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Managing Water in the West

Sediment Transport during Drawdown of the Copco 1 Reservoir on the Klamath River under Dam Removal Scenarios

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Background

To perform **hydrologic, hydraulic, and sediment transport studies**

to support the Secretarial Determination on Klamath Dam Removal and Basin Restoration

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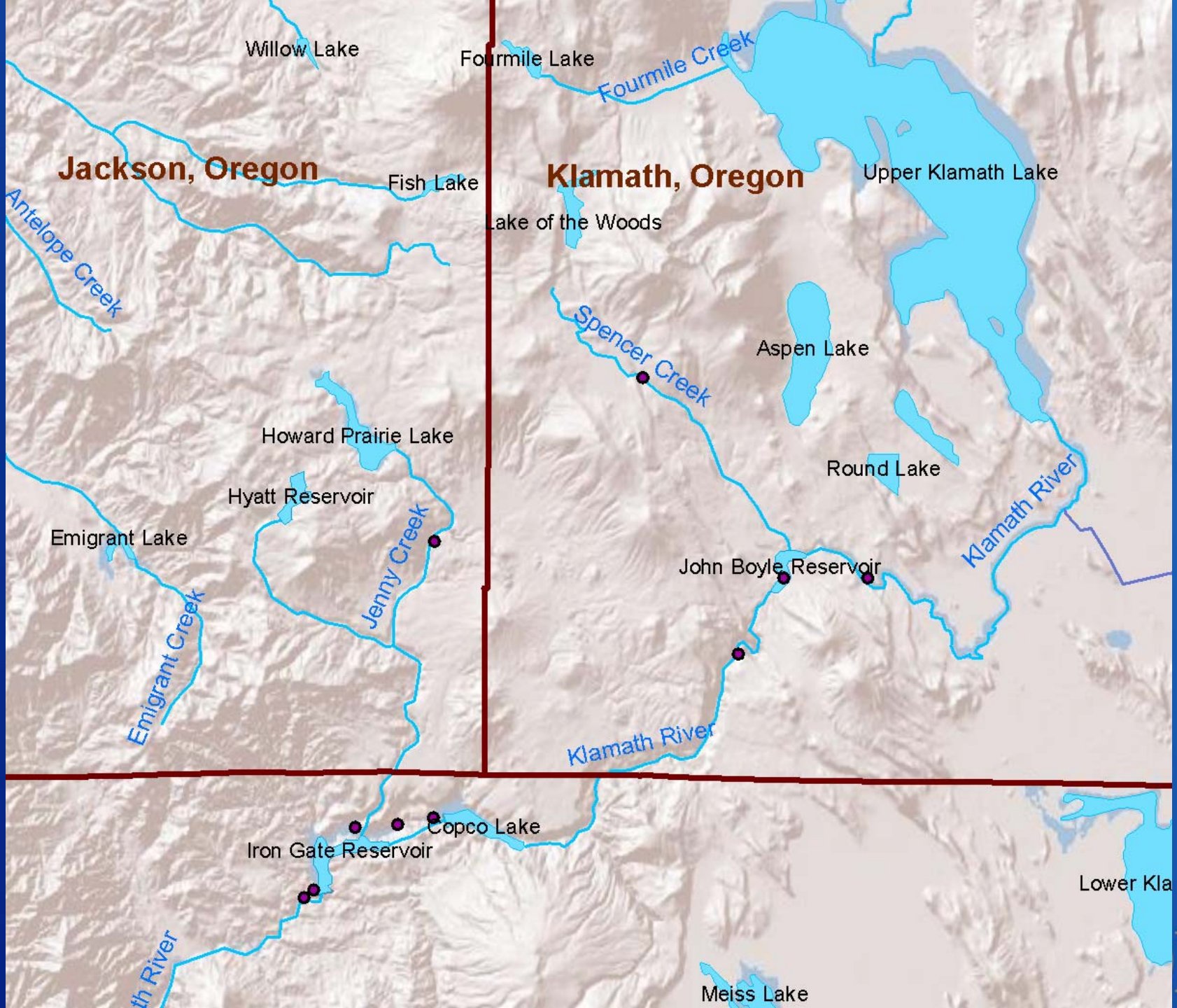
Willow Lake
Fourmile Lake
Fourmile Creek
Jackson, Oregon
Fish Lake
Klamath, Oregon
Upper Klamath Lake
Lake of the Woods
Antelope Creek
Spencer Creek
Aspen Lake
Howard Prairie Lake
Round Lake
Hyatt Reservoir
Klamath River
Emigrant Lake
John Boyle Reservoir
Jenny Creek
Emigrant Creek
Klamath River
Copco Lake
Iron Gate Reservoir
Lower Kla
Meiss Lake

Background

- Two alternatives (2012 to 2061):
  - "No Action" and "Dam Removal"
- Dam Removal Scenario:
  - JC Boyle, Copco 1, Copco 2, and Iron Gate Dams will be removed by December 31, 2020. A free flowing river will be established by that date.
  - Reservoir drawdown of JC Boyle, Copco 1, and Iron Gate Dams will begin on November 15, 2019 or January 1, 2020.

Scope of this Study

- Reservoir **Drawdown Process** of Copco 1
- **SRH-2D** is used: Two-Dimensional flow and sediment transport model
- The **channel incision** process as a result of the drawdown
- **Sediment delivered** to the downstream

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SRH-2D Stands for:

Sedimentation and **R**iver **H**ydraulics – **2D** modeling

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History

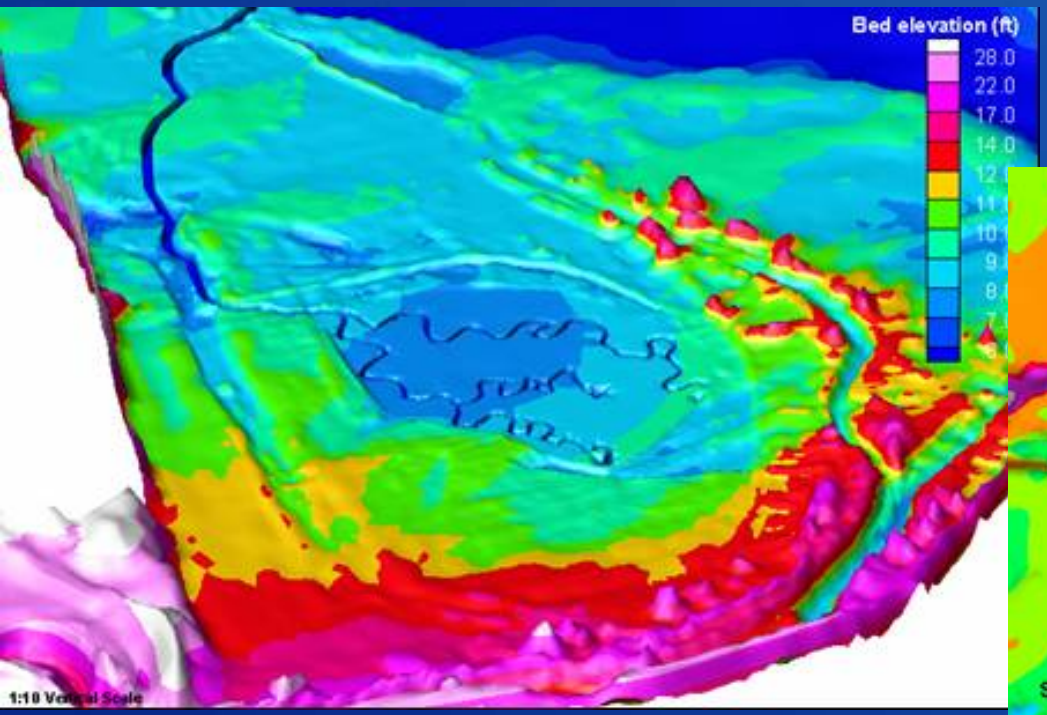
- SRH-W version 1 (2006)
- SRH-2D version 2 (2008)
- SRH-2D version 3 (beta)

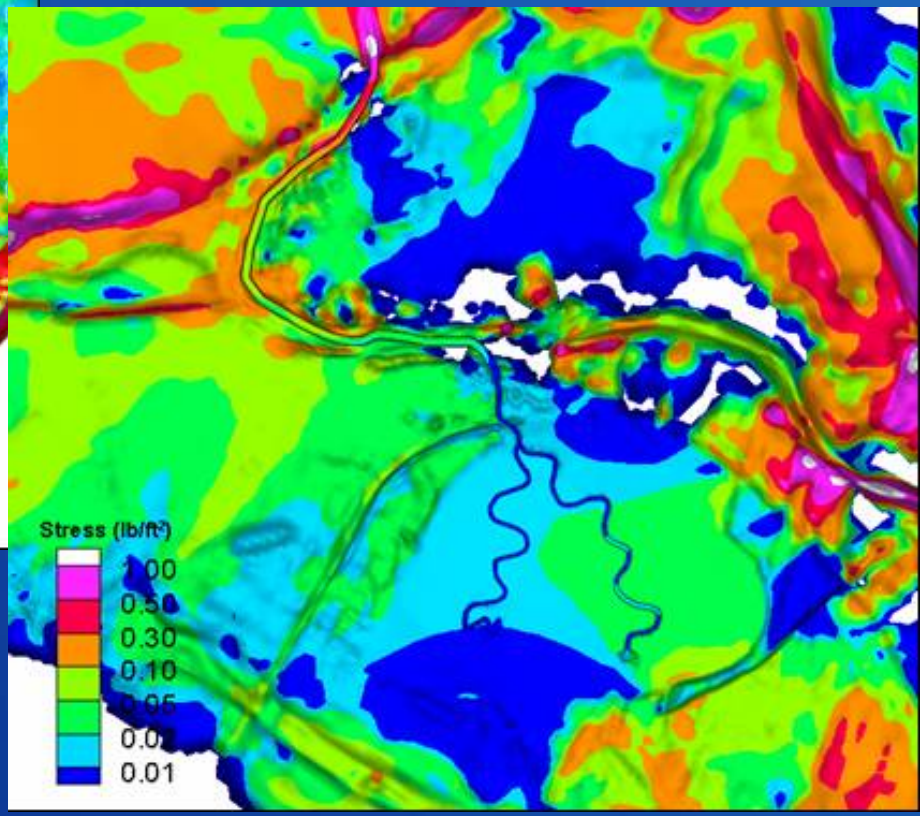
Current Release: SRH-2D v2

www.usbr.gov/pmts/sediment/model/srh2d

Habitat / Wetland / Reconnection

- **Restoration Projects**





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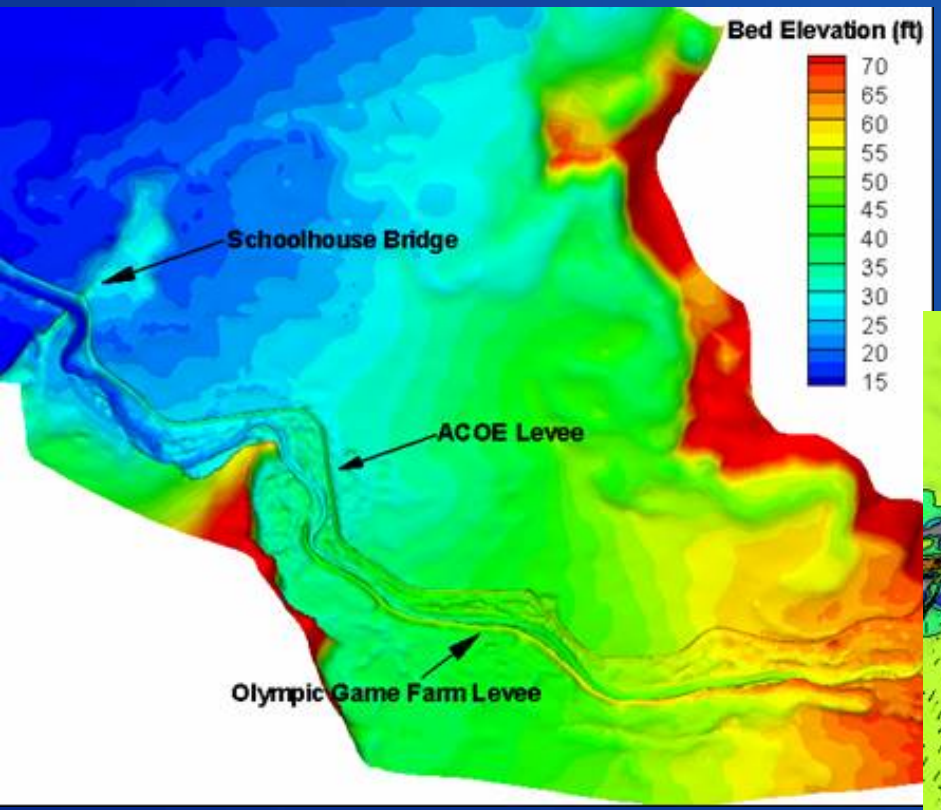
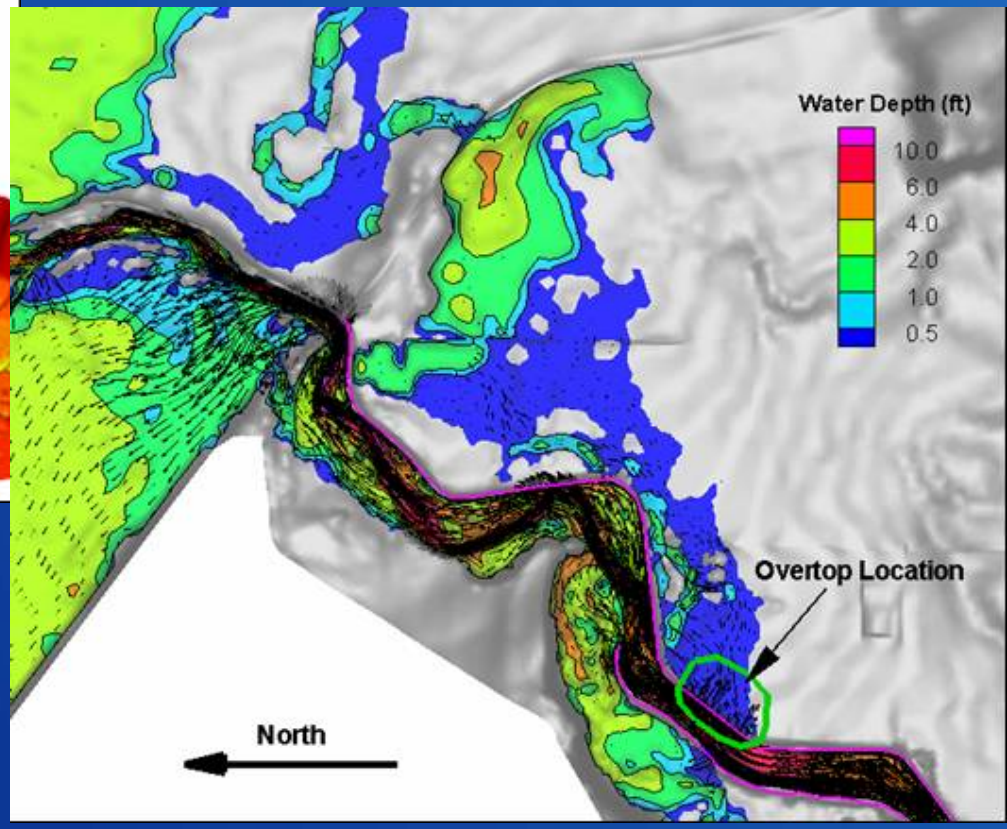
Lateral Variations; Bank/Levee Overtop





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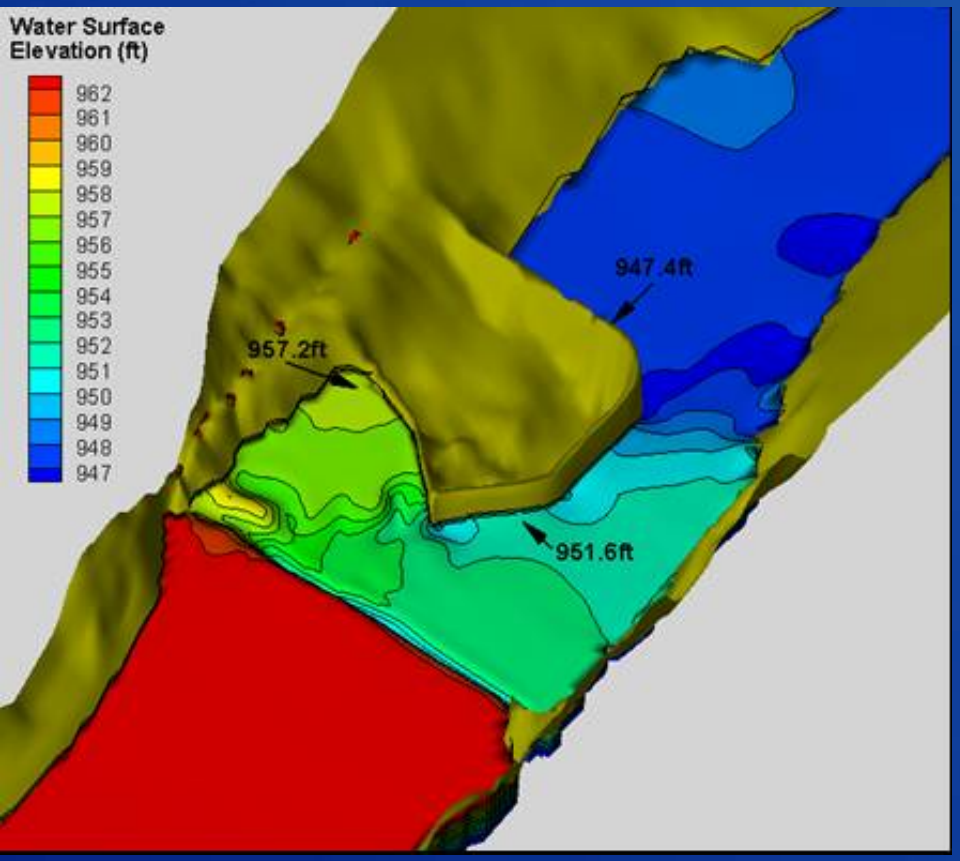
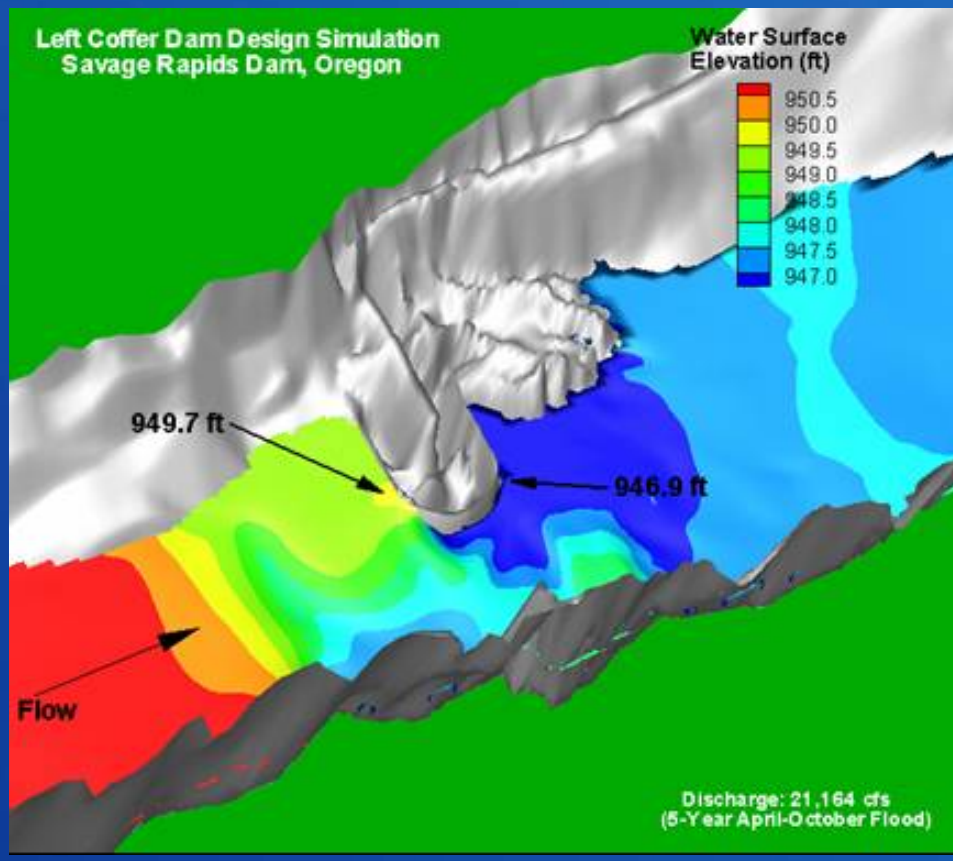
In-Stream Structures
(Weirs, Dams, Gates, Cofferdams, Levees …)





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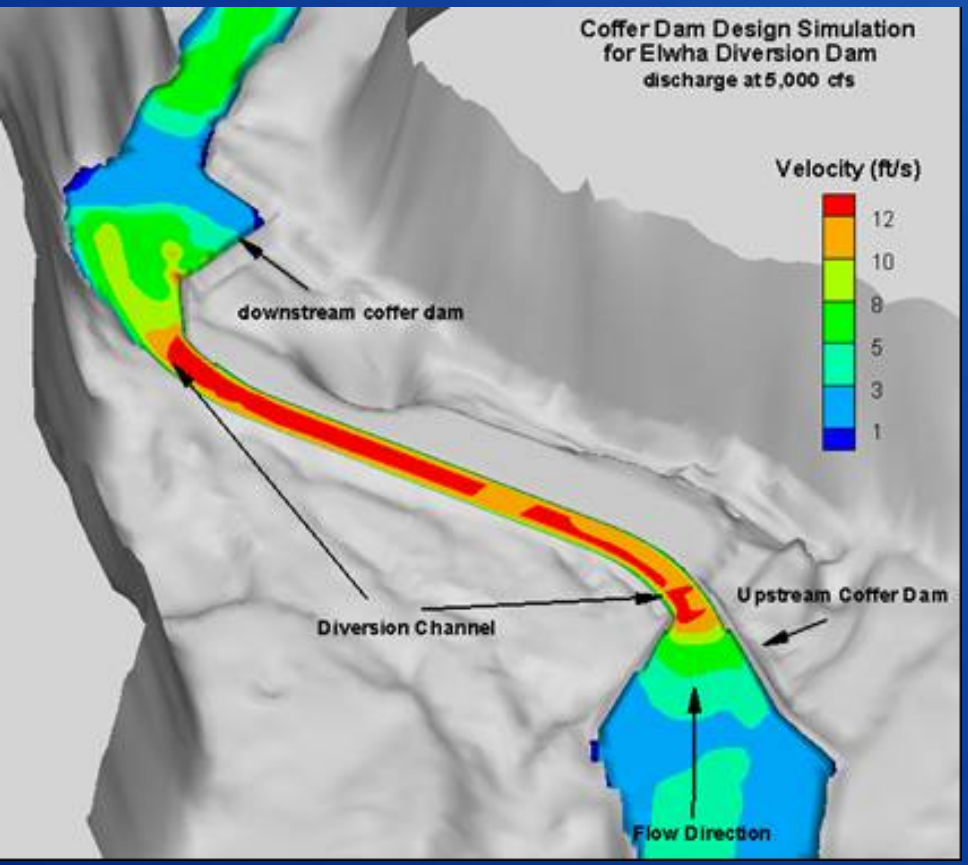
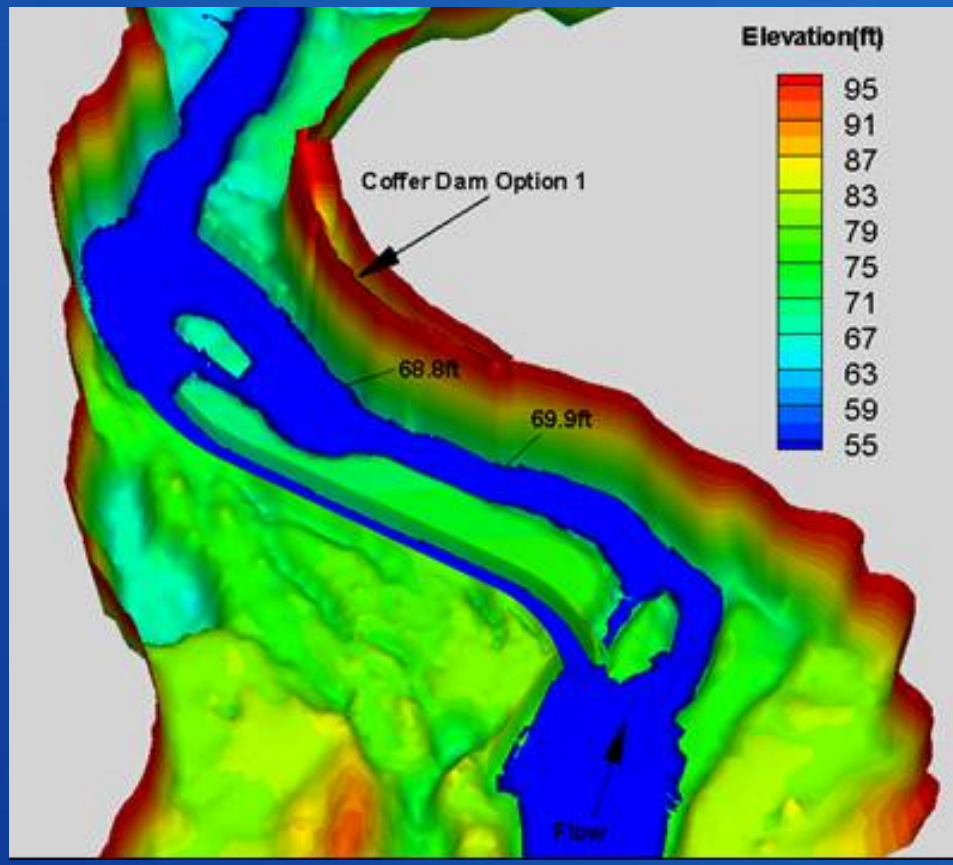
Perched or Multiple Channels





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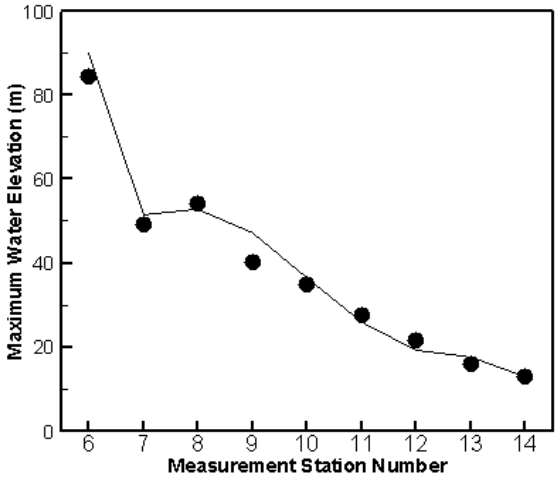
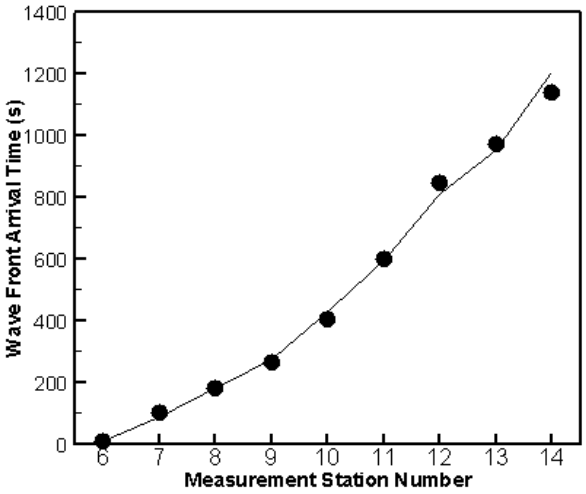
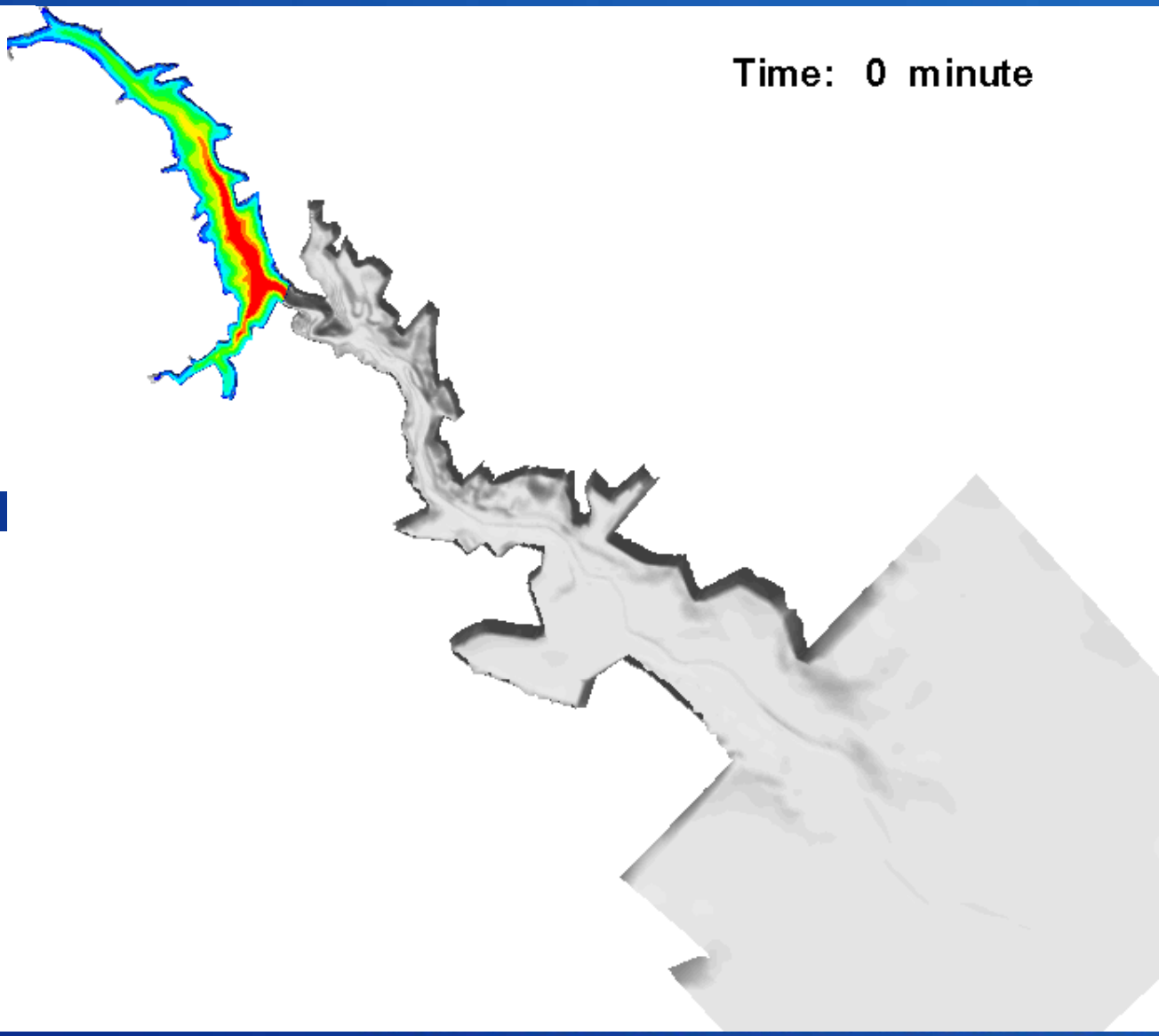
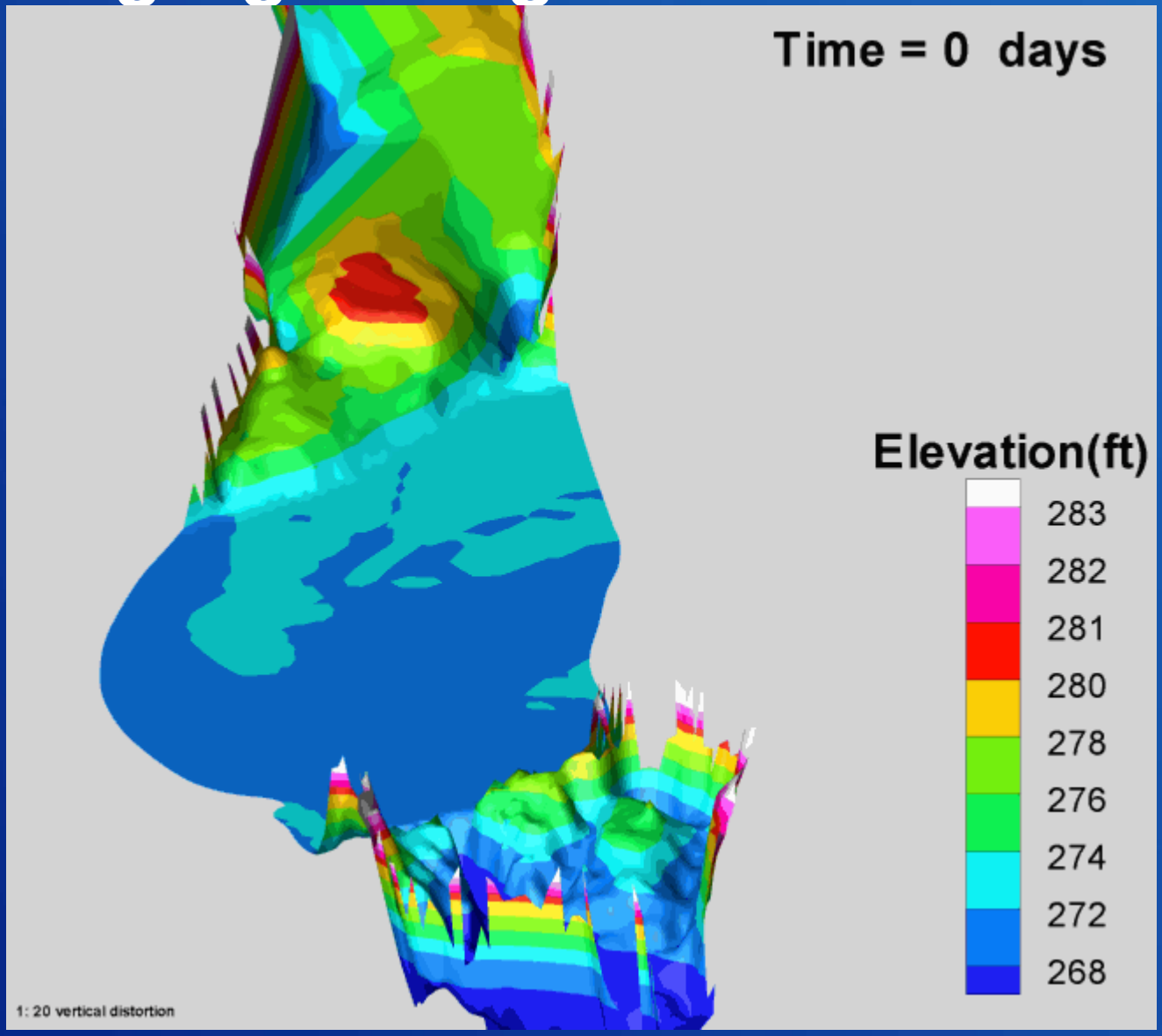
Malpasset Dam Break Modeling







Is Dredging Going to Work ?



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Copco 1 Modeling

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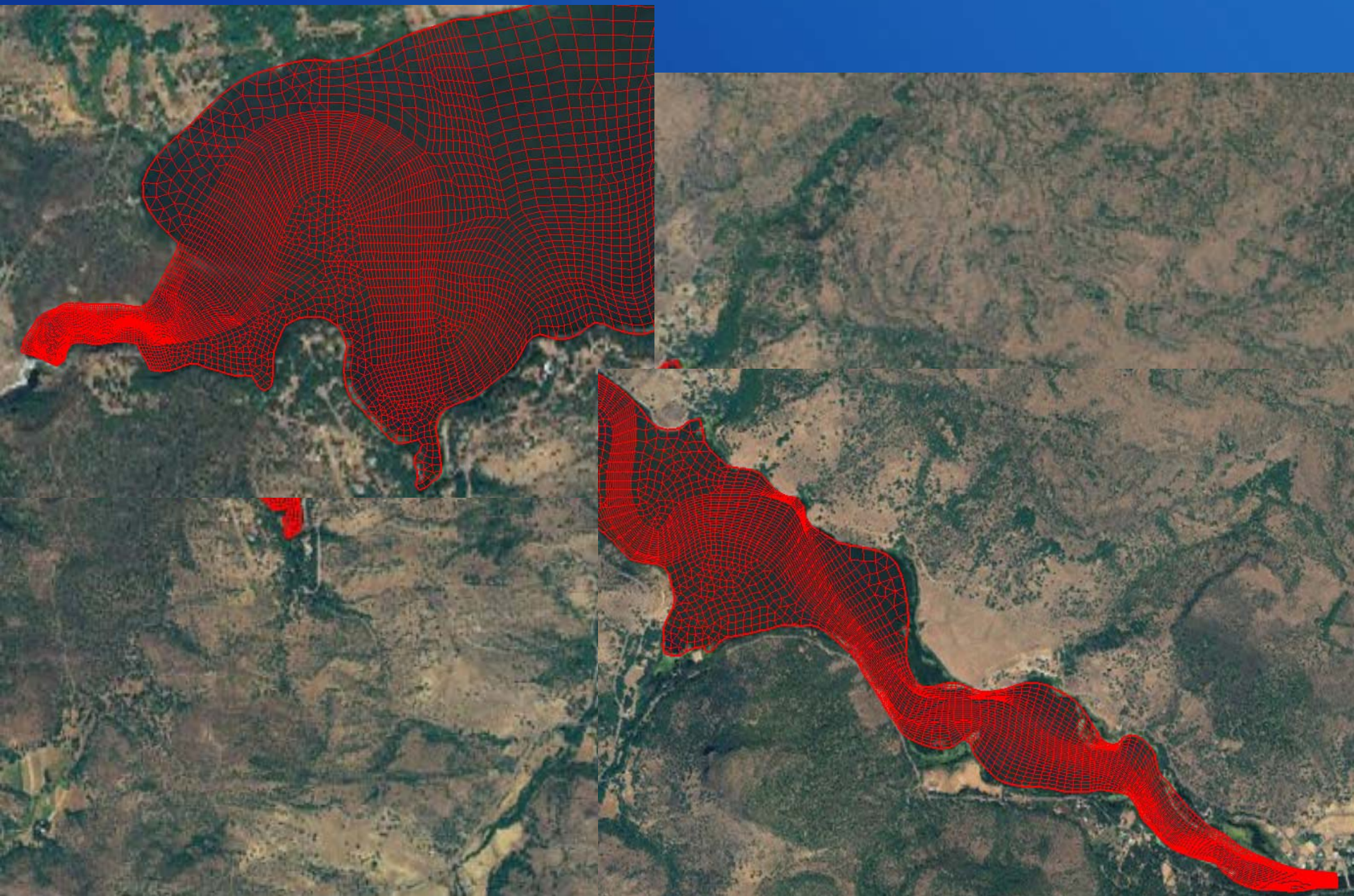
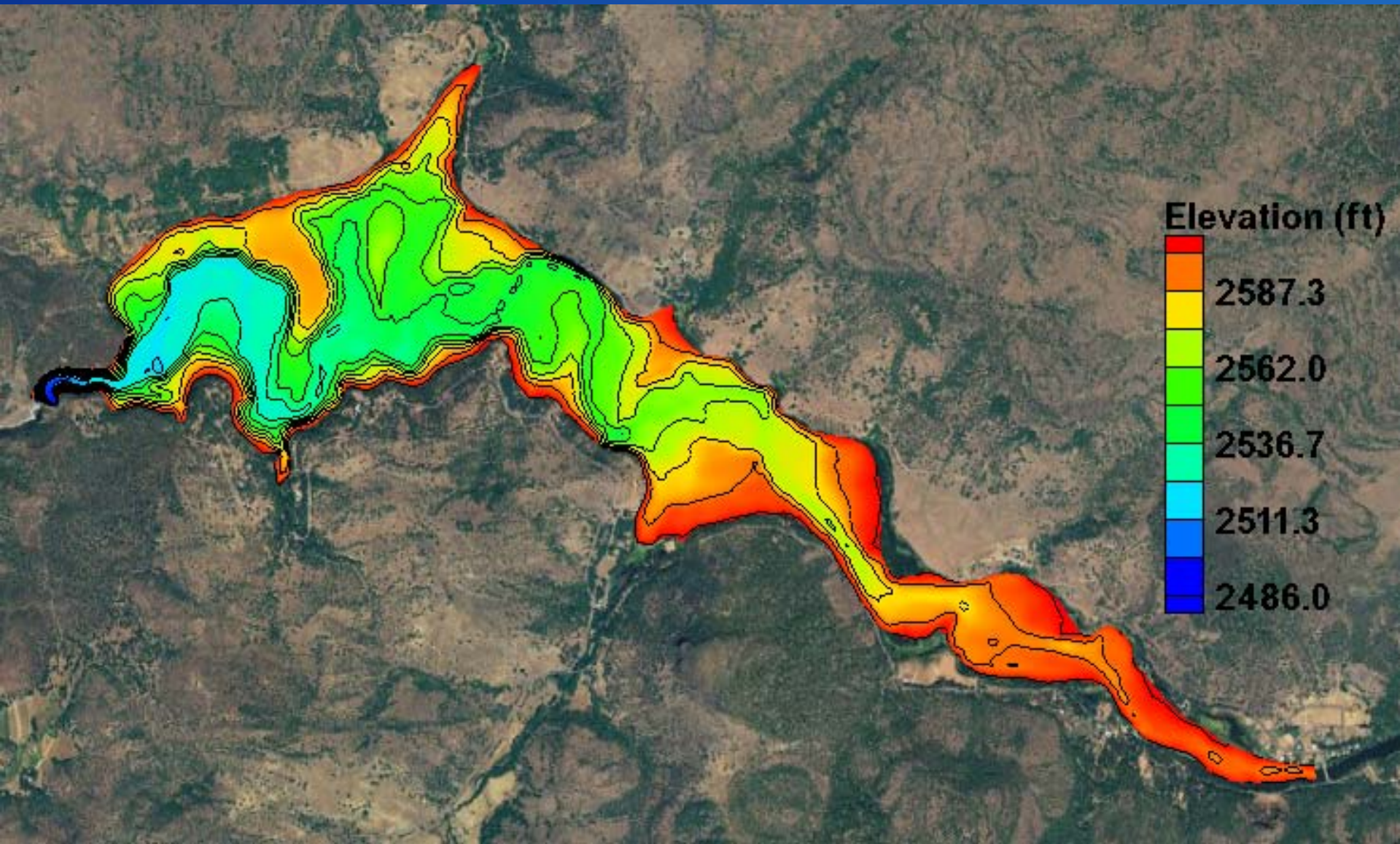
Solution Domain (~ 4 miles)

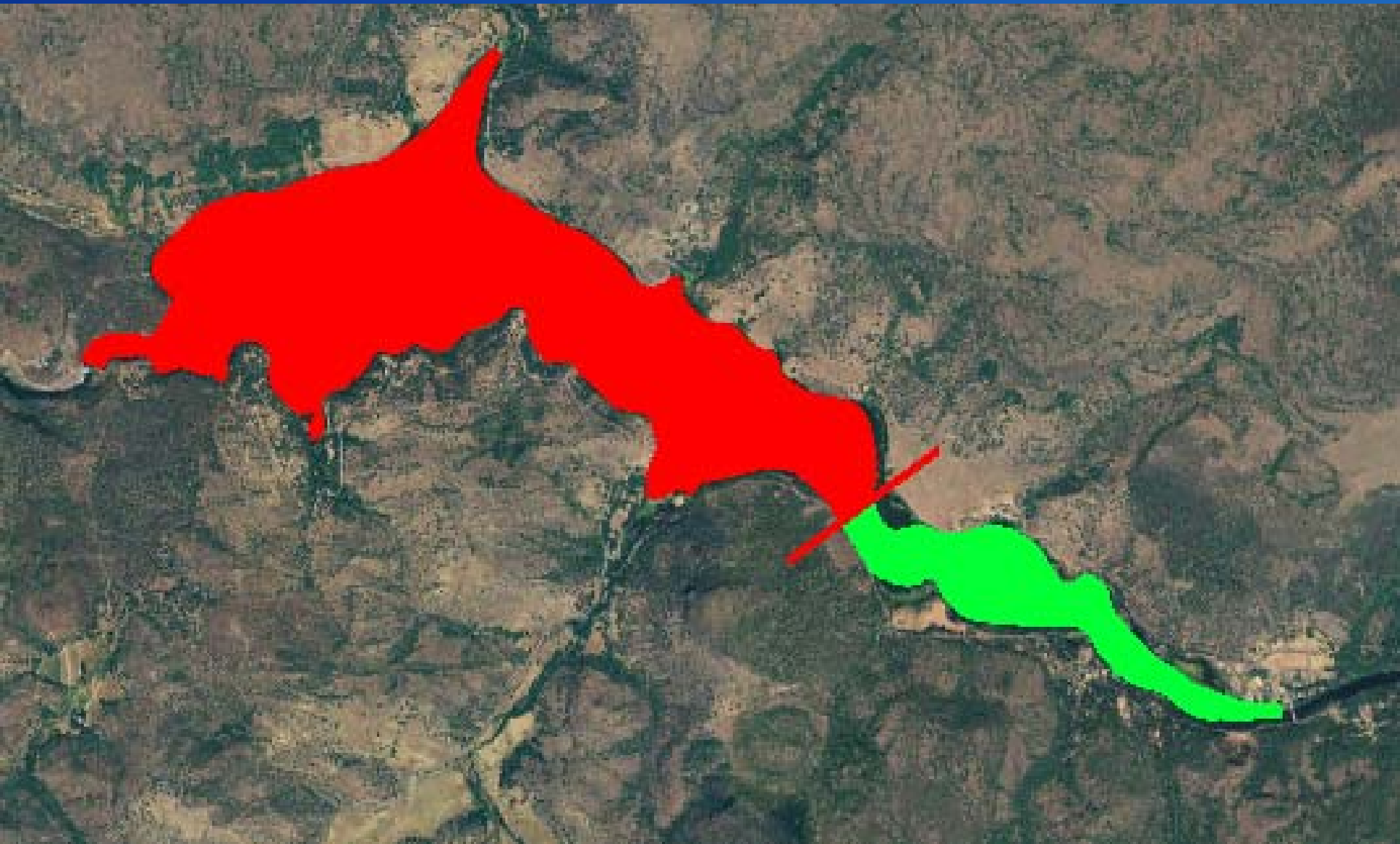
Mesh: Mixed Quad & Triangles



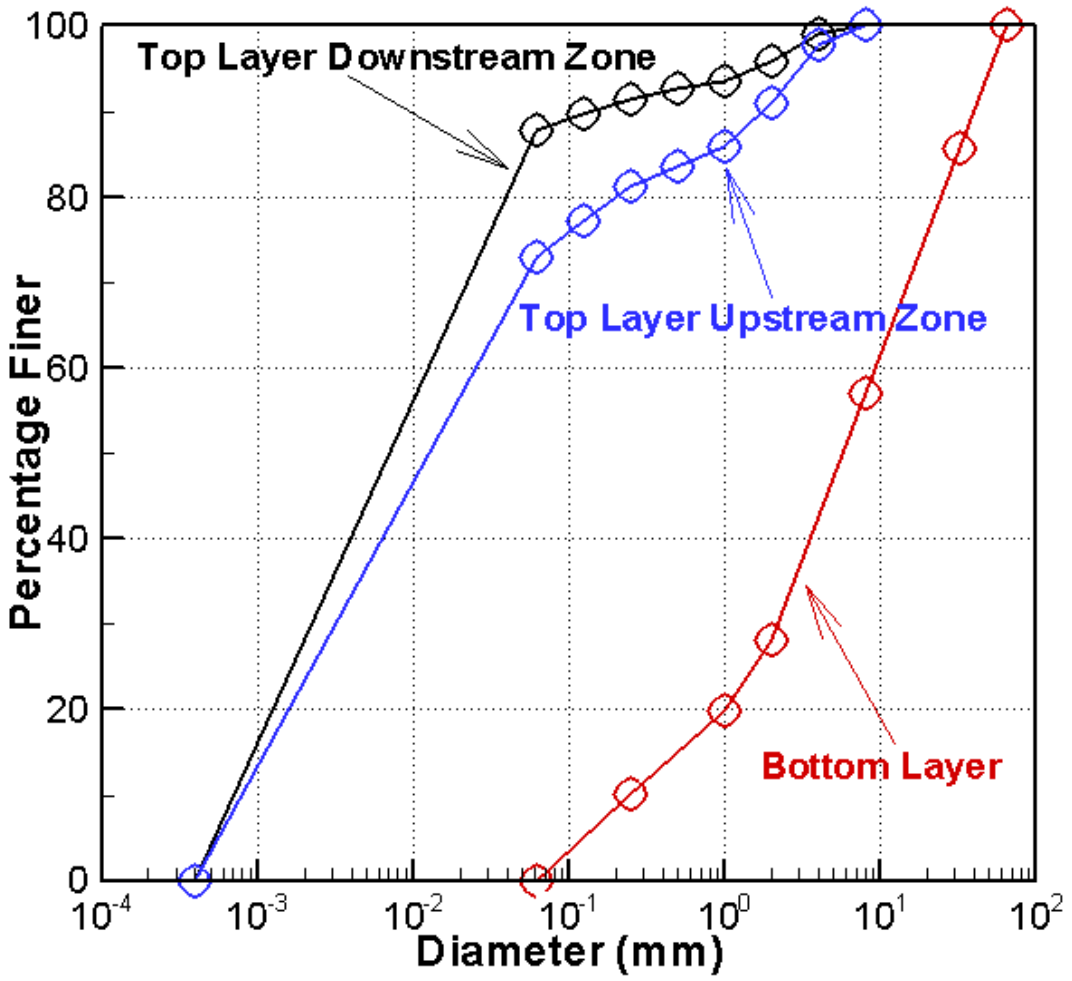
Current Topo/Bathymetry
(Survey Data)



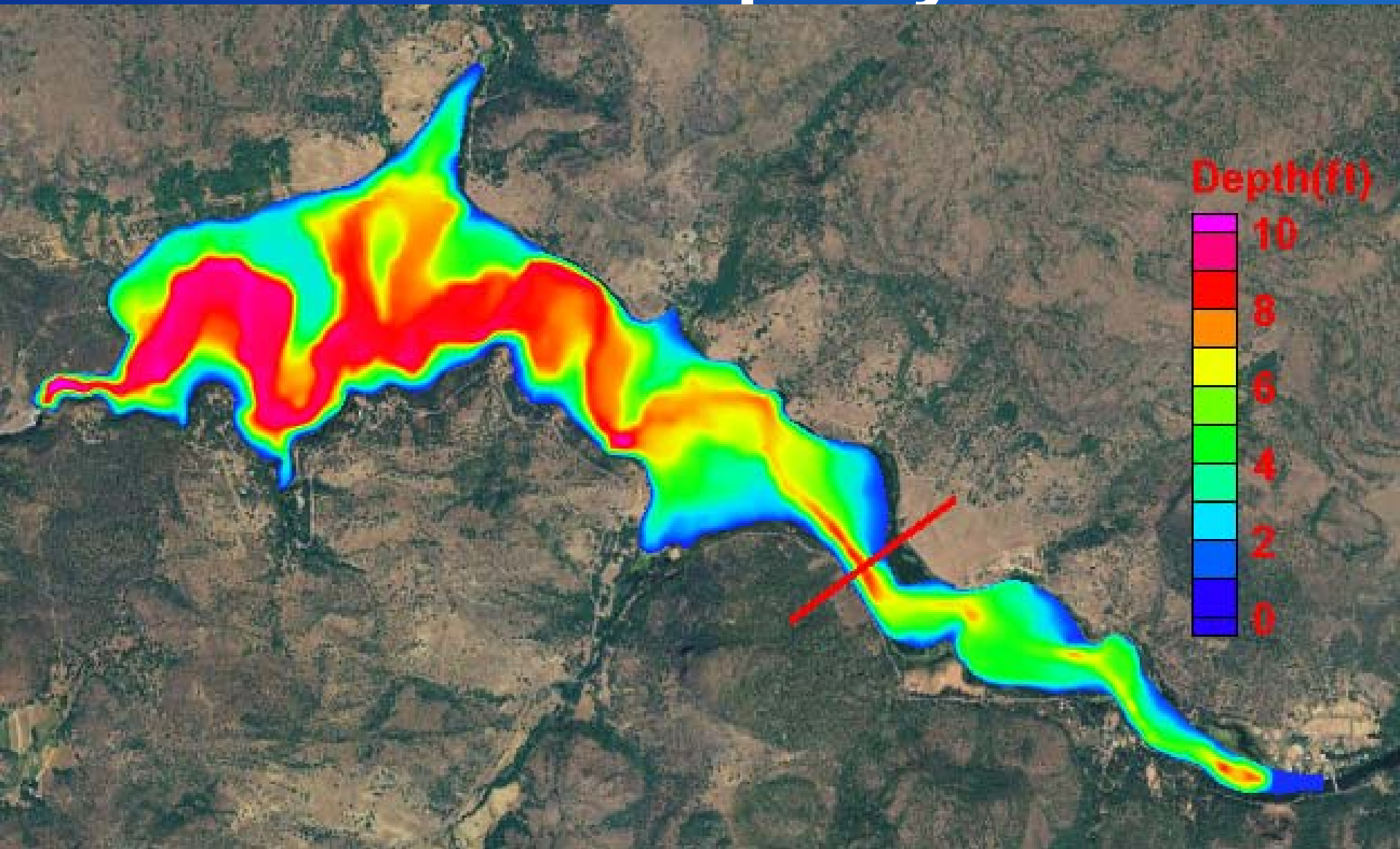
Subsurface Sediments
(Two Zones Horizontally)



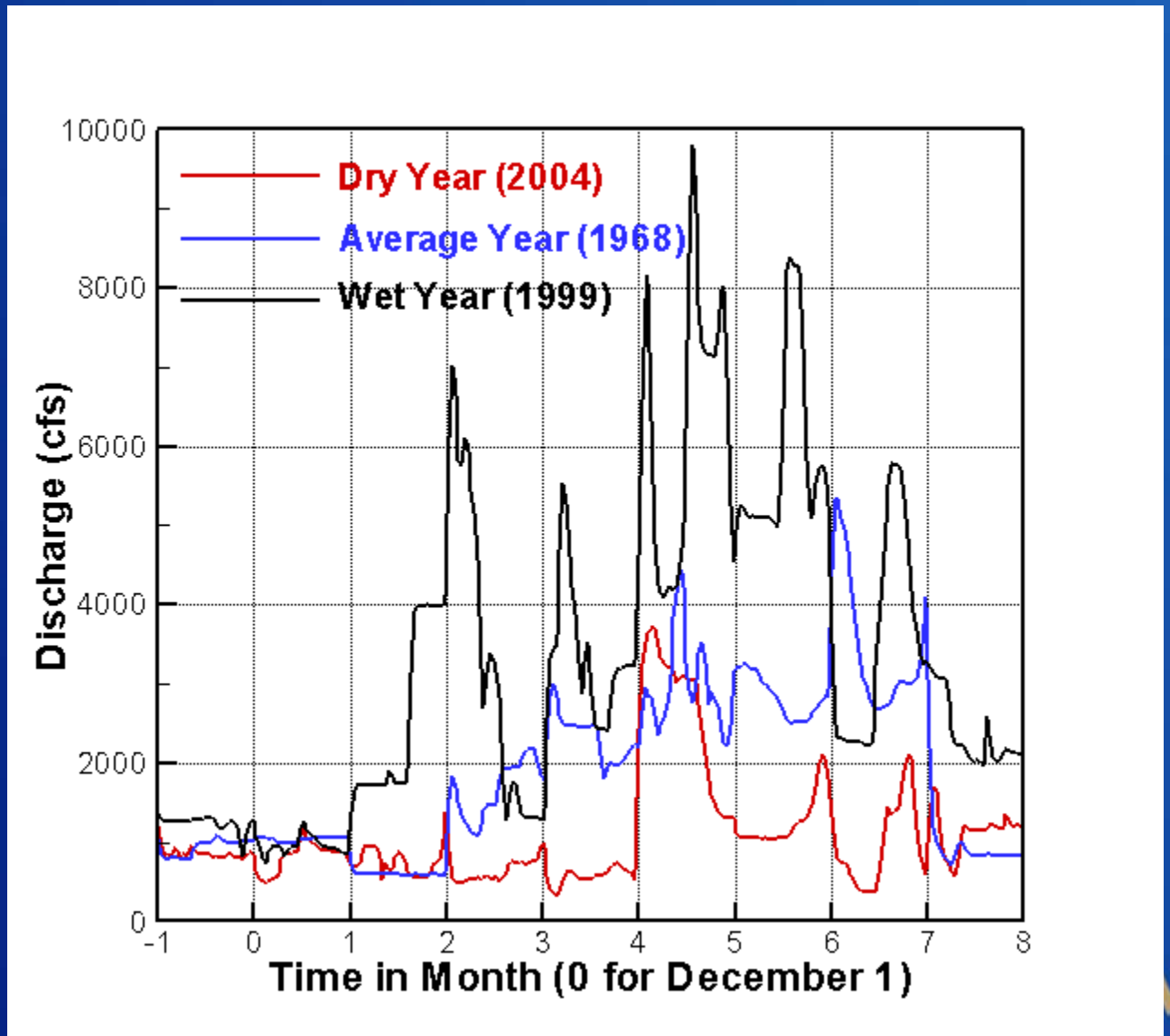
Subsurface Gradations: Two-Layers Vertically



Subsurface Sediments: Thickness of Top Layer



Hydrology: Three Scenarios
(Start on November 15; duration is six month



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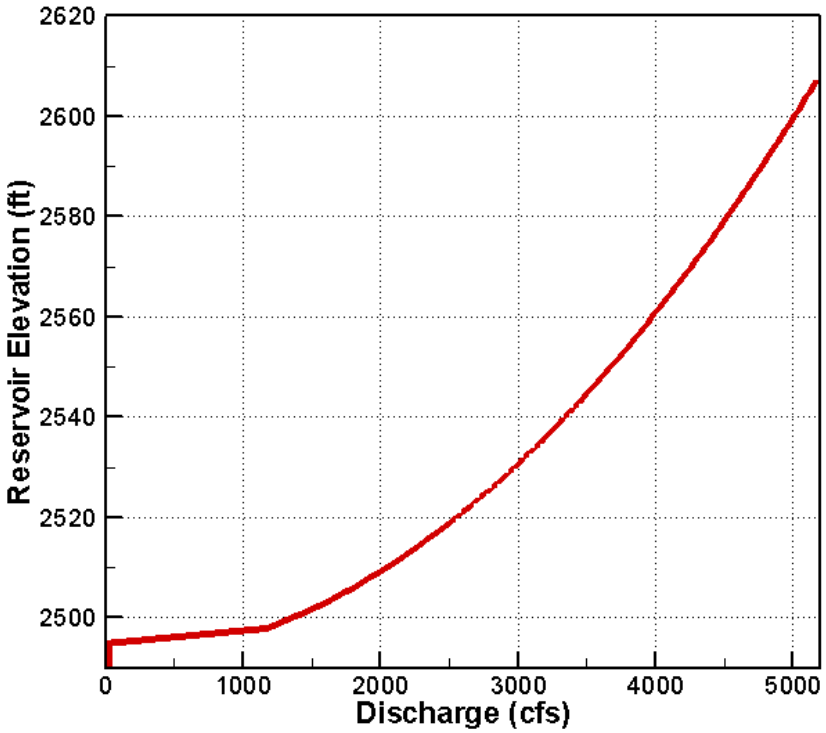
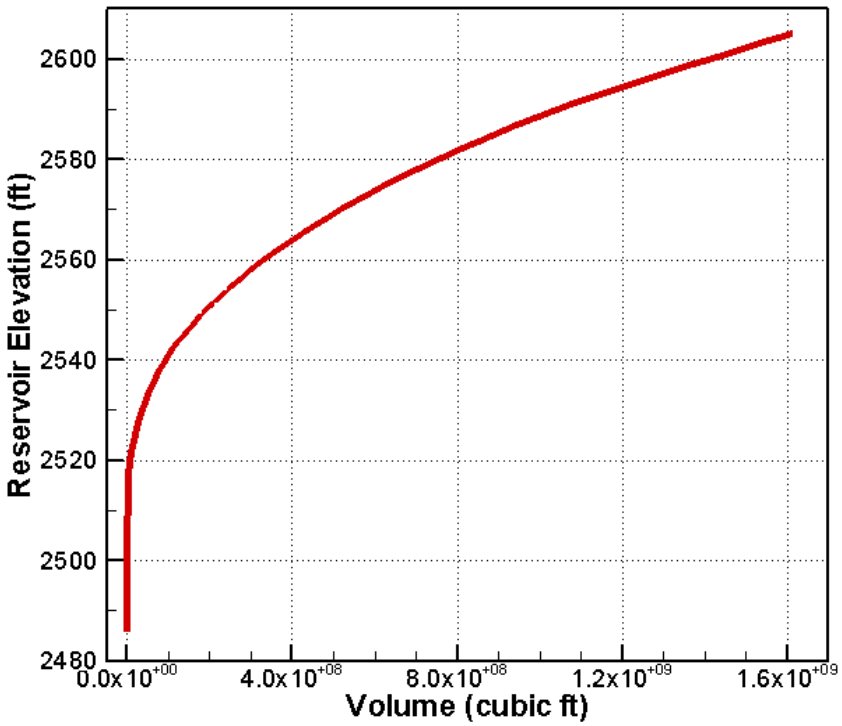
Initial Condition

Reservation Elevation = 2603 ft
Maximum Drawdown rate = 3 ft/day

Discharge Capacity



Storage Capacity



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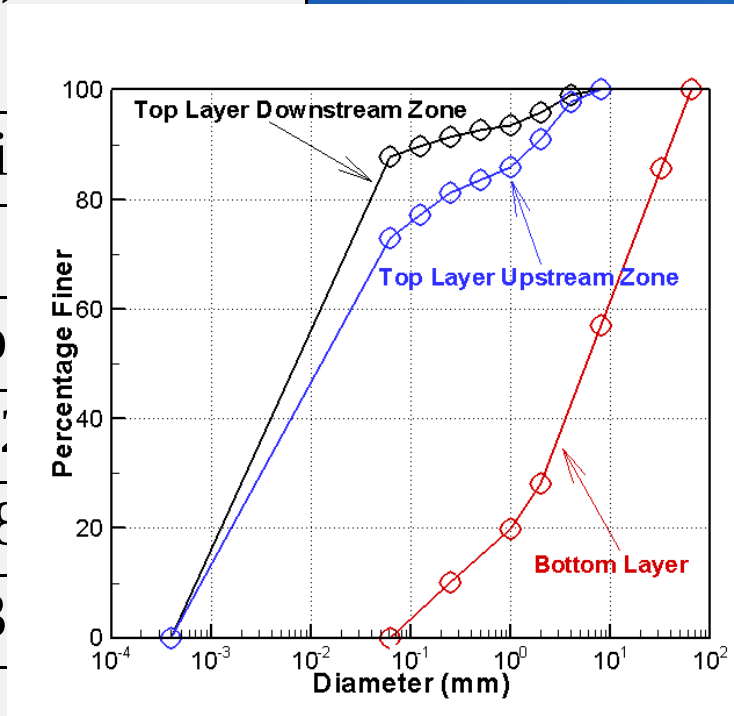
Sediment Size Classes

Sediment Size Class	(mm)
1	Cohesi
2	.0625 to
3	.125 to
4	.5 to
5	2 to 8
6	8 to 3
7	32 to 12



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Cohesive Sediment Properties

$$\frac{\partial hC}{\partial t}+\frac{\partial \cos(\alpha)V_t hC}{\partial x}+\frac{\partial \sin(\alpha)V_t hC}{\partial y}=S_E$$

$$S_E = V_e\ p_k - V_d\ C$$

$$V_e = k(\tau_b - \tau_{cri})$$

Field Test of Cohesion by ARS:

$$k(cm^3 / N - s) = 0.5, 2.0, 20.0$$

$$\tau_{cri}(Pa) = 0.2, 0.25, 2.0$$

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Sample Results

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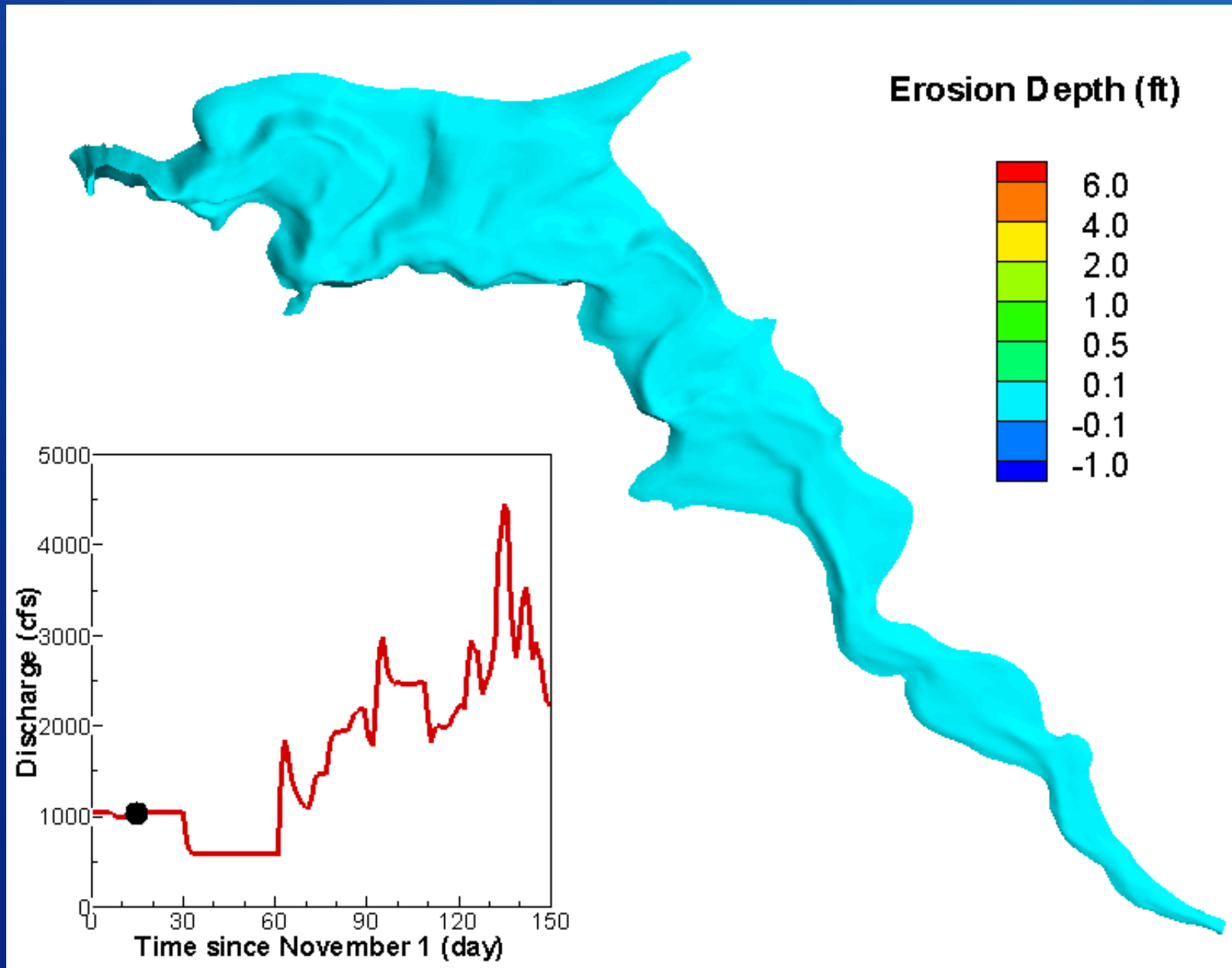
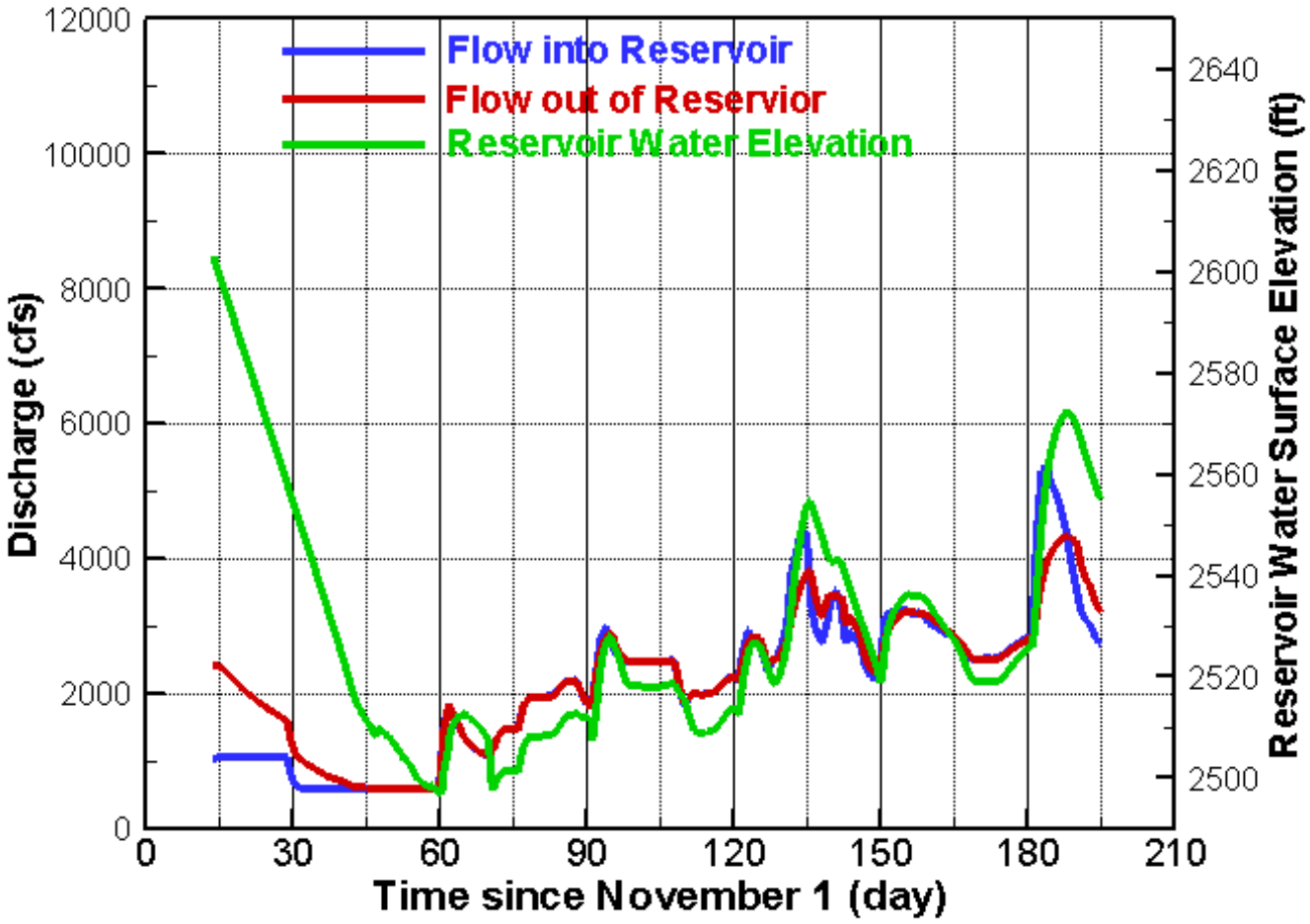
Typical Channel Incision through Reservoir Sediments due to Reservoir Drawn-Down (Paonia Reservoir in Colorado)

Predicted Incision



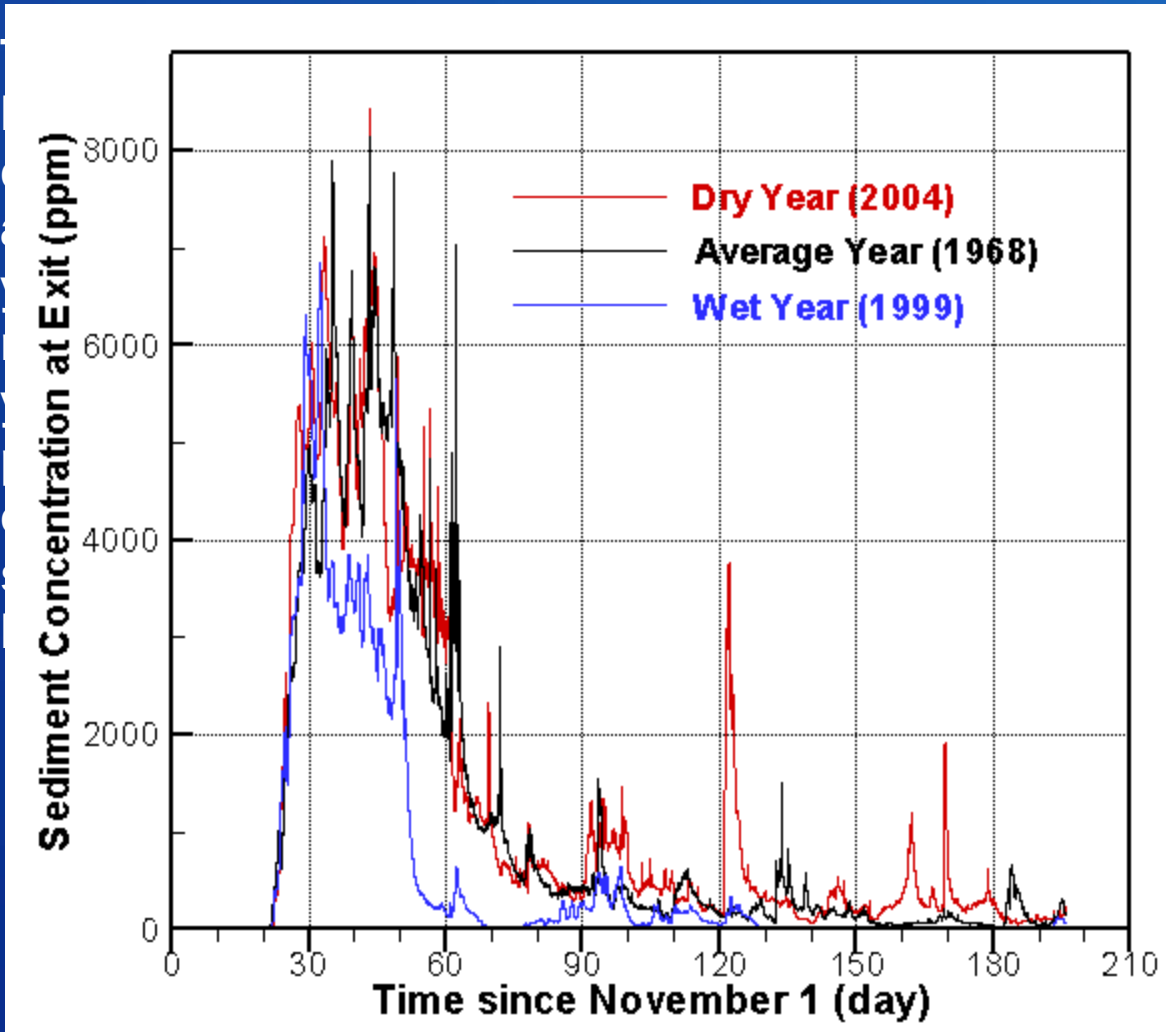
Predicted Reservoir Water Elevation and Flow Exiting the Reservoir

(average year; medium-erode)

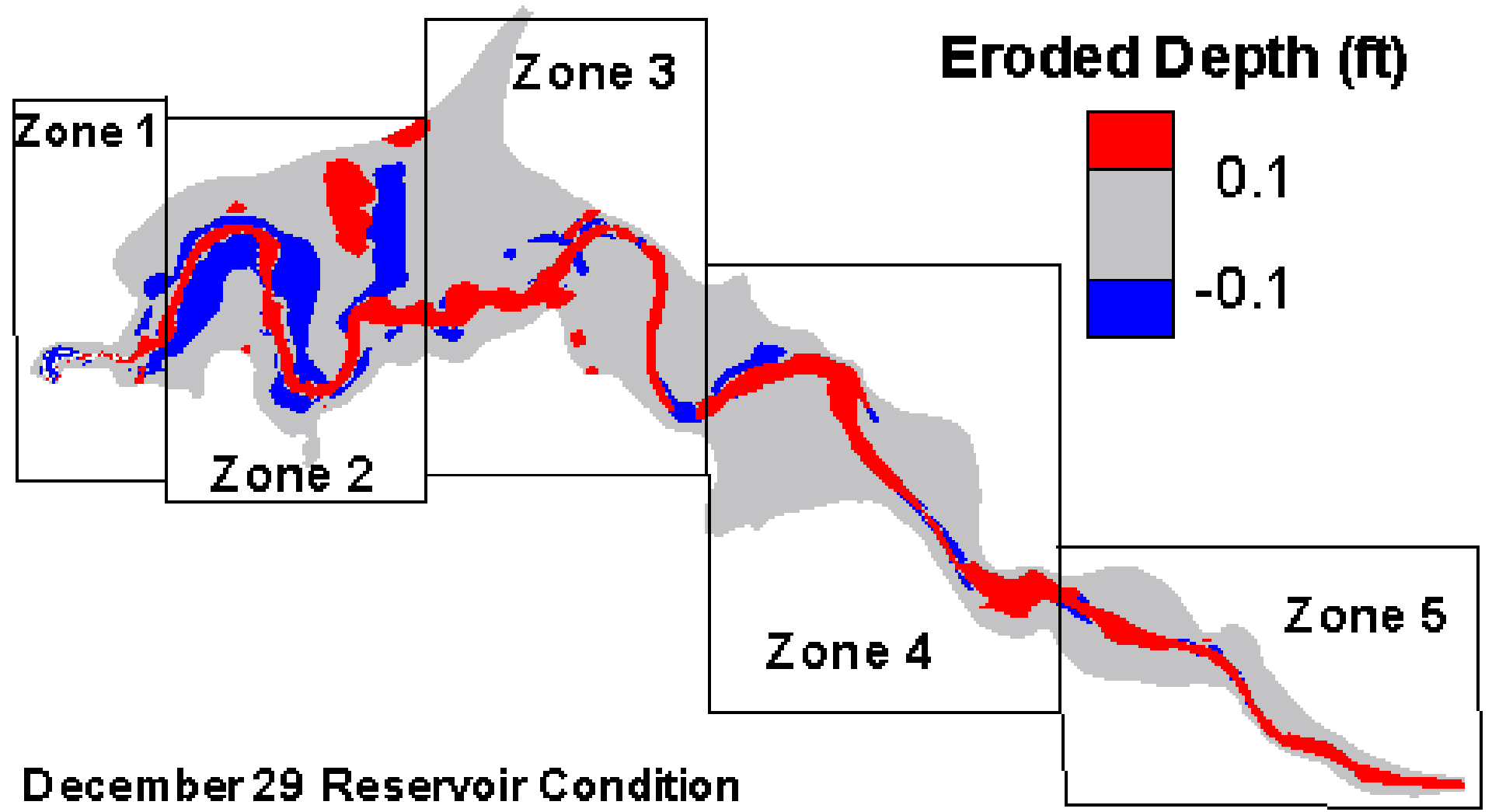


Sediment Concentration Delivered to Downstream

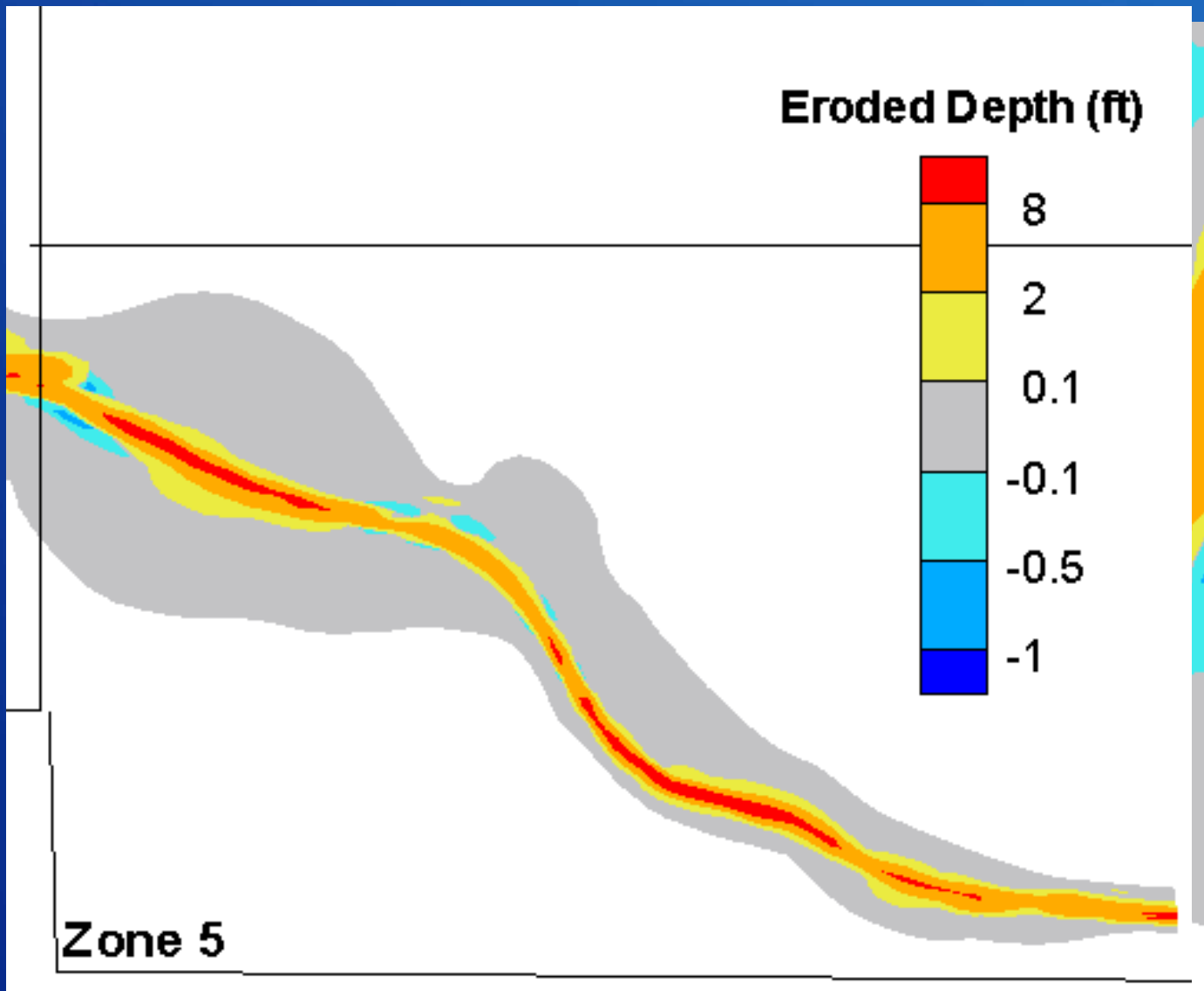
~ 6,000 ppm; duration=1.5 months



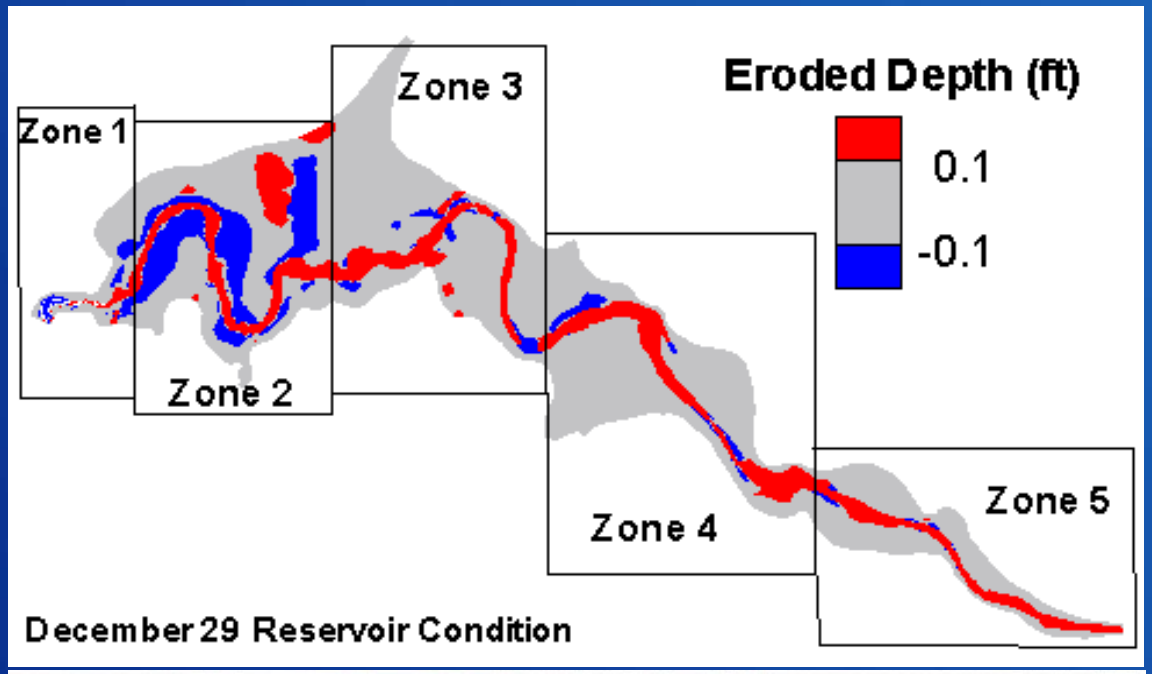
Erosion/Deposition Pattern
(average year)

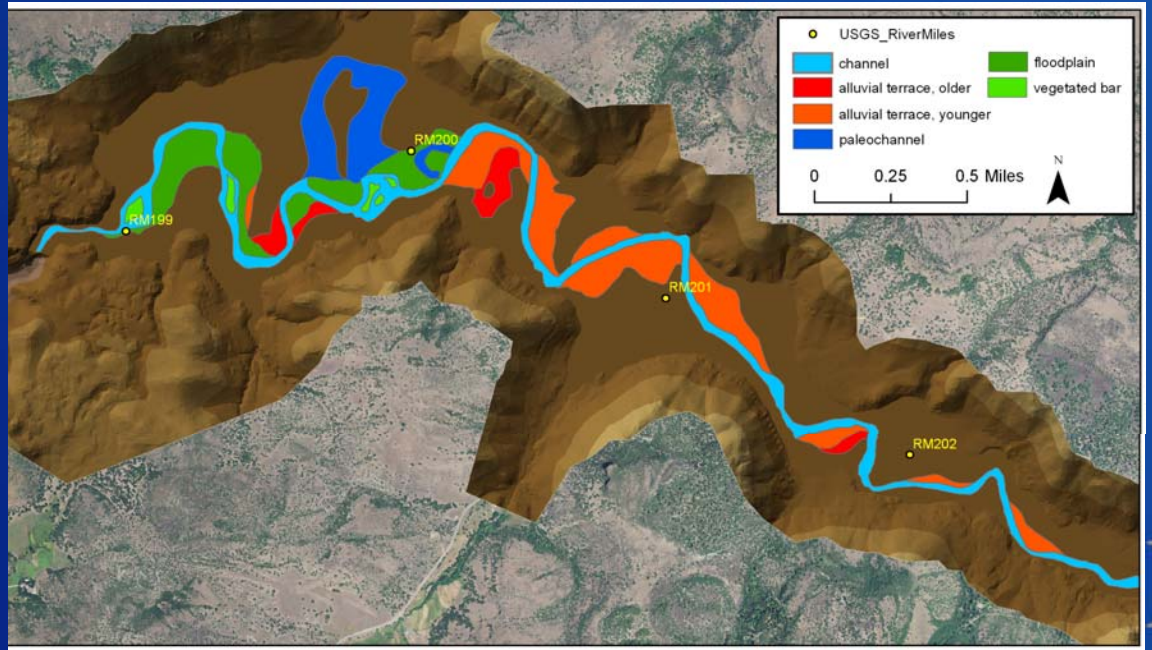


Erosion/Deposition Pattern: Zonal View (average year)



Comparison with Pre-Dam Geomorphology





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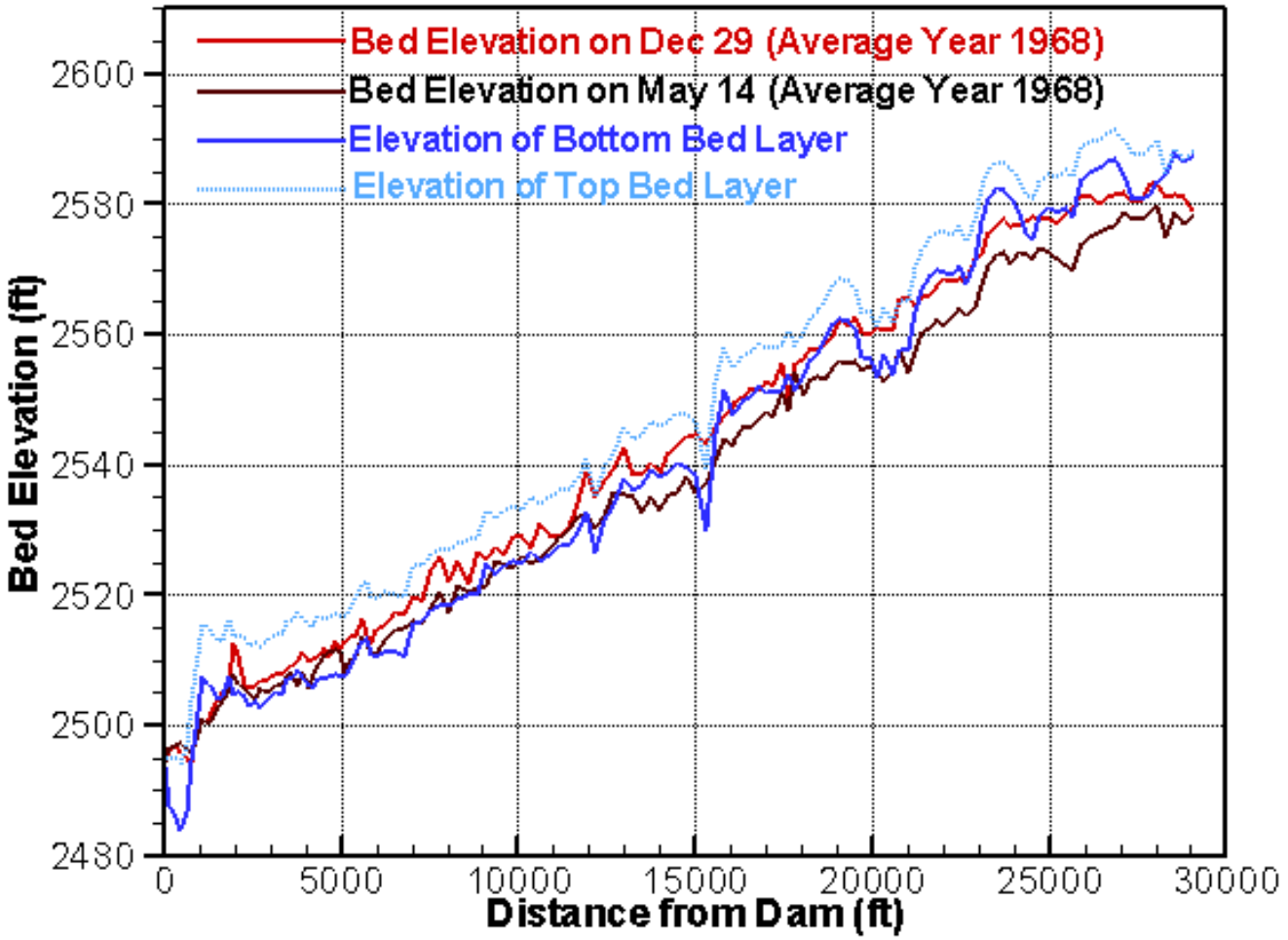
Predicted Bed Elevation along Thalweg (average year)



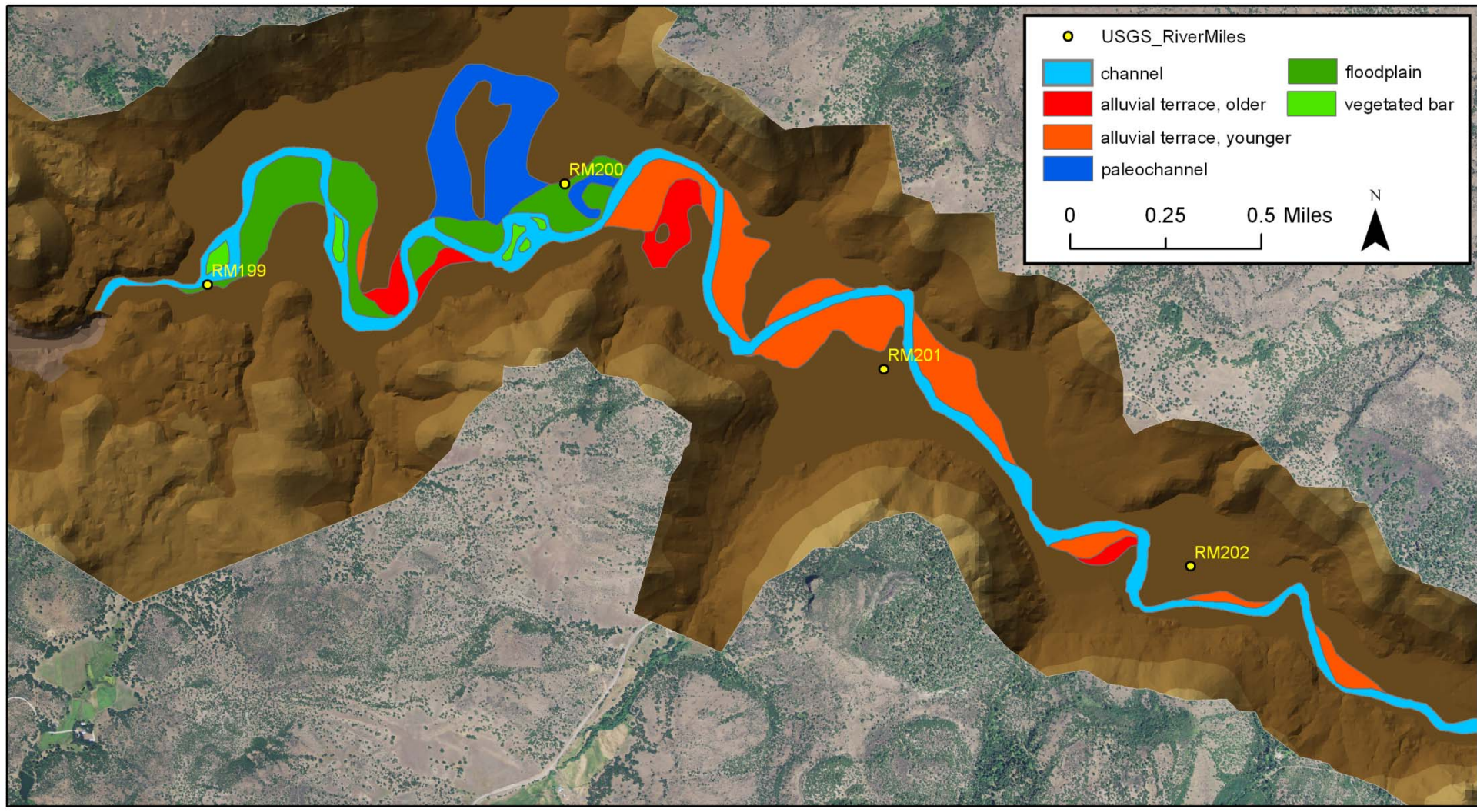
Conclusions

- An incised channel would be formed as a result of the drawdown.
- Majority of the deposits would be eroded during the 1.5-month drawdown, particularly for the upstream half of the solution domain.
- About 6,000 ppm concentration for 1.5 months would be released downstream.
- Some deposition is predicted on the old floodplains in the lower half of the modeled domain.

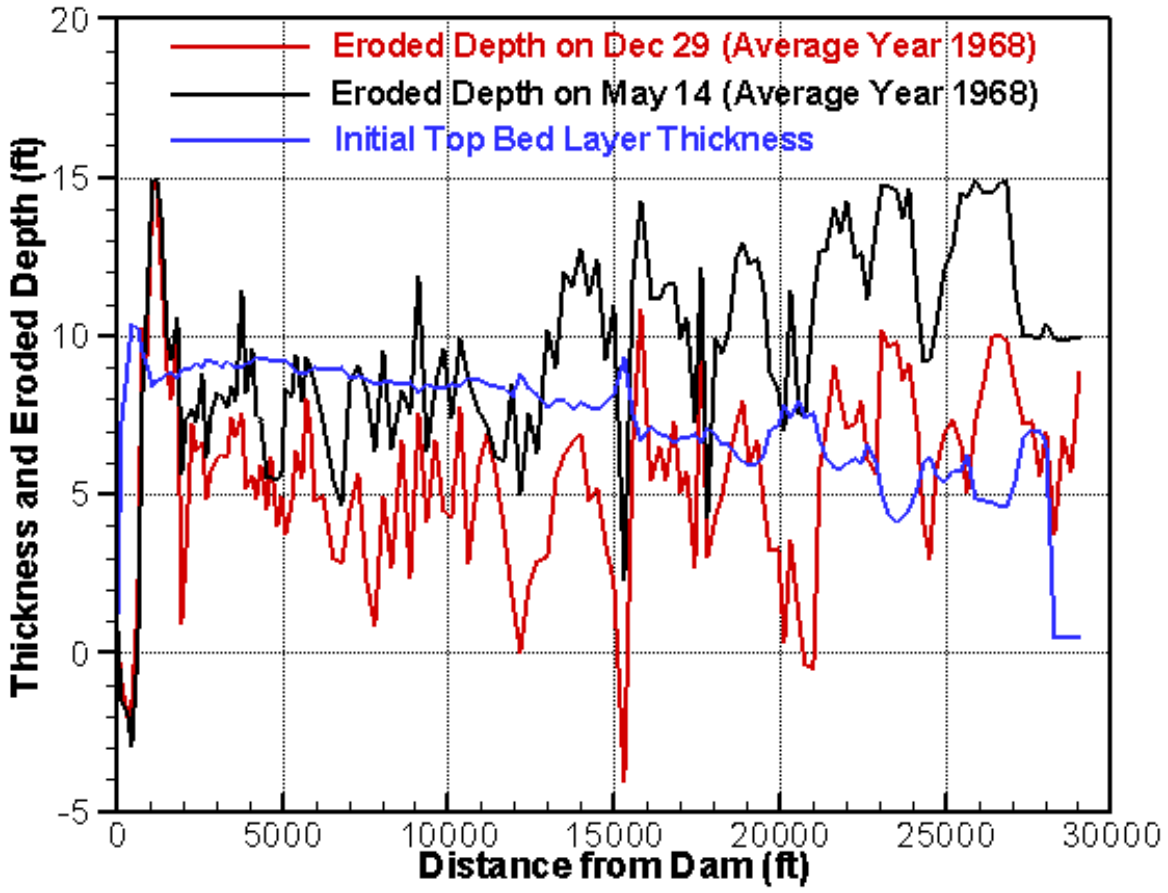

THANK YOU
QUESTIONS ?
5 10:37AM

Geomorphic Map of Copco Reservoir

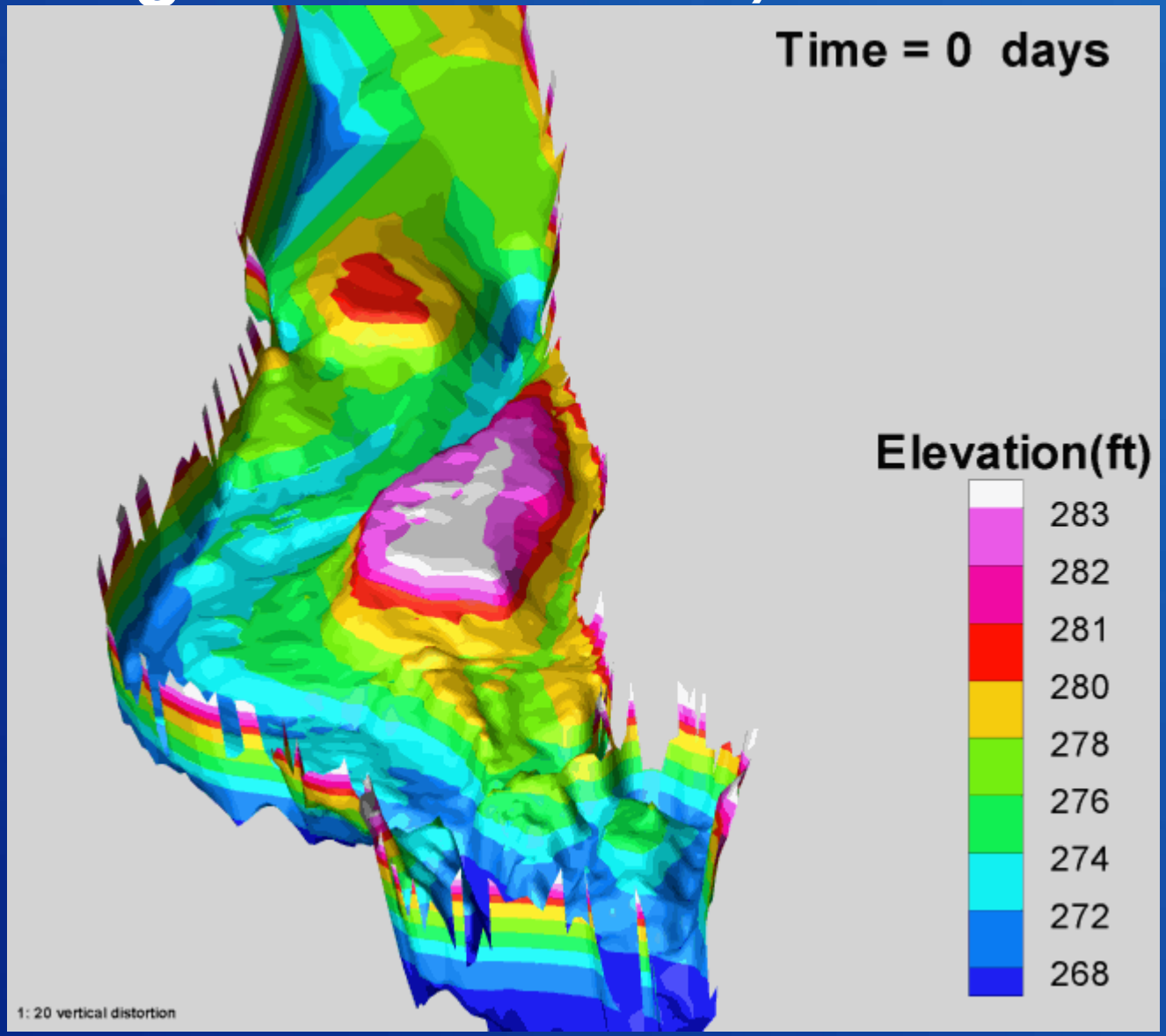
Pre-dam geomorphology was interpreted using historical topographic maps



Eroded Depth along Thalweg Compared with Initial Top Layer Thickness (average year)



Existing Condition: 19,000 cfs



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Bed Elevation Profile