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Analysis of Virtual Shorelines in Relation to Archaeological Sites in the Colorado River Ecosystem

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Adaptive Management Work Group Meeting, Phoenix
April 30, 2009

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

Background: AMWG Motion

- ***Review flow levels associated with 158 archaeological sites that have been identified for monitoring and/or impact mitigation***

- ***Report this information and recommendations with regard to how these data would fit into the process of making choices of sites to be monitored and/or impacts mitigated***

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Modeling Virtual Shorelines

- Basic model developed by Magirl and others, 2008
- Uses topography generated from 2002 remotely sensed aerial imagery (photogrammetry)
- Assigns elevation values from 1D model at 2,680 cross-sections, then interpolates between cross-sections to generated 3D surfaces
- Generates “areas of inundation” by comparing the elevation of the water surface layers with the topographic layer

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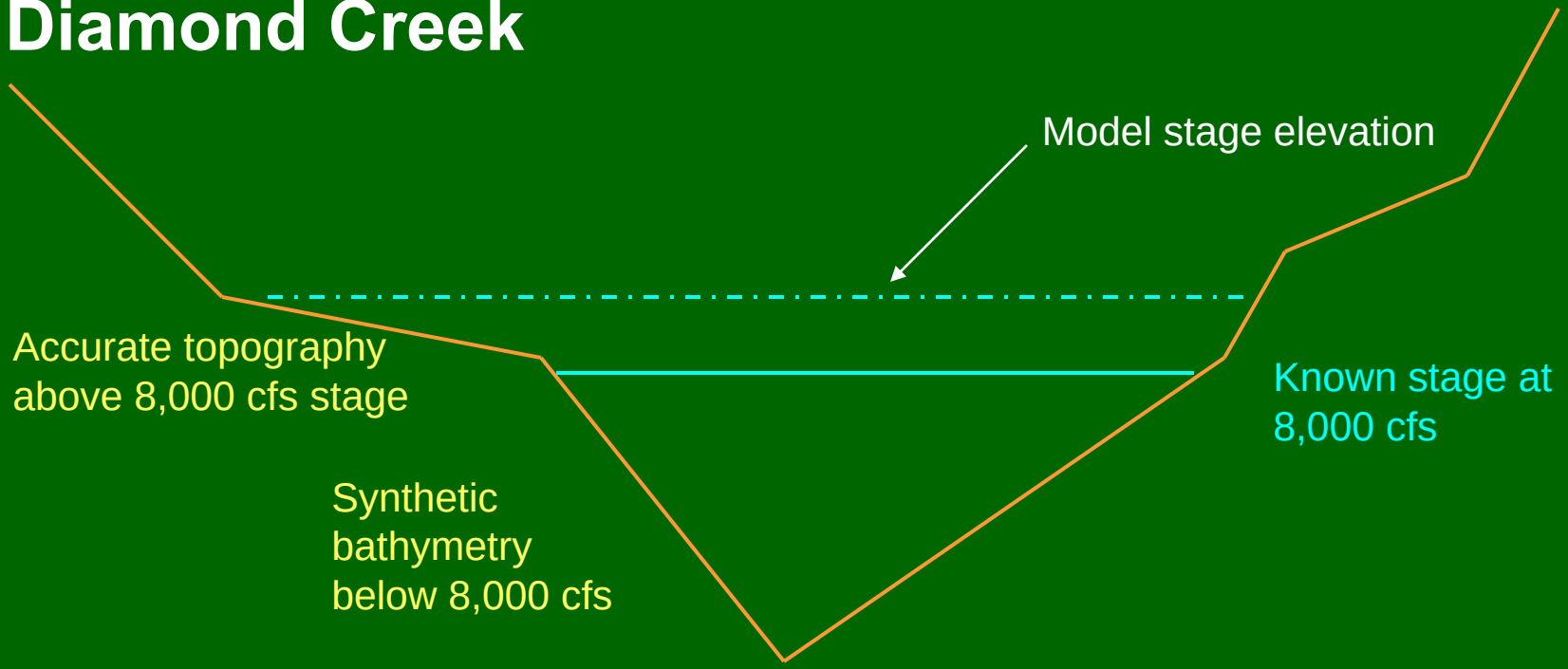
Basic Diagram of Model Components

2,680 cross-sections between Lees Ferry & Diamond Creek



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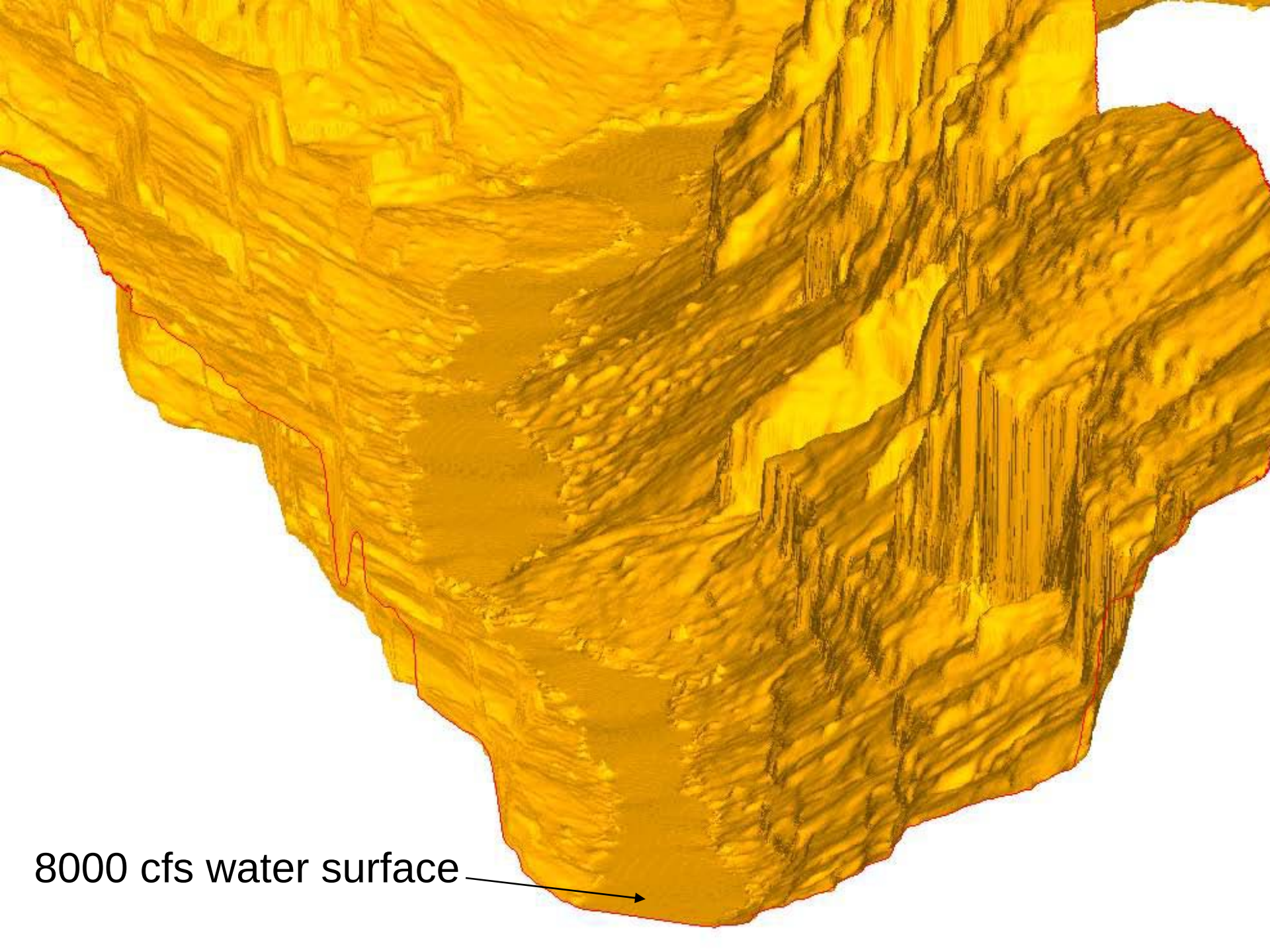
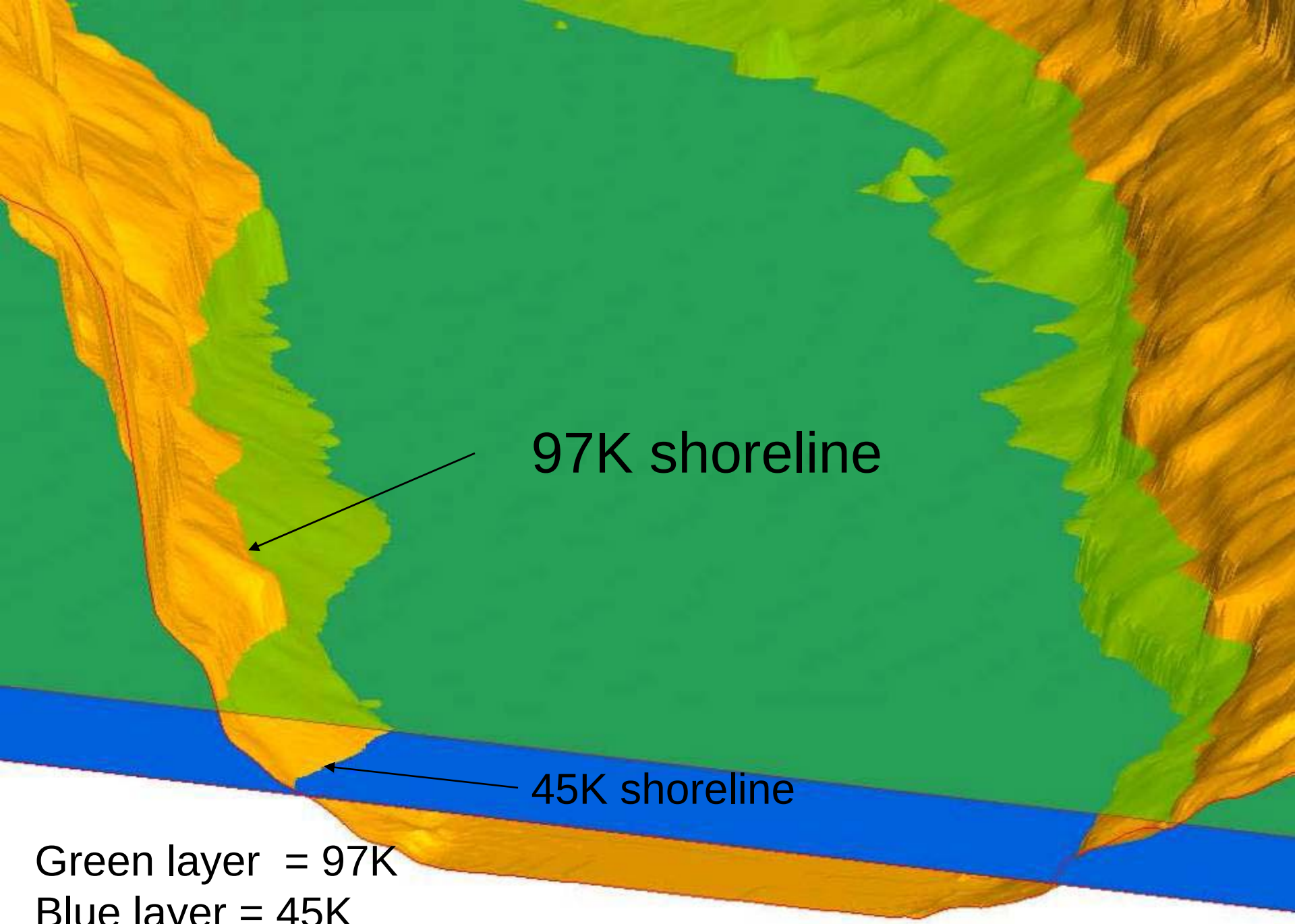
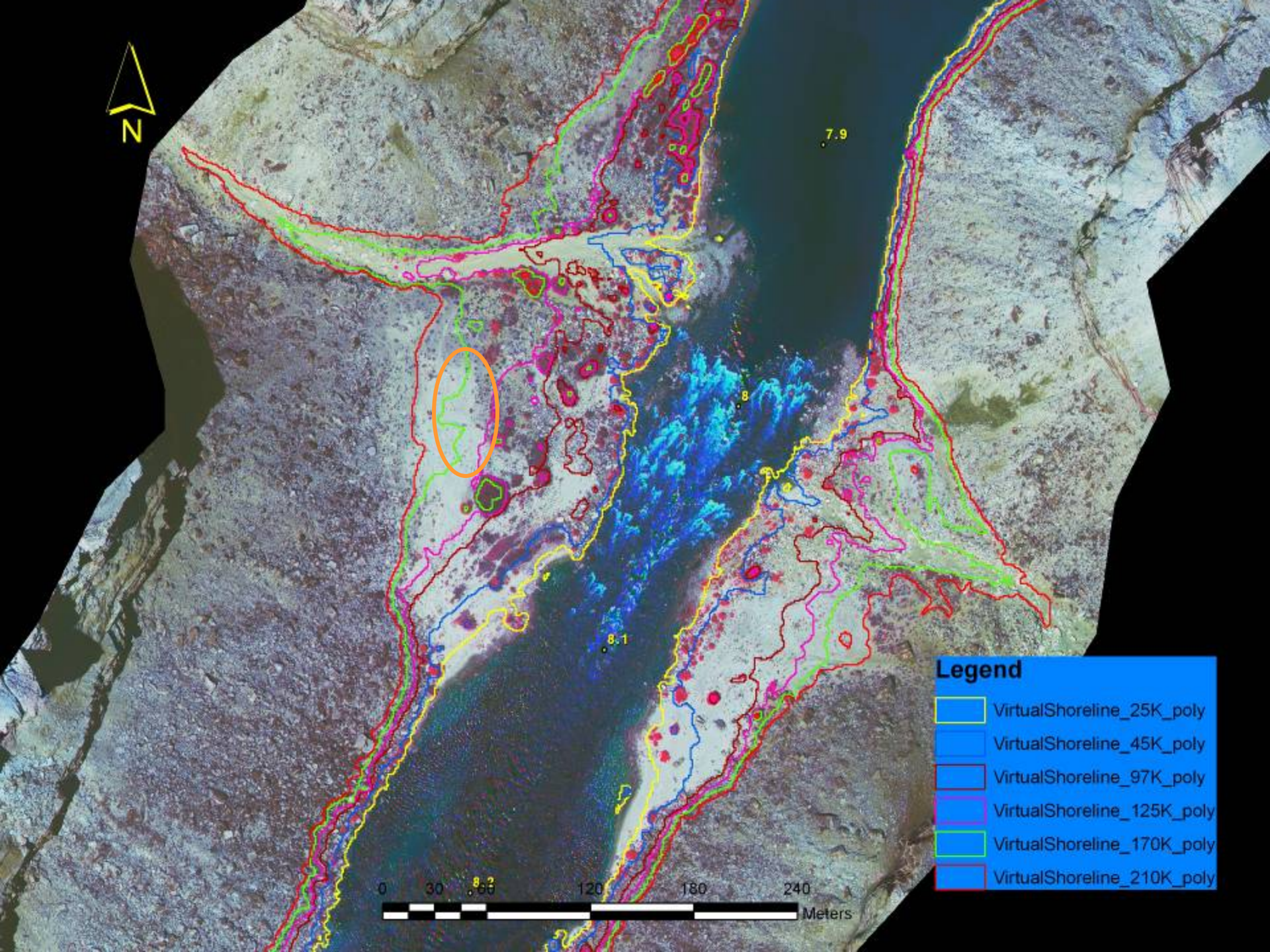
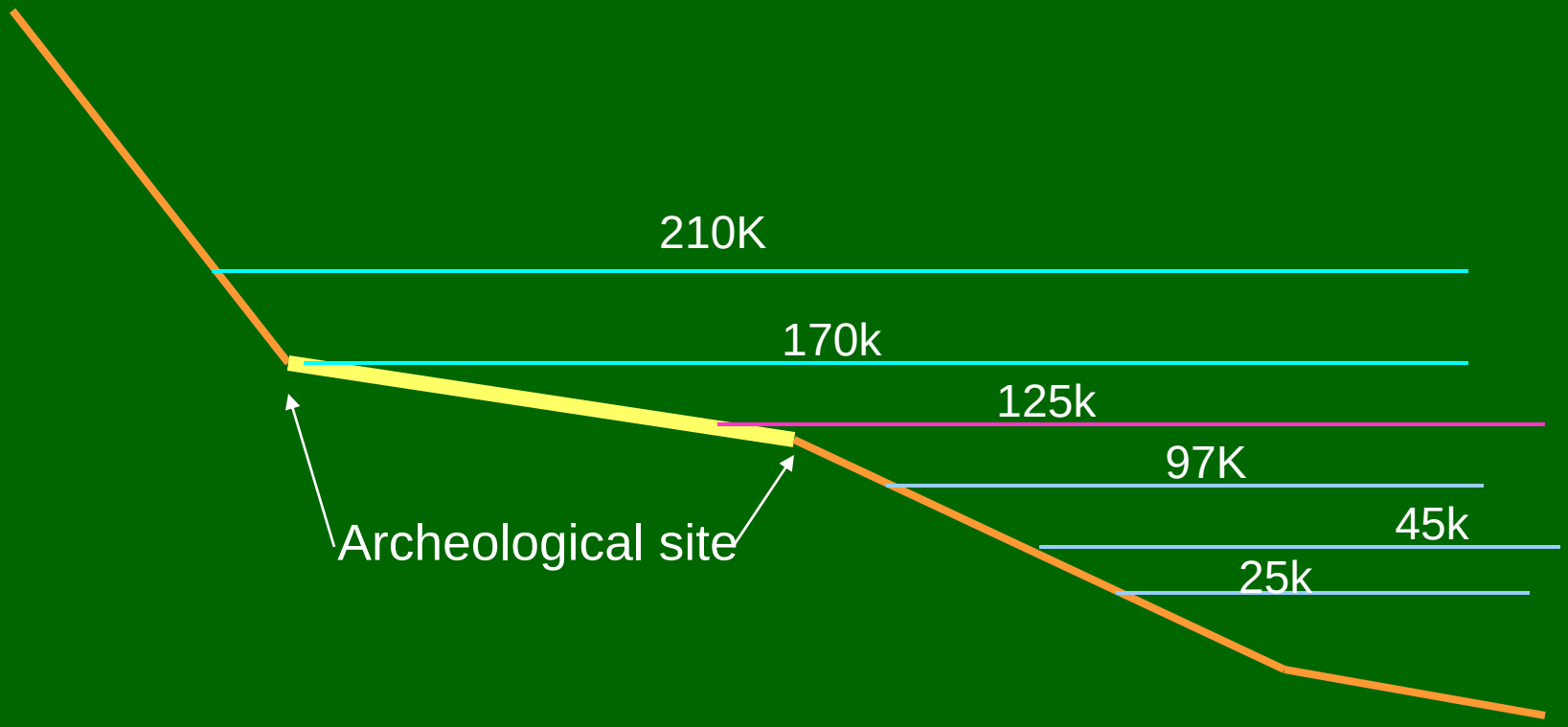

8000 cfs water surface



Green layer = 97K
Blue layer = 45K


N
7.9
8
8.1
8.2
0
30
60
120
180
240
Meters
Legend
VirtualShoreline_25K_poly
VirtualShoreline_45K_poly
VirtualShoreline_97K_poly
VirtualShoreline_125K_poly
VirtualShoreline_170K_poly
VirtualShoreline_210K_poly

Profile view showing intersection of modeled water surfaces with arch. site



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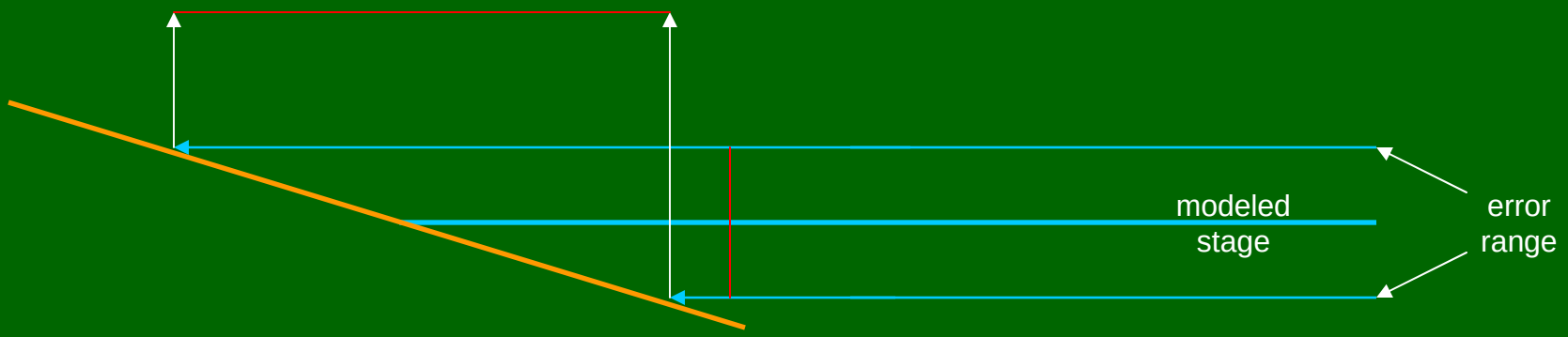
Analysis incorporates error range

Small vertical difference may result in large horizontal difference



Stage predicted to within:

- **± 0.4 m (1.31 ft) for discharge less than 1,300 m3/s (<46,000 cfs)**
- **± 1.0 m (3.28 ft) for discharge ranging 1,300−2,500 m3/s (46,000-88,000 cfs)**
- **± 1.5 m (4.92 ft) for discharge ranging 2,500−5,900 m3/s (88,000-210,000 cfs)**

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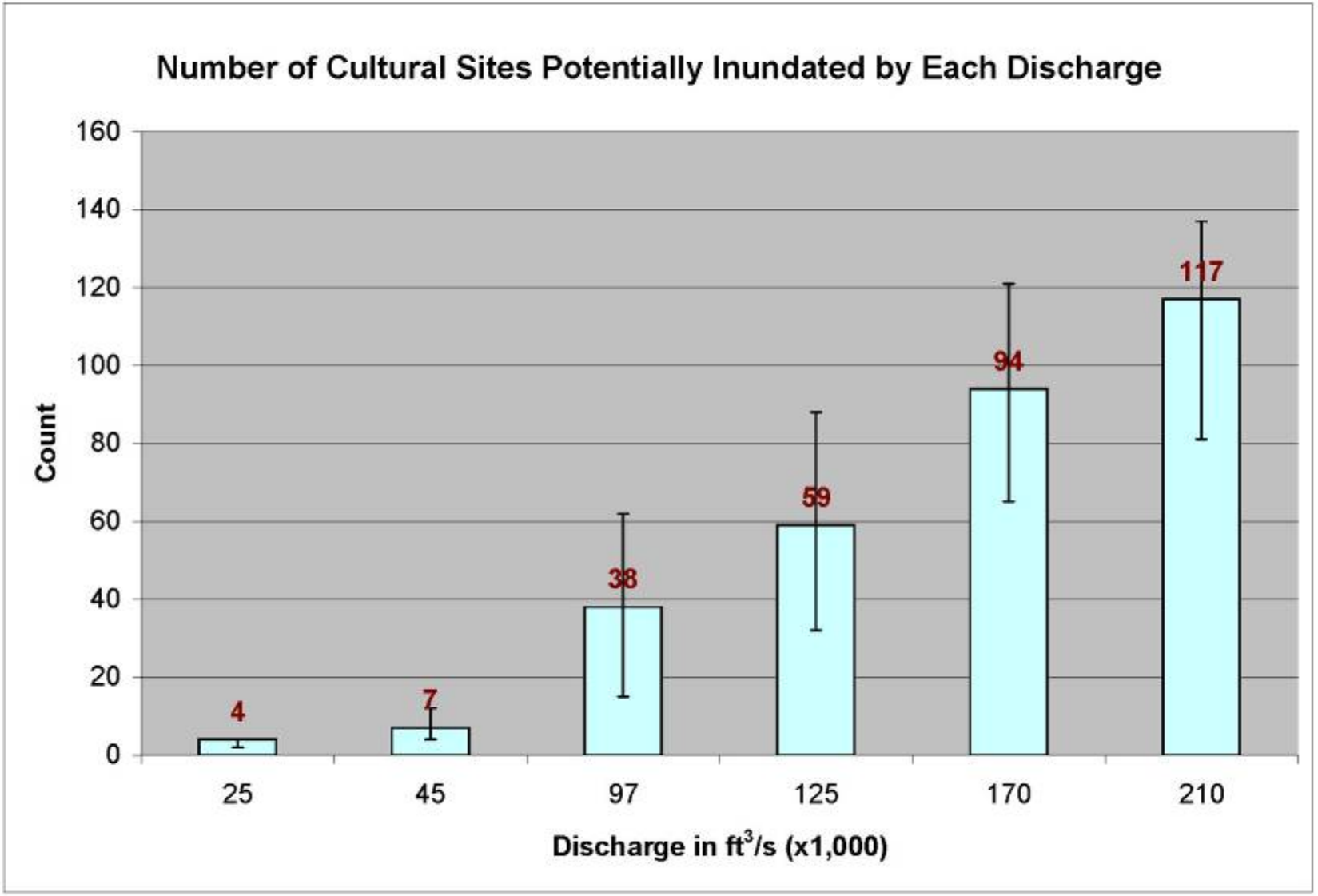
Number of Cultural Sites Potentially Inundated by Each Discharge
Count
160
140
120
100
80
60
40
20
0
4
7
38
59
94
117
25
45
97
125
170
210
Discharge in ft3/s (x1,000)

Limitations of Analysis

- Analysis depends on accurate outline of archaeological site area – small boundary changes may produce different results
- Only ground surface at archaeological sites was considered—how each flow level could affect 3D sites was not analyzed
- Error range may exceed preceding or subsequent stage (e.g., upper error range of 170K exceeds lower & mid range of 210K)
- Modeled water-surface elevations are based on current (2002) topography—changes in local topography (e.g., by debris flow from tributary) may change local stage-discharge relationships
- Synthetic bathymetry suboptimal— future measured bathymetry from channel mapping project may be used to update model

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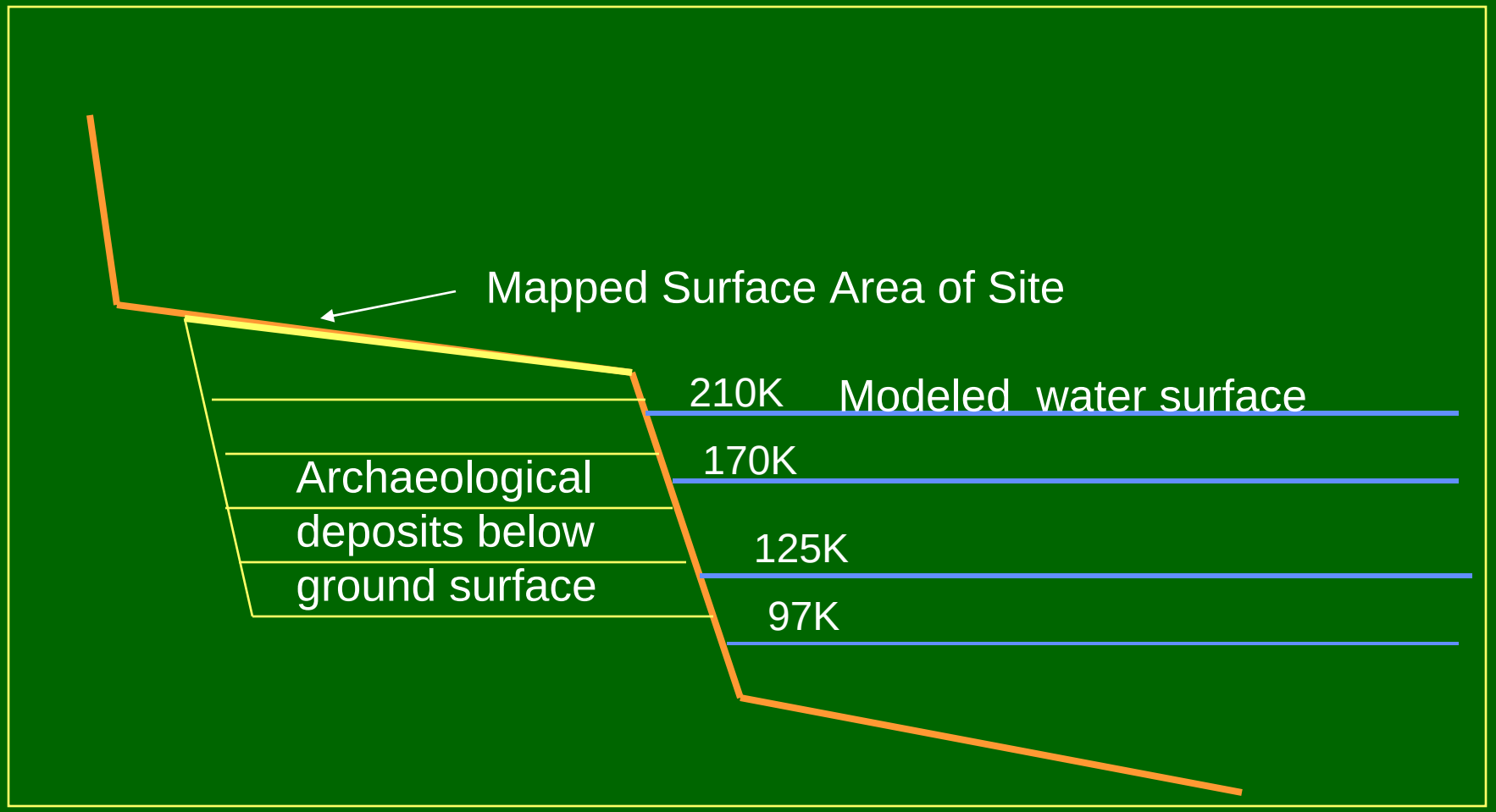
False negative: Archaeological site is affected, but GIS analysis says it is not



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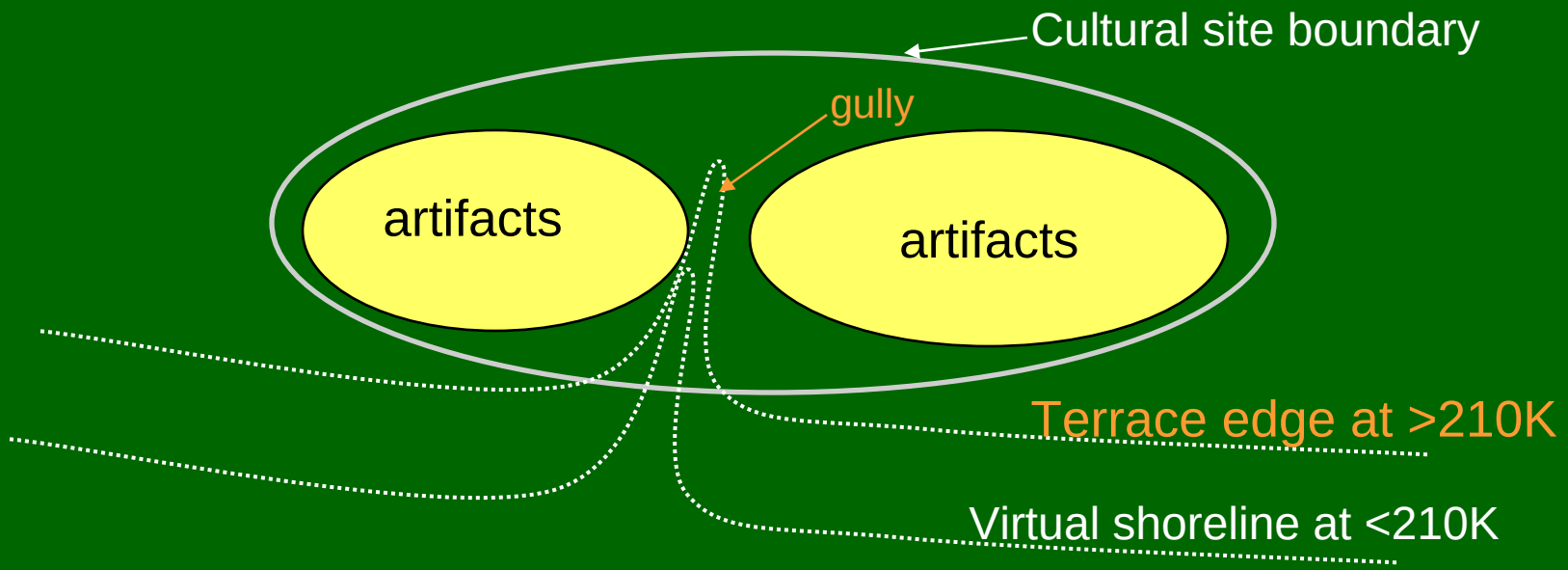
False positive: GIS analysis indicates site is inundated when it is not

Cultural site on terrace surface with deep gully cutting through the middle of the artifact scatter.

GIS analysis indicates site is partly inundated, but in fact no archaeological materials are affected.



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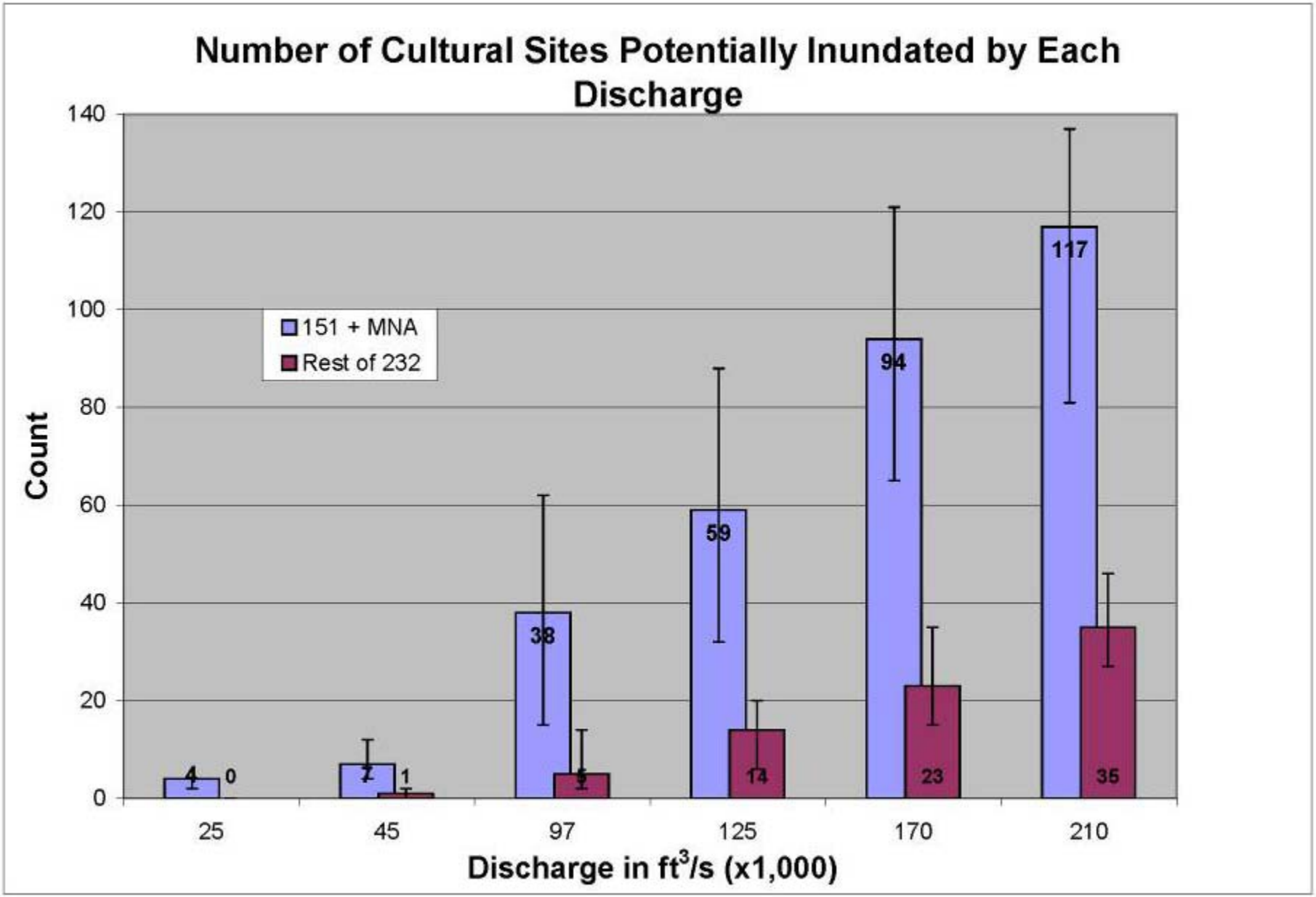
Number of Cultural Sites Potentially Inundated by Each Discharge
Count
140
120
100
80
60
40
20
0
151 + MNA
Rest of 232
4
0
7
1
38
5
59
14
94
23
117
35
25
45
97
125
170
210
Discharge in ft3/s (x1,000)


QUESTIONS?