An Evaluation of GIS/LIDAR Remote Sensing Methods for Historic Hydraulic Gold Mine Investigation, Grant County, Oregon

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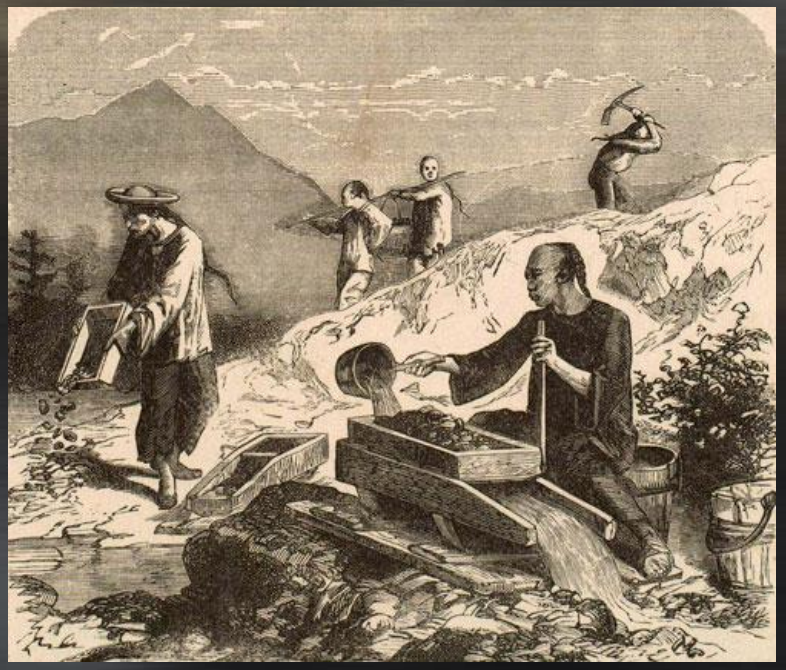
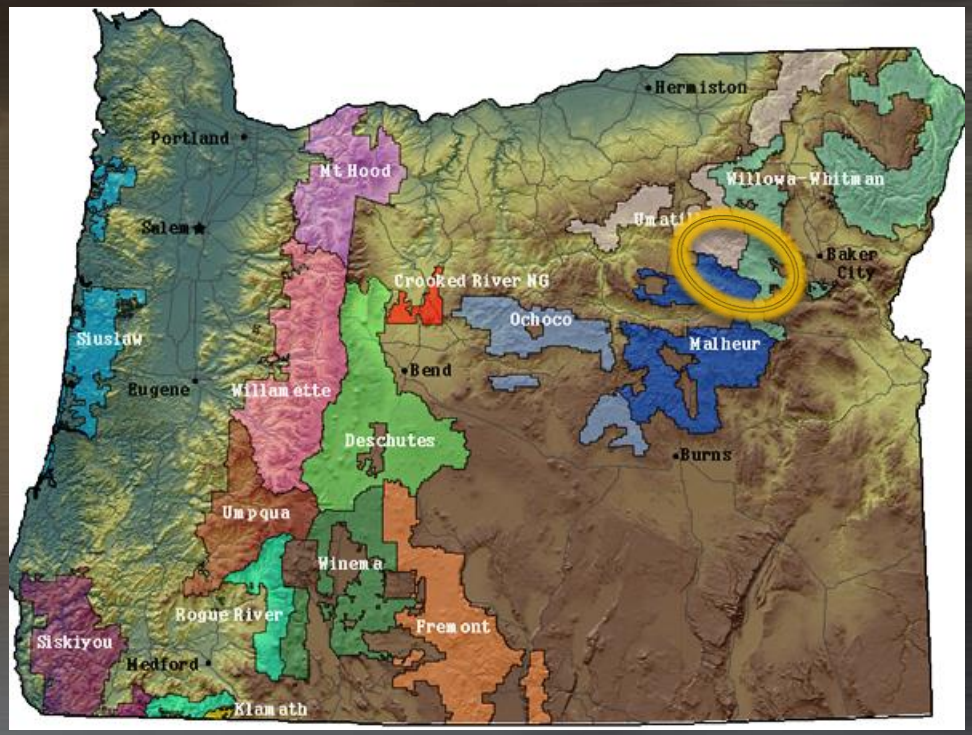


Management Context

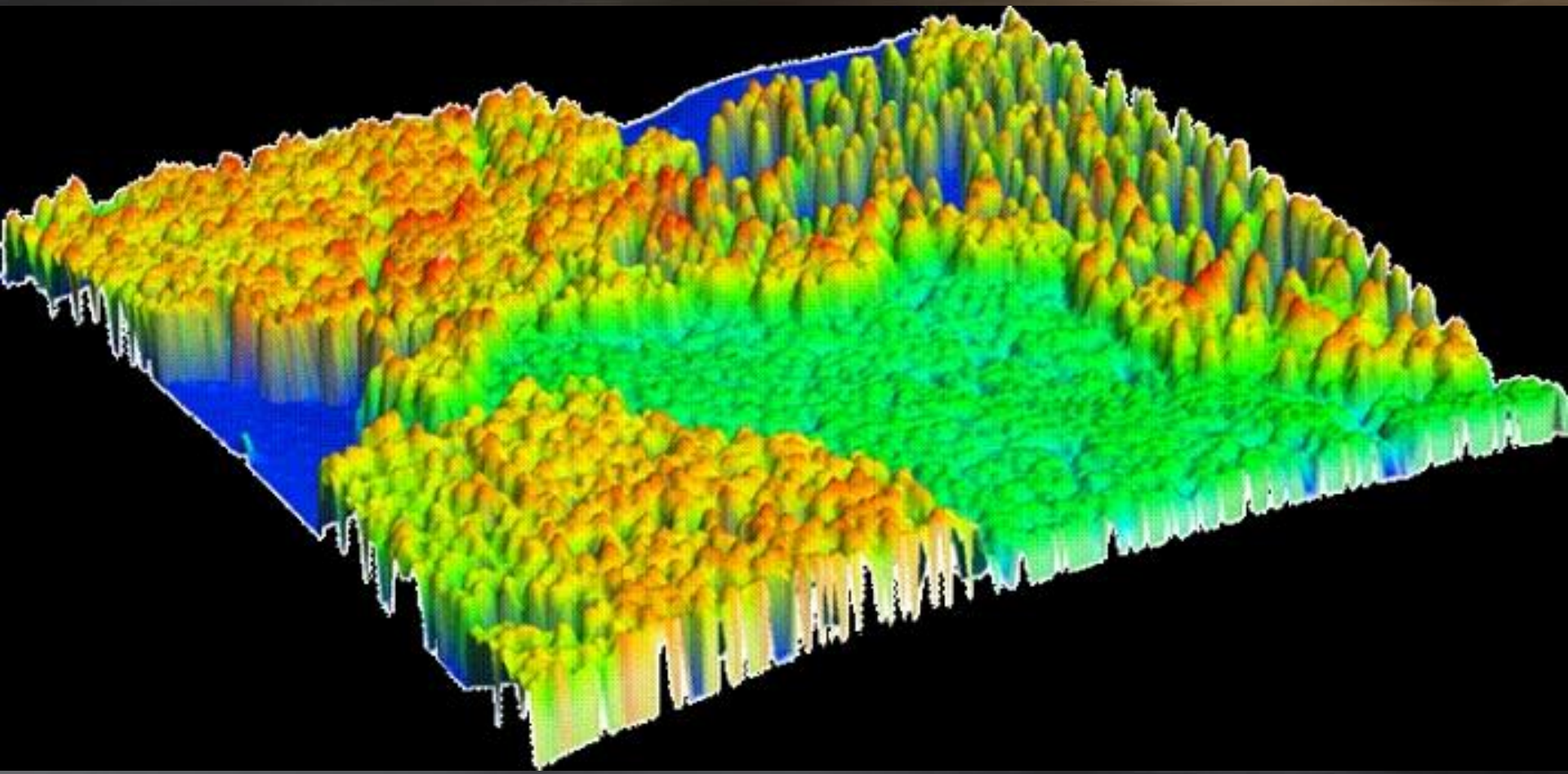


- Large number of historic mining features
- Incomplete documentation during timber harvest era
- New management paradigm- landscape scale restoration harvest

What is lidar?

- Remote sensing technique using airborne lasers and GPS to capture three dimensional data points for the earth's surface
- Each laser pulse results in multiple "returns" of laser light reflected back to sensors in the plane
- The first return captures the highest point in the vegetation, the second return limbs on trees or understory vegetation, the last return ideally captures the surface of the ground
- The resultant "data cloud" can be processed to generate a variety of landscape models

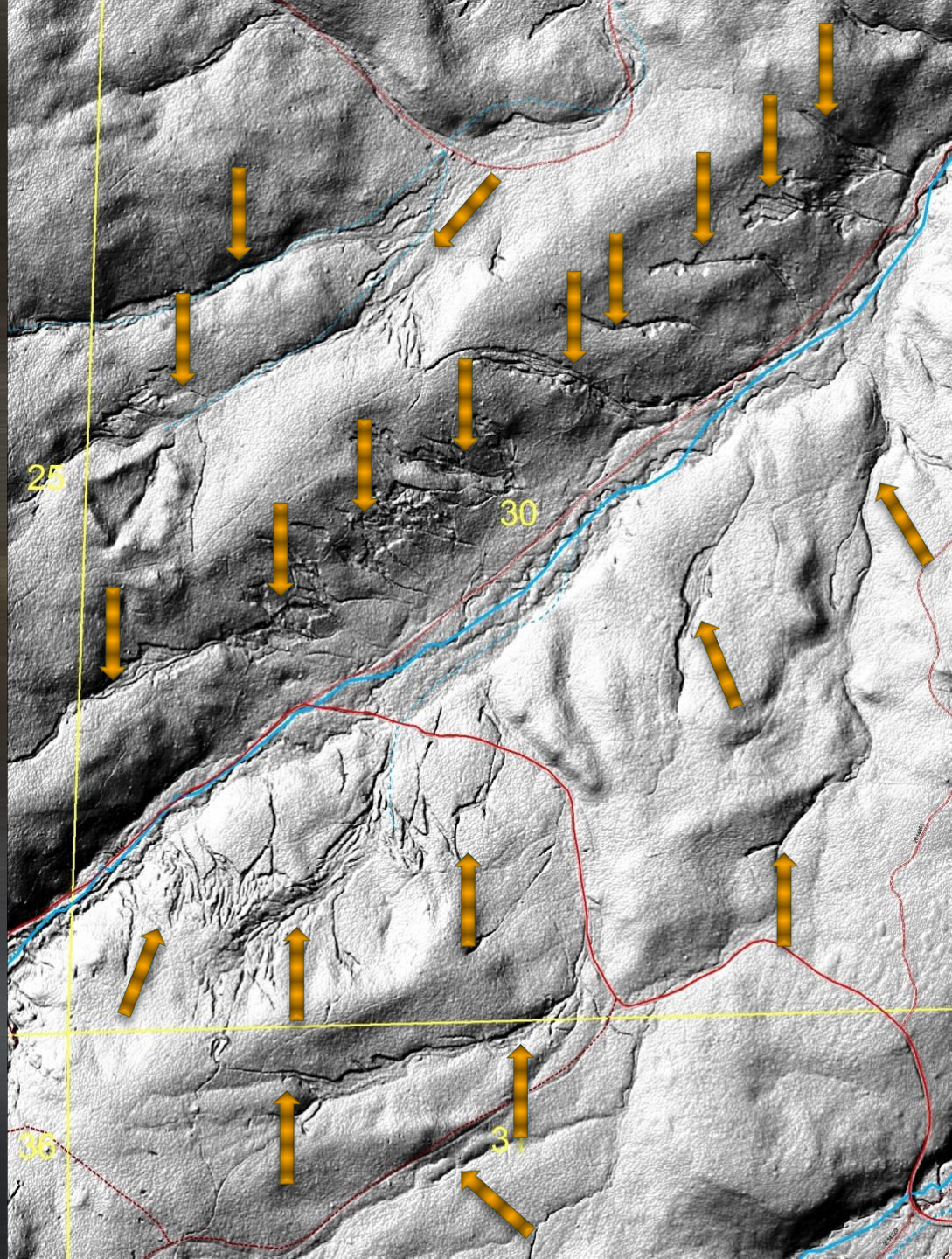
What is lidar?



- Raster model with heights differentiated by color- good for vegetation modeling

- Modeling only the last returns provides a fairly accurate representation of the ground surface
- Areal photo showing a tributary of the Middle Fork John Day River

- Bare Earth Model of same area based on lidar last returns
- Deeply incised features are all remnants of historic placer mining



LIDAR Remote-Sensing Inventory and Evaluation (Warm Springs Geo Visions)

- Inventory- Identify and map hydraulic mining features within 30,720-acre study area
- Evaluation- Assess suitability of methods and data output for future inventory projects

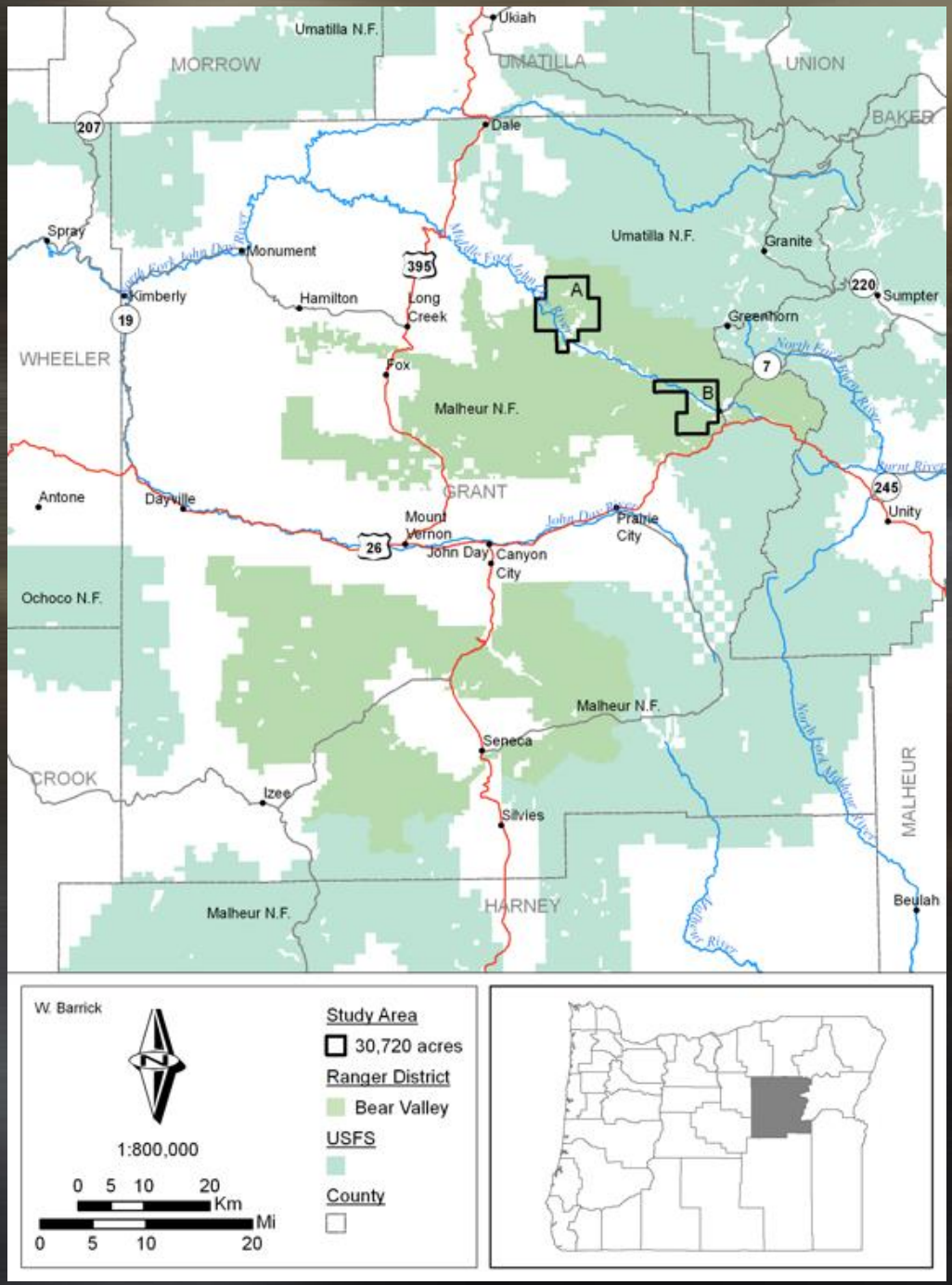
Study Area Background

- Environment

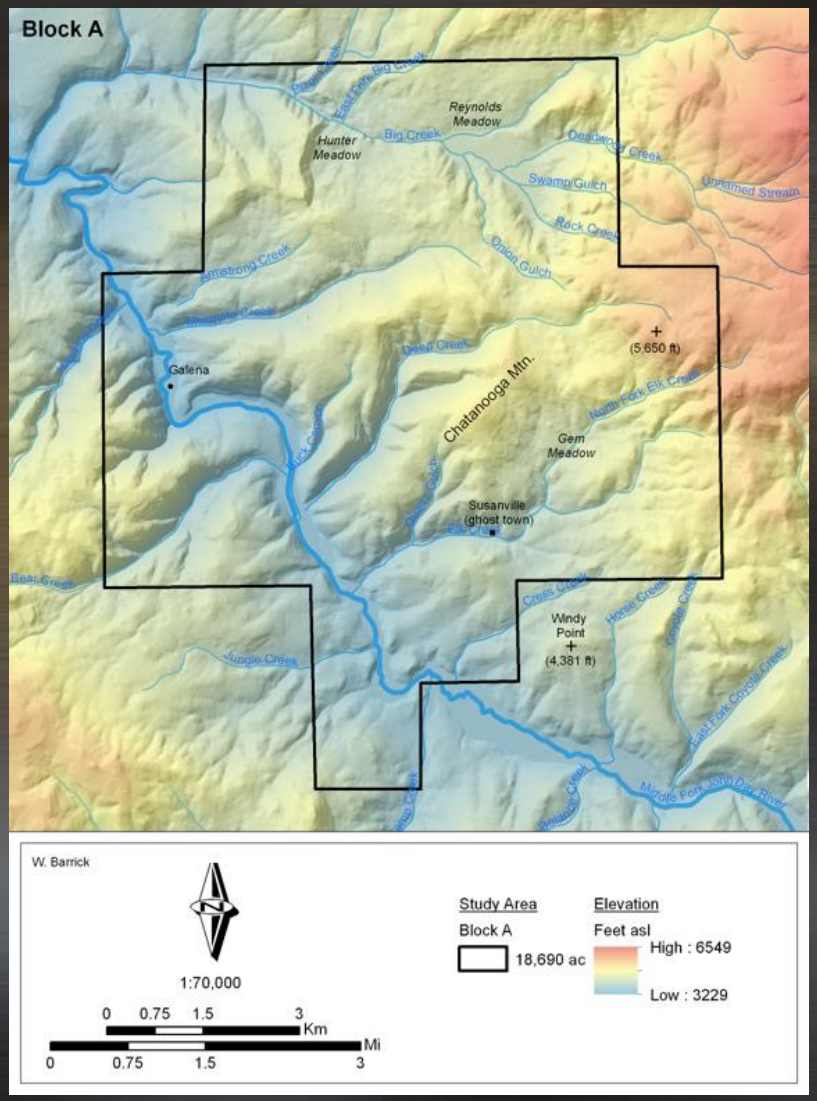
Blue Mountains (Middle Fork John Day R.)
Numerous active streams
Abundant winter snow melt
Gold-bearing geology
Dense coniferous forest

- Culture History

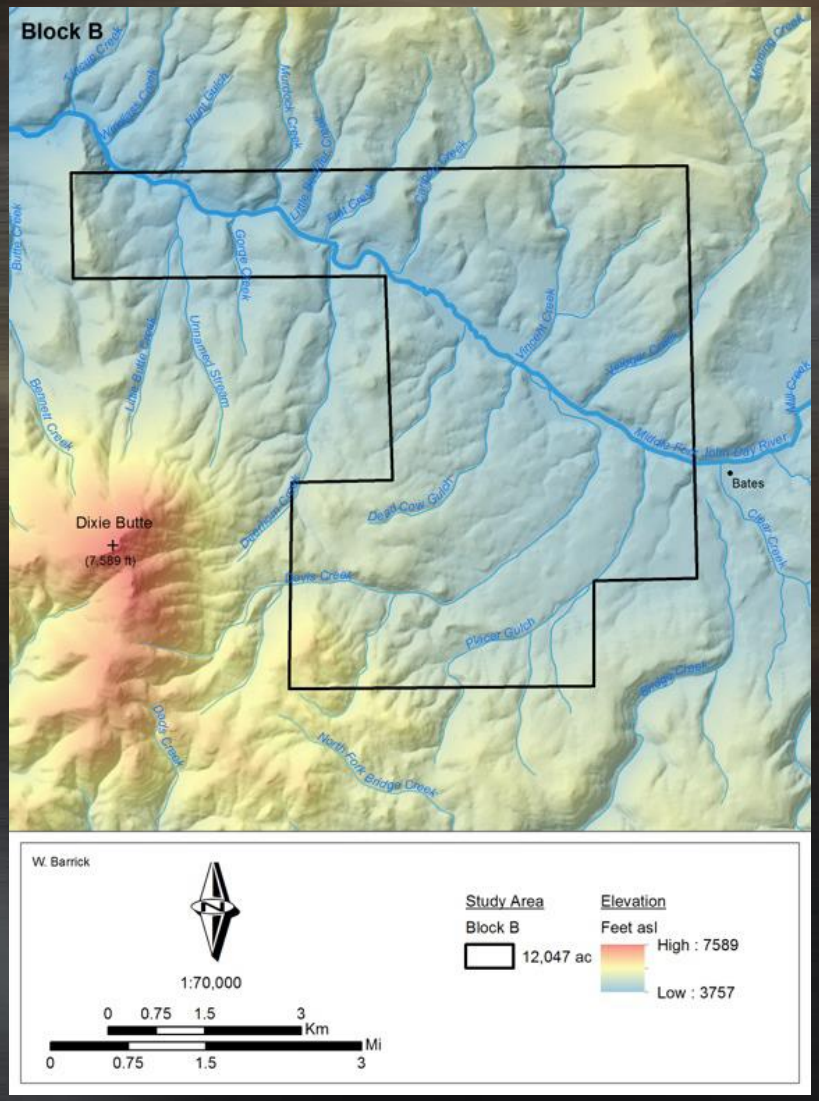
Precontact: Plateau and Great Basin
Euro-American and Chinese miners
Susanville Gold Mining District (ca. 1864)



Block A:
18,680 acres



Block B:
12,047 acres

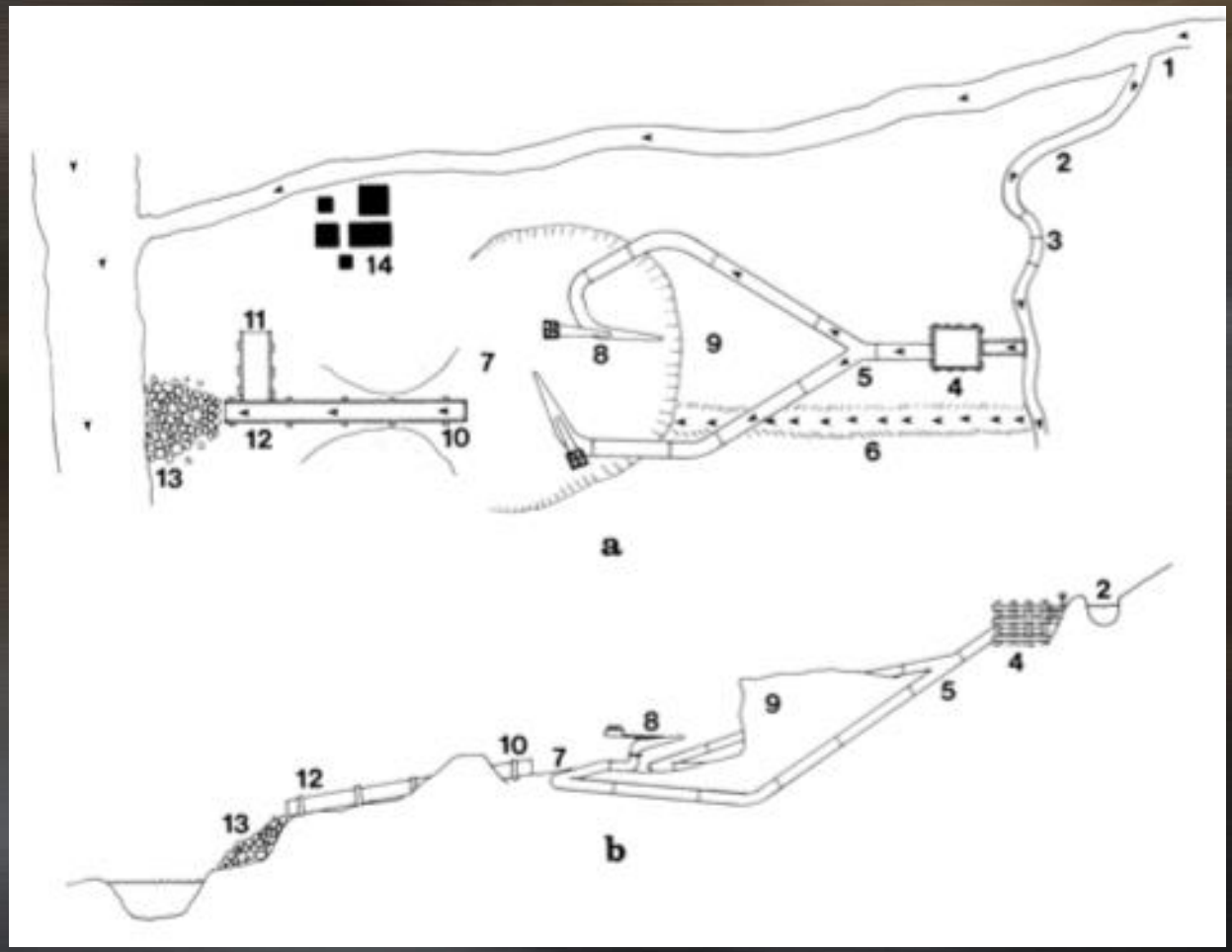


Hydraulic Gold Mining (placer mining)

-Pressurized water is used to undermine and wash away gold-bearing alluvial sediments (placer deposits) into sluicing systems that concentrate the sediments and collect gold particles

Mining System Features

- Prospect pits
- Reservoir
- Wing dam
- Ditch intake (#1)
- Lateral ditch (#2)
- Wash pit (#8)
- Sluice channel (#7)
- Tailings (#13)
- Camp (#14)



(LaLand 1985:38)

LIDAR Analysis Methods/Materials

Remote Sensing Inventory

- LIDAR elevation data
- Geographic Information Systems (GIS)
- Surface anomaly recognition technique

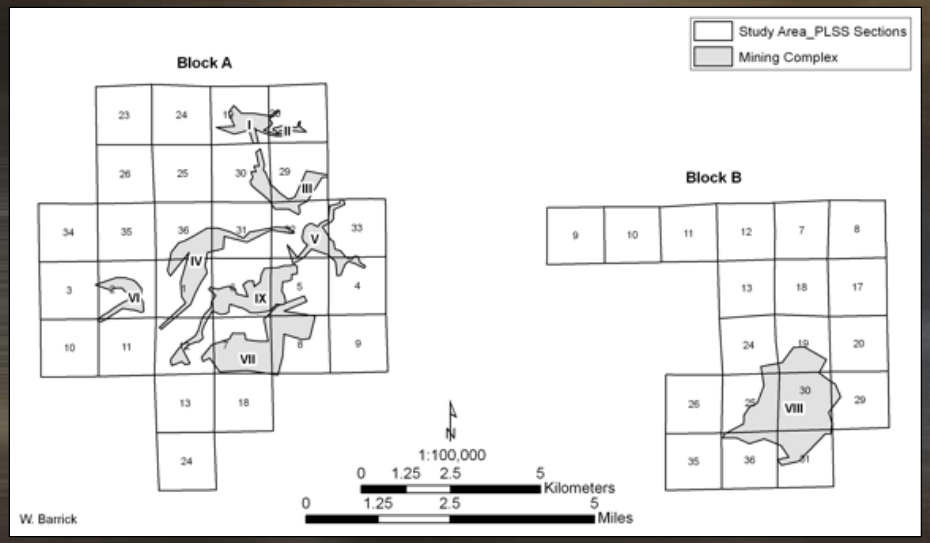
Field Investigation/Evaluation

- Ground truthing (28% sample)
  - Thematic accuracy- correct feature type identified
  - Spatial precision- mapped features are within 1 m of actual location
  - Completeness- proportion of mapped features compared to total

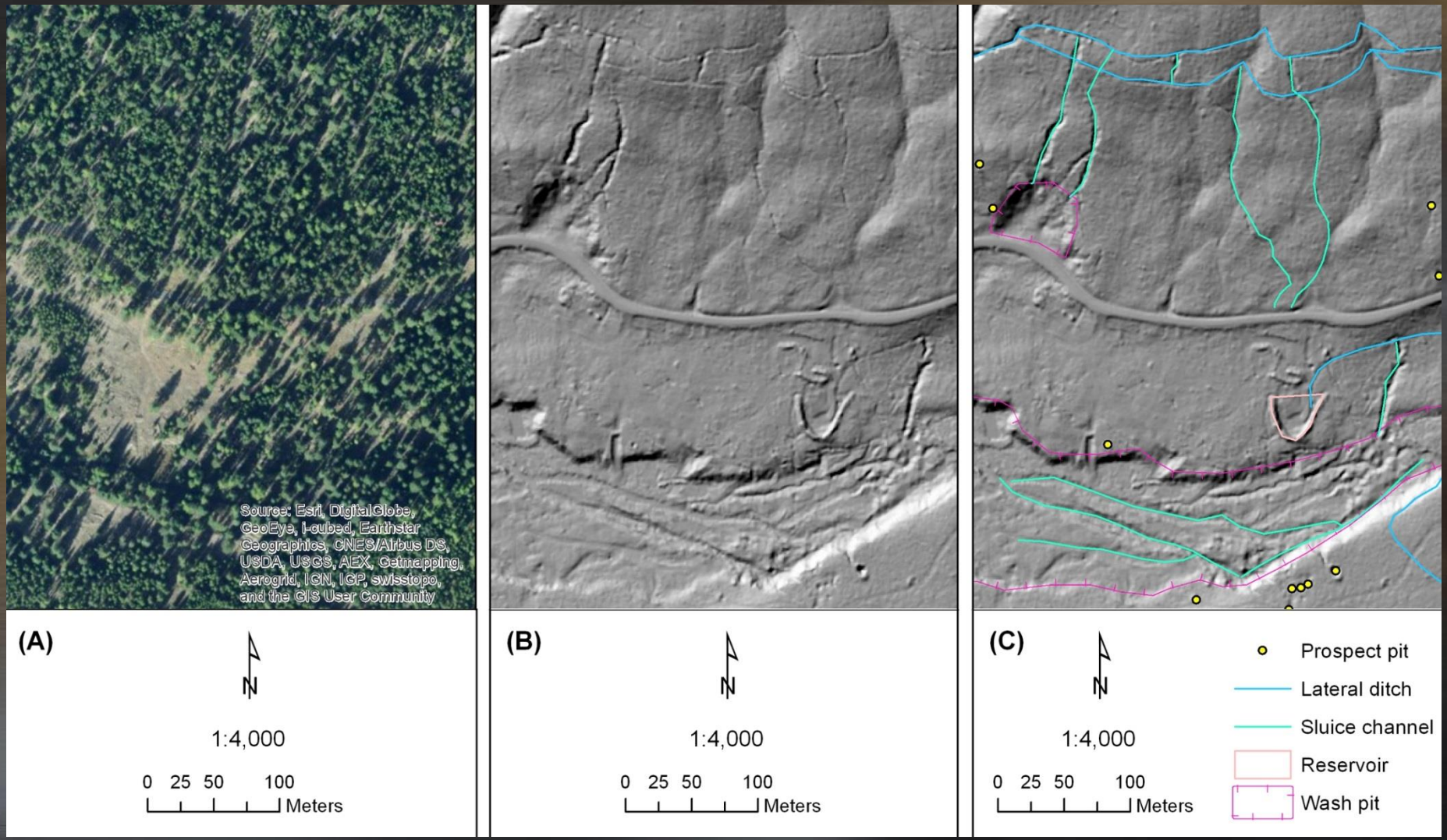
Results: Remote Sensing

- 687 hydro-mining features
- 9 hydro-mining complex

Hydraulic Mining Complex	Area (acres)	Associated Previous Documentation	Mapped Features (count)									
			Prospect Pit	Reservoir	Wing Dam	Lateral Ditch Intake	Lateral Ditch	Wash Pit	Sluice Channel	Tailings	Camp/ Cabin	Total
I	176	Y	43	1	1	3	7	3	12	1	2	73
II	28		9			1	2	4	1	0		17
III	280		8			1	11	8	6	6		40
IV	483		31			3	5	7	13	1	1	61
V	251		17			3	8	6	16	3		53
VI	163		27		1	3	17	10	15	10		83
VII	721	Y	69			3	11	9	7	2	1	102
VIII	1,431	Y	31	2	2	7	43	30	28	30	2	175
IX	512		75			1	2	1	2	0		81
None											2	2
Total	4,045	3	310	3	4	25	106	78	100	53	8	687



Discussion: Vegetation Penetration

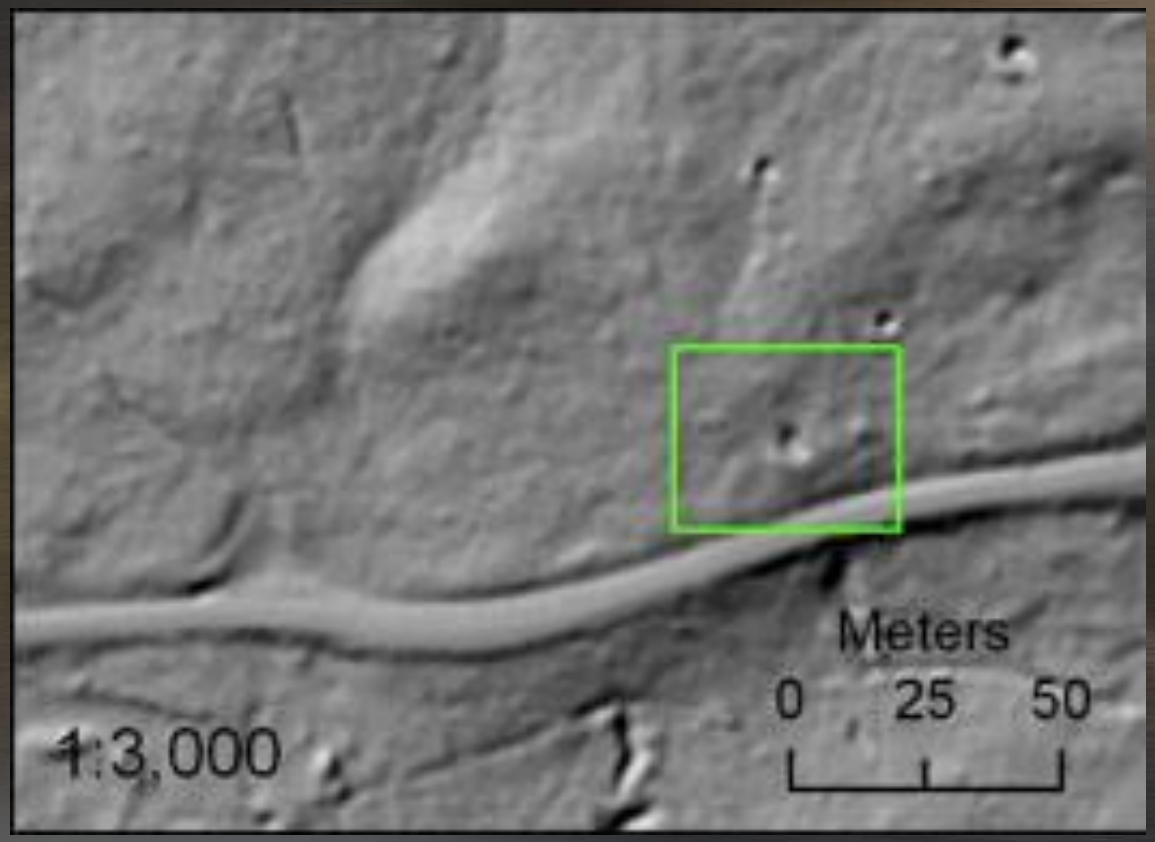


View of vegetation canopy (A), LIDAR bare-earth model (B), and feature mapping (C)

Discussion: Feature Identification

Prospect Pit

Discussion: Feature Identification

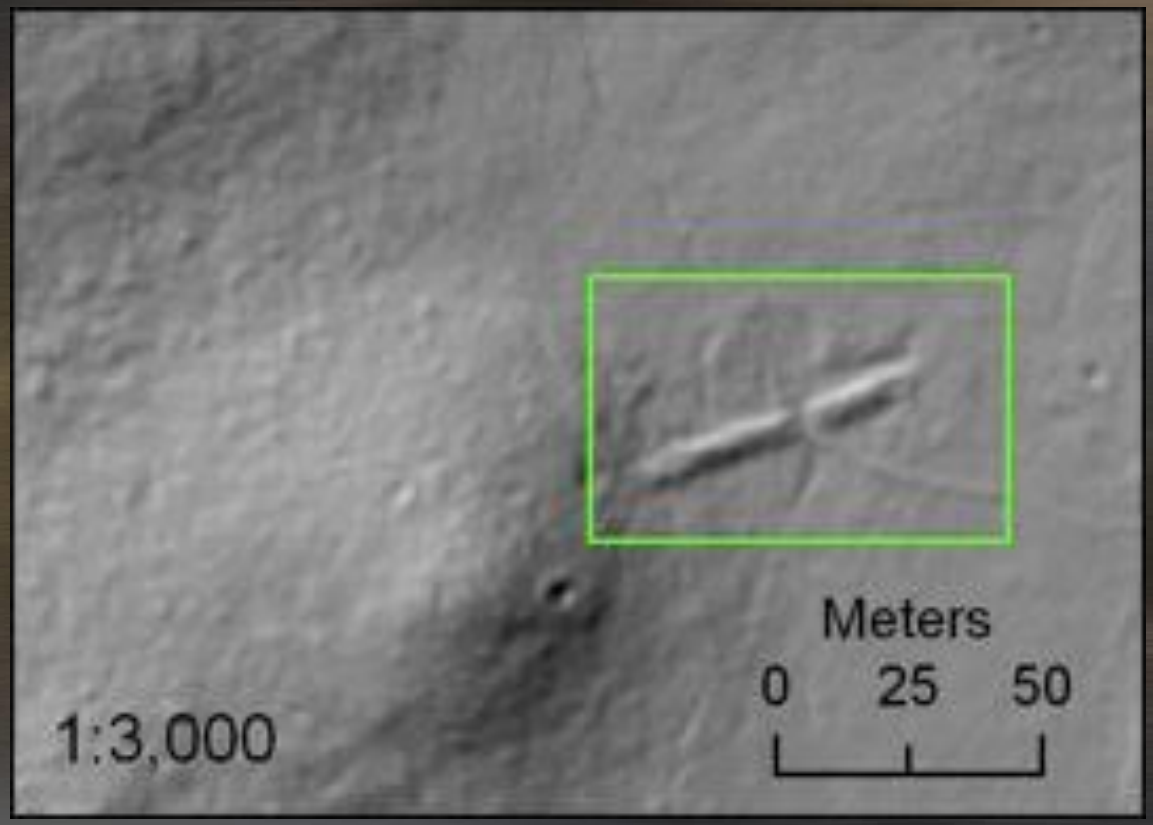


Prospect Pit

Discussion: Feature Identification

Wing Dam

Discussion: Feature Identification

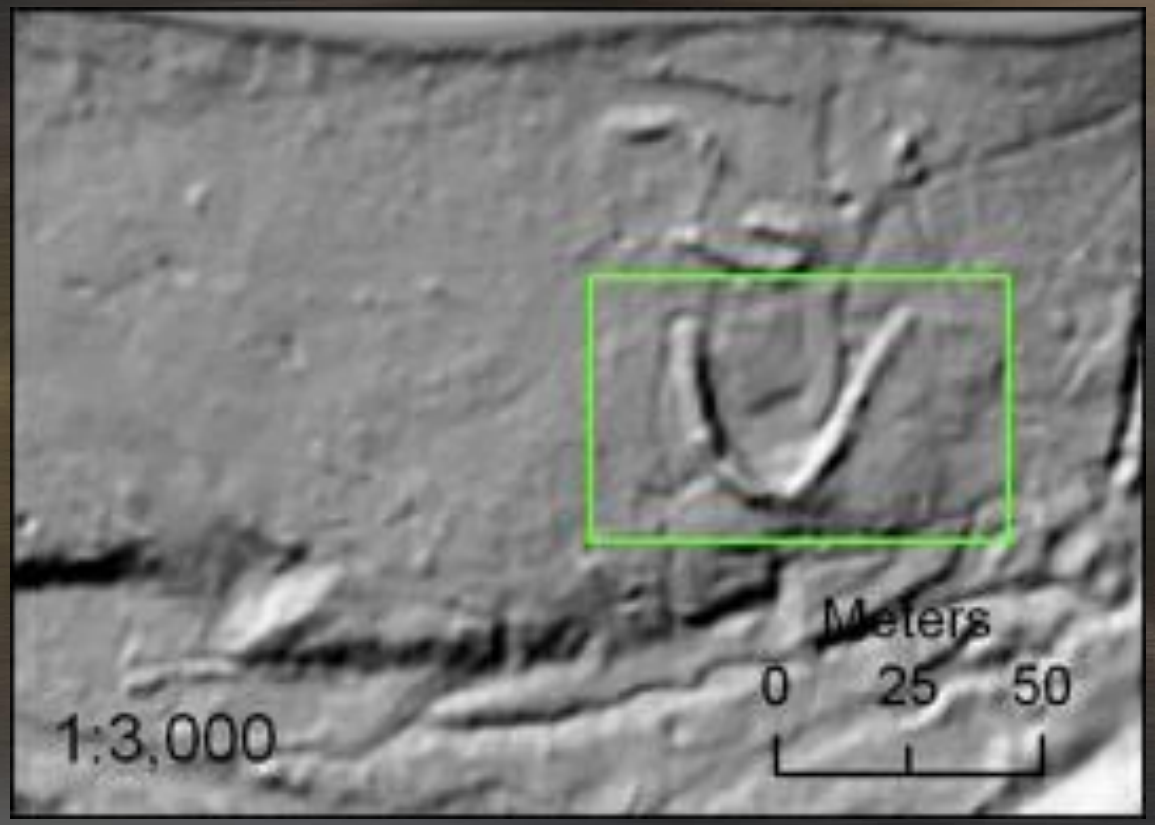


Wing Dam

Discussion: Feature Identification

Reservoir

Discussion: Feature Identification

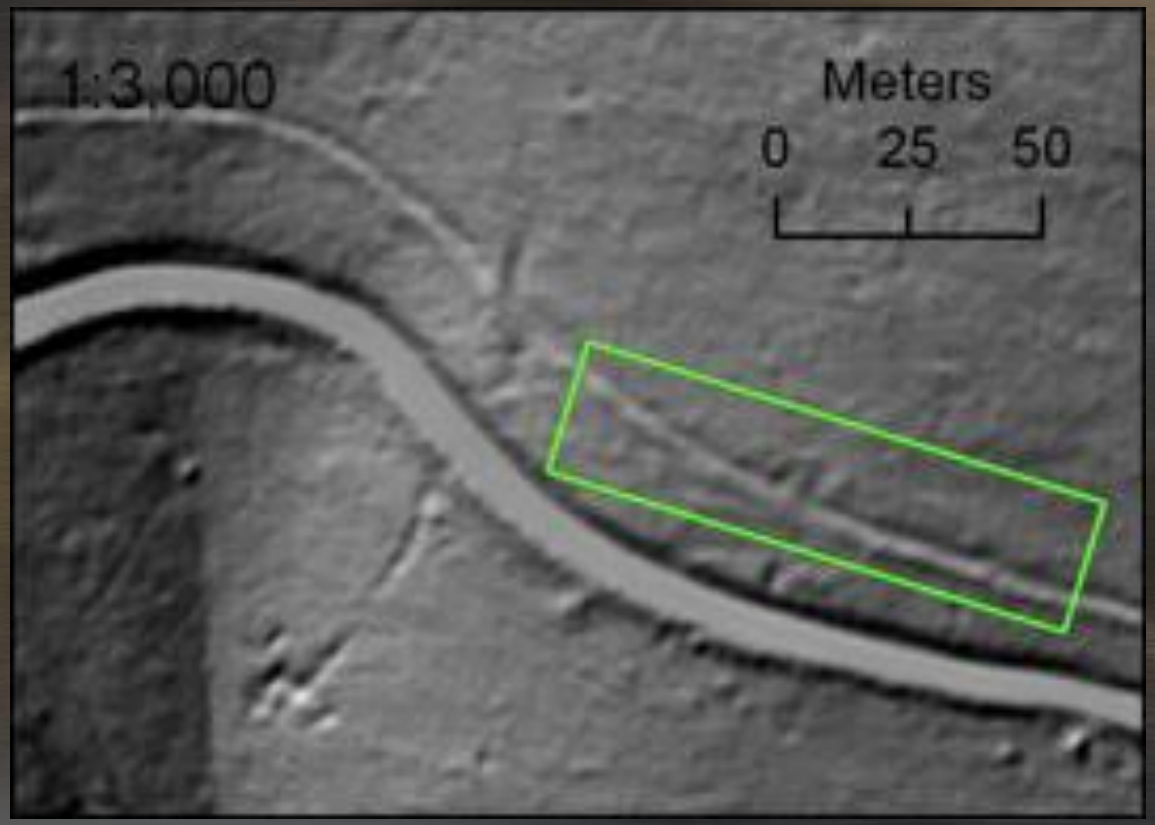


Reservoir

Discussion: Feature Identification

Lateral Ditch

Discussion: Feature Identification

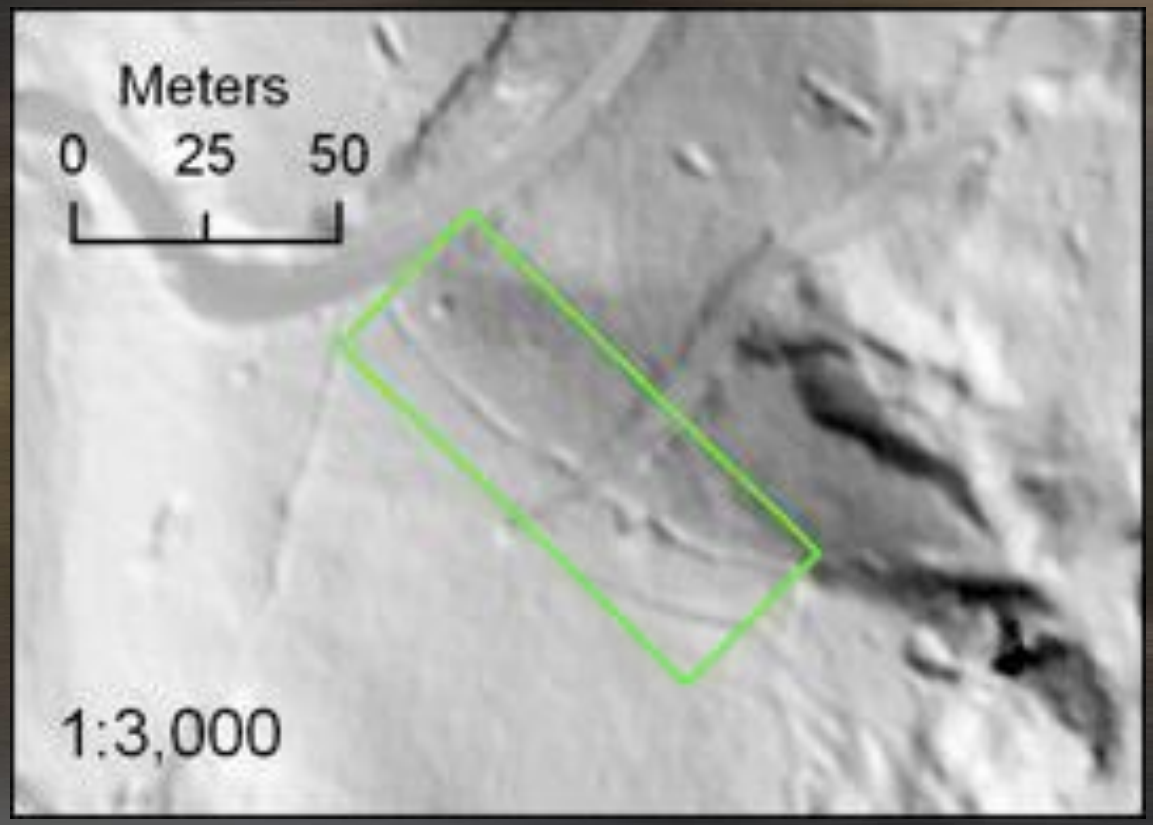


Lateral Ditch

Discussion: Feature Identification

Sluice Channel

Discussion: Feature Identification

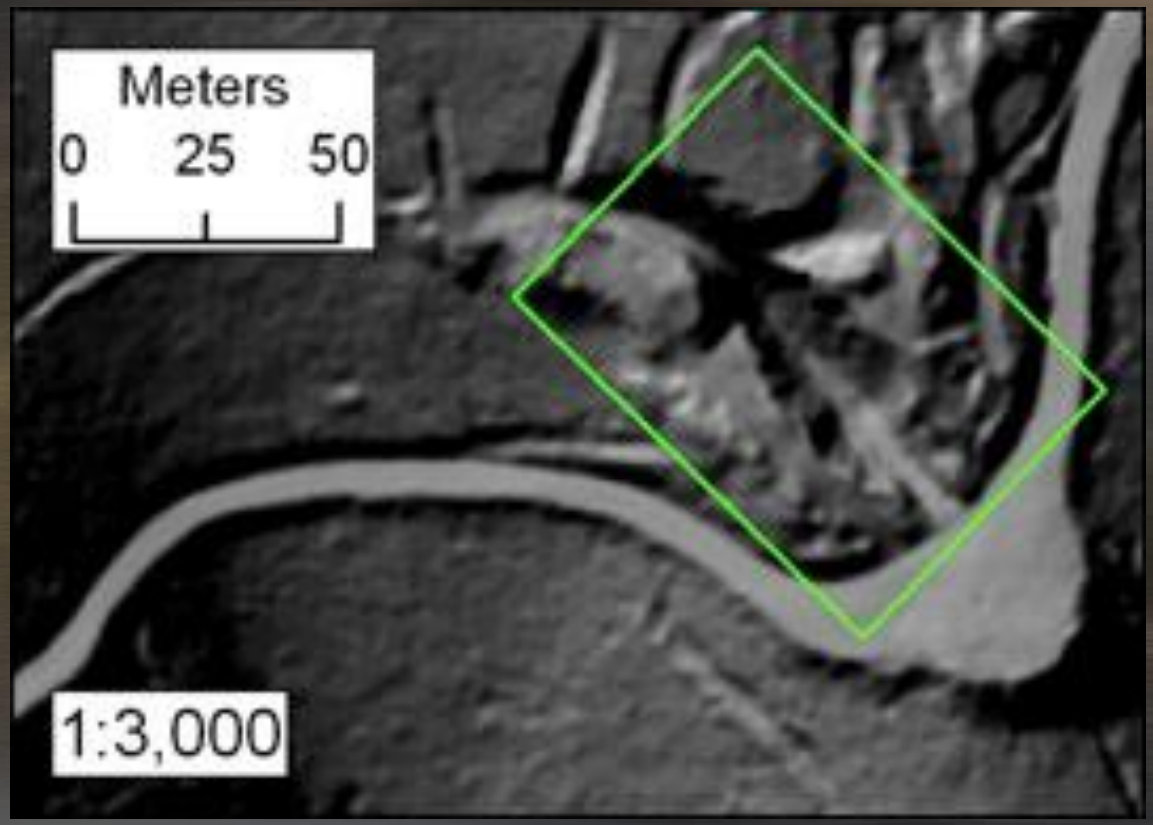


Sluice Channel

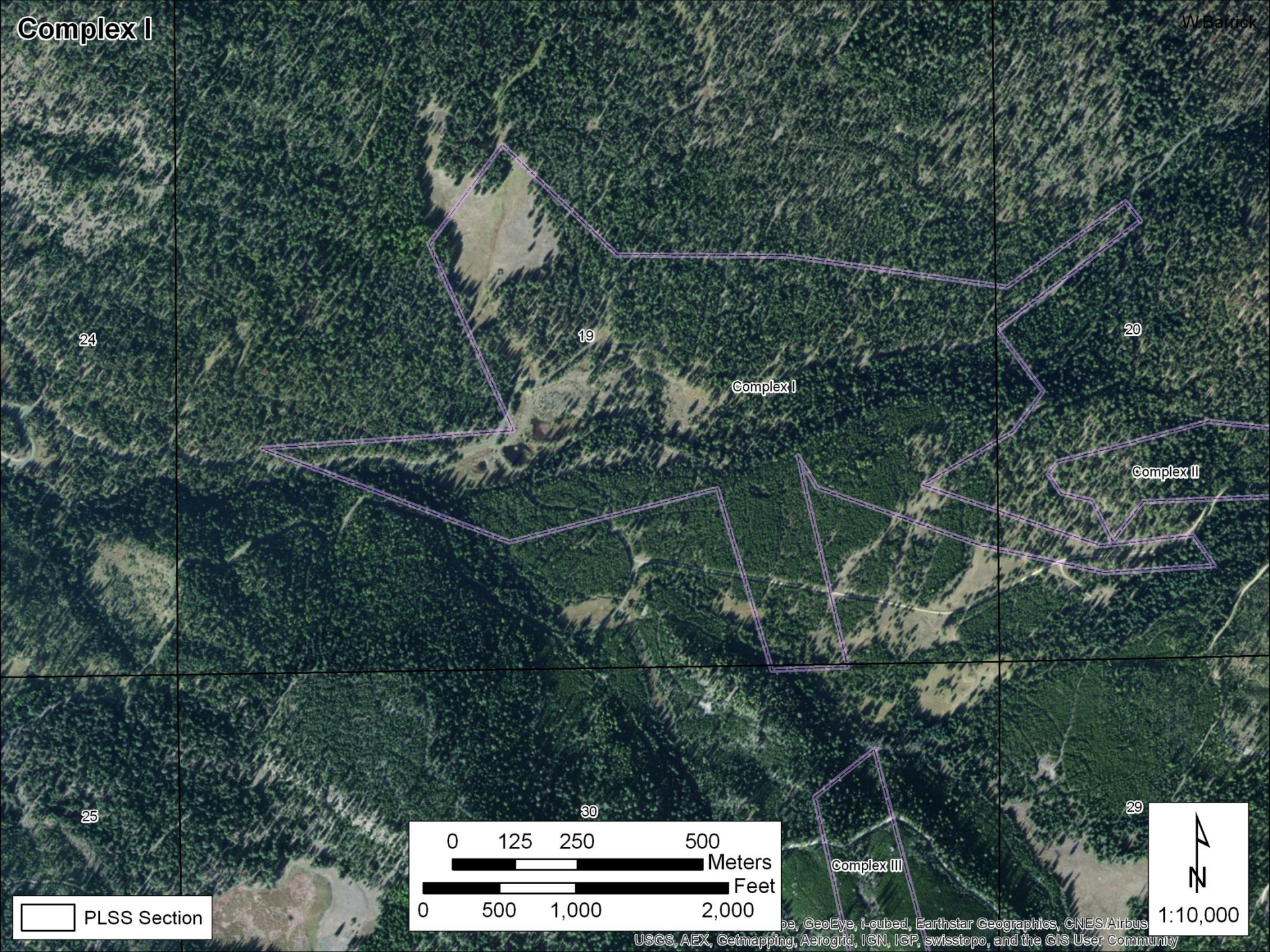
Discussion: Feature Identification

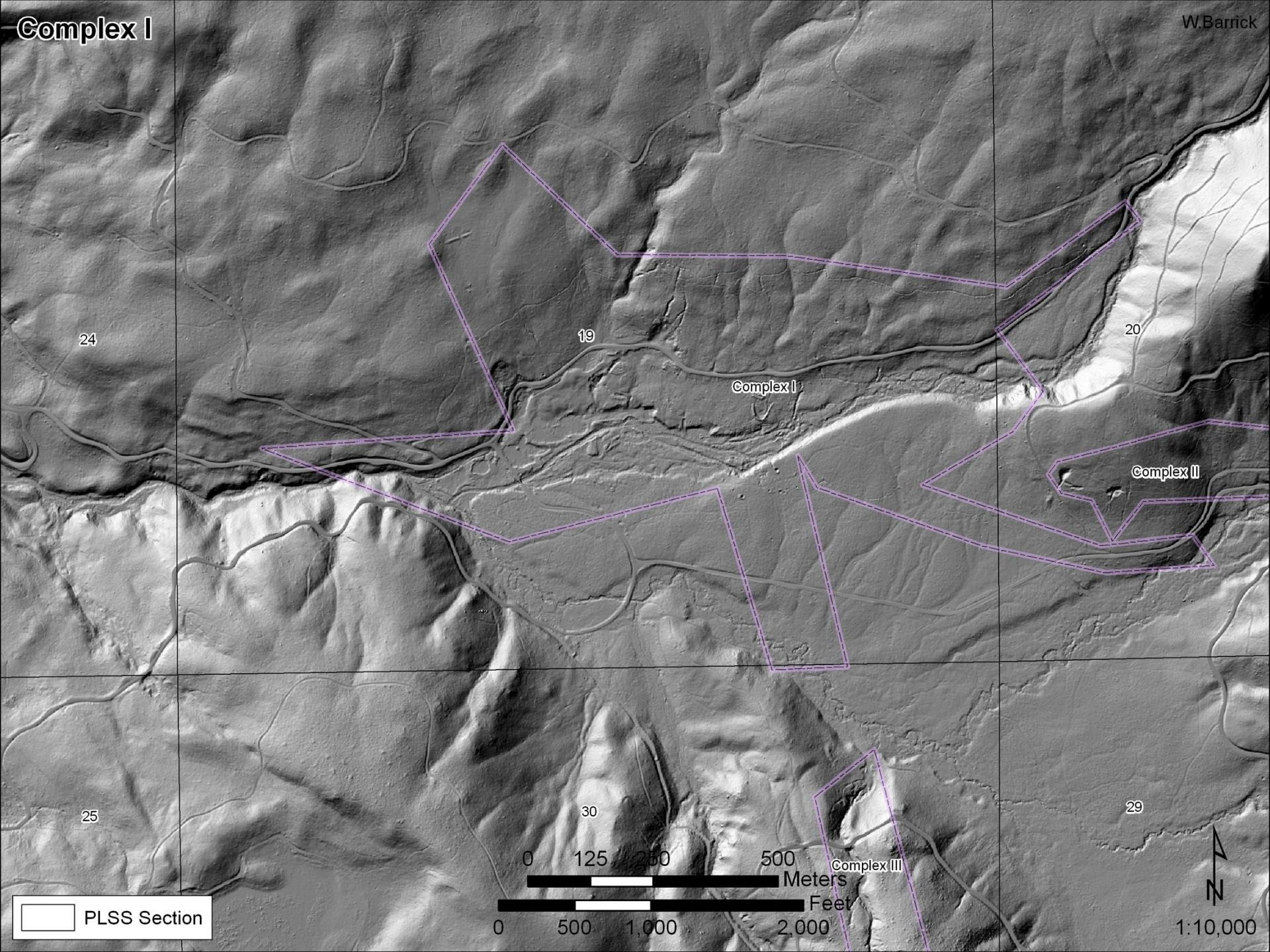
Wash Pit

Discussion: Feature Identification



Wash Pit


Complex I
W.Barrick
24
19
20
Complex I
Complex II
25
30
29
Complex III
0 125 250 500
Meters
Feet
0 500 1,000 2,000
PLSS Section
N
1:10,000
USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Complex I
W.Barrick
24
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Complex I
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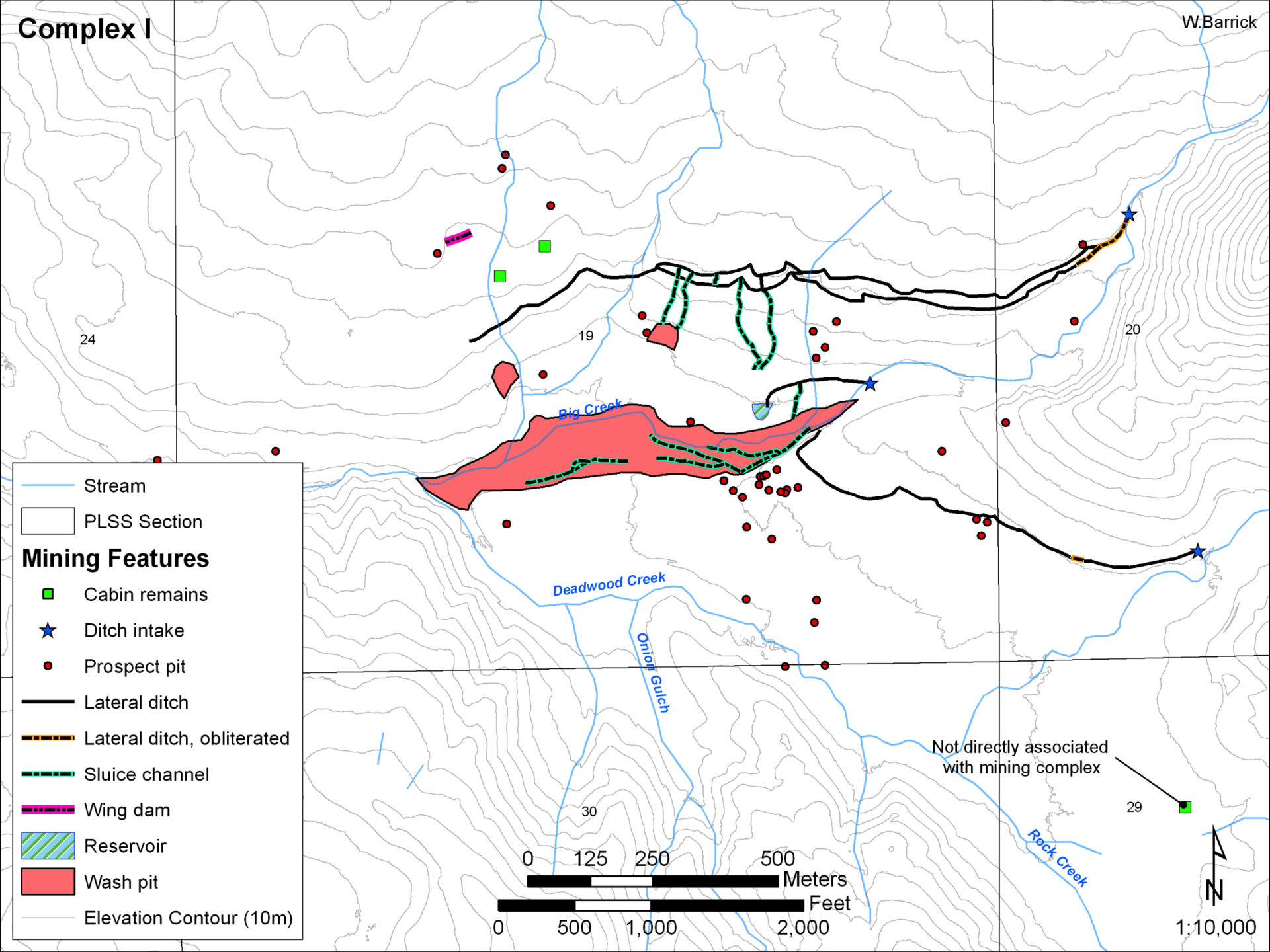
29
Complex III
0 125 250 500
Meters
Feet
0 500 1,000 2,000
PLSS Section
N
1:10,000

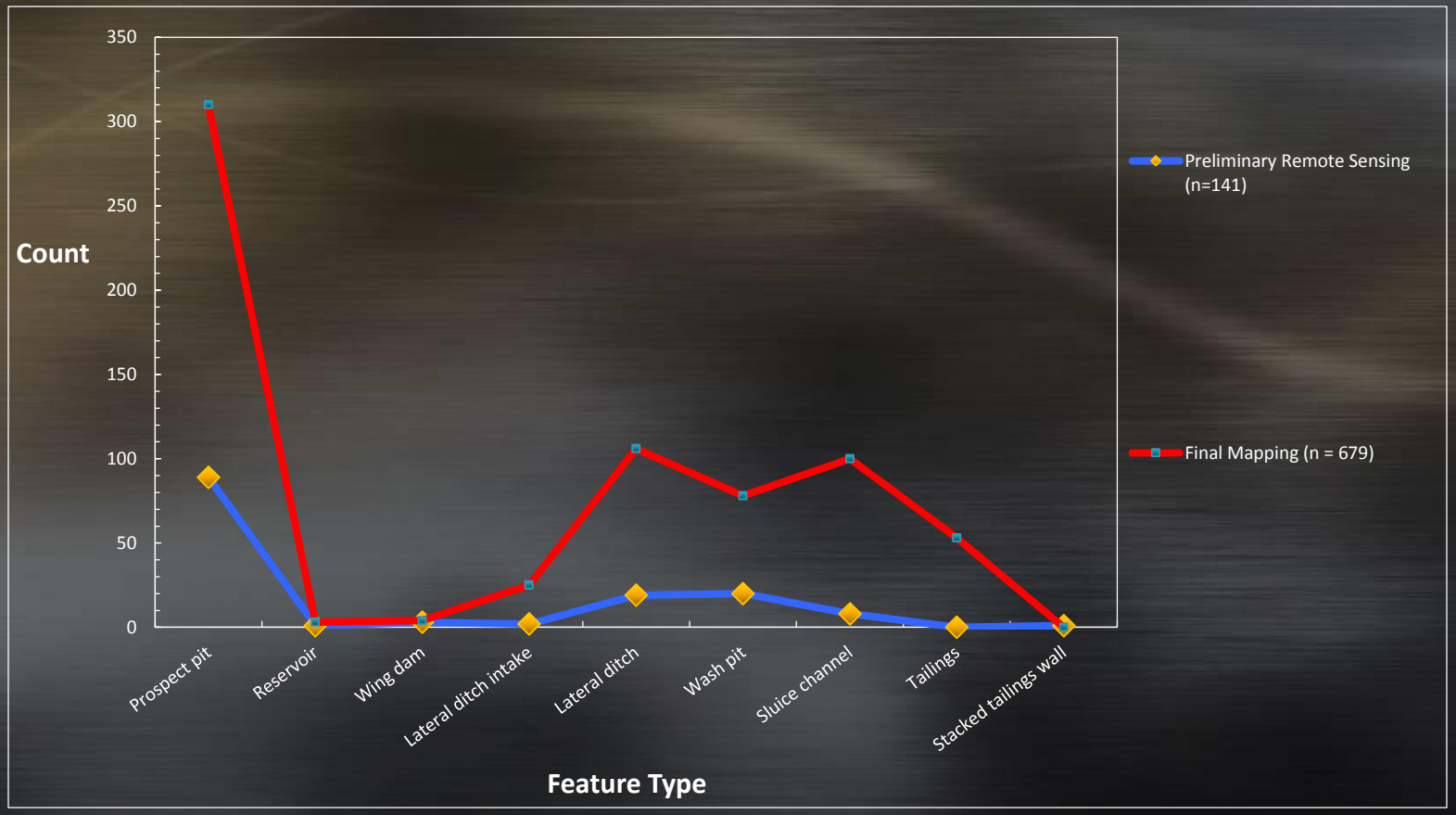

Complex I
W.Barrick
24
19
20
30
29
Big Creek
Deadwood Creek
Onion Gulch
Rock Creek
Not directly associated with mining complex
Stream
PLSS Section
Mining Features
Cabin remains
Ditch intake
Prospect pit
Lateral ditch
Lateral ditch, obliterated
Sluice channel
Wing dam
Reservoir
Wash pit
Elevation Contour (10m)
0 125 250 500
Meters
0 500 1,000 2,000
Feet
N
1:10,000

Field Investigation/Evaluation

Feature Verification Study

- Remote Sensing (before ground truthing)
  - *Thematically accuracy*- correct feature type identified (78%)
  - *Spatially precise*- digitally mapped features are within 1 m of actual location (90%)

★ 79% increase in identified features *after* ground truthing



Conclusion

Strengths

- Effective vegetation-penetrating feature identification/mapping capabilities
- Cost and time-effective inventory within expansive study areas
- Ability to produce high-quality data outputs

Limitations

- Need for ground-truth field investigations
- Need for previous site-level documentation
- Difficulty/inability to remotely detect some feature types (e.g. tailings, stacked rock walls, and cabin/domestic support structures)

Next Steps/Recommendations…

1. Stand-alone remote sensing is *not* recommended for comprehensive inventory-scale studies
   - Field investigations should be applied after remote sensing (repeated if necessary)

2. Landscape-scale documentation and management
   - LIDAR mapping ideal for understanding spatial relationships

1. 3-D Modeling
   - Use to better understand hydraulic mining systems/ quality control for mapping

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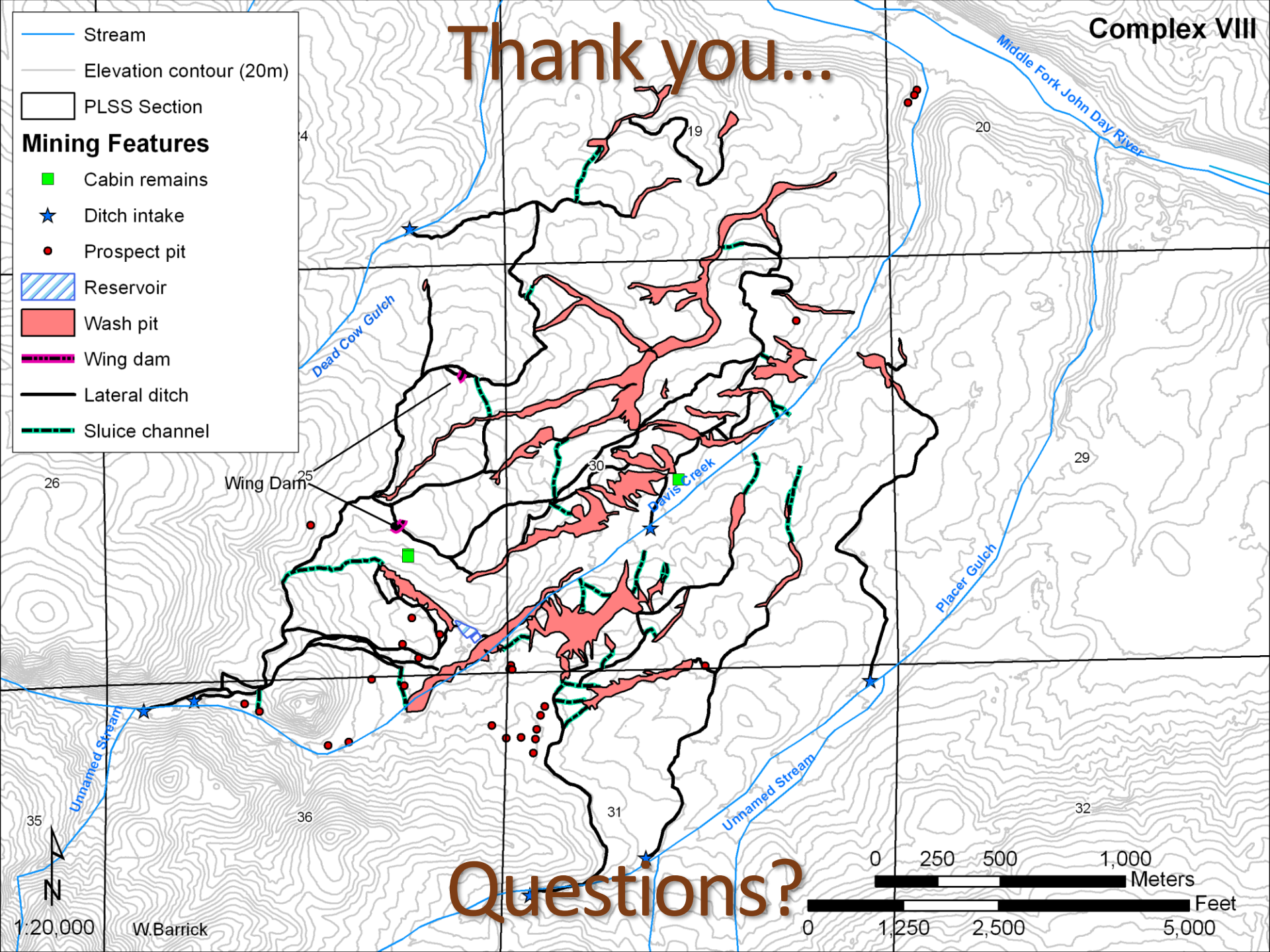
Stream
Elevation contour (20m)
PLSS Section
Mining Features
Cabin remains
Ditch intake
Prospect pit
Reservoir
Wash pit
Wing dam
Lateral ditch
Sluice channel
Complex VIII
Thank you…
Questions?
Wing Dam
Dead Cow Gulch
Middle Fork John Day River
Davis Creek
Placer Gulch
Unnamed Stream
Unnamed Stream
19
20
29
30
25
26
31
32
35
36
N
1:20,000
W.Barrick
0 250 500 1,000
Meters
0 1,250 2,500 5,000
Feet