



CARSON WATER SUBCONSERVANCY DISTRICT ALLUVIAL FAN MAPPING STUDY

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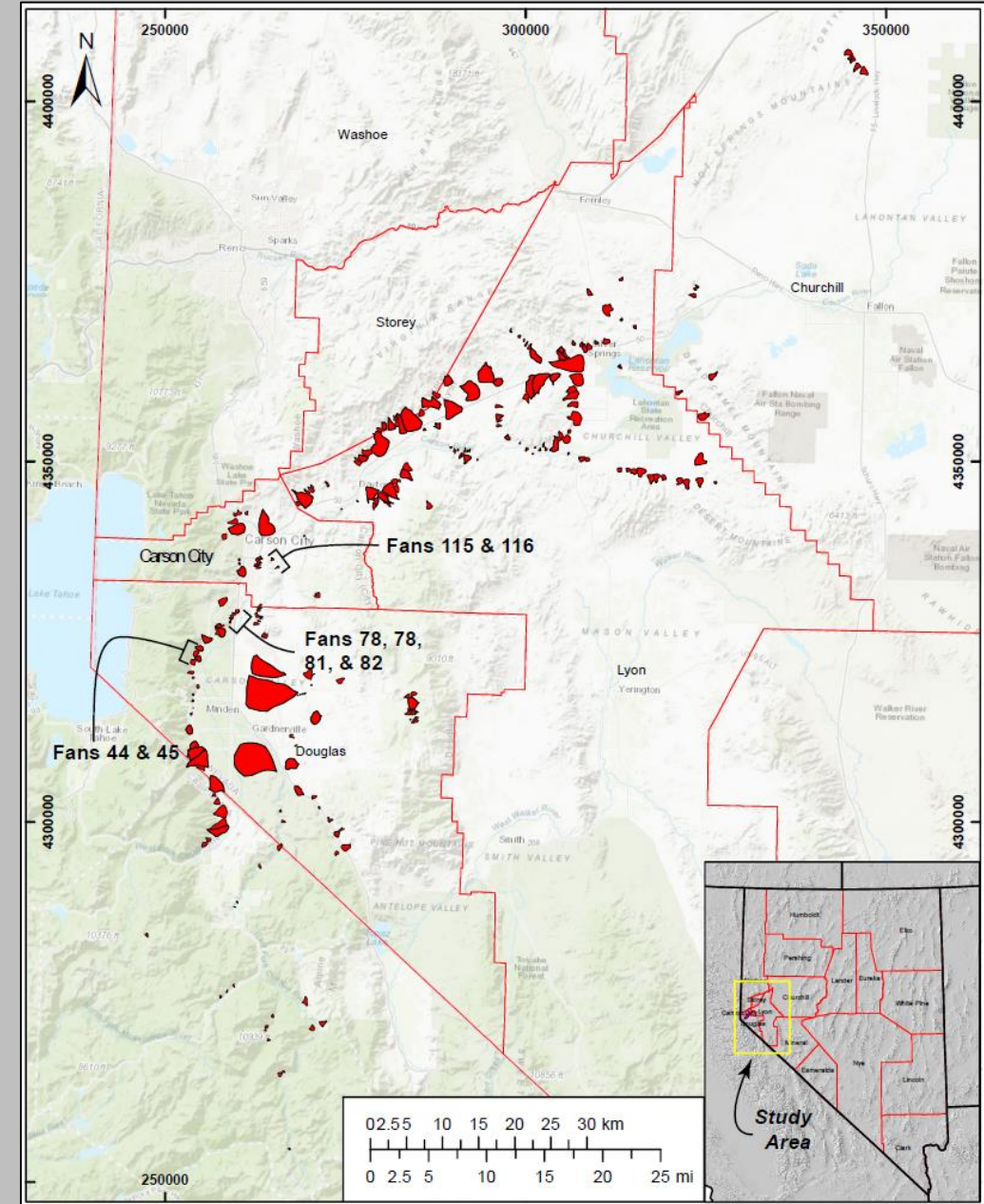
OVERVIEW

- Study History (Phase 1 & Phase 2)
- Geologic Assessment
- Hydraulic Assessment
- What's Next?



STUDY HISTORY

- Phase One completed in 2017
 - Mapped and classified 297 alluvial fans based on apparent risk within the Carson River Watershed
- Phase Two identified specific alluvial fans for further geologic and hydraulic analyses

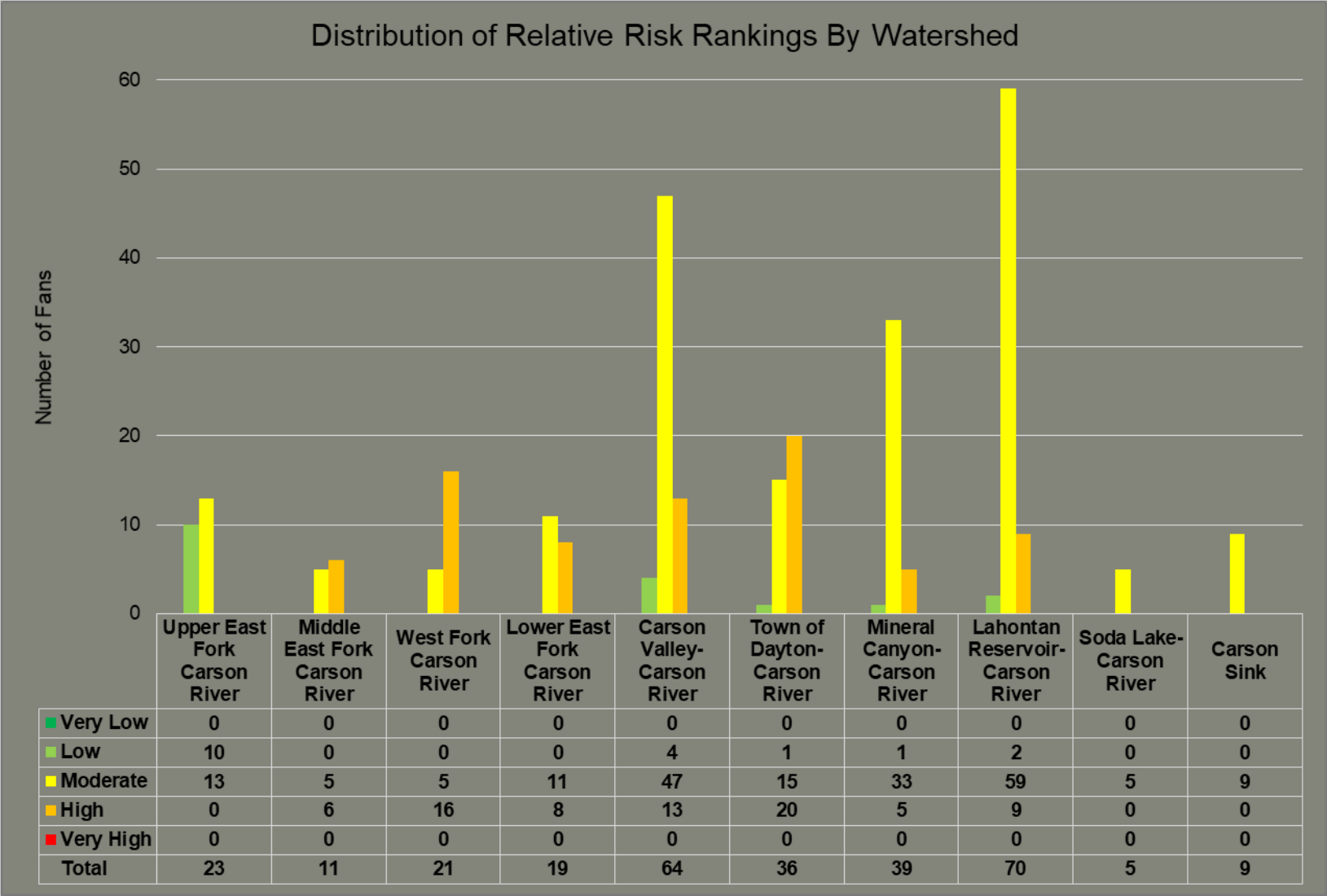




PHASE 1 RESULTS: DISTRIBUTION OF RISK RANKING

- A majority of the fans were classified as moderate risk
- No fans were classified as very high risk or as very low risk
- The Town of Dayton-Carson River watershed had the most high risk fans at 20
- West Fork Carson River watershed had the highest proportion of high risk fans at 76%

	Very Low	Low	Moderate	High	Very High	Total
Number of Fans	0	18	202	77	0	297
Percent	0%	6%	68%	26%	0%	100%





GOALS FOR PHASE 2

- **GOALS**

1. Develop additional in-depth datasets for planners and city/county managers to increase knowledge of alluvial fan risk.
2. Increase the certainty of alluvial fan delineations on selected fans.
3. Conduct hydraulic analysis on selected fans.

- **SIGNIFICANCE**

- To better understand and prioritize watershed risk, which would prevent further development in high hazard areas and develop strategies to mitigate in areas where development already occurs.



GEOLOGIC ASSESSMENT

- **Goal**

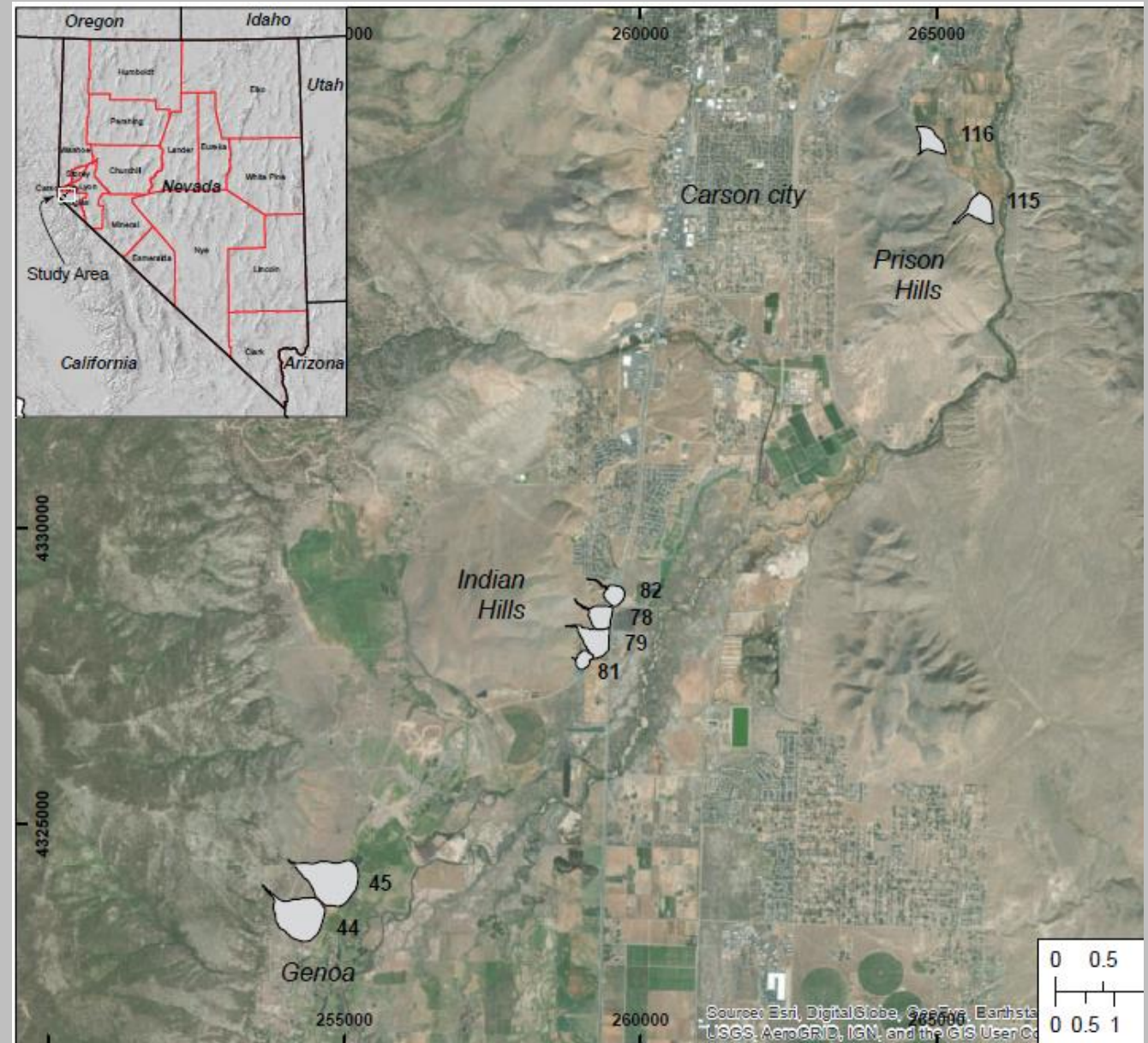
- Evaluate geohazards (areas susceptible to floods/debris flows)

- **Methodology**

- 8 fans selected by County
 - Douglas County: (6 fans) 44, 45, 78, 79, 81 & 82
 - Carson City County: (2 fans) 115 & 116

- **Fans had to have LiDAR data available**

- LiDAR data downloaded from USGS
- 3DEP Elevation Data
(<https://viewer.nationalmap.gov/basic/>)



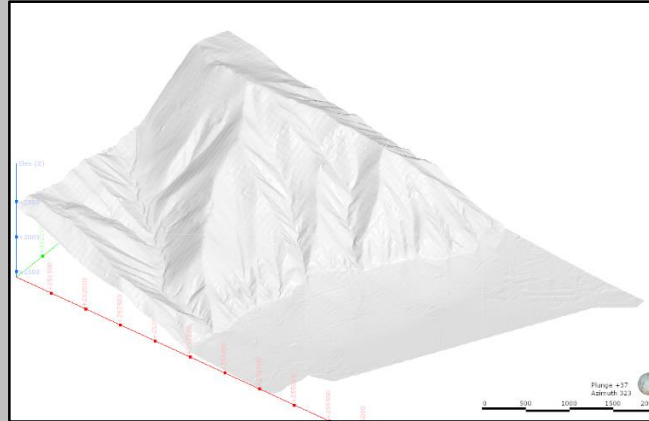


GEOLOGIC ASSESSMENT

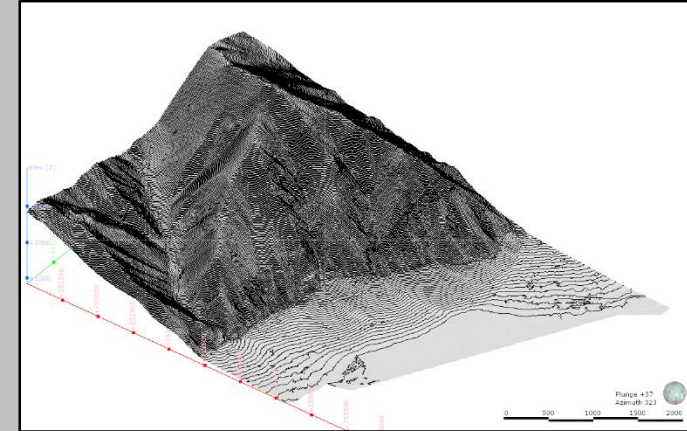
- **LiDAR Assessment:**

- Only use bare earth data from LiDAR collection
- Digital elevation models
- Generated contours (1m, 2m, & 5m)
- Slope maps
 - Surface morphology
 - Calculate gradients
 - Define outer toe (distal edge) : 1° - 2°

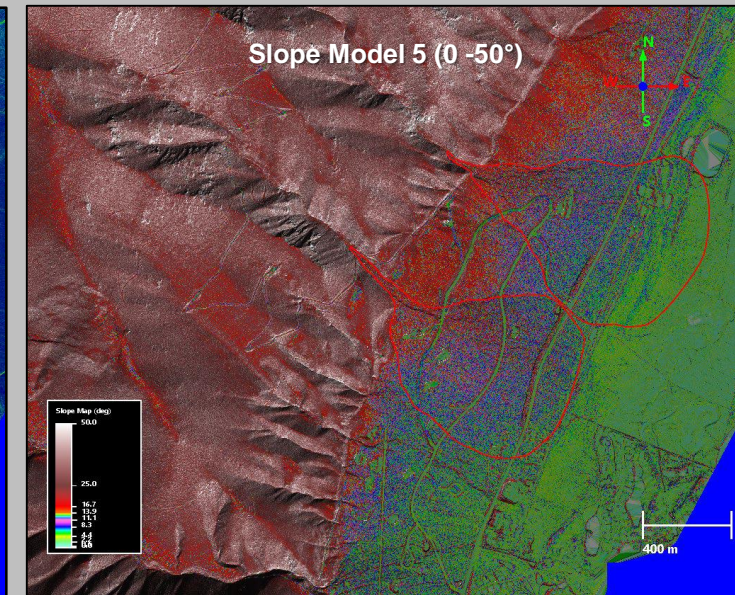
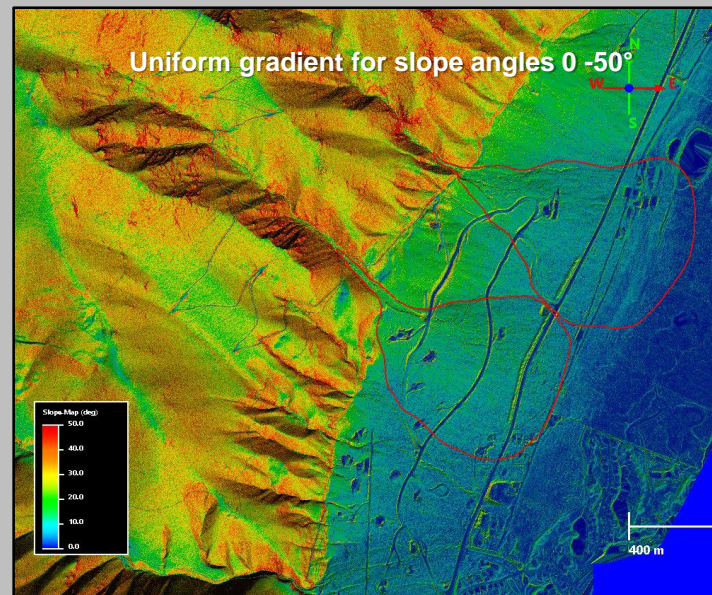
Digital elevation model



LiDAR Derived Contours (5 m)



Slope Model Examples



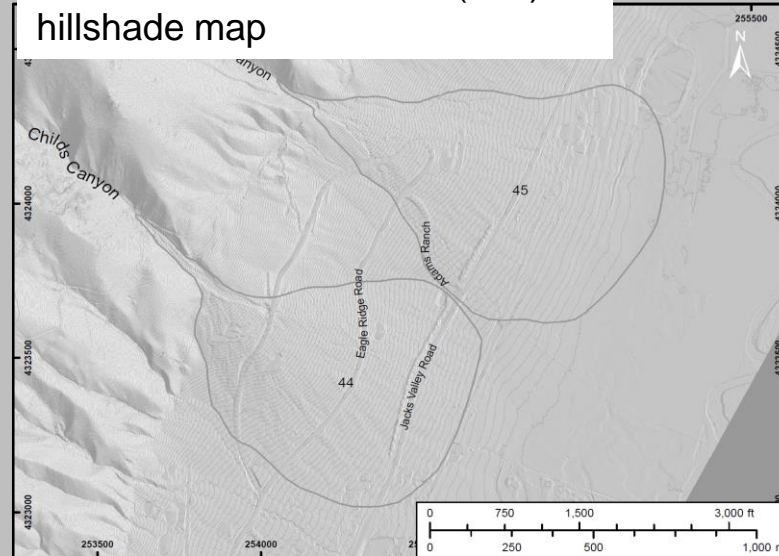


GEOLOGIC ASSESSMENT

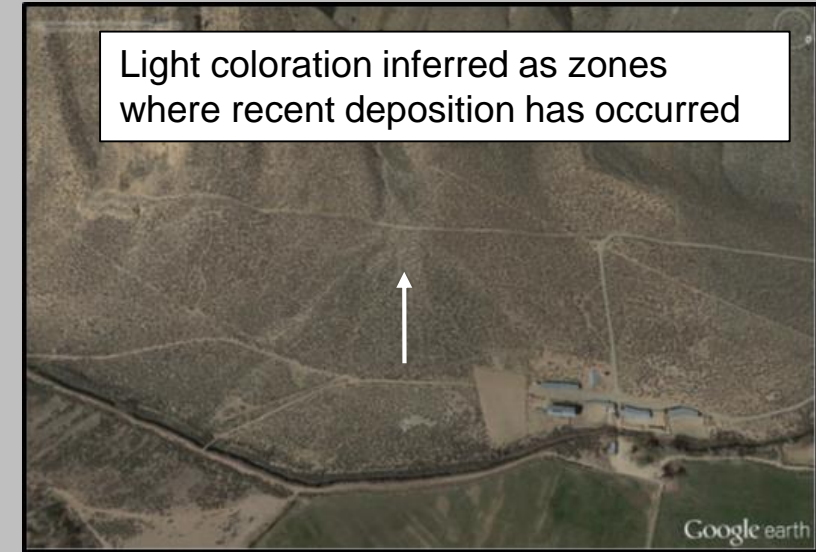
- **LiDAR Assessment (cont.):**

- Fan boundaries
 - Contours superimposed on LiDAR hillshade
 - Slope maps
 - Aerial photography
- Site visits
- Evaluate Geohazards

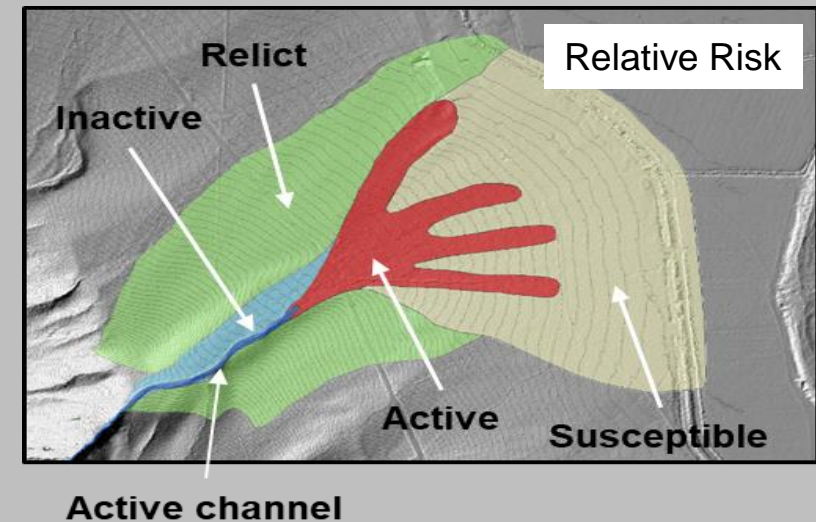
LiDAR Derived Contours (5 m) on hillshade map



Light coloration inferred as zones where recent deposition has occurred

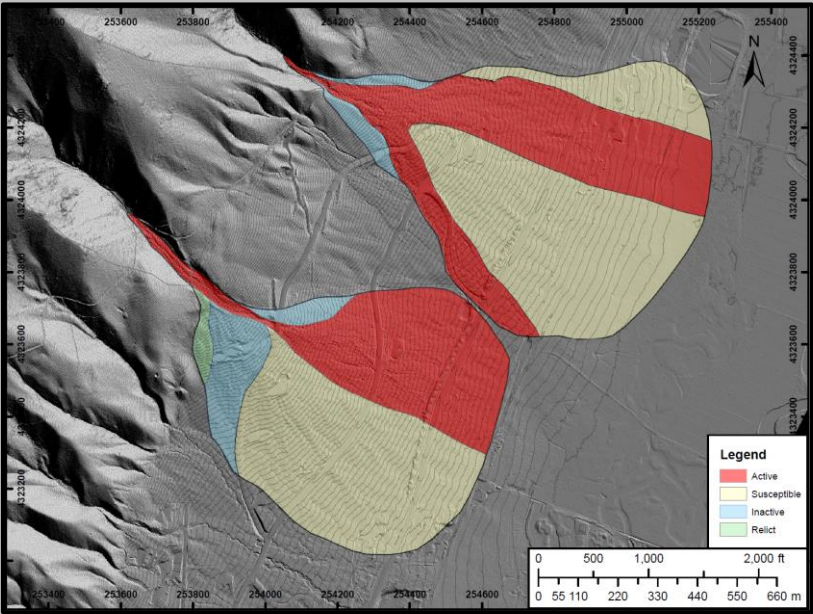


Sandy alluvial deposits of Fan 78





GEOLOGIC ASSESSMENT



Fan	Surface		Process		Avulsion	Development	Geohazard
	Texture	Slope	Alluvial	Debris Flows	Potential		
44	Rough	>10*	Mod - Hi	Mod - Hi	Hi	Mod***	Hi
45	Rough	>10	Mod - Hi	Mod - Hi	Hi	Low***	Hi
78	Smooth-moderate	6 - 8**	Mod - Hi	Low	Low	Mod	Low
79	Smooth	6 - 8	Mod	Low	Low	Mod	Low
81	Smooth-moderate	4 - 9	Mod	Low	Mod - Hi	Low - Mod	Low
82	Moderate	4 - 6	Low - Mod	Low	Low	Mod	Low
115	Smooth	4 - 9	Mod	Low	Low - Mod	Low	Low
116	Smooth-moderate	6 - 9	Mod - Hi	Low - Mod	Low	Mod	Mod

* Consistant slope

** Near topographic apex

*** Undergoing development

(Do not cite/reproduce)



GEOLOGIC ASSESSMENT

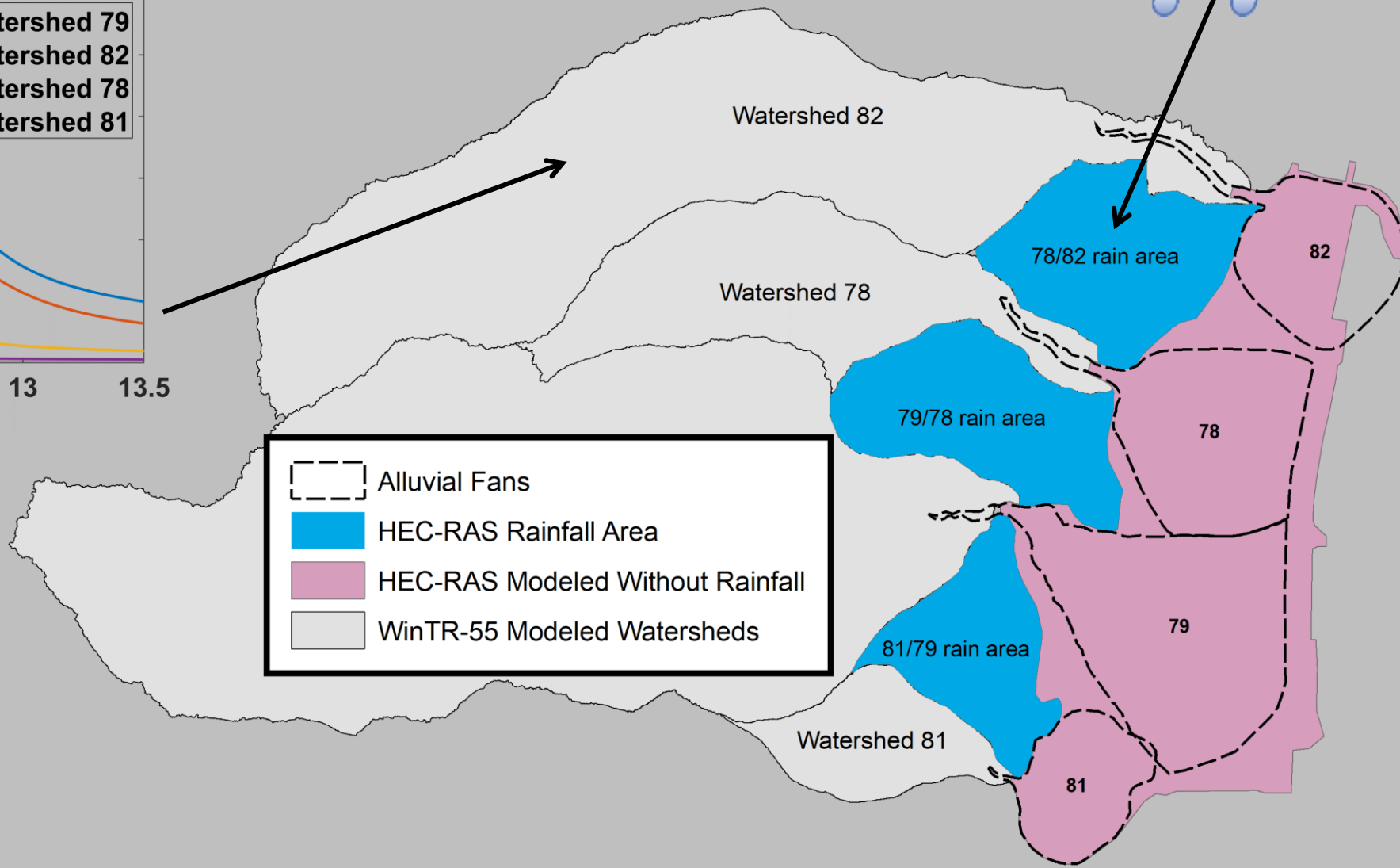
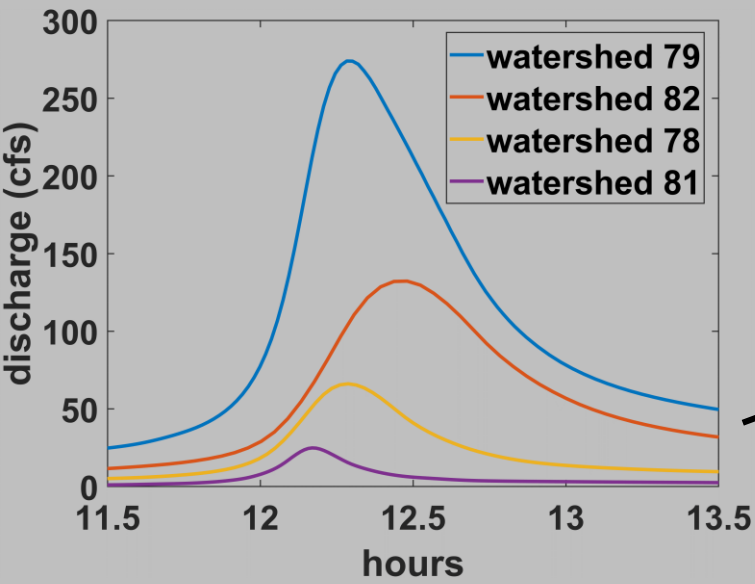
- **Summary:**

- All fans are active (varying degrees)
 - #79 & 82 pretty benign
 - #44 & 45 very active (steepest of fans)
- Alluvial transport & deposition occurring
 - Channel & sheet flow deposits common (active indicator)
 - Fresh deposits along road during site visit
- Debris flow possible
 - #44 & 45 most susceptible
 - Steep sections near fan apex (#81 & 116; maybe #78)





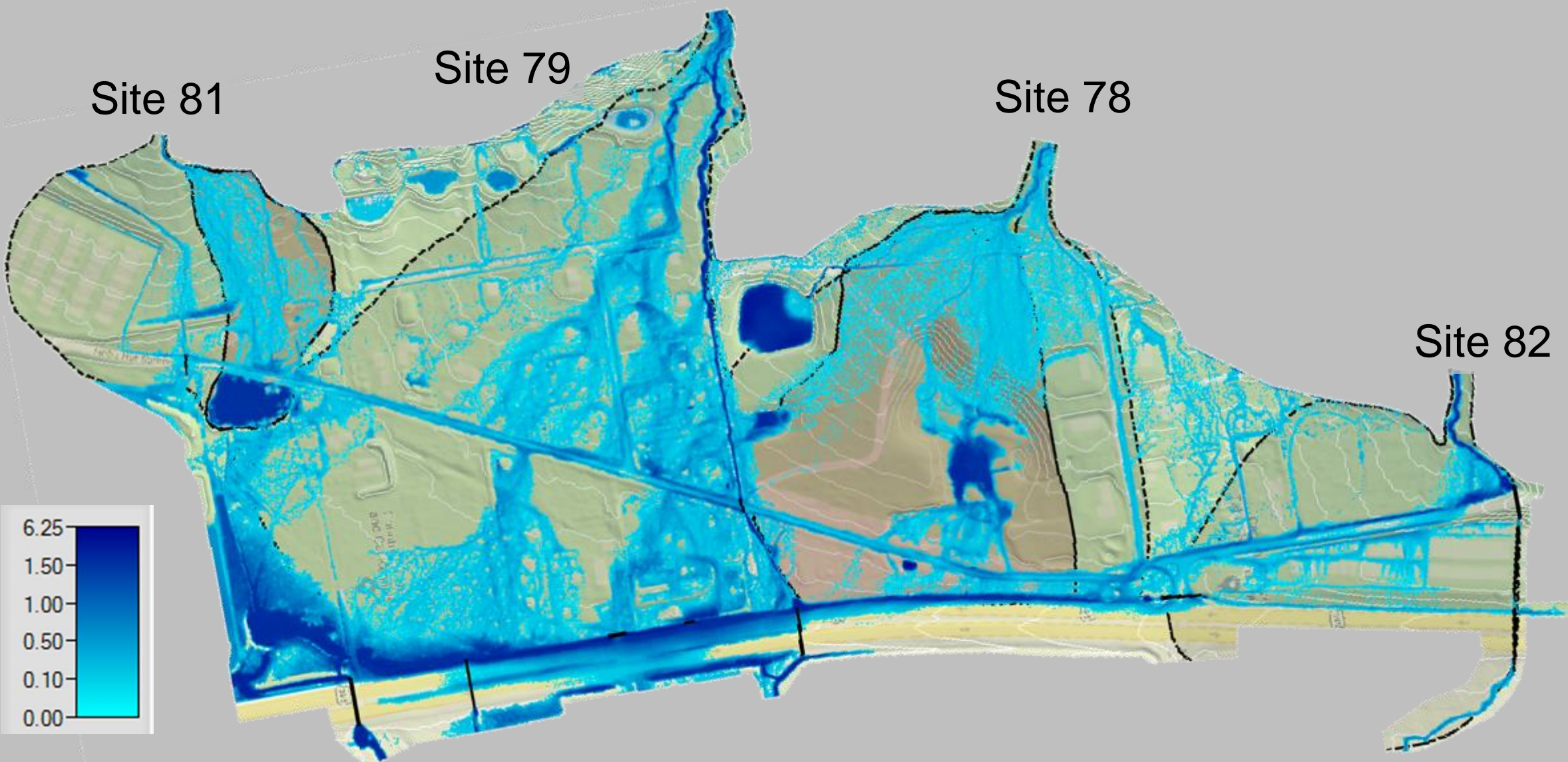
HYDRAULIC ASSESSMENT





HYDRAULIC ASSESSMENT

Inundation Maps

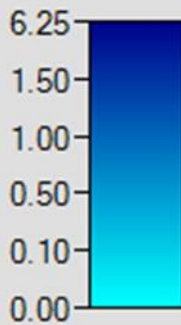


Site 81

Site 79

Site 78

Site 82

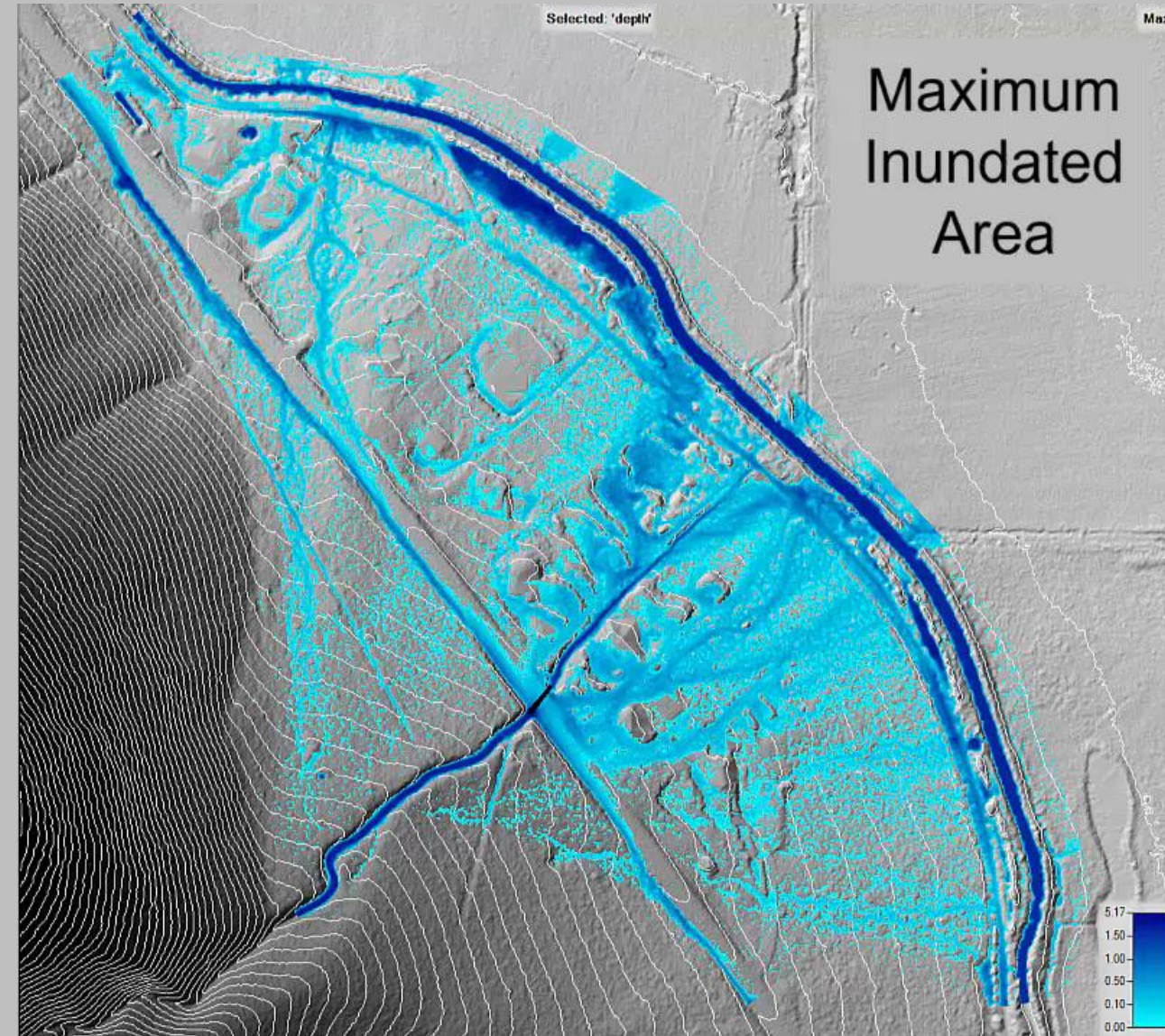




HYDRAULIC ASSESSMENT

HEC-RAS 2D Hydraulic Model

- Maximum inundation depth at every location
- Inundation depths assuming no channel movement for a 100-year event

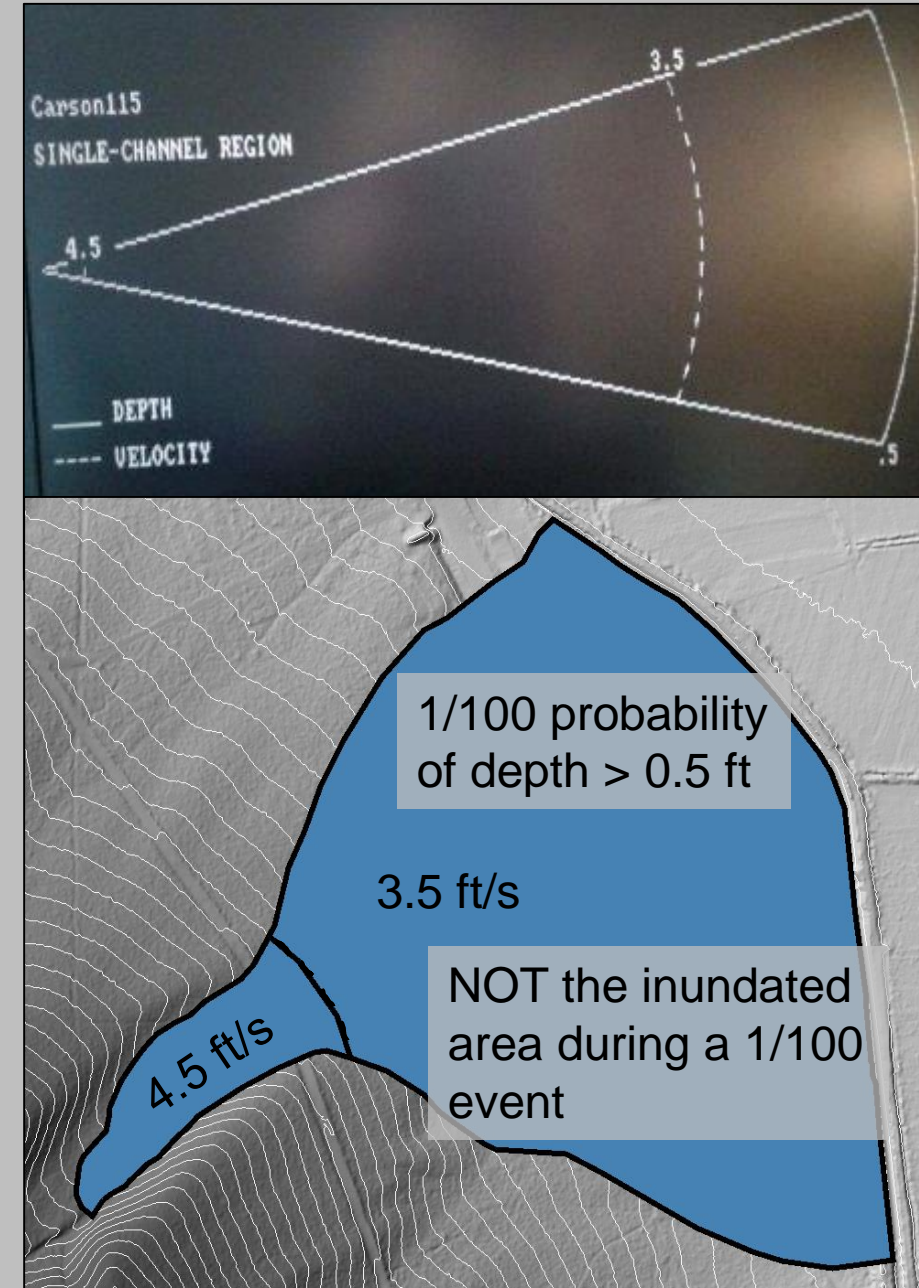




HYDRAULIC ASSESSMENT

FEMA FAN Program

- Only performed on highly active fans
- Looking to see what would happen if the channel moves – areas that could be flooded
- Program uses peak flows and probabilities, rather than a 100-yr hydrograph.
- Program is mapping the area that has a 1% chance of being inundated, while the HEC-RAS model is mapping the inundated depth during a 1% probability event
- **Assumptions**
 - Highly active alluvial fans
 - Flow paths are allowed to move randomly
 - Simple relationship between depth and flow
 - Not valid for debris flow

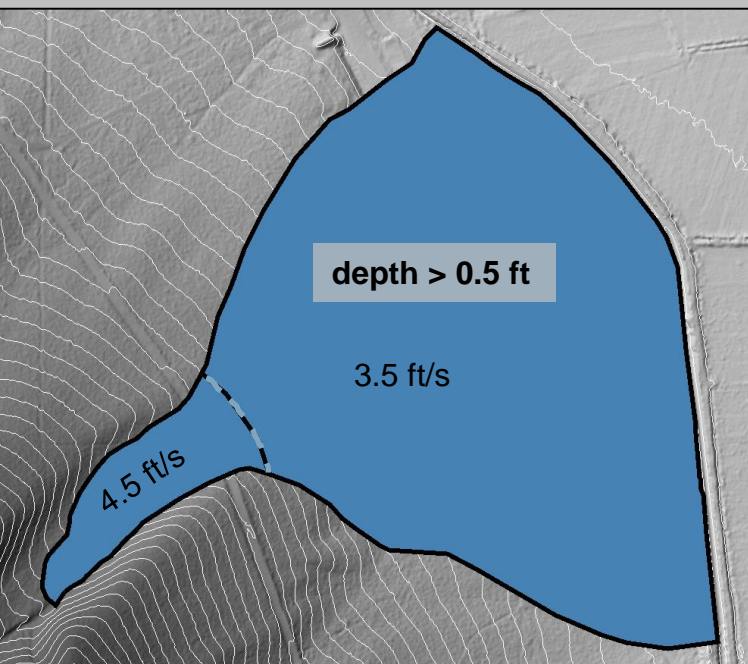




HYDRAULIC ASSESSMENT

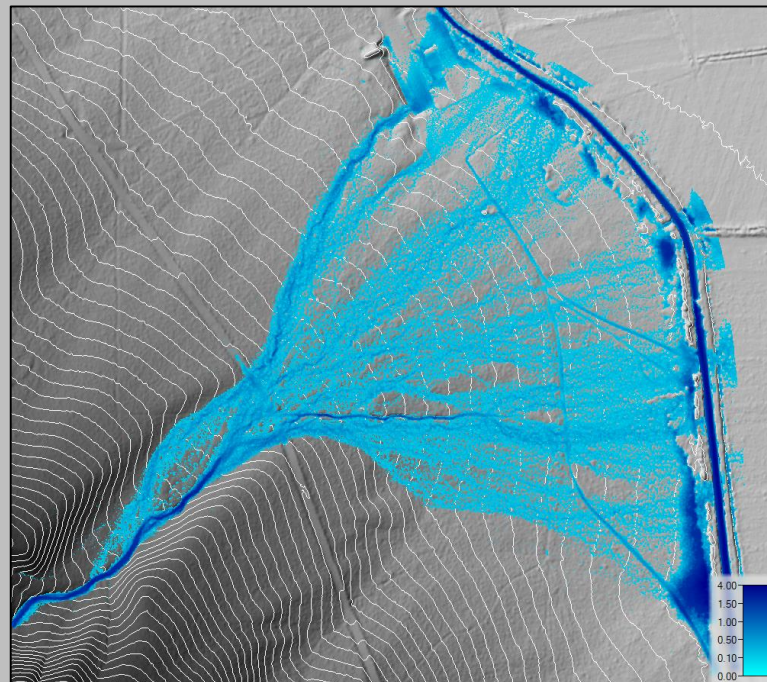
Geologic Assessment

FEMA FAN



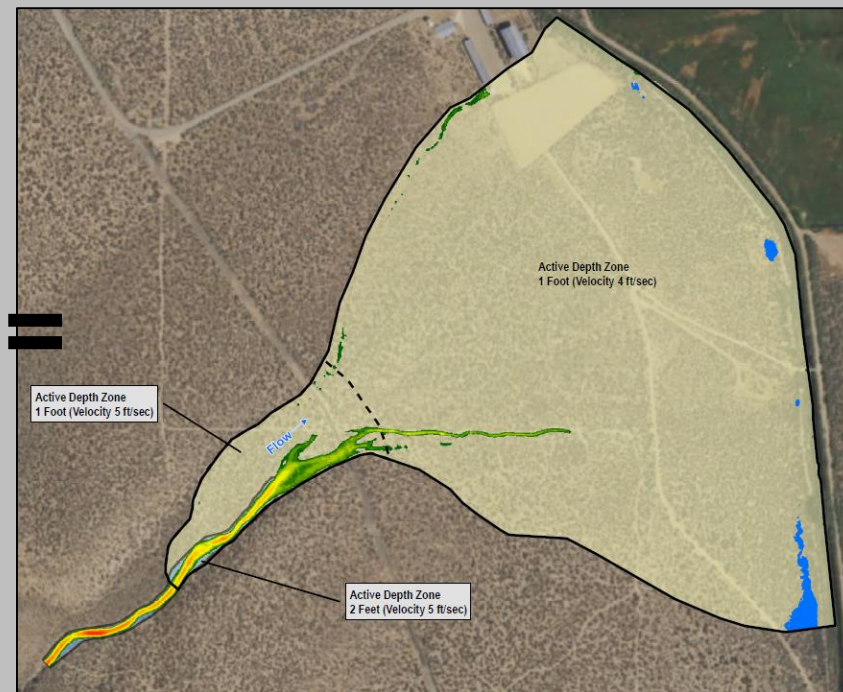
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2D HEC-RAS



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Inundation Map

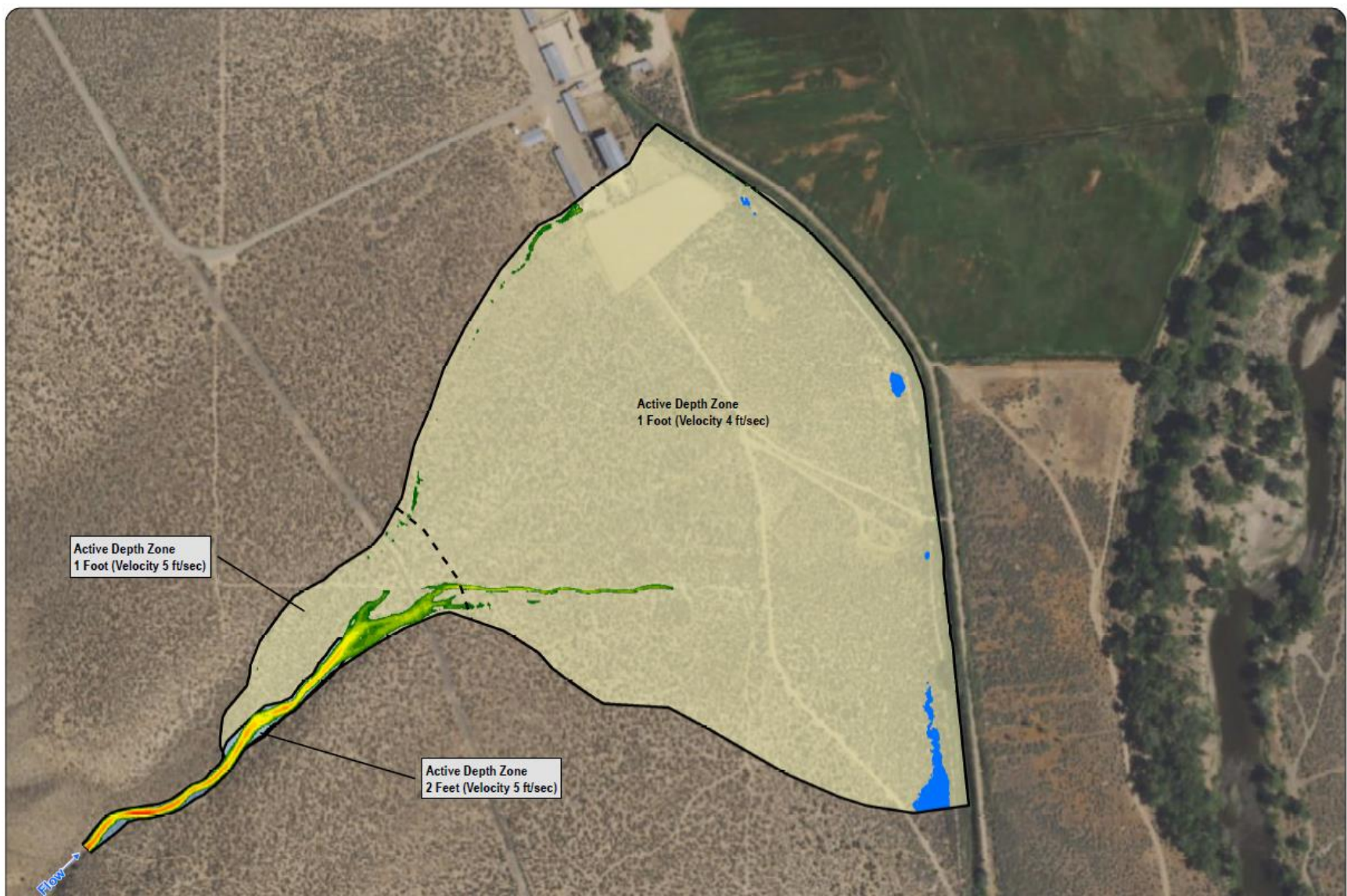




HYDRAULIC ASSESSMENT

Site 115

Inundation Maps



Legend

Velocity Greater Than 4.5 Ft/Sec

4.5 - 5.5
5.5 - 6.5
6.5 - 7.5
7.5 - 8.5
8.5 - 9.5
9.5 - 10.5
10.5 - 11.5
11.5 - 12.5
12.5 - 13.5
13.5 - 14.5
14.5 - 15.5
15.5 - 16.28

Active Fan Depths (Feet)

1 Foot Zone
2 Foot Zone
Greater Than 1.5 Feet

Velocity Zone Change

Flow Direction

Carson River Watershed

Vicinity of Carson City, Nevada

Alluvial Fan Site 115

1 in = 0.05 miles

0 10 20 Miles

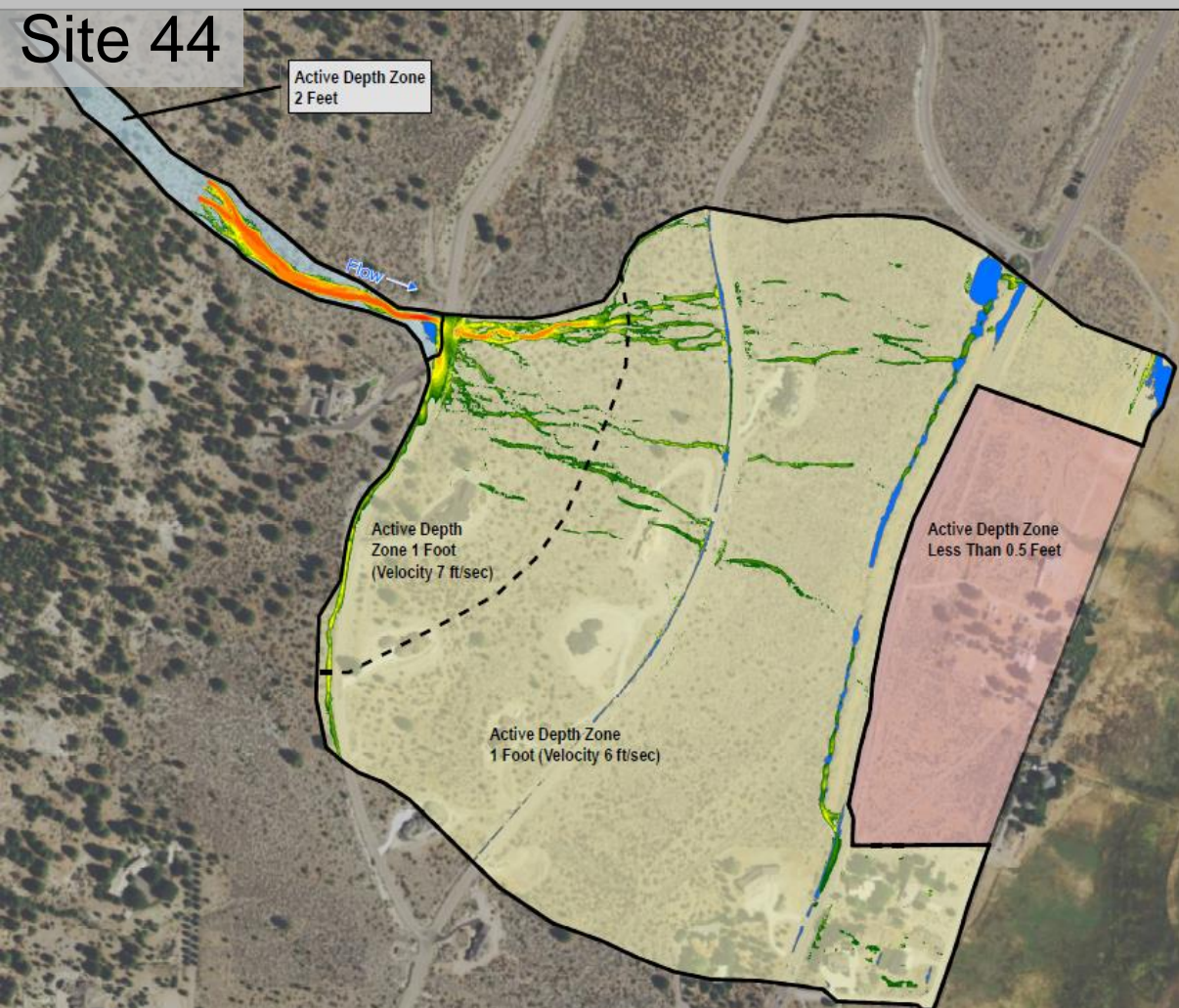
0 10 20 Feet



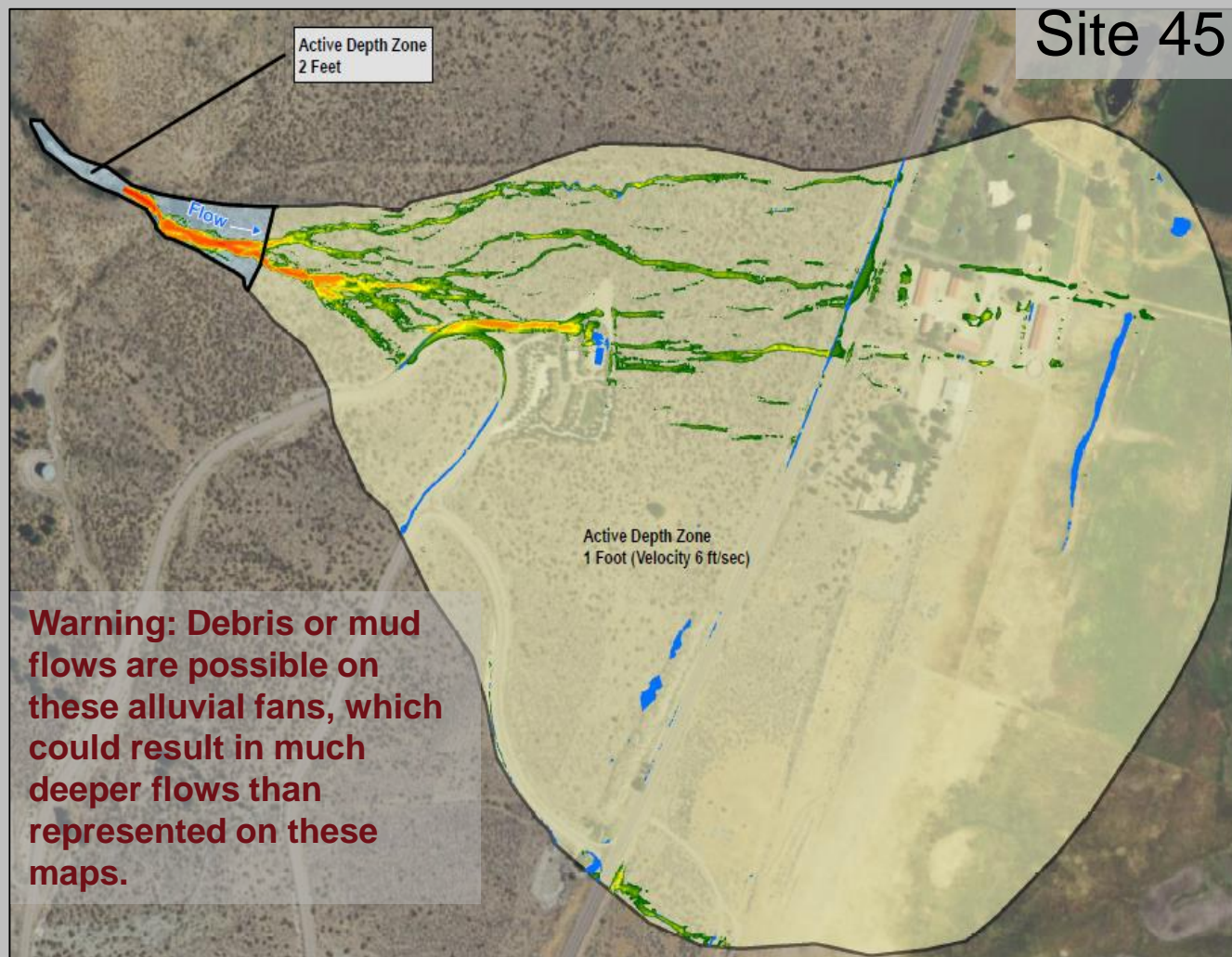
HYDRAULIC ASSESSMENT

Inundation Maps

Site 44



Site 45





WHAT'S NEXT?

- Understanding impacts to existing and future development
- Prioritizing watershed risk and develop strategies to minimize that risk
- Utilizing identified alluvial fan areas and associated risk in development review



Source: esri.com

QUESTIONS?

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