



# GIS Dam Safety Applications



## FEDERAL ENERGY REGULATORY COMMISSION DIVISION OF DAM SAFETY AND INSPECTIONS

MIDWEST HYDRO USERS GROUP  
SPRING MEETING

MAY 20, 2010

Wausau, WI



# GIS Dam Safety Applications



FEDERAL ENERGY REGULATORY COMMISSION  
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Division of Dam Safety and Inspections - Chicago Regional Office  
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November 8, 2007

RE: Emergency Action Plans

One of the most important parts of an Emergency Action Plan (EAP) is the inundation map which shows the approximate downstream area that would be affected by a dam failure. Early versions of inundation maps were often created by drawing inundation zones on USGS quad sheets based on interpolating between cross section flood elevations from a dambreak model. Presently, geographic information system (GIS) technology is commonly used to develop inundation maps.

During functional exercises over the past few years, representatives of several emergency management agencies (EMAs) have requested that dam owners submit digital files of inundation zones to be incorporated into their agencies' GIS. The EMAs can use the files to access additional information from their databases, such as contact information for all residences within the inundation zones, which would aid their warning and evacuation procedures.

Since the use of GIS technology would have positive impacts on an emergency response to a dam failure, we are requesting that licensees and exemptees submit a plan and schedule for preparing inundation map files in GIS format and providing the files to the EMAs and Commission. **This initiative will be limited to projects classified as having a high hazard potential and where**



## GIS Dam Safety Applications



# Complying with the new GIS Map Initiative

A Quick look at the  
components that make up an  
EAP Map Submittal



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## New Chapter 6 of FERC Dam Safety Guidelines

- Revised EAP Chapter 6 is now final.
- Appendix D includes the specifications for GIS data submittals.





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## Requirements for Submittal

- Dam must have a high hazard potential rating.
- Local emergency management agencies must be able to utilize GIS data.



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## 5 Components of a GIS Inundation Map Submittal

- Reference point file for georeferencing drawings and locating structures.
- Raster copy of paper maps for data verification.
- Inundation polygon for each failure scenario.



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## 5 Components of a GIS Inundation Map Submittal

- Cross section file for storing data from the hydraulic model.
- Metadata – Literally data about data. This file should include sources and details about each of the other four parts.



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## What is a Map Projection?

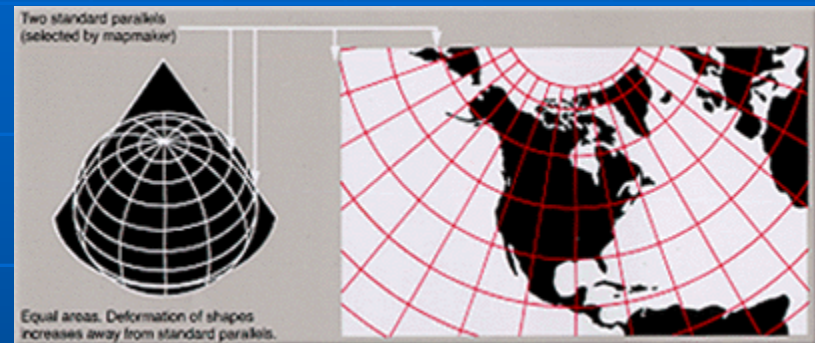
A map projection is a method for displaying the earth (a sphere) on a flat surface (paper or computer screen).

It is not possible to do this without distortion, but different geometric properties can be maintained.

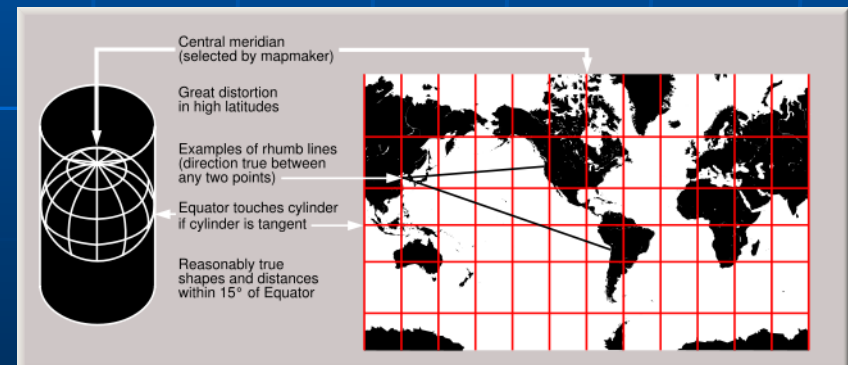


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Conic – Preserves area,  
but not shape or  
distance.



Cylindrical – Preserves  
distance along the  
mercator (the equator  
in the picture on the  
right).



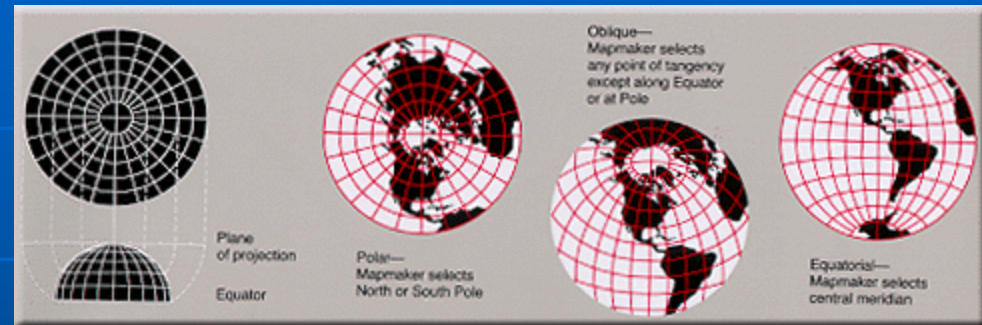




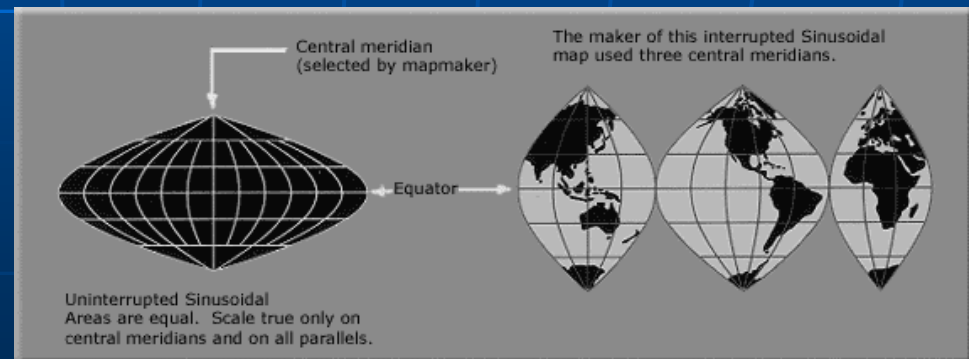
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Asimuthal – Preserves direction, from the central point.



Pseudocylindrical – Preserves area and distance along a meridian.





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## Useful Data Sources from the Web

The following websites host ArcIMS servers for public data access:

- US Dept. of Agriculture  
<http://gdw.apfo.usda.gov>
- US Geological Survey  
<http://gisdata.usgs.gov>
- ESRI  
<http://www.geographynetwork.com>

## Industries

### Hydropower - Safety and Inspections - Initiatives

#### Tips for Developing and Submitting GIS Inundation Map Files

In order to provide assistance on developing and submitting GIS inundation map files to the Commission, FERC staff has created a Frequently Asked Questions (FAQ) document, along with sample map files. The samples are meant to provide an example of what is expected in terms of general appearance and features. The FAQ document will be continually updated as we receive questions during this initiative. Dam owners and contractors are encouraged to check back often.

» [Frequently Asked Questions \(FAQ\)](#) 

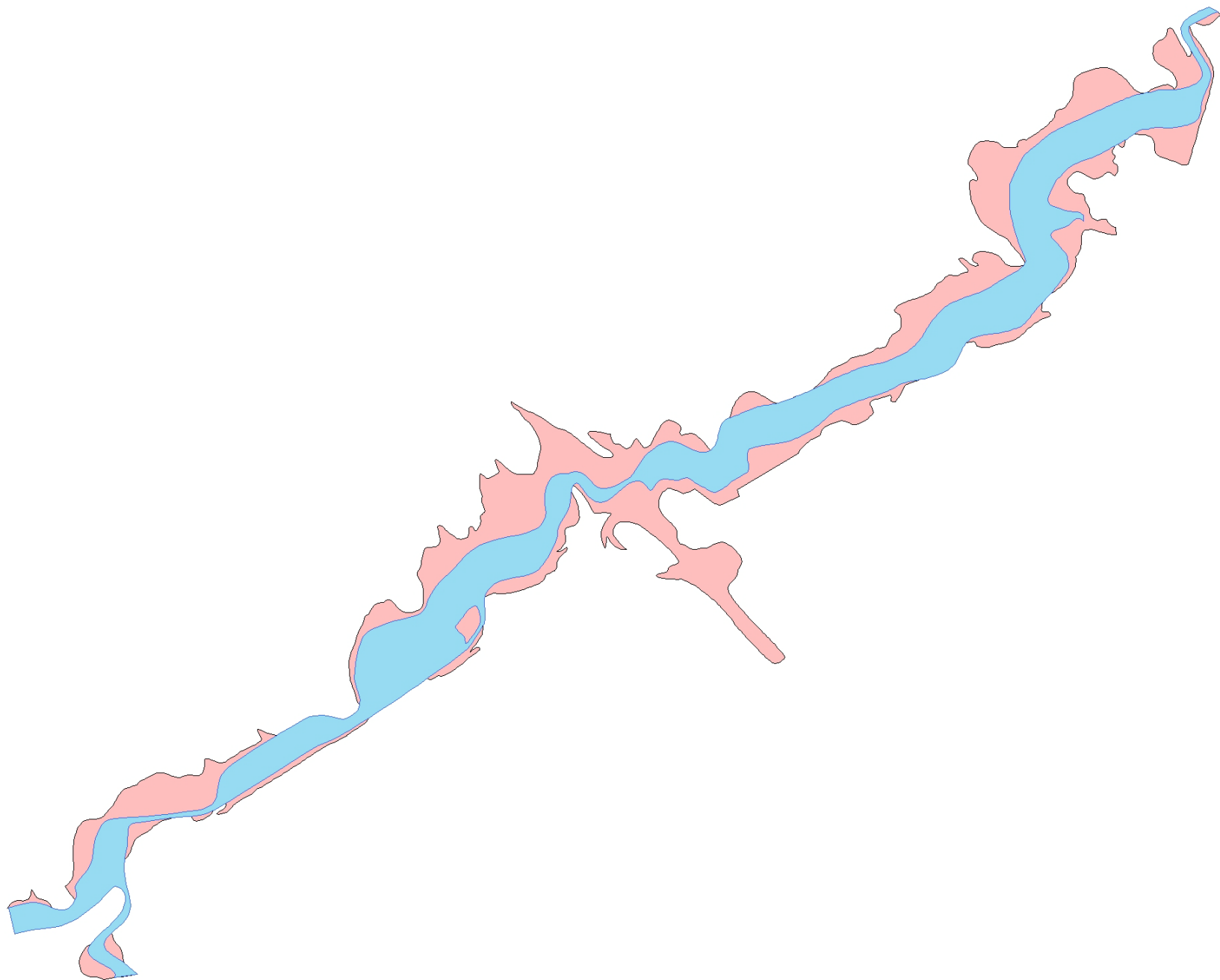
» [Sample Map Files](#) [ZIP]

**Note:** This file is a self-extracting .zip file that contains a fictitious inundation polygon on a section of river in Michigan. The two aerial images are included solely as reference and no such imagery is required as part of the GIS inundation map requirement. All files were created using ArcGIS 9.1 and 9.2.

#### Initiatives

- » [Tips for Developing and Submitting GIS Inundation Map Files](#)
- » [Pumped Storage Technical Guidance Initiative](#)

Updated: February 6, 2008





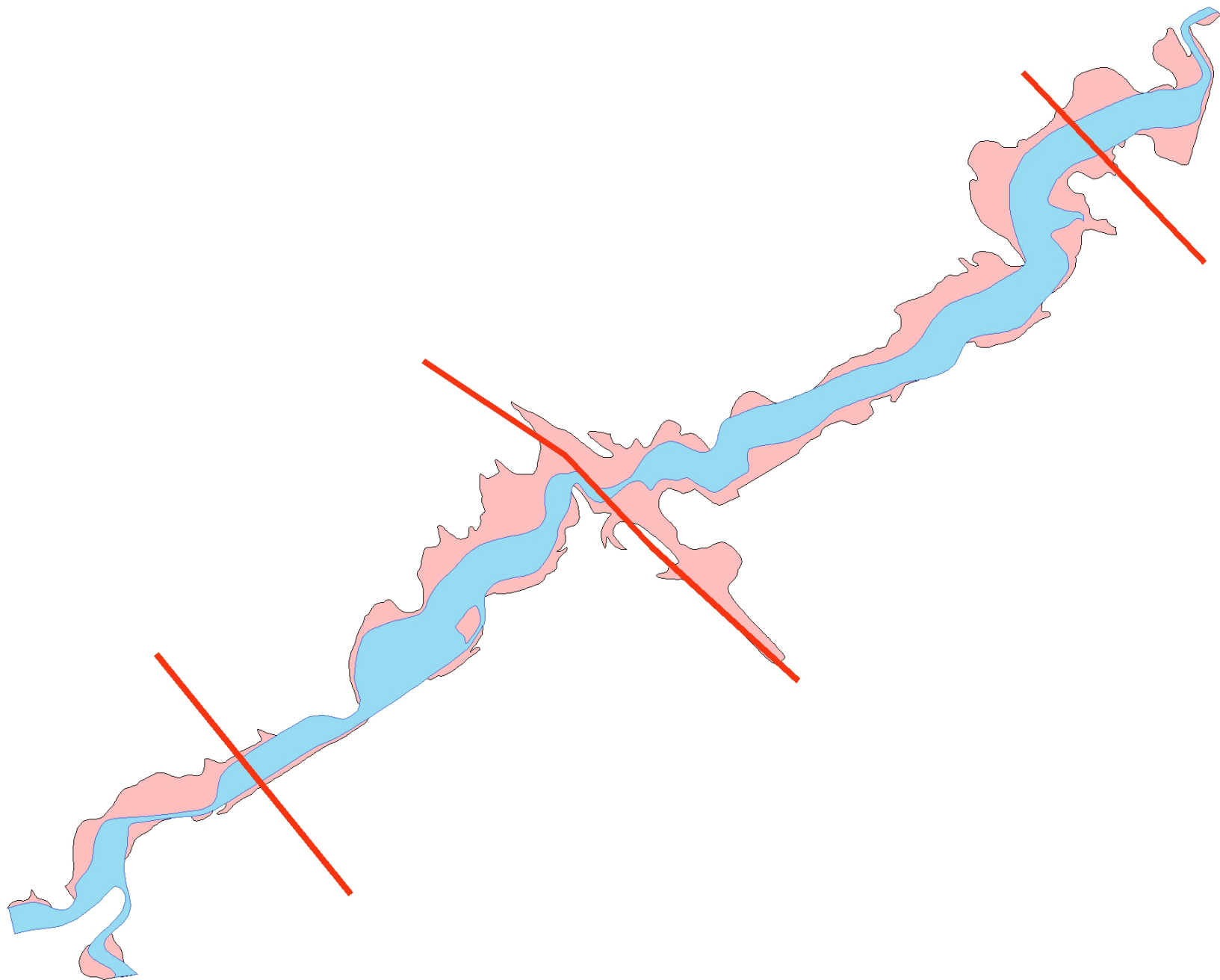
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## Comments on Inundation Areas

- Areas should be a single closed polygon. Collections of line work that is not contiguous will not be accepted.
- Different scenarios should be separate shapes, but can be in separate file if desired.





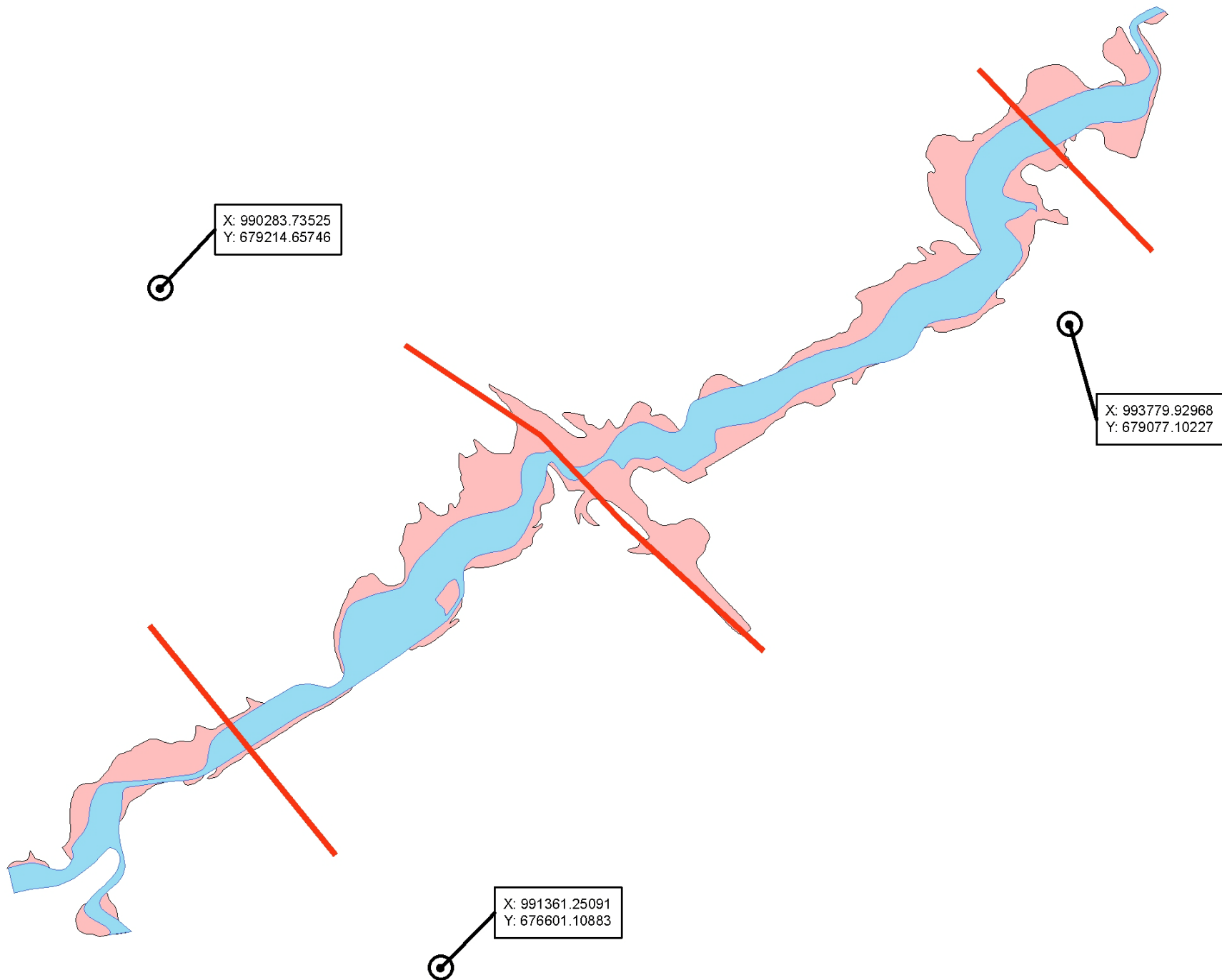


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## Comments on Cross sections

- Table format should be strictly followed.
- If hydraulic modeling results are not available, leave missing data spaces blank.





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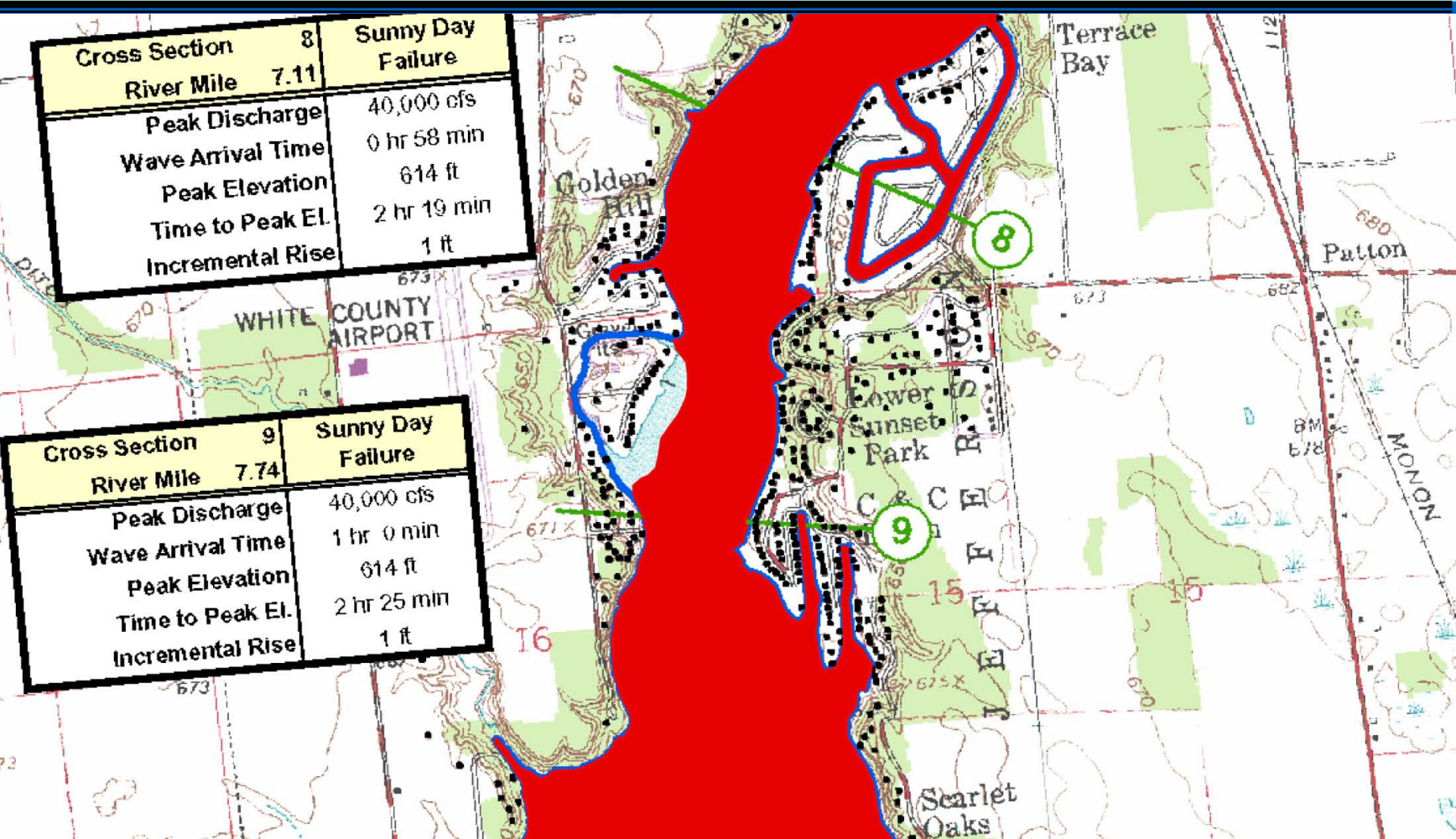


## Comments on Reference Points

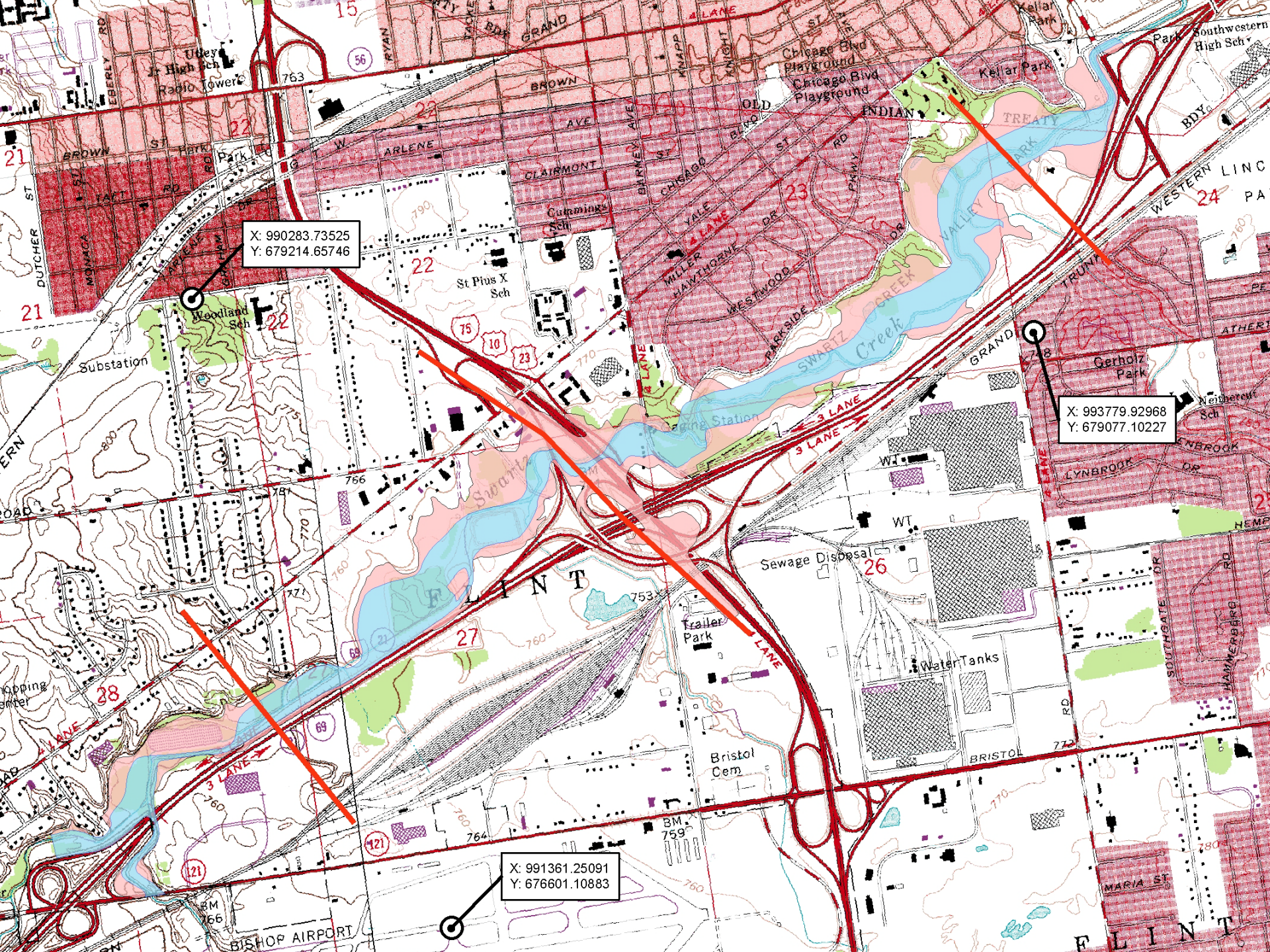
- Ref. Points **do not** need to be physical features.
- The X and Y coordinates of each ref. point should be labeled.
- For structure points, the name of the structure should be labeled (center).



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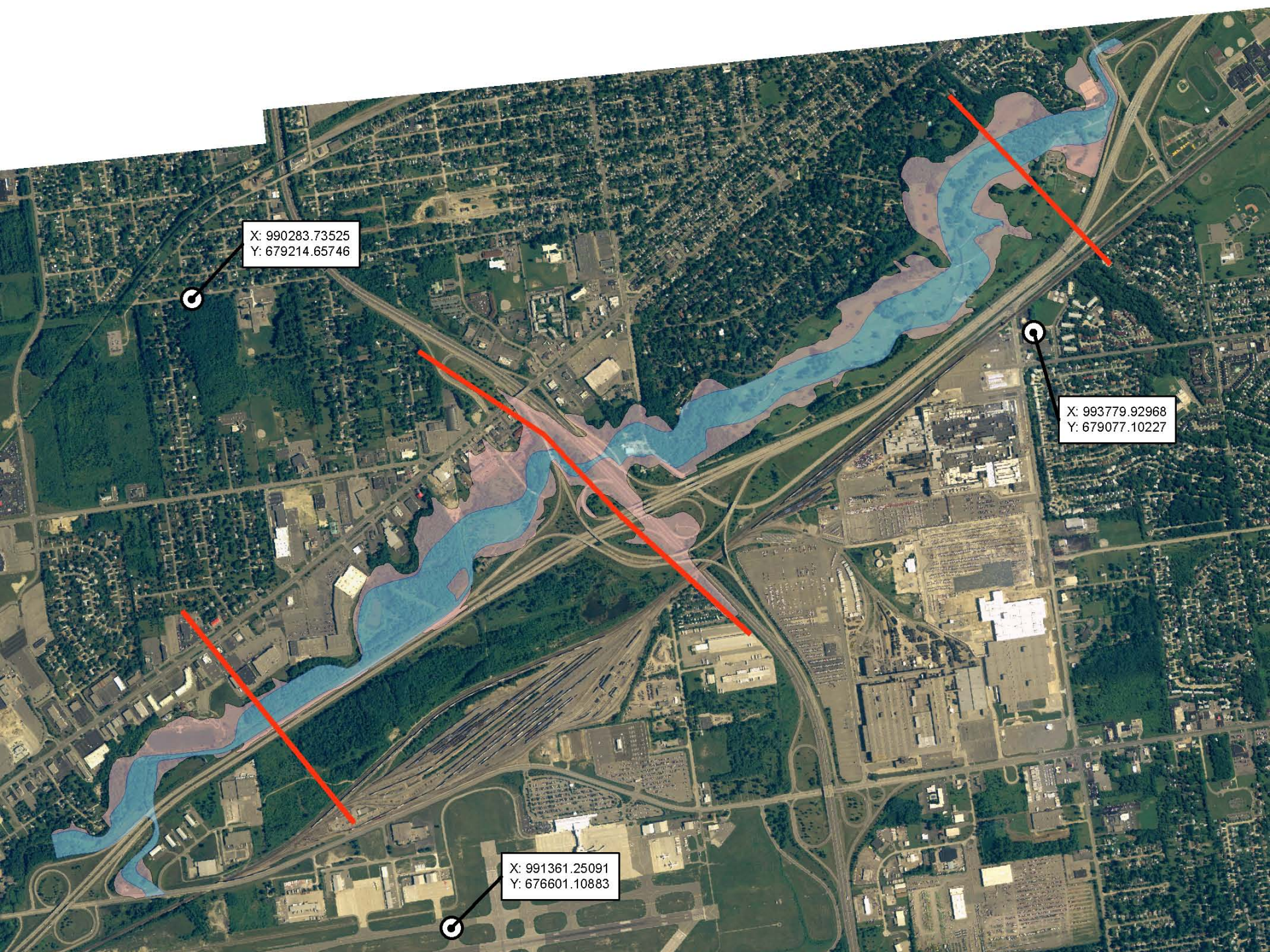


X: 990283.73525  
Y: 679214.65746

X: 993779.92968  
Y: 679077.10227

X: 991361.25091  
Y: 676601.10883





X: 990283.73525  
Y: 679214.65746

X: 993779.92968  
Y: 679077.10227

X: 991361.25091  
Y: 676601.10883





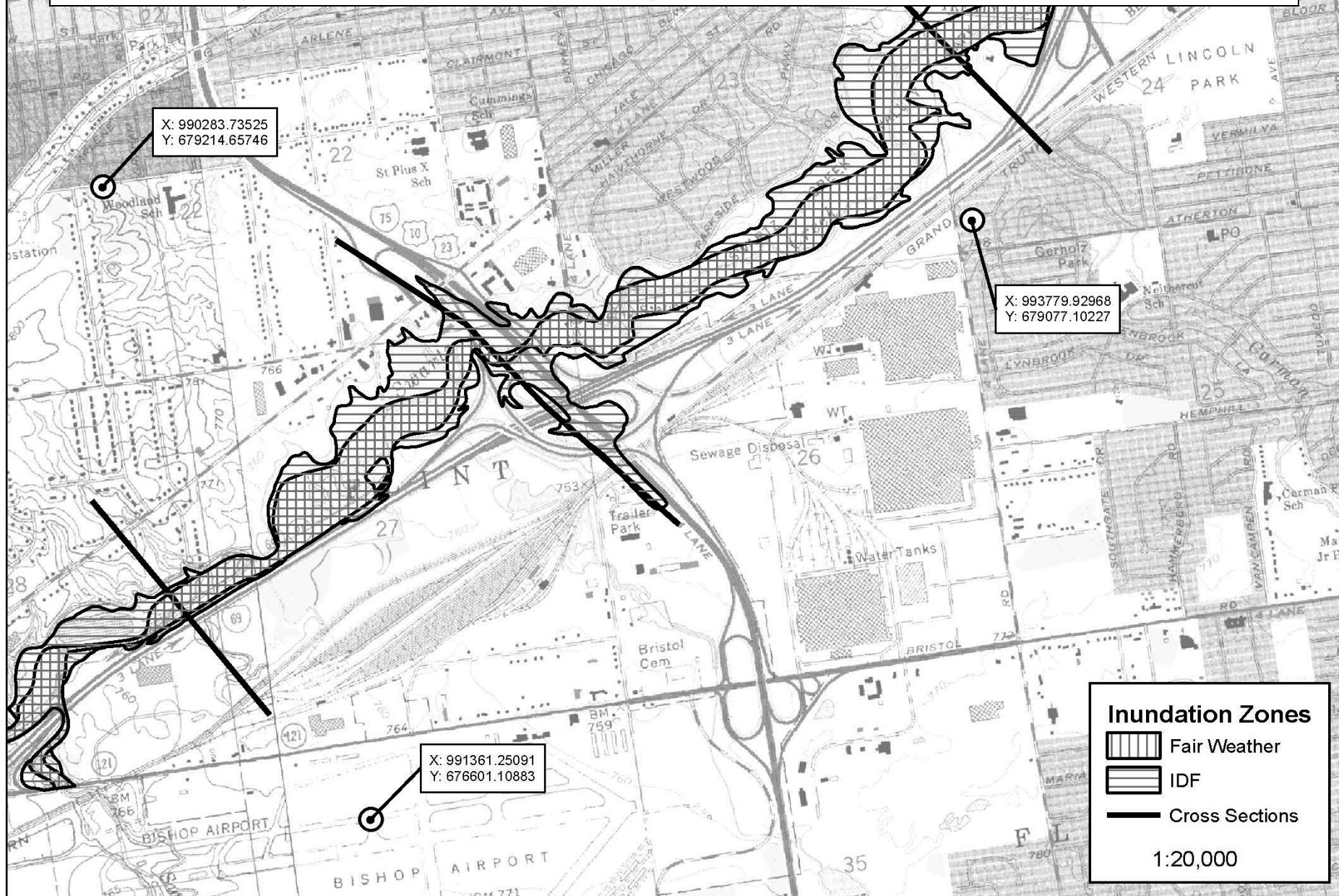
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## Comments on Base data

- Base data should be either aerial photography or topographic maps.
- Base data layer should be dimmed (transparent) so that inundation area is visible.

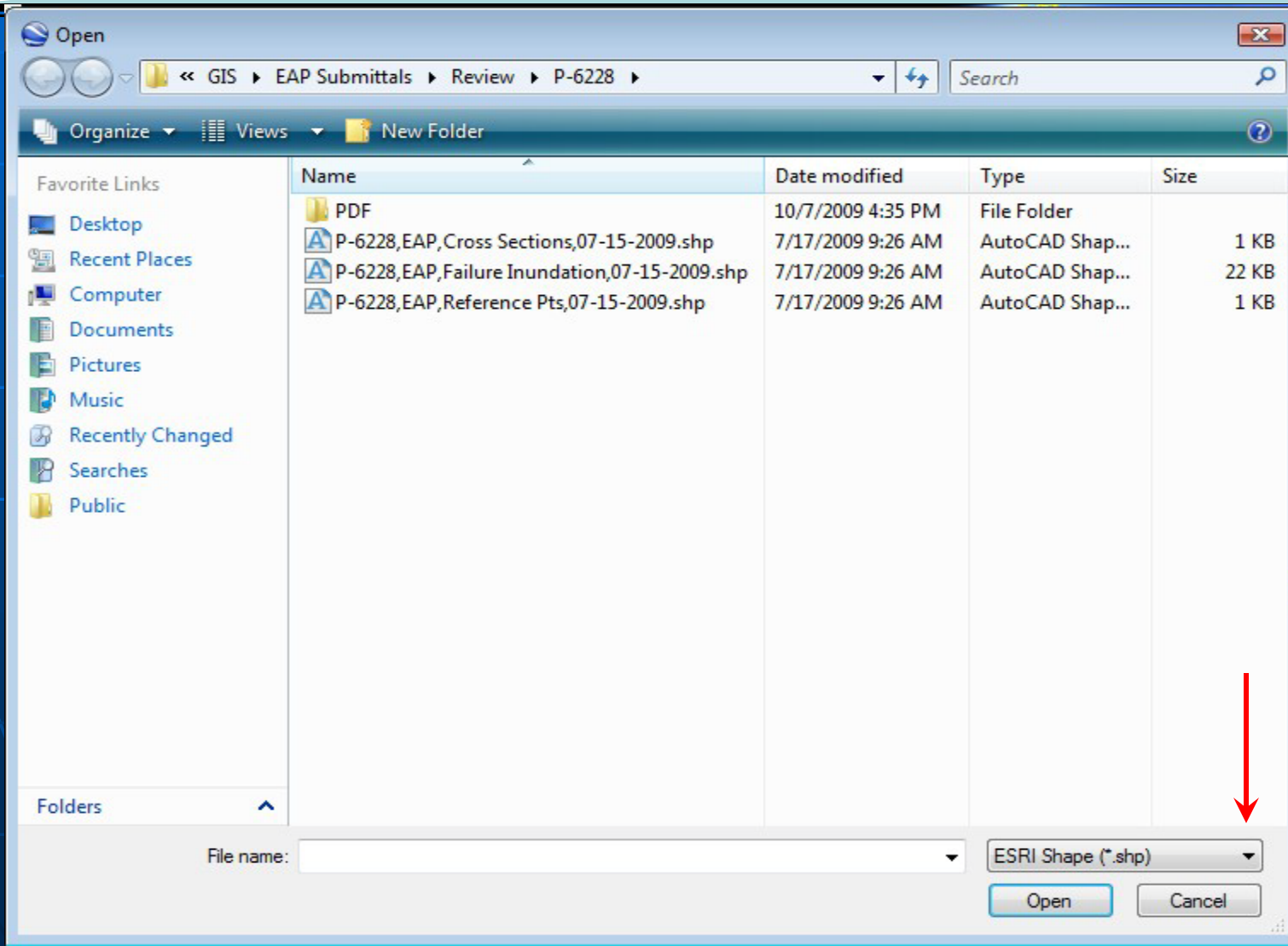
# Example of a Correctly Submitted Raster Map







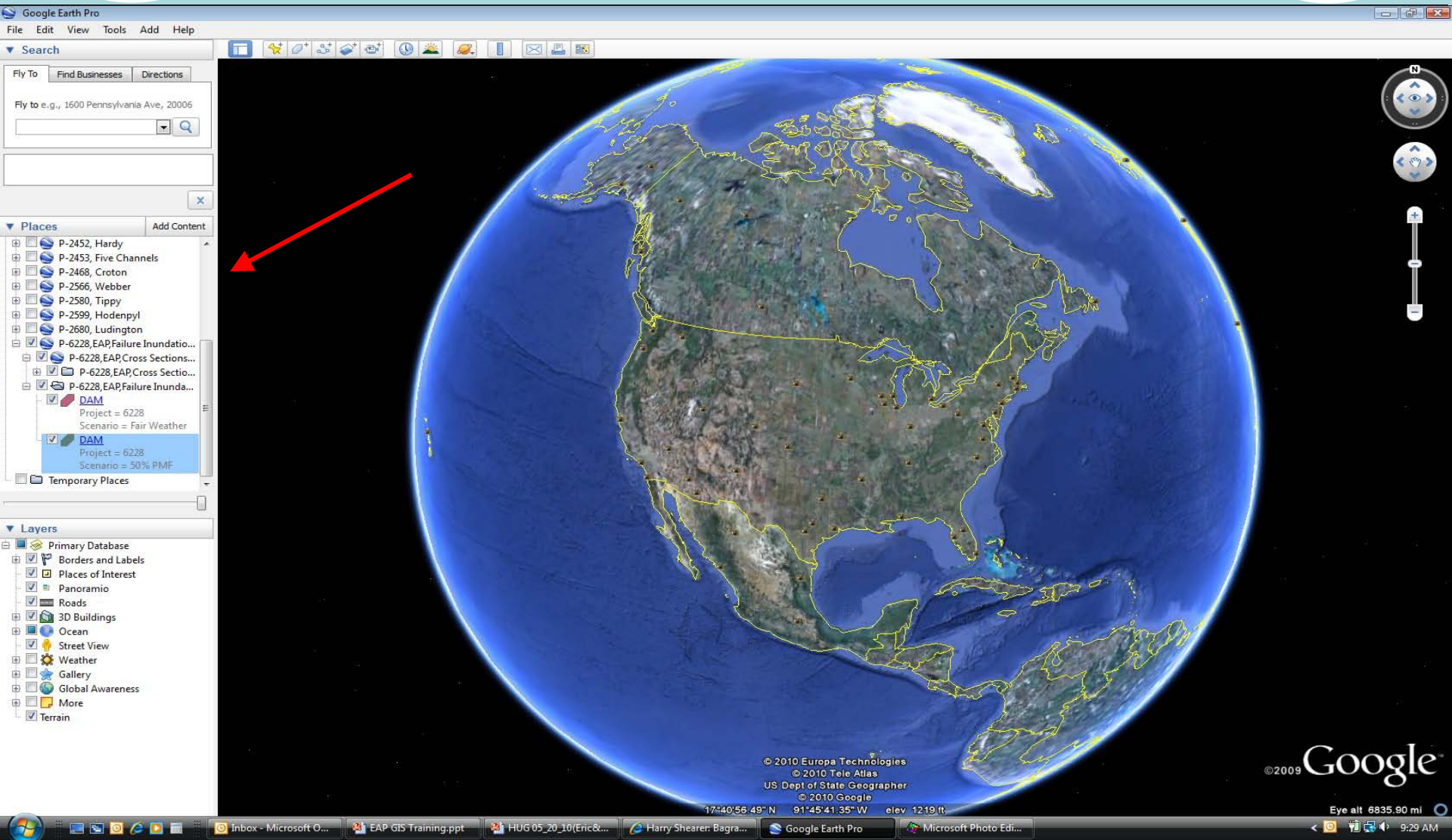
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# GIS Dam Safety Applications







# GIS Dam Safety Applications



Google Earth Pro

File Edit View Tools Add Help

▼ Search

Fly To Find Businesses Directions

Fly to e.g., 37 25.818' N, 122 05.36' W

▼ Places

Add Content

- [-] P-2450, Cooke
- [-] P-2451, Rogers
- [-] P-2452, Hardy
- [-] P-2453, Five Channels
- [-] P-2468, Croton
- [-] P-2566, Webber
- [-] P-2580, Tippy
- [-] P-2599, Hodenpyl
- [-] P-2680, Ludington
- [-] P-6228, EAP Failure Inundatio...
- [-] P-6228, EAP Cross Sections...
- [-] P-6228, EAP Failure Inunda...
- [+] **DAM**
  - Project = 6228
  - Scenario = Fair Weather
  - [+] **DAM**
    - Project = 6228
    - Scenario = 50% Flood

▼ Layers

- Primary Database
- [+] Borders and Labels
- [+] Places of Interest
- [+] Panoramic
- [+] Roads
- [+] 3D Buildings
- [+] Ocean
- [+] Street View
- [+] Weather
- [+] Gallery
- [+] Global Awareness
- [+] More
- [+] Terrain

Google Earth - Edit Polygon

Name: **DAM**

Description Style, Color View Altitude

Lines

Color: ■ Width: 3.0 Opacity: 100%

Area

Color: ☐ Filled+Outlined Opacity: 0%

☒ Random

OK Cancel

© 2010 Google  
Image © 2010 DigitalGlobe  
Image USDA Farm Service Agency  
42°58'09.13" N 85°30'10.79" W elev 630 ft

Eye alt 39403' ft

10:10 AM

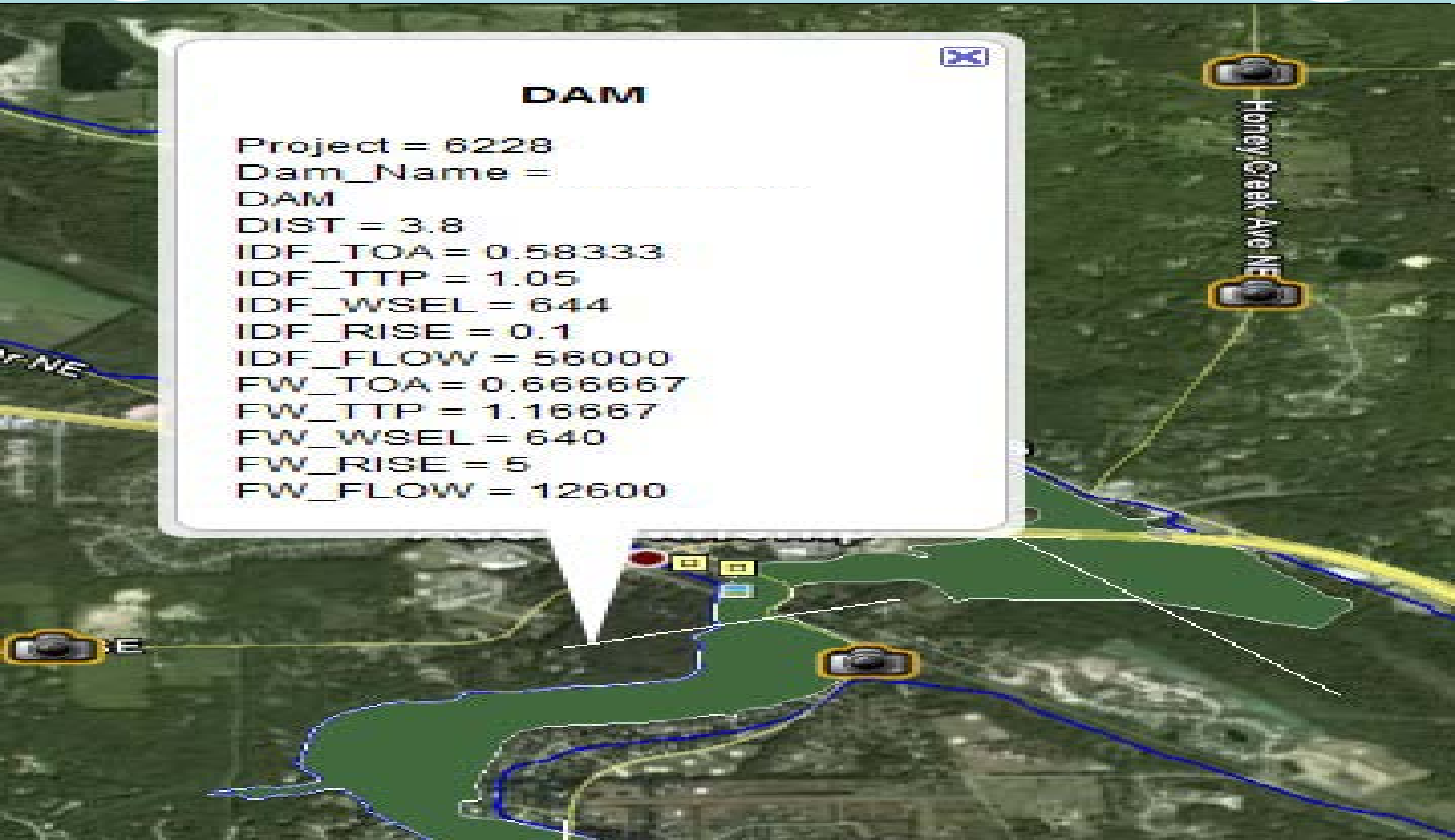


# GIS Dam Safety Applications



**DAM**

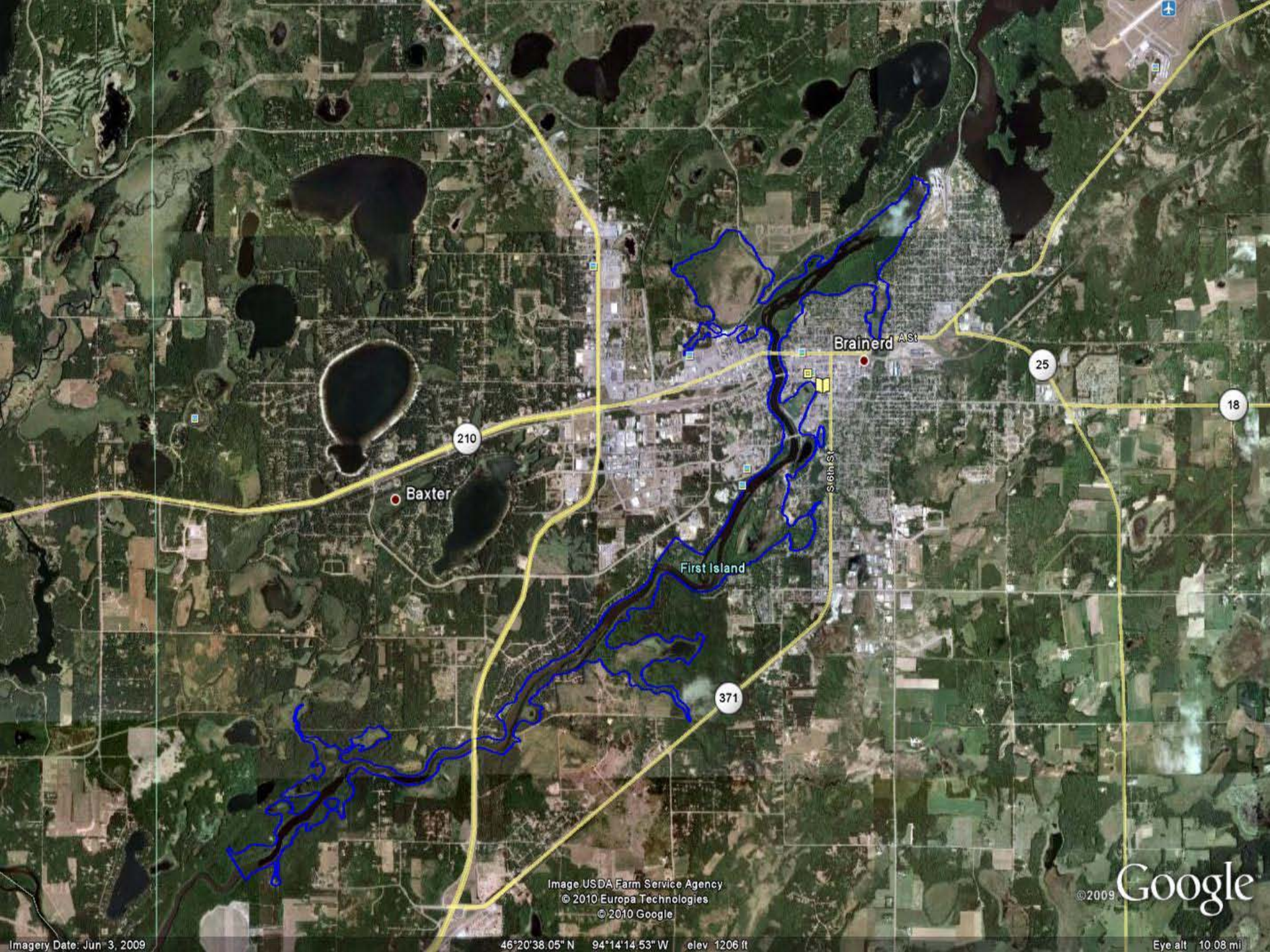
Project = 6228  
Dam\_Name =  
DIST = 3.8  
IDF\_TOA = 0.58333  
IDF\_TTP = 1.05  
IDF\_WSEL = 644  
IDF\_RISE = 0.1  
IDF\_FLOW = 56000  
FW\_TOA = 0.666667  
FW\_TTP = 1.16667  
FW\_WSEL = 640  
FW\_RISE = 5  
FW\_FLOW = 12600











Brainerd

Baxter

First Island

210

25

18

371

56th St

Image USDA Farm Service Agency  
© 2010 Europa Technologies  
© 2010 Google

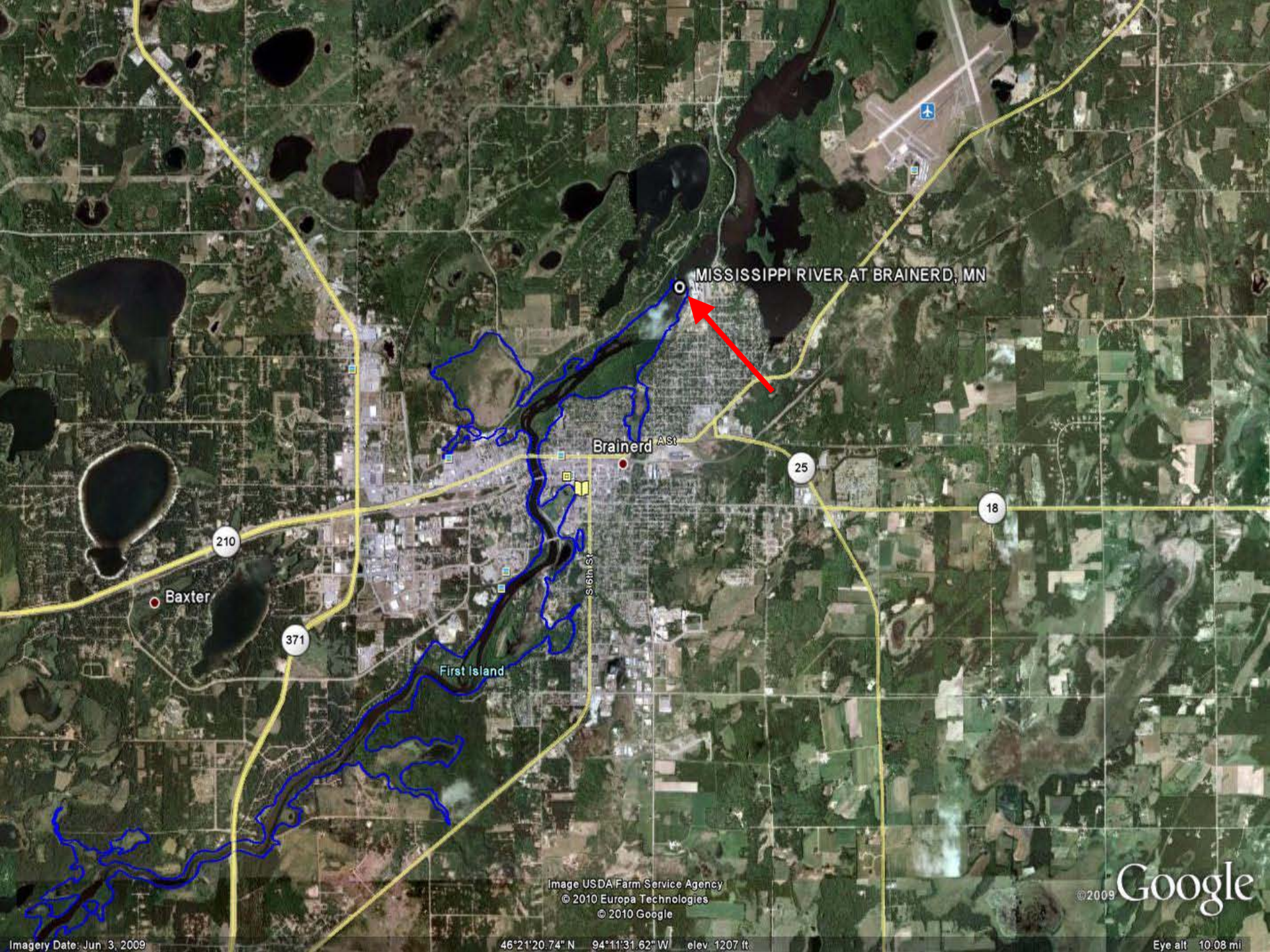
©2009 Google

Imagery Date: Jun 3, 2009

46°20'38.05" N 94°14'14.53" W elev 1206 ft

Eye alt 10.08 mi





MISSISSIPPI RIVER AT BRAINERD, MN

Brainerd AS

Baxter

First Island

Image USDA Farm Service Agency  
© 2010 Europa Technologies  
© 2010 Google

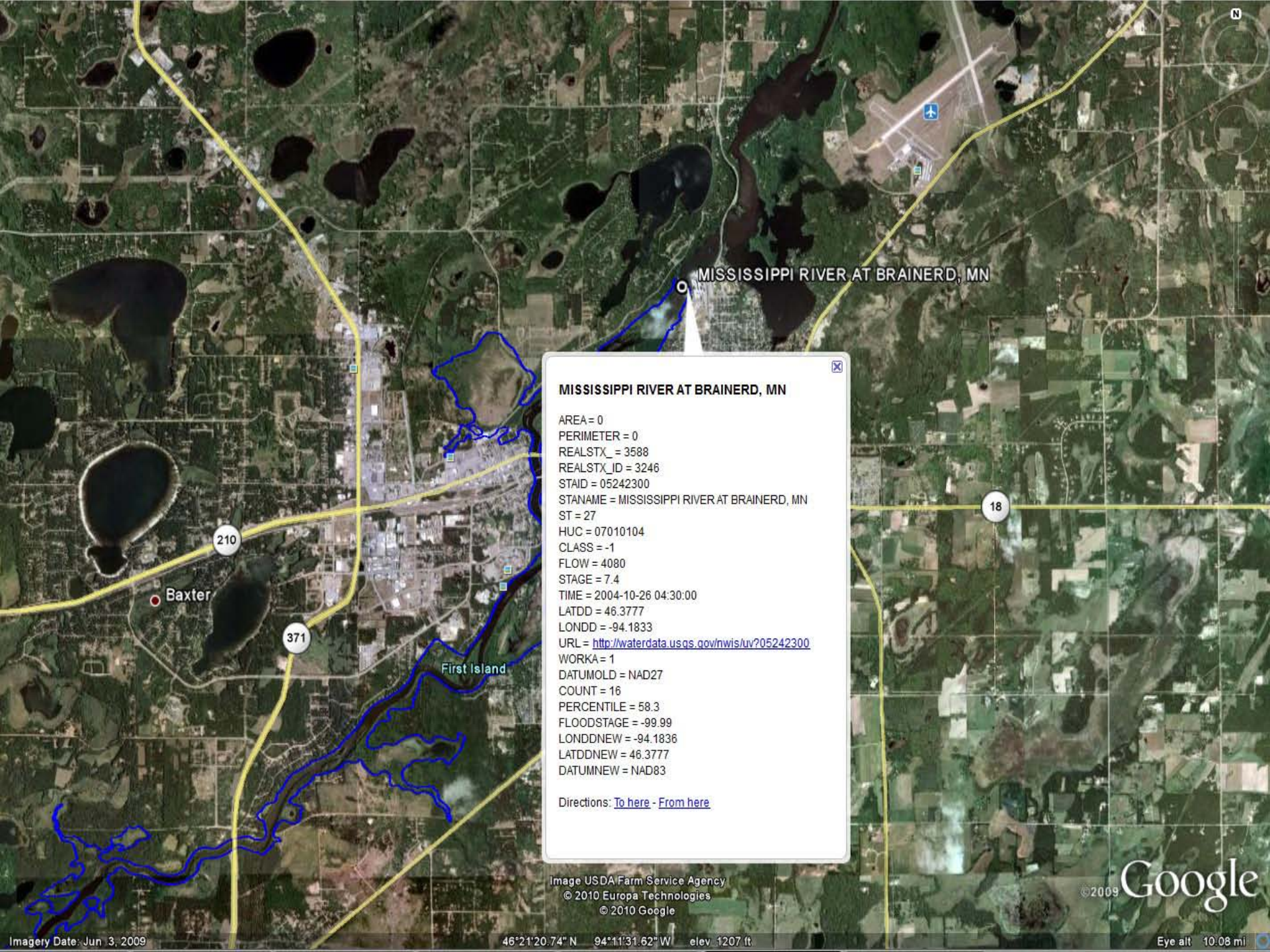
©2009 Google

Imagery Date: Jun 13, 2009

46°21'20.74" N 94°11'31.62" W elev. 1207 ft

Eye alt 10.08 mi





MISSISSIPPI RIVER AT BRAINERD, MN

**MISSISSIPPI RIVER AT BRAINERD, MN**

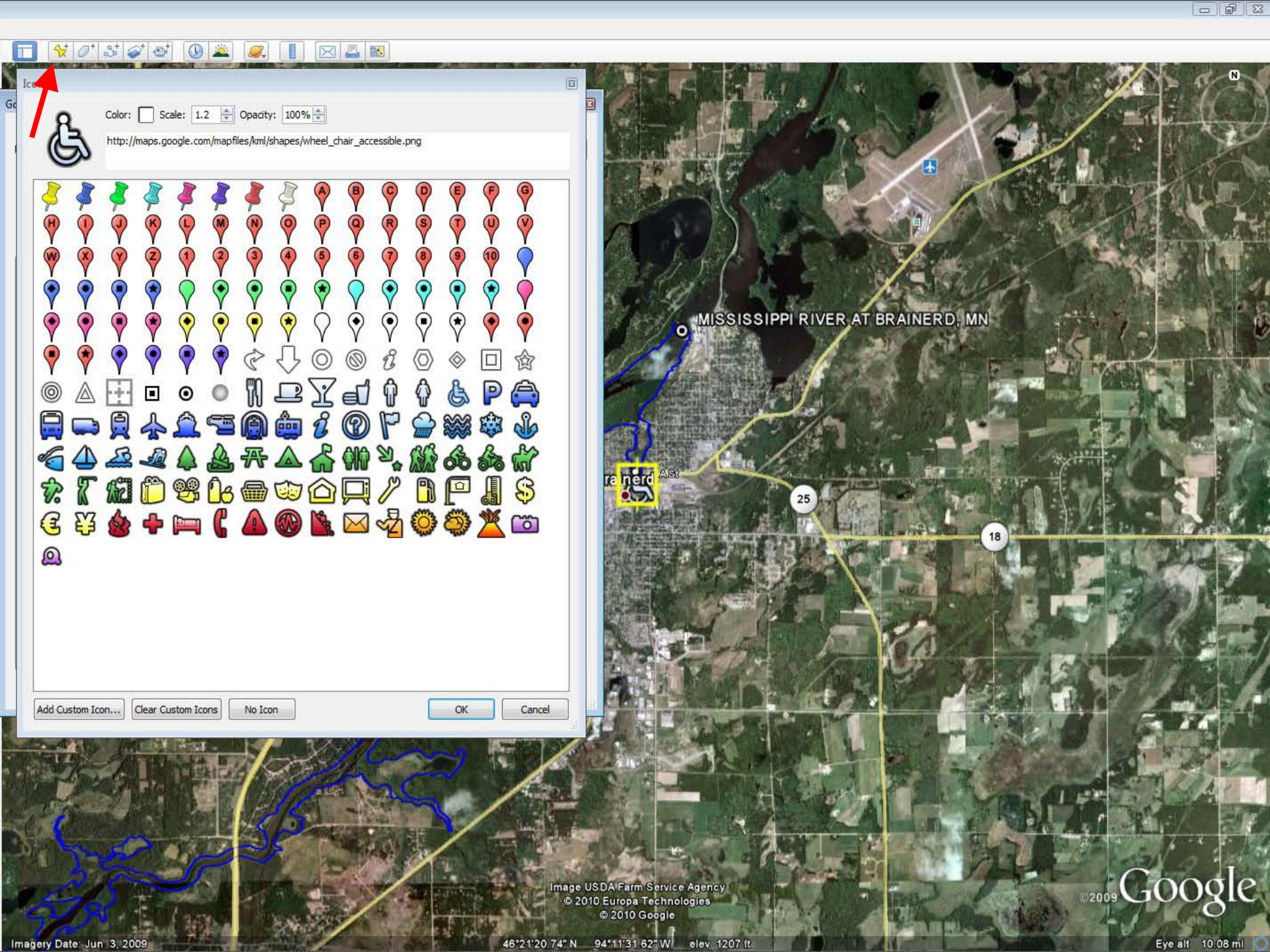
AREA = 0  
PERIMETER = 0  
REALSTX\_ = 3588  
REALSTX\_ID = 3246  
STAID = 05242300  
STANAME = MISSISSIPPI RIVER AT BRAINERD, MN  
ST = 27  
HUC = 07010104  
CLASS = -1  
FLOW = 4080  
STAGE = 7.4  
TIME = 2004-10-26 04:30:00  
LATDD = 46.3777  
LONDD = -94.1833  
URL = <http://waterdata.usgs.gov/nwis/uv?05242300>  
WORKA = 1  
DATUMOLD = NAD27  
COUNT = 16  
PERCENTILE = 58.3  
FLOODSTAGE = -99.99  
LONDDNEW = -94.1836  
LATDDNEW = 46.3777  
DATUMNEW = NAD83

Directions: [To here](#) - [From here](#)

Image USDA Farm Service Agency  
© 2010 Europa Technologies  
© 2010 Google

©2009 Google







EVACUATE

1 Residence

Joe Mill  
743 Fourth Street  
555-7744

Special Needs - Wheel Chair, Oxygen Tank

Arrival Time = 32 minutes  
Time to Peak = 2.25 hours  
Max Rise = 5 feet  
Directions: [To here](#) - [From here](#)

EVACUATE

EVACUATE

EVACUATE



MISSISSIPPI RIVER AT BRAI

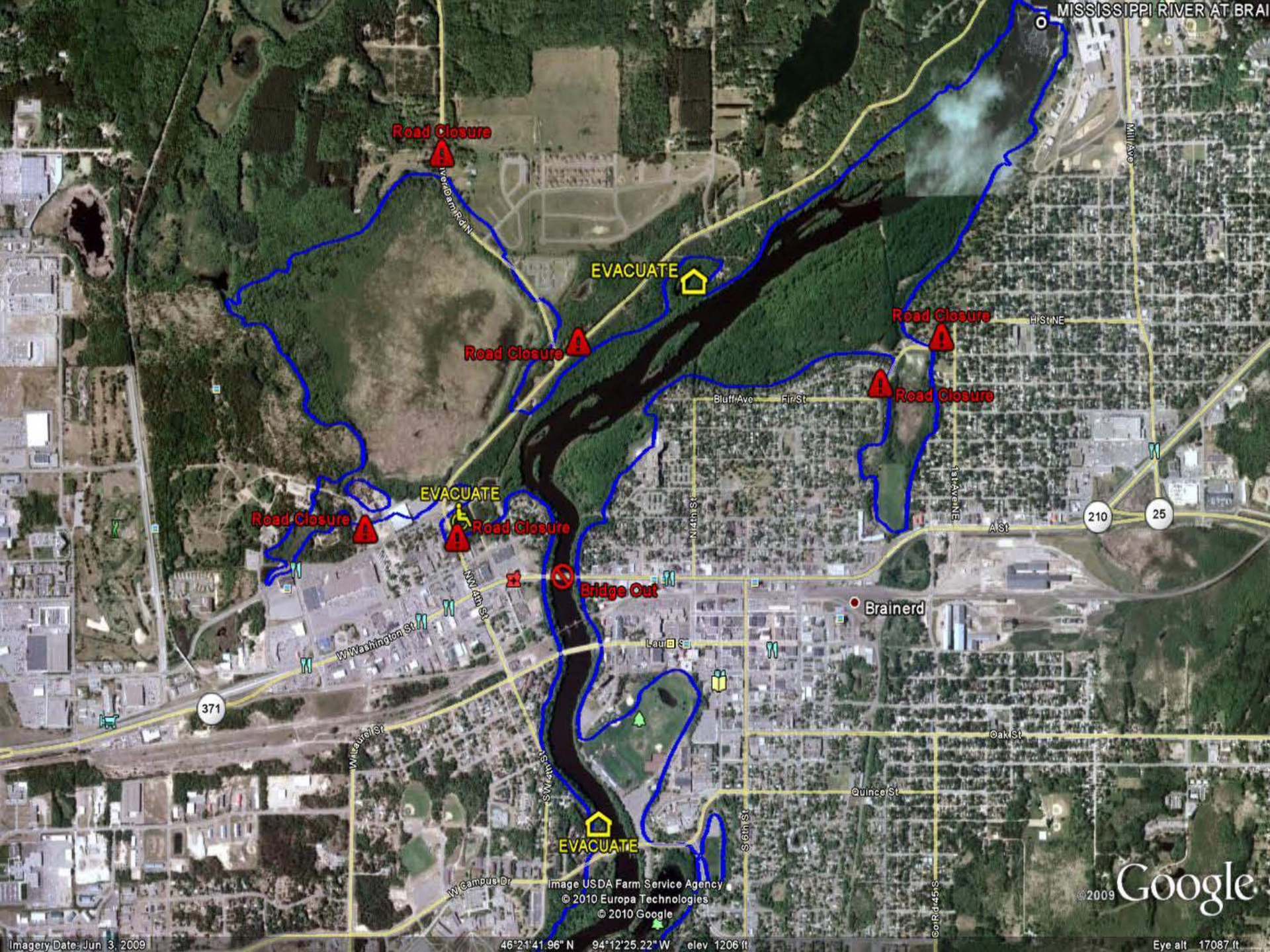


Image USDA Farm Service Agency  
© 2010 Europa Technologies  
© 2010 Google

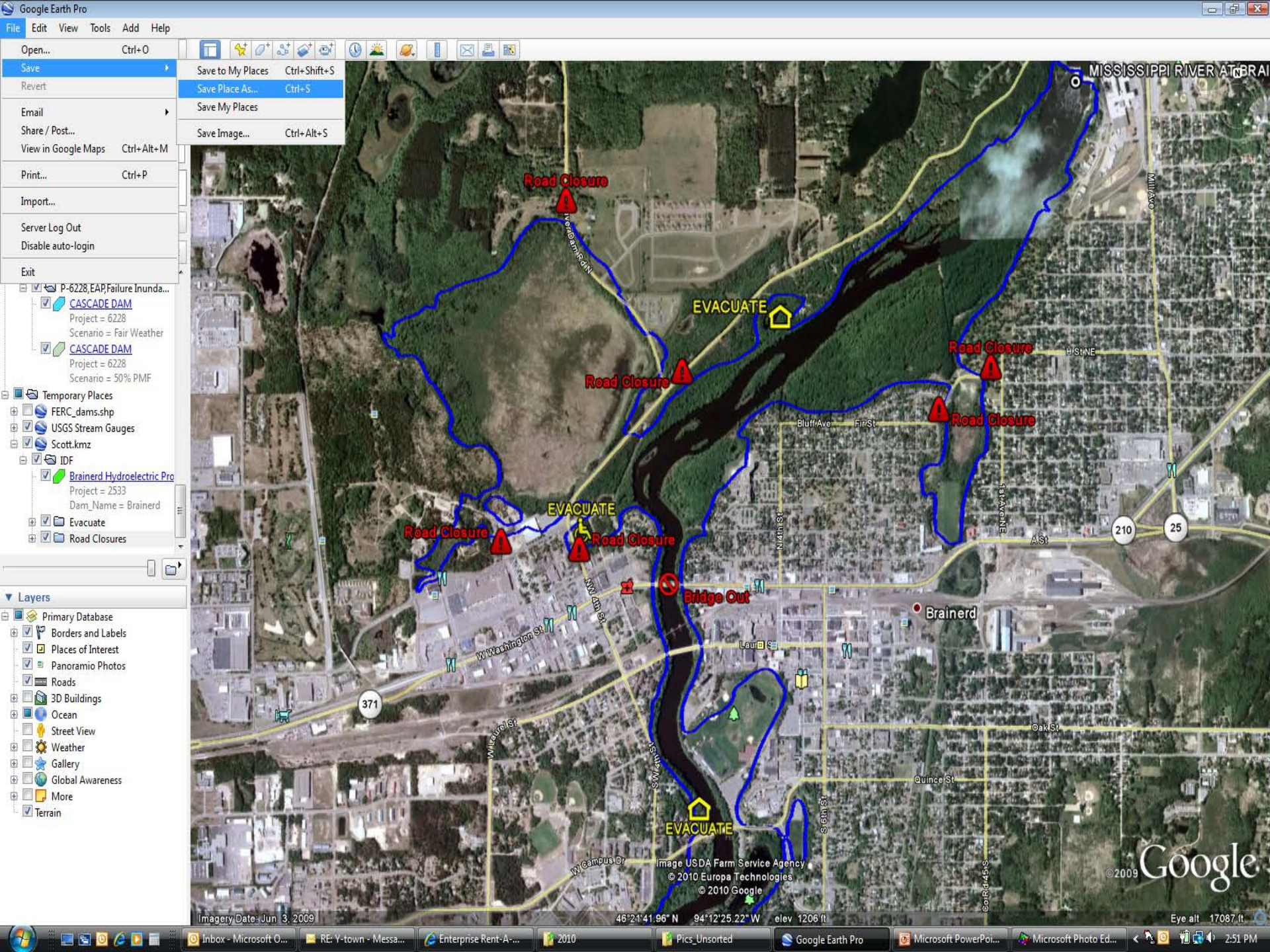
©2009 Google

Imagery Date: Jun 3, 2009

46°21'41.96" N 94°12'25.22" W elev 1206 ft

Eye alt 17087 ft









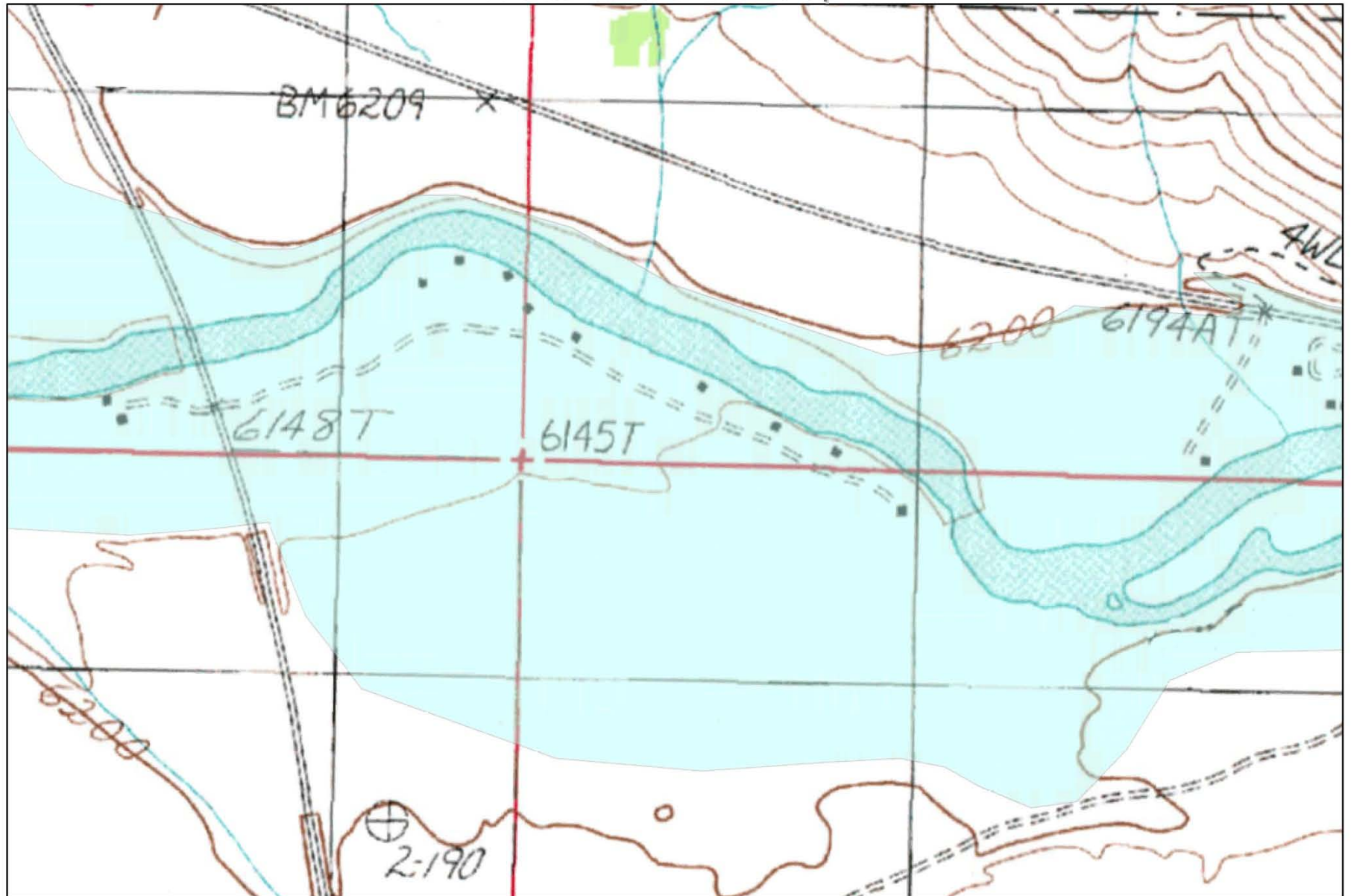
# GIS Dam Safety Applications



## Estimating Population at Risk from GIS inundation files

- Risk Analysis
- Security Group Classification

Estimating the Population Effected  
in a Dam Failure Inundation Zone  
from a USGS Topo



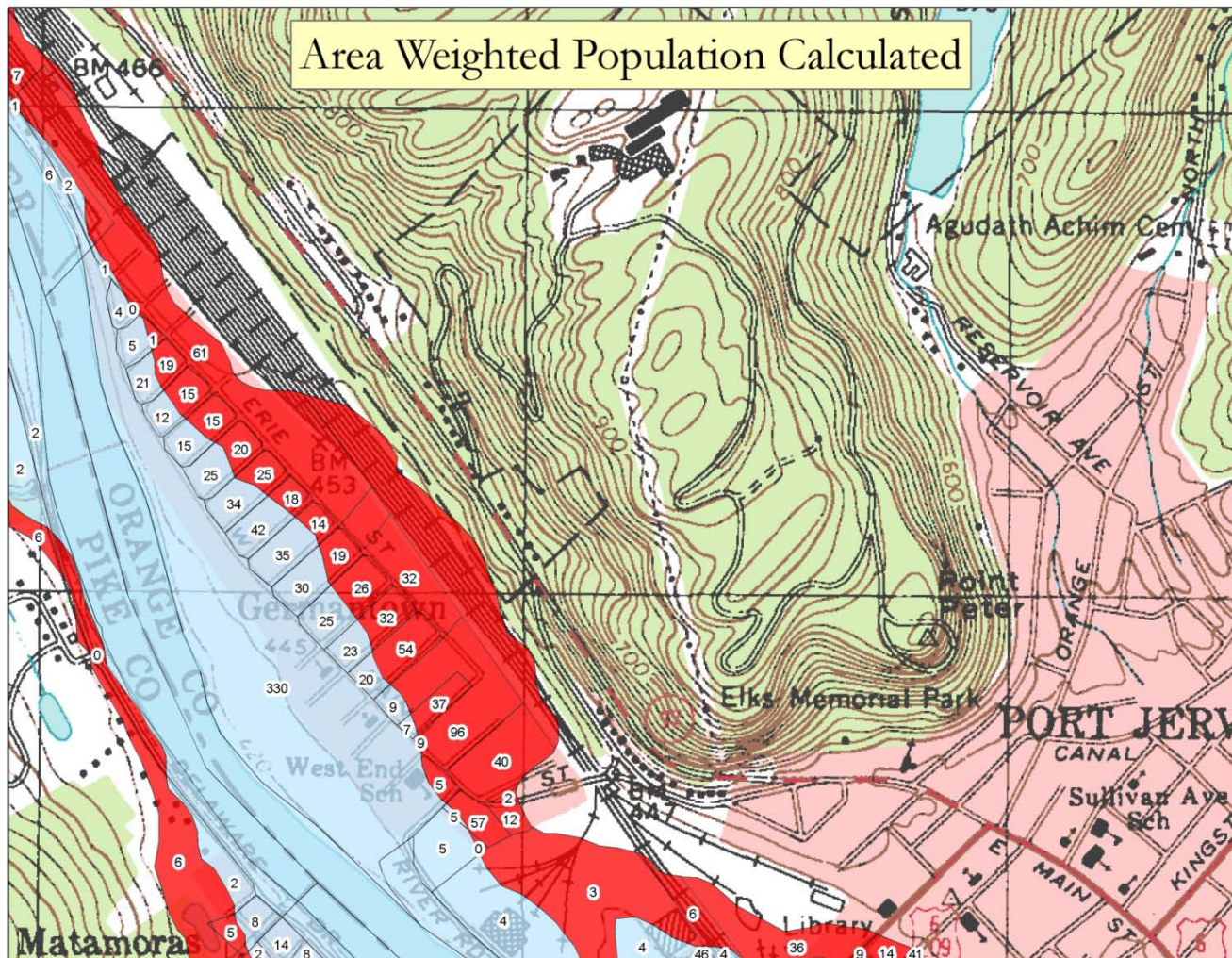
# Estimating the Population Effected in a Dam Failure Inundation Zone from Aerial Photography







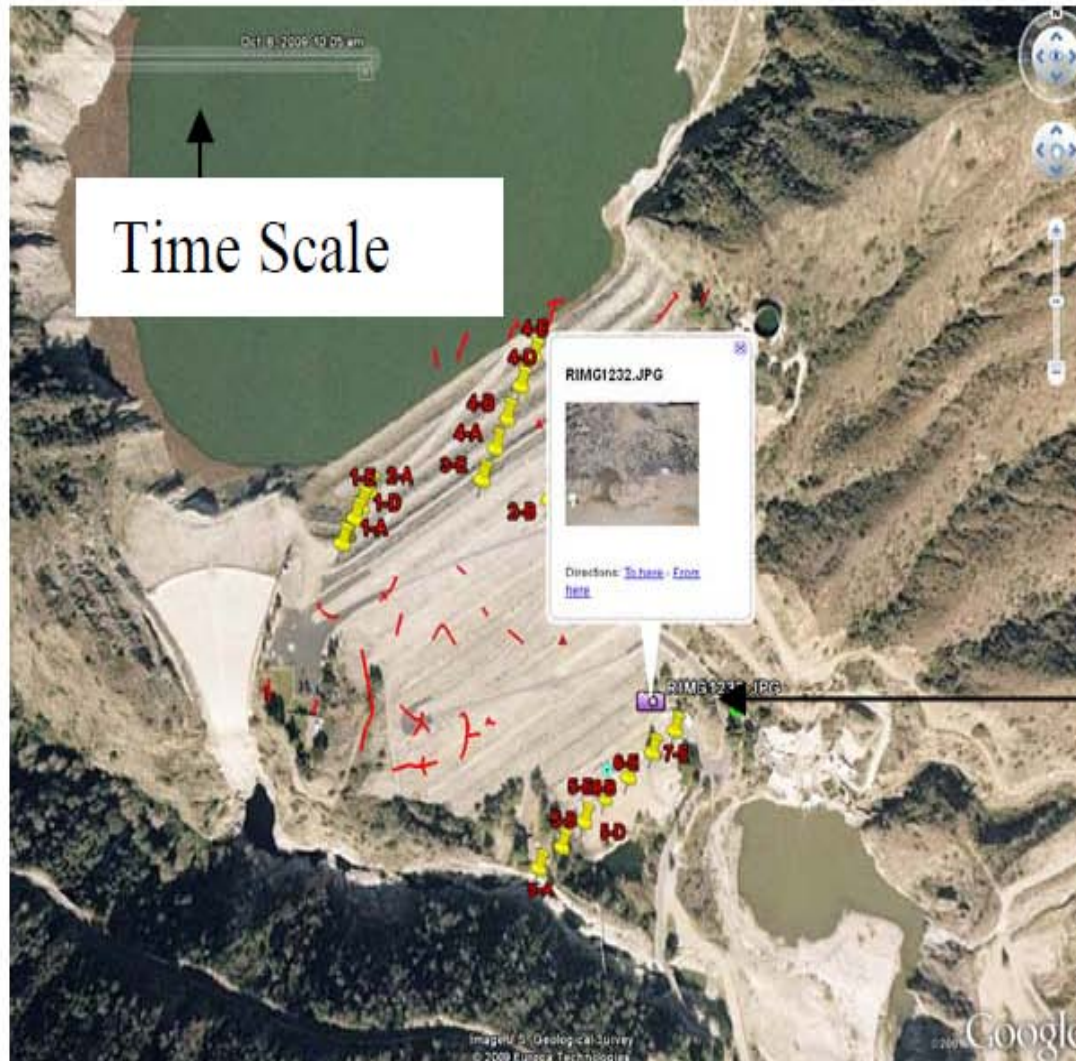
# Census Data GIS Dam Safety Applications







# GIS Dam Safety Applications

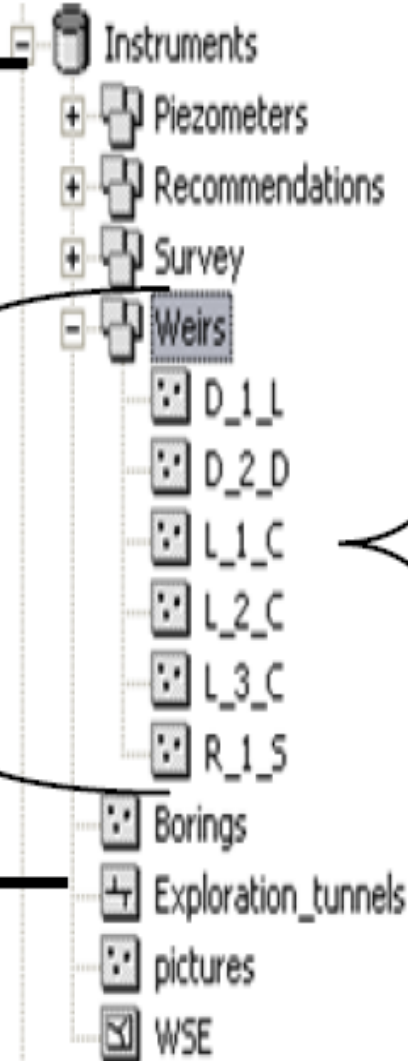


Clickable  
Icon



# GIS Dam Safety Applications

Geodatabase



Feature  
Dataset

Feature  
Class

Attributes of L-1-C

OBJECTID	SHAPE	reading	remarks	who rec	narrative	rea	media_id	feat_n	weir_id	read_date
121	Point Z	0.95	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960413
122	Point Z	0.95	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960413
123	Point Z	0.95	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960414
124	Point Z	0.95	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960414
125	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960415
126	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960416
127	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960416
128	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960417
129	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960417
130	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960418
131	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960418
132	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960419
133	Point Z	1.07	<Null>	<Null>	Exit from main	cts	Refdoc\piezc	L-1-C	SG_weirL1C	19960419





# GIS Dam Safety Applications



## Review Aerial Imagery

- Inventory the total number of trees at Dam



## Review Individual Photos

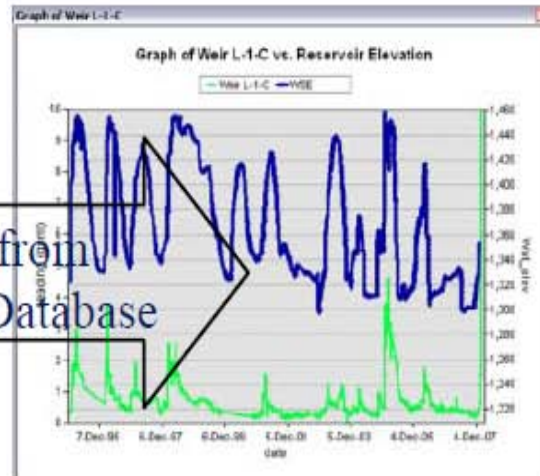
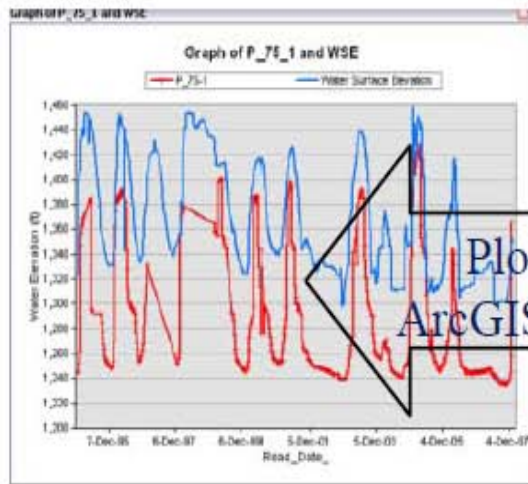
- For species type, height, etc.



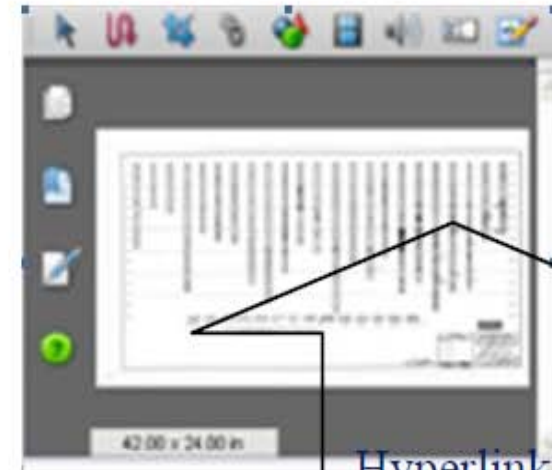




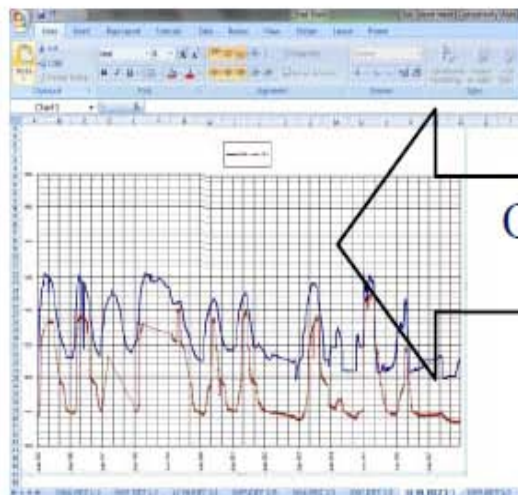
# GIS Dam Safety Applications



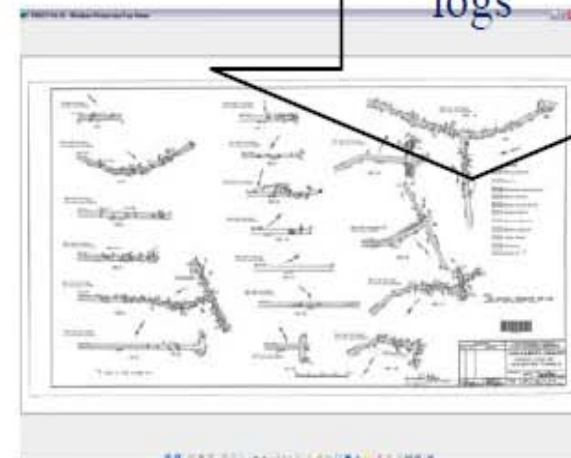
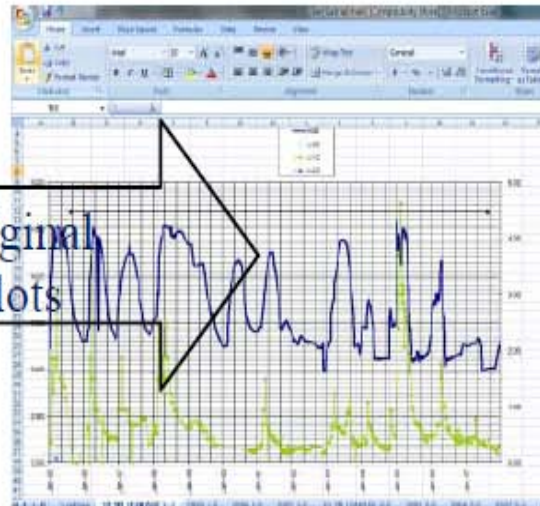
Plots from  
ArcGIS Database



Hyperlink  
Subsurface  
logs



Original  
Plots





# GIS Dam Safety Applications

Abnormal  
Reading  
Identified

- Review GIS system



Review  
Original Data

- Review logged data spreadsheet



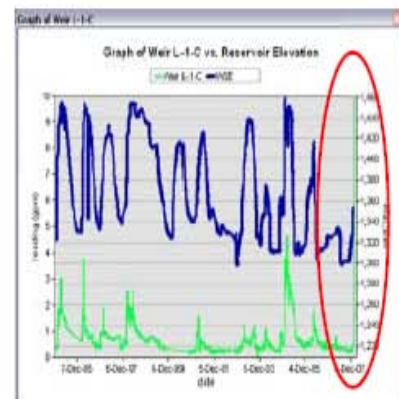
Review  
Photographs

- L-1-C near the abnormal reading date (2/12/08)

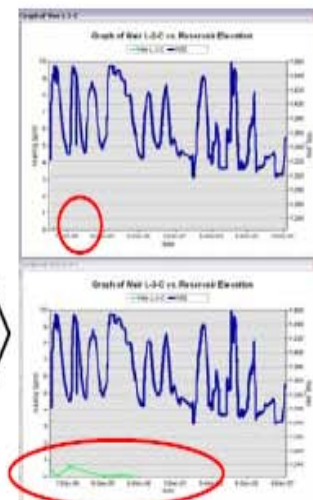


Review  
Other  
Instruments

- Weirs L-2-C and L-3-C



A	B
DATE	L-1-C
1/2/2008	0.28
1/8/2008	0.47
1/15/2008	0.47
1/22/2008	0.63
2/5/2008	1.5
2/12/2008	15







# GIS Dam Safety Applications



Questions?

Eric Gross – 312-596-4448

Scott Airato – 312-596-4431