GEOSPATIAL INFORMATION & TECHNOLOGY ASSOCIATION®

Terrestrial Spill Modeling – Increasing Confidence in the Estimation of HCA Impact

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Liquids Transmission Pipelines

- Integrity Management Program
- Locate Pipeline Segments That Could Affect HCAs

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Refinement to the Buffer

- Direct Impact
- Indirect Impact
- Potential Impact

- Consider effects of terrain and hydrology

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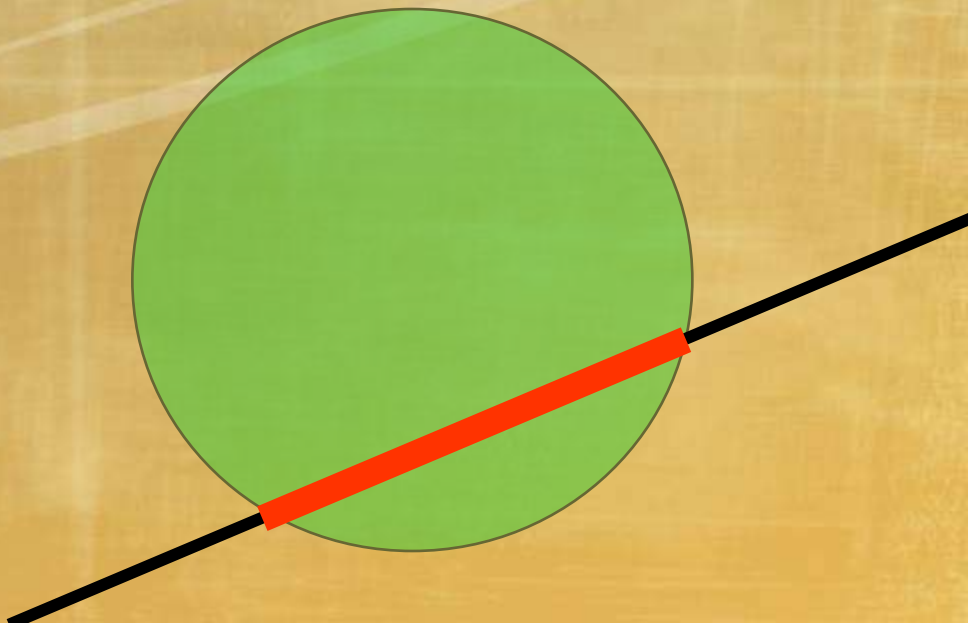
Direct Impact

- Pipe directly passes through
- Record the pipeline segment



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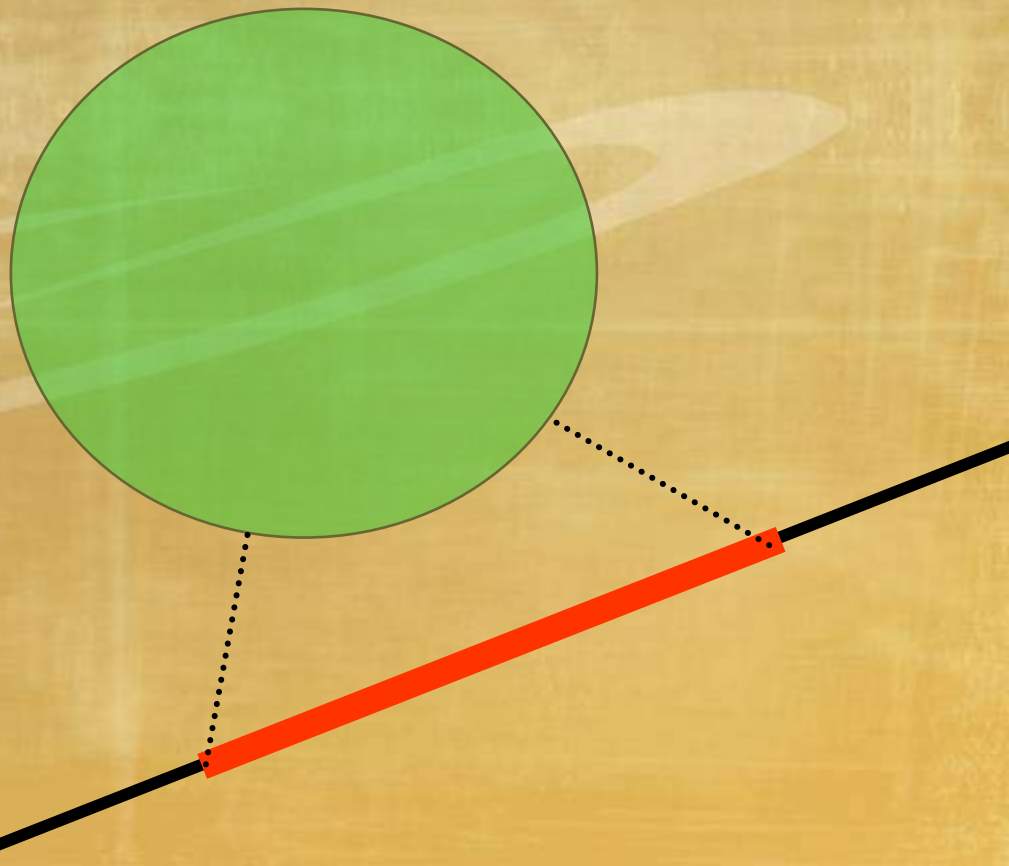
Indirect Impact

- Segments of pipeline within a specified distance of HCAs



Potential Impact: Simple Buffer Method

- Set buffer around pipeline
- Intersect with HCAs

Problem:

- What buffer distance?

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Buffer Distance

Vary by considering

- Terrain
- Hydrology

Problem:

- Tends to be Qualitative

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Potential Impact: Spatial Modeling Method

- Model terrain and hydrological transport
- Find pipe with potential to affect HCAs

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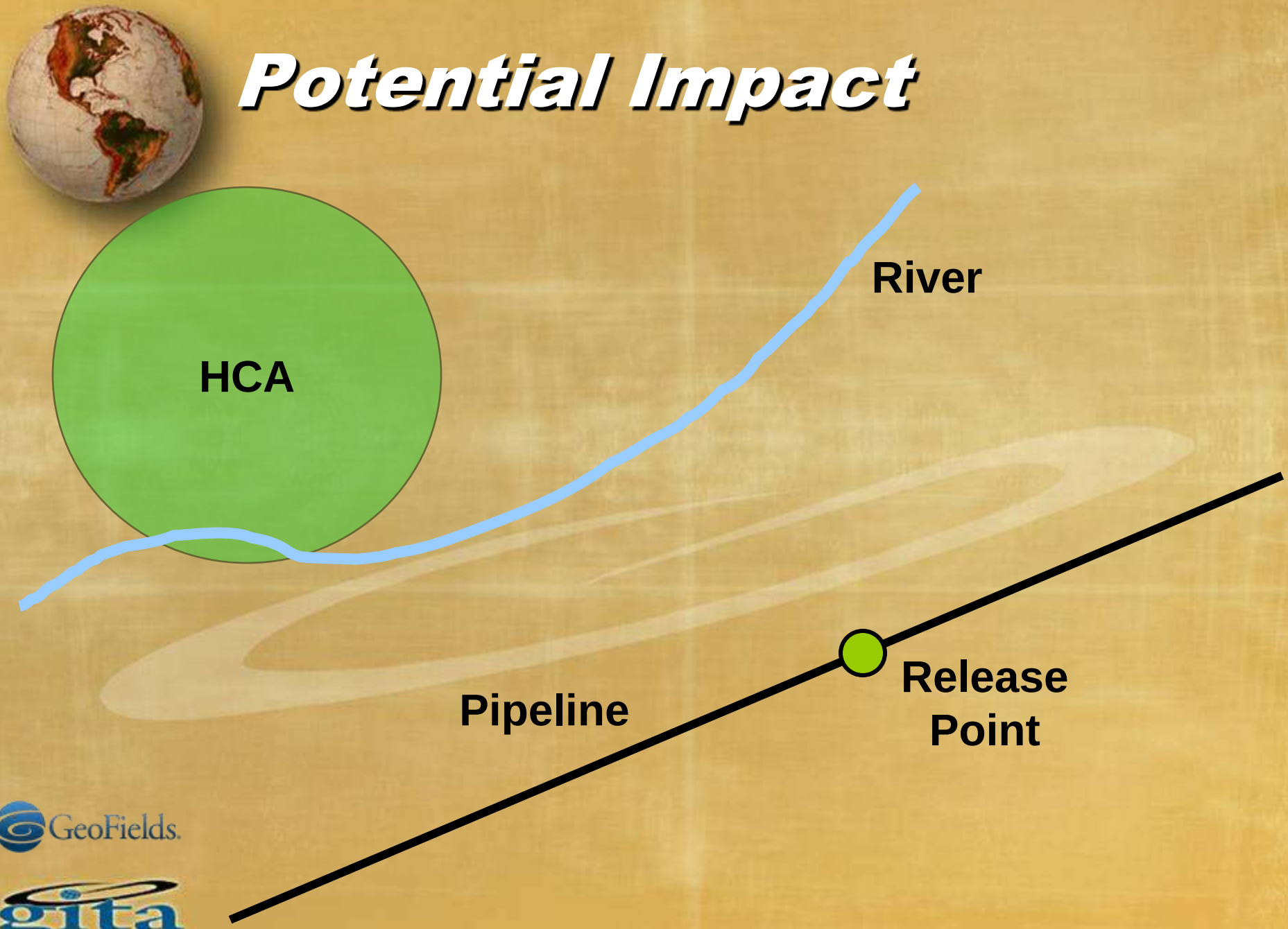
Potential Impact



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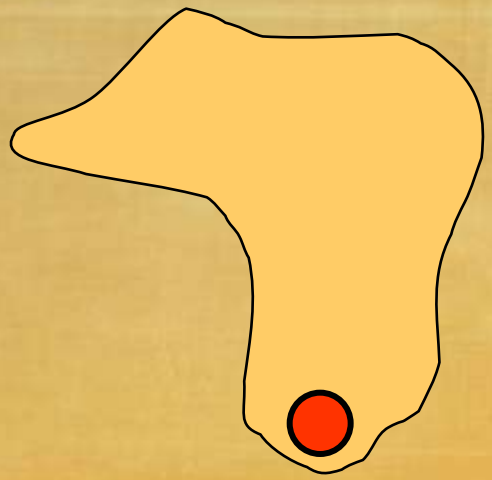
Overland Spread

- Model the flow of liquid over land
- Account for terrain
- Considers pool thickness
- Time elapsed can be estimated with an understanding of flow rate



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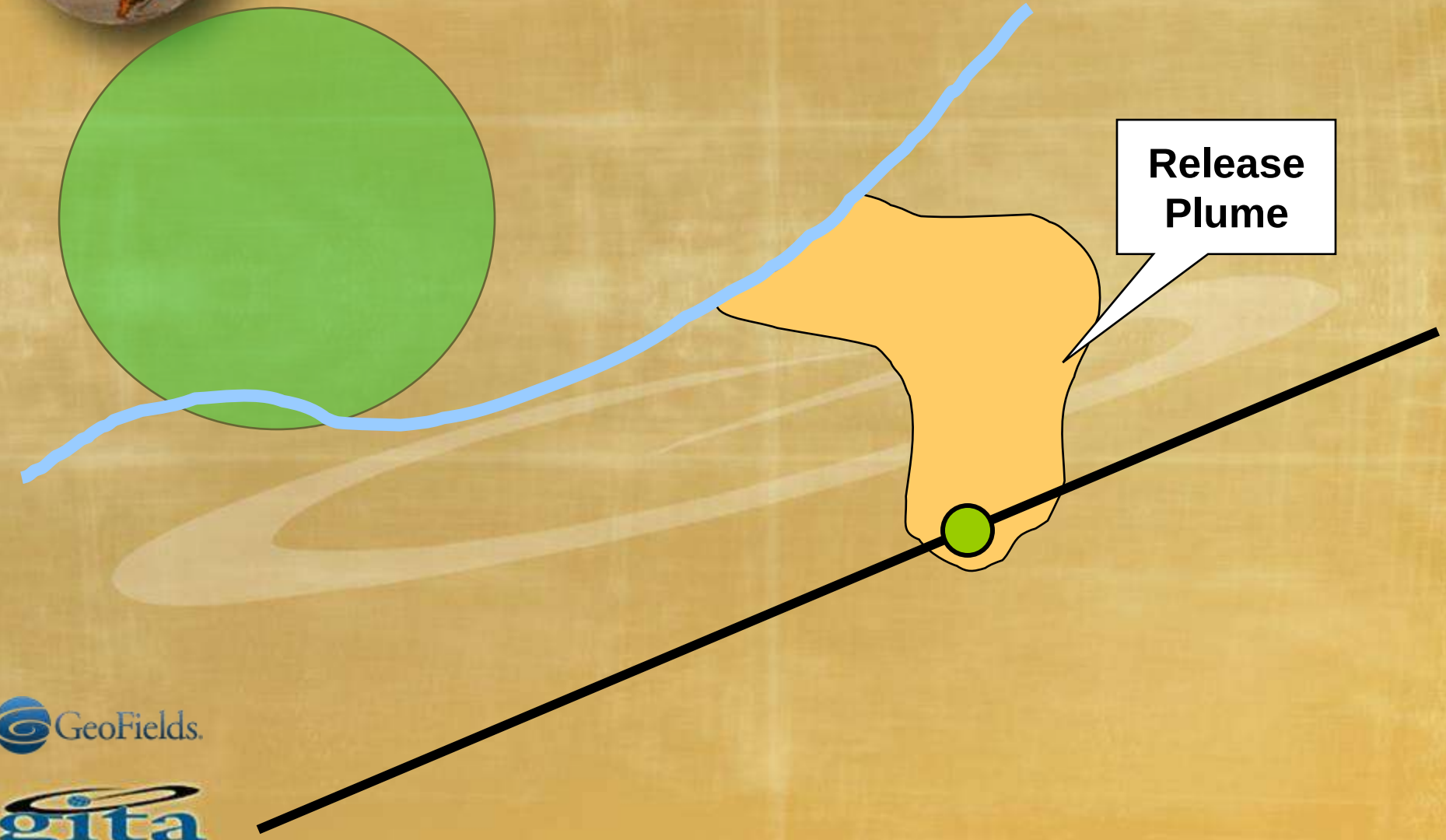
Potential Impact



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Hydrological Analysis

- Capture Overland Spread at hydrological features
  - Prevents flow across rivers
- Flow direction
- Flow rate
- Carry through stream network

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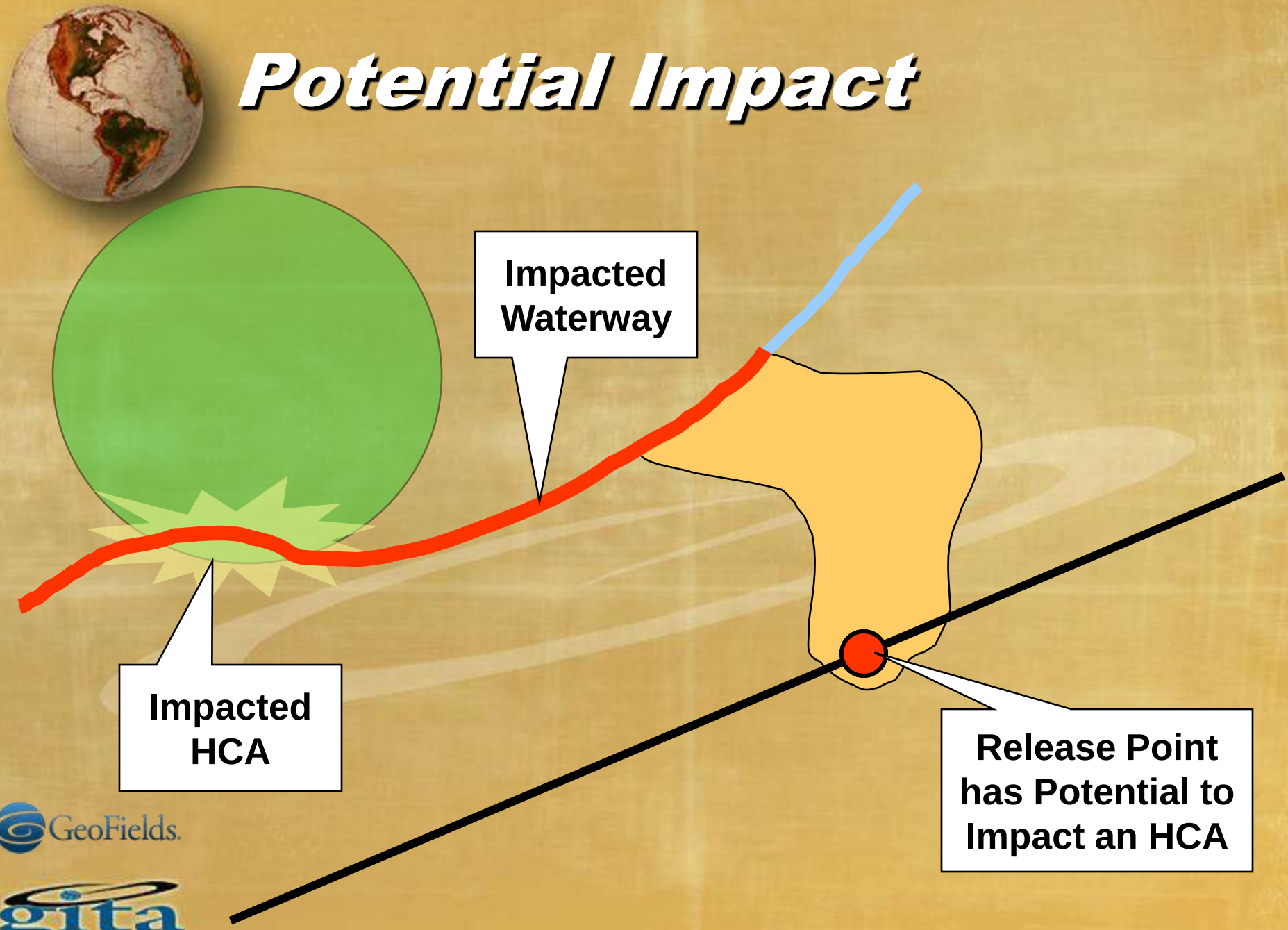
Potential Impact



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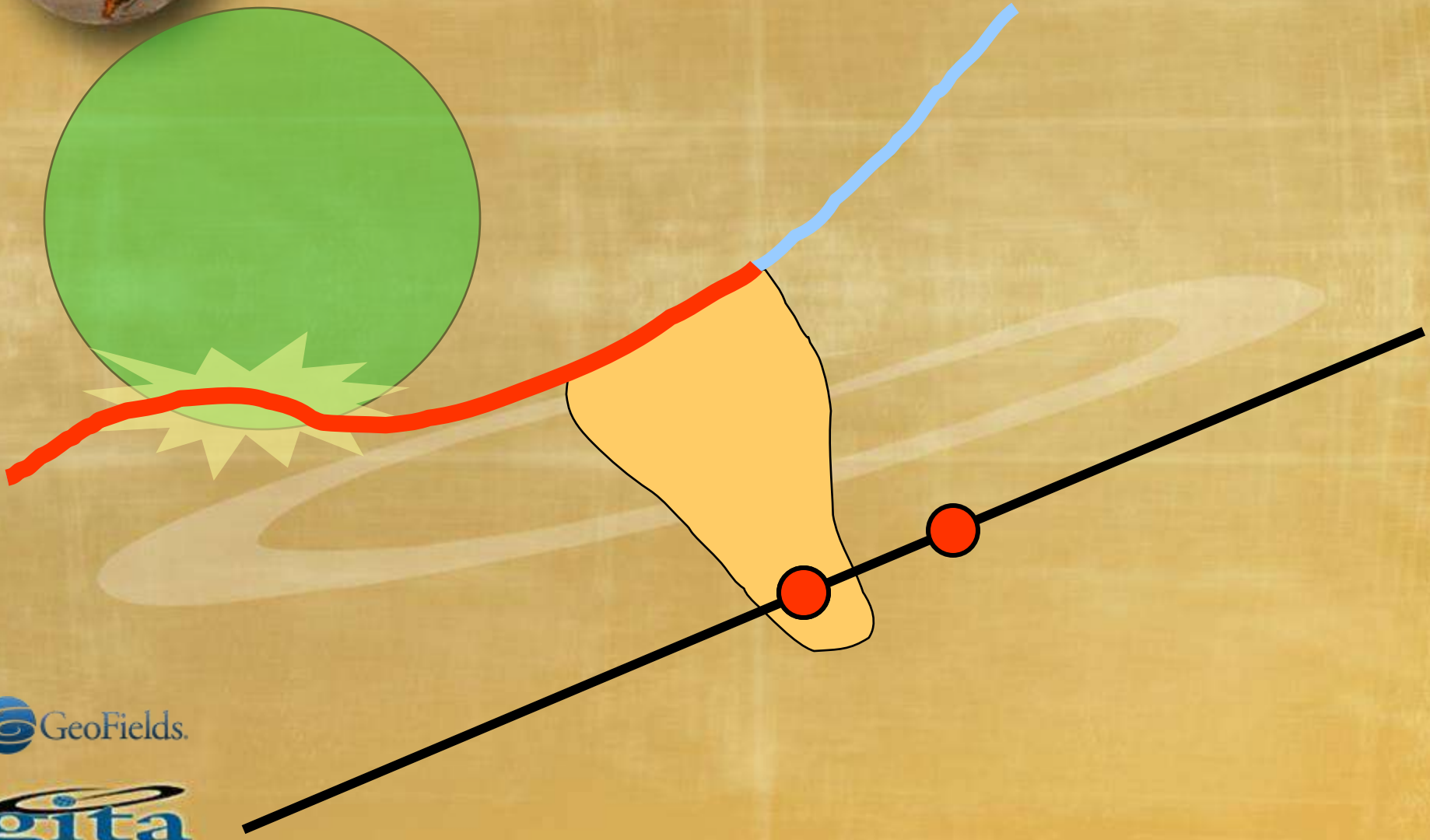
Potential Impact



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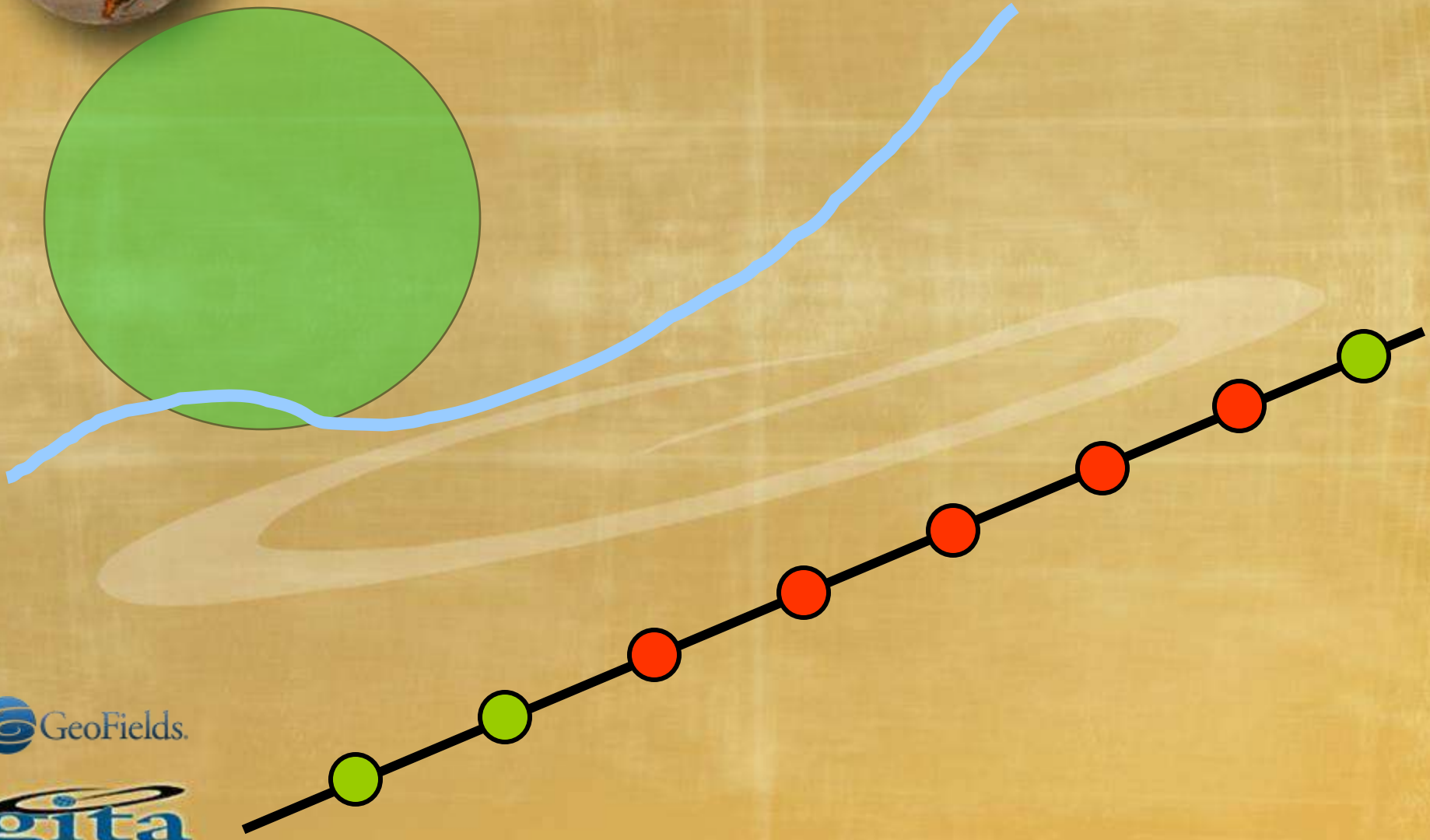
Potential Impact



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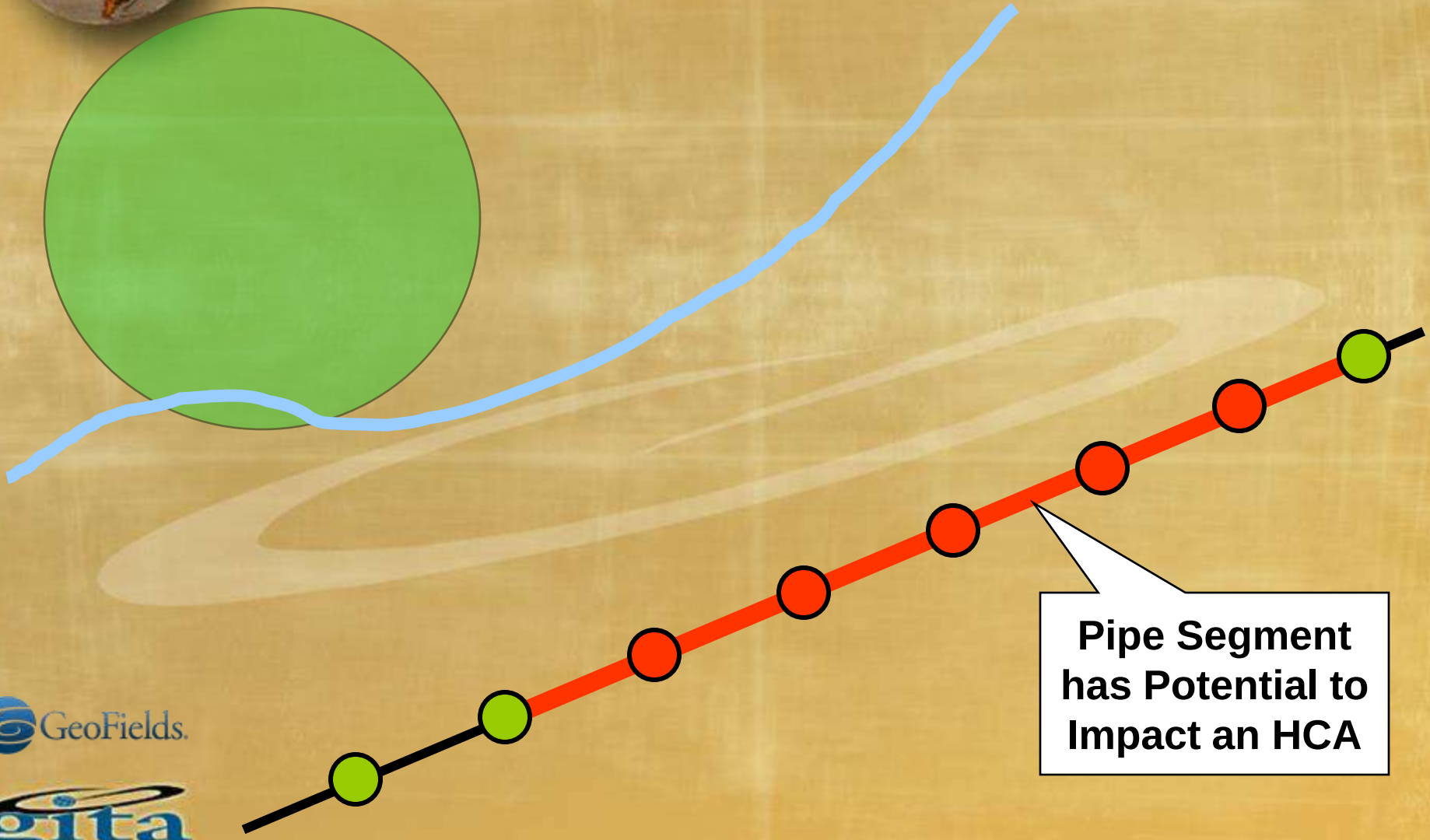
Potential Impact



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Potential Impact

- Spatial Modeling Process

Steps:

- Drain Volume Calculation
- Overland Spread Calculation
- Hydrological Impact Analysis
- HCA Impact Analysis

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Data Requirements

- "Best of Breed" Approach

- Elevation Data
- Release Volume
- Pool Thickness
- Hydrological Data

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Elevation Data

- Vast array of potential sources
- Digital and hardcopy
- Federal, state, local, private

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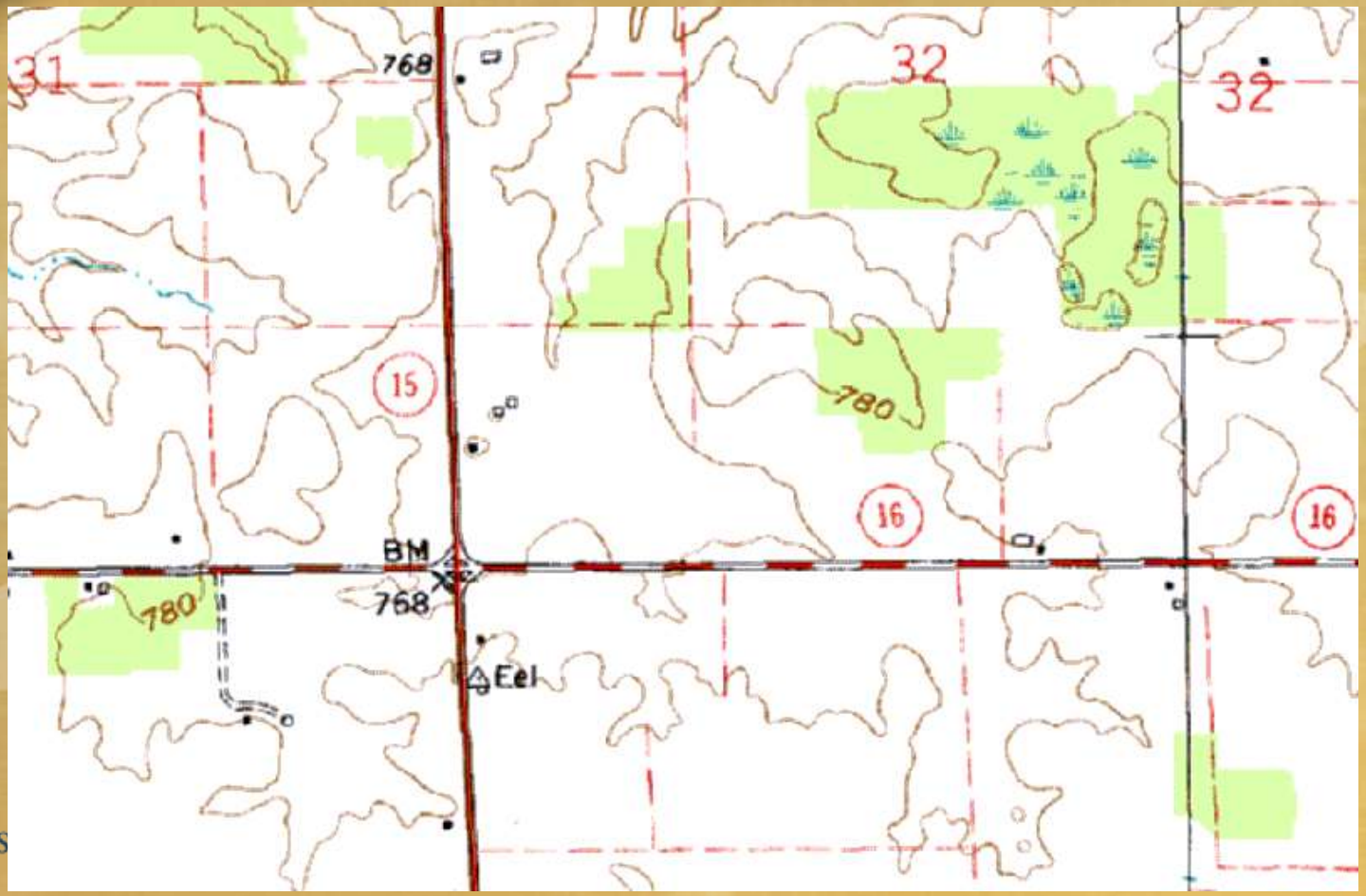
Elevation Data – Contours



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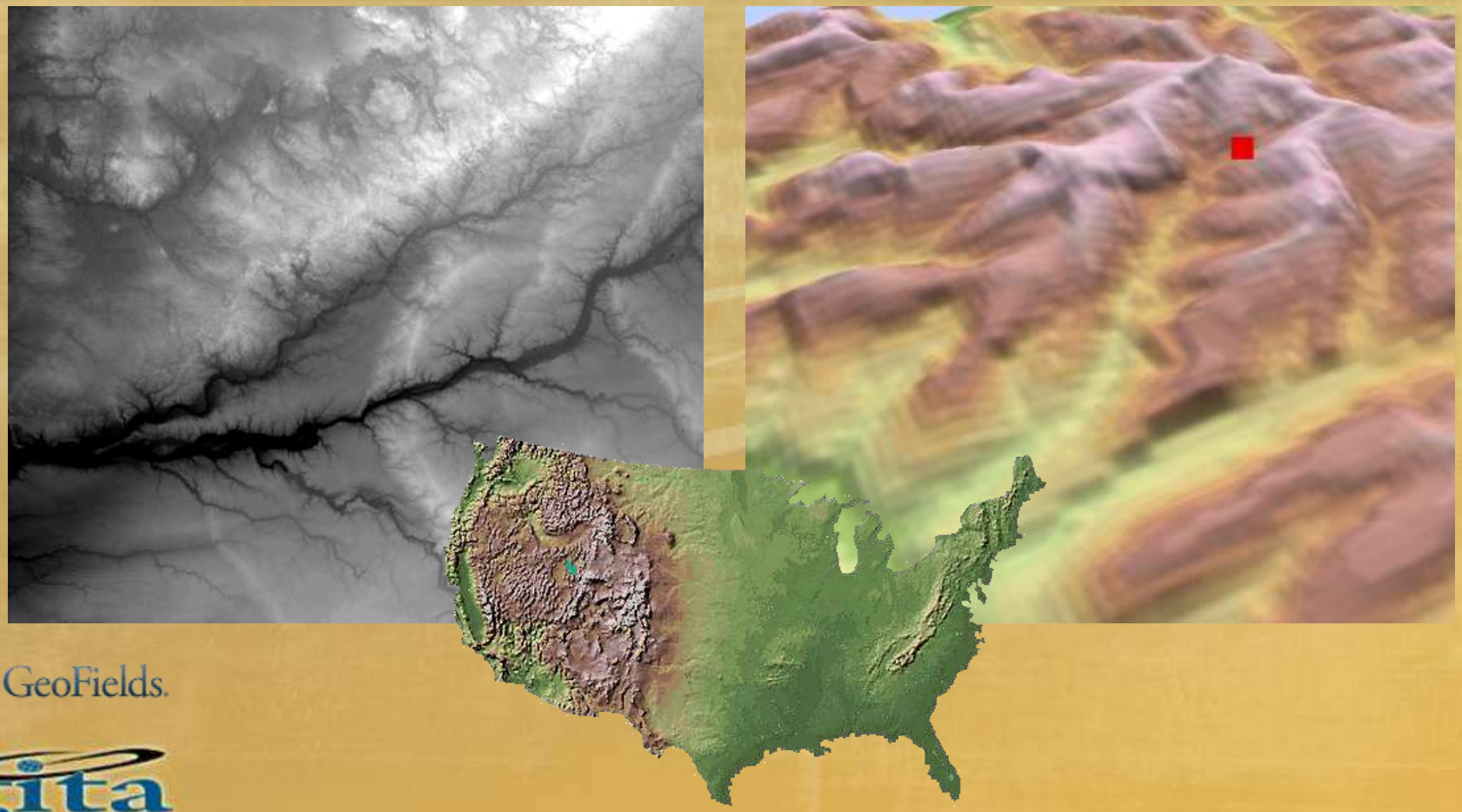
Elevation Data – Digital Models



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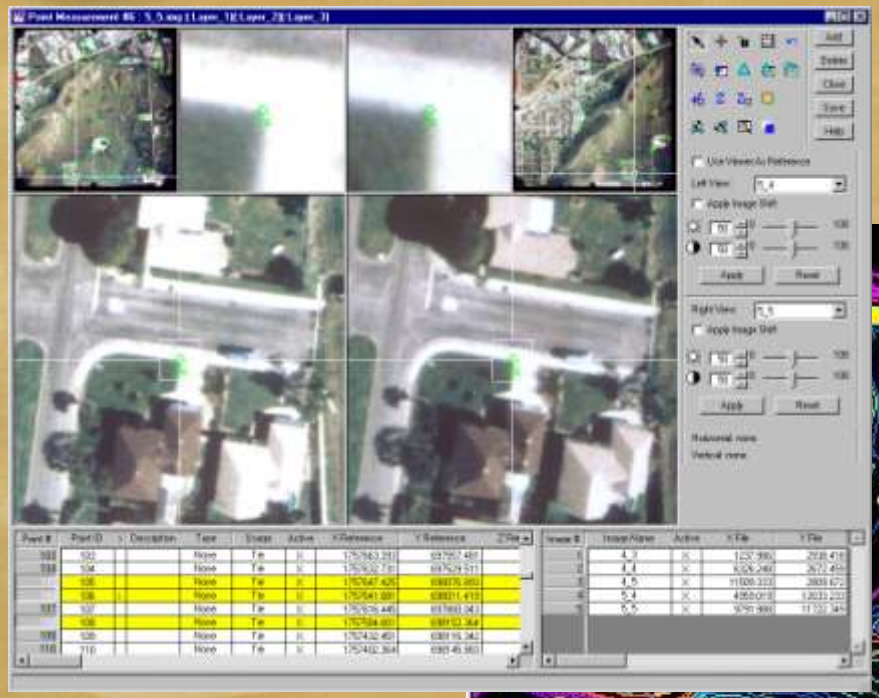
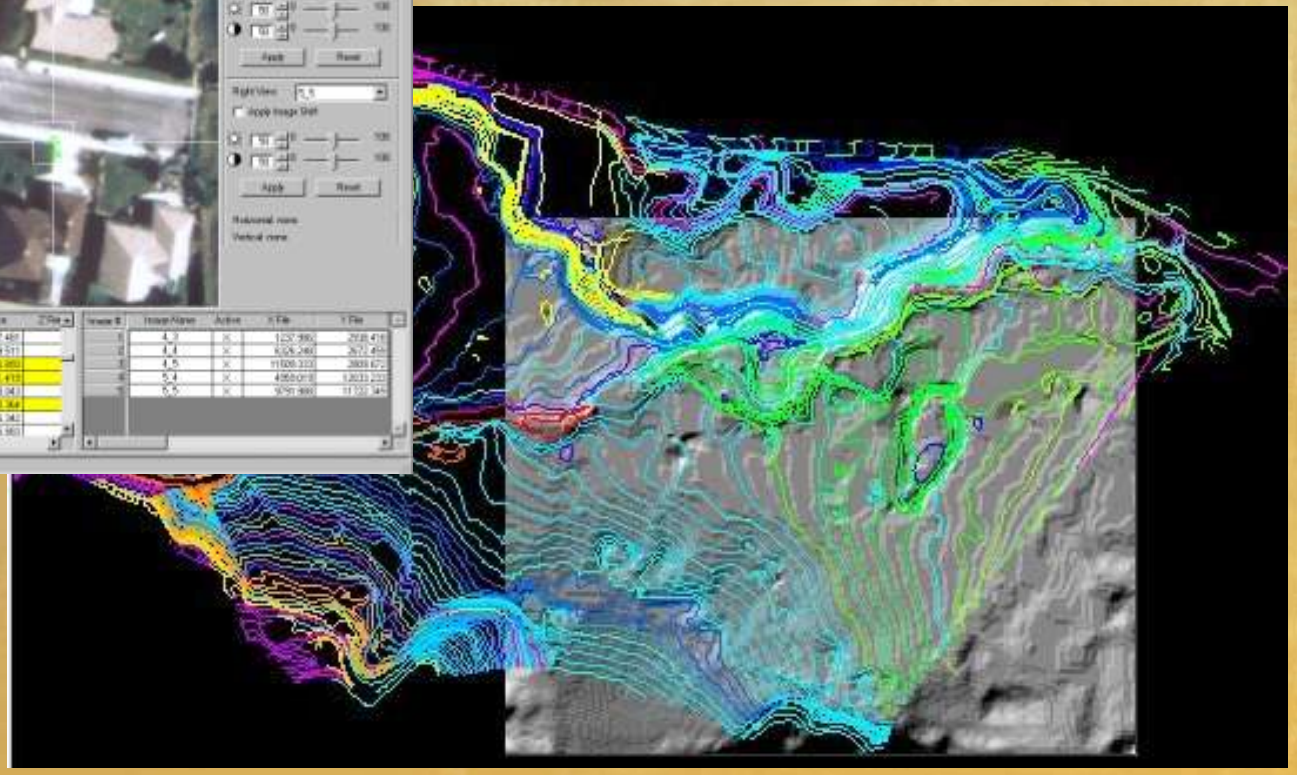
Elevation Data – Stereo Imagery



- Various software
- Aerial & Satellite



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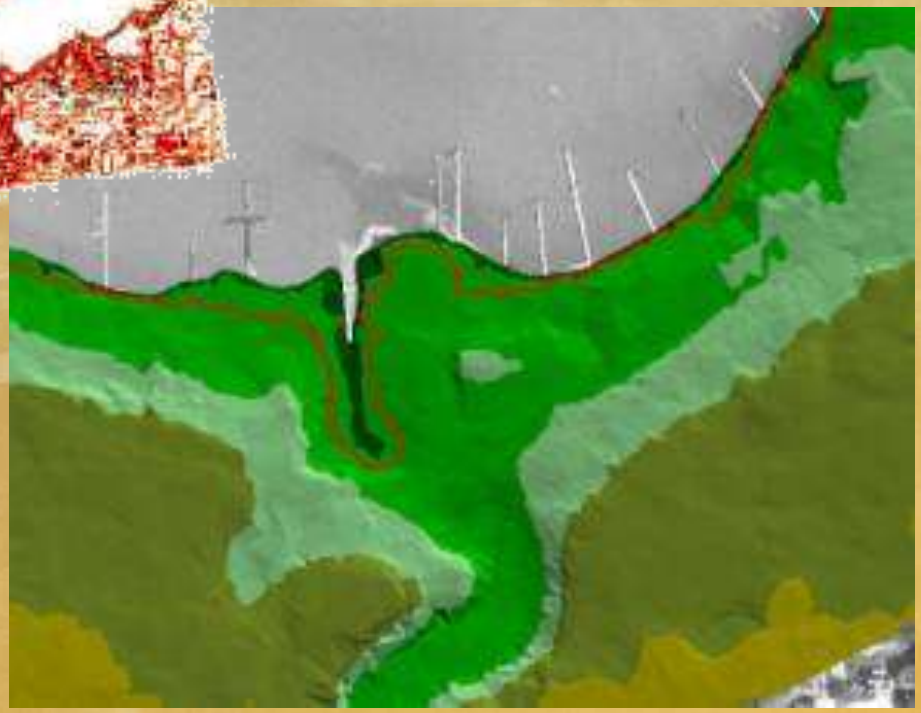
Elevation Data – LIDAR



Source: U.S. Army Corps of Engineers - Detroit District

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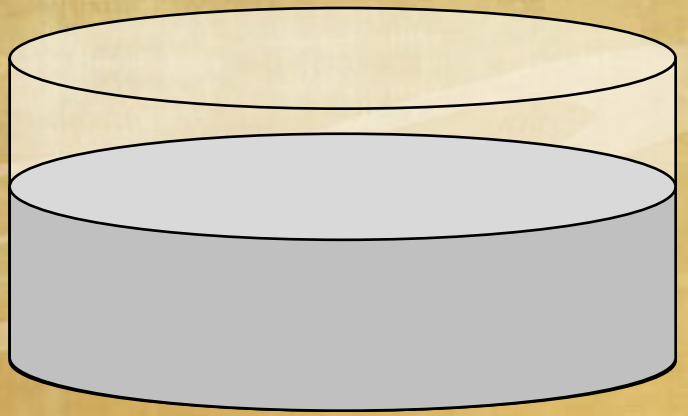
Release Volume

- Calculate volume that would be released
  - Drain Down Volume
  - Surplus
- Influence of:
  - Terrain
  - Pressure
  - Valves
  - Response Times



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Pool Thickness

Absorptivity Factor

- Land Cover
  - Surface Type
  - Soil Wetness
- Product
  - Rate of absorption
  - Evaporation
  - Residual Thickness

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Hydrological Data

Vast array of potential sources

- Digital and hardcopy
- Federal, state, local, private

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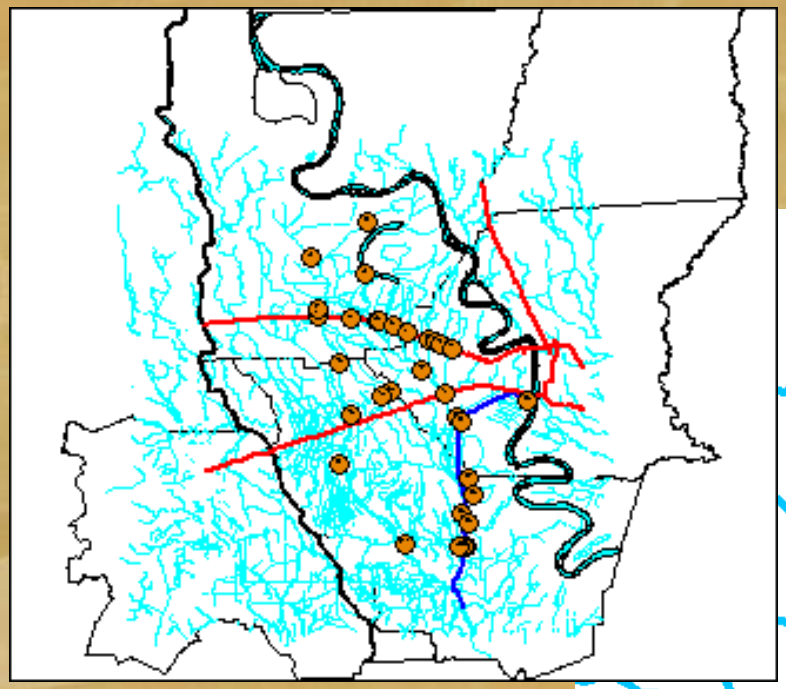
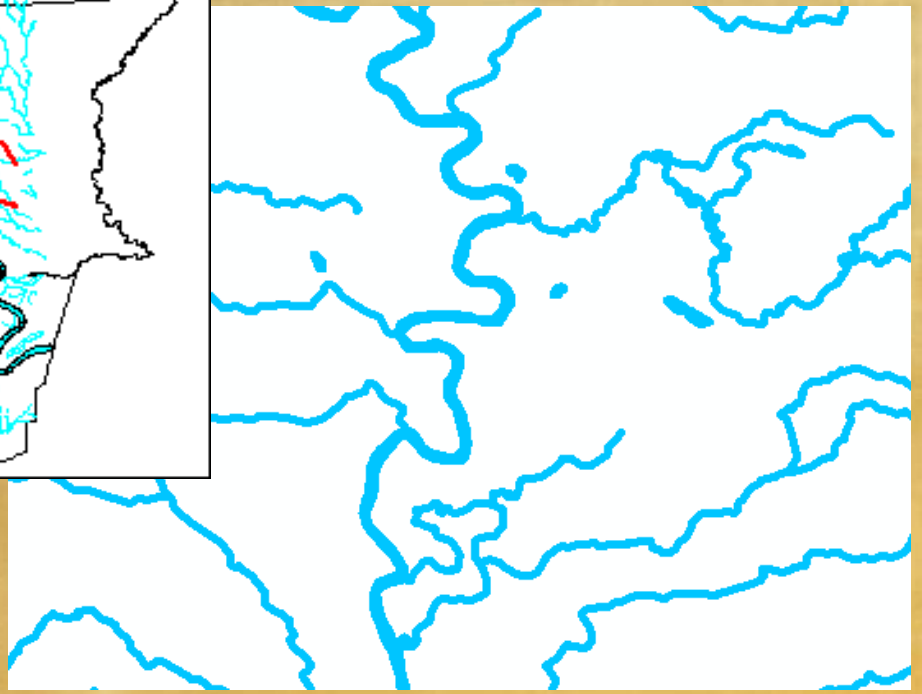
Hydrological Data – Digital Data





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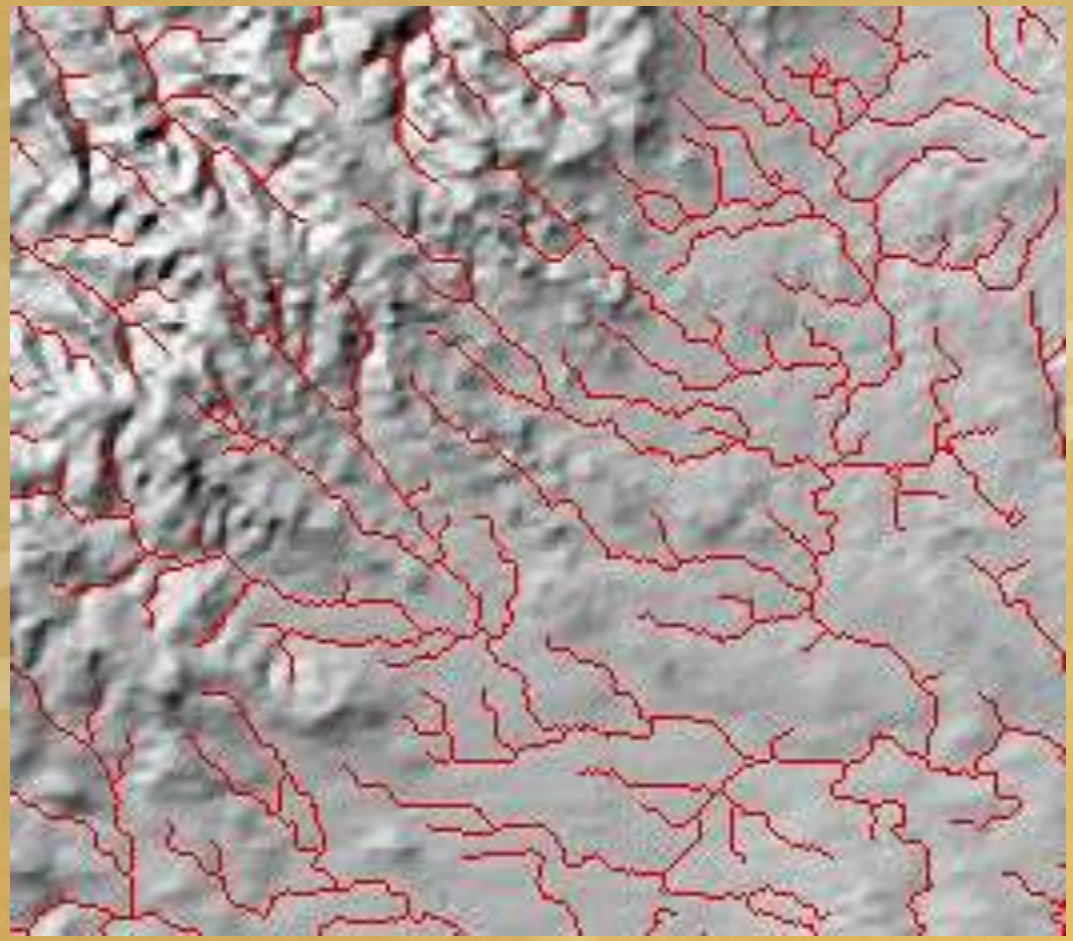
Hydrological Data – Derived



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Hydrological Data – From Maps

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Validation

- “Laboratory” Test Surfaces
- Real Test Surfaces
- Real Spills

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Laboratory Test Surfaces

- 16 Surfaces Tested, including:
  - Flat
  - Slopes
  - Gully
  - Ridge
  - Ditch
  - Barrier

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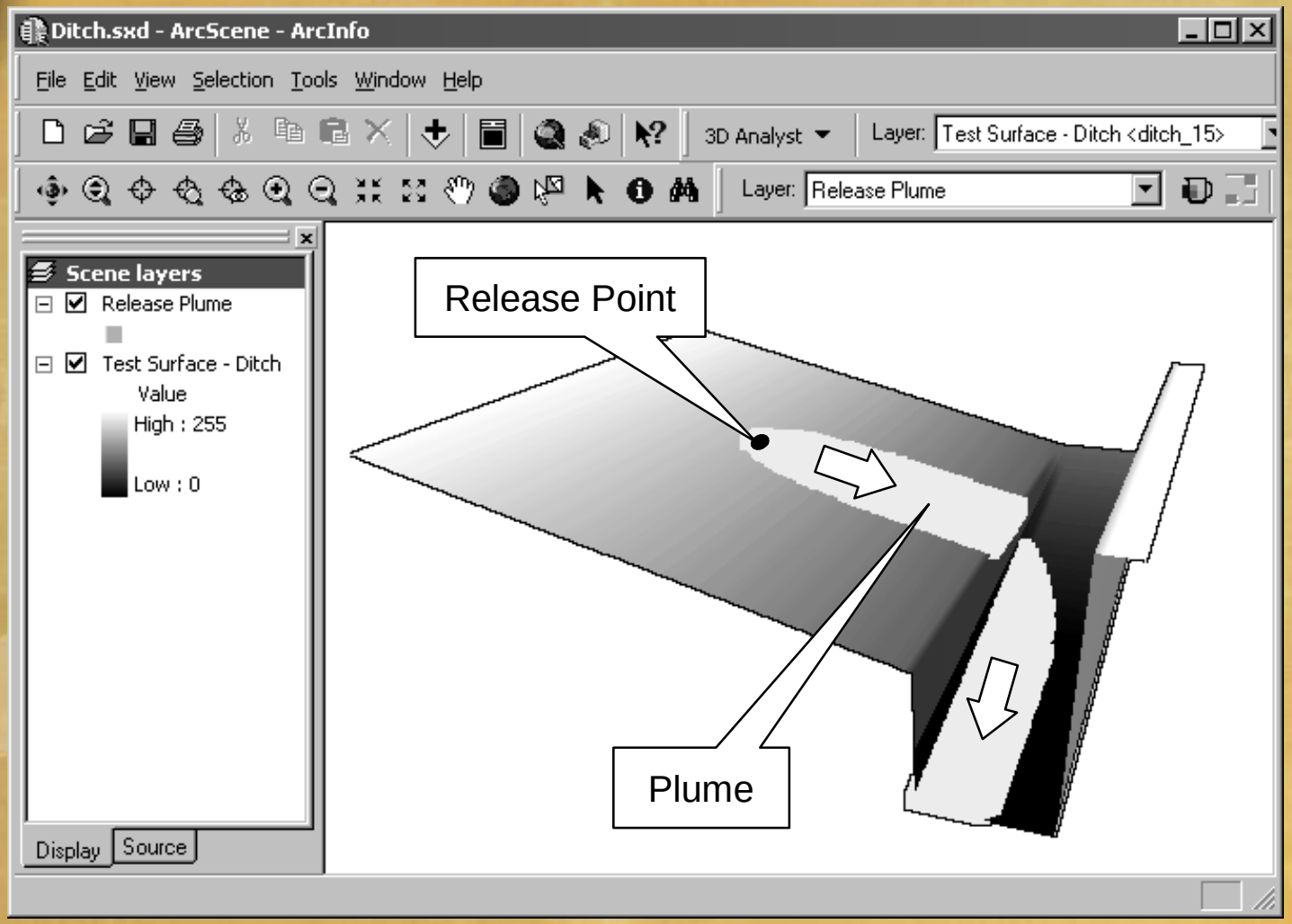

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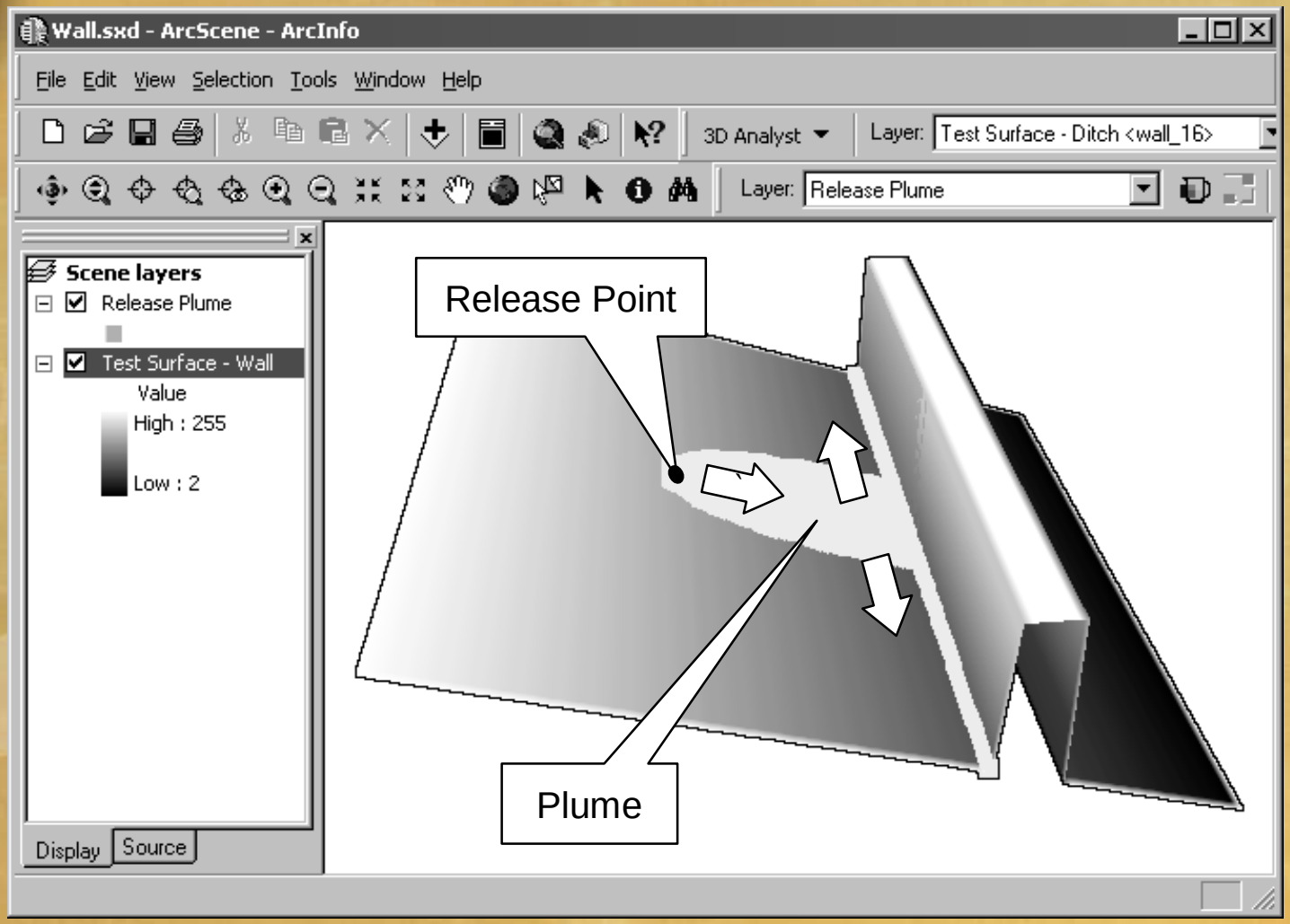

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Real Test Surfaces

- Actual terrain data
- Significant features found
- Mapped results of tests

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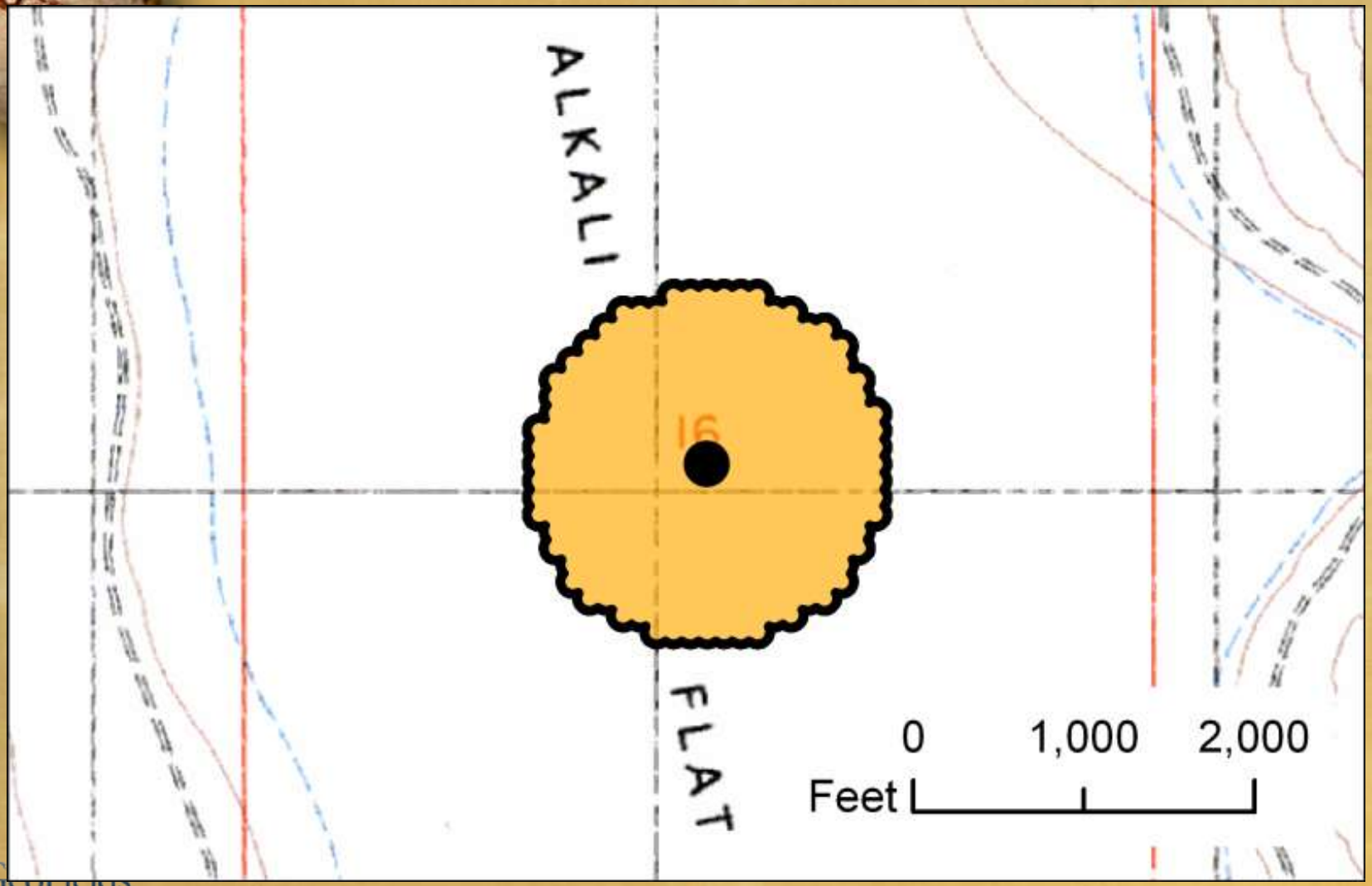

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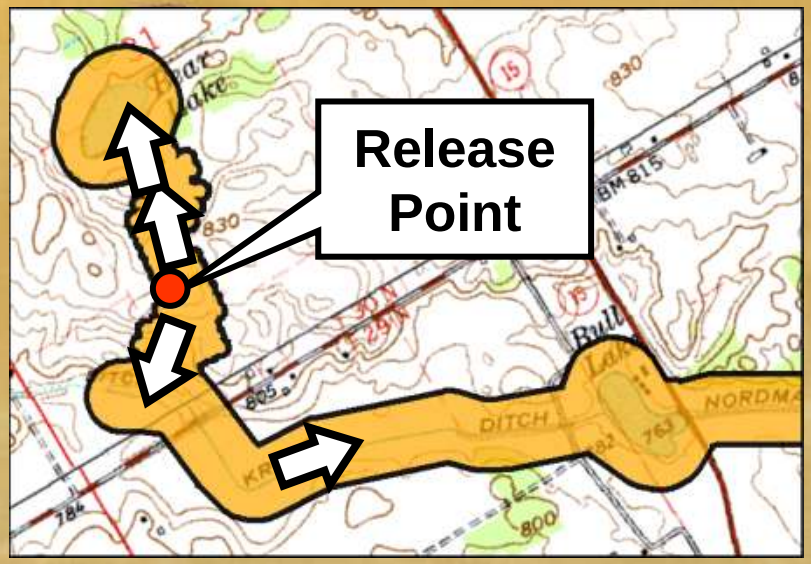

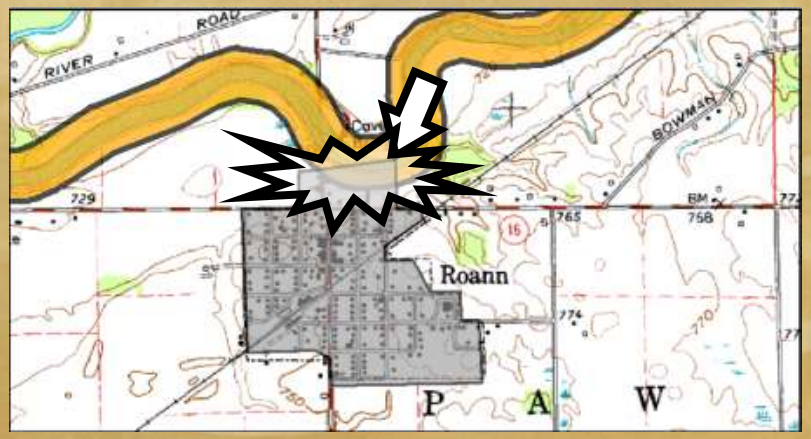

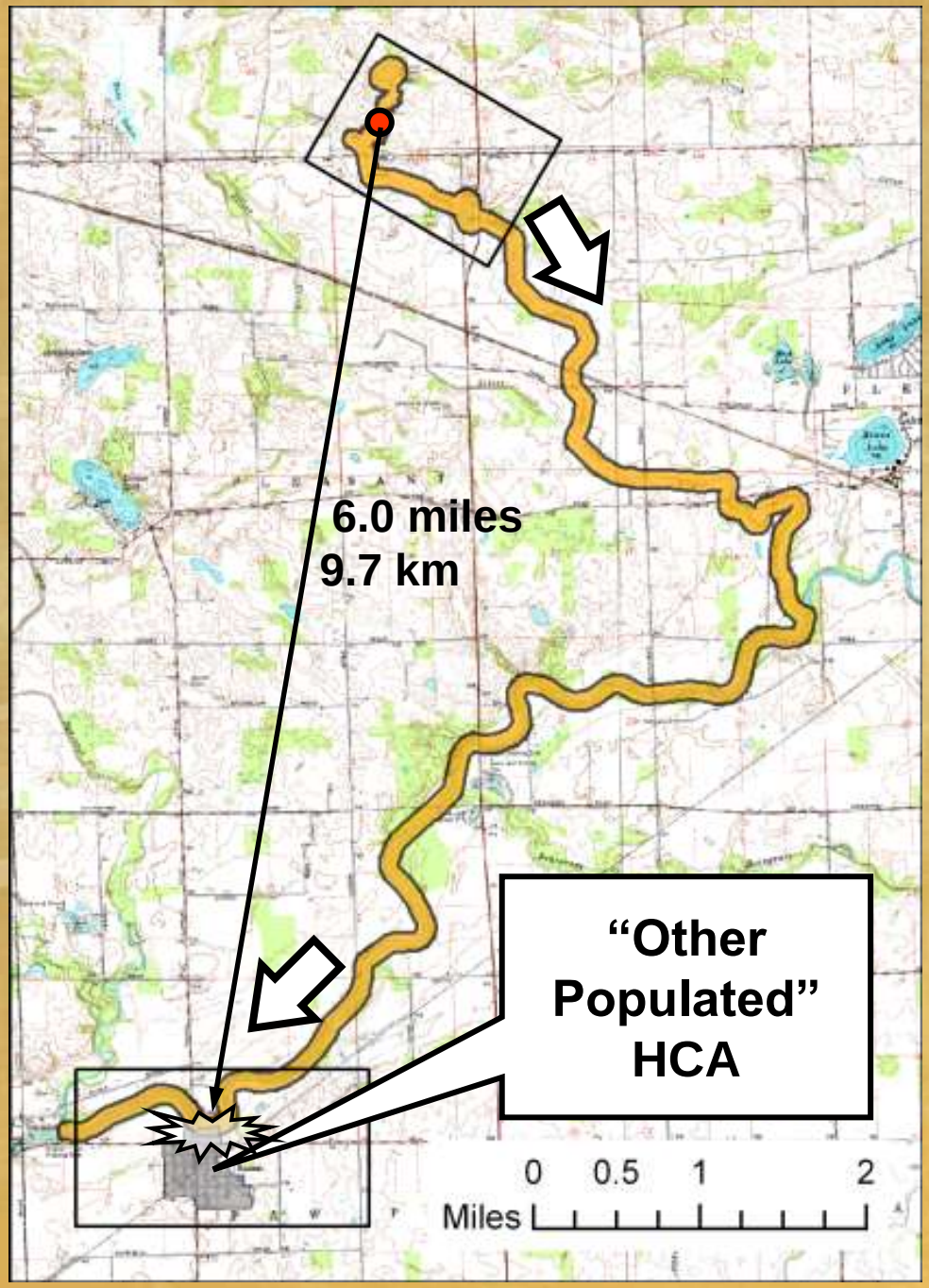

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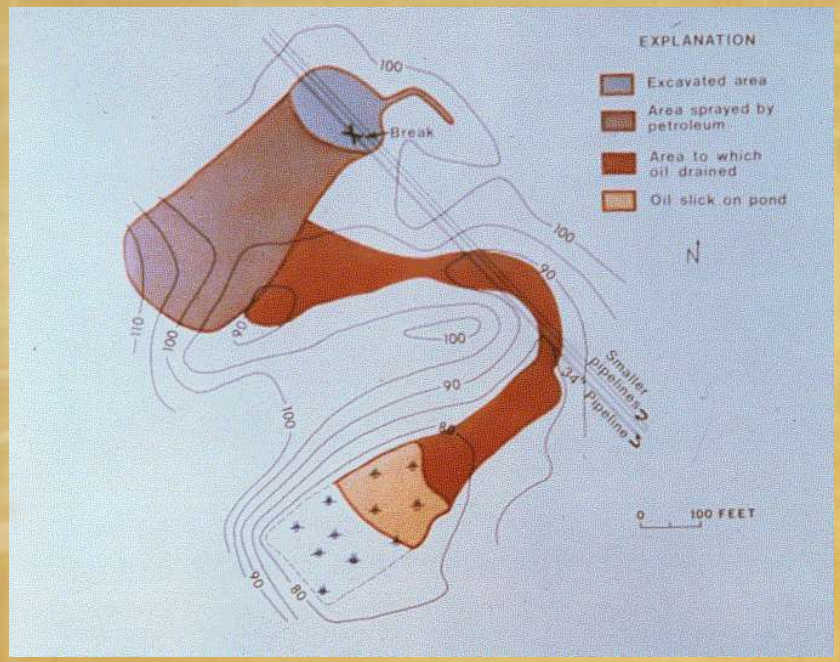
Real Releases

- Bemidji, MN
- 1979 Release
- USGS Mapping available
- Comparison to model yields similar results



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Process Result

- Predicted Spill Plume
  - Shows area that will be impacted on land
- Impacted Waterways
  - Shows predicted rivers and water bodies that will be impacted by the release

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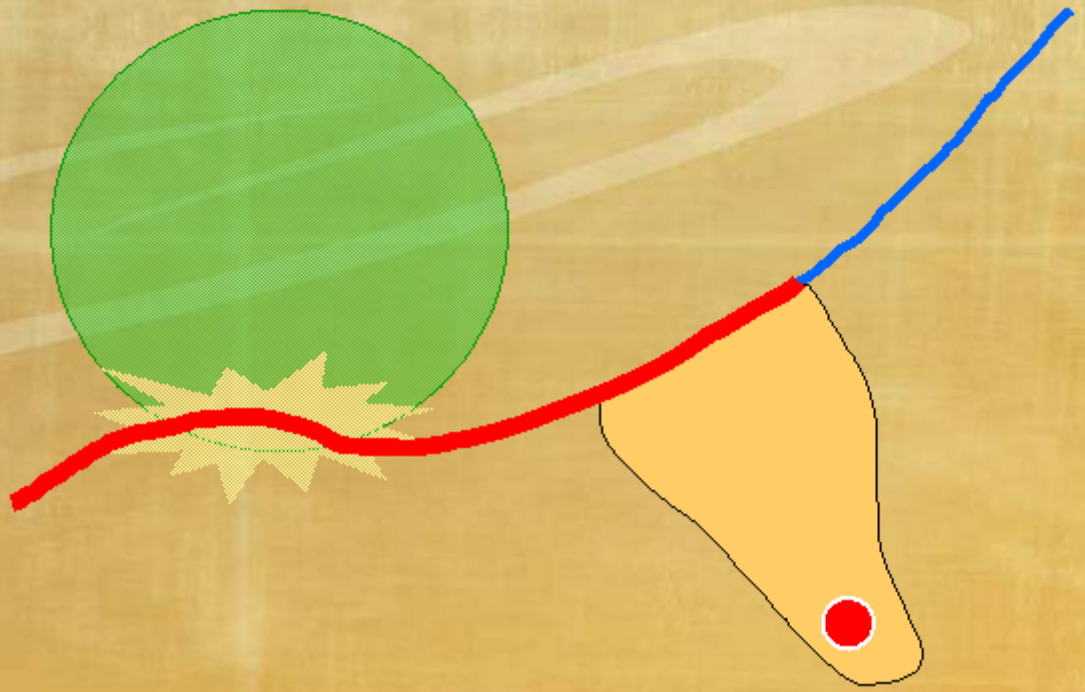
HCA Analysis

- Using HCA data sources, consider which impacted land areas and water features could impact an HCA.



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Reporting

- Tabular Products
  - Tables listing stationing of impact segments
- Map Products
  - Maps showing location of impact segments

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Tabular Data

FROM	TO	OPA	FROM X	FROM Y	TO X	TO Y
6275+00	3225+00	Chester	-89.82	37.89	-89.80	37.90
7865+00	7945+00	Oakdale	-89.52	38.26	-89.51	38.28
7955+00	7965+00	Oakdale	-89.51	38.28	-89.51	38.28
8645+00	8695+00	NewMinden	-89.37	38.43	-89.36	38.44
9145+00	9195+00	Hoffman	-89.27	38.54	-89.26	38.55
10045+00	10145+00	Patoka	-89.10	38.74	-89.09	38.77

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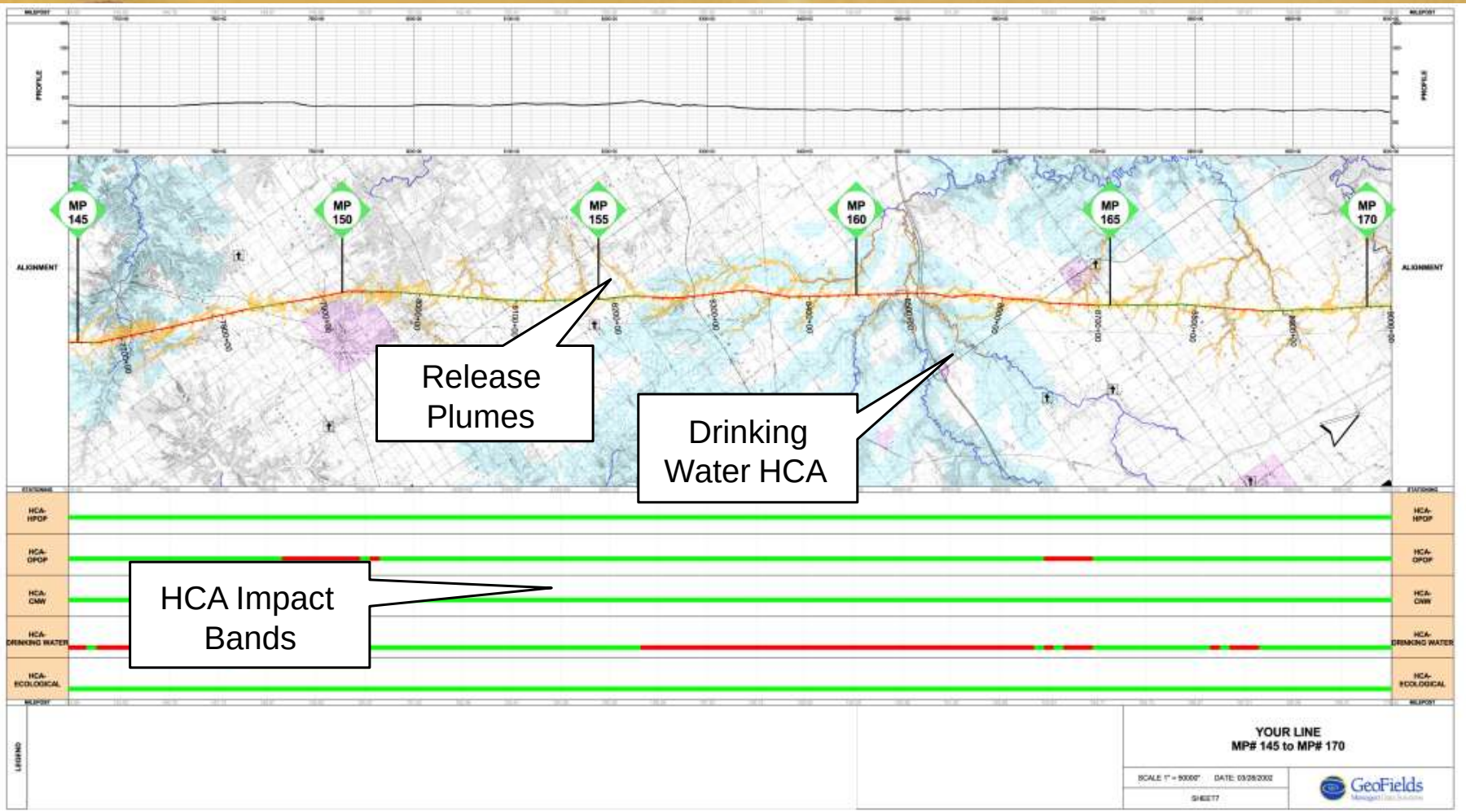

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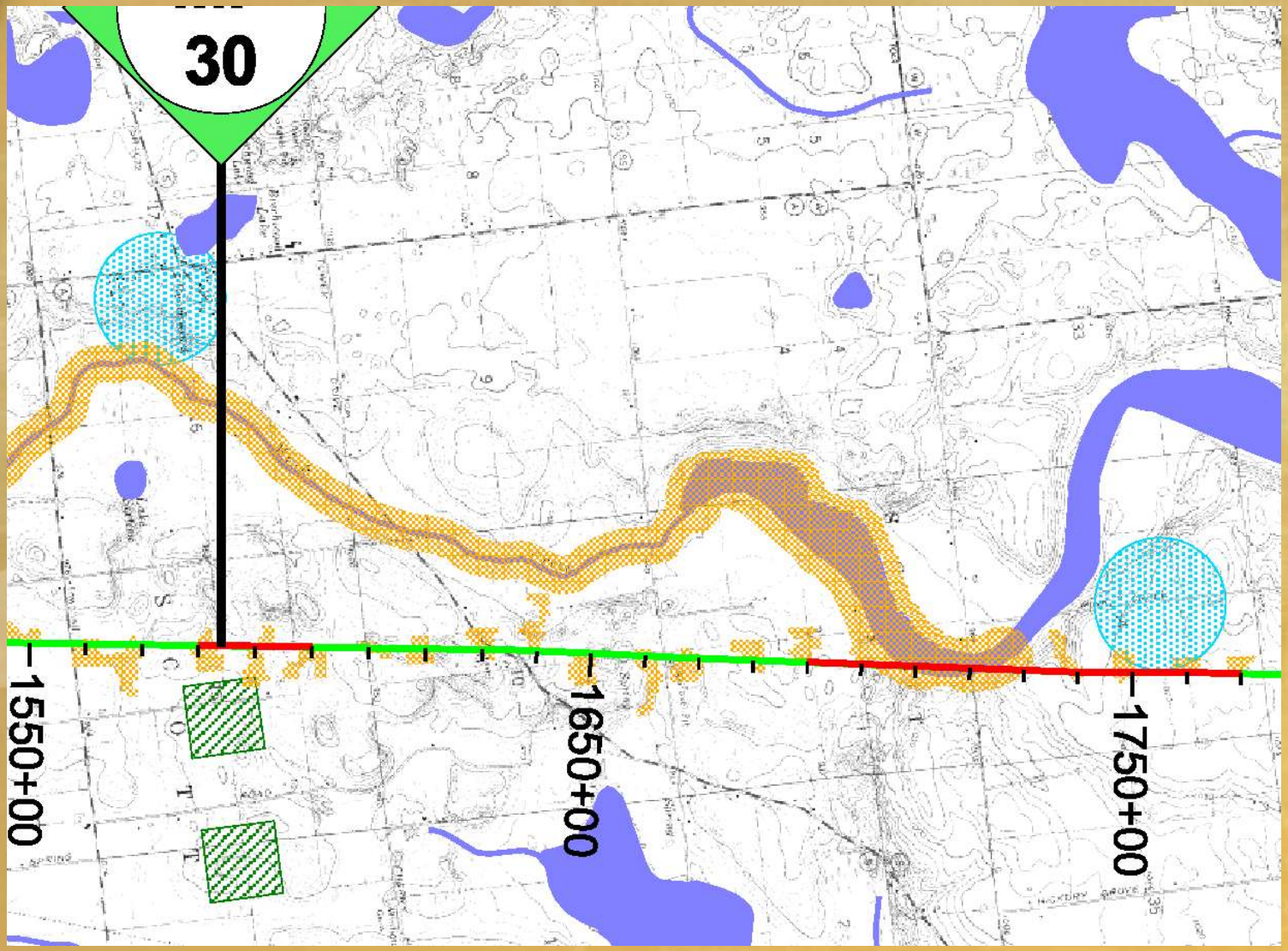
Results



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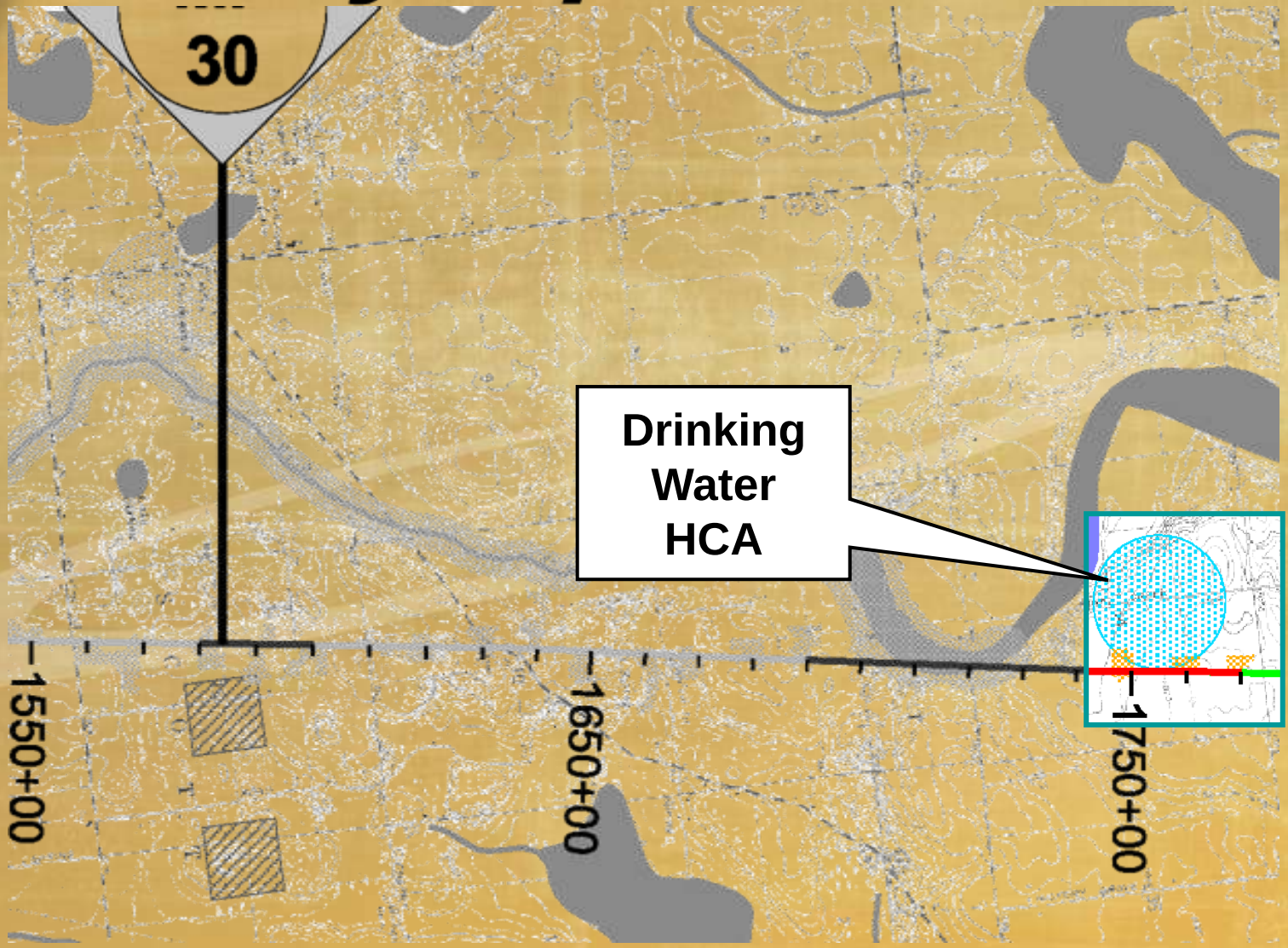
Overland Plumes Directly Impact HCA



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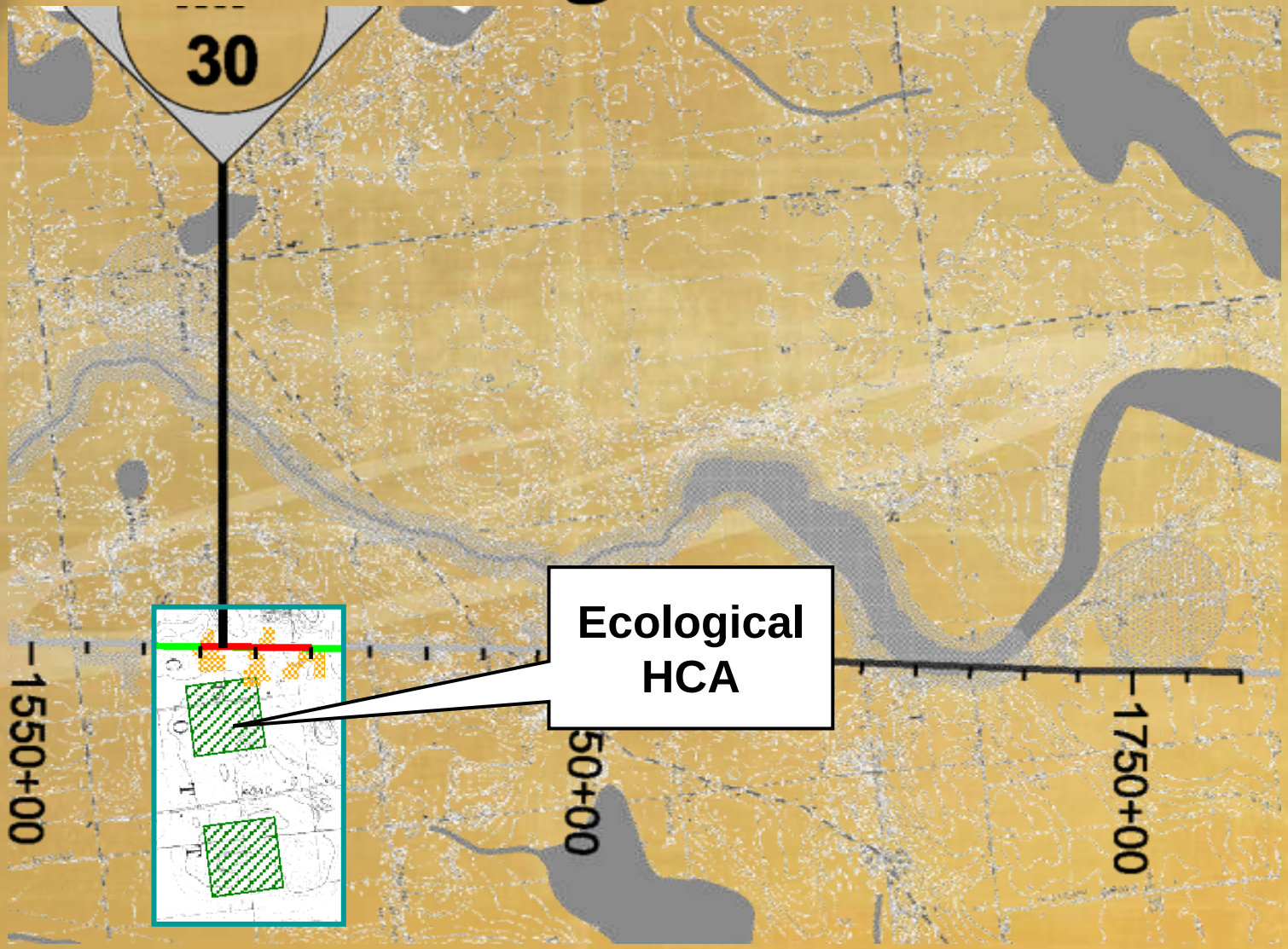
Single Plume Impact Creates Segment



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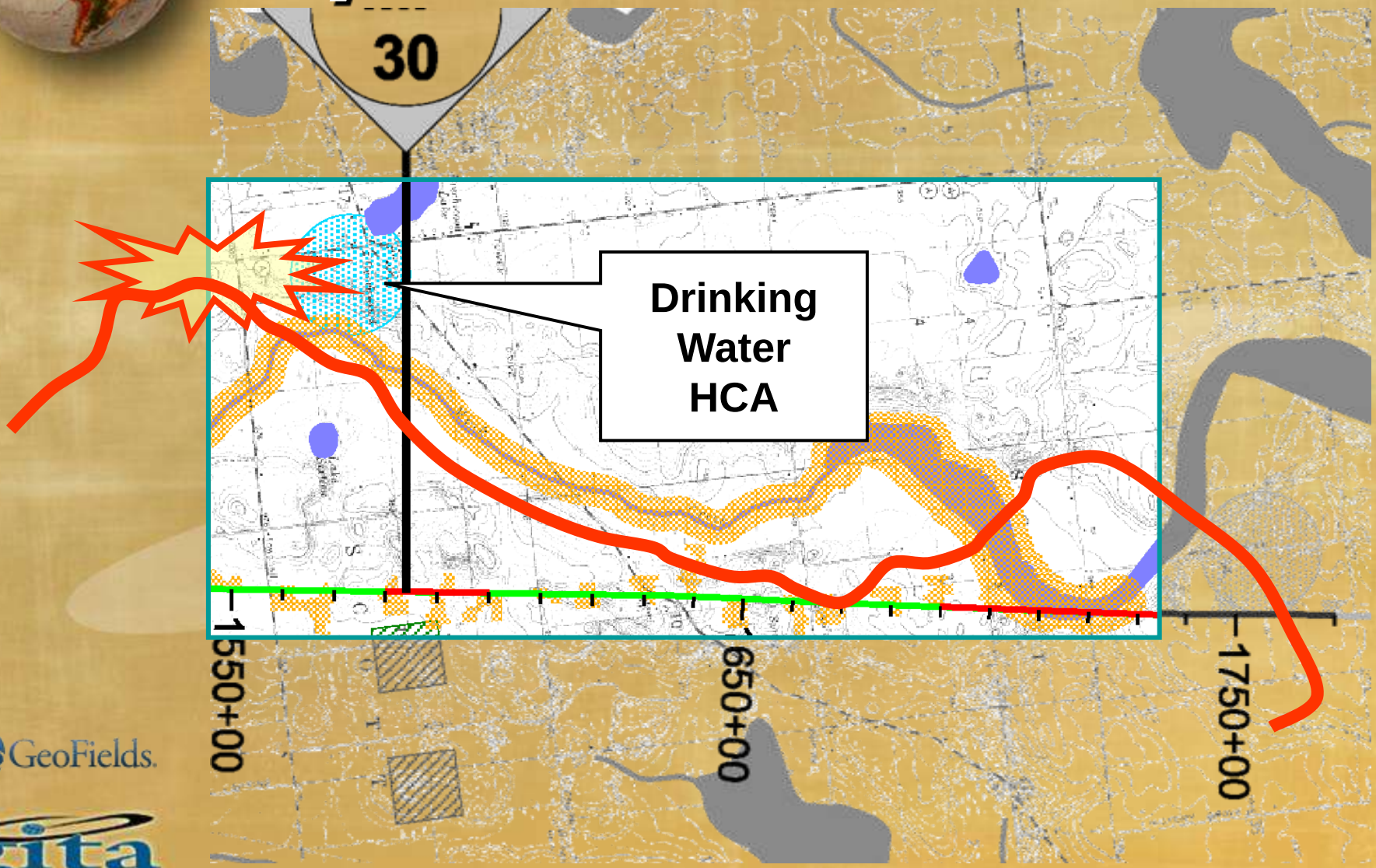
River Transport Carries Impact into HCA



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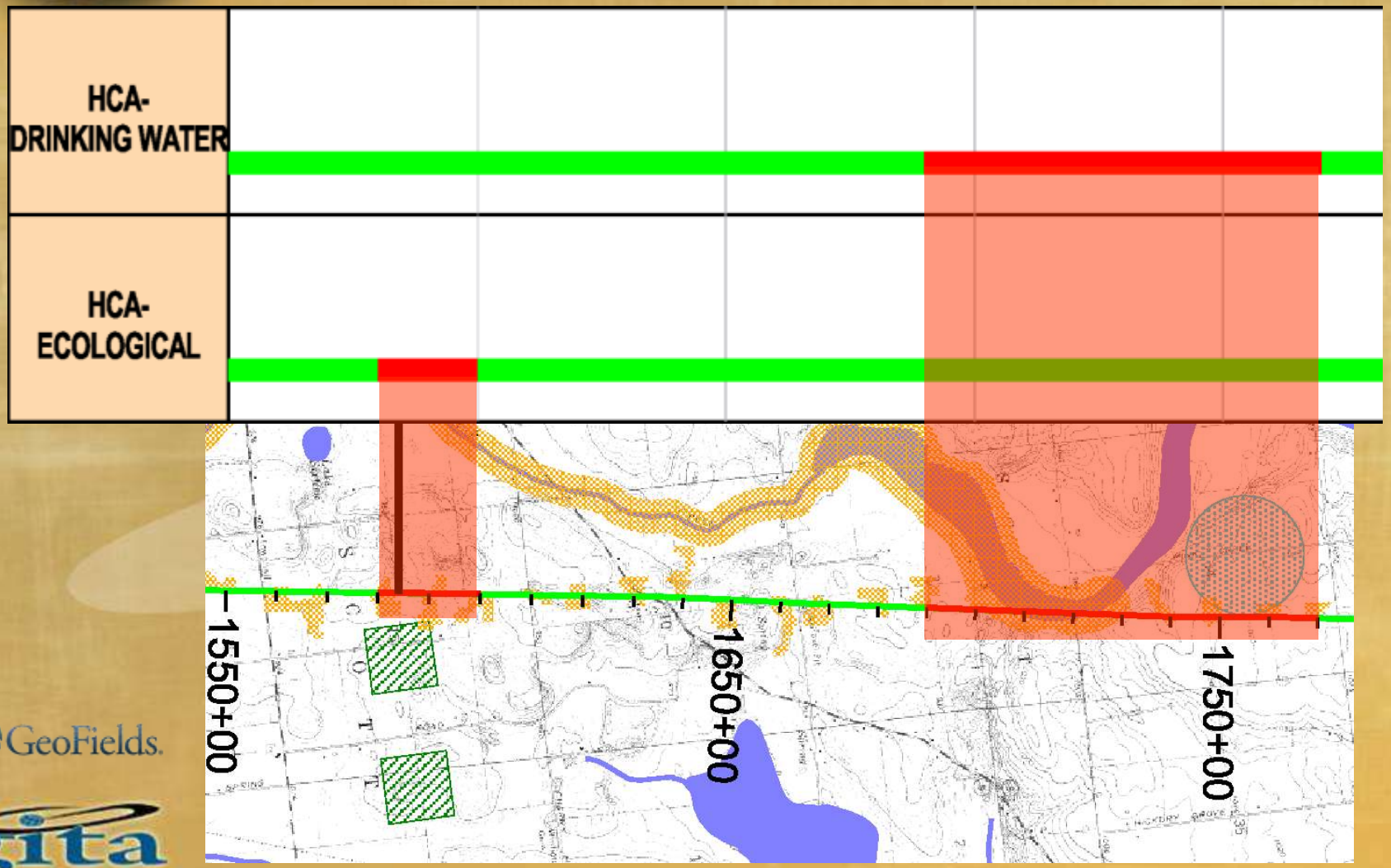
HCA Segments Generated from Impacts



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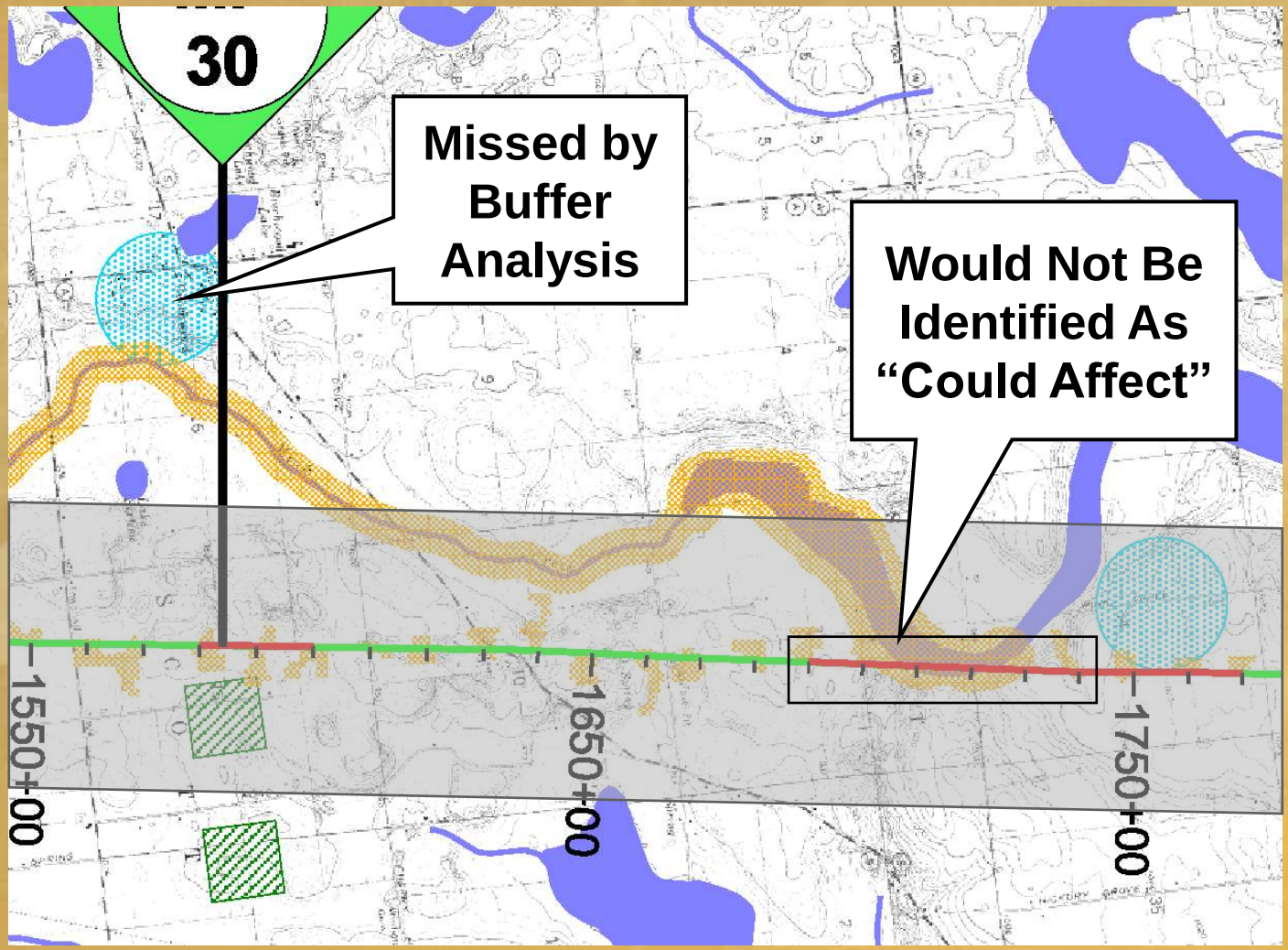
Results: 1/2 mile Buffer



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Future Enhancements

- Better Data
- Continuing refinement to algorithms

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Summary of Process

Goal:

- Locate HCA Potential Impact Segments

Data:

- Elevation, Hydrology, Drain Volume, Pool Thickness, etc.

Results

- Show impacts of releases on HCAs
- Derive Segments that Could Affect HCAs
- Use as data input to IMP

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Integrity Management Plan

- Potential Release: Major Consideration
- Model is robust
- Continued improvements with future data
- Integration as key component of IMP

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