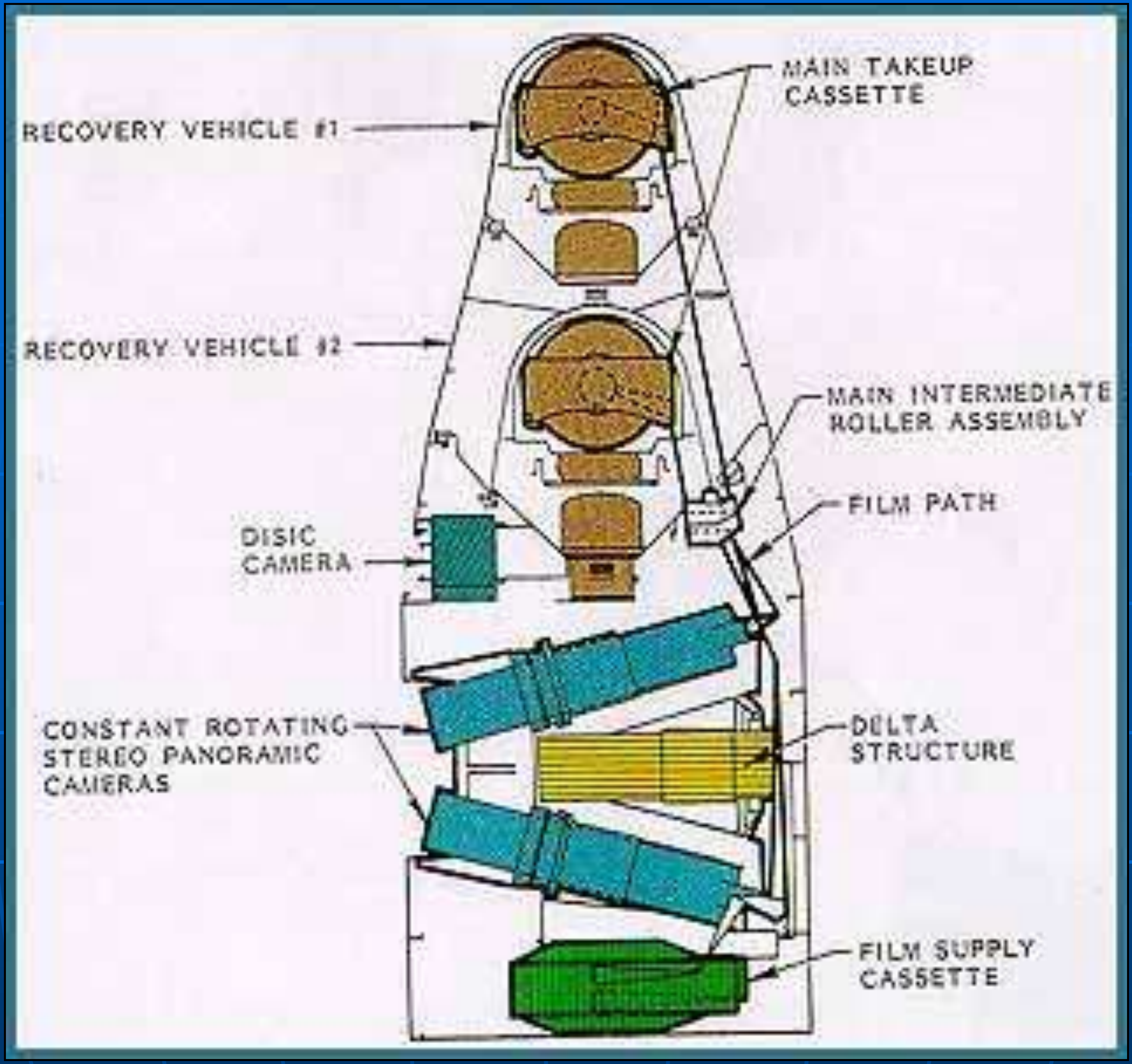
SPACE-BASED IMAGING





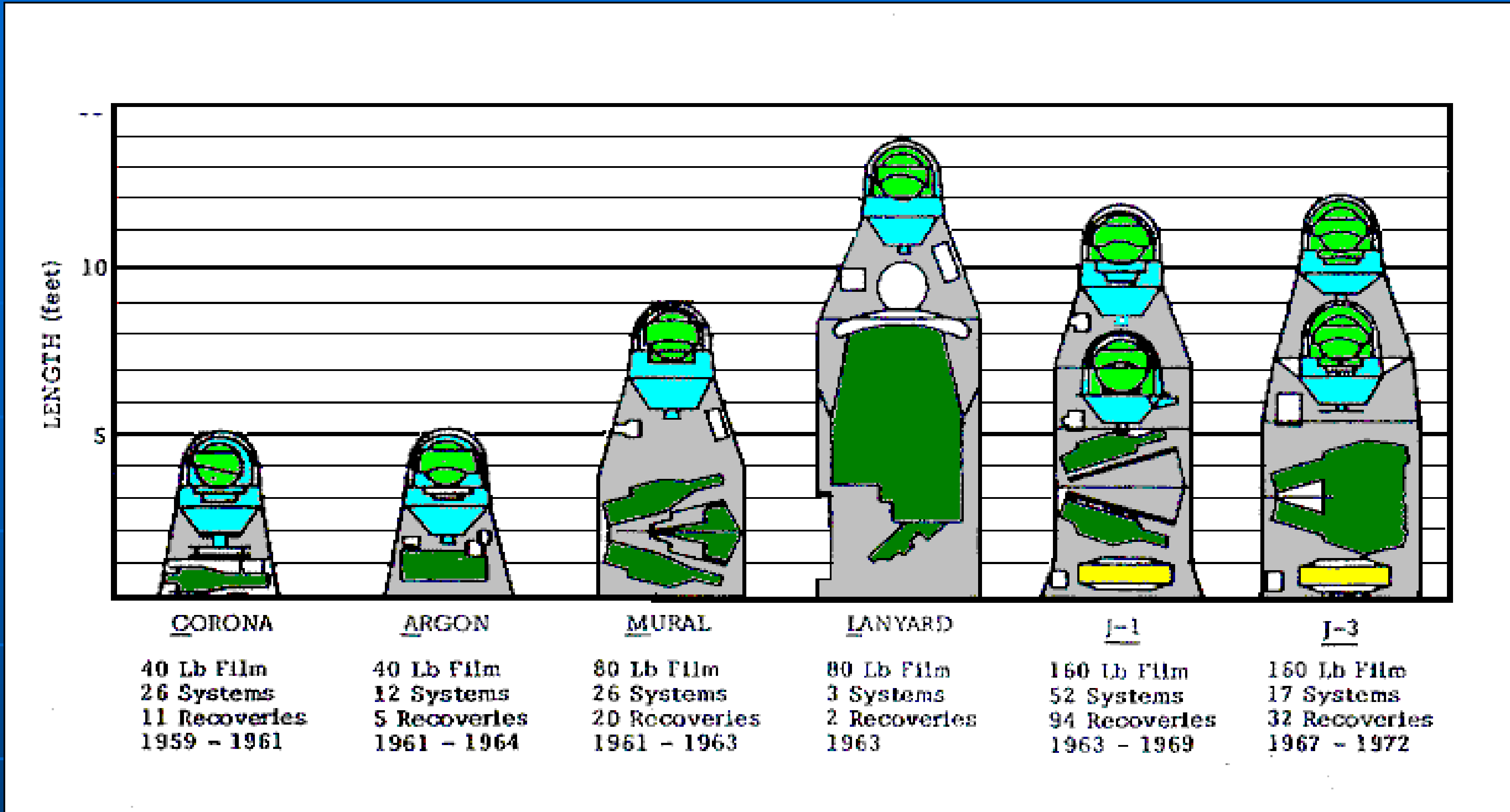


Between 1960-1972 the Corona Project collected 800,000 images, using KH-1 thru KH-4B cameras. Film had to dropped to Earth for processing.

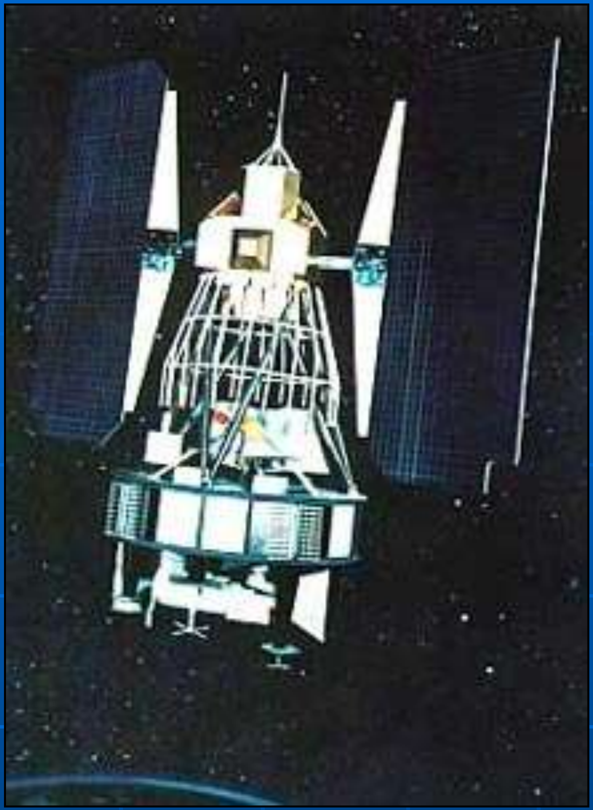


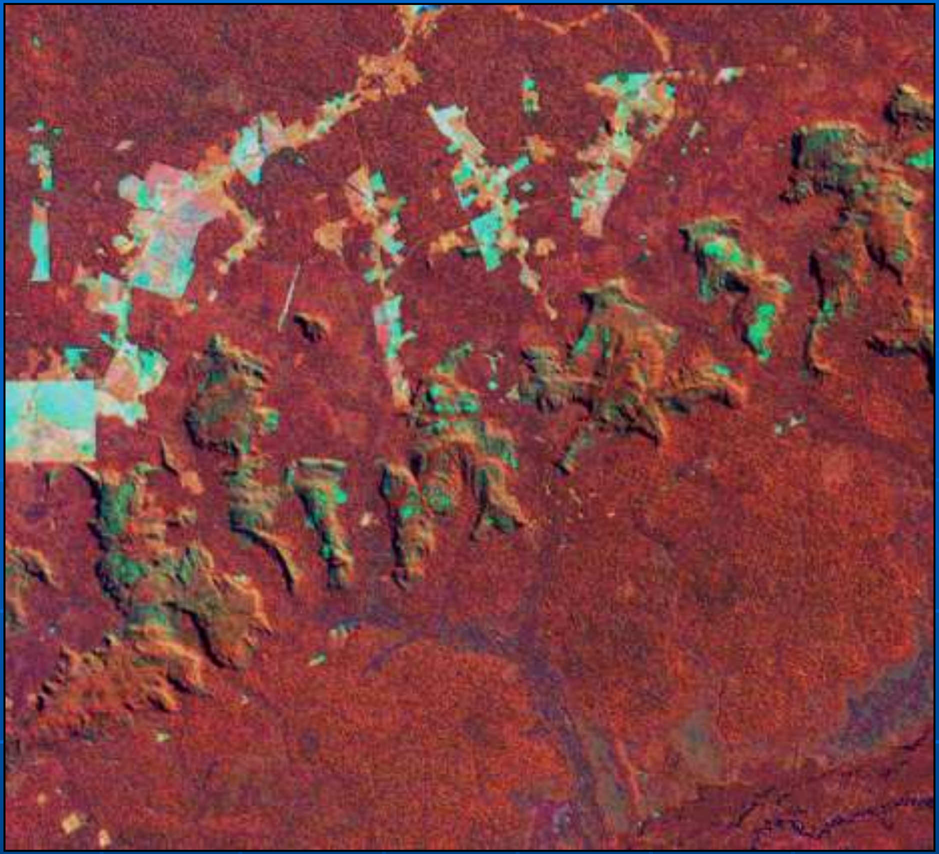
A sophisticated set of static and rotating cameras evolved during the Corona Project to maximize coverage of large areas using rolled film from an altitude of 80 nautical miles

- Corona image of Tell Hamoukar in Syria. Note old channels and tracks across landscape, not visible on the ground
- Photo resolution is around 1 m

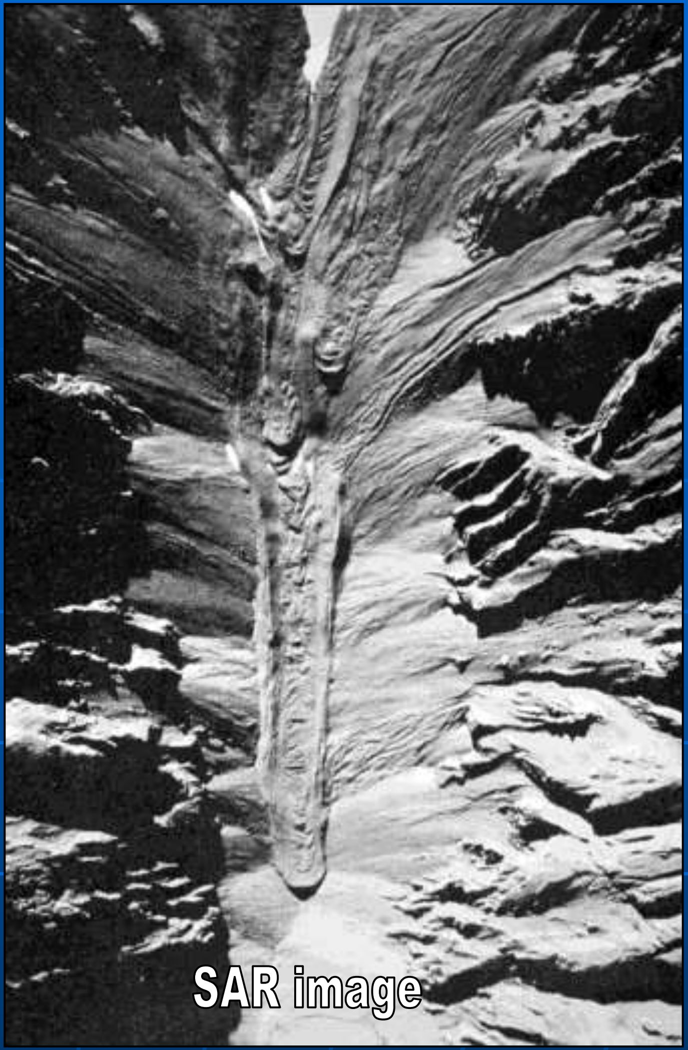


- **Spaced based cameras continued to evolve throughout the 1960s and early 1970s, when digital and multispectral collection began**



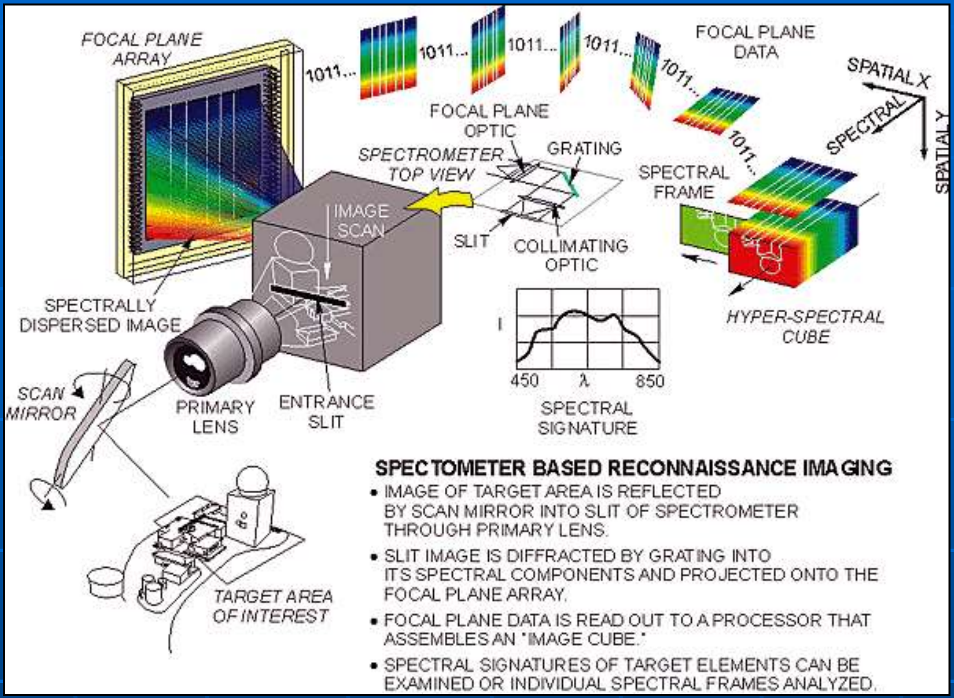


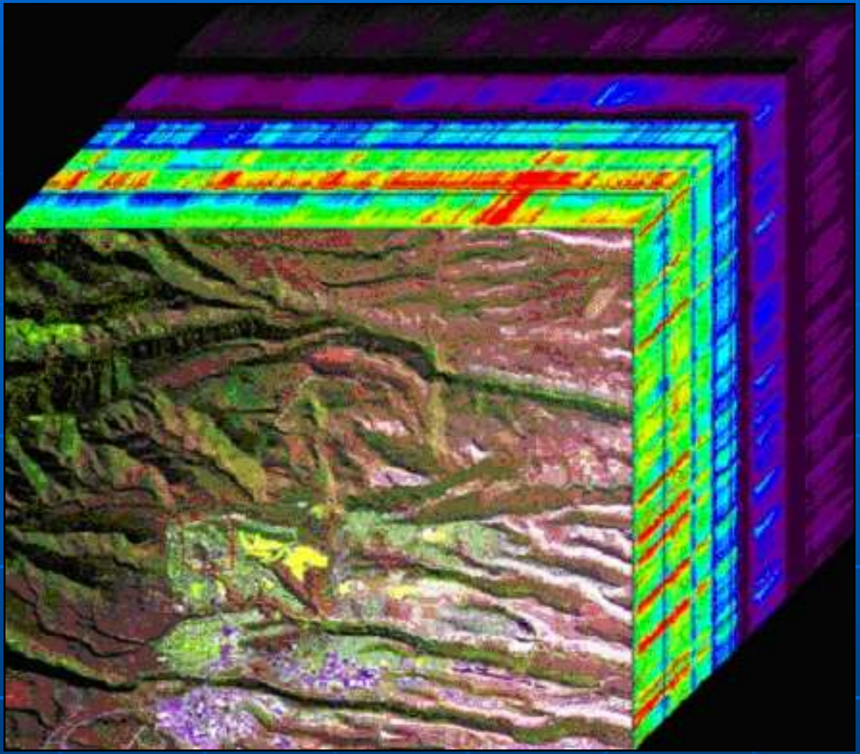
- Landsat 1 or Earth Resource Technology Satellite (ERTS) was launched in mid-1972; with new launches every 3 years.
- Carried 3 cameras, a near IR scanner and a 4 channel MSS at altitude of about 570 miles
- Digital images measured 111 x 102 miles, but with resolution of only about 100 ft



After 1989 reconnaissance satellites shifted to Synthetic Aperture Radar, IR and thermal IR, operating between 150 to 600 miles altitude. These systems are capable of sensing through clouds and brush cover.

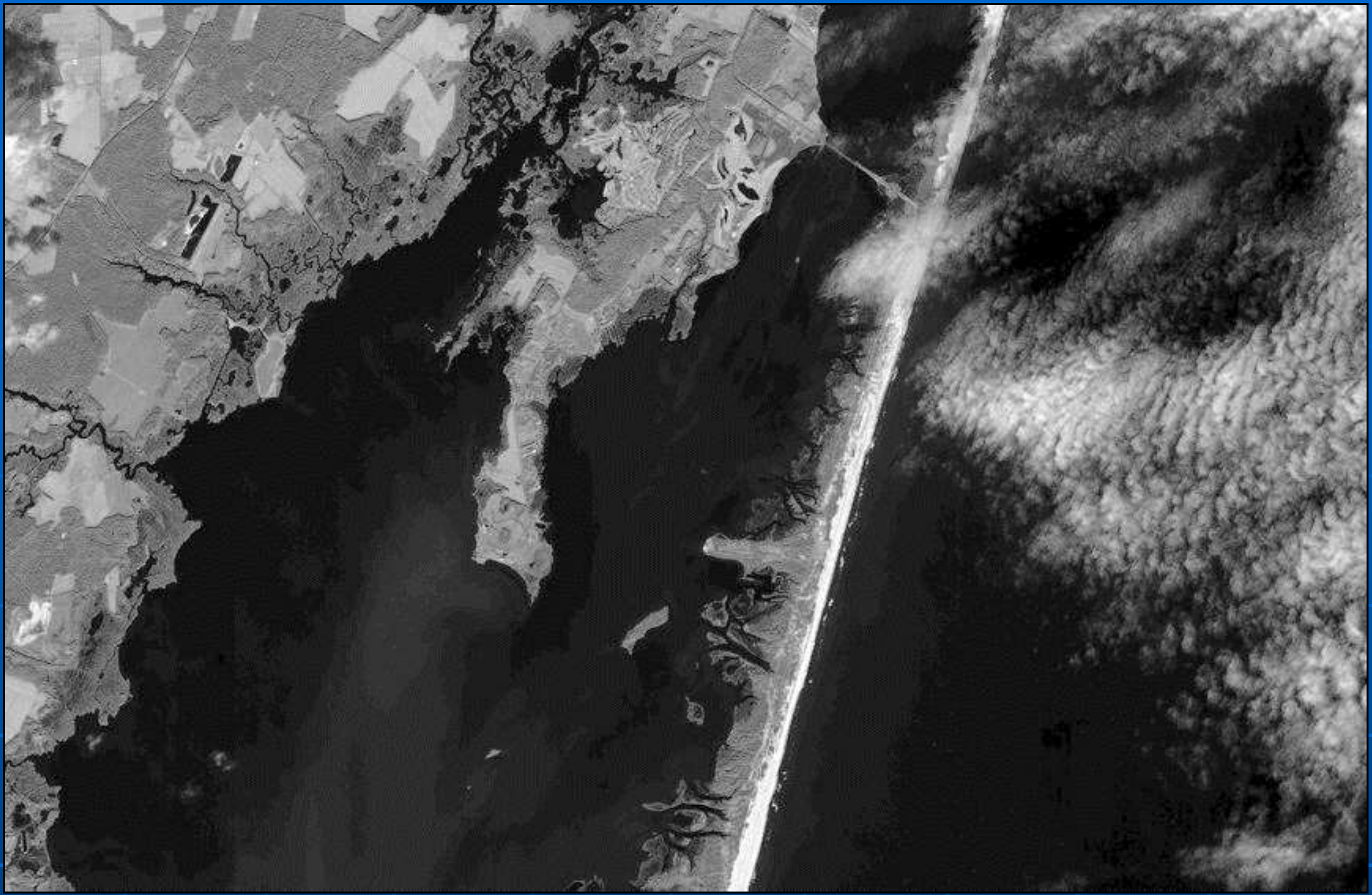
Transition to Hyperspectral Data



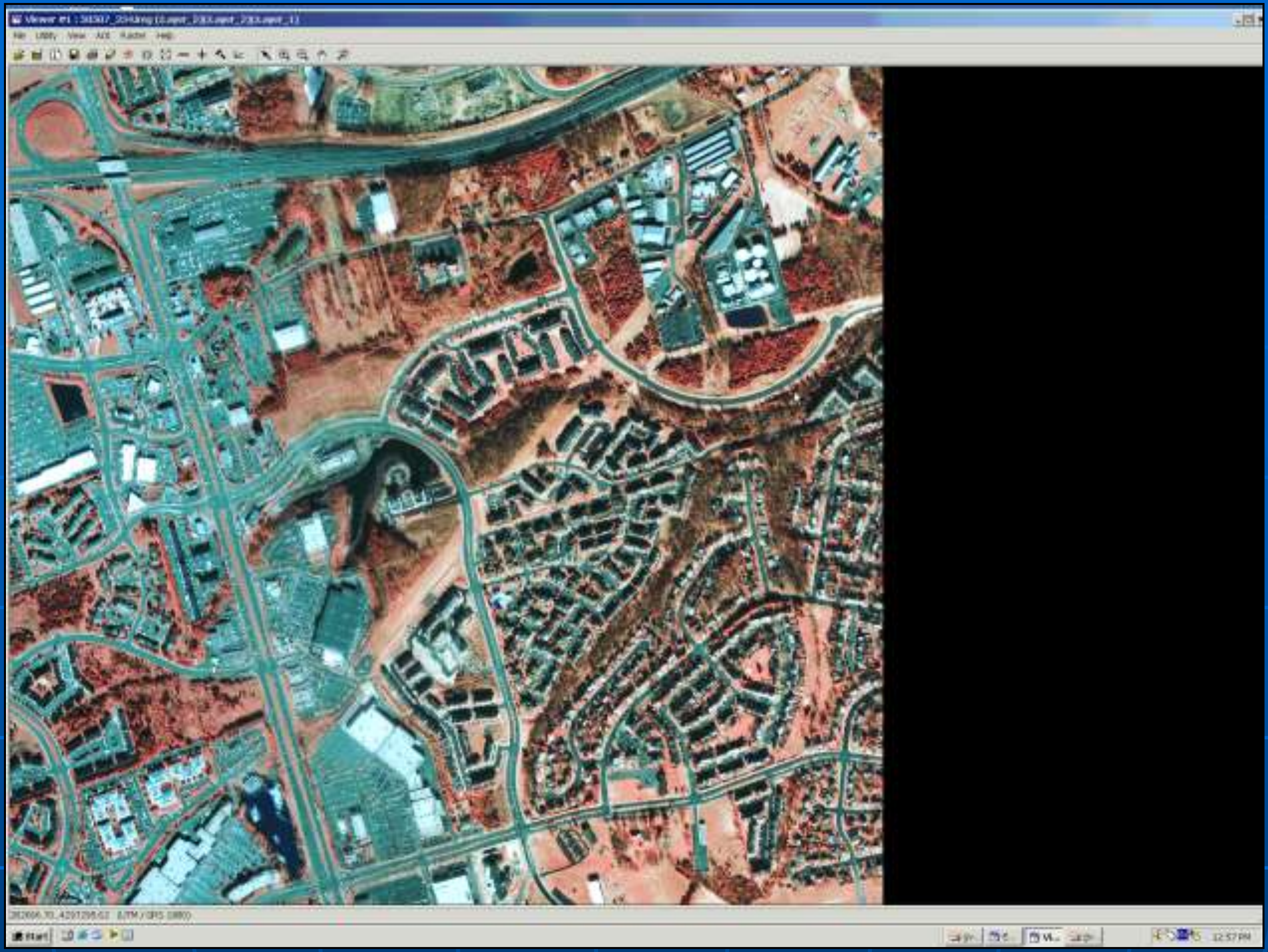


Multispectral scanners (MSS) have been increasing deployed on airborne and spaced-based sensing platforms. These allow large files of information to be collected across the electromagnetic spectrum; and will eventually change the way we look at the Earth (e.g. motor tracks across water)

- **Mosul, Iraq as imaged by US reconnaissance satellite using Thematic Mapper Multispectral Scanners. Intelligence platforms are capable of resolutions < 6 inches for high interest areas**



- In 1999 Space Imaging EOSAT launched Ikonos, offering commercial imagery with 1 m panchromatic and 4 m multispectral images, world wide.



- **Ikonos imagery collects MSS data at rate of 2,000 sq km per minute, making fifteen 98-minute orbits each day. They offer digital imagery with RMSE of < 0.9 m for detailed urban analysis.**

- Modern digital imagery is orthorectified
- This allows manipulation in GIS, integrating countless layers of information

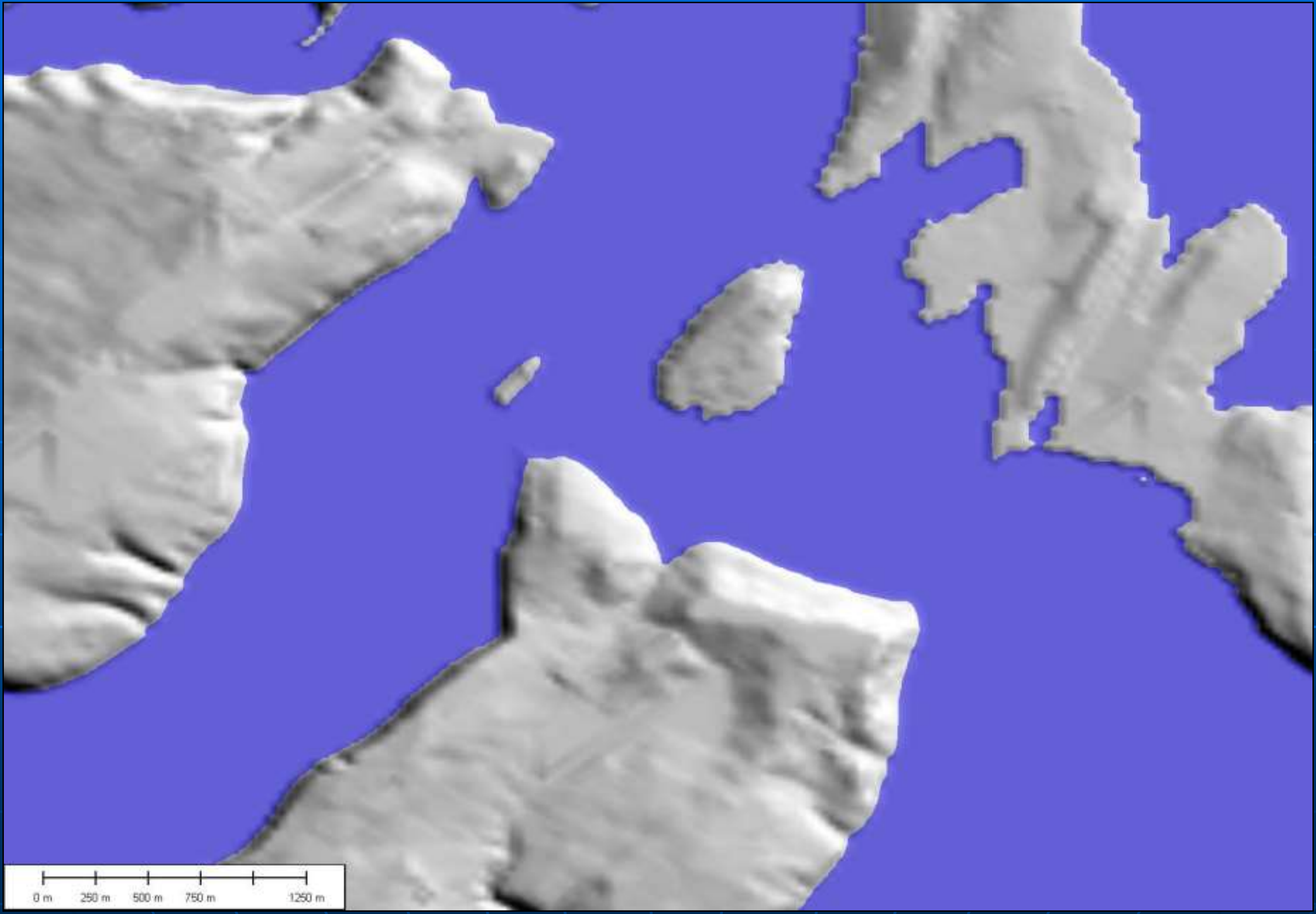
Orthorectified digital images can be overlain to make meaningful comparisons, as shown here

This shows the Pentagon while under construction in 1940 (at right) and after completion in 1943 (at left)

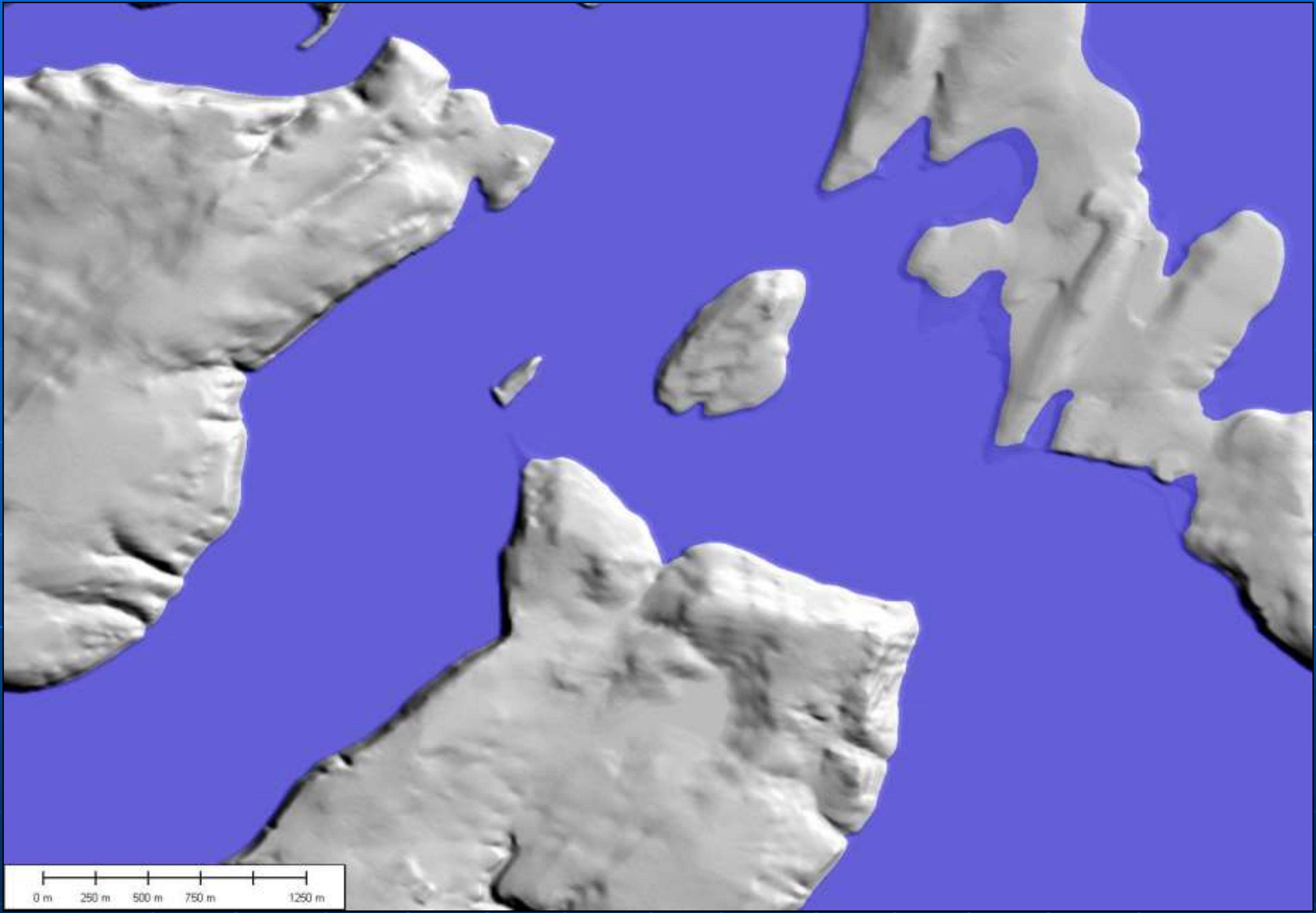
Note details of support and frame layout

Topographic Surface Imaging Using Light Detection and Ranging (LiDAR)

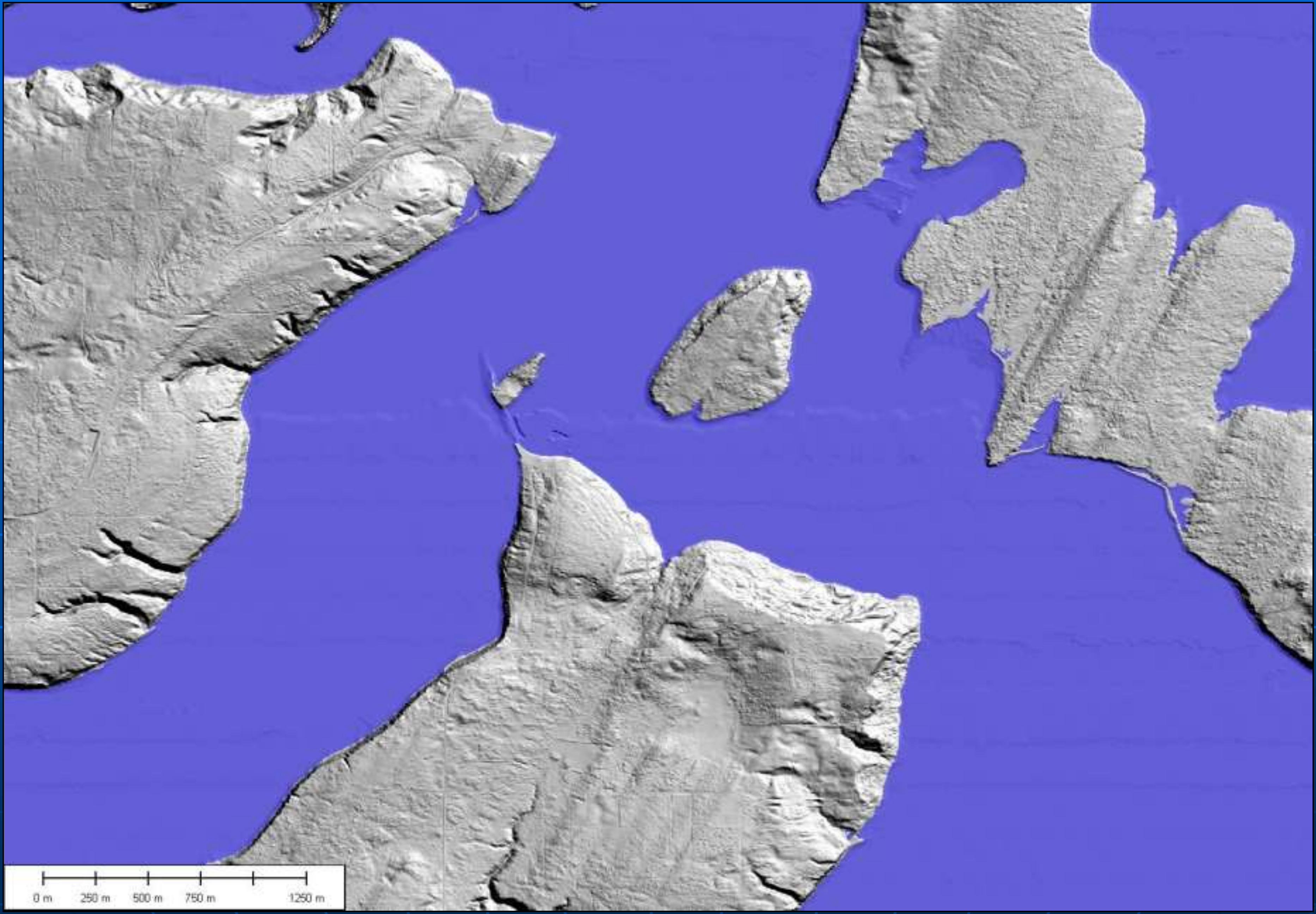
2m LiDAR DEMs
Squaxin Island
Thurston County, Washington



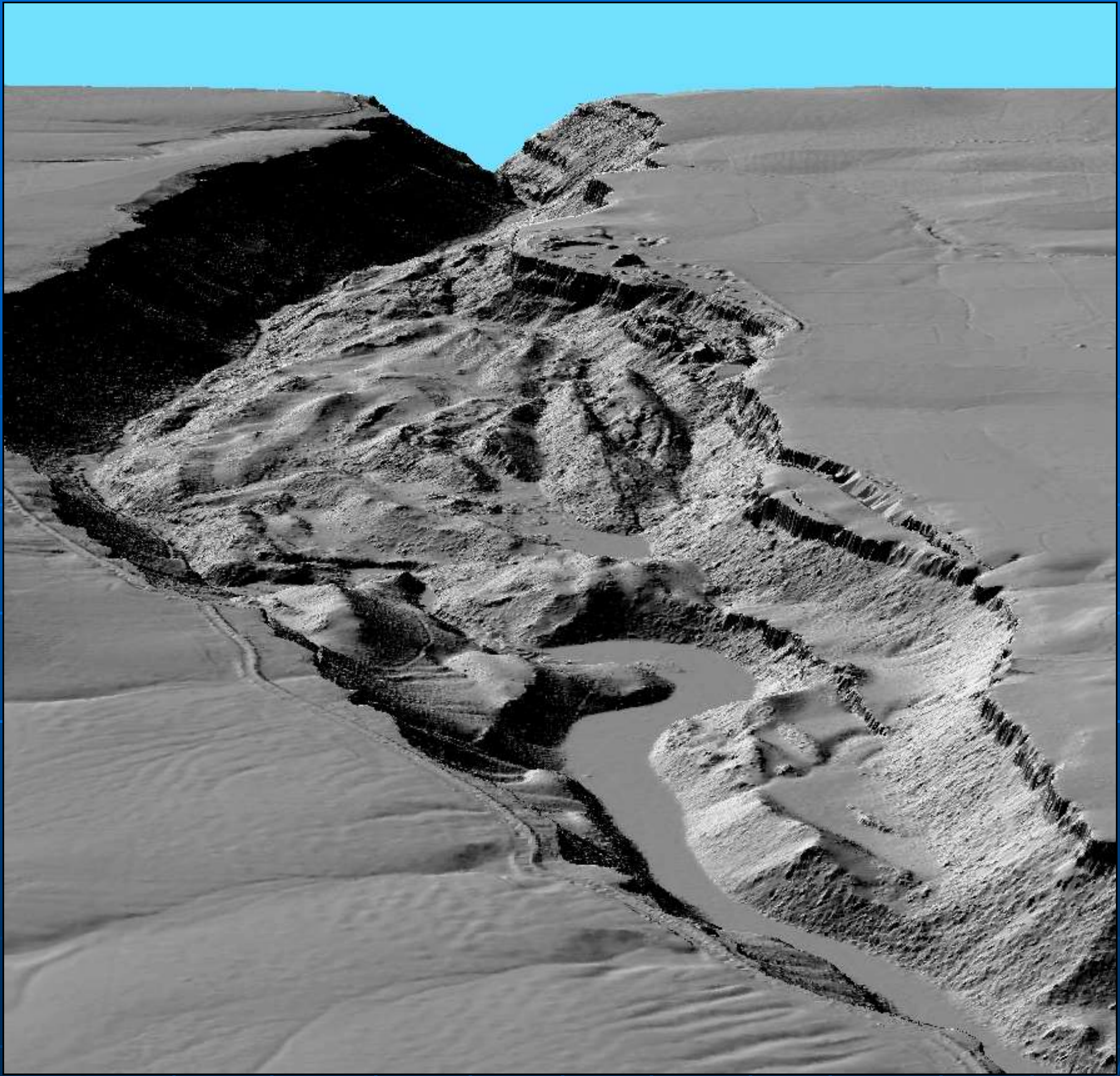
USGS 30m DEM



USGS 10m DEM

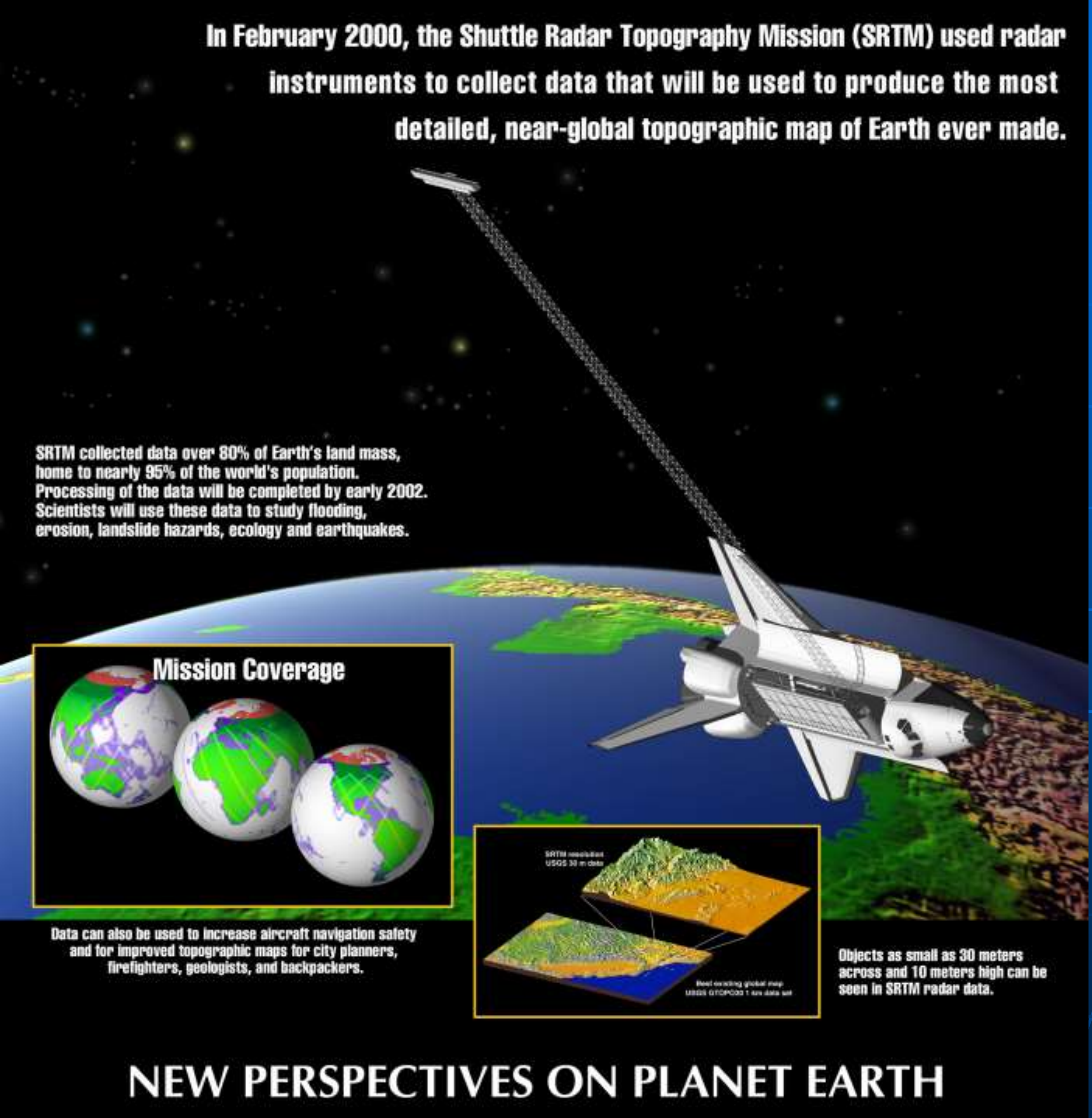


LiDAR 2m DEM



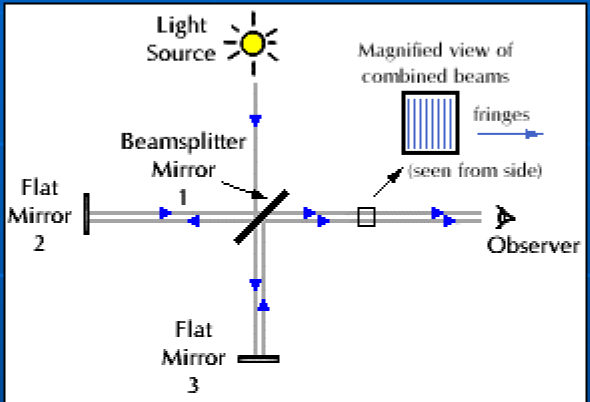
1 m LiDAR posting image of the Salmon Falls Landslide southwest of Twin Falls, ID.

The image is comprised of 13 million data points, which allowed a vertical resolution of 15 cm over a slide area of 0.2 square kilometers.

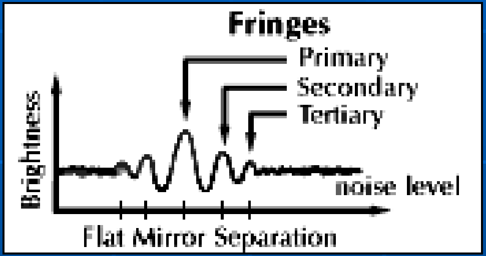


In February 2000 NASA launched Space Shuttle Mission STS-99, the Shuttle Radar Topography Mission (SRTM), which mapped the Earth using interferometric synthetic aperture radar (INSAR)

Interferrometric Synthetic Aperture Radar (INSAR)



Michelson Interferometer



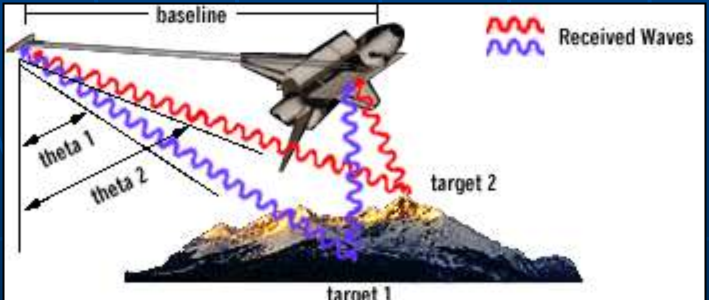
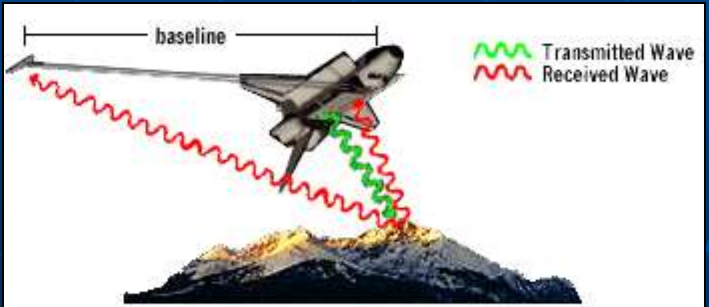
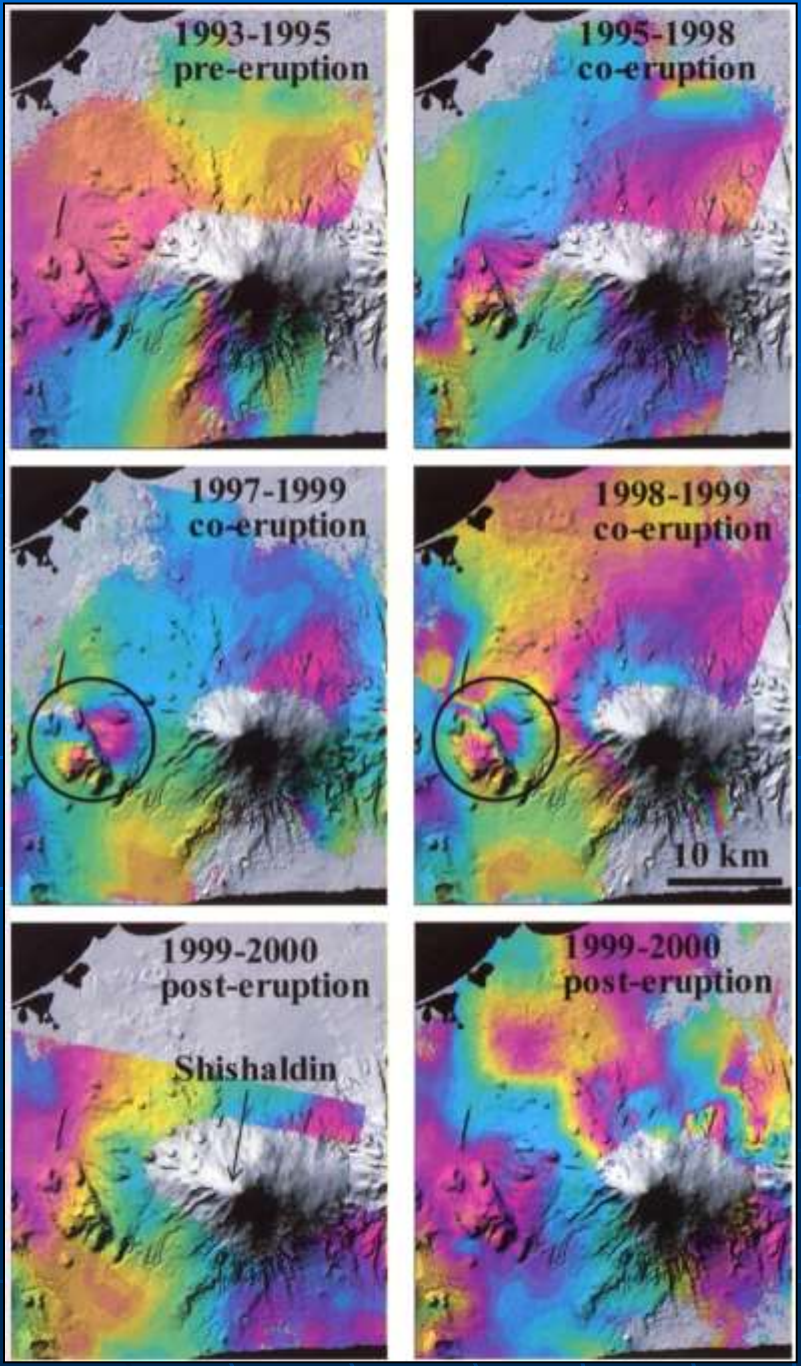


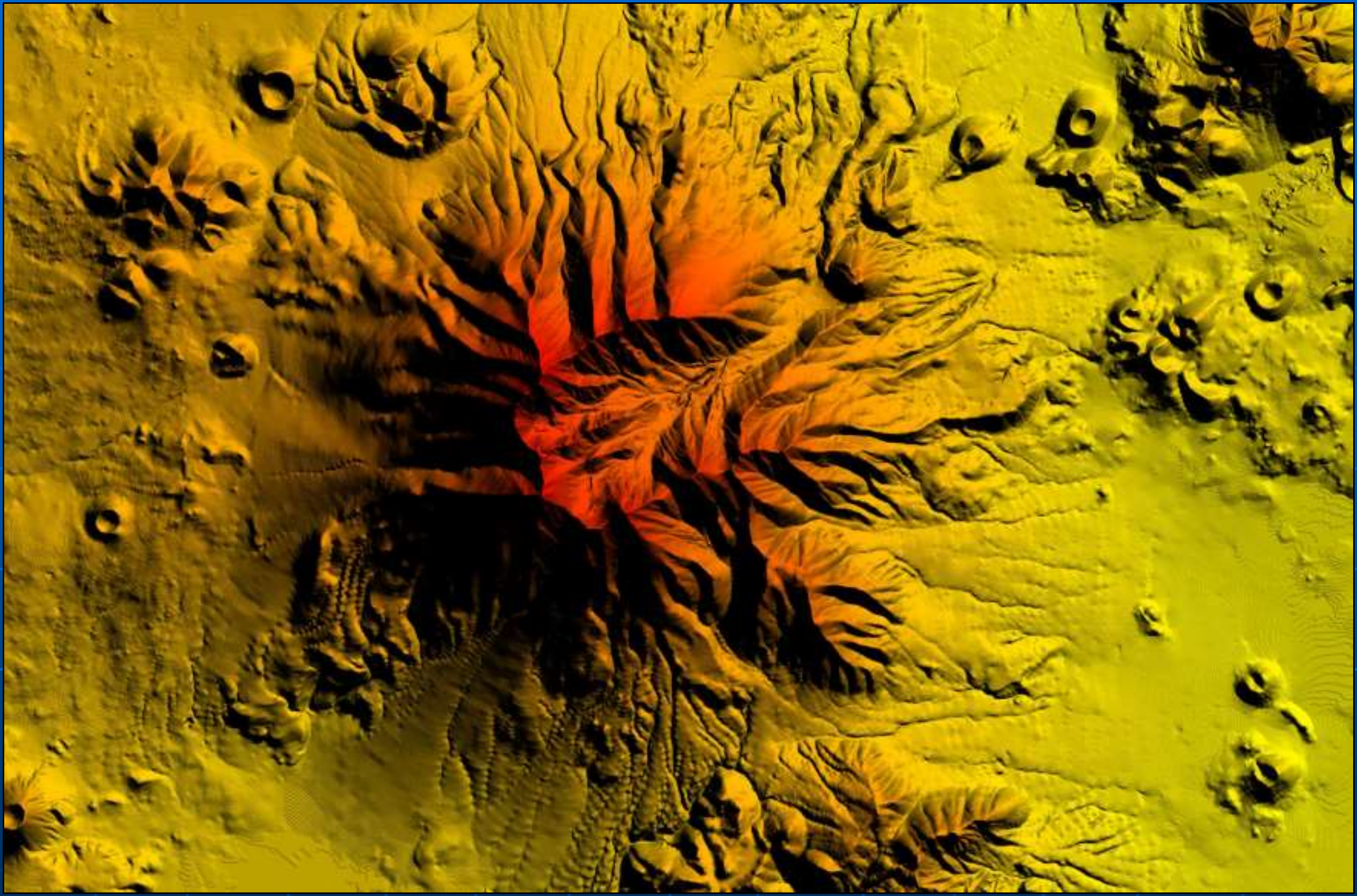
Figure 4: Differential Distance Gives Topography



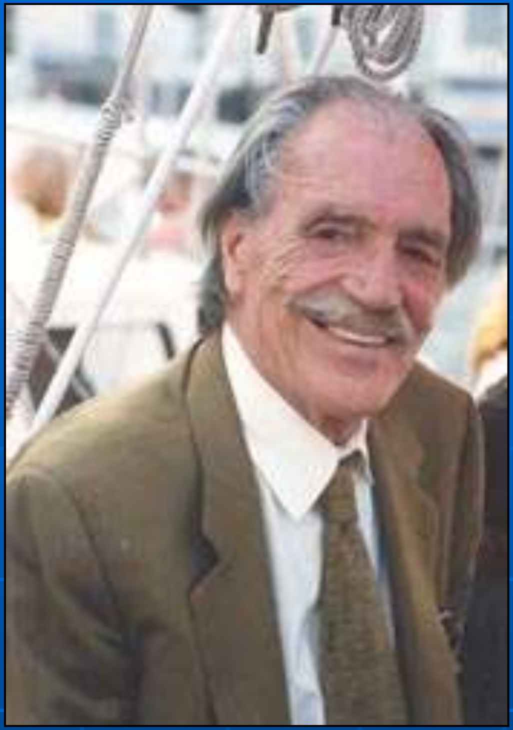
Radar signals being transmitted and recieved in the SRTM mission (image not to scale).

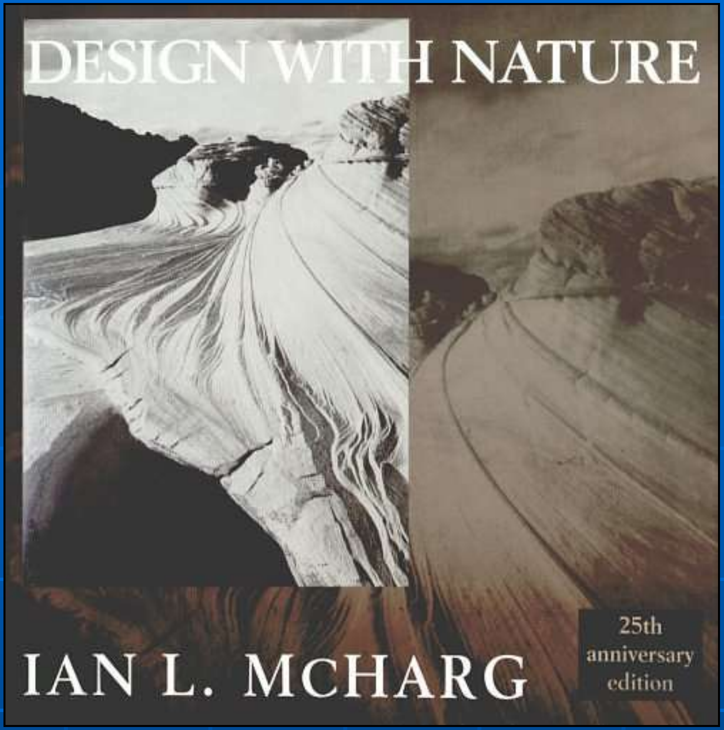


- Repeated INSAR passes allow slight variations in elevation and spatial distribution to be monitored with amazing accuracy
- Topo-removed interferograms draped over shaded DEMs of Shishaldin volcano from 1993 to 2000
- Circles indicate areas of marked elevation change



INSAR image of the San Francisco Peak volcanic field near Flagstaff, AZ

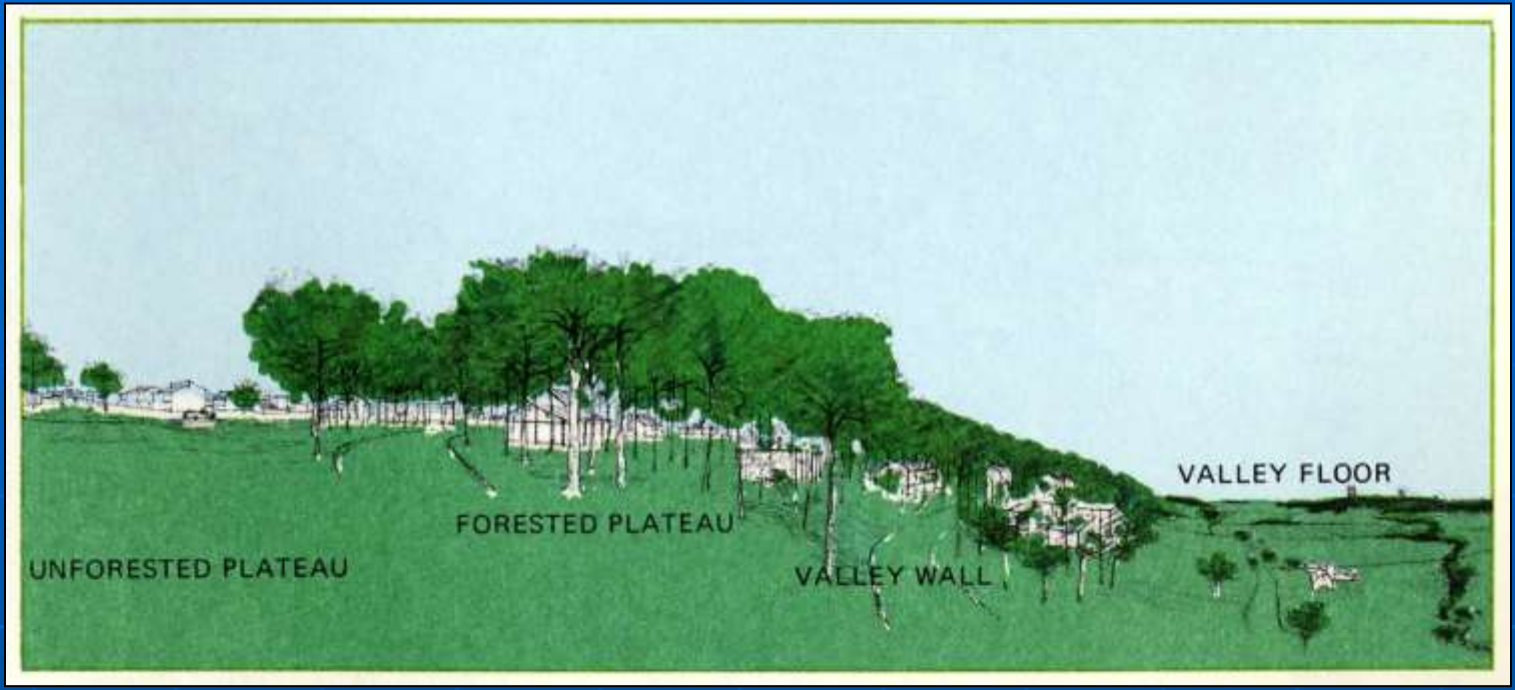




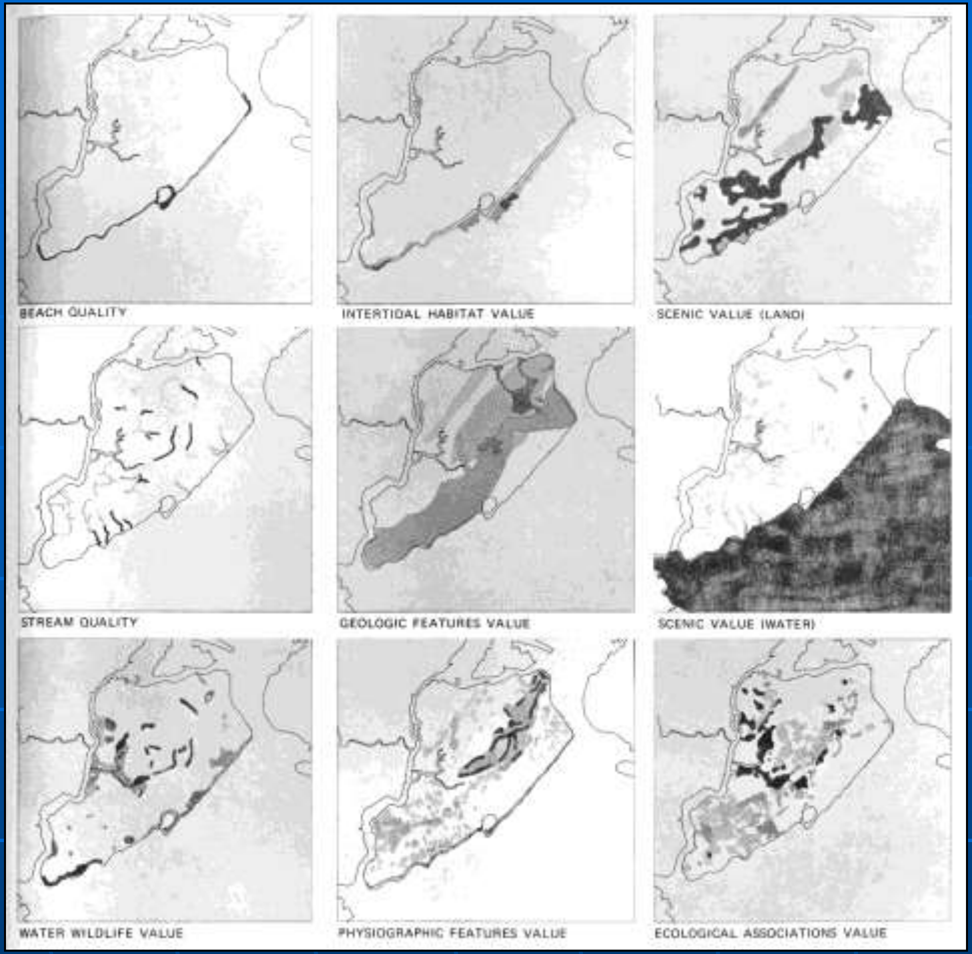
- **Ian McHarg (1920-2001) is credited with being the father of map overlays, which had a big impact on Geographical Information Systems**
- **He was a Professor of Landscape Architecture and Regional Planning at the University of Pennsylvania from 1954-2001**

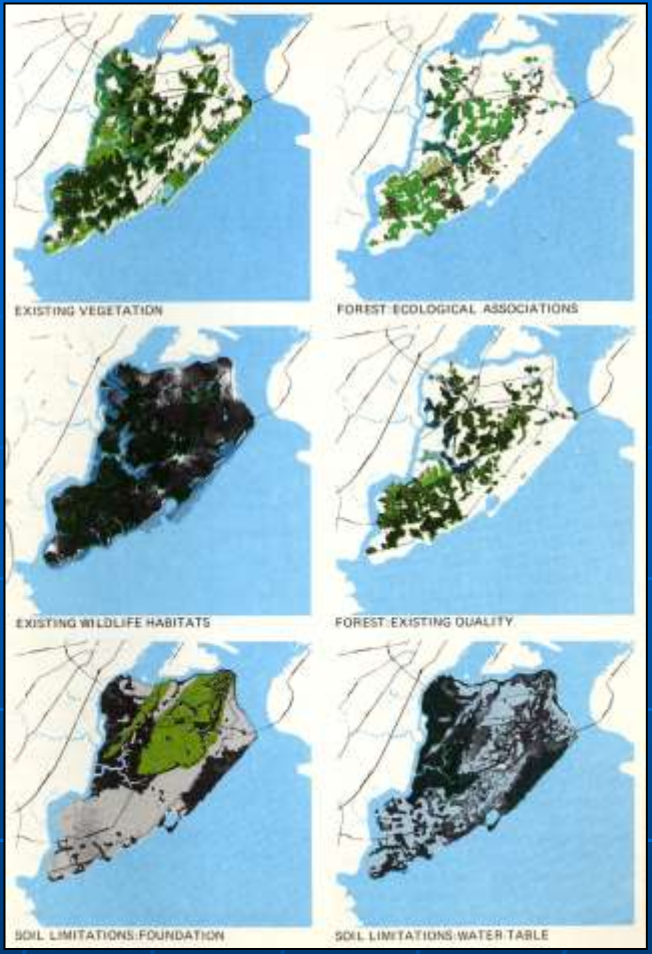
Some quotes from the "Father of GIS…"

- **Ian McHarg described engineers as those individuals "*who, by instinct and training, were especially suited to gouge and scar landscape and city without remorse*"**
- **McHarg argued that "*form must not follow function, but must also respect the natural environment in which it is placed.*"**

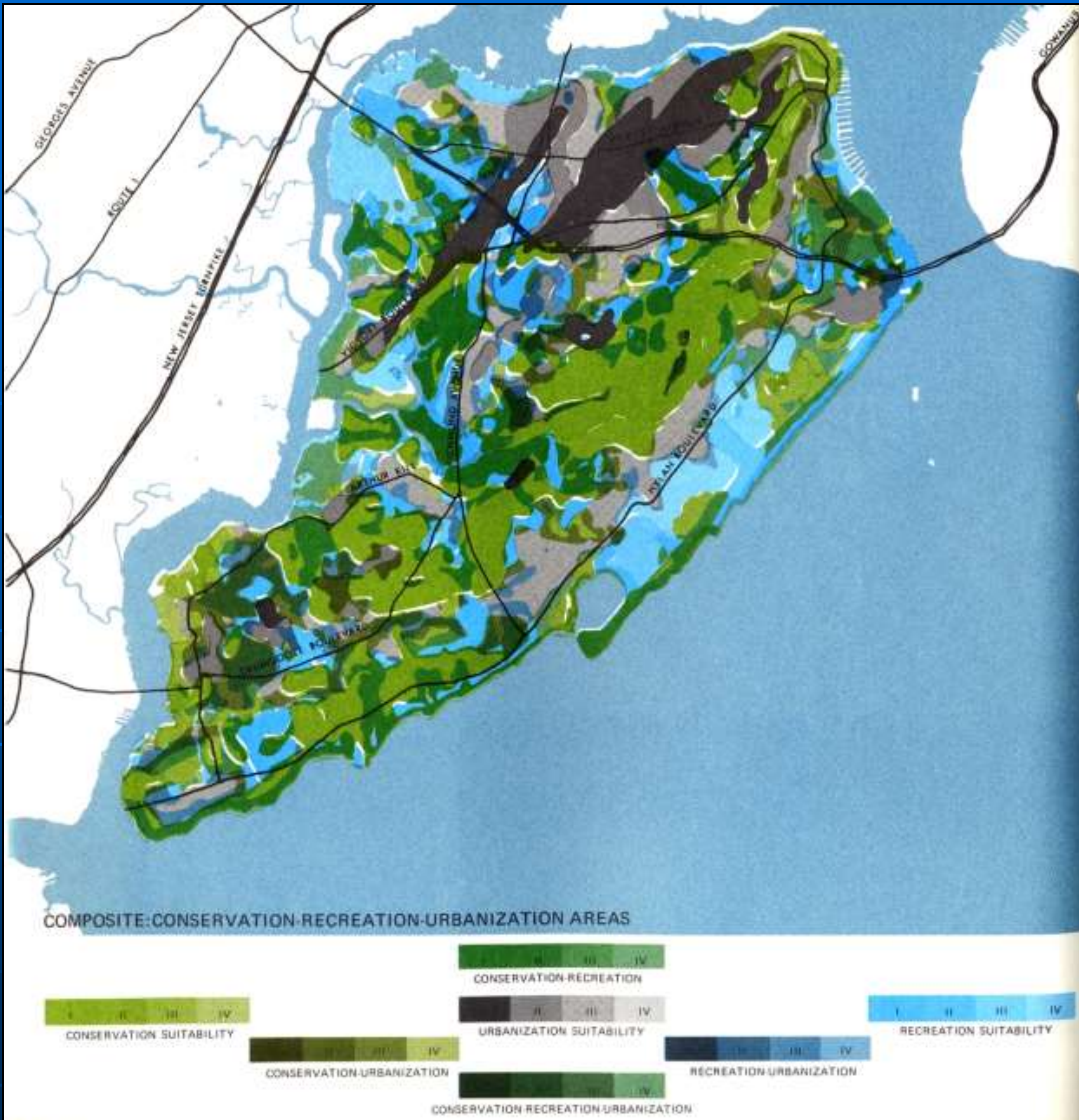


McHarg took landscape architecture concepts and applied them to maps, initially as overlays; later as hybrid maps



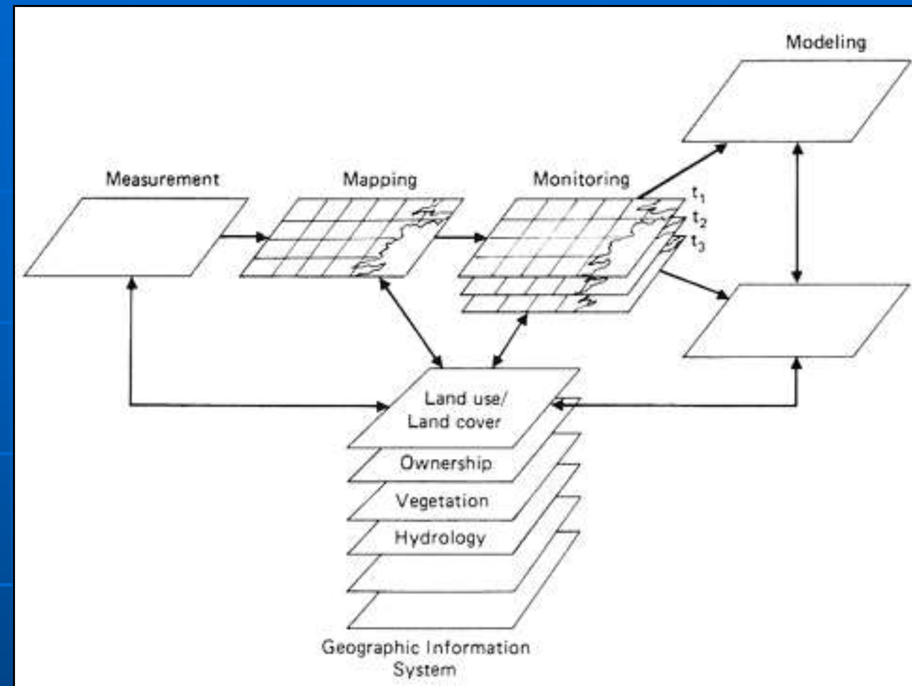


- **McHarg's map overlay method was first used in a consulting project for a 5-mile stretch of the controversial Richmond Parkway on Staten Island in 1968**



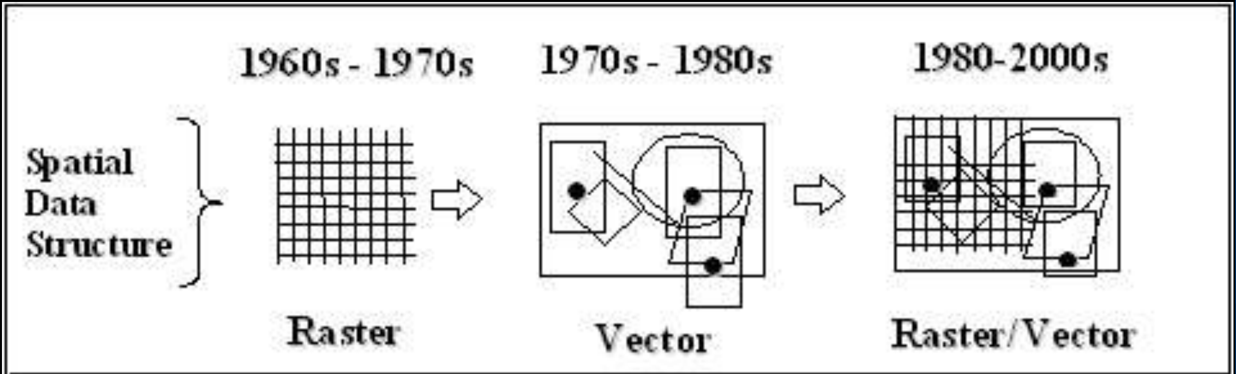
- **McHarg's hybrid map included ecological, political and aesthetic rankings to be combined with physical attributes**

McHarg's Map Layering Concept



McHarg's four M"s: Measurement, Mapping, Monitoring and Modeling. GIS allows a limitless combination of mapable attributes to be arbitrarily weighted and electronically combined to create hybrid "maps"; which are simply spatial representations using the Earth's surface as their datum

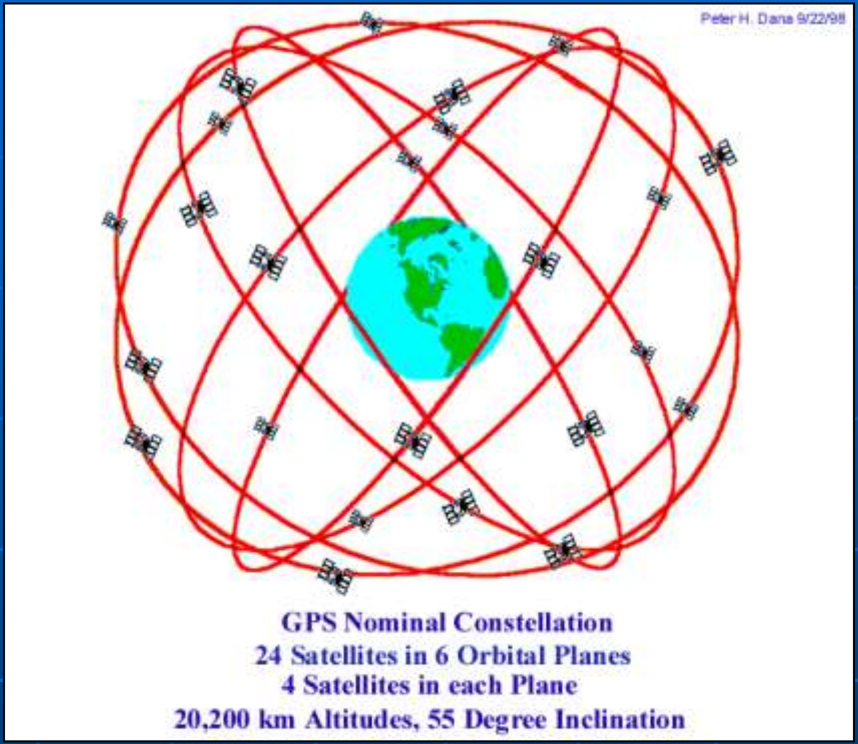
SPATIAL DATA MODELS

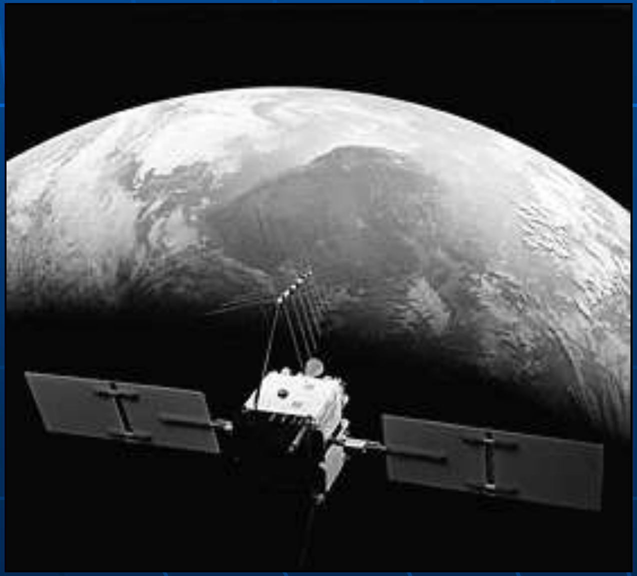


Computer	*Mainframe*	*PC - XT*	*Pentium 4*
Cost:	High	High	Low
Memory:	Low	Medium	High
Processing	Low	High	High

- **GIS has evolved with computing technology. Today, raster and vector data can be combined with increasingly sophisticated digital imagery, manipulating large data files**

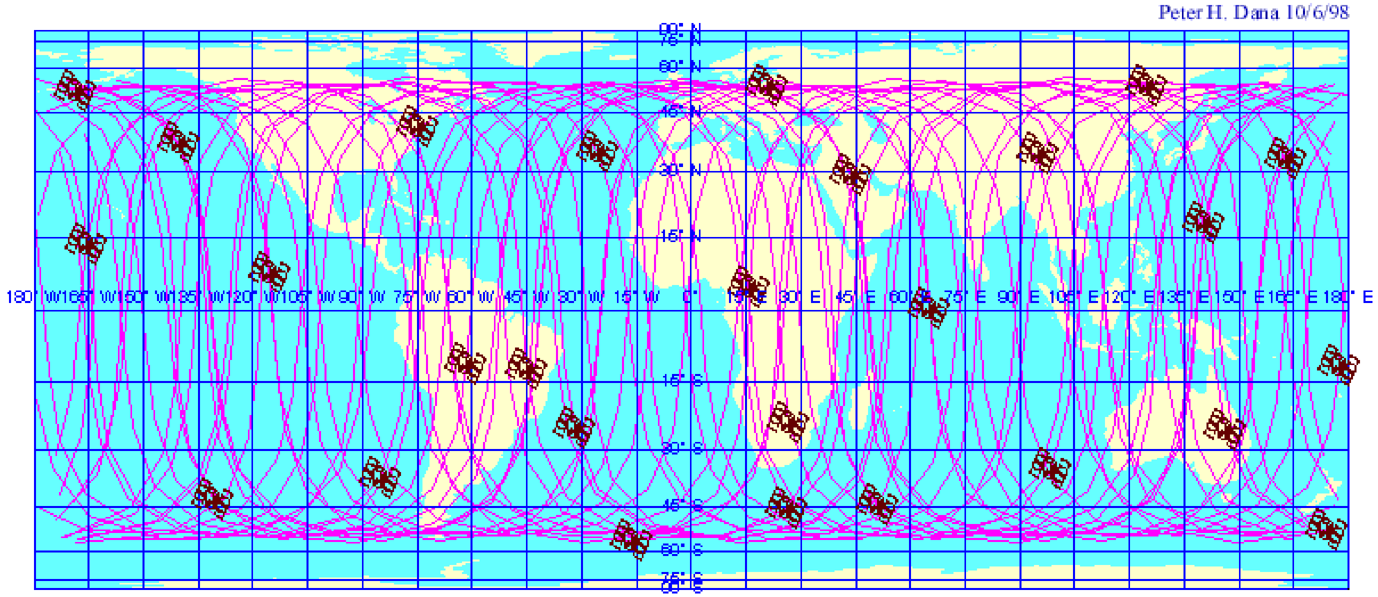
GLOBAL POSITIONING SYSTEM





Navstar launched in 1982; requires a minimum of 18 operable satellites, 6 in 3 orbital planes spaced 120 degrees apart at 12, 660 miles

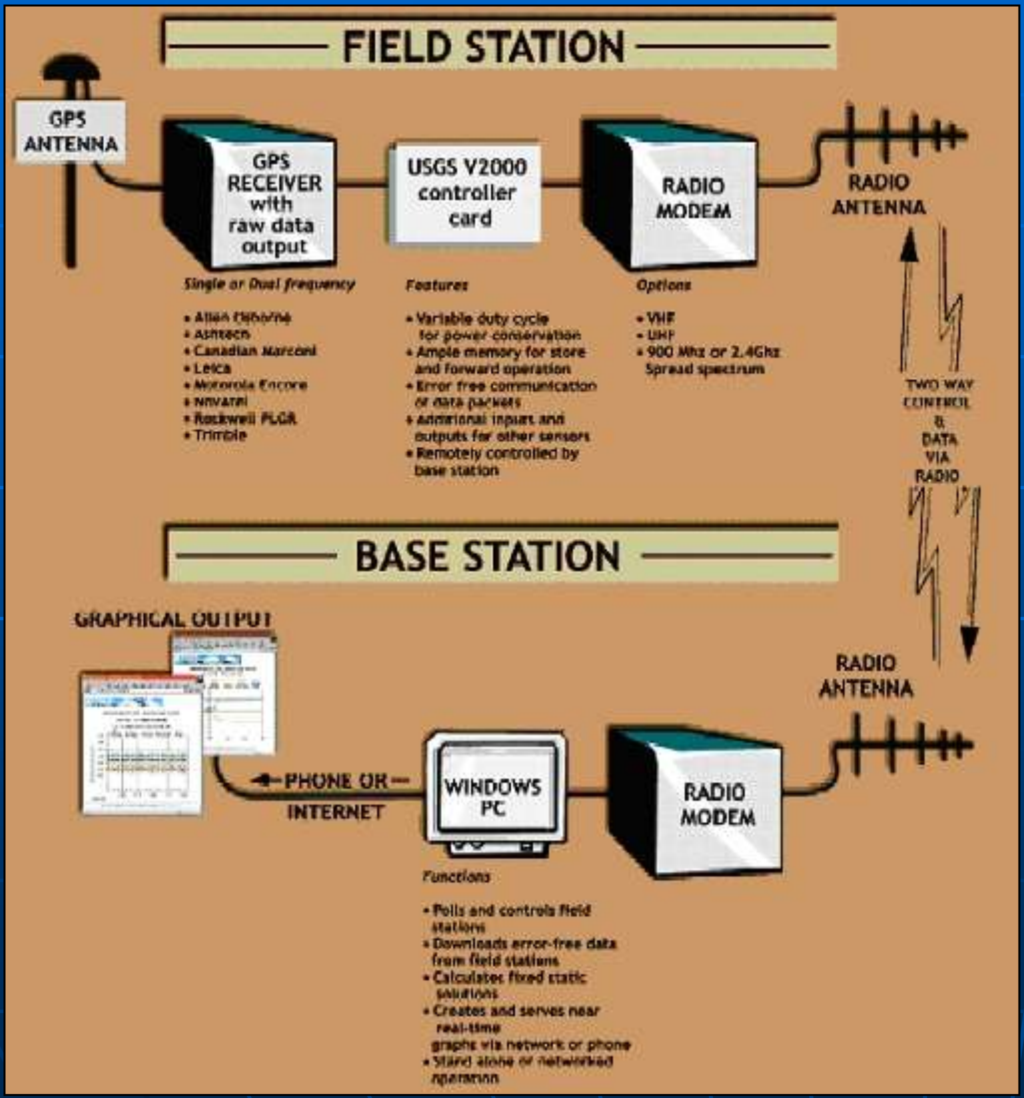
Contact with 5 to 8 satellites required to provide fix



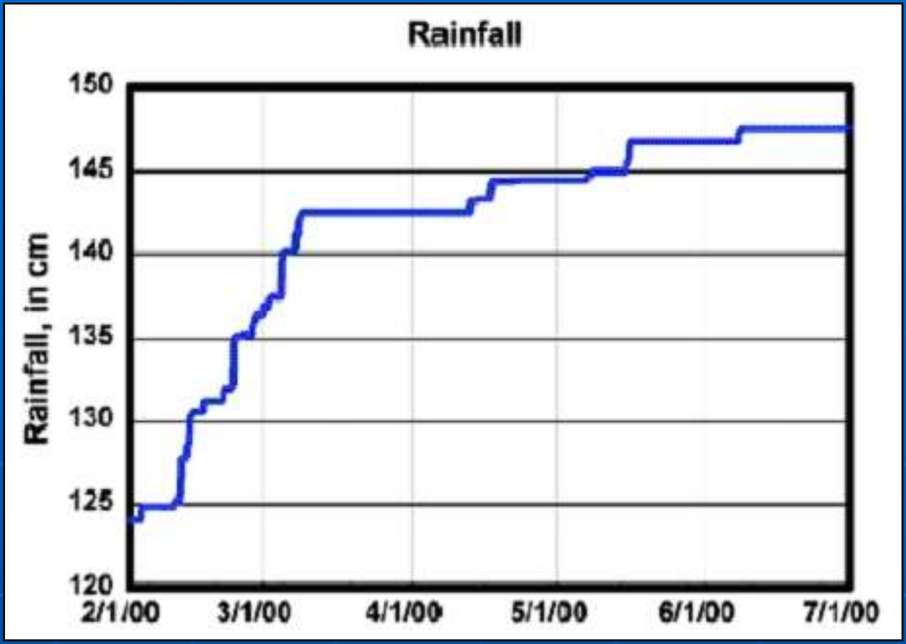
Global Positioning System Satellites and Orbits
for 27 Operational Satellites on September 29, 1998
Satellite Positions at 00:00:00 9/29/98 with 24 hours (2 orbits) of Ground Tracks to 00:00:00 9/30/98

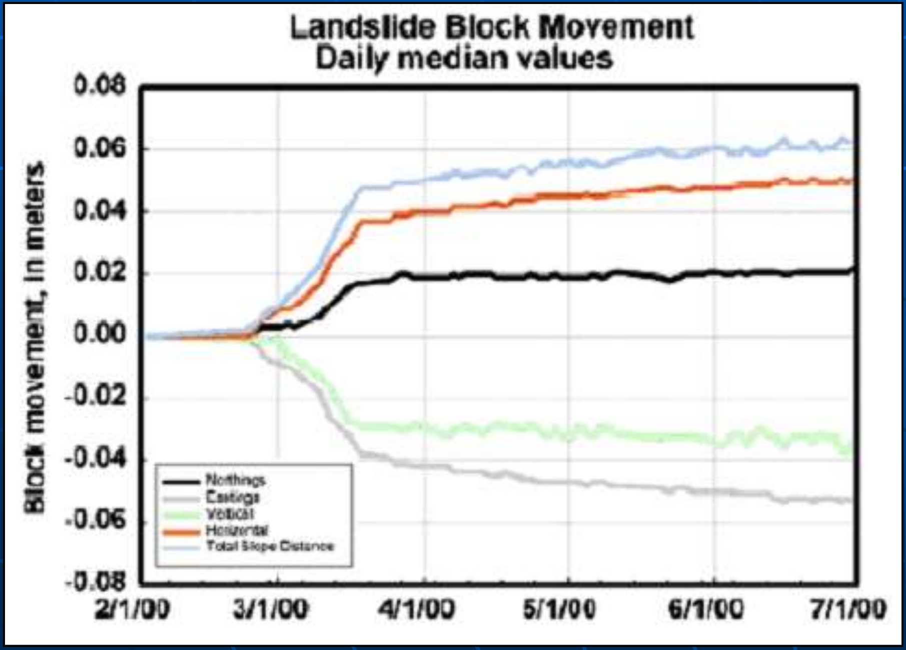
- **By March 1994 all 24 satellites were orbiting Earth.**
- **In May 2000 NOAA turned off selective availability, allowing public to receive GPS fixes within < 10 m under good conditions**
- **Worldwide, GPS industry nets $16 billion annually**
- **GPS allows inexpensive location fixing using hand-held receivers and palm pilots, with electronic data transfer**

REAL TIME MONITORING OF SLOPE MOVEMENTS USING GPS

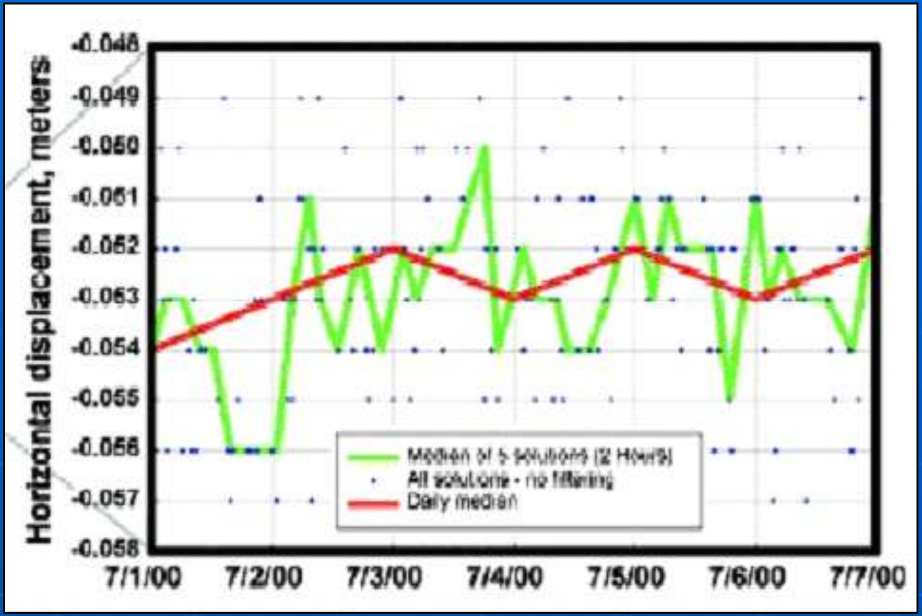


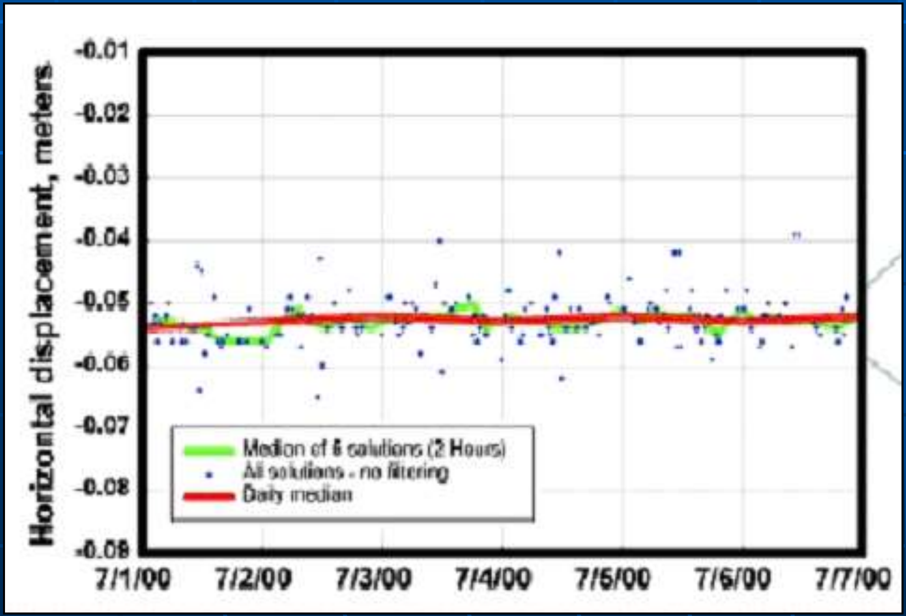
- **Field Station had baseline length of 70 m**
- **GPS readings stored, forwarded and processed for 20 minute segments of 10 second intervals, updated every 30 minutes**





- **Upper figure shows rainfall for interval Feb 1 to July 1 2000 shown in blue (top)**
- **Lower figure presents recorded median values for horizontal and vertical motion of incipient landslide block during the same interim**





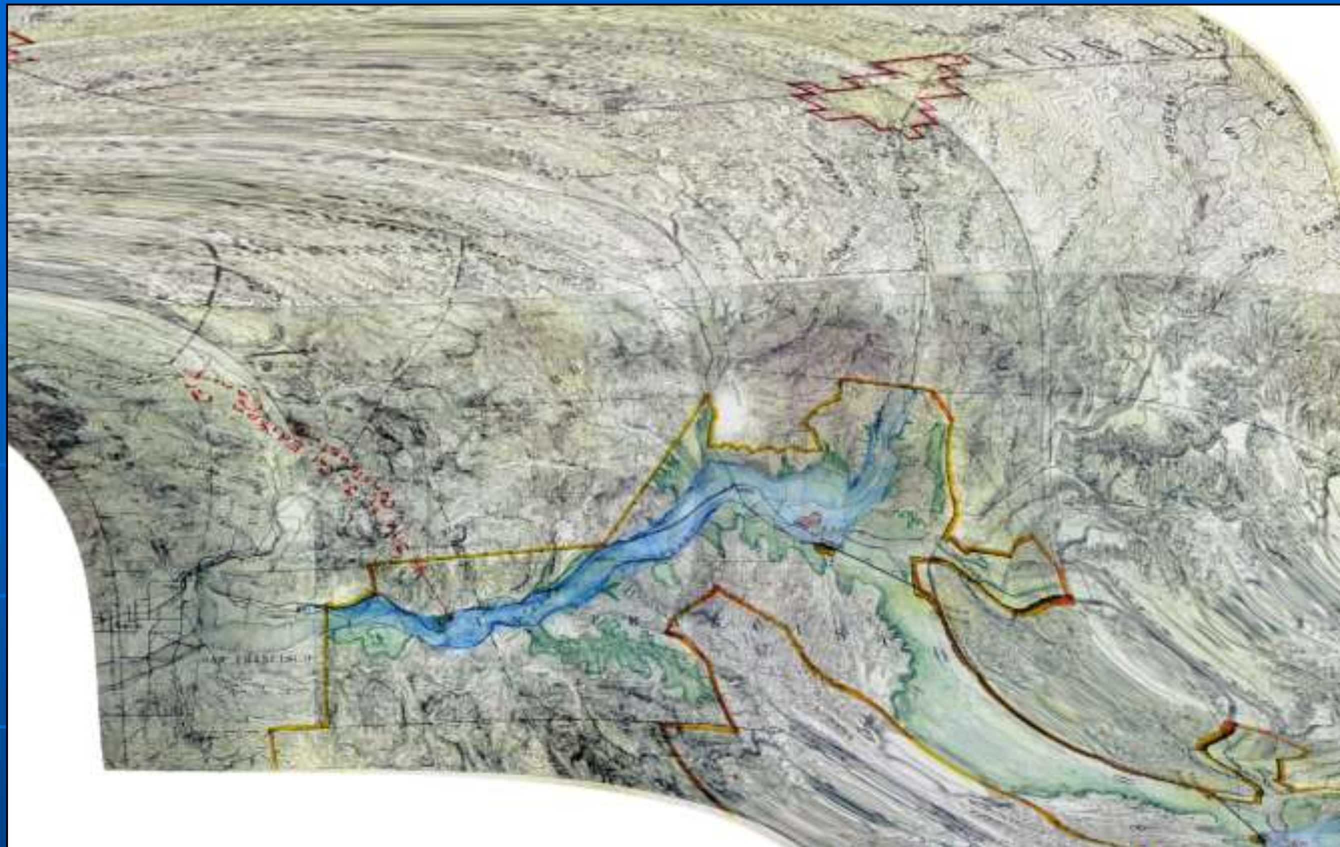
- Upper figure presents detail of GPS measurement noise, with median values traced in green. Red line records daily median
- Lower figure shows daily median horizontal motion in red. Noise is typical aspect of system

COMMON INPUT FOR GIS

- **Global Positioning System data becoming dominant location tool**
- **Base Maps: USGS Digital Raster Graphics, UTM, or State Plane Coordinate Systems**
- **Projection and Registration: Spatial data must be registered using georeference points; using projection conversion subroutines**

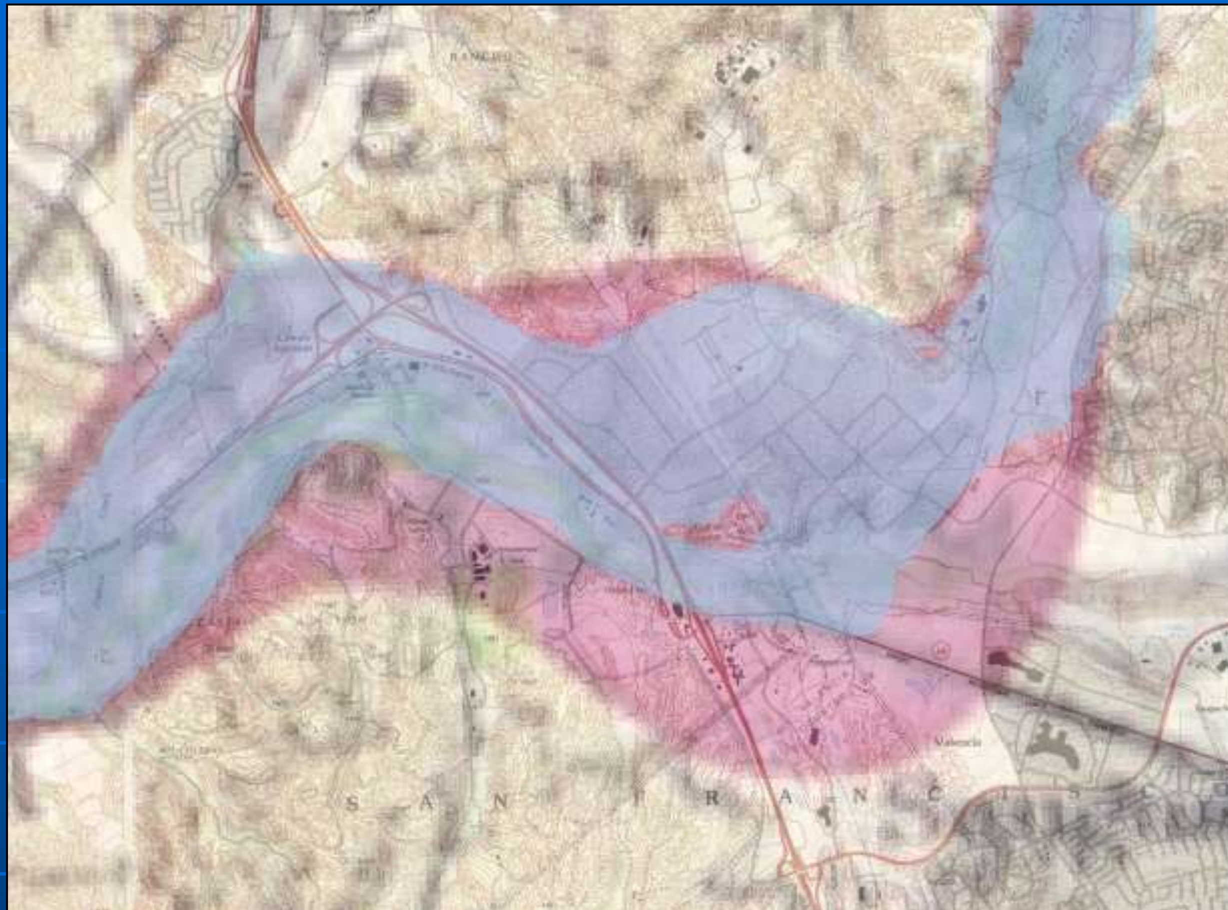
Projection and Registration

A common example of projection and georeferencing would be integrating older information prepared on maps that were not spatially configured for the Earth's curvature, such as that shown above right



- Excerpts from older maps can be orthorectified using cadastral features, such as section lines, boundaries, or longitude and latitude. This shows electronic "stretching" of 1928 map onto an existing DRG mosaic

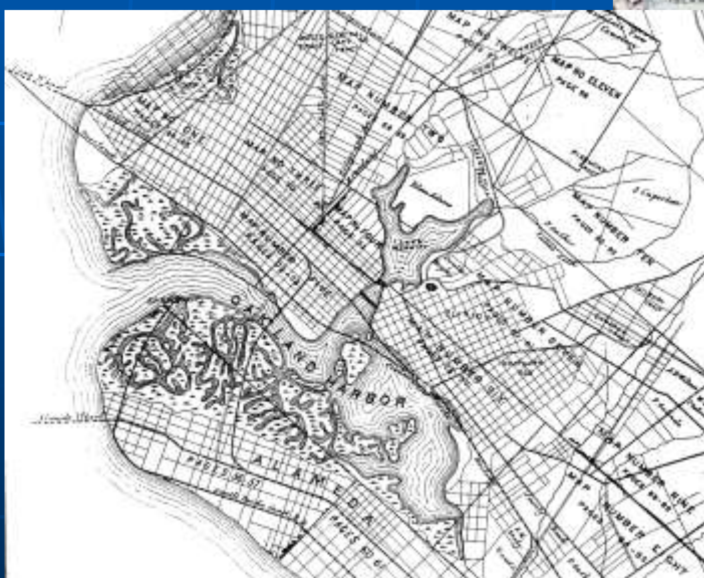
- **Orthorectified 1928 flood map, cropped and georeferenced. By applying UTM NAD 1983 geospatial controls, the planar map is skewed slightly when orthorectified to present-day map projection standards that account for the Earth’s curvature**

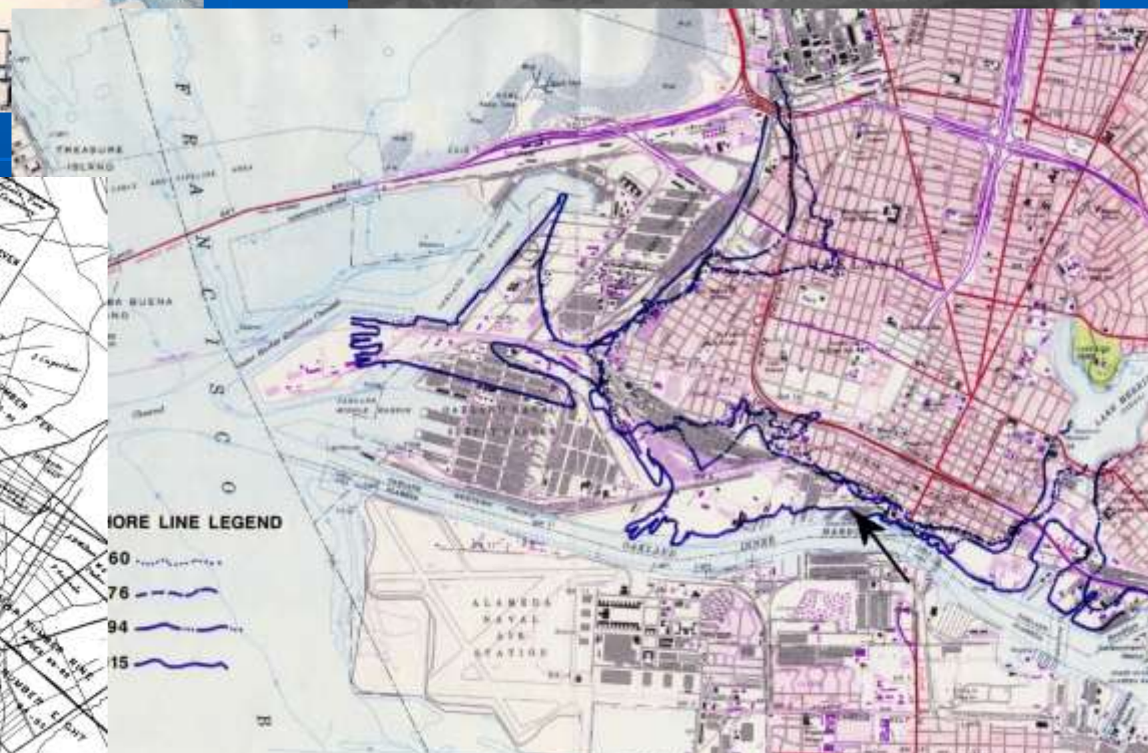


- **When detailed map (blue) was overlain electronically on large scale inundation map (red), large discrepancies were noted**

COMMON INPUT FOR GIS

- **Data Capture**: used to be most expansive aspect of GIS because of paucity of digitized data. Subroutines designed to handle raster or data scans now
- **Data Integration**: Allows dissimilar data bases to be merged; like NRSC soil maps; and creation of "data maps", like average water use on individual parcels

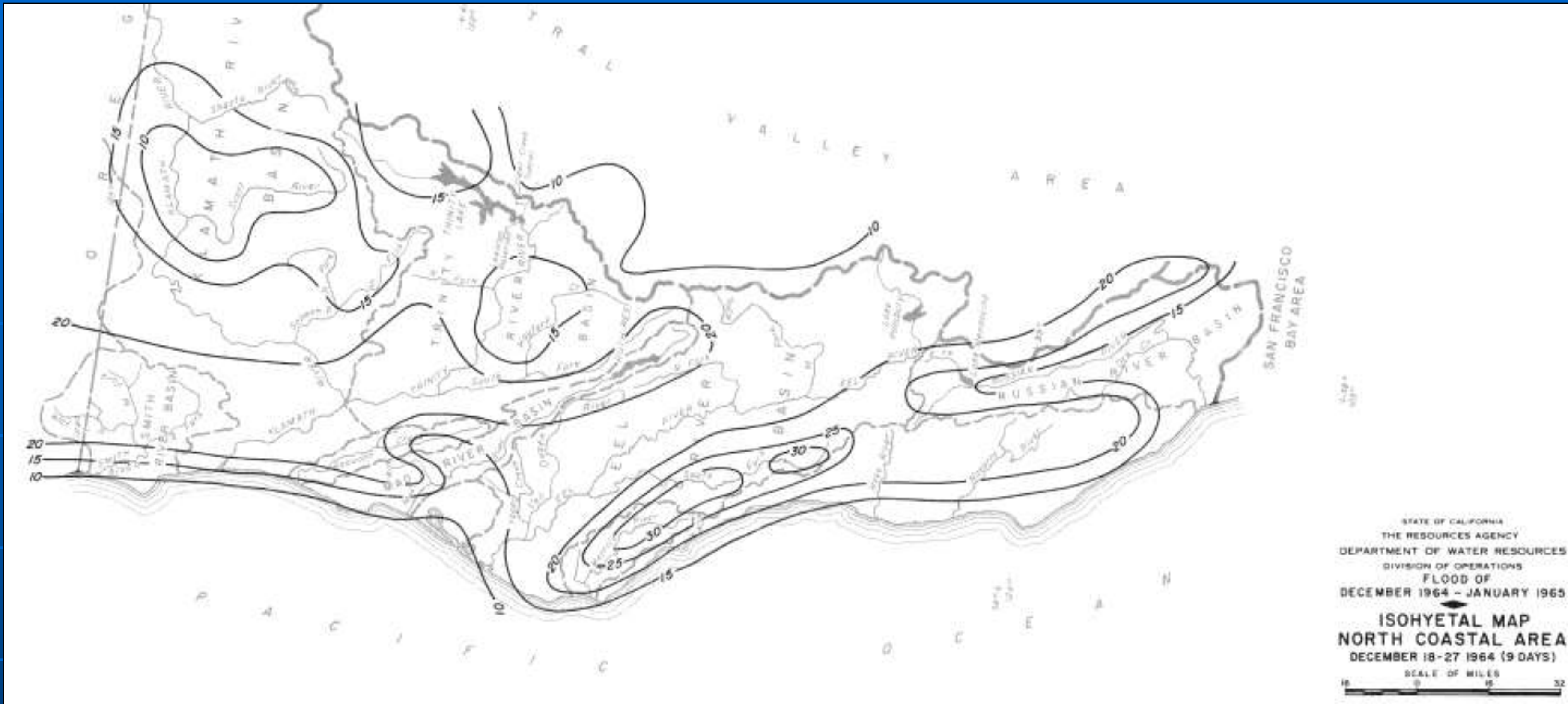




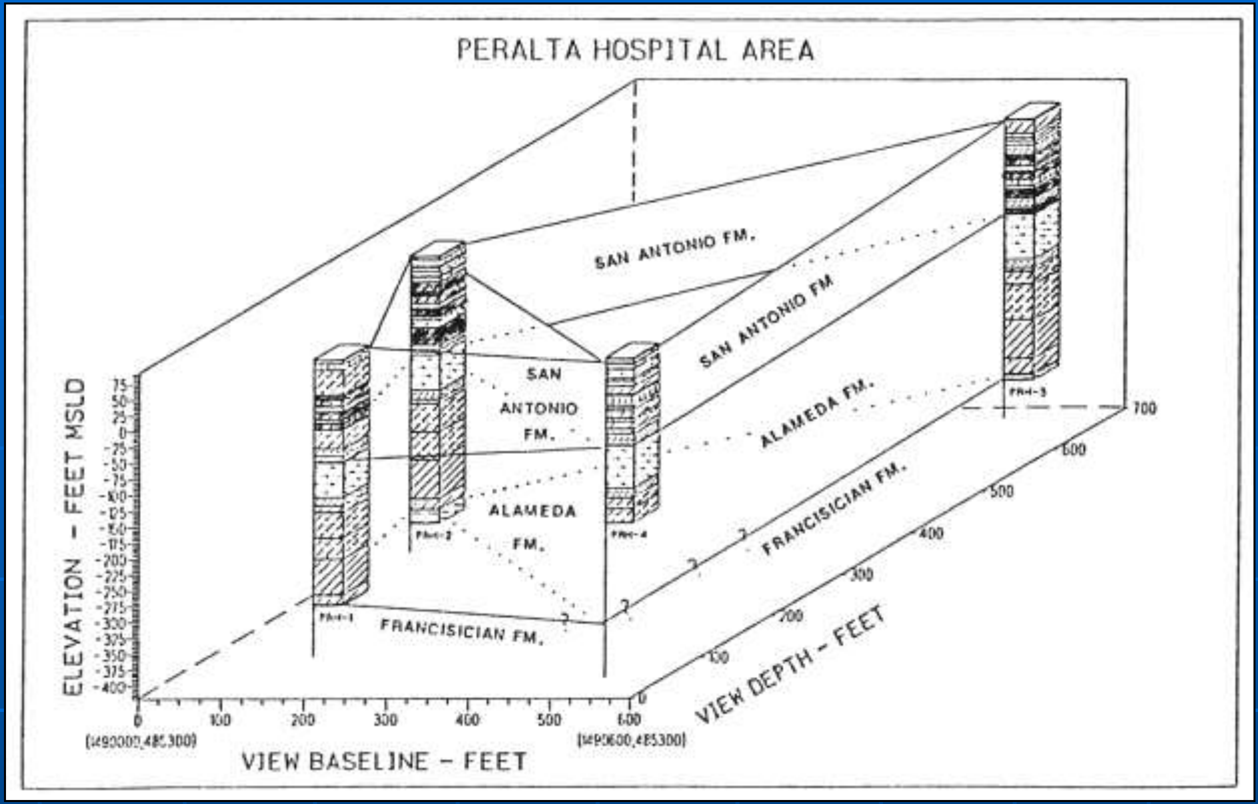
GIS allows integration of dissimilar data sources to prepare map overlays, this one showing shoreline development in Oakland, CA

COMMON INPUT FOR GIS

- **Data Structures**: Subroutines used to convert digitized data from one form to another without corruption; i.e. Oracle files to XML
- **Data Modeling**: Allows 3D data to be catalogued and manipulated; enables linear interpolation of Kriging; emerging ability to perform feature extraction, using spectral and physical signatures

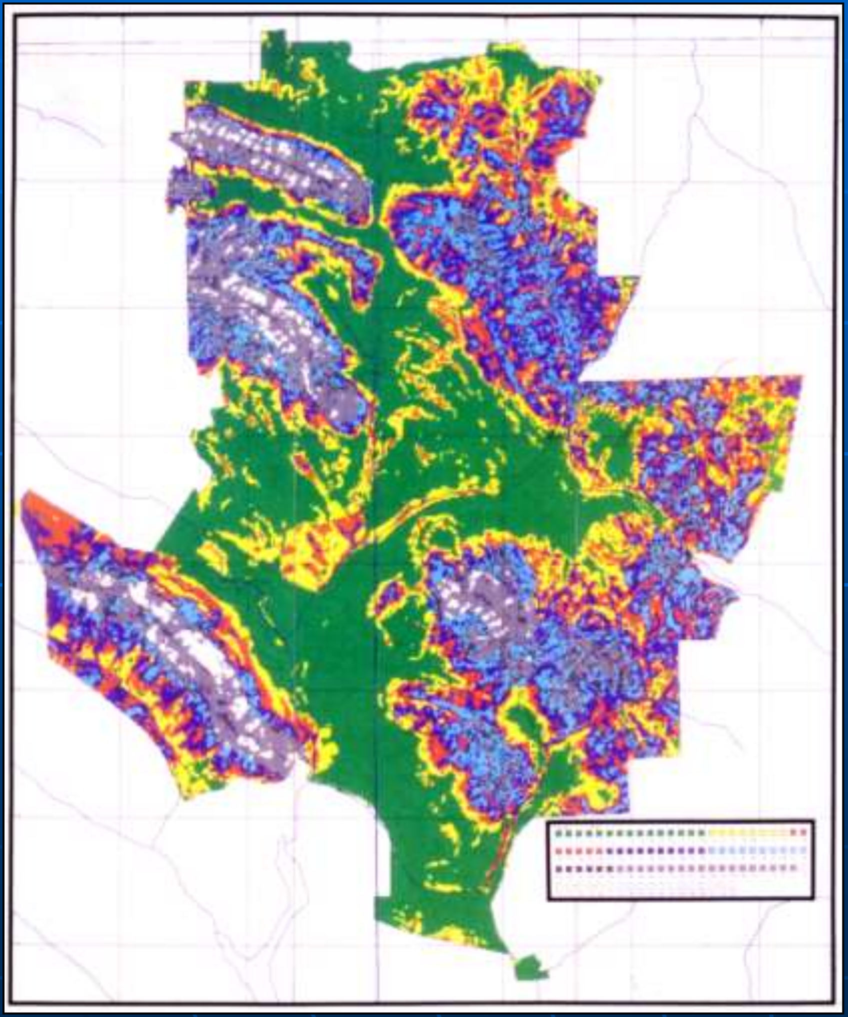


- **Contouring rainfall isohytes is a typical example of data modeling; combining location information, rainfall measurements and selecting an appropriate base datum**



- Subsurface information can be recalled and manipulated to create a three-dimensional image of geologic conditions
- Human judgment will remain a key component in unraveling problems with dissimilar nomenclature

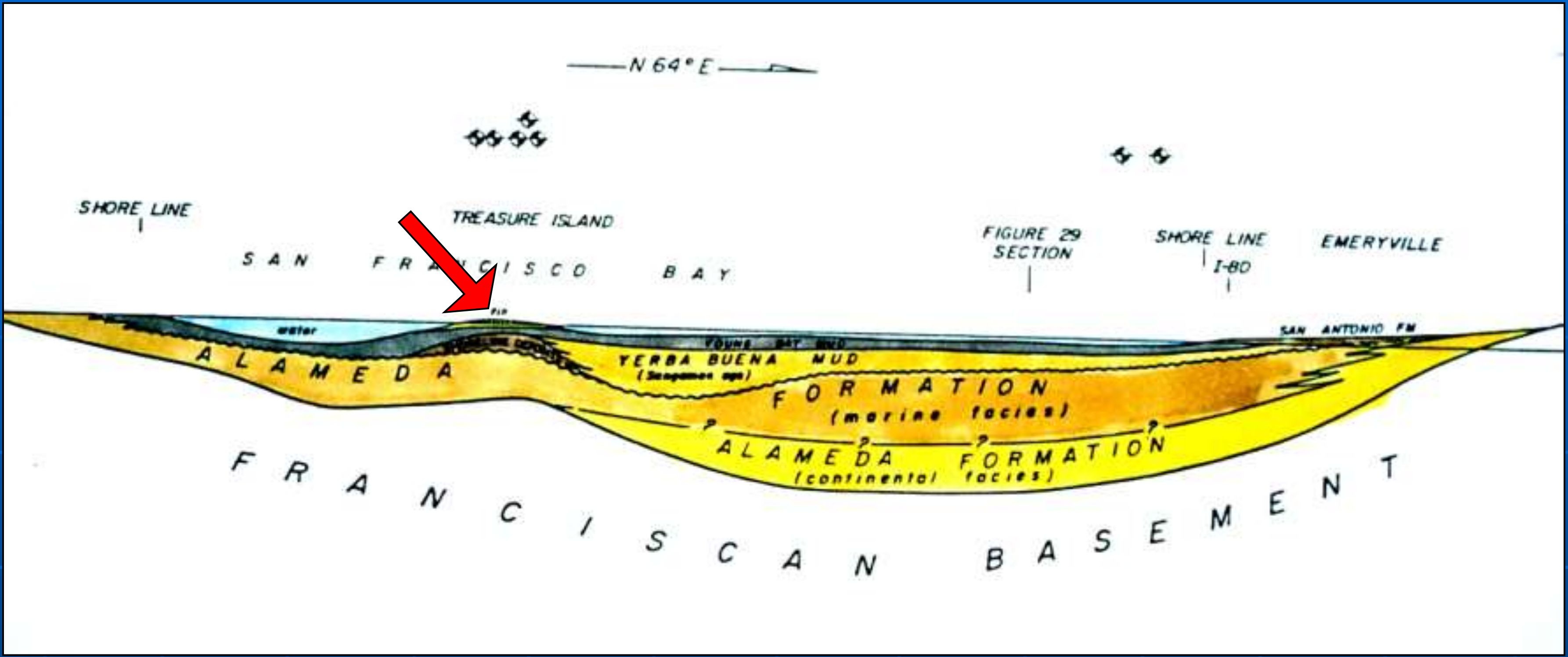
COMMON ANALYTICAL METHODS IN GIS



- **This shows a hybrid development capabilities map**
- **Such products are based on geologic and geotechnical data, usually collected from the public domain**

TREASURE ISLAND NGES

Created by hydraulic filling in 1936-37



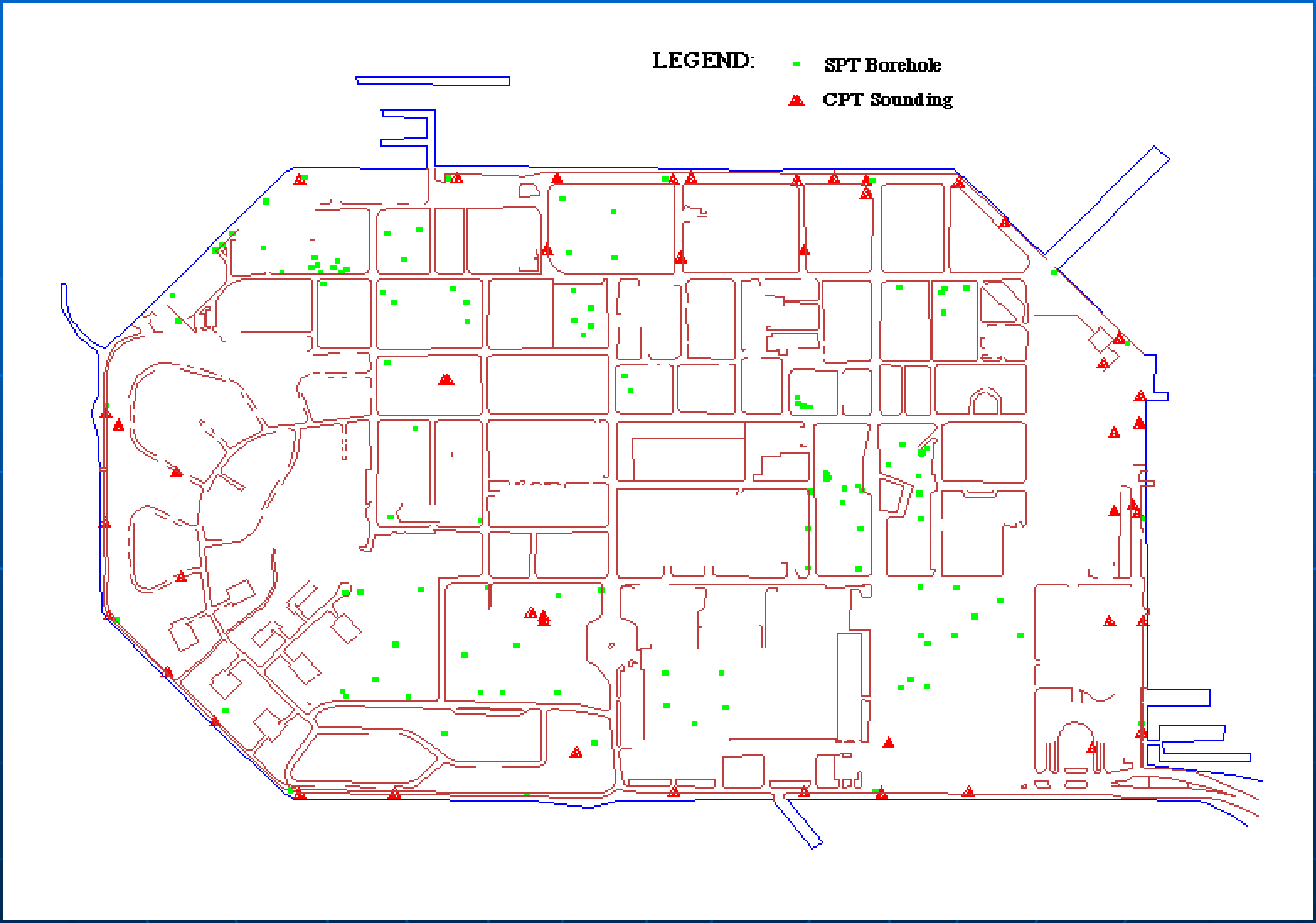
- **Treasure Island was built on a natural bedrock rise in the central San Francisco Bay. The basins on either side are filled with several hundred feet of estuarine clay and sand**

Treasure Island Pilot Study

- **Spatial Liquefaction Assessment**
  - Spatial Distribution of Subsurface Explorations
    - Deterministic Results
    - Probabilistic Results

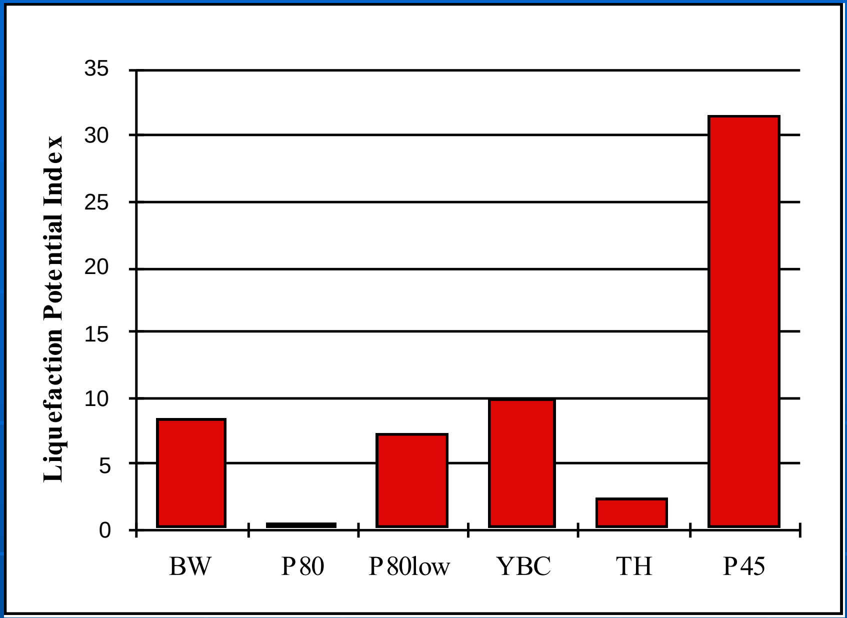
- **Issues Encountered During Liquefaction Analysis**
  - Distribution of Data in the Vertical (z) Direction
  - Distribution of Data in the Horizontal (x, y) Direction

Spatial Distribution of Subsurface Borings Used

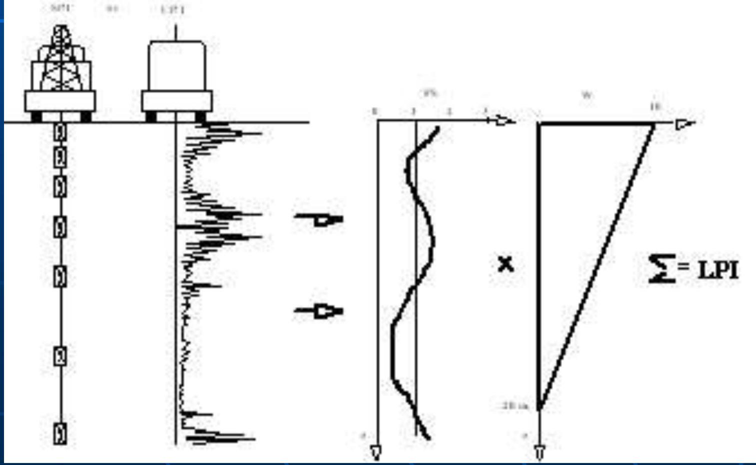


LPI Severity Criteria

In the fills along SF Bay margins Chameau et al. (1991) calculated the LPI



Concept of LPI Calculation

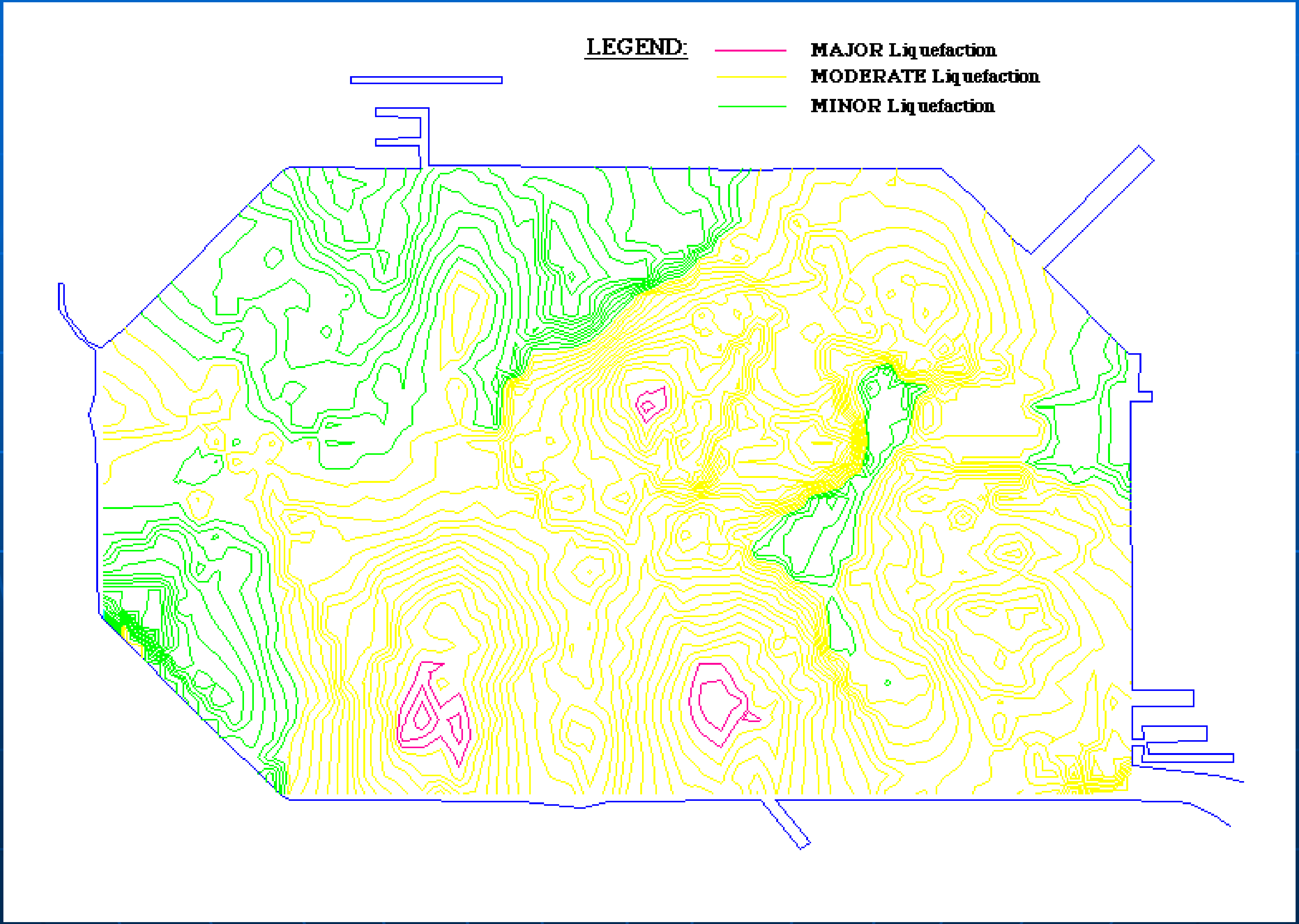


Proposed Severity Criteria

Little to none	LPI = 0
Minor	0 < LPI < 15
Moderate	15 < LPI < 30
Major	30 < LPI

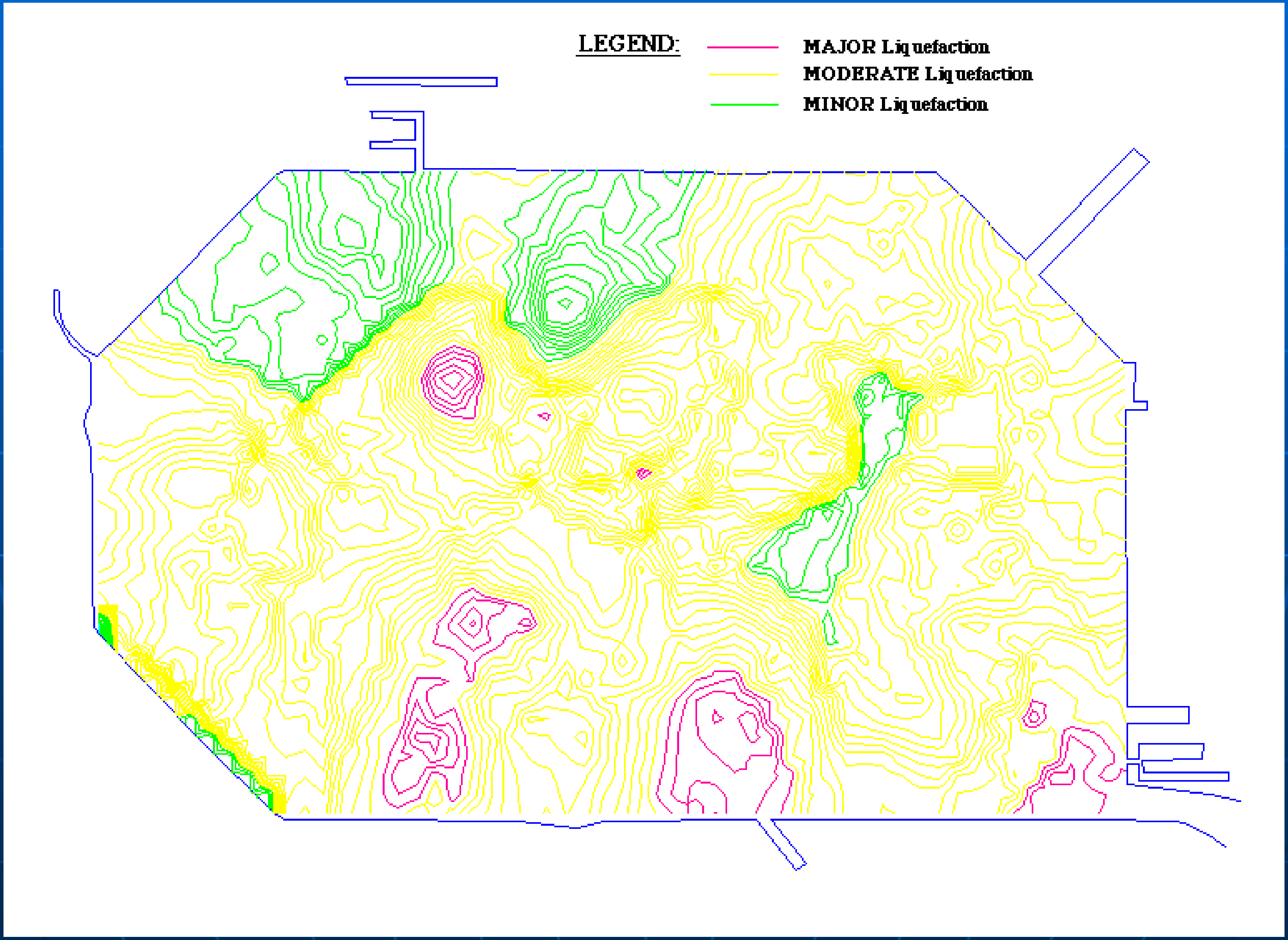
Liquefaction Severity Distribution (SPT only)

1989 M 6.9 Loma Prieta Earthquake



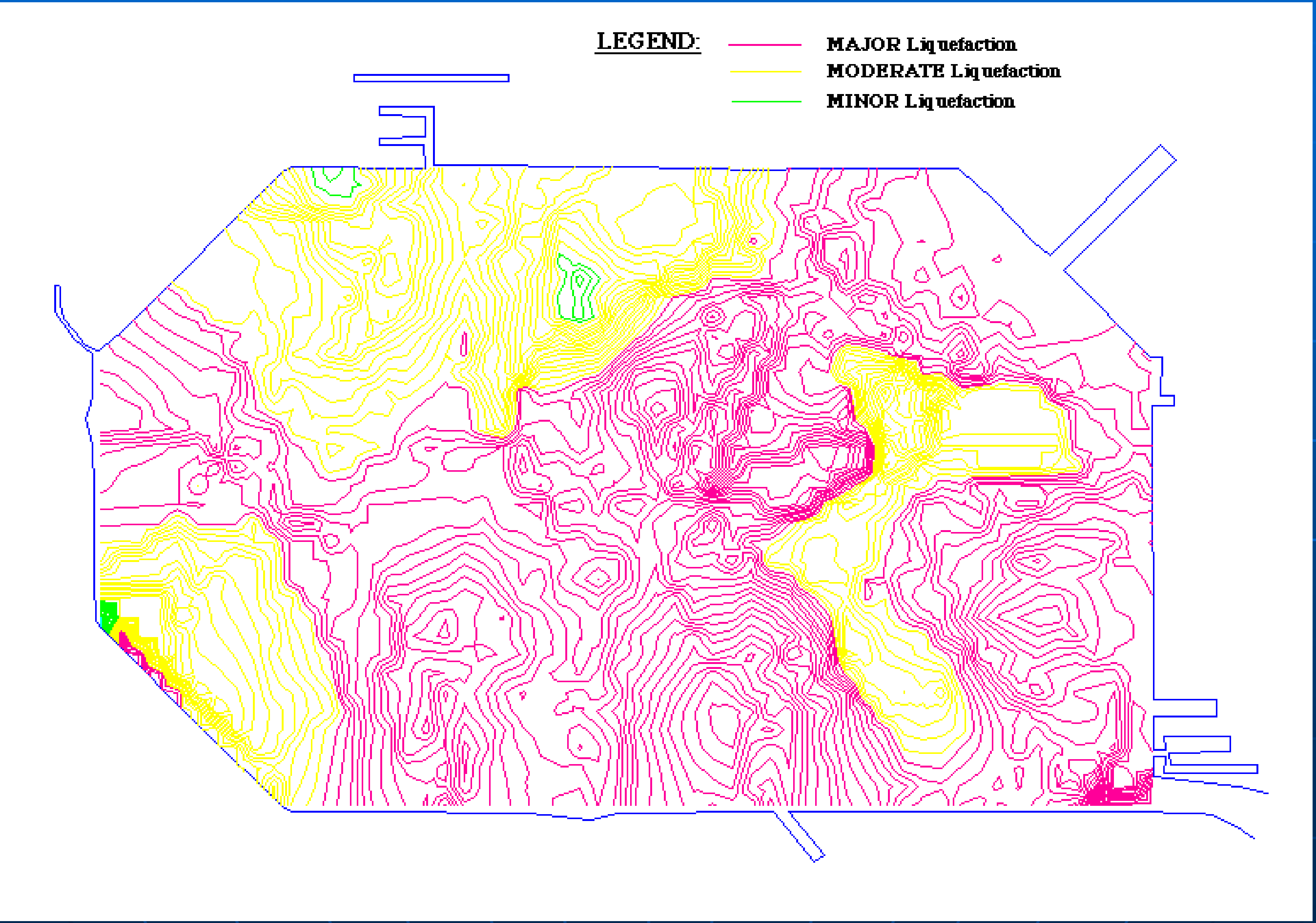
Liquefaction Severity Distribution

(SPT & CPT) M = 7.0 and PGA = 0.16g

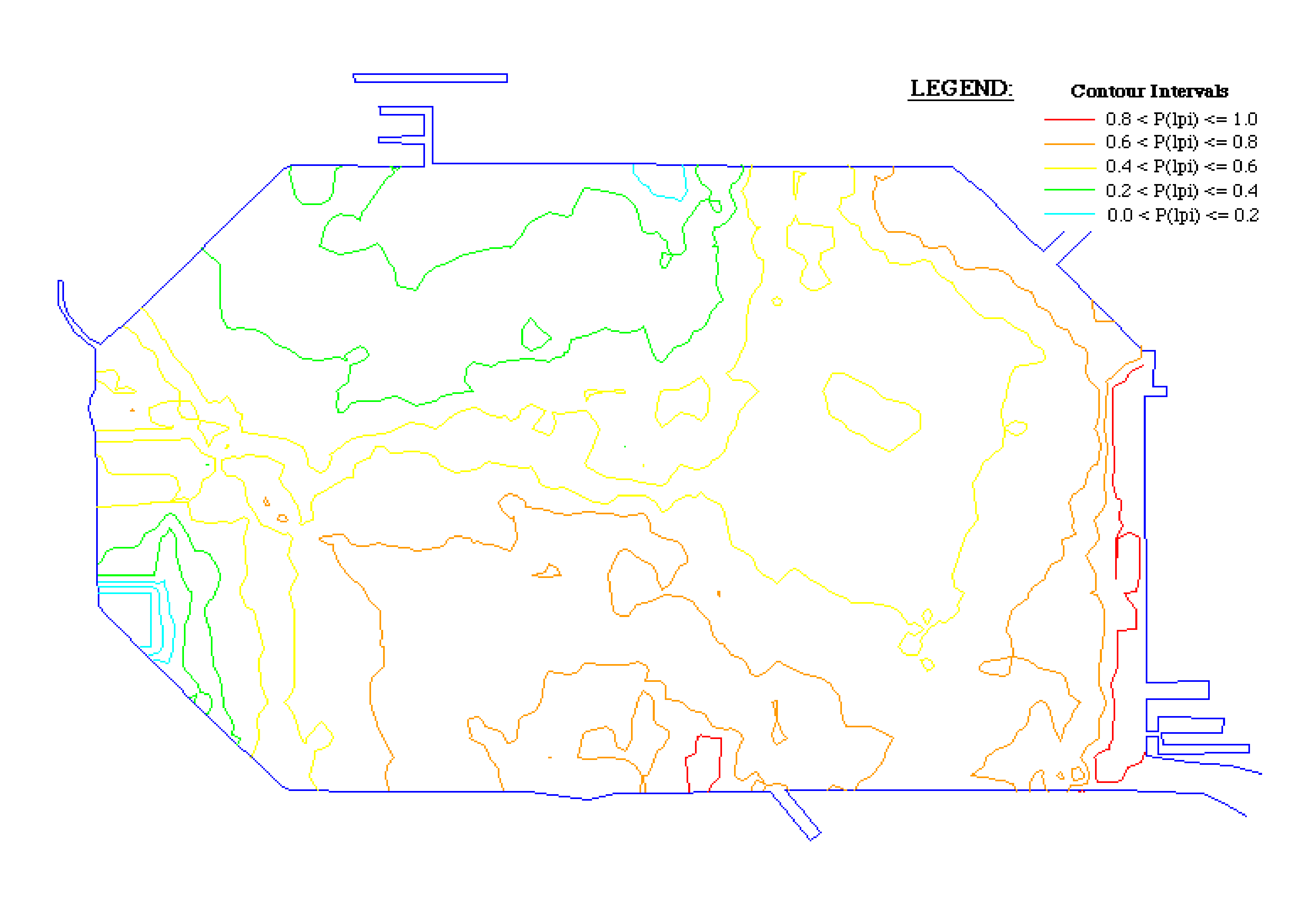


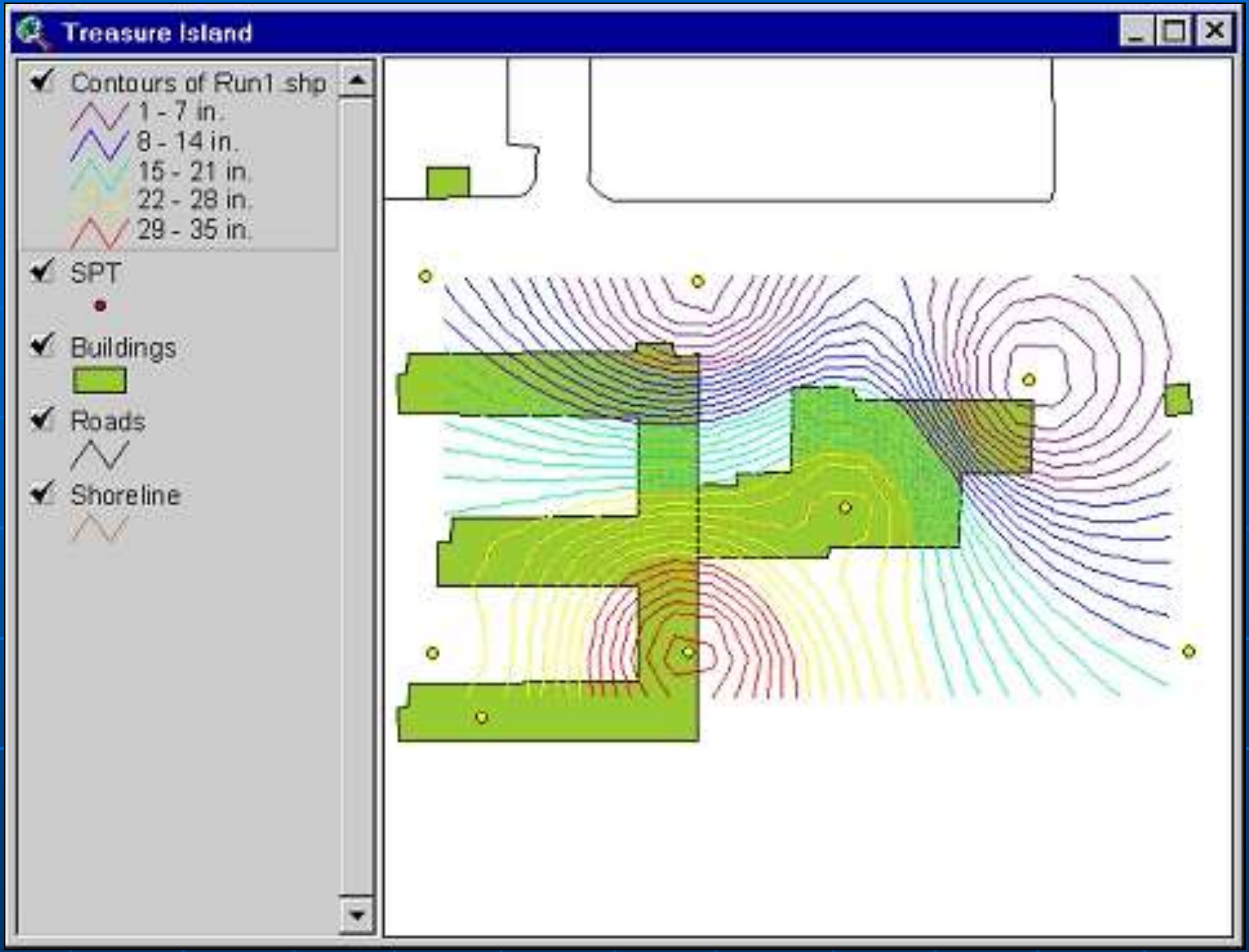
Liquefaction Severity Distribution

(SPT & CPT) M = 7.5 and PGA = 0.3g



Probability Distribution of Major Liquefaction
(SPT only) M = 7.5 and PGA = 0.3g





- **Settlement distribution overlain with building footprint**

COSMOS/NGES Virtual Geotechnical Database: Will it Become the Model Architecture for the United States?

- ESRI ArcIMS - Front Door
- XML (Excel) and COSMOS Database File System
- Java Script - Back end

COSMOS

- **Consortium of Organizations for Strong Motion Observation Systems**
  - Formed in Oakland, CA in Dec 1997
  - Core Members are the USGS, CGS, USCOE, USBR, Puerto Rico Strong Motion Program, PG&E, Caltrans, MCEER-Buffalo, PEER-Berkeley, SCEC-Los Angeles, and the World Seismic Safety Initiative

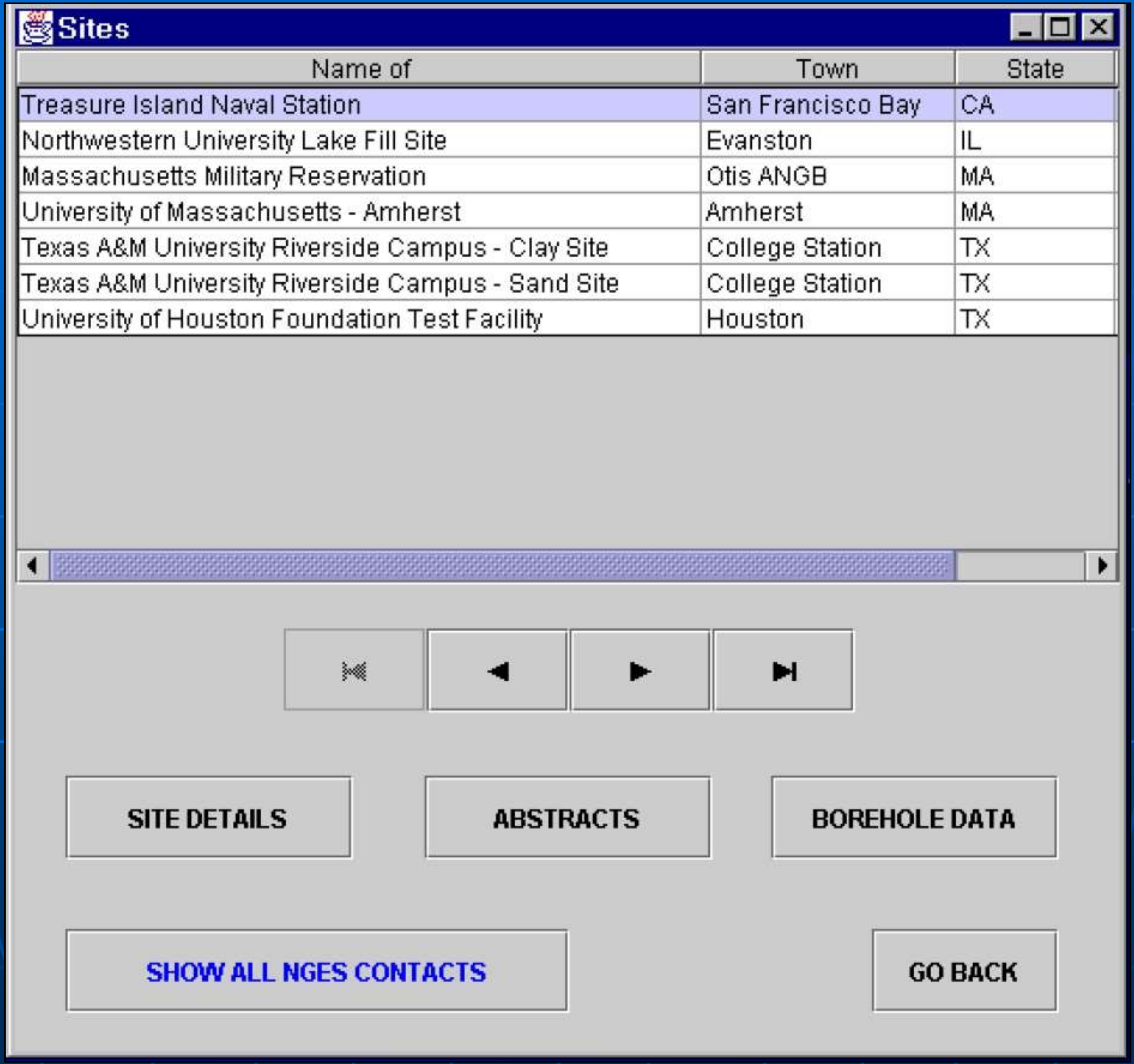
Long-Term Objective of the Virtual Geotechnical Database

- Extend the pilot system and develop a web-based system linking multiple data sets
- Capable of serving the broad needs of practicing geotechnical and earthquake hazards professionals for efficient access to geotechnical data
- Create GIS based hazard maps that can be incorporated into the geotechnical data set

National Geotechnical Experimentation Site Database Architecture

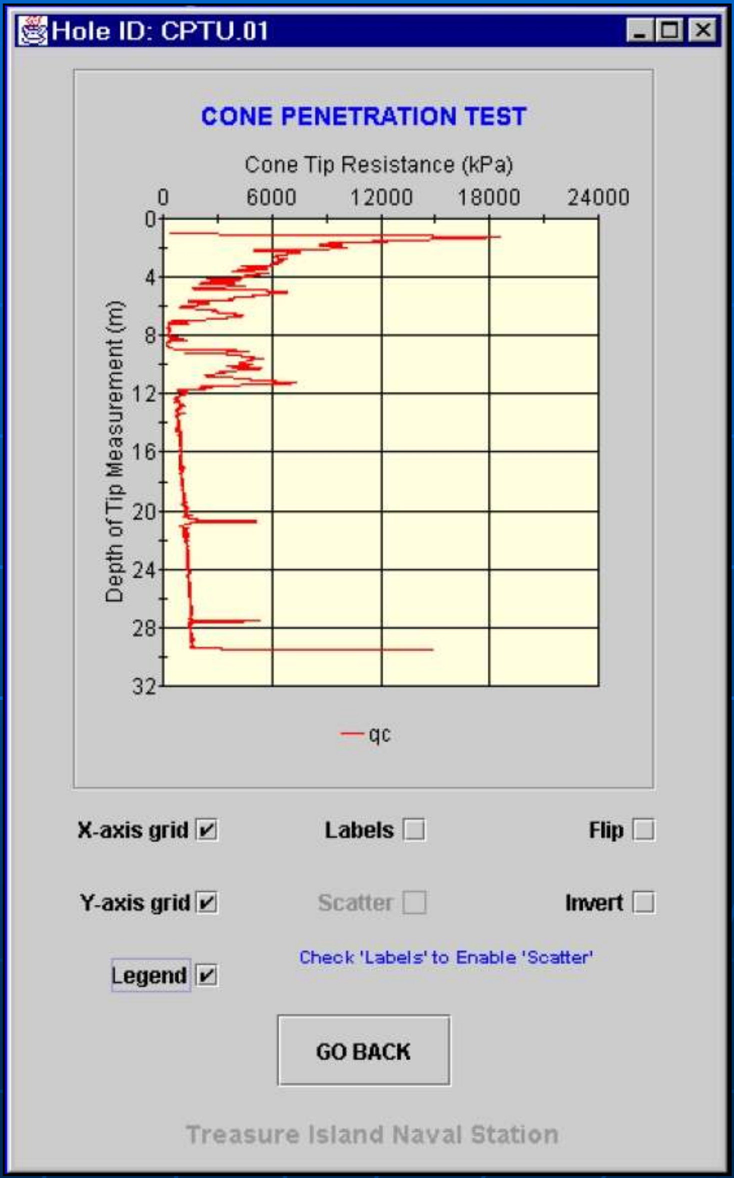
Example Geotechnical Database Inquiry

NGES Treasure Island


Sites
Name of
Town
State
Treasure Island Naval Station
San Francisco Bay
CA
Northwestern University Lake Fill Site
Evanston
IL
Massachusetts Military Reservation
Otis ANGB
MA
University of Massachusetts - Amherst
Amherst
MA
Texas A&M University Riverside Campus - Clay Site
College Station
TX
Texas A&M University Riverside Campus - Sand Site
College Station
TX
University of Houston Foundation Test Facility
Houston
TX
SITE DETAILS
ABSTRACTS
BOREHOLE DATA
SHOW ALL NGES CONTACTS
GO BACK

Example CPT Data on NGES site

- ID
- Code Space
- CPT ID
- Depth
- Tip Resistance
- Friction Resistance
- Pore Pressure
- Inclination
- Remarks
- Updates



Cone Penetration... SITE: Treasure Island Naval Station HOLE: CPTU.01

GENERAL DATA

CPT ID	CPT Type	Saturation Fluid	End Area Ratio Correction: Tip	End Area Ratio Correction: Sleeve	Remarks
CATIFS:CPTU.01	CPTU	Water	0.9	0.015	

Tip Area (mm^2)	Sleeve Area (mm^2)	Dist From Center of Sleeve to Tip (mm)	Number of Filter Elements	Position of Filter Elements	Capacity of Tip Load Cell (MN)	Rate of Penetration (mm/sec)
10.0	150.0	100.0		TIP		20.0

Row: 1

TEST DATA

7380 Total Rows Fetched

Depth tip measurement (m)	Cone tip resistance (qc) (kPa)	Friction sleeve resistance (fs) (kPa)	Penetration pore pressure - element 1 (kPa)	Penetrati... pressure... (kPa)	Penetrati... pressure... (kPa)
1.016	373.67	0.773	-8.4		
1.019	472.67	2.273	-8.4		
1.022	627.67	4.523	-8.4		
1.025	825.67	5.263	-8.4		
1.027	1050.67	6.013	-8.4		
1.03	1290.67	6.013	-8.4		
1.033	1544.67	6.013	-8.4		
1.036	1798.67	6.763	-8.4		
1.039	2038.67	6.013	-8.4		
1.042	2278.67	6.013	-8.4		

PLOT OPTIONS

DISSIPATION DATA

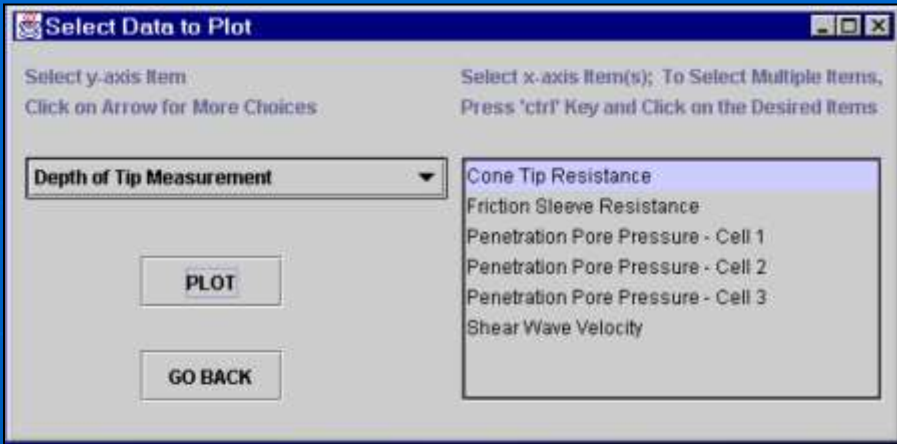
SEARCH

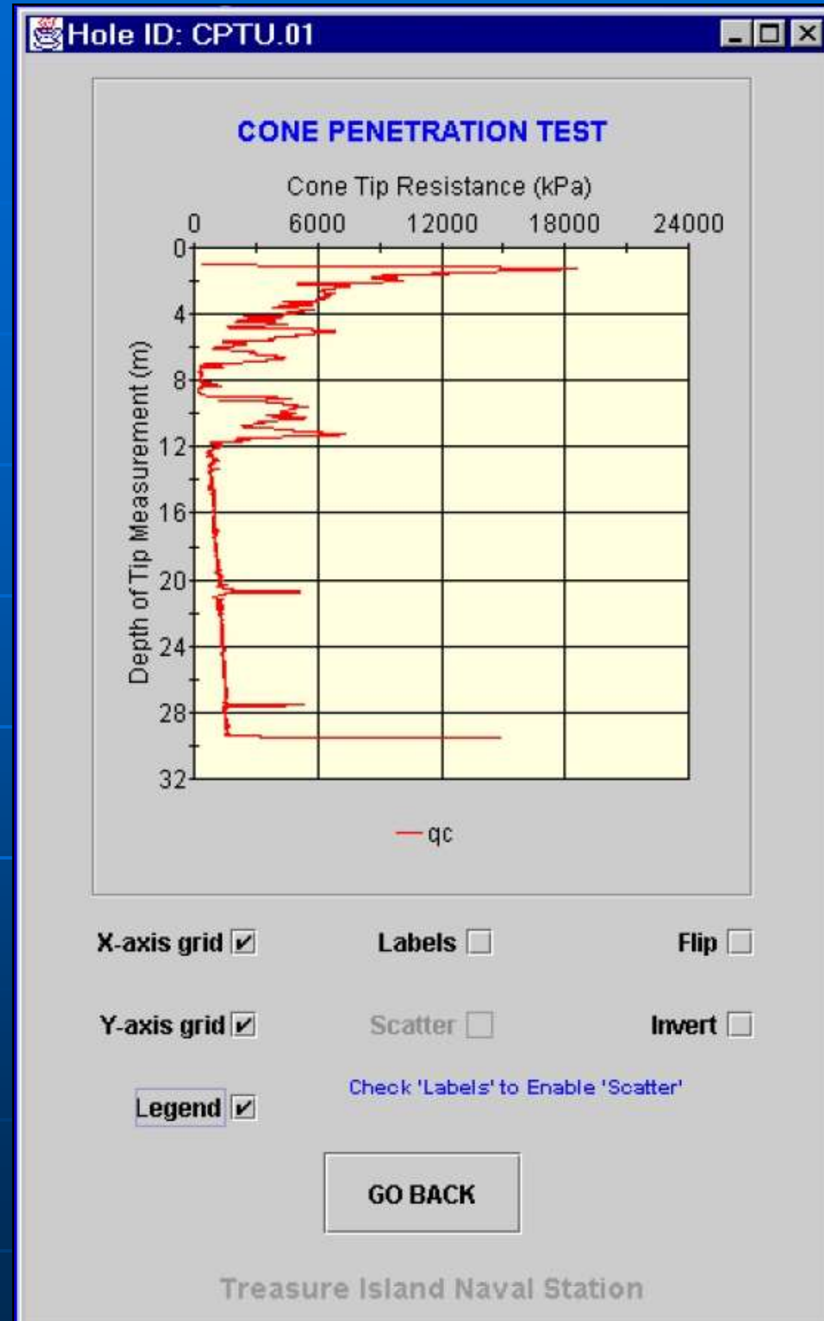
TEST DATA

DOWNLOAD

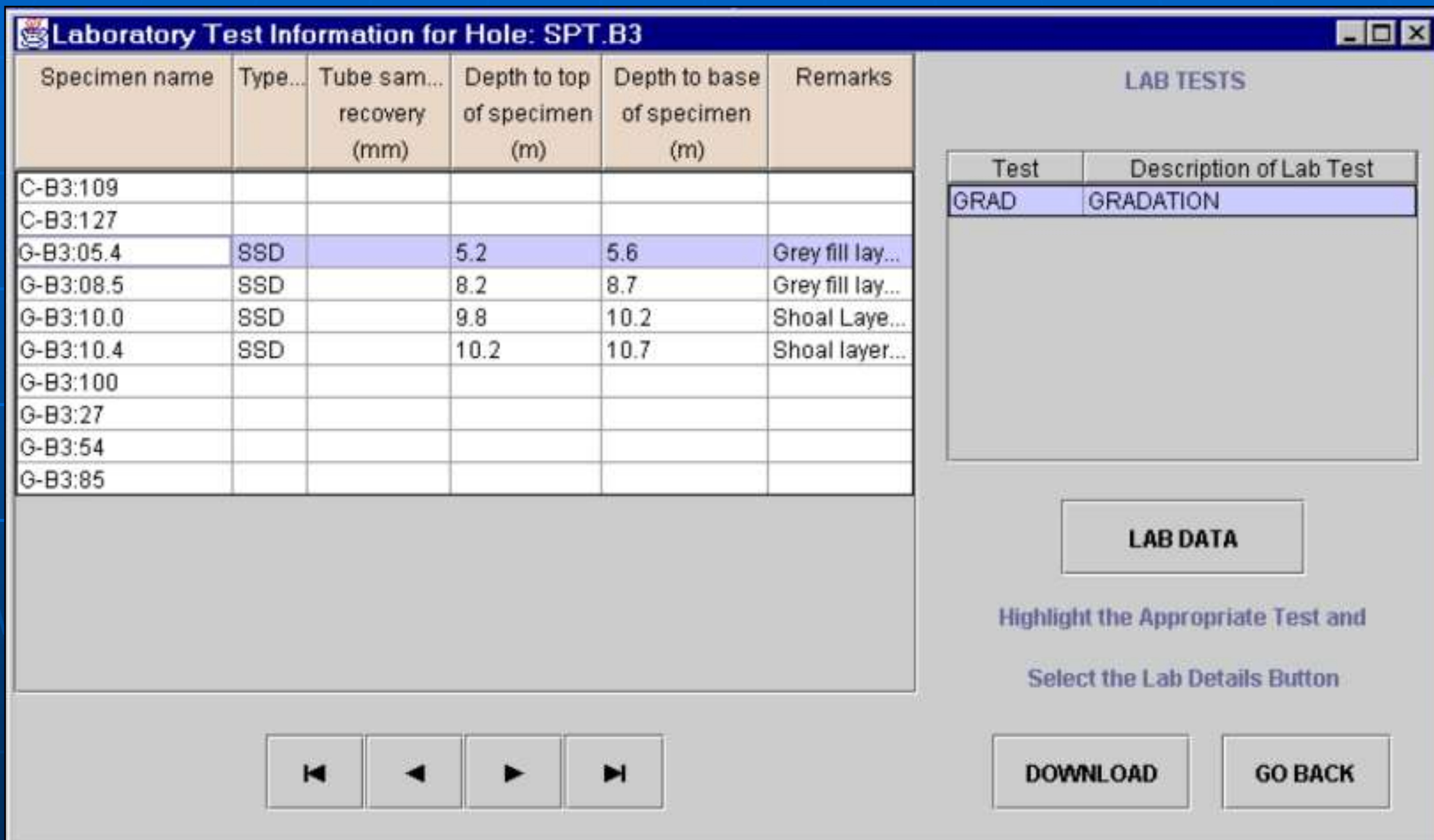
FETCH TEST DATA

GO BACK


Select Data to Plot
Select y-axis Item
Click on Arrow for More Choices
Select x-axis Item(s); To Select Multiple Items,
Press 'ctrl' Key and Click on the Desired Items
Depth of Tip Measurement
Cone Tip Resistance
Friction Sleeve Resistance
Penetration Pore Pressure - Cell 1
Penetration Pore Pressure - Cell 2
Penetration Pore Pressure - Cell 3
Shear Wave Velocity
PLOT
GO BACK


Hole ID: CPTU.01
CONE PENETRATION TEST
Cone Tip Resistance (kPa)
0
6000
12000
18000
24000
Depth of Tip Measurement (m)
0
4
8
12
16
20
24
28
32
qc
X-axis grid
Labels
Flip
Y-axis grid
Scatter
Invert
Legend
Check 'Labels' to Enable 'Scatter'
GO BACK
Treasure Island Naval Station

SPT Data on the same NGES site



Laboratory Test Information for Hole: SPT.B3

Specimen name	Type...	Tube sam... recovery (mm)	Depth to top of specimen (m)	Depth to base of specimen (m)	Remarks
C-B3:109					
C-B3:127					
G-B3:05.4	SSD		5.2	5.6	Grey fill lay...
G-B3:08.5	SSD		8.2	8.7	Grey fill lay...
G-B3:10.0	SSD		9.8	10.2	Shoal Laye...
G-B3:10.4	SSD		10.2	10.7	Shoal layer...
G-B3:100					
G-B3:27					
G-B3:54					
G-B3:85					

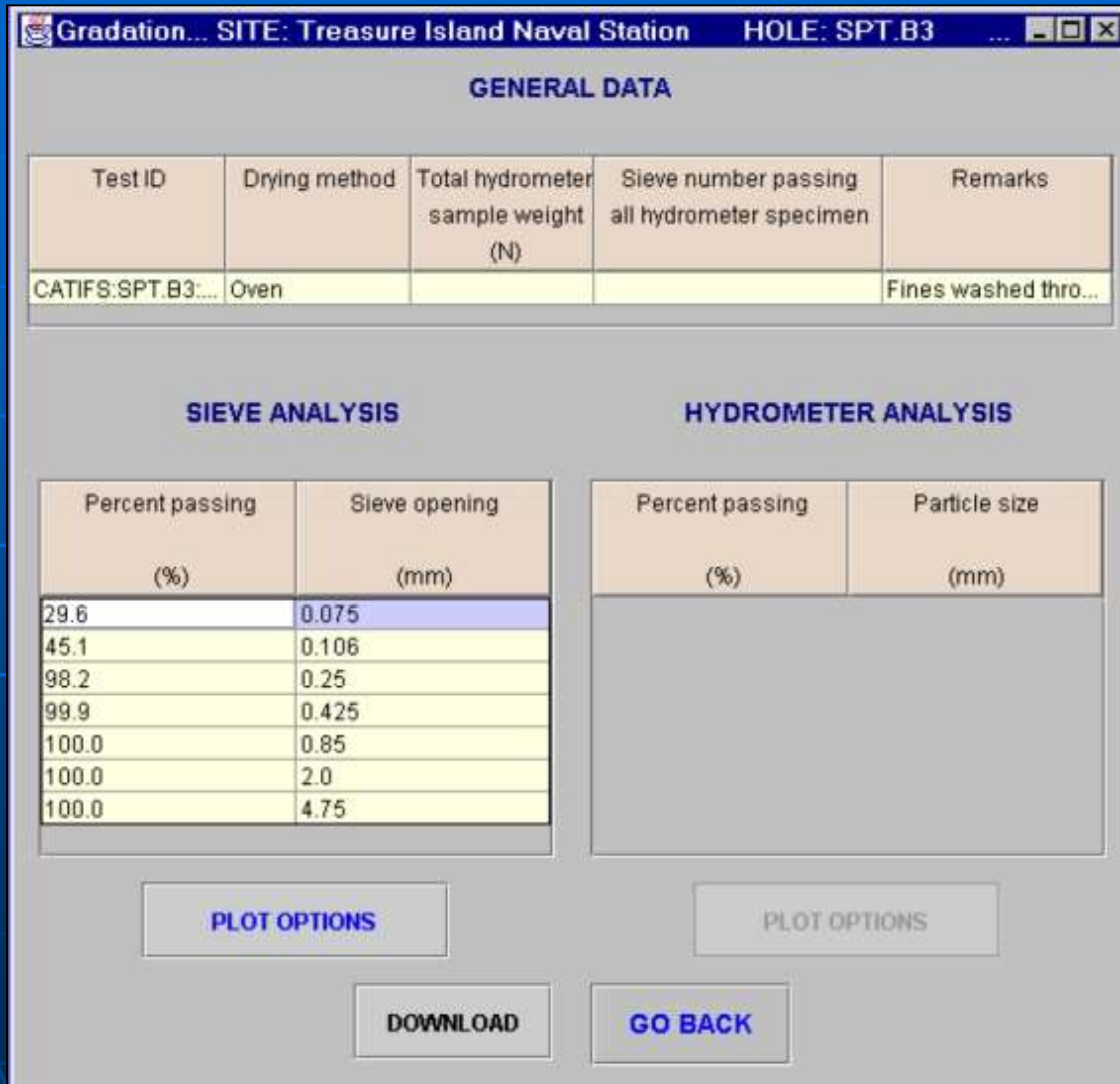
LAB TESTS

Test	Description of Lab Test
GRAD	GRADATION

CPT Data in Database Form

CPT ID	DEPTH		TIP RESISTANCE		FRICTION RESISTANCE		PORE PRESSURE		INCLINATION DEGREES	REMARKS
731 TC	0.05	ft	893.87	ton	2.3355	na			0.45	
731 TC	0.1	ft	594.47	ton	4.4059	na			0.6	
731 TC	0.15	ft	415.73	ton	3.4361	na			0.1	
731 TC	0.2	ft	265.97	ton	2.5304	na			0.09	
731 TC	0.25	ft	223.64	ton	2.0594	na			0.06	
731 TC	0.3	ft	207.76	ton	1.9412	na			0.12	
731 TC	0.35	ft	158.67	ton	1.6396	na			0.07	
731 TC	0.4	ft	121.87	ton	0.9642	na			0.22	
731 TC	0.45	ft	88.03	ton	0.859	na			0.22	

Sieve Analysis



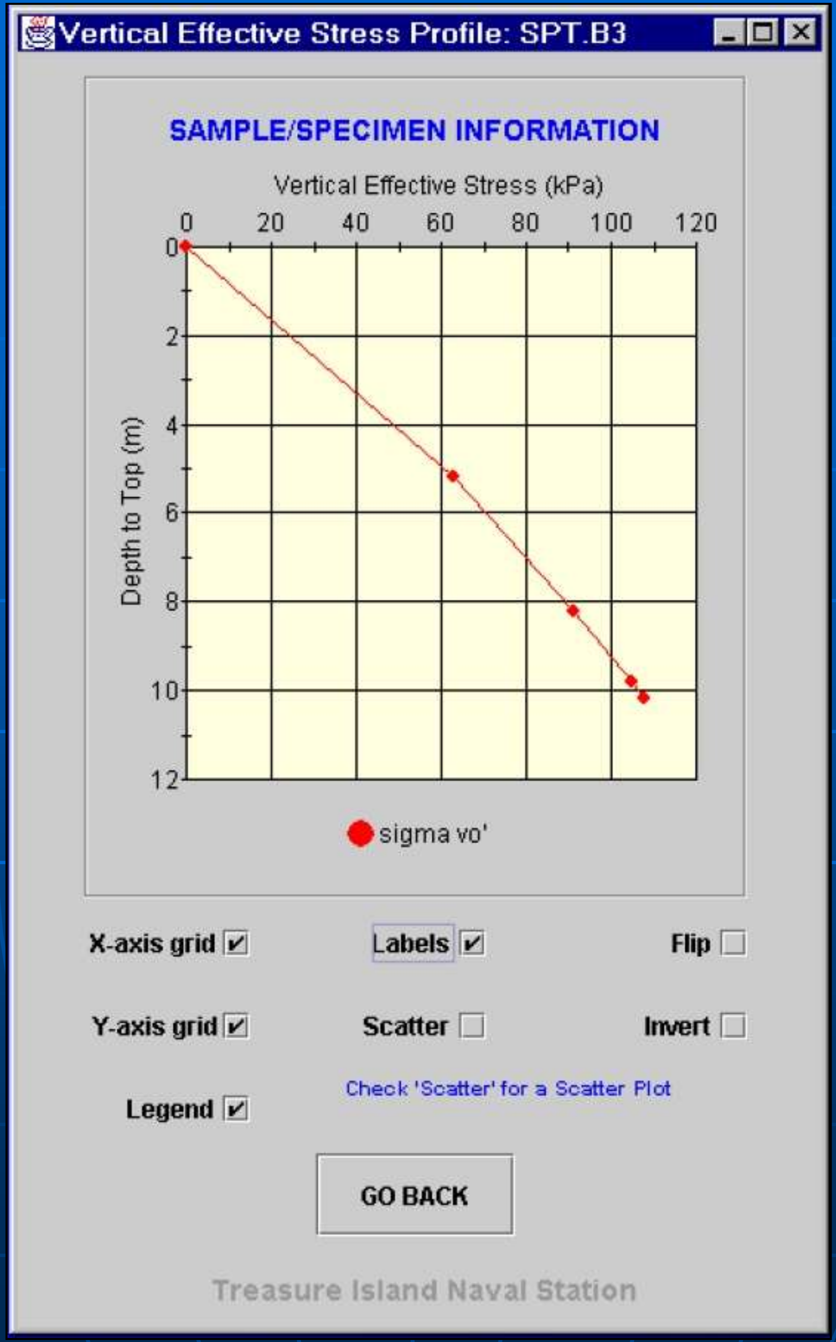
Test ID	Drying method	Total hydrometer sample weight (N)	Sieve number passing all hydrometer specimen	Remarks
CATIFS:SPT.B3:...	Oven			Fines washed thro...

SIEVE ANALYSIS

Percent passing (%)	Sieve opening (mm)
29.6	0.075
45.1	0.106
98.2	0.25
99.9	0.425
100.0	0.85
100.0	2.0
100.0	4.75

HYDROMETER ANALYSIS

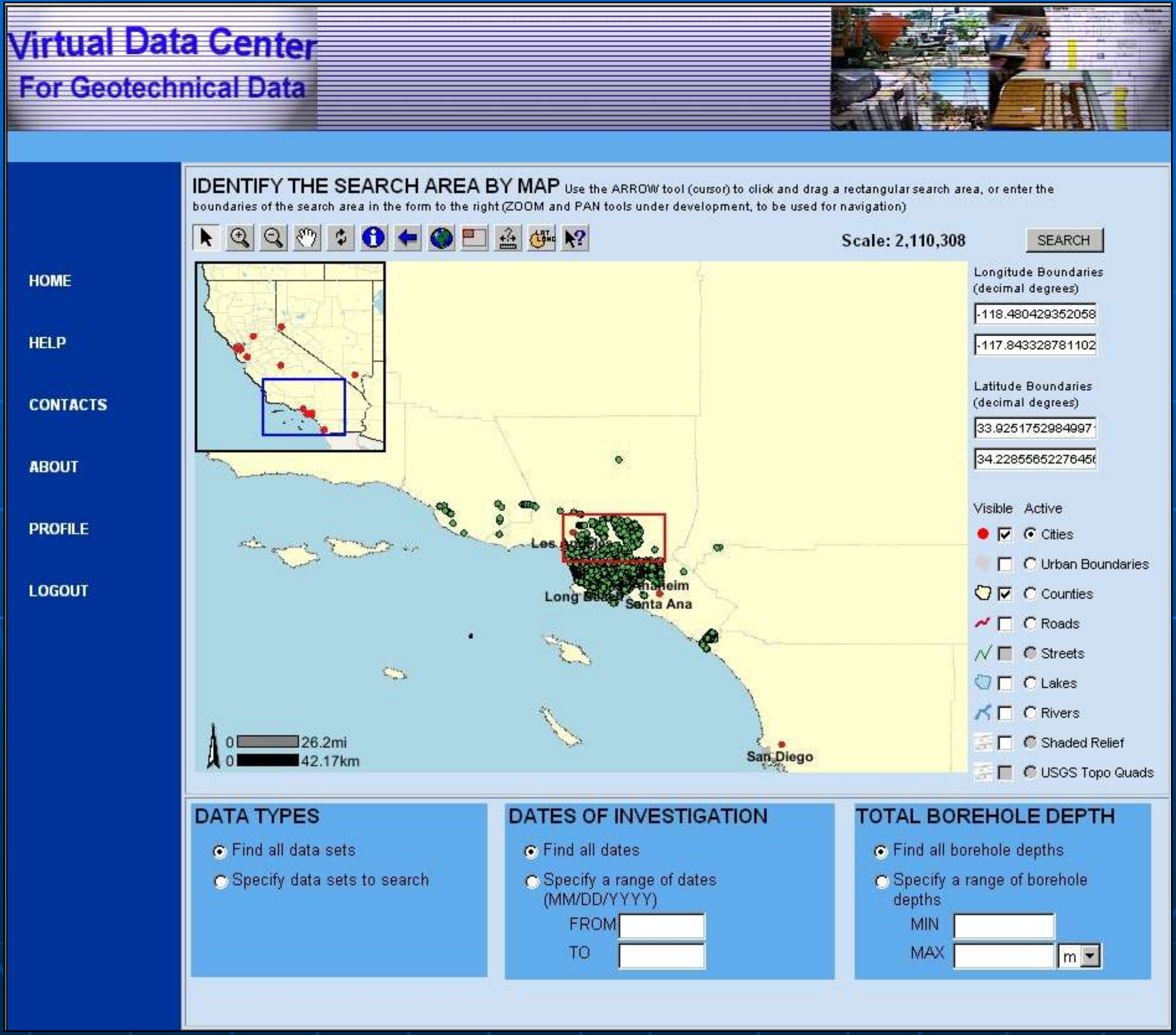
Percent passing (%)	Particle size (mm)


Vertical Effective Stress Profile: SPT.B3
SAMPLE/SPECIMEN INFORMATION
Vertical Effective Stress (kPa)
0
20
40
60
80
100
120
Depth to Top (m)
0
2
4
6
8
10
12
sigma vo'
X-axis grid
Labels
Flip
Y-axis grid
Scatter
Invert
Legend
Check 'Scatter' for a Scatter Plot
GO BACK
Treasure Island Naval Station

COSMOS Virtual Geotechnical Database ArcIMS / XML System

Example Inquiry

Virtual Geotechnical Database



Virtual Data Center
For Geotechnical Data

HOME

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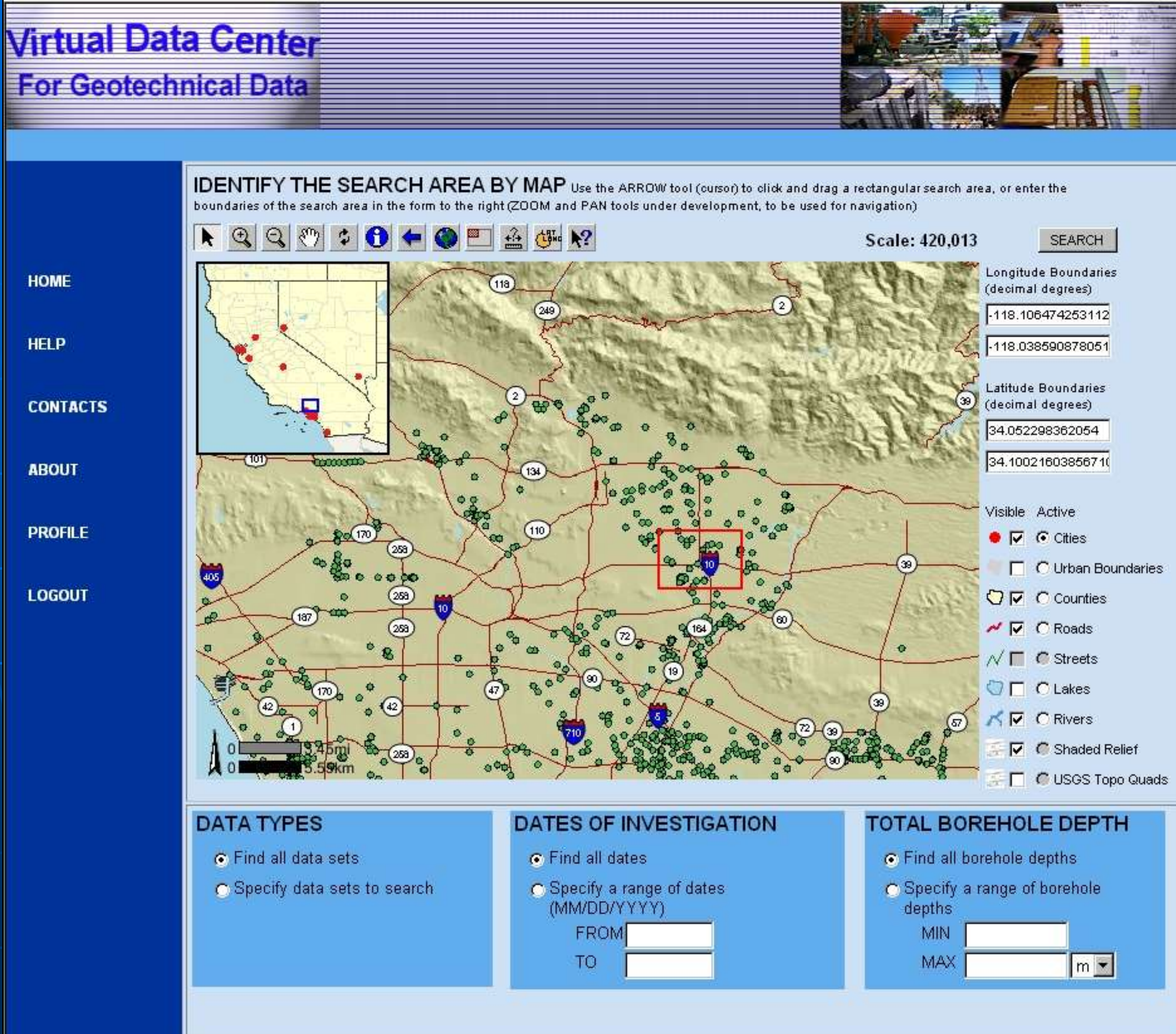
Search Results

Your search returned 550 data sets from the following data sources:

PROJECT NAME	DATA TYPE	DATA SOURCE	PROJECT DATE	LAST UPDATED	DOWNLOADS/ CONTACT
ORANGE FWY 57 AND TONNER CANYON BRIDGE	DGC, FLL, BLG, SPT	50	1989-12-10	2002-03-14	
ORANGE FWY 57	BLG, DGC, FLL, SPT	60	1989-12-10	2002-03-14	
ORANGE FWY 57	DGC, FLL, BLG, SPT	85	1989-12-10	2002-03-14	
C.C. Industries	BLG, DGC	51	1989-12-10	2002-03-14	
Kayo Oil Company - Jet Gas Station	BLG, DGC, FLL, SPT	57	1989-12-10	2002-03-14	
Mobil Oil Corporation Service Station No. 18-F34	SPT, BLG, DGC, FLL	50	1989-12-10	2002-03-14	
Mobil Oil Corporation - Service Station No.18-F34	SPT, FLL, BLG, DGC	31.5	1989-12-10	2002-03-14	
Mobil Station 11-E13	BLG, DGC, FLL, SPT	51.5	1989-12-10	2002-03-14	
City of La Habra Fire Station No. 2	SPT, BLG, DGC, FLL	31	1989-12-10	2002-03-14	
Lincoln Mortgage	BLG, DGC, FLL, SPT	60	1989-12-10	2002-03-14	
Former Chevron Station No. 9-2214	BLG, DGC, FLL, SPT	35	1989-12-10	2002-03-14	
Air Conditioning Systems, Inc.	FLL, SPT, DGC, BLG	50	1989-12-10	2002-03-14	
Cleere Property	FLL, SPT, DGC, BLG	28	1989-12-10	2002-03-14	
UGST Site Assessment	BLG, DGC, FLL, SPT	36	1989-12-10	2002-03-14	


Virtual Data Center
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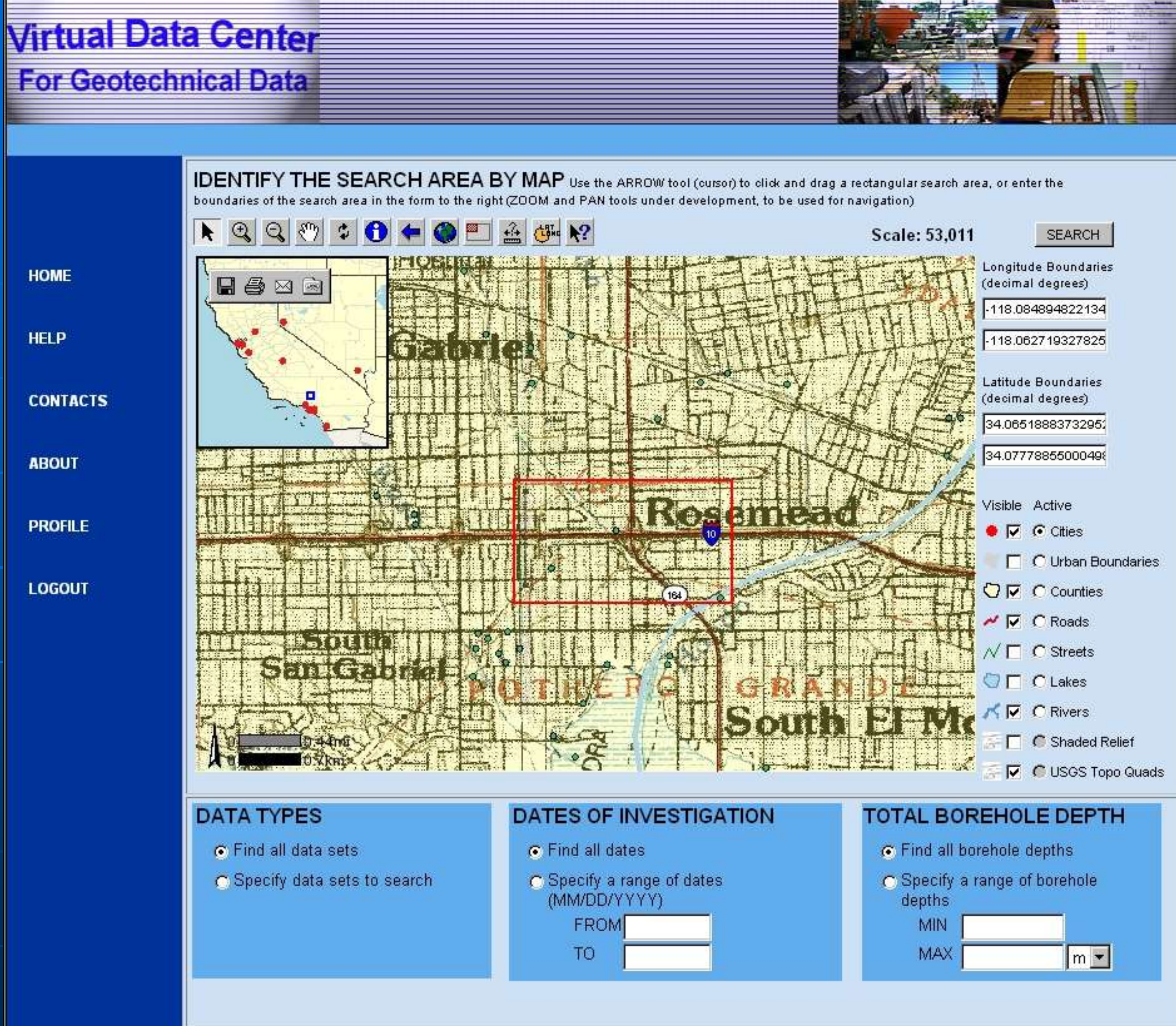
IDENTIFY THE SEARCH AREA BY MAP Use the ARROW tool (cursor) to click and drag a rectangular search area, or enter the boundaries of the search area in the form to the right (ZOOM and PAN tools under development, to be used for navigation)
Scale: 420,013
SEARCH
Longitude Boundaries (decimal degrees)
-118.106474253112
-118.038590878051
Latitude Boundaries (decimal degrees)
34.052298362054
34.1002160385671(
Visible Active
Cities
Urban Boundaries
Counties
Roads
Streets
Lakes
Rivers
Shaded Relief
USGS Topo Quads
DATA TYPES
Find all data sets
Specify data sets to search
DATES OF INVESTIGATION
Find all dates
Specify a range of dates (MM/DD/YYYY)
FROM
TO
TOTAL BOREHOLE DEPTH
Find all borehole depths
Specify a range of borehole depths
MIN
MAX
m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IDENTIFY THE SEARCH AREA BY MAP Use the ARROW tool (cursor) to click and drag a rectangular search area, or enter the boundaries of the search area in the form to the right (ZOOM and PAN tools under development, to be used for navigation)
Scale: 53,011
SEARCH
Gabriel
Rosemead
South San Gabriel
South El Mo
10
164
Longitude Boundaries (decimal degrees)
-118.084894822134
-118.062719327825
Latitude Boundaries (decimal degrees)
34.06518883732952
34.0777885500049
Visible Active
Cities
Urban Boundaries
Counties
Roads
Streets
Lakes
Rivers
Shaded Relief
USGS Topo Quads
DATA TYPES
Find all data sets
Specify data sets to search
DATES OF INVESTIGATION
Find all dates
Specify a range of dates (MM/DD/YYYY)
FROM
TO
TOTAL BOREHOLE DEPTH
Find all borehole depths
Specify a range of borehole depths
MIN
MAX
m

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Search Results

Your search returned 2 data sets from the following data sources:

PROJECT NAME	DATA TYPE	DATA SOURCE	PROJECT DATE	LAST UPDATED	DOWNLOADS/ CONTACT
2922	BLG	Unknown	1700-01-01	2004-02-04	
2913K	BLG	Unknown	1700-01-01	2004-02-04	

Key to DOWNLOADS/CONTACT INFO:

Download available in Microsoft Excel Format

Download available in COSMOS XML Format

PREVIEW *Graphical Preview of data is available*

NEW SEARCH

California Geological Survey
Seismic Hazard Mapping
ArcIMS System

Example Inquiry

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Seismic Hazard Mapping HOME

Zone Maps, Reports, & GIS Data

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Probabilistic Seismic Hazard Assessment Maps

Alquist-Priolo Earthquake Fault Zones

Seismic Hazards Mapping Bulletins

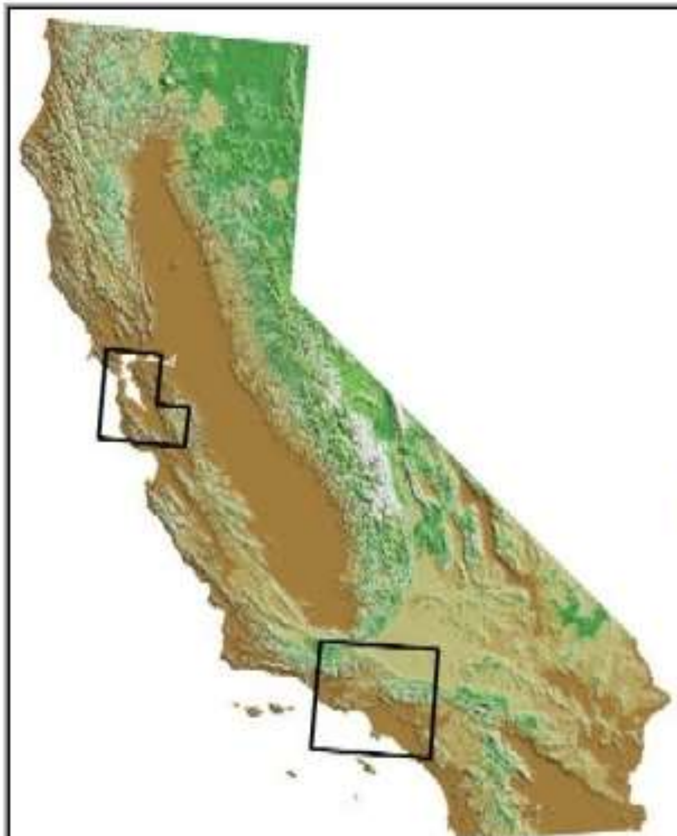
Mapping Options:

- Download Data
- Review Maps

Click on the Map of California to Select a SHMP Map Area

Welcome to the CGS's Seismic Hazard Mapping Program (SHMP) Data Access Page

See Left Navigation Bar for Mapping Options



Choose a mapping option from the Left Navigation Bar

Purpose of the Map

This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act

For information regarding the general approach and recommended methods for preparing this map, See DMG Special Publication 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California*

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*

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Welcome to California

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Seismic Hazards Mapping Bulletins

Mapping Options:

Select Map Area By:

By County

By Zip Code

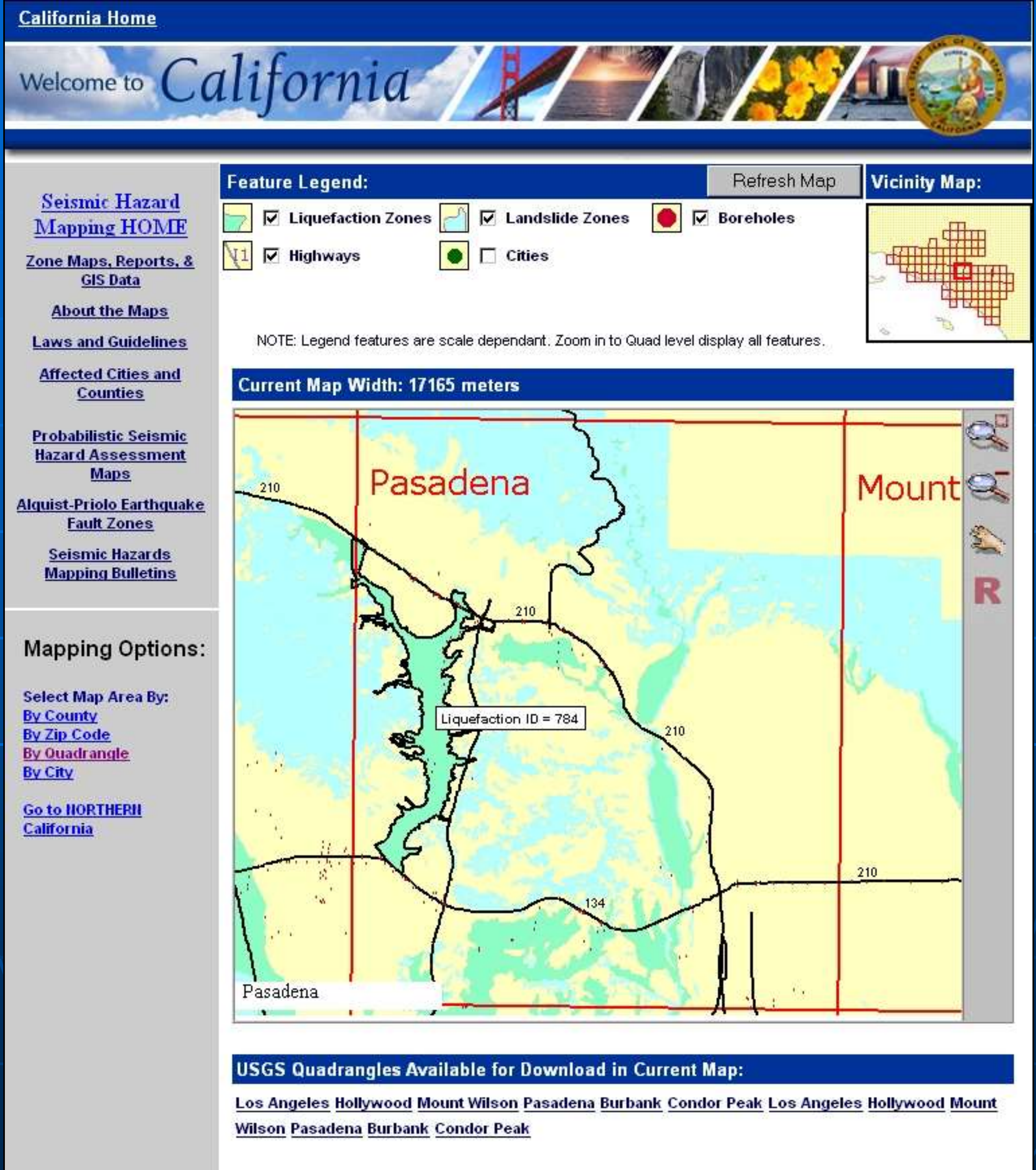
By Quadrangle

By City

Go to NORTHERN California

Southern California Interactive Quadrangle Map

Click on a Quadrangle to Begin Interactively Building SHMP Maps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Seismic Hazards Mapping Bulletins
Mapping Options:
Select Map Area By:
By County
By Zip Code
By Quadrangle
By City
Go to NORTHERN California
Feature Legend:
Refresh Map
Liquefaction Zones
Landslide Zones
Boreholes
Highways
Cities
NOTE: Legend features are scale dependant. Zoom in to Quad level display all features.
Vicinity Map:
Current Map Width: 17165 meters
Pasadena
Mount
210
134
Liquefaction ID = 784
Pasadena
USGS Quadrangles Available for Download in Current Map:
Los Angeles Hollywood Mount Wilson Pasadena Burbank Condor Peak Los Angeles Hollywood Mount Wilson Pasadena Burbank Condor Peak

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Seismic Hazard Mapping HOME

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Seismic Hazards Mapping Bulletins

Mapping Options:

Select Map Area By:
By County
By Zip Code
By Quadrangle
By City

Go to NORTHERN California

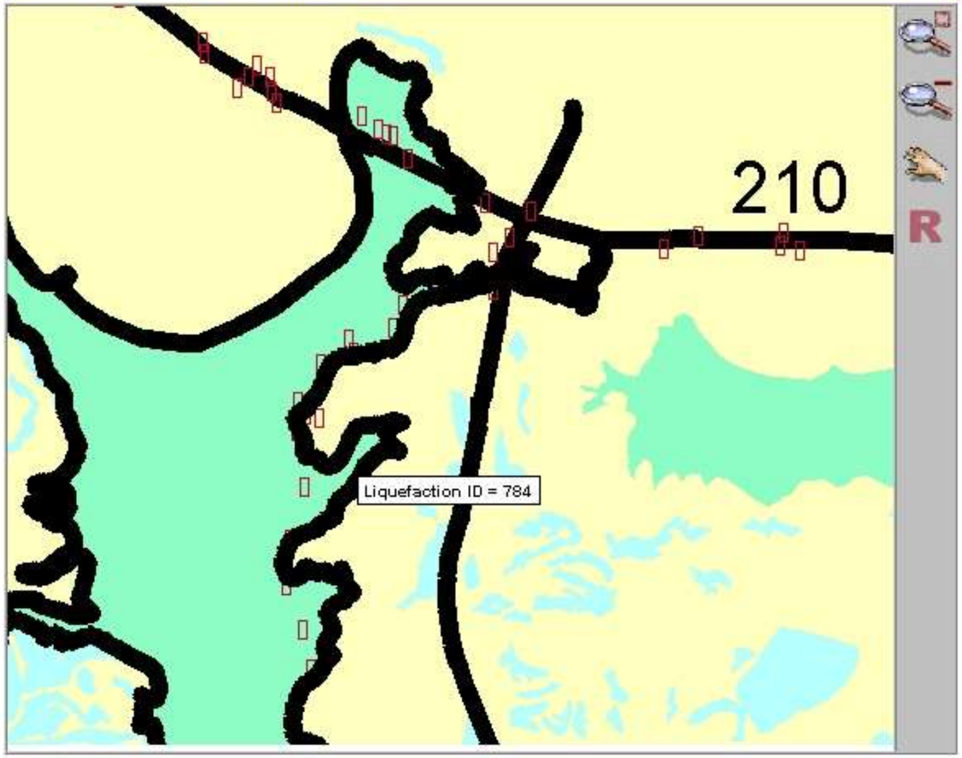
Feature Legend: Refresh Map

- ☑ Liquefaction Zones
- ☑ Landslide Zones
- ☑ Boreholes
- ☑ Highways
- ☐ Cities

NOTE: Legend features are scale dependant. Zoom in to Quad level display all features.

Vicinity Map:

Current Map Width: 17165 meters



USGS Quadrangles Available for Download in Current Map:

Los Angeles Hollywood Mount Wilson Pasadena Burbank Condor Peak Los Angeles Hollywood Mount Wilson Pasadena Burbank Condor Peak