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Monitoring Landscape Changes Resulting from Coalbed Methane Development in the Powder River Basin, Wyoming using Remote Sensing Techniques: A Landscape Change Analysis Proof of Concept

Jamie L. McBeth
Rocky Mountain Mapping Center
Lakewood, CO

U.S. Department of the Interior
U.S. Geological Survey

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- Steve Blauer of the USGS Rocky Mountain Mapping Center also contributed to this analysis.
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What is a landscape change analysis?

- Also called **change detection**, it's an analysis of how the land surface has changed over time.
- Land cover and/or land use is categorized from imagery for different time periods.
- There are different methods of classifying the land cover.
- The classifications from all time periods are compared for change. . .

  Were there any new land covers appearing over time?

  Any land covers lost?

  How much of each land cover was lost and/or gained over time?

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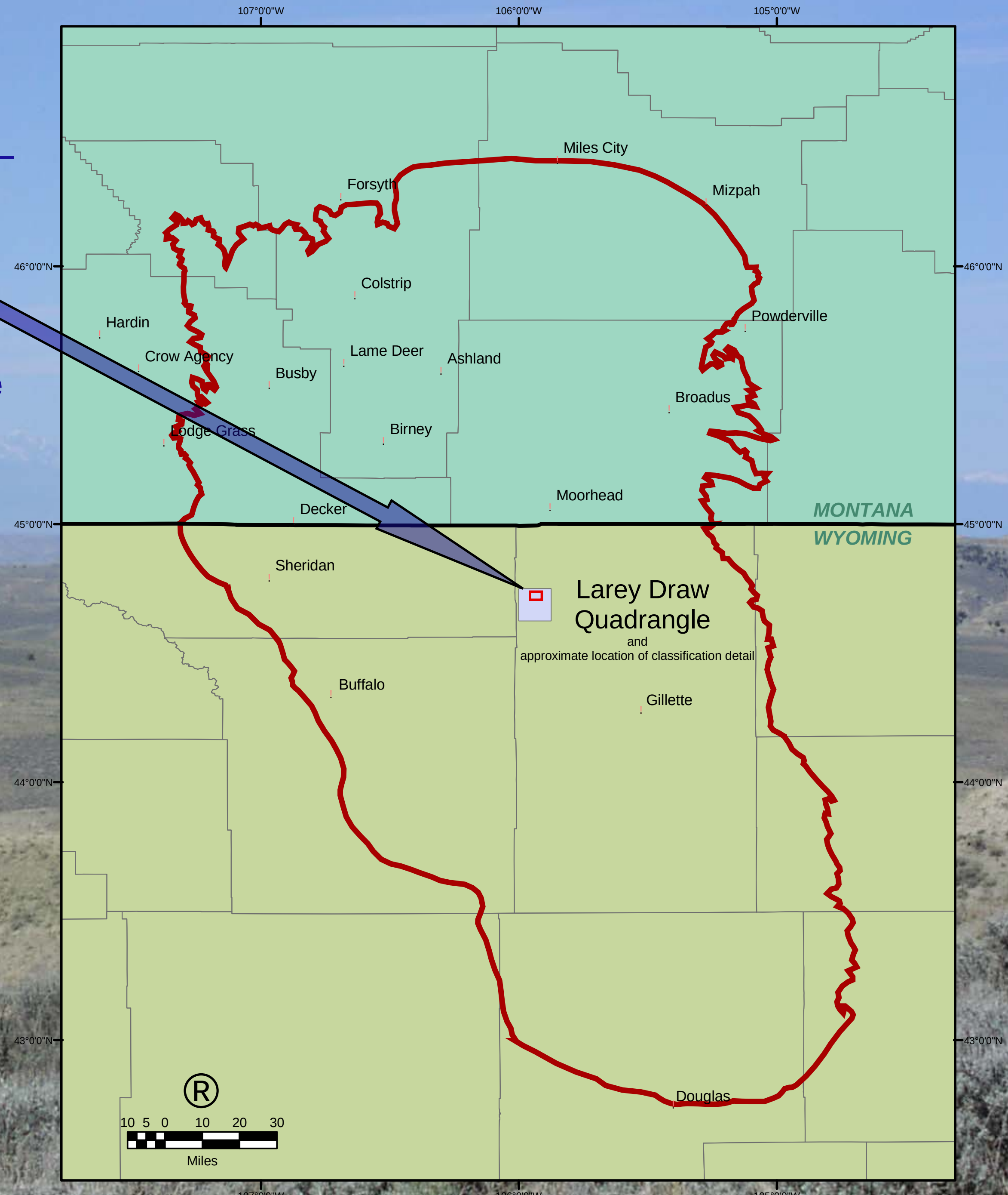
Project Objective:

- Compare two classification methods, determine their pros and cons, and determine the best for use in monitoring CBM-related landscape changes.

Study Area

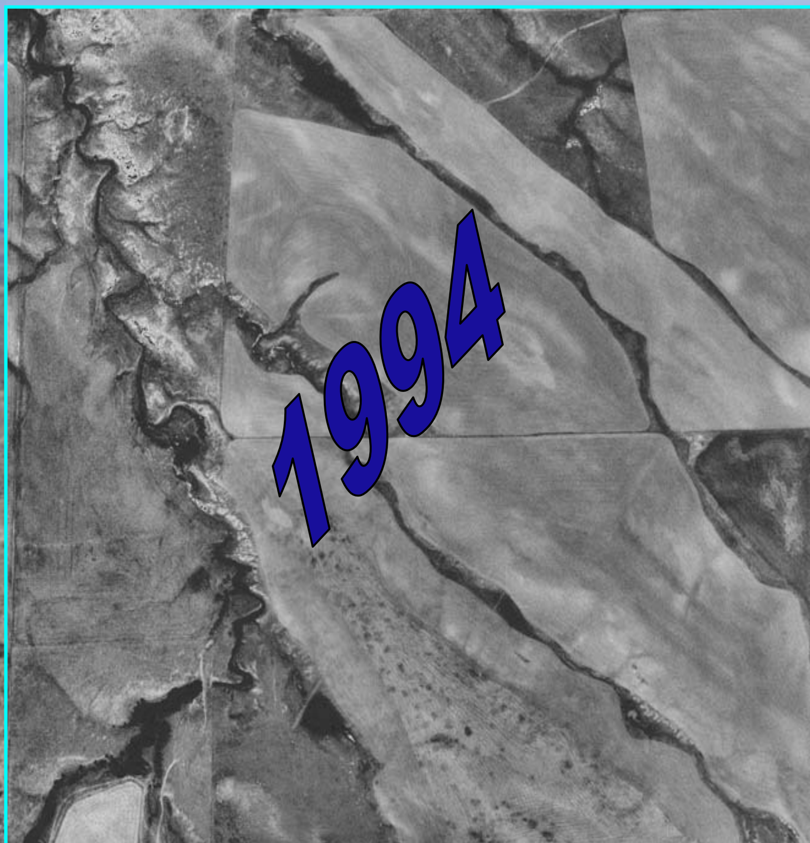
Larey Draw 1:24,000 quadrangle –
Campbell County, Wyoming,
T 54&55 N, R 75&76 W

Focus area of landscape change
analysis proof of concept:
Larey Draw Section 19



Imagery used for this project:

- Pre-CBM development –
  1994 black & white Digital Orthophoto Quarter Quadrangles (DOQQs)
- Post-CBM development –
  2001 color infrared DOQQs



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The Methods

"Cartographic"

- Incorporated cartographic feature input
  - Features such as roads and drainages imported from Digital Raster Graphics (DRGs)
- Used cartographic methods of feature identification
  - Use of buffers as part of collection to show feature extent / disturbance
  - Use of boxed rasters for CBM wellpad identification
- Also used spectral similarities and photo interpretation

"Geographic"

- Identified and classified features by their full extent on land surface
- Used unsupervised classification and photo interpretation

The Categories

a) **Open Water**
b) **Riparian Vegetation** – grasses, trees, etc. contiguous to water bodies or drainages; any vegetation distinctly different from surrounding cover
c) **Manmade Structure / Dam** – earthen dams, houses, etc.
d) **Unimproved Roads** – minimally maintained roads that provide public or private parties limited or restricted access
e) **Bare Ground or Rock** – ground that does not support vegetation

The Categories

f) **Pasture / Agriculture** – maintained pasture or planted fields of row crop

g) **Grass / Sage Shrub** – natural vegetation consisting of grass and shrub land

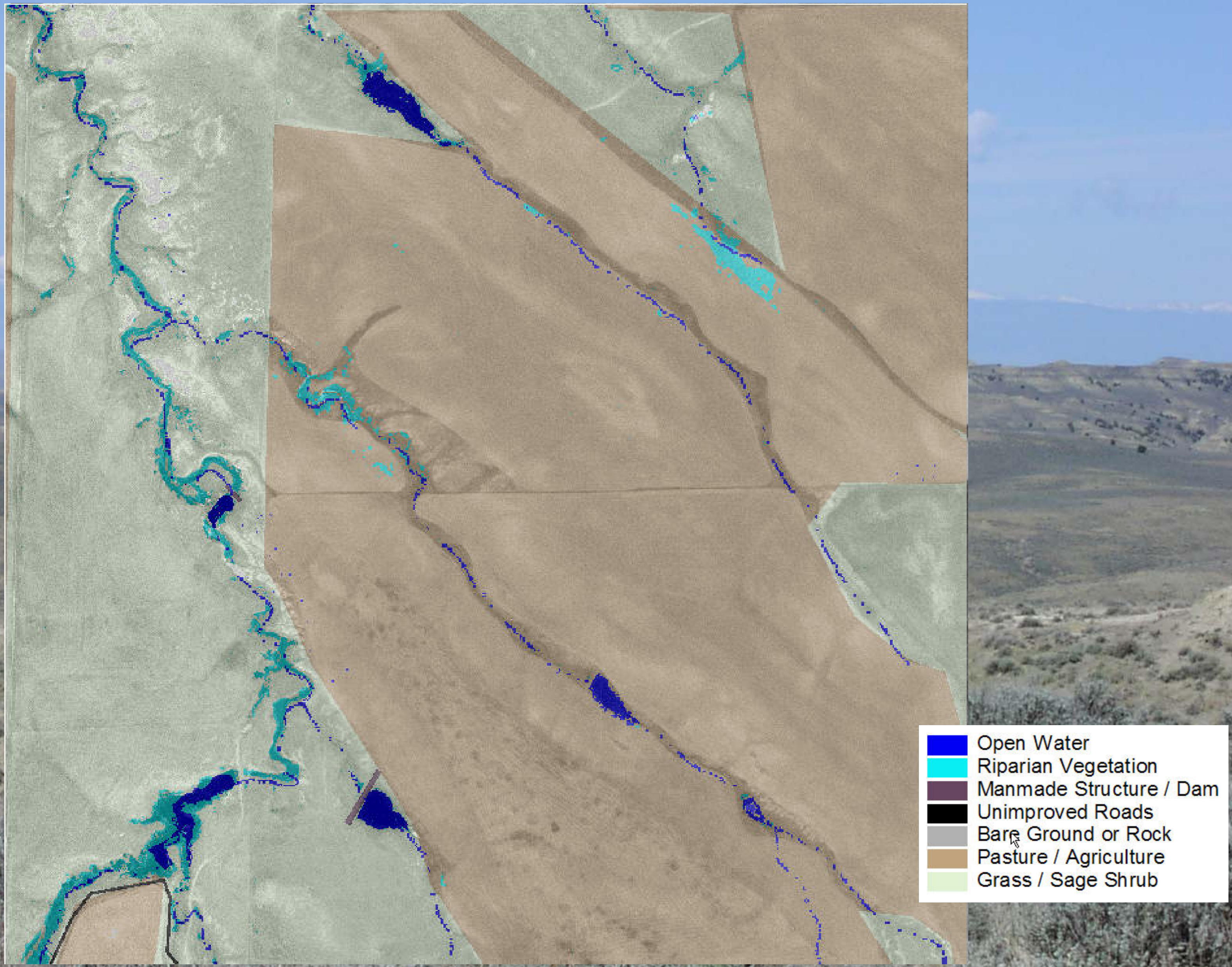
h) **Ranch Trails** – narrow, limited access paths generally only used by ranchers

i) **CBM Wellpad** – drill site and associated surface disturbance (Geographic Method)

j) **CBM Pipeline Scar** – area on land surface defining pipeline burial location

k) **CBM Infrastructure** – infrastructure associated with production of coalbed methane, e.g., booster/compressor stations

Cartographic Method – 1994 Classification



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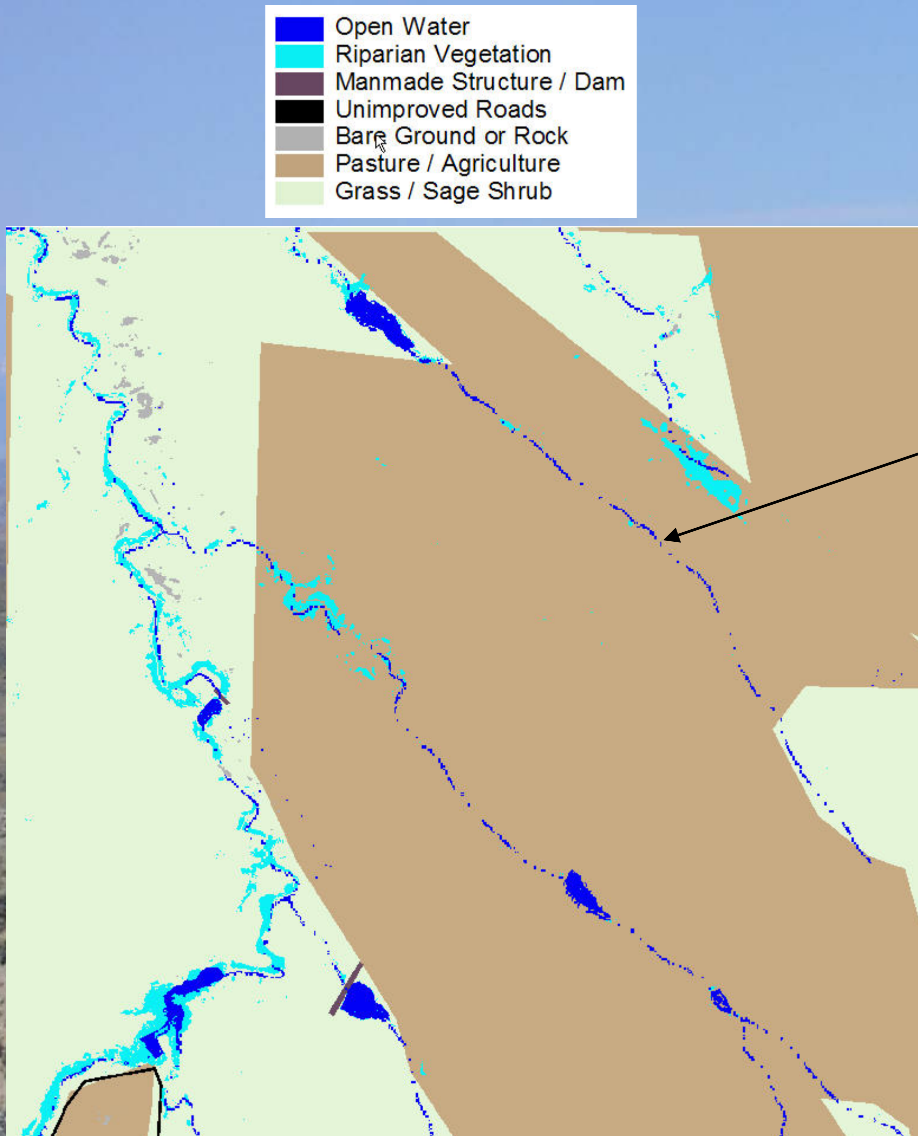
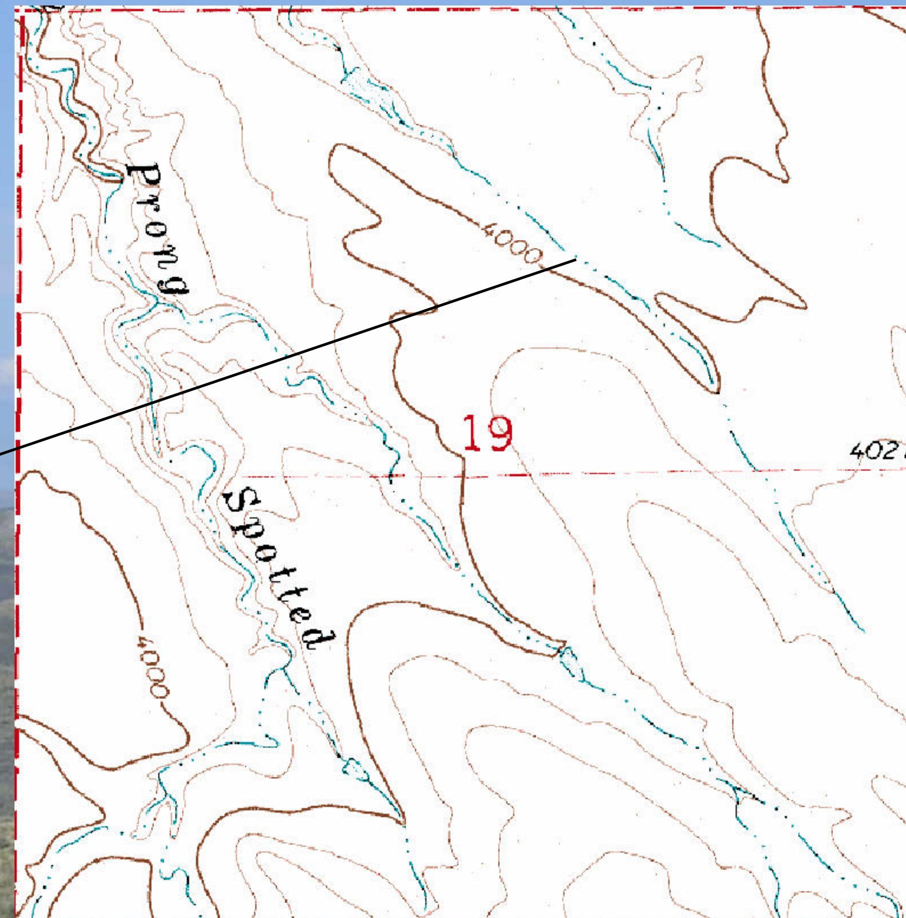
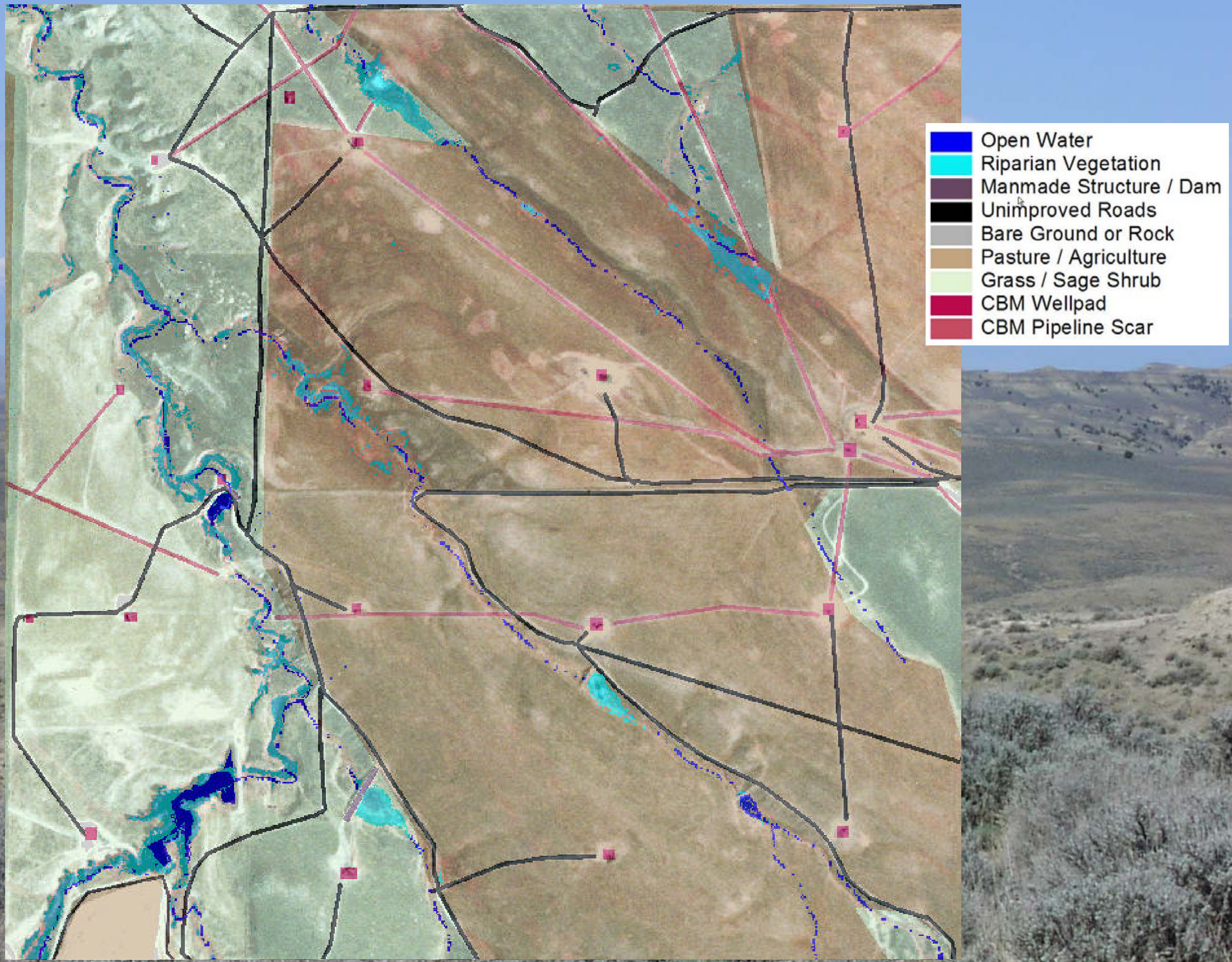
Cartographic Method – 1994 Classification





Drainages imported from DRGs; other features identified through combination of photo interpretation and spectral similarities

Cartographic Method – 2001 Classification



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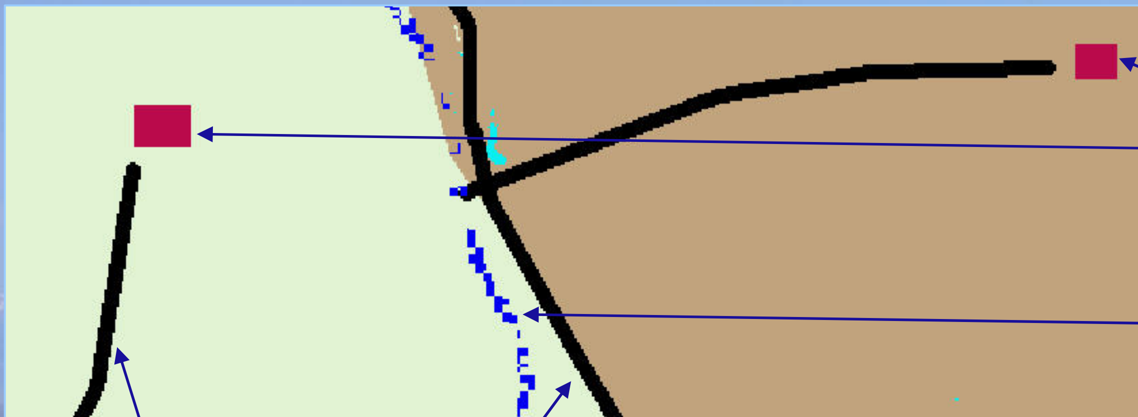
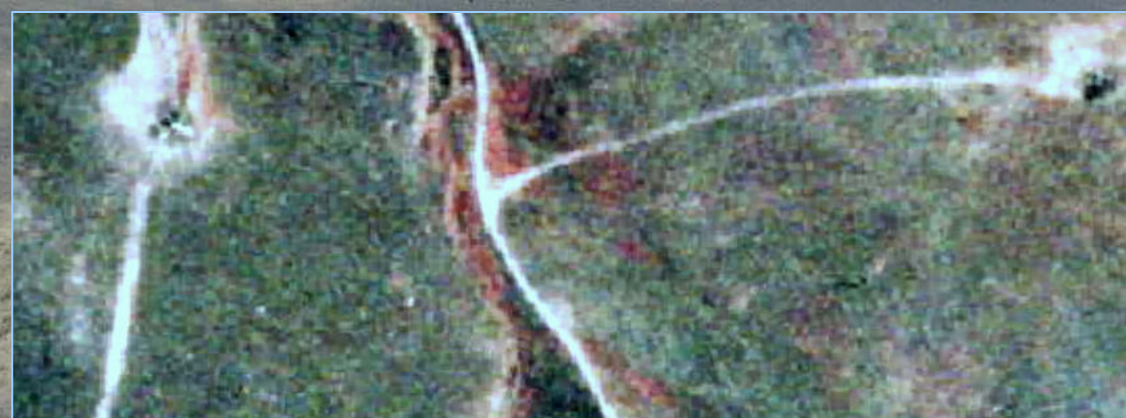
Cartographic Method Example – 2001 Classification



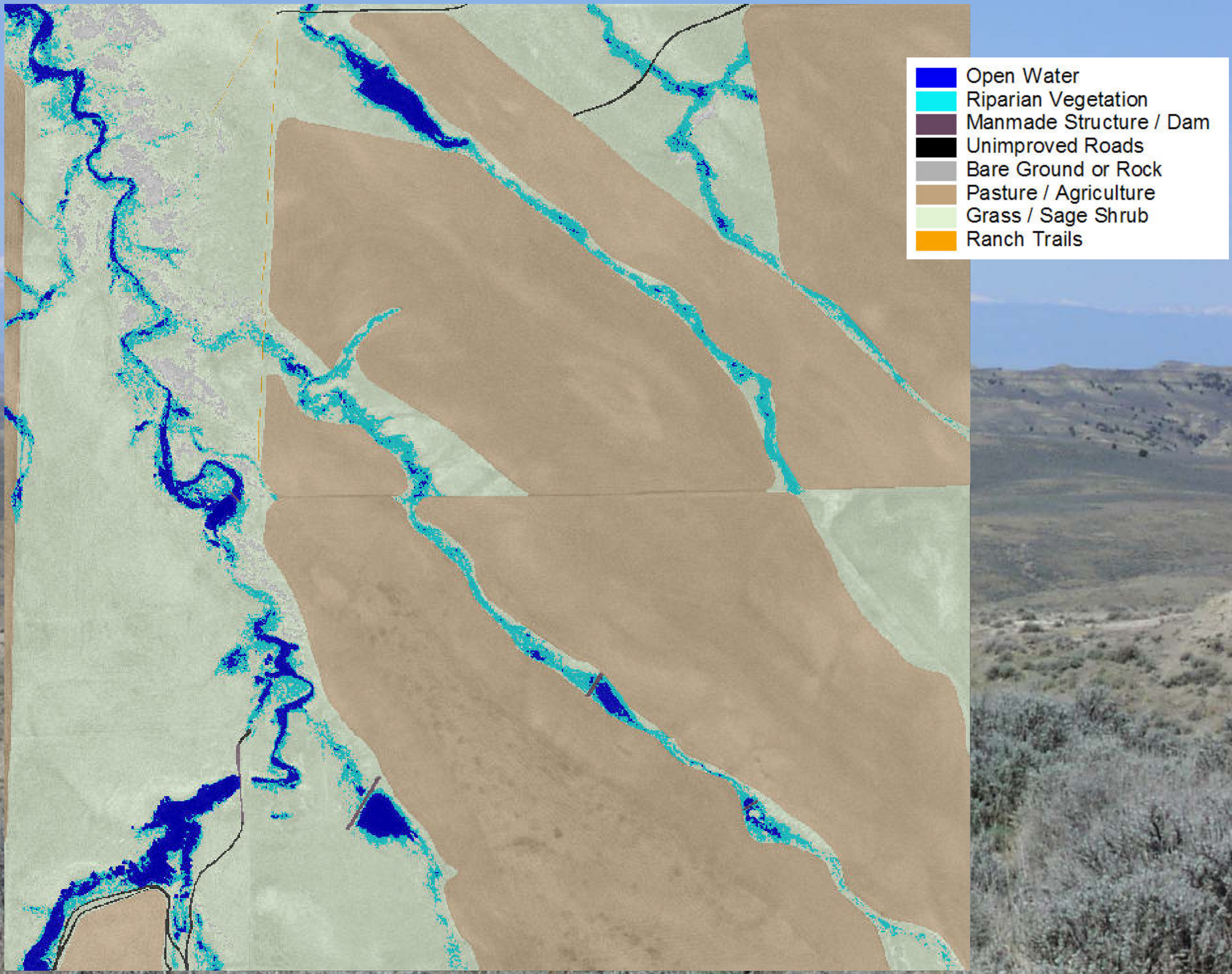
Wellpads shown as a boxed raster with no specific size

Drainages imported from DRGs

Roads collected with constant buffer



Geographic Method – 1994 Classification



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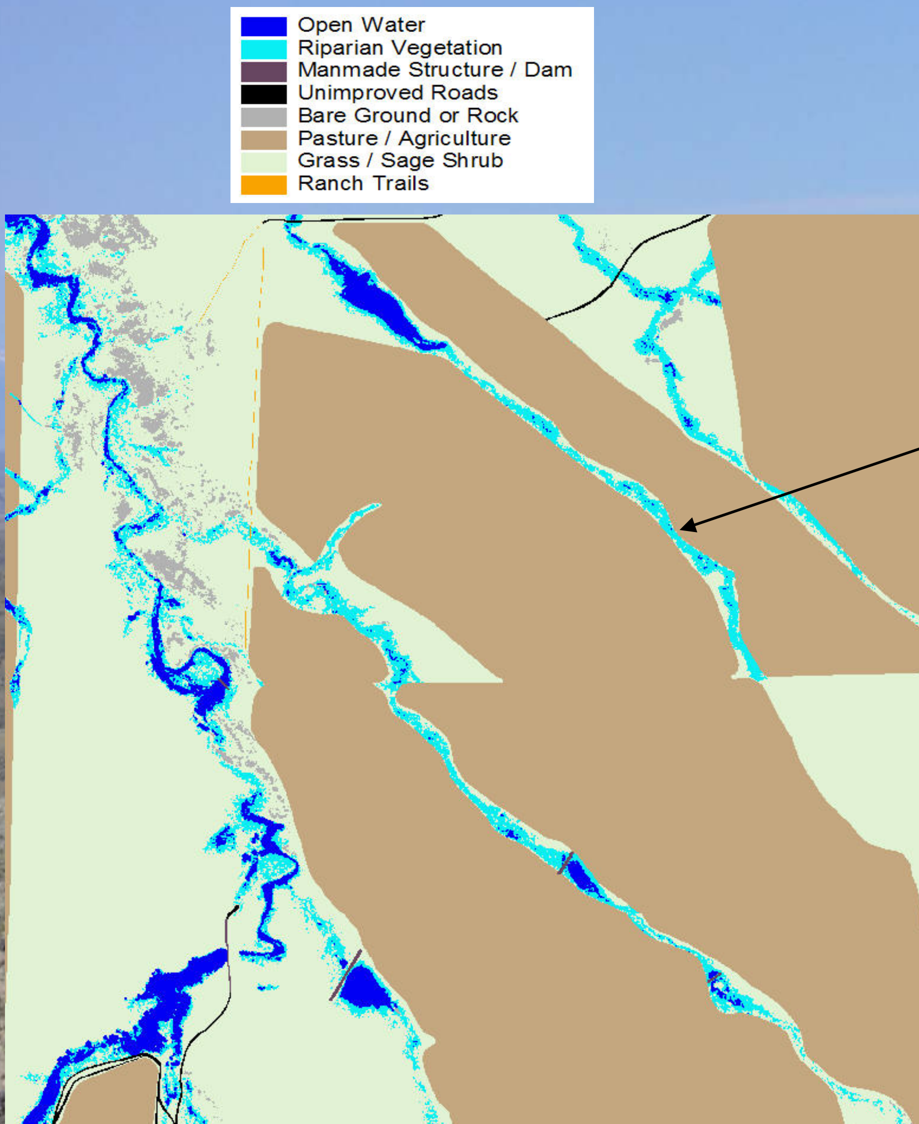
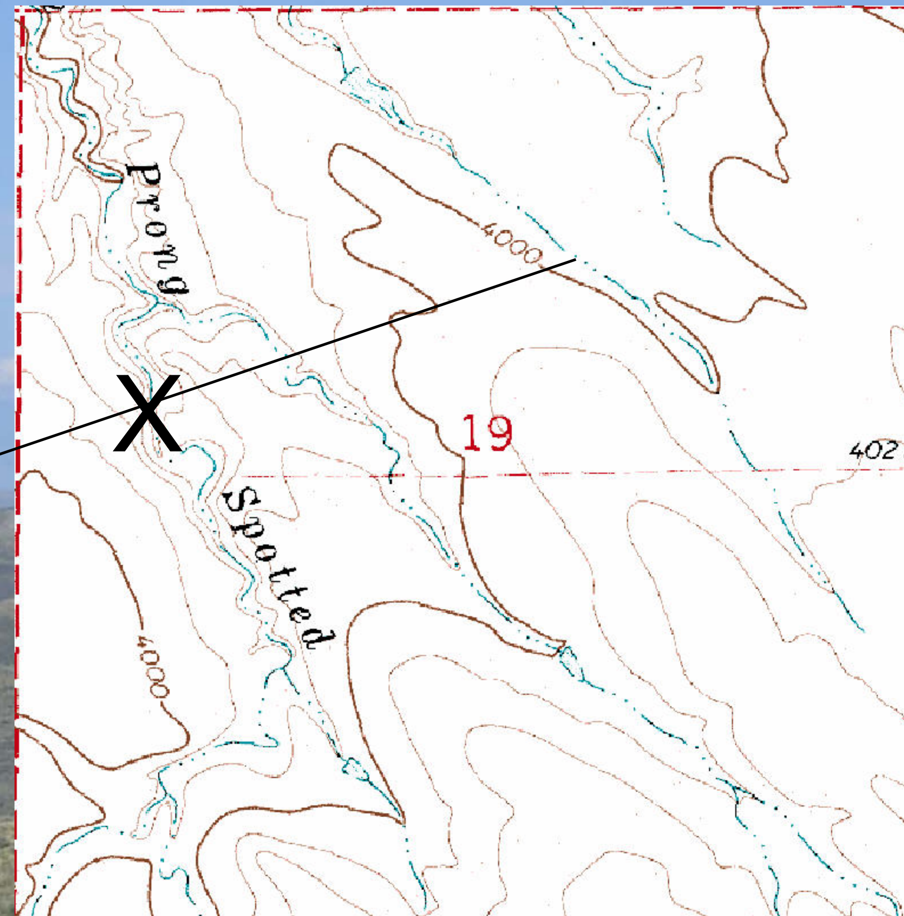
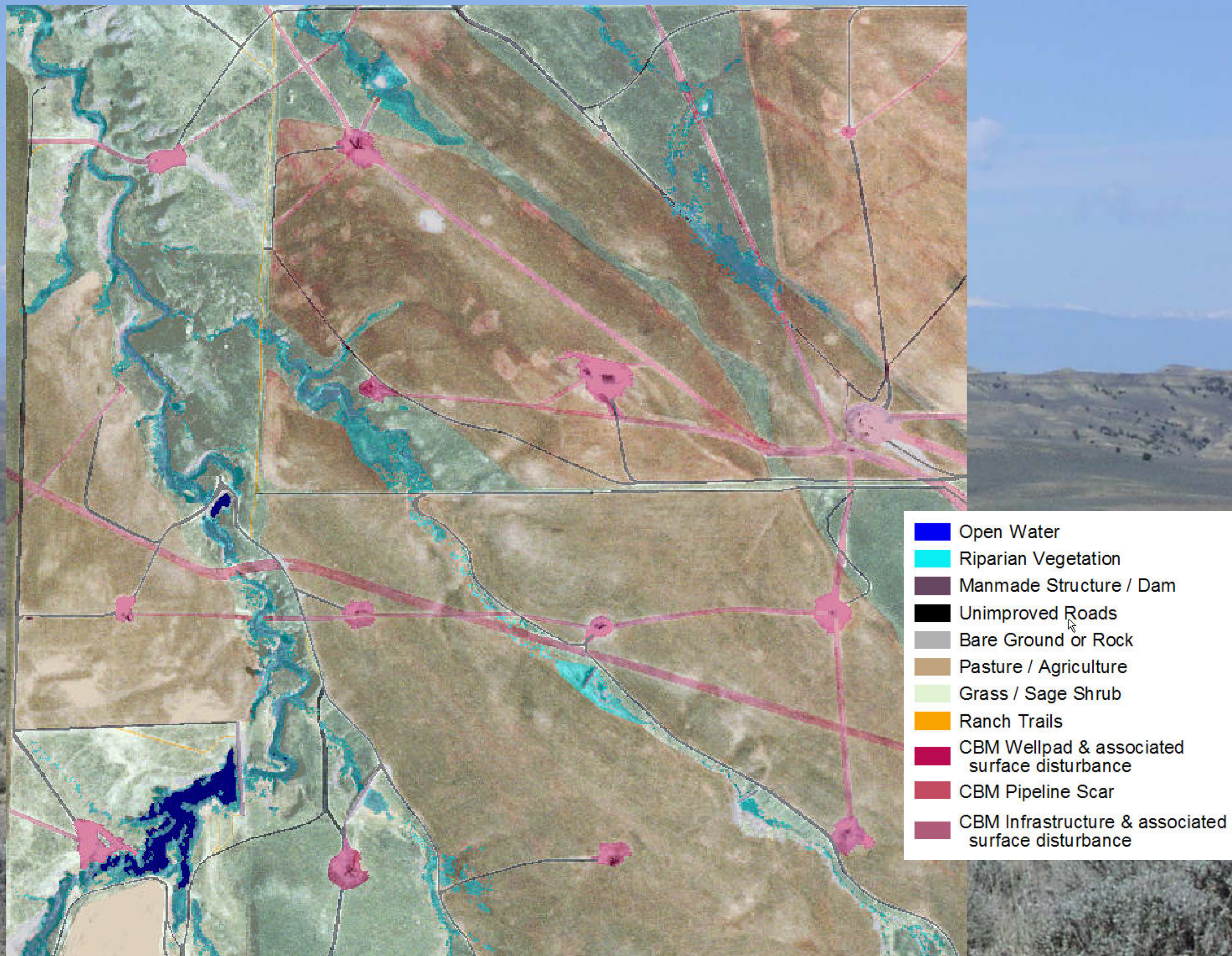
Geographic Method – 1994 Classification





Drainages and water bodies NOT imported from DRGs; identified via unsupervised classification of spectral similarities

Geographic Method – 2001 Classification



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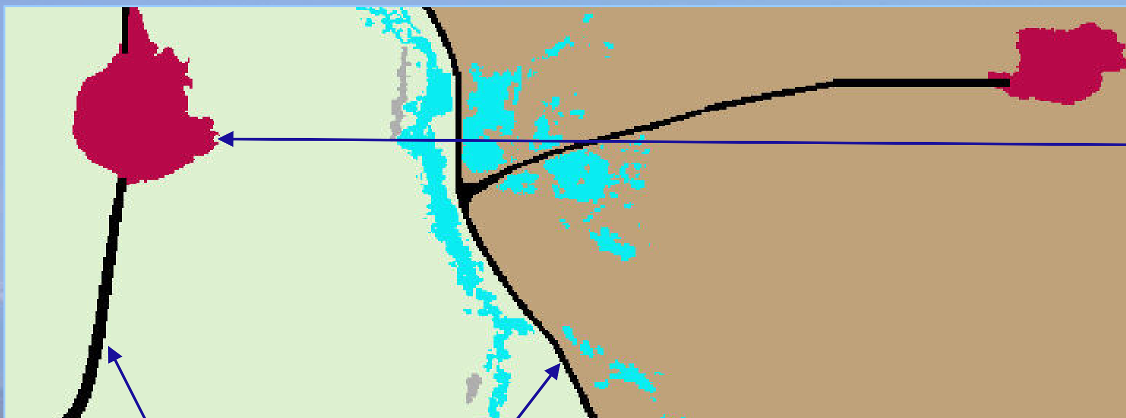
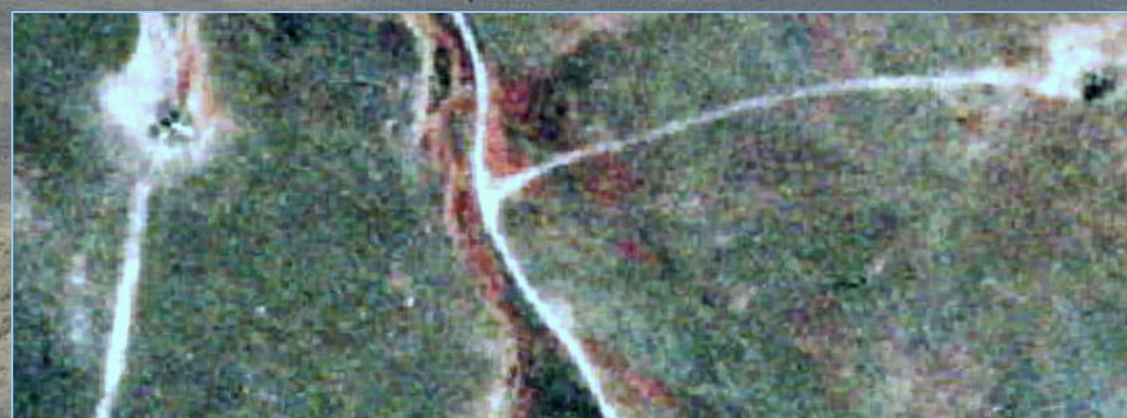
Geographic Method Example – 2001 Classification



Wellpads collected as wellhead(s) PLUS surrounding disturbed area

Road (and pipeline scar) collection based on full extent and shape of feature



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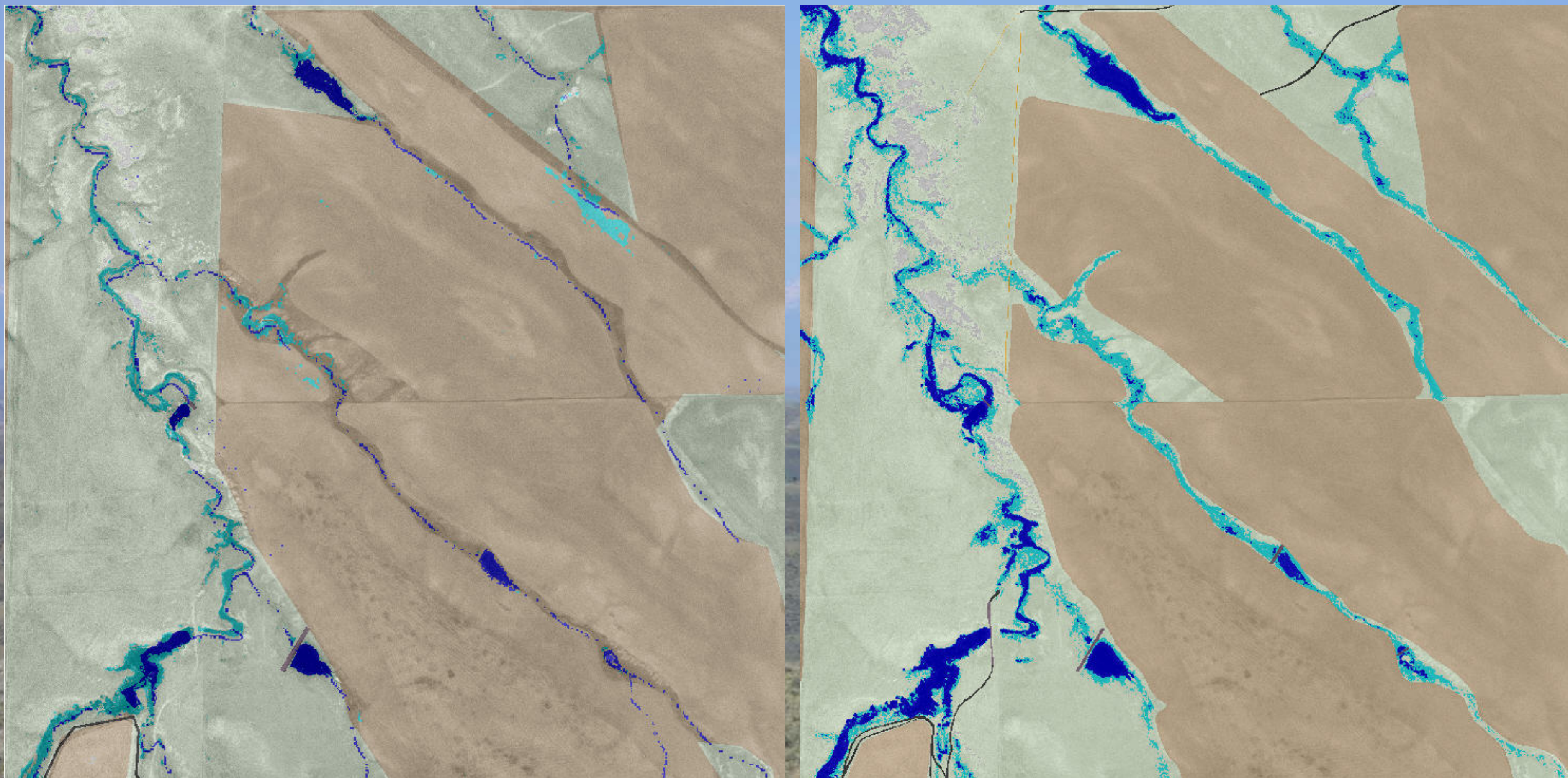
Lessons Learned

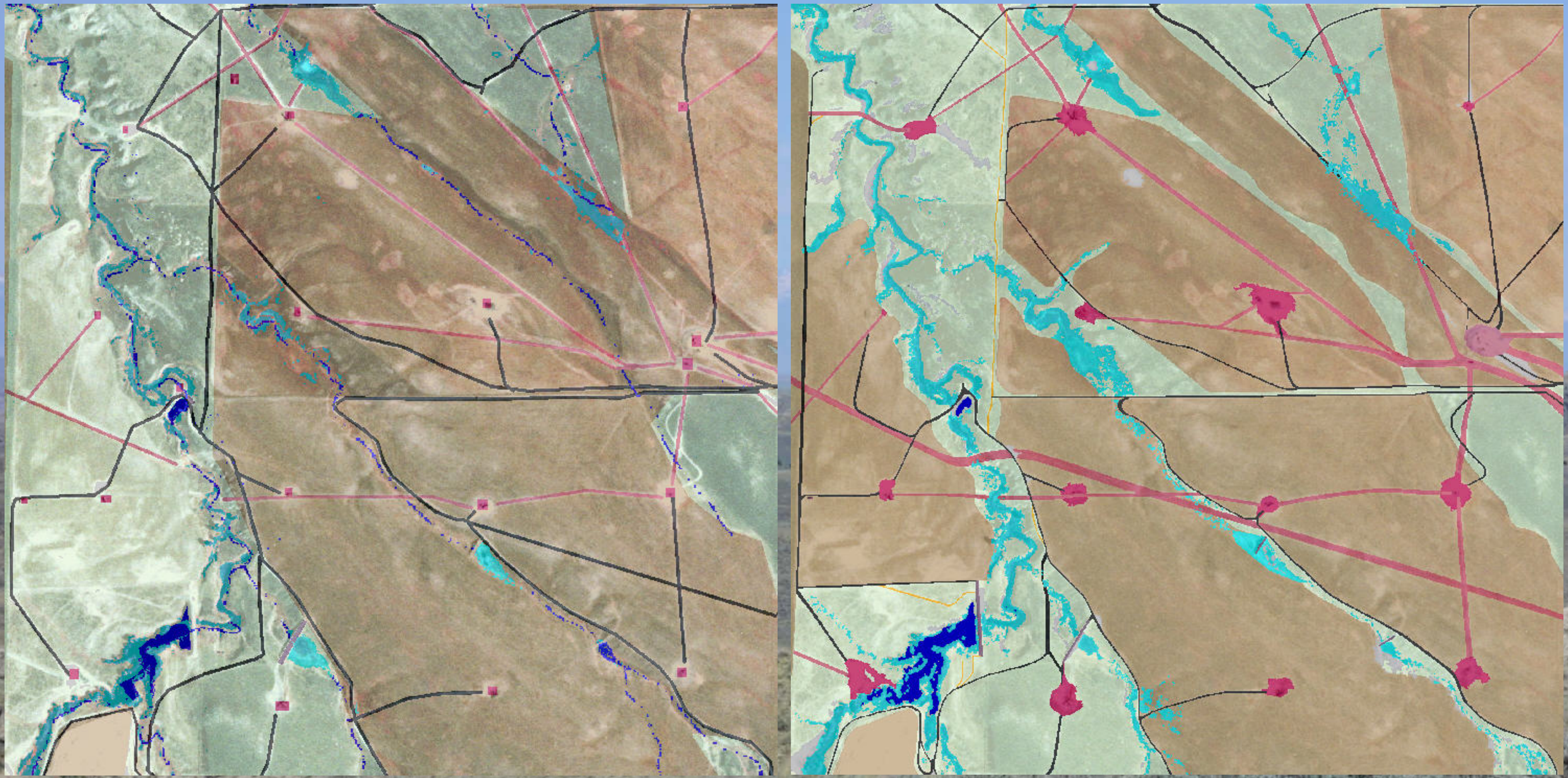
- Be sure there is coordination and agreement on what features will be collected and at what resolution.
- Field visits and talks with landowners are imperative for validating the land cover classification.
- Pipeline or road? Interpretation of roads versus pipeline scars was difficult; often times they are one and the same.

Side-by-side: Cartographic vs. Geographic, 1994



Geographic method extracted more riparian vegetation, bare ground/rock, open water, and unimproved roads. Also collected were a few ranch trails.

Side-by-side: Cartographic vs. Geographic, 2001



Cartographic method has cleaner look for display purposes, but falls short of depicting true land cover and, consequently, land cover change.

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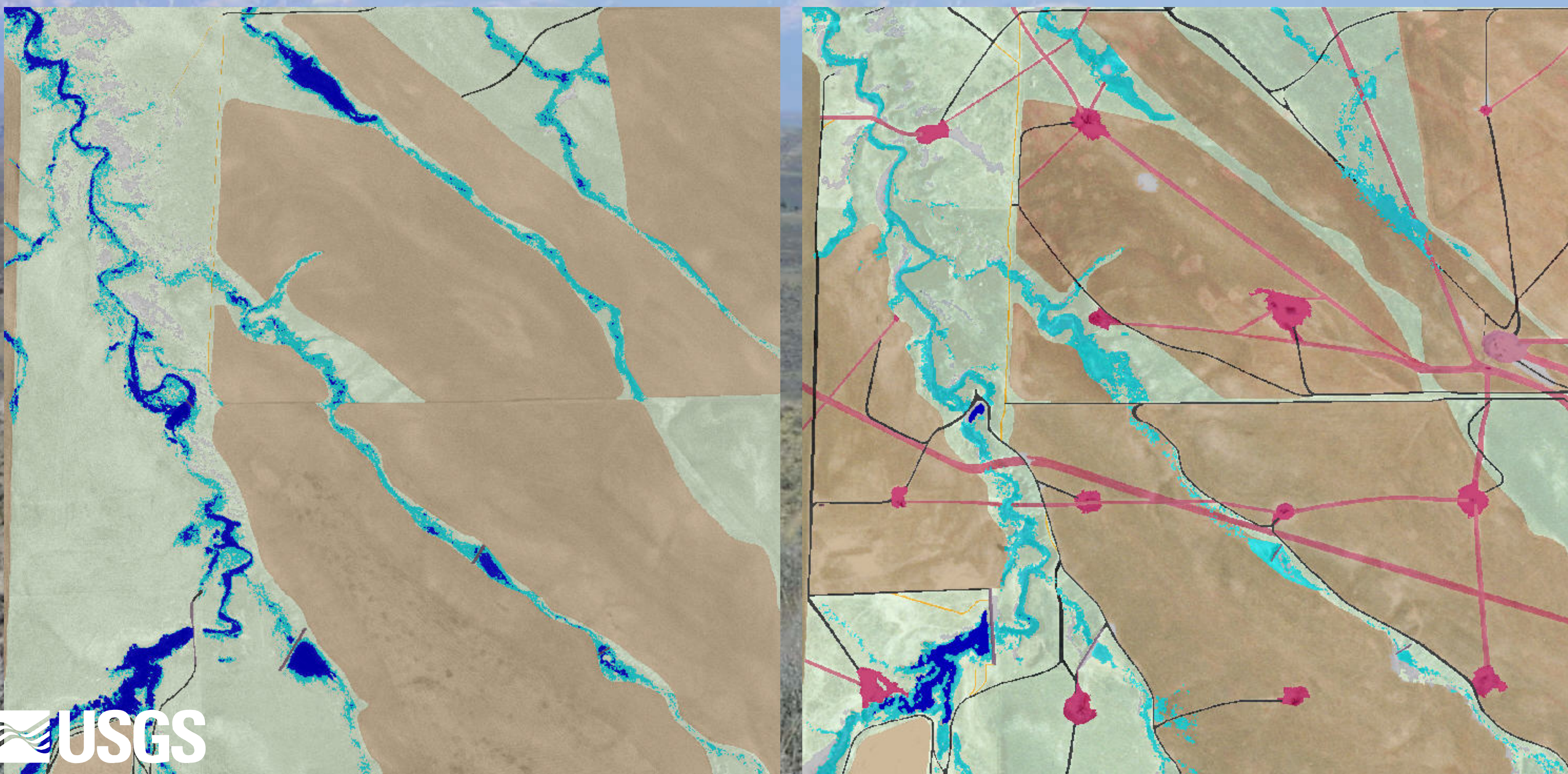
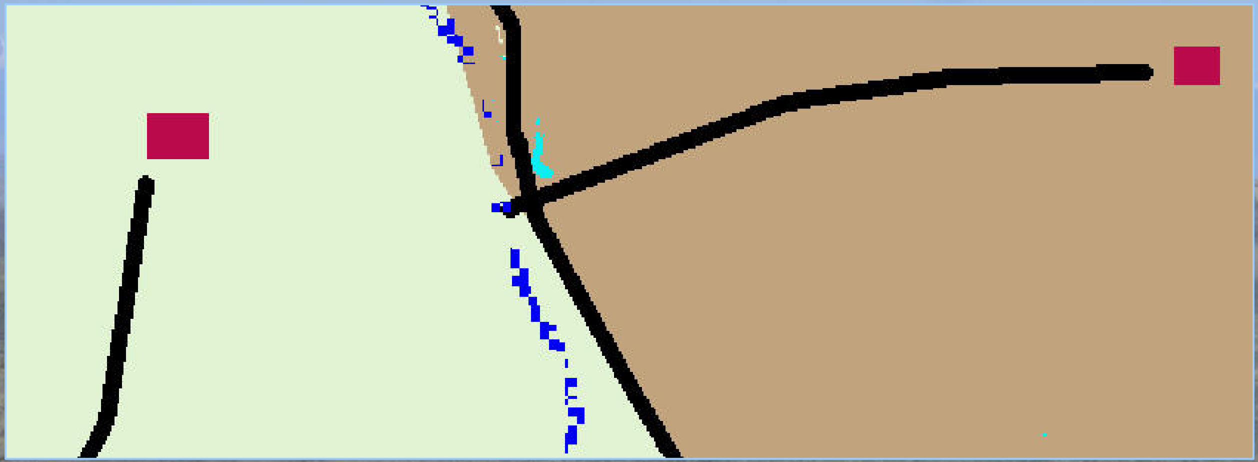
Results

- Geographic method of feature classification gave a more satisfactory view of how the land surface appeared both pre-CBM development (1994) and post-CBM development (2001).
- Because it takes into account the full geographic extent of a feature or disturbance, this method should provide a more accurate idea of the amount and extent of change attributable to CBM development.



Results

- Use of DRG feature input to the classification model limits the analytical value of the cartographic method because of the speckled graphics of the feature and the features' incompleteness.



Conclusions

- Remote sensing techniques can aid land managers and decision-makers monitor large areas for landscape change.
- Use geographic method of feature extraction if you want the most accurate picture of how the landscape is changing.
- Of the two methods, the geographic method would work best for monitoring impacts due to oil and gas development.
- Cartographic method gives a *general* idea of temporal landscape change and could be used in cases where no baseline imagery is available.