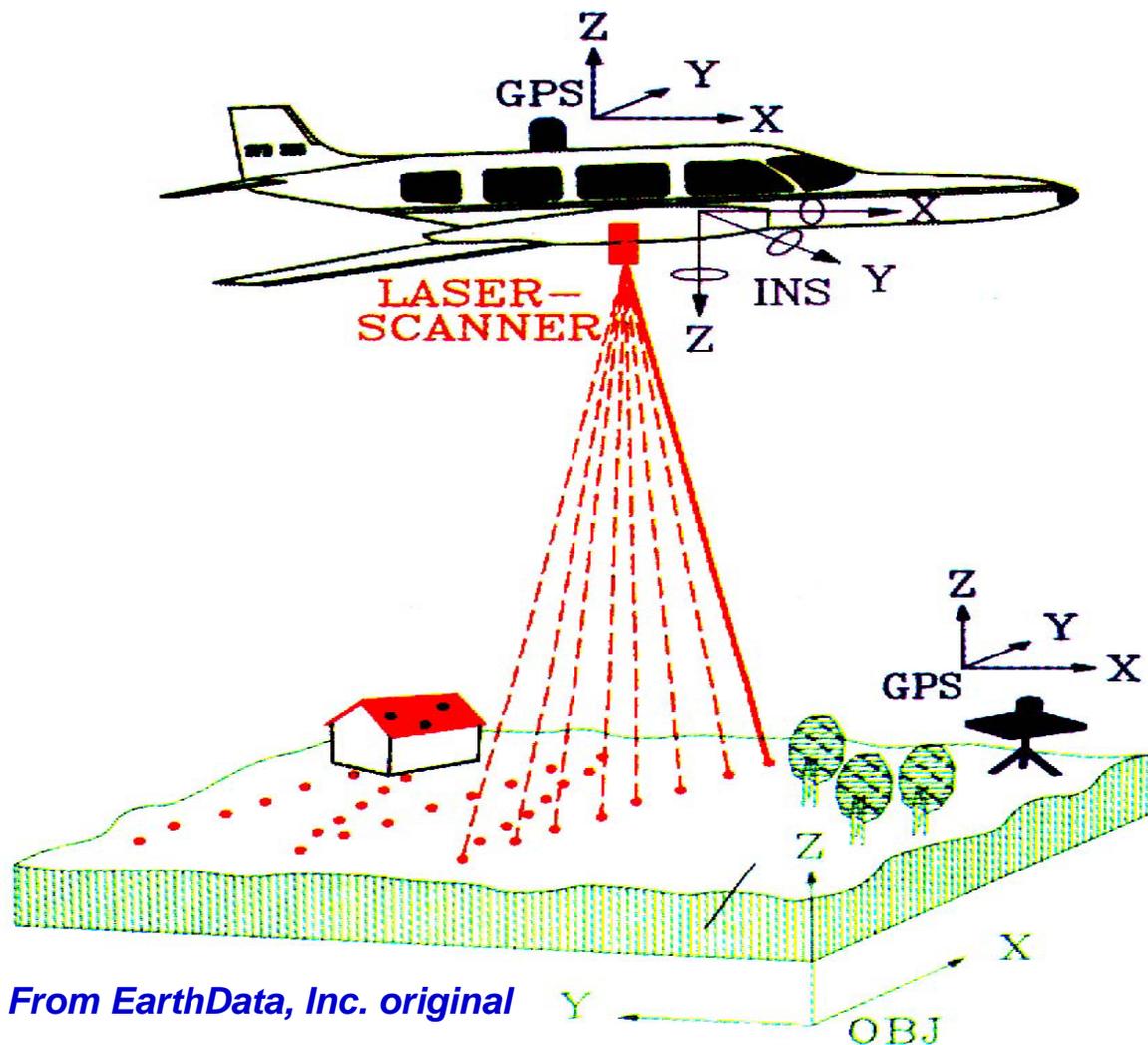


Association of Montana Floodplain Managers

LiDAR
and other types of
Digital Terrain Model data
for the Yellowstone River
floodplain

LIDAR

LASER-SCANNING

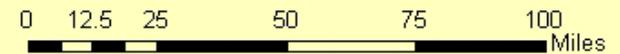
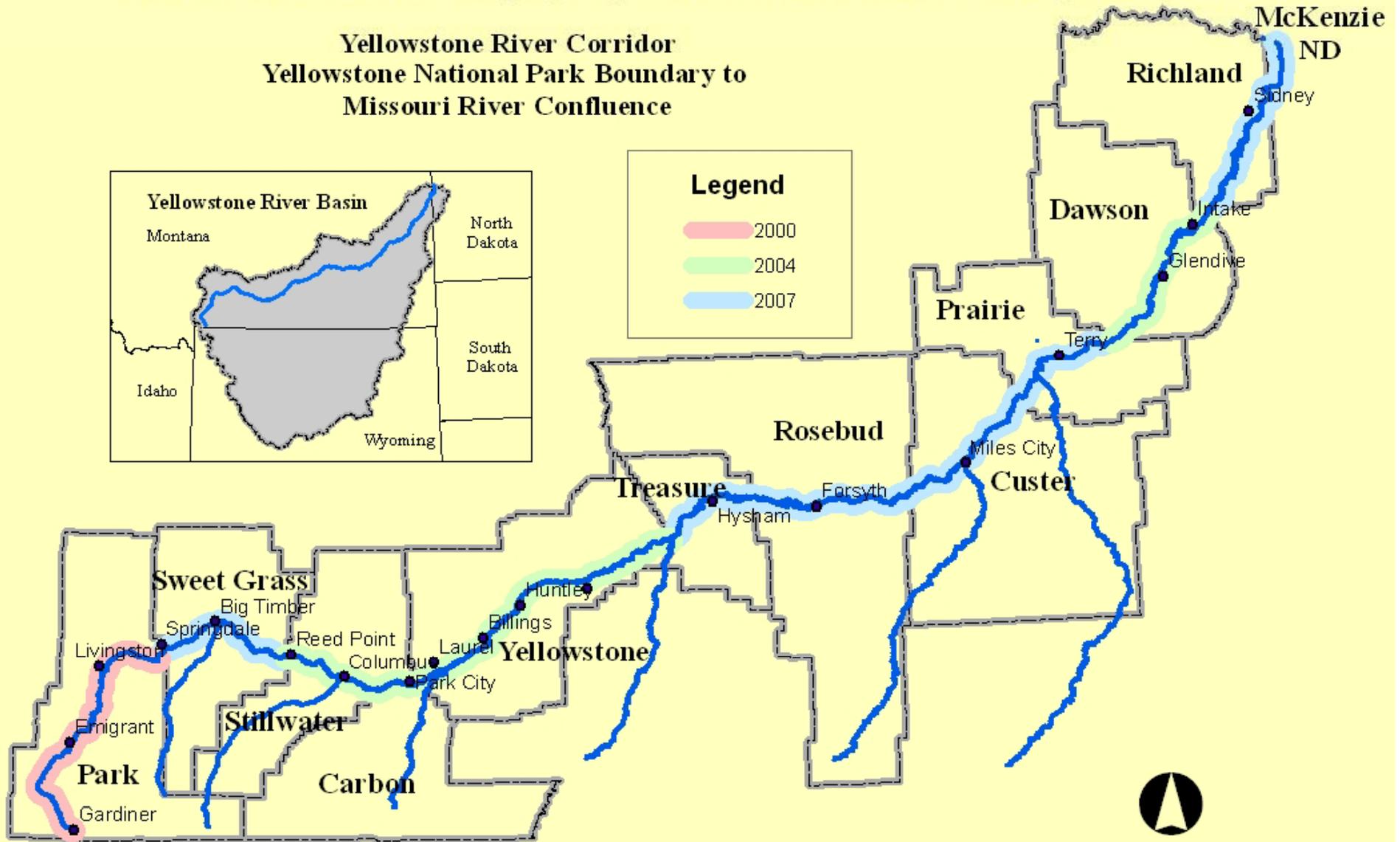
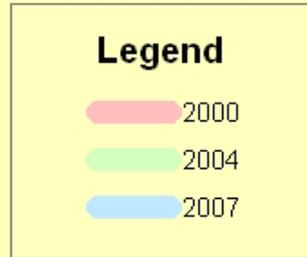


From EarthData, Inc. original

- **LASER = Light Amplification by Stimulated Emission of Radiation**
- **Active sensing: can collect at night**
- **Timing of pulse gives elevation (DEM)**
- **Magnitude of return pulse gives intensity image (DOQ)**
- **Minimum of thousands of pulses per second (KhZ+)**

Yellowstone River Topographic Data Collection Project

Yellowstone River Corridor
Yellowstone National Park Boundary to
Missouri River Confluence



Yellowstone River CEA – Data Acquisition

Baseline Data and Mapping Summary –

- **High resolution imagery and topo mapping (2004/2007)**
 - LiDAR terrain data
 - High Resolution Orthophotography
 - Planform feature geodatabases
- **Historic Imagery Products (Air Photo Collection)**
 - Corridor-wide airphoto coverage - **1950/1976/1995/2001**
 - Sporadic coverage back to 1930s
 - 1997 flood photos – Reed Point to Custer
- **GIS Data Coverages**
 - Physical Feature Inventories
 - Historic Banklines and Flowlines
 - 100-year Inundation Boundary
 - Riparian vegetation, wetland, and aquatic habitat
- **Results**
 - Channel Classification / Historic Change Detection
 - Channel Migration Zone
 - Flood Insurance Rate Maps
 - Human Impacts Timeline

Yellowstone River CEA

Topographic Mapping Projects

- **Terrain models, hi-res orthophotos, geodatabases**
 - **PHASE I** - Photogrammetric (Surdex, 2000) **Park County**
 - **PHASE II** - LIDAR (Merrick & Co, 2004) **Stillwater, Yellowstone, Dawson**
 - **PHASE III** - LIDAR (Eisenbraun Associates, 2007)
Sweetgrass, Treasure, Rosebud, Custer, Prairie, Dawson, Richland, McKenzie
-
- 1-meter contour topographic mapping **over 750 square miles of floodplain (Gardiner to Mo River confluence)**
 - 0.5-meter contour channel bottom bathymetric mapping **of 130 river miles (Reed Point to Pompeii's Pillar and Glendive)**
 - 30-cm (1-foot) resolution true color orthophotos **over 750 square miles (Gardiner to Mo River confluence)**
 - Planimetric mapping of surface features **(e.g., roads, bridges, buildings, flood control features, hydrographic features, etc.)**

Yellowstone River Floodplain Mapping Projects

Park County terrain mapping costs (51 sq miles)

Aerial Photography -	\$ 25,000 (MAP, Inc)
Ground Control -	\$ 15,000 (USFS/DNRC)
DTM, DOQs, feature mapping -	\$180,000 (Surdex Corp)
Channel Cross Sections #120 -	\$ <u>85,000</u> (USGS)
TOTAL	\$305,000

Approximate Cost per Square Mile - \$6,000 !!

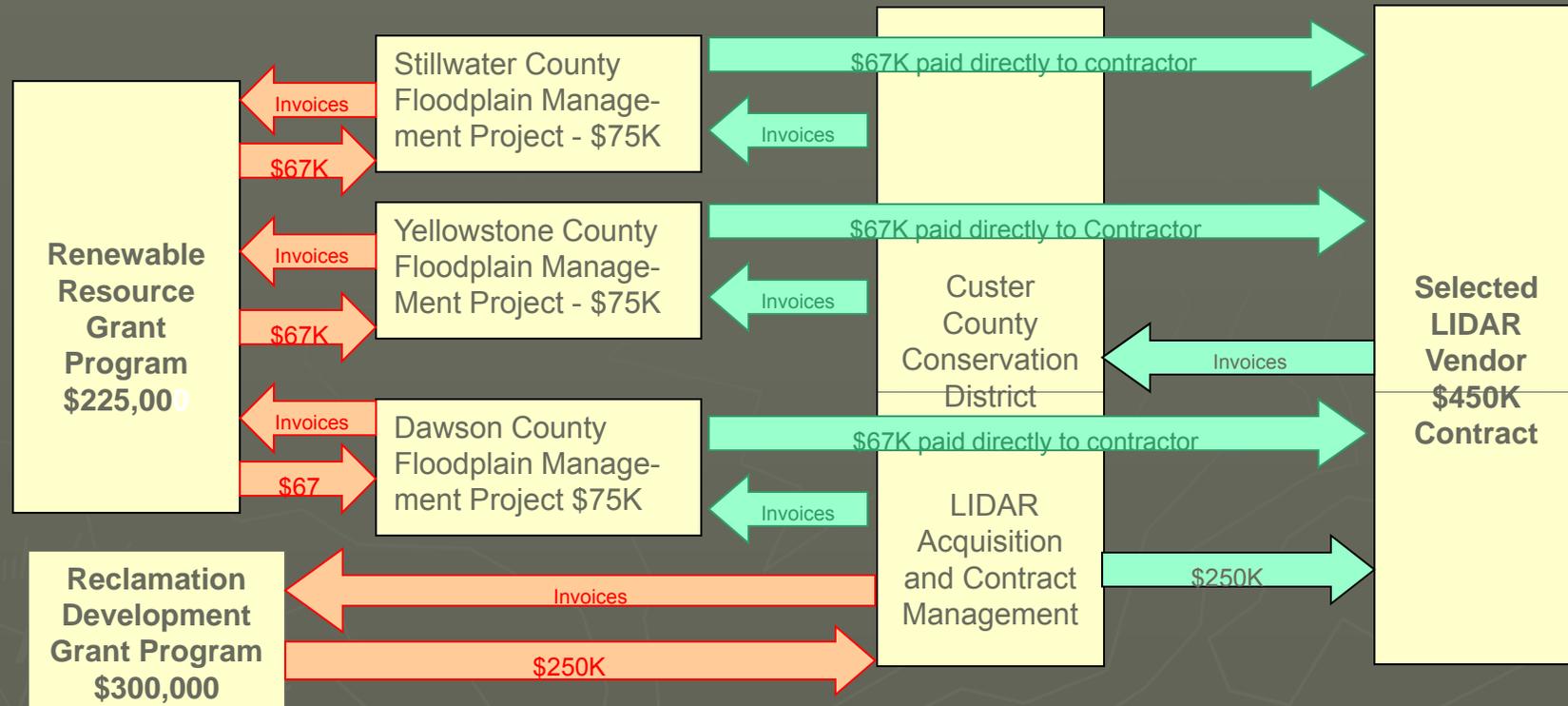
Yellowstone River LiDAR Precision Topographic Mapping and High Resolution Aerial Photography

Approximate Cost per square mile:

295 sq miles of floodplan / \$400,000

= \$1,355 per square mile

Yellowstone River LIDAR Data Acquisition Strategy



- Modify contracts between RR (Yellowstone, Stillwater and Dawson Counties) and RD (Custer CD) programs and Applicants to reflect change in scope of work for awarded funds.
- Develop contracts between Custer CD and Floodplain Counties for LIDAR acquisition and contract management. Contract management by Custer would involve invoicing individual counties for their share of the contractor invoice. Counties would pay their share of the invoice directly to vendor after receipt of funds from grant program.

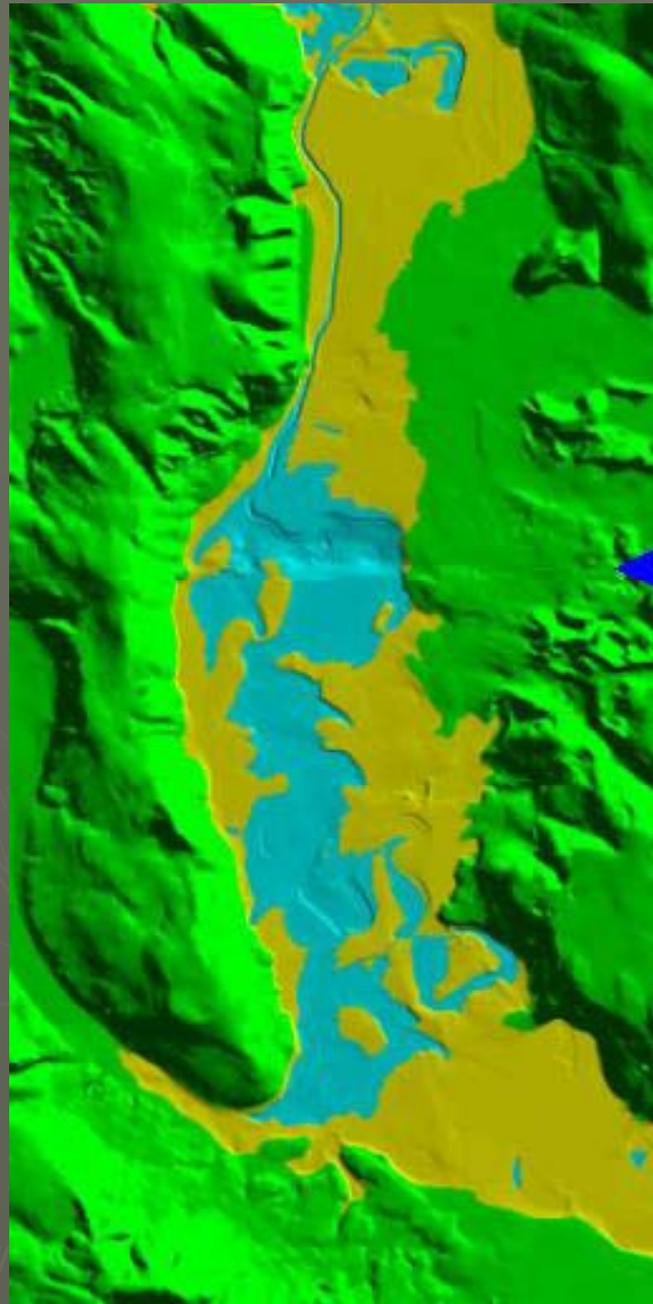
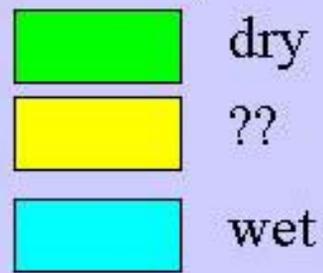
Flood forecasting

The effect of elevation uncertainty:

10m DEM,
 $\pm 1/3$ contour interval (7 ft)

LIDAR DEM
 ± 1 ft

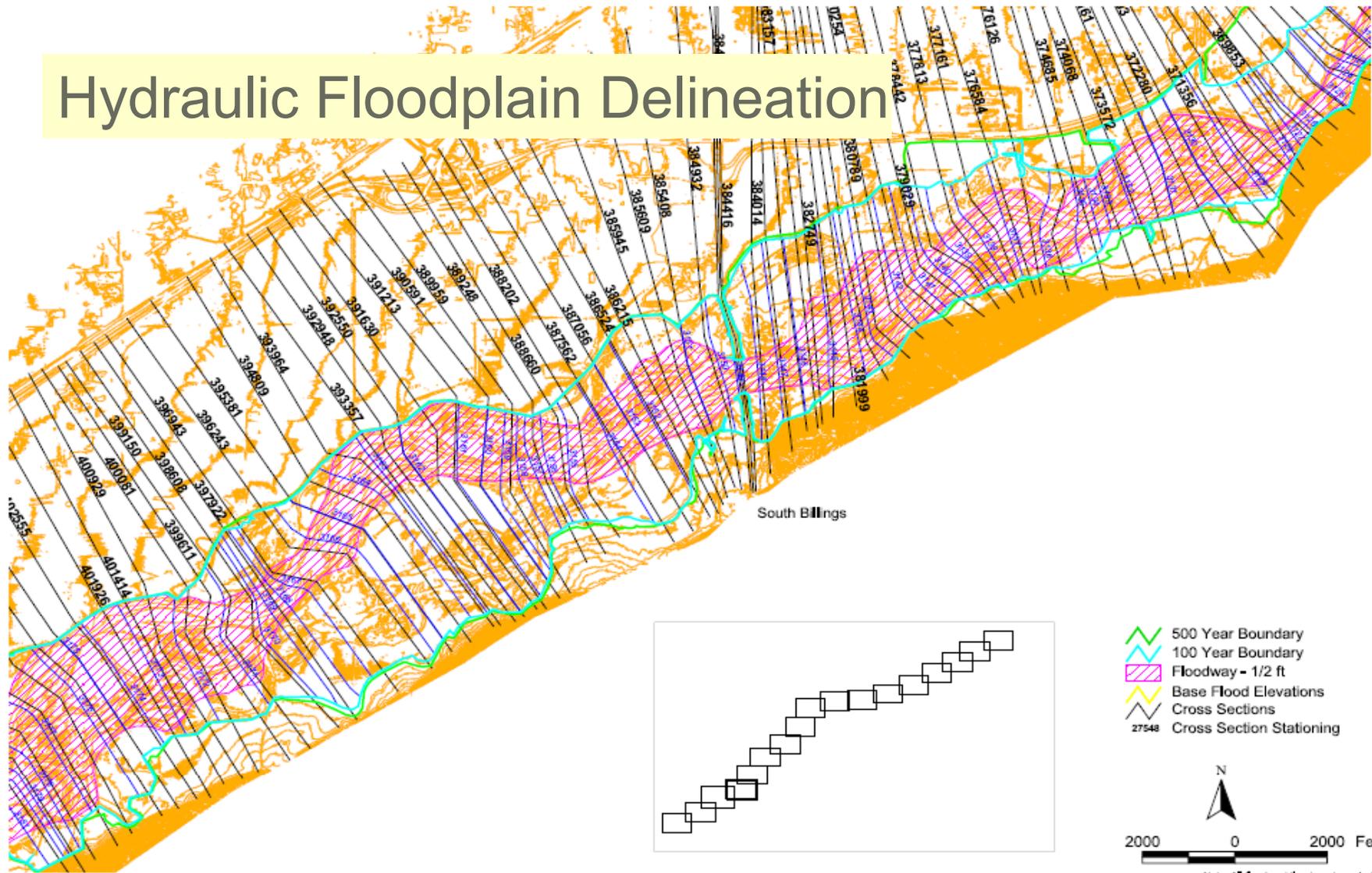
an arbitrary model flood



Source: USGS

Yellowstone River LiDAR Applications

Hydraulic Floodplain Delineation



Designed by: J.S.S.	Submitted by: US Army Corps of Engineers Omaha District
Drawn by: J.S.S.	Submitted by: Ronald Bealm Charles Schlegel Shawn Beckwith
Reviewed by: J.S.S.	
	 Yellowstone County, Montana Yellowstone River Corridor Study
	Yellowstone County Sheet 4 of 17
Date: April 2007	
Scale: 1" = 2000'	
Plate No: 04	

Note: All flood and floodway boundaries subject to FEMA review and approval.



0 0.5 Miles

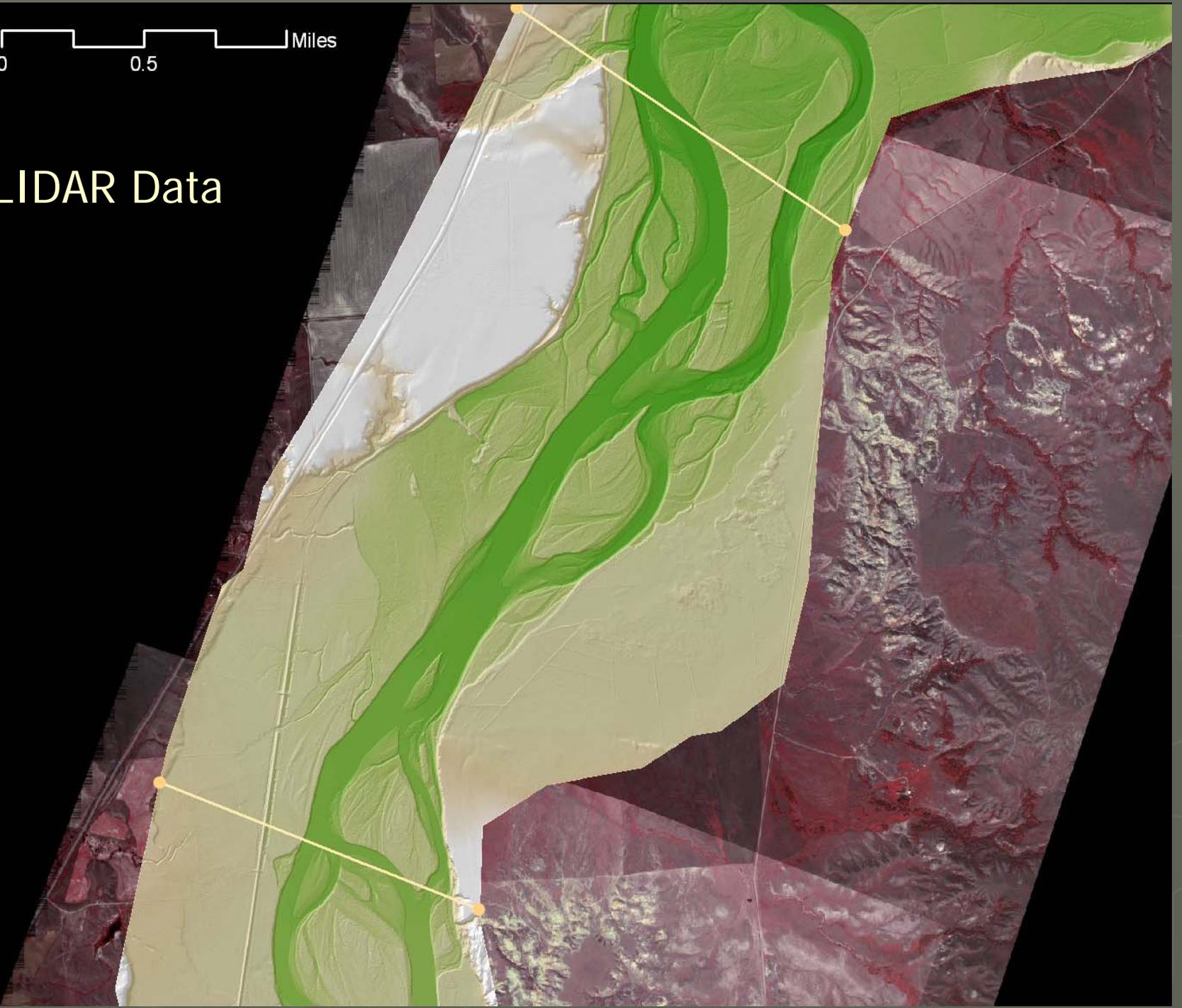
Dawson County





0 0.5 Miles

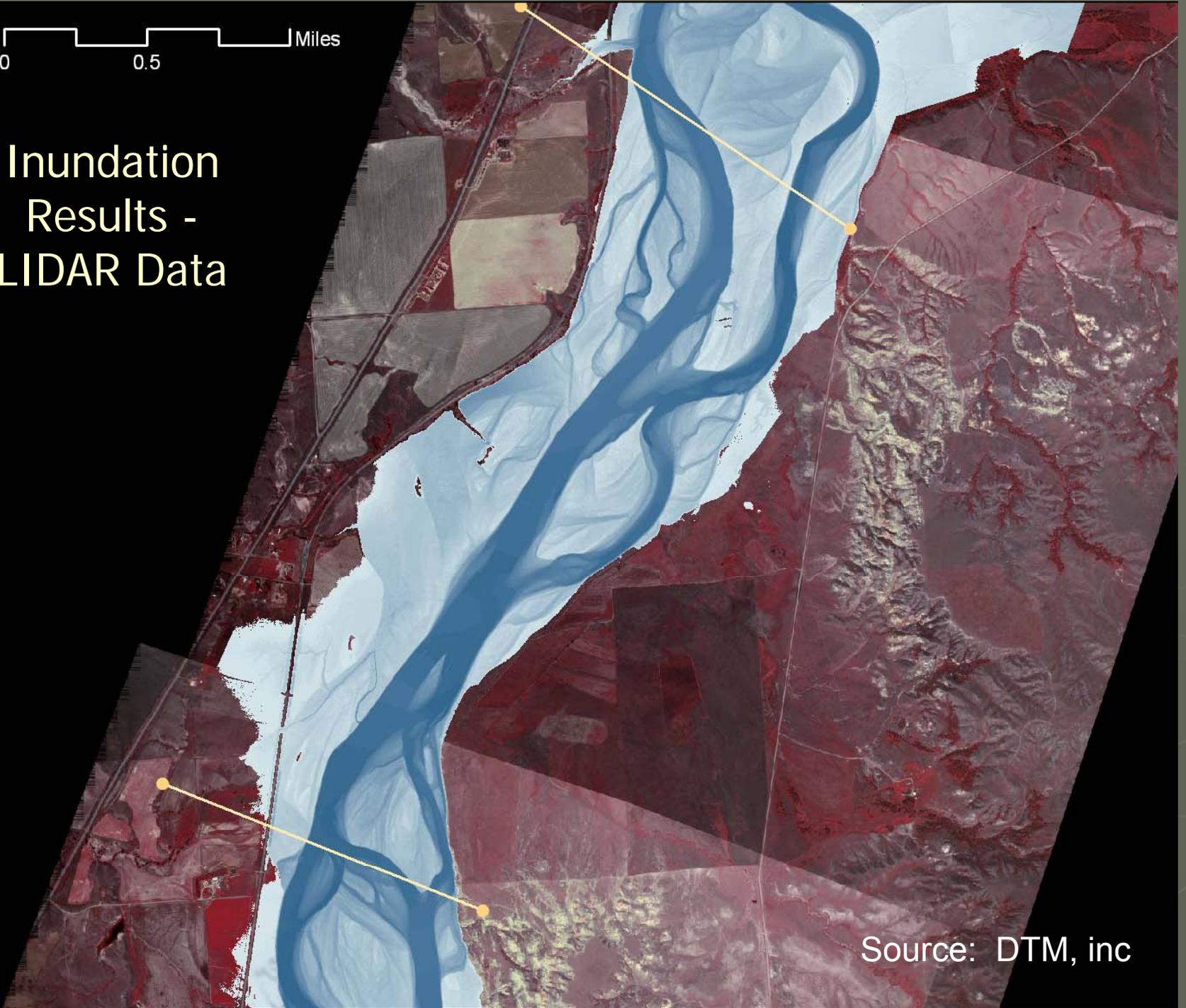
LIDAR Data





0 0.5 Miles

Inundation Results - LIDAR Data

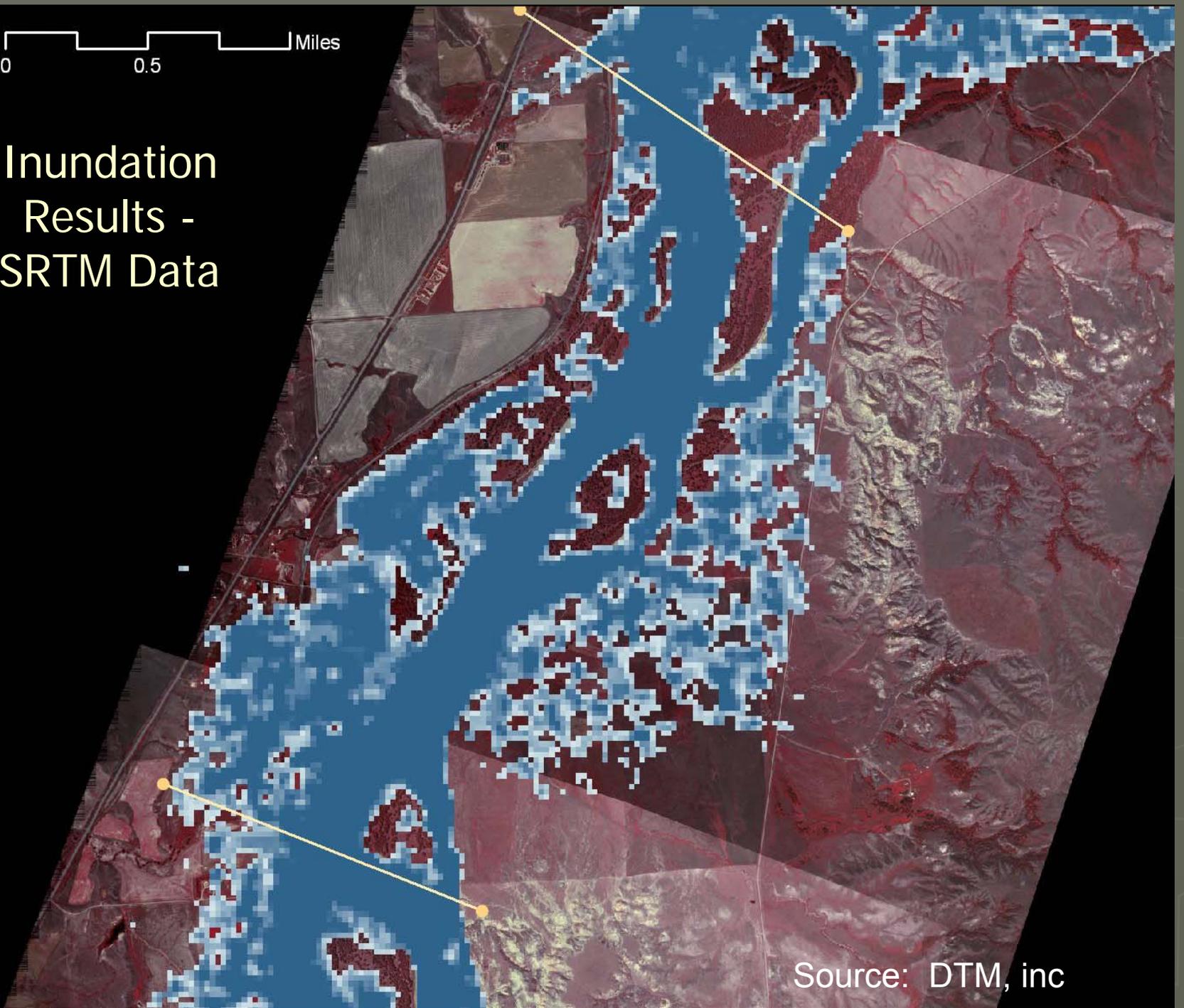


Source: DTM, inc



0 0.5 Miles

Inundation Results - SRTM Data

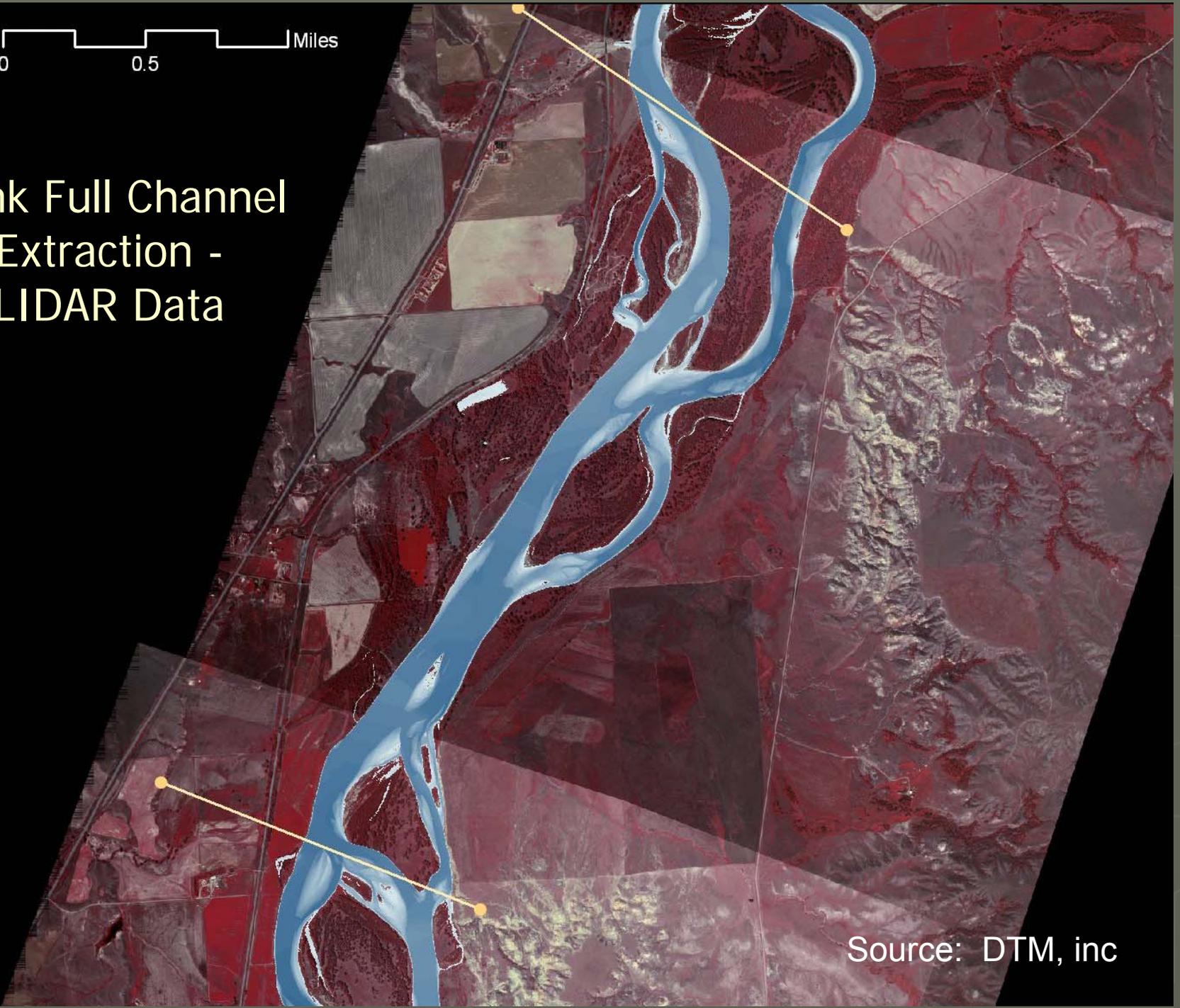


Source: DTM, inc



0 0.5 Miles

Bank Full Channel Extraction - LIDAR Data



Source: DTM, inc



Yellowstone River Corridor Resource Page

This web page provides a single point of access to a variety of data and publication resources that NRIS has prepared or compiled for the Yellowstone River Corridor. The listed data sets and publications were developed by several federal, state, and private entities. The intent is to provide a clearinghouse for information associated with the Yellowstone River Corridor.

MIDDLE and LOWER YELLOWSTONE RIVER (Springdale to Missouri River)

These data were created as part of a joint Yellowstone River Conservation Districts Council and U.S. Army Corps of Engineers, Omaha District investigation of the Yellowstone River stream corridor. The interdisciplinary planning study extends 477 river miles from Sweetgrass County, Montana to the Missouri River confluence in McKenzie County, North Dakota. Data developed as part of the mapping project are intended to support hydraulic, geomorphic, biologic and socioeconomic analyses of the stream corridor ecosystem.

HYDRAULICS, HYDROLOGY, AND GEOMORPHOLOGY

- [Lower Yellowstone River Corridor Color Infrared Digital Orthophotography and Physical Feature Data](#) (August, 2001) The Montana Natural Resources Conservation Service (NRCS) produced these mosaics of color infrared aerial photography as a basis for resource inventory and monitoring. Currently, these images are available for download by county. In addition, the physical feature

- **GIS Data and Aerial Photos** from the 2004 Yellowstone River Floodplain Mapping Project. The first phase of the mapping focused on Stillwater, Yellowstone and Dawson Counties in Montana and included approximately 295 square miles of floodplain.
 - **Planimetric GIS Data sets**
 - **Aerial Photos**
 - Stillwater County
 - West half of Yellowstone County

<http://nris.mt.gov/yellowstone>

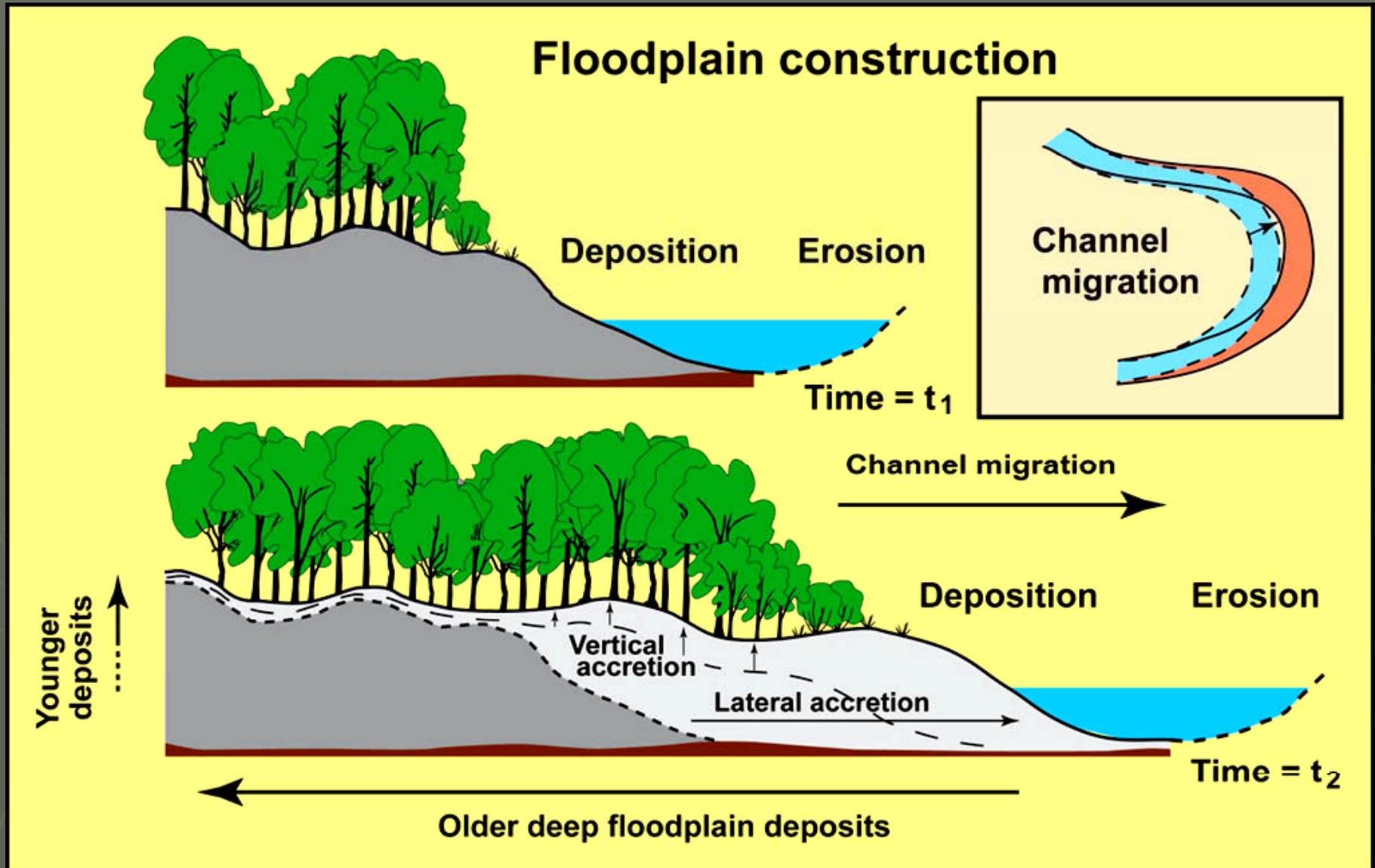
- Stillwater County
- West half of Yellowstone County
- East half of Yellowstone County
- Dawson County
- **TIN (Triangulated Irregular Network) Elevation Data**
 - Stillwater County
 - West half of Yellowstone County
 - East half of Yellowstone County
 - Dawson County



Yellowstone River Channel Modifications

SEP 27

Yellowstone River Cumulative Effects Assessment

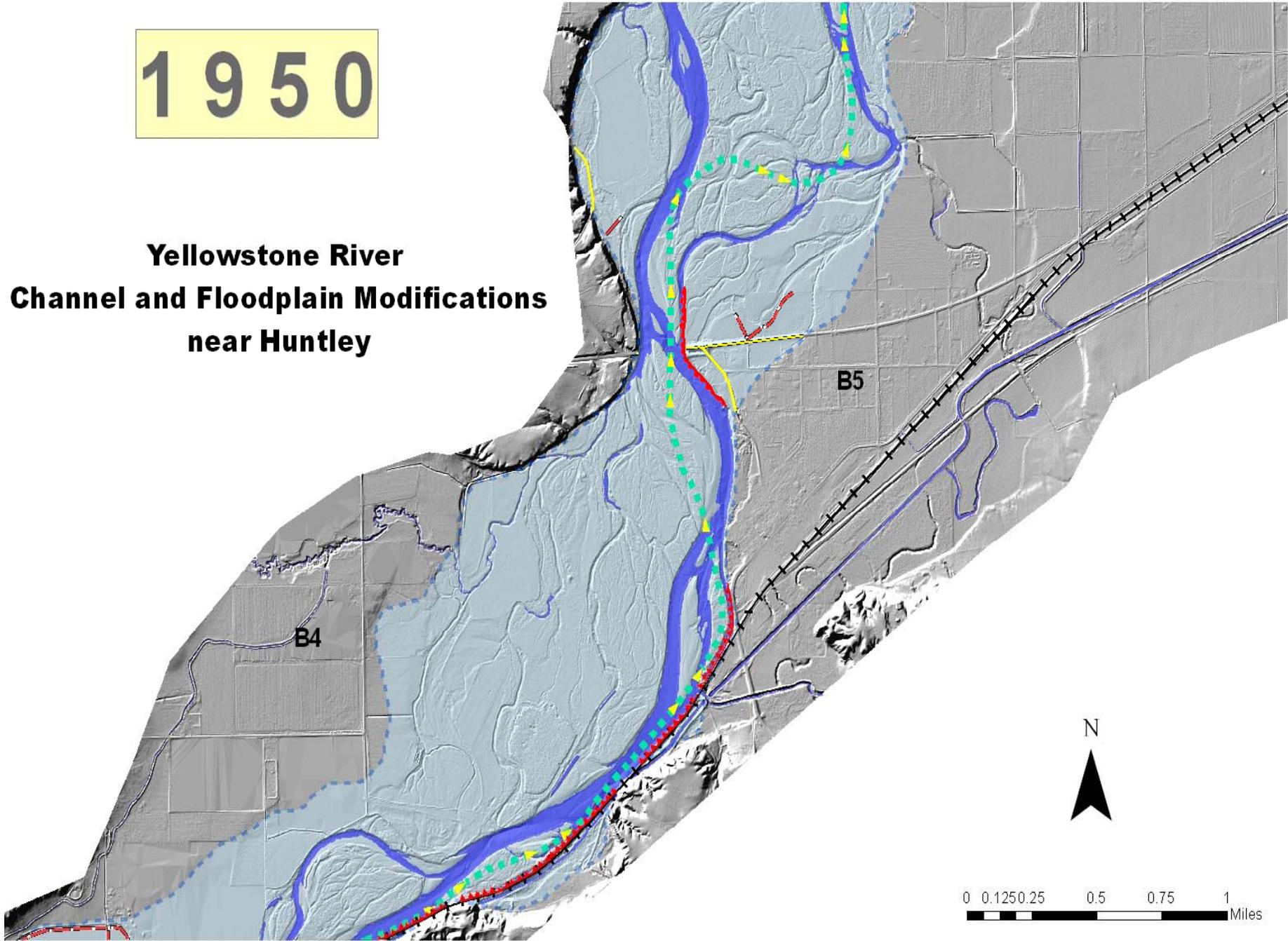




Car Bodies
400 feet

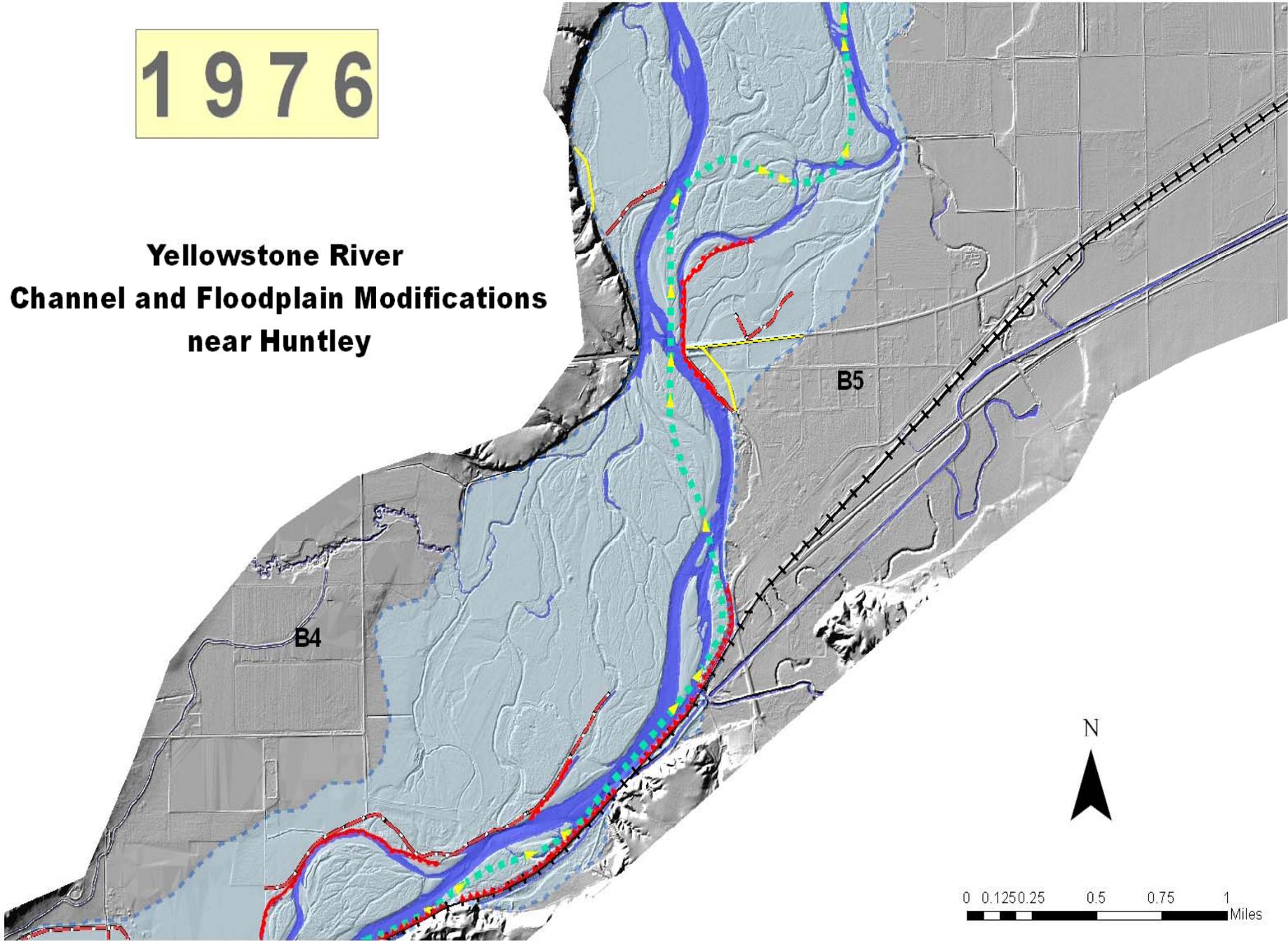
1950

**Yellowstone River
Channel and Floodplain Modifications
near Huntley**



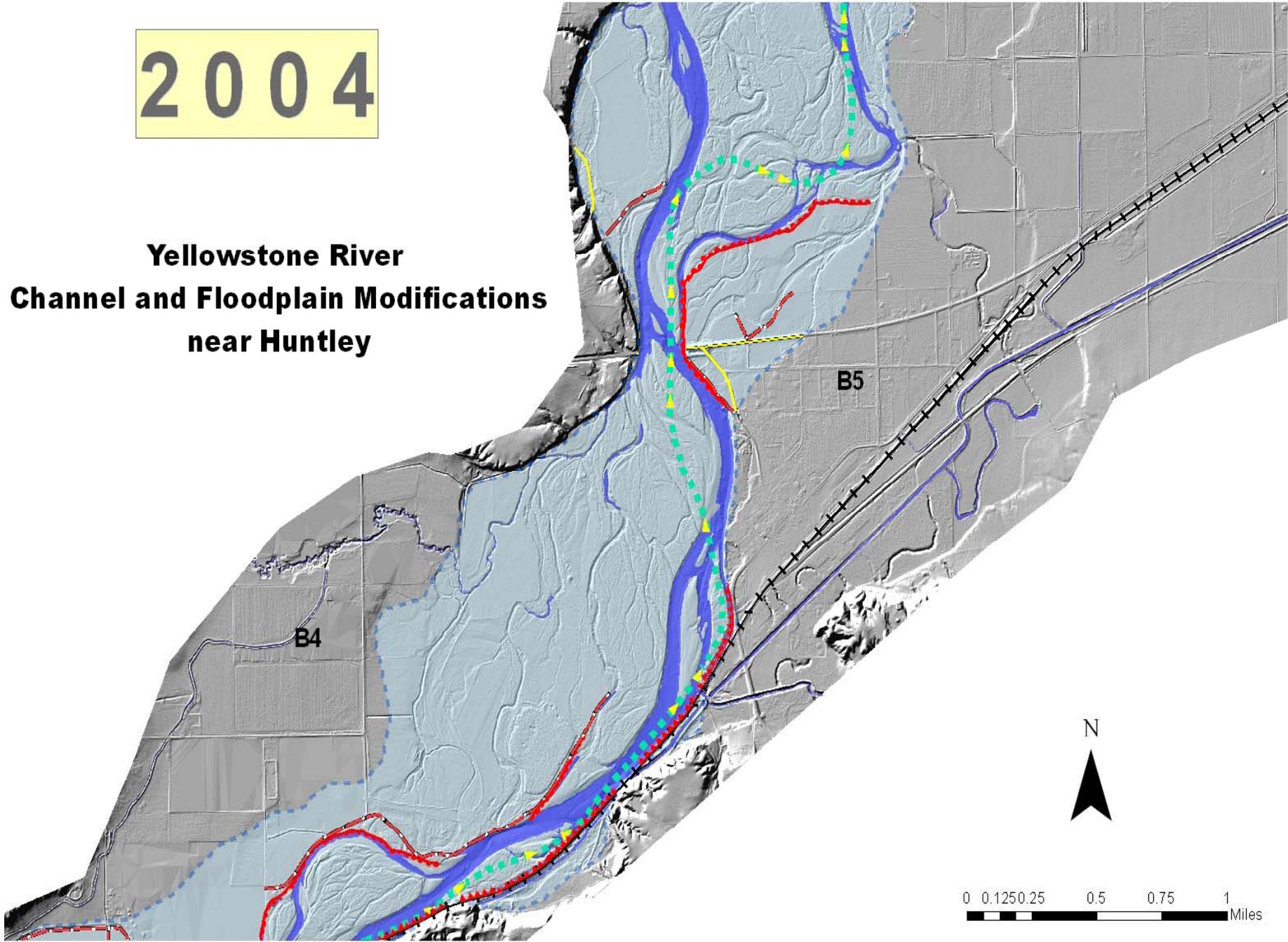
1976

**Yellowstone River
Channel and Floodplain Modifications
near Huntley**



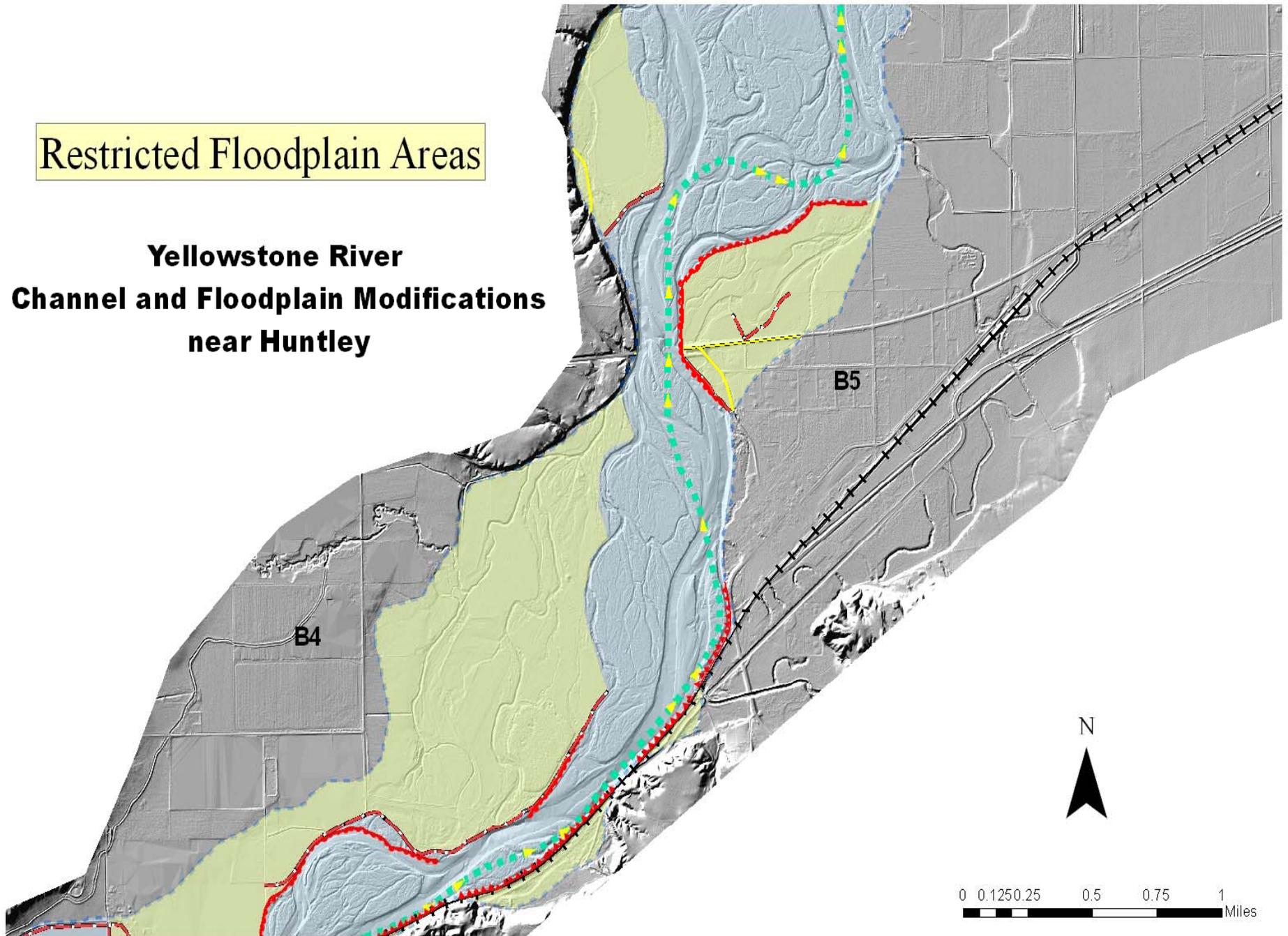
2004

**Yellowstone River
Channel and Floodplain Modifications
near Huntley**



Restricted Floodplain Areas

**Yellowstone River
Channel and Floodplain Modifications
near Huntley**



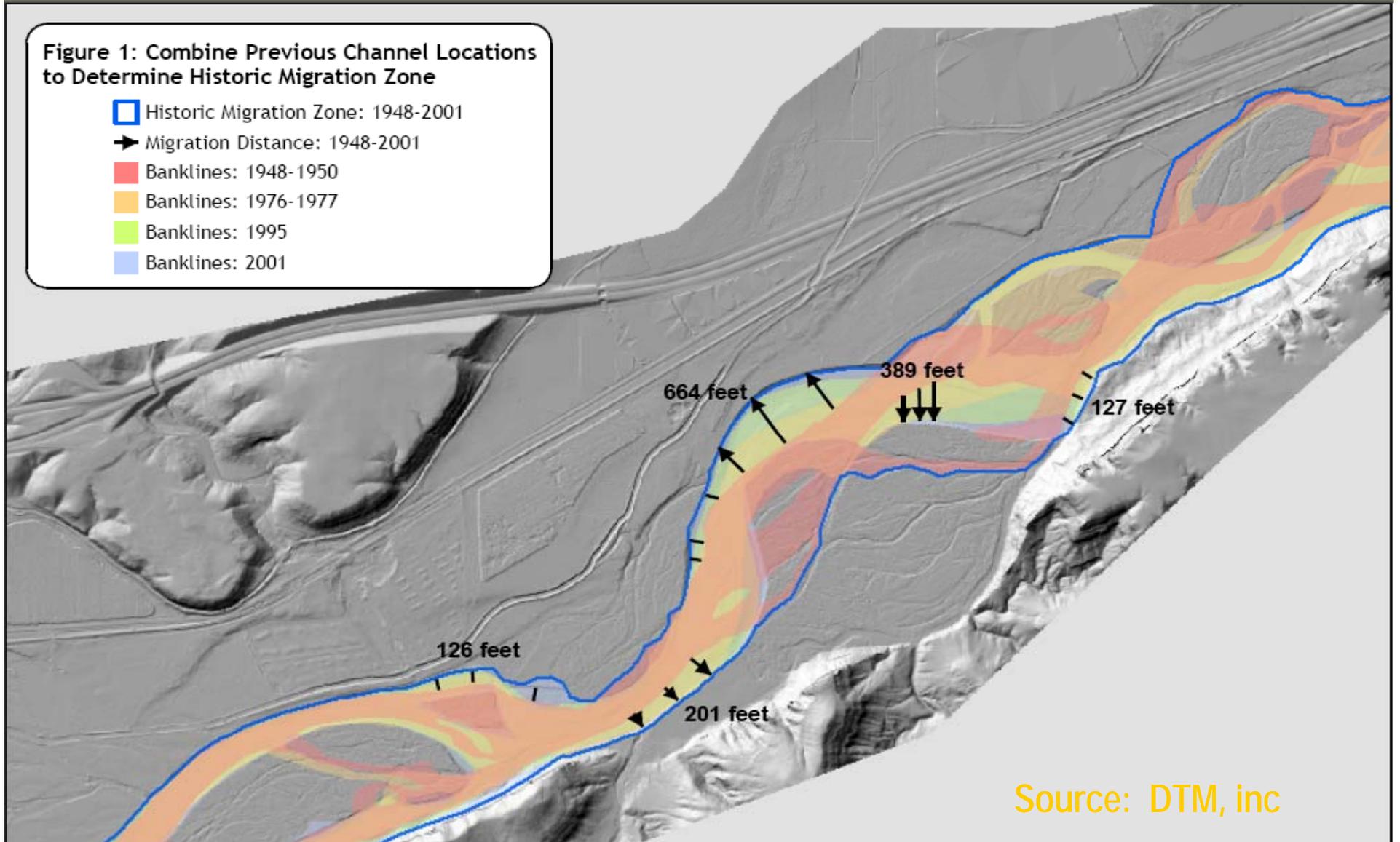
Channel Migration Zone and Avulsion Potential Zone (CMZ and APZ)

- Concept – Erosion Hazard vs. Flood Hazard
- CMZ – Portion of the river corridor prone to channel occupation due to bank erosion...
(Rapp and Abbe, 2003, Skidmore, et al, 1999)
- APZ – Portion of the river corridor prone to rapid channel shift into a new primary channel...
- Purpose – generate a defined corridor that reflects variable streambank conditions and erosion rates

Yellowstone River LiDAR Applications Channel Migration Zone (CMZ)

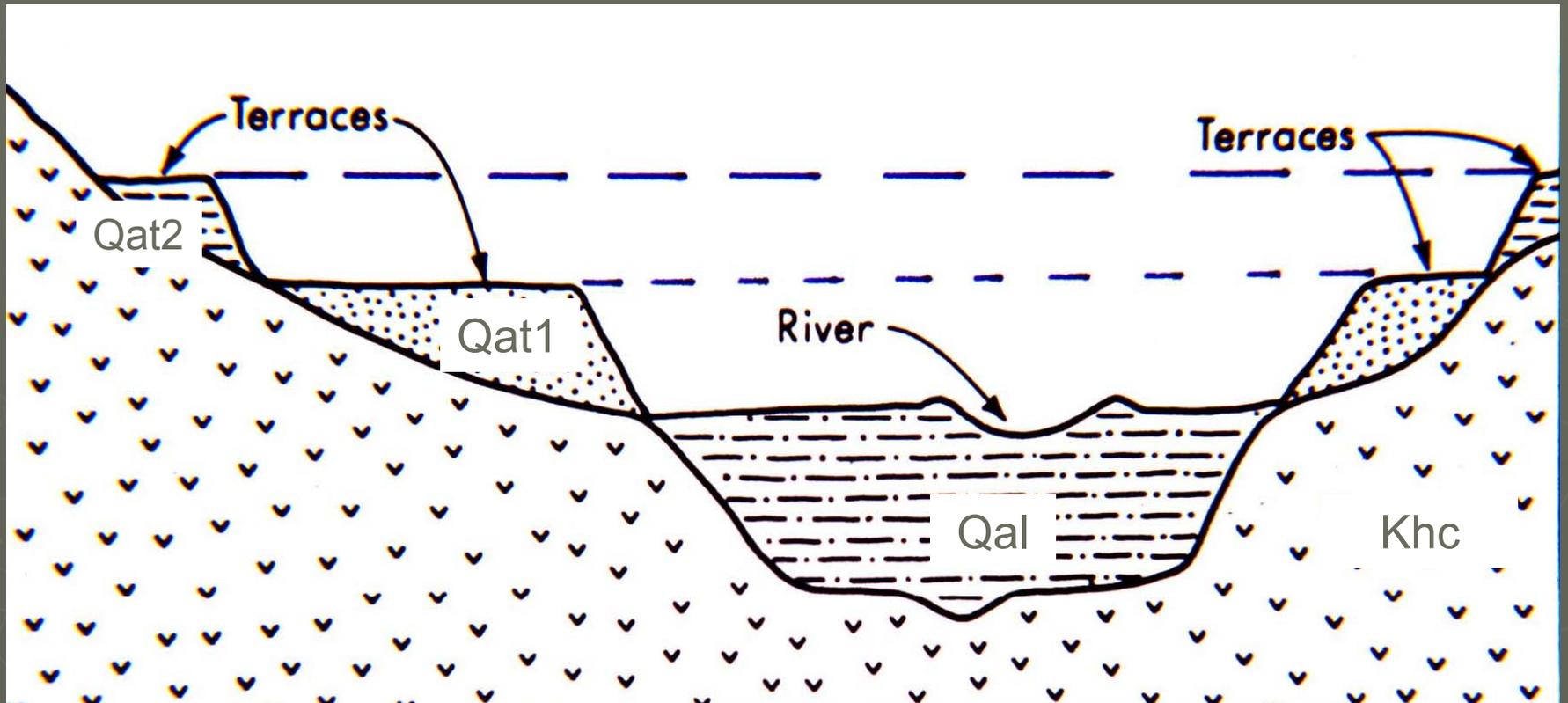
Figure 1: Combine Previous Channel Locations to Determine Historic Migration Zone

- Historic Migration Zone: 1948-2001
- ➔ Migration Distance: 1948-2001
- Banklines: 1948-1950
- Banklines: 1976-1977
- Banklines: 1995
- Banklines: 2001



Source: DTM, inc

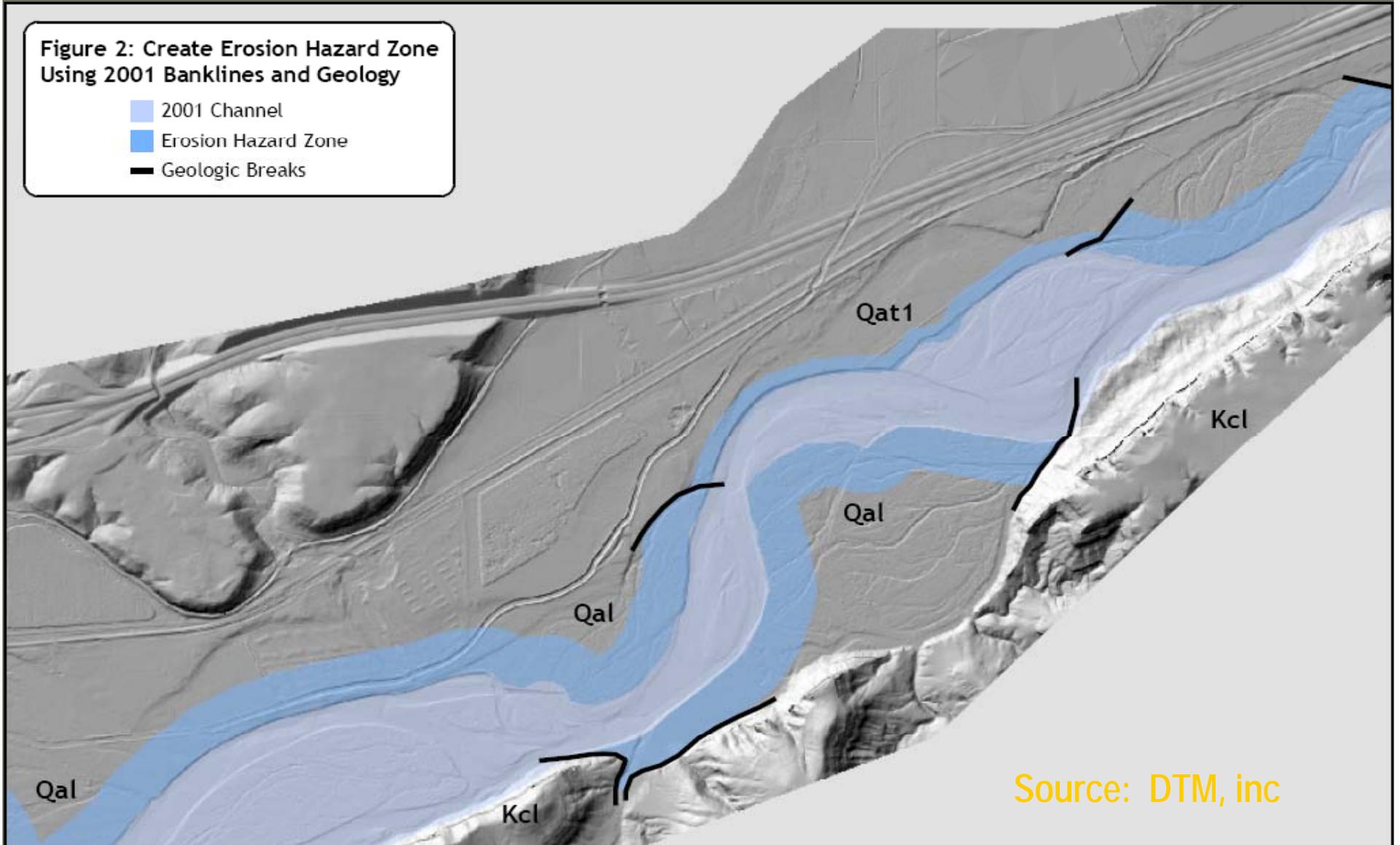
Yellowstone River LiDAR Applications



Yellowstone River LiDAR Applications Channel Migration Zone (CMZ)

Figure 2: Create Erosion Hazard Zone
Using 2001 Banklines and Geology

- 2001 Channel
- Erosion Hazard Zone
- Geologic Breaks



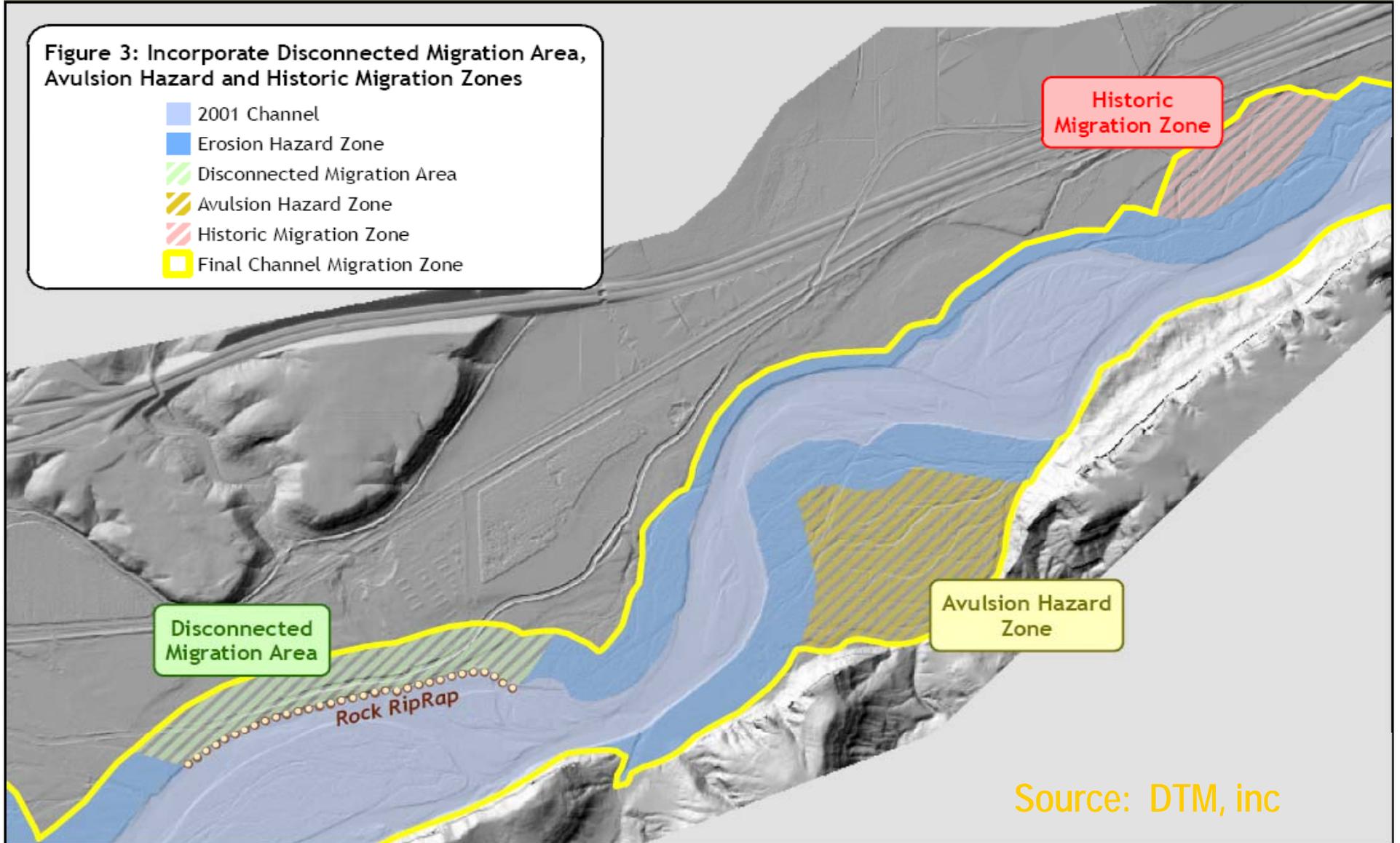
Source: DTM, inc

Yellowstone River LiDAR Applications

Channel Migration Zone (CMZ)

Figure 3: Incorporate Disconnected Migration Area, Avulsion Hazard and Historic Migration Zones

- 2001 Channel
- Erosion Hazard Zone
- Disconnected Migration Area
- Avulsion Hazard Zone
- Historic Migration Zone
- Final Channel Migration Zone

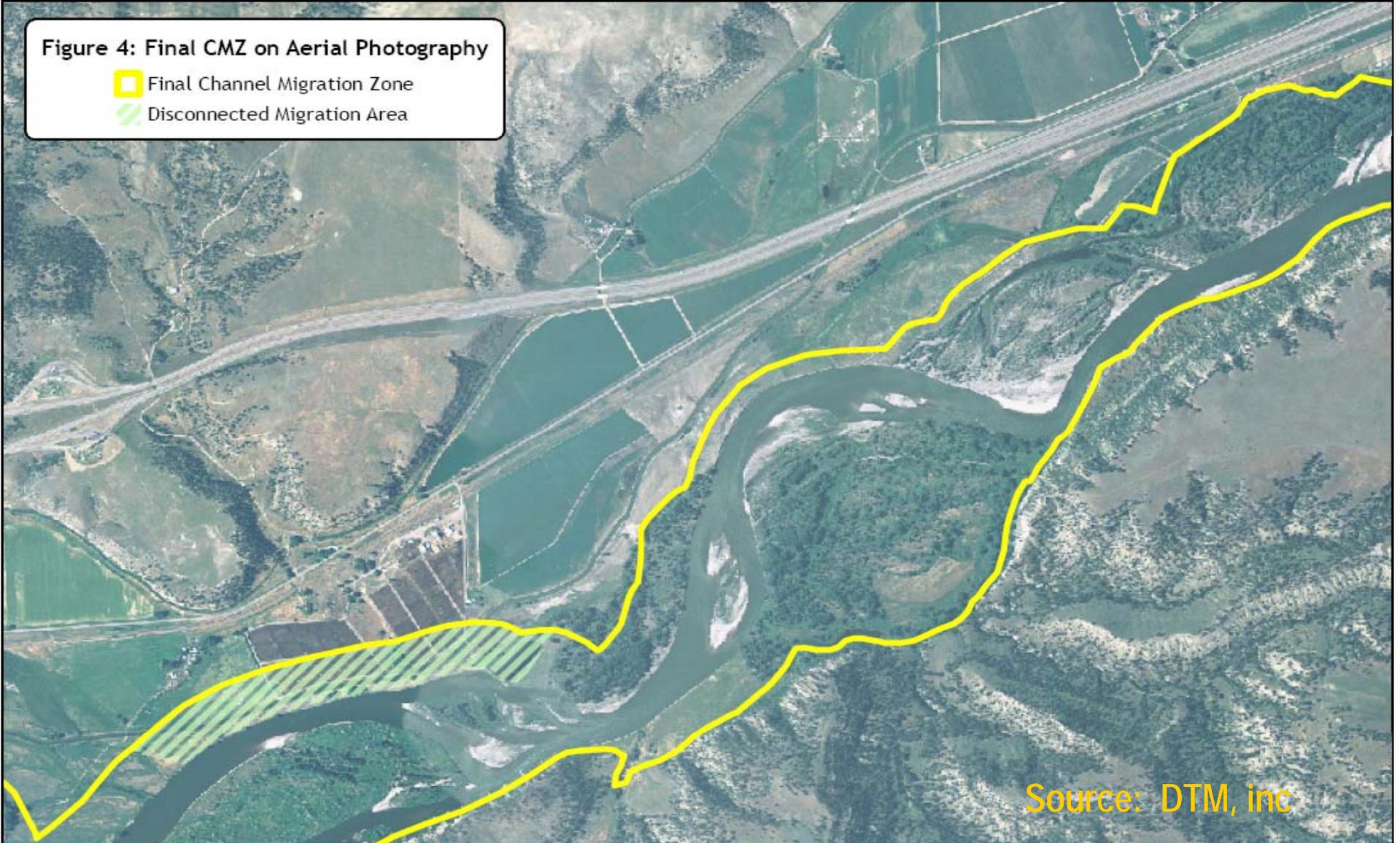


Source: DTM, inc

Yellowstone River LiDAR Applications Channel Migration Zone (CMZ)

Figure 4: Final CMZ on Aerial Photography

- Final Channel Migration Zone
- Disconnected Migration Area



Source: DTM, inc

Yellowstone River Cumulative Effects Assessment and LiDAR Applications Acknowledgements

► Project Sponsors & Management:

- Governor's Upper Yellowstone River Task Force
- Yellowstone River Conservation District Council
- U.S. Army Corps of Engineers, Omaha District
- MT DNRC, Reclamation and Development Grant Program
- Stillwater, Yellowstone, and Dawson Counties

► Technical Service Providers:

- DTM Consulting, Inc.
Bozeman, Montana
- Applied Geomorphology, Inc.
Bozeman, Montana
- Merrick and Company,
Aurora, Colorado
- Eisenbraun & Associates,
Yankton, South Dakota
- U.S. Army Corps, Omaha District
- MT DNRC, Water Resources and
Conservation and Resource
Development Divisions

<http://nris.mt.gov/yellowstone>