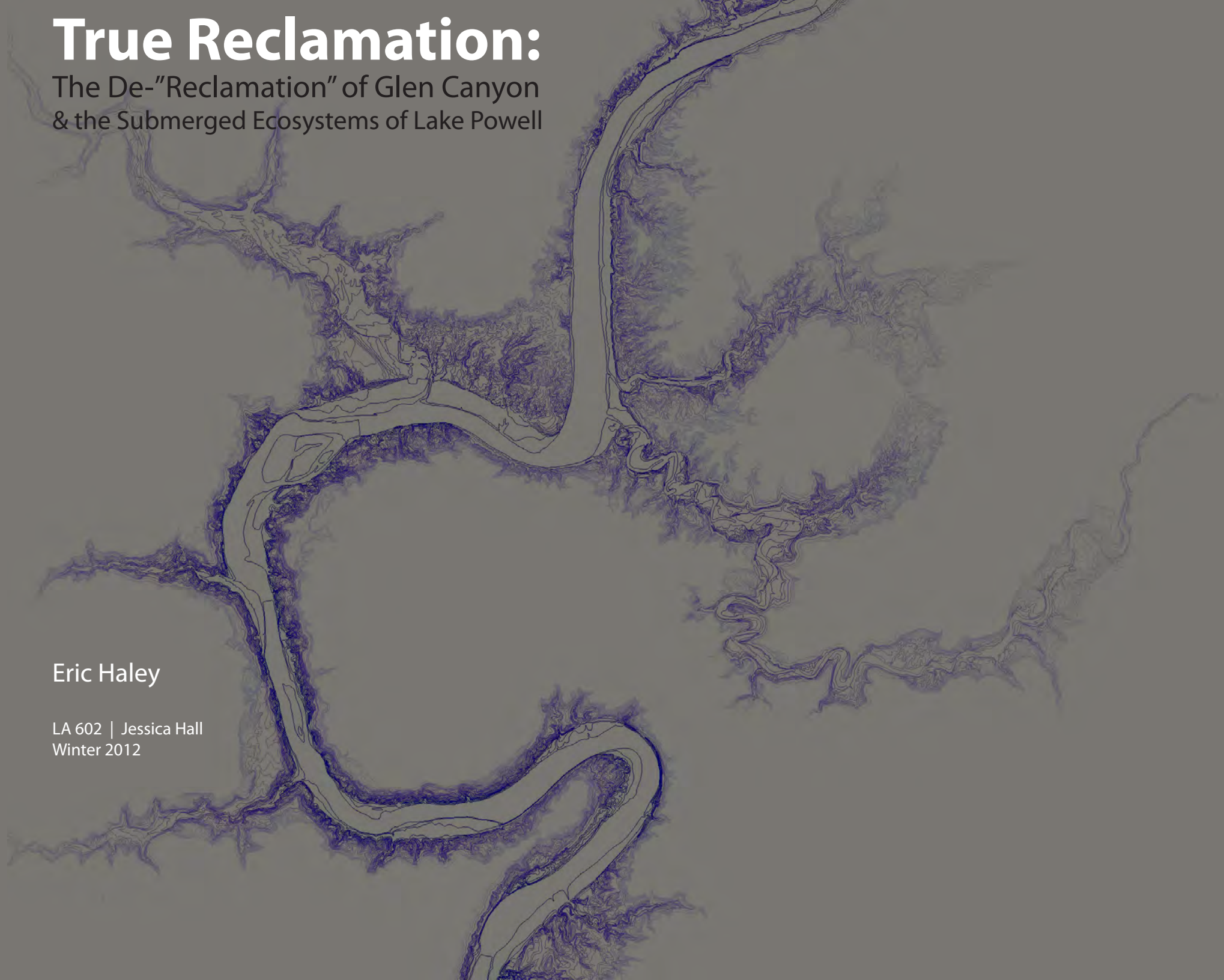
True Reclamation:

The De-"Reclamation" of Glen Canyon
& the Submerged Ecosystems of Lake Powell

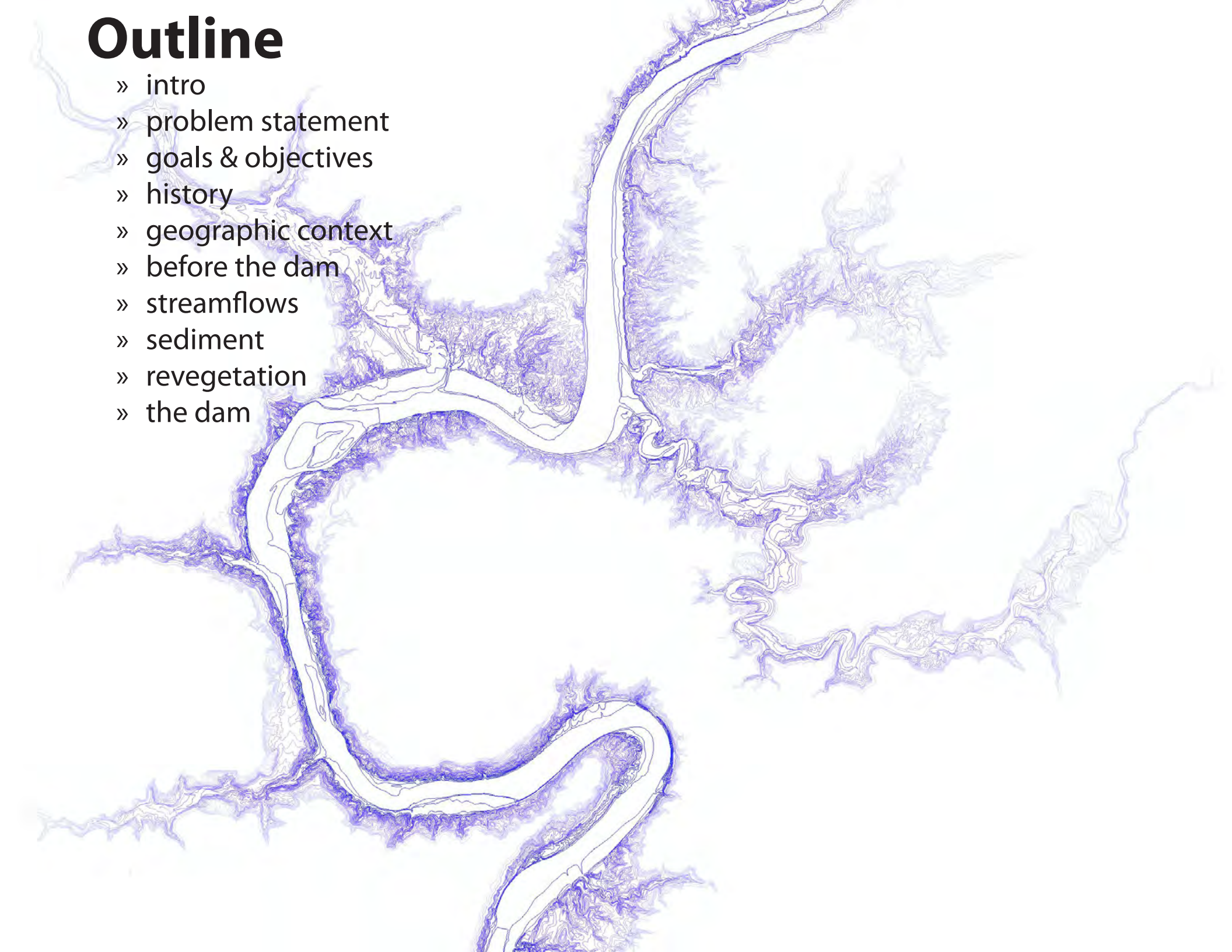


Eric Haley

LA 602 | Jessica Hall
Winter 2012

Outline

- intro
- problem statement
- goals & objectives
- history
- geographic context
- before the dam
- streamflows
- sediment
- revegetation
- the dam



True Reclamation:

The De-"Reclamation" of Glen Canyon & the Submerged Ecosystems of Lake Powell

(Cathedral in the Desert rmrv.com)

(Lake Powell low levels in 2005 NRDC)

(Glen Canyon Dam simulated flood, 2008 Bureau of Reclamation)

Problem statement:

Glen Canyon Dam and its reservoir, 186 mile long **Lake Powell**, are harmful and unnecessary relics of a past paradigm in water management in the west. **Sediment** impoundment, an artificial **flow** regime with drastically reduced **flood** events and **daily fluctuations**, **cold temperatures** of released water, water loss to **evaporation and seepage**, and the inundation of **archaeological and natural wonders**, are all factors that point to the importance of the removal of Glen Canyon Dam and the draining of Lake Powell. However, **pollution** that has accumulated in the lakebed sediment over the last 50 years, requires more than just removal of the dam to repair the **flooded ecosystems** and those downstream in the **Grand Canyon**.

I am proposing a phased phytoremediation to habitat restoration revegetation program in tandem with lake draw-down, as well as incorporation of the existing monumental structure of the dam itself to a new international eco-tourism destination.

Goals:

» Rehabilitate Glen Canyon to a functioning riparian ecosystem
» Maintain or improve contingent social and economic vitality

Objectives:

» Restore predam flows
» Remediate polluted sediment
» Restore native vegetation and habitat
» Improve recreational programming
» Foster ecosystem stewardship

History:

- » Colorado Compact of 1922
- » Lee's Ferry
- » Lower basin: 7.5 million acre-feet/year
  - California, Nevada, Arizona
- » Upper basin: 7.5 million acre-feet/year
  - Wyoming, Utah, Colorado, New Mexico

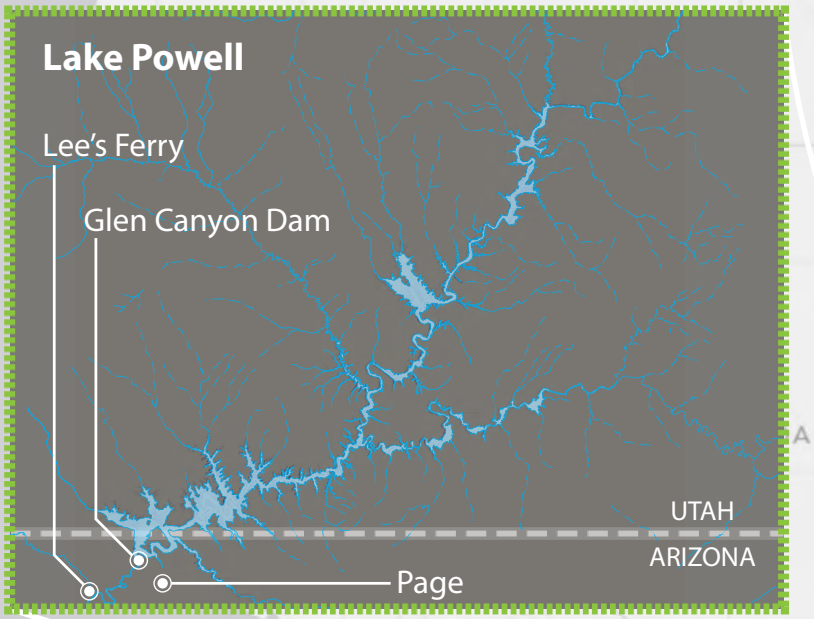
- » Glen Canyon Dam construction:
  1956-1963
- » Lake Powell reaches its crest in 1980

(coffer dam during construction, 1959 explorepdx.com)

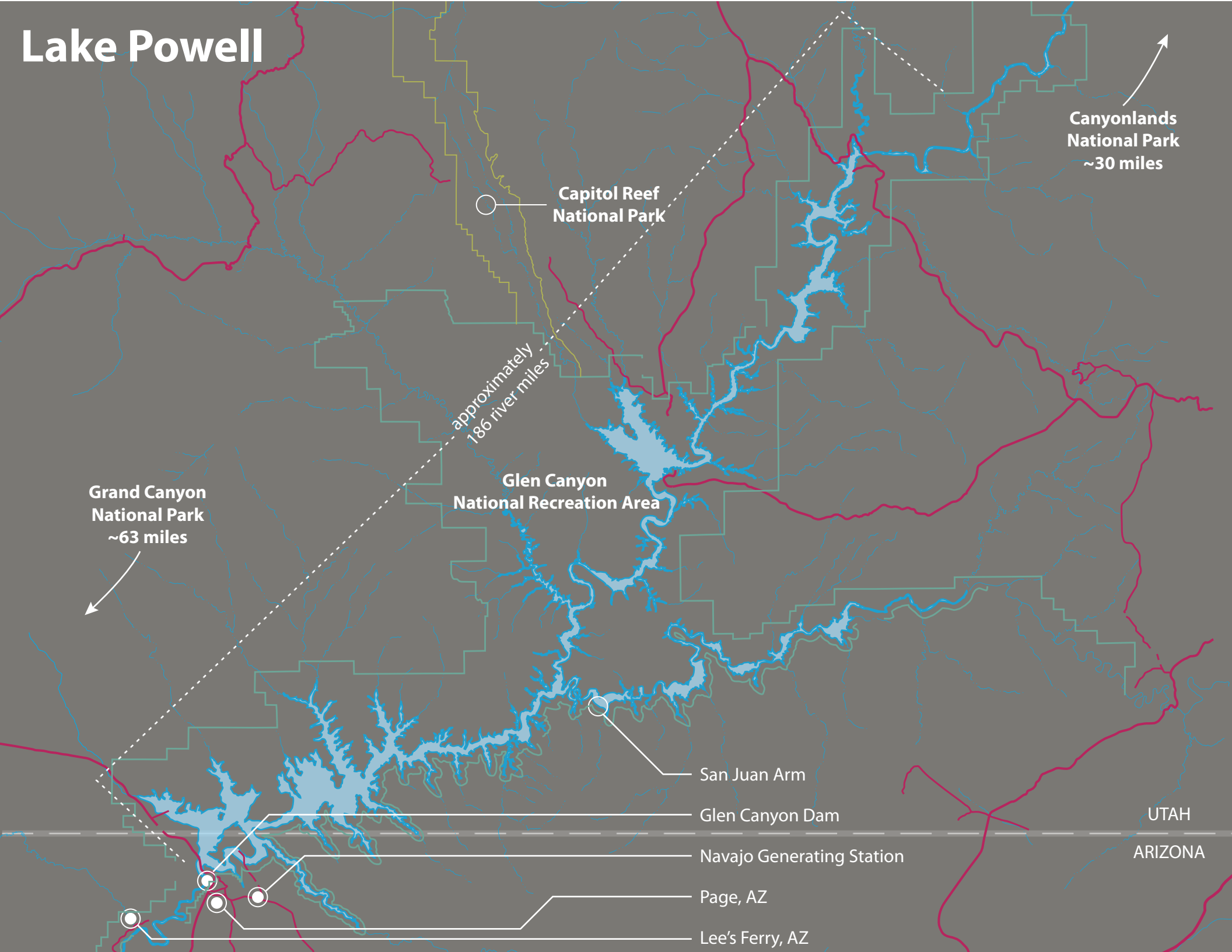
(dam construction, 1963 explorepdx.com)

(back of Glen Canyon Dam during construction, 1963 explorepdx.com)

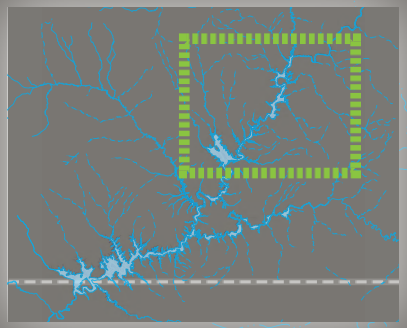
Watershed context



OREGON
WYOMING
U TAH
COLORADO
CALIFORNIA
Las Vegas
Colorado River Watershed
Upper Colorado River Basin
Lower Colorado River Basin
NEW MEXICO
ARIZONA
Los Angeles
Phoenix
Salton Sink
BAJA CALIFORNIA
SONORA


Lake Powell
Canyonlands
National Park
~30 miles
Capitol Reef
National Park
approximately
186 river miles
Glen Canyon
National Recreation Area
Grand Canyon
National Park
~63 miles
San Juan Arm
Glen Canyon Dam
Navajo Generating Station
Page, AZ
Lee's Ferry, AZ
UTAH
ARIZONA

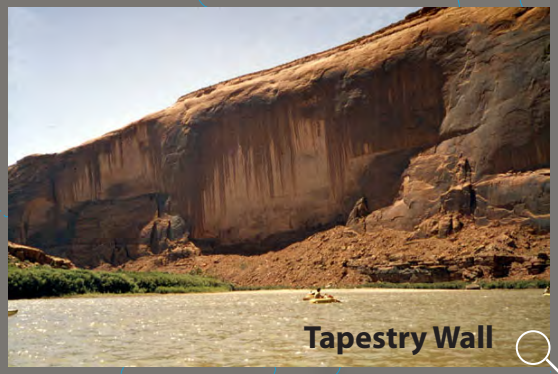
Before the dam
upper reaches

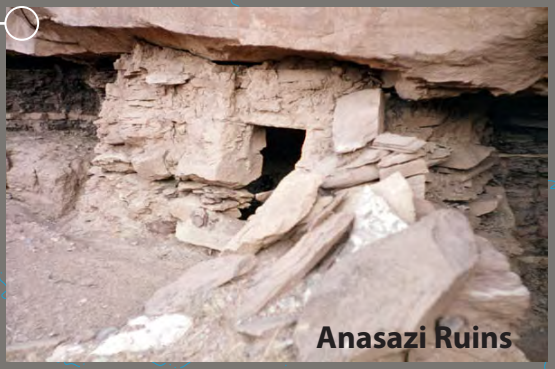



Hite ferry


Cedar Canyon


White Canyon

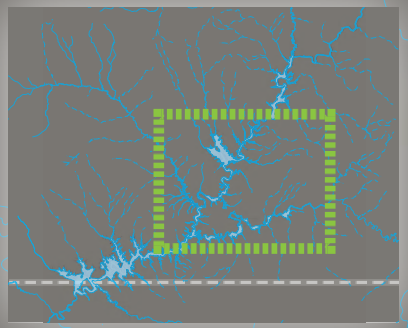

Tapestry Wall

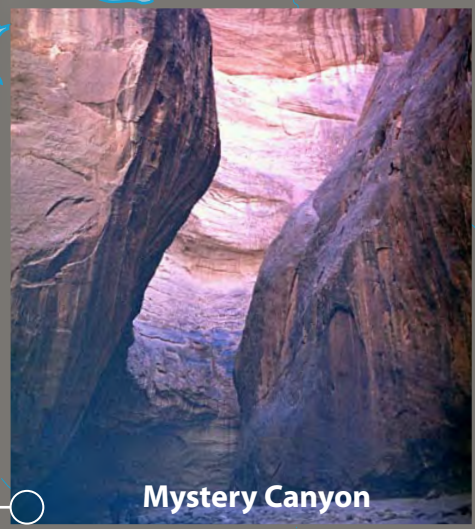

Anasazi Ruins


The Horn

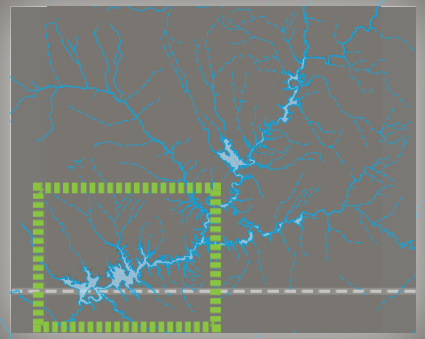

Anasazi Ruins

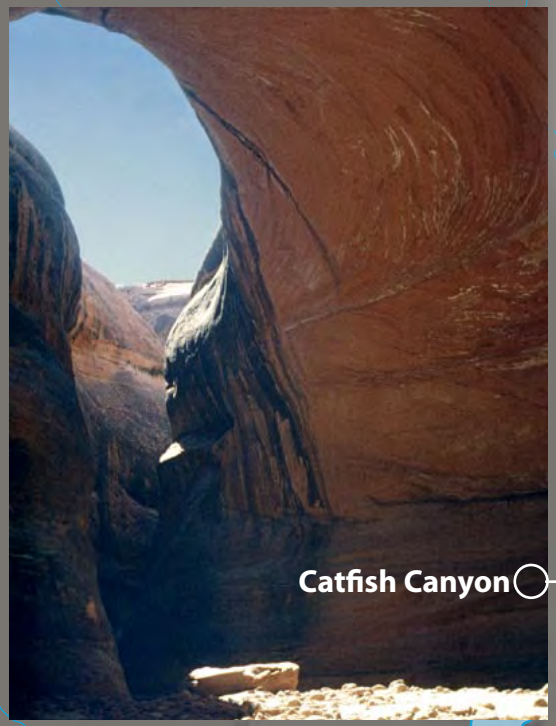
Before the dam
middle reaches

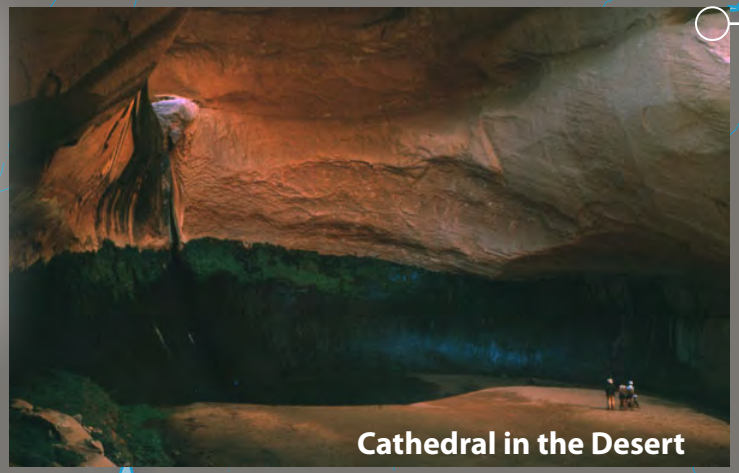




Before the dam
lower reaches

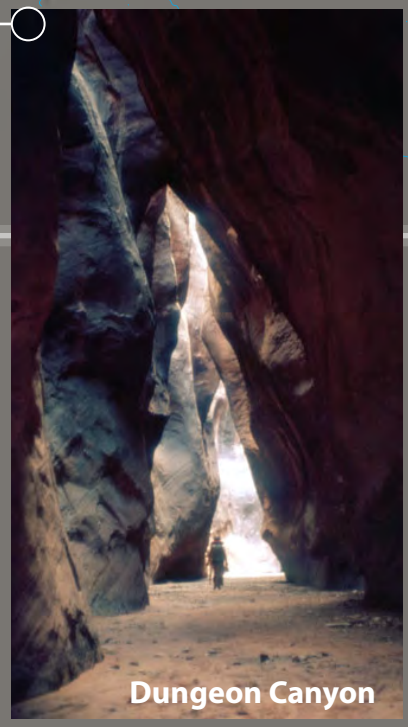






UTAH

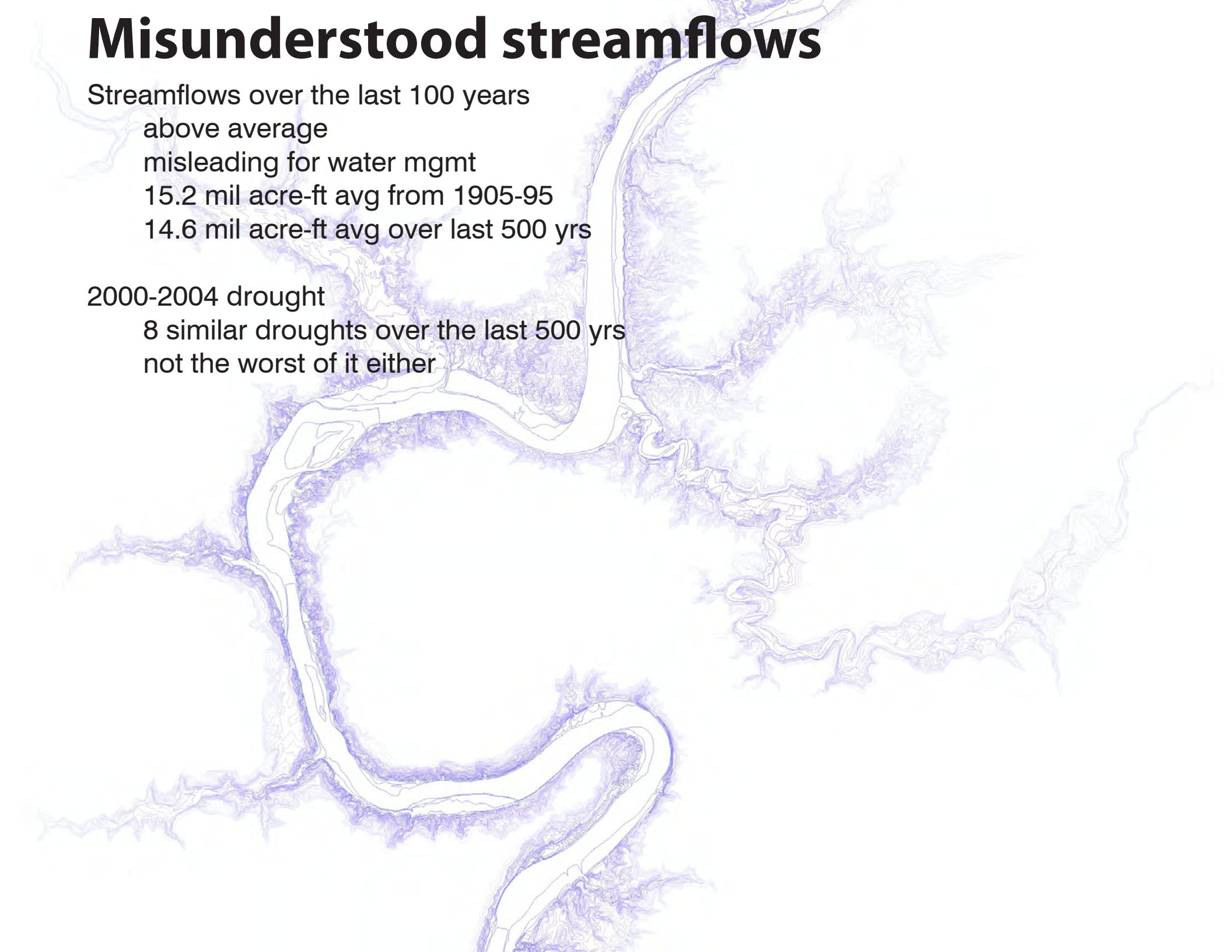
ARIZONA



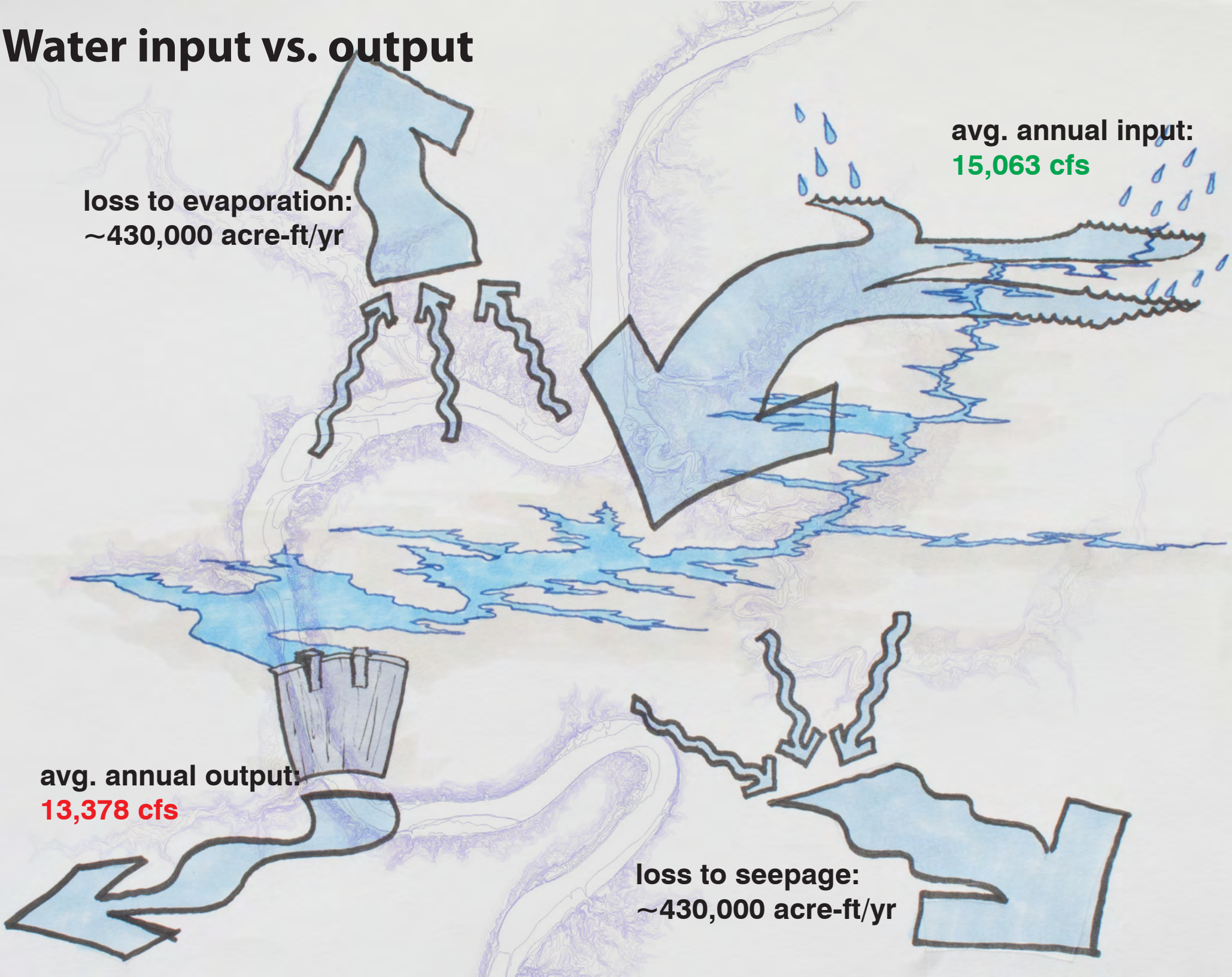
Misunderstood streamflows

Streamflows over the last 100 years
- above average
- misleading for water mgmt
- 15.2 mil acre-ft avg from 1905-95
- 14.6 mil acre-ft avg over last 500 yrs

2000-2004 drought
- 8 similar droughts over the last 500 yrs
- not the worst of it either



Water input vs. output



Sediment input vs. output

- between 27,000 and 85,400 acre-feet/year input
  - about 30,000 dump truck loads per day
- could fill entire lake in as little as 316 years
- all of it is trapped in the Lake
- sediment is needed downstream for habitat
- sediment is polluted
  - uranium
  - selenium
  - arsenic
  - mercury
  - petroleum by products

(sediment deposition at Hite, Lake Powell, 2005 nps.gov)

Sediment study area

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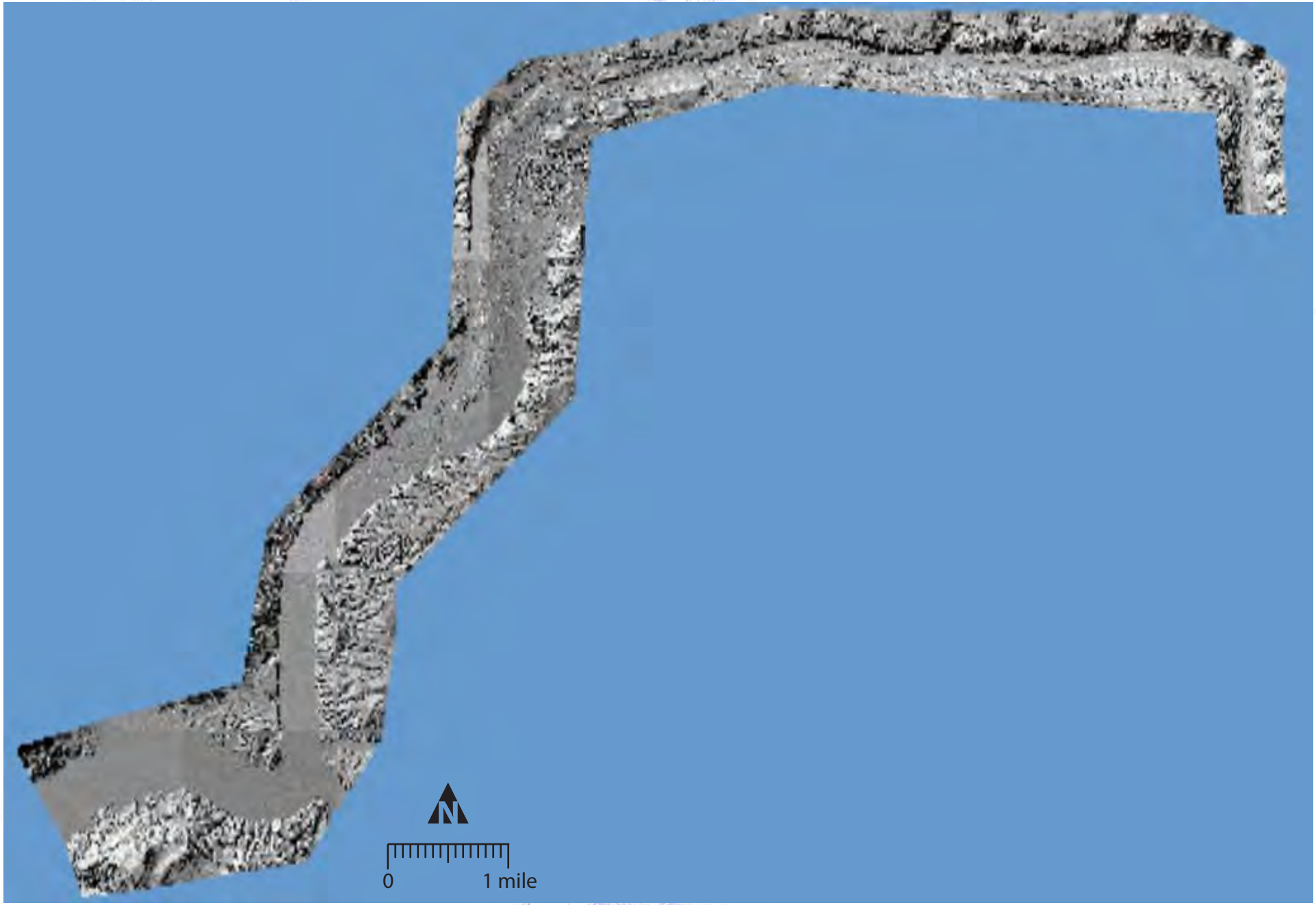
Sediment measurement

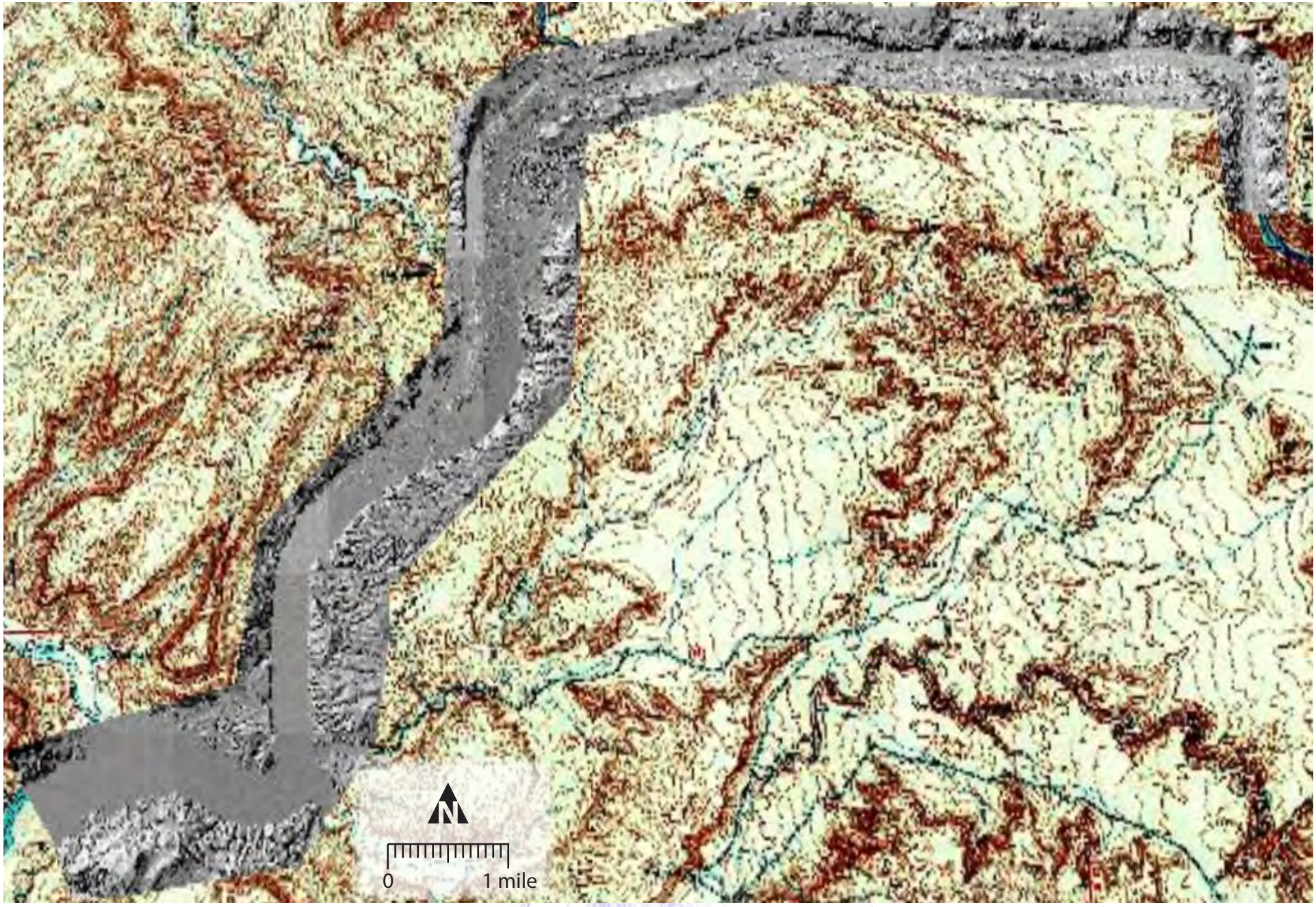
Imagery compiled from 1.31-meter-resolution LiDAR-generated (Light Detection And Ranging) DEMs (Digital Elevation Models)



(data source: NCALM; James P. Evans, Utah State University 2005)

Sediment measurement

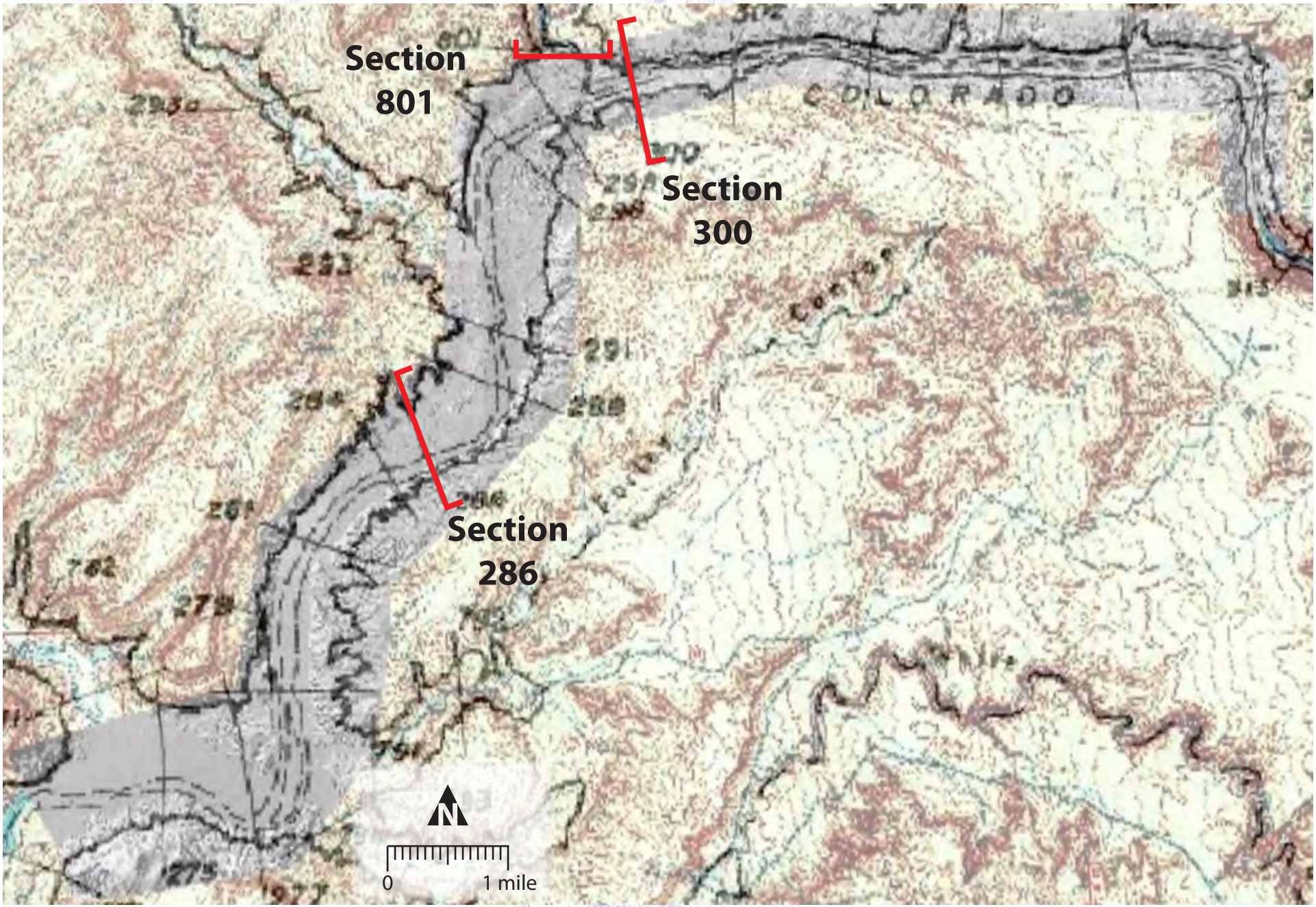
LiDAR imagery overlay on 1952 topographic map (before Lake Powell)



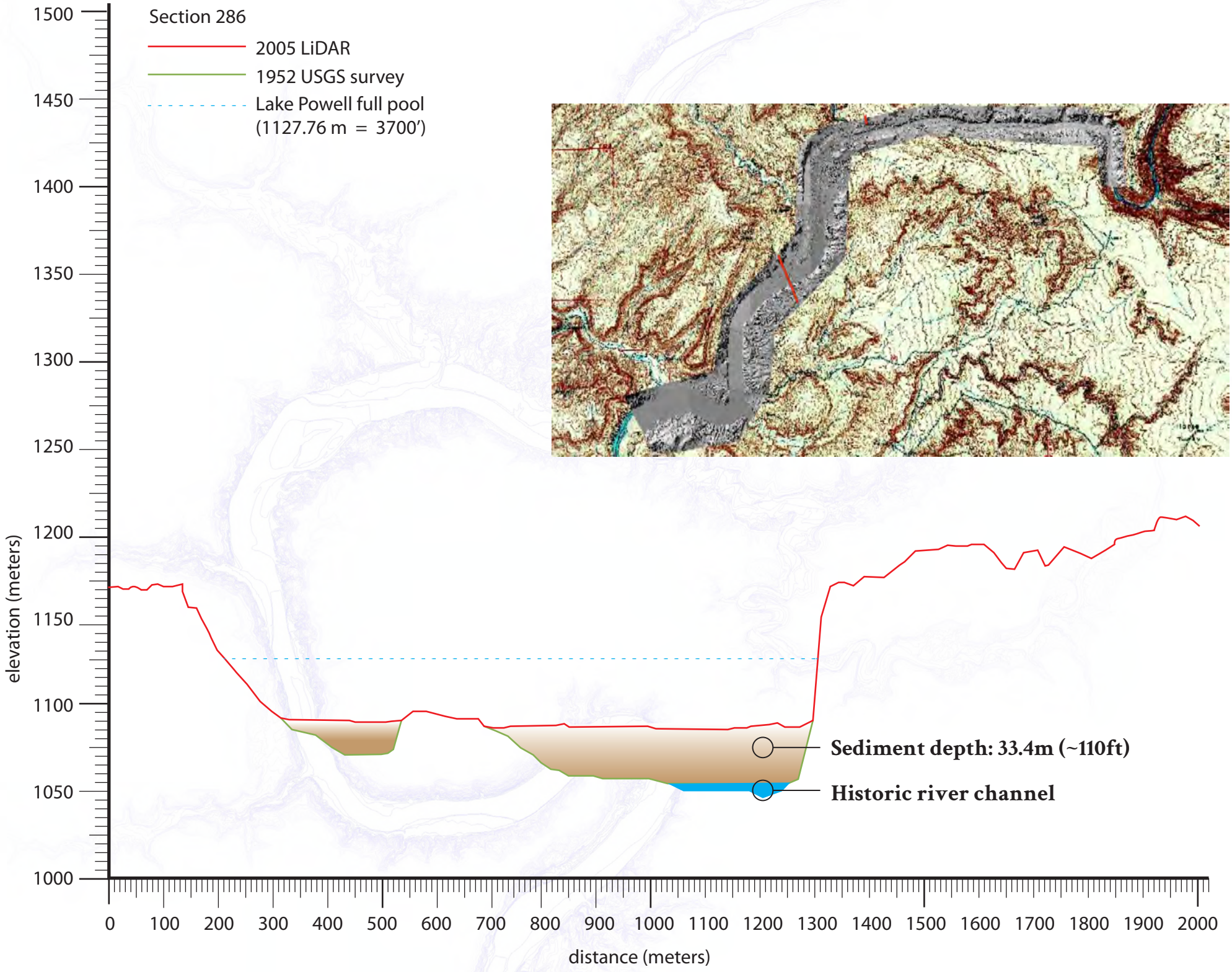
(data source: NCALM; James P. Evans, Utah State University 2005; USGS 1952)

Sediment measurement

Sample river cross-sections aligned with Bureau of Reclamation reference sections from a 1986 bathymetric survey



(data source: NCALM; James P. Evans, Utah State University 2005; USGS 1952; Bureau of Reclamation 1986)

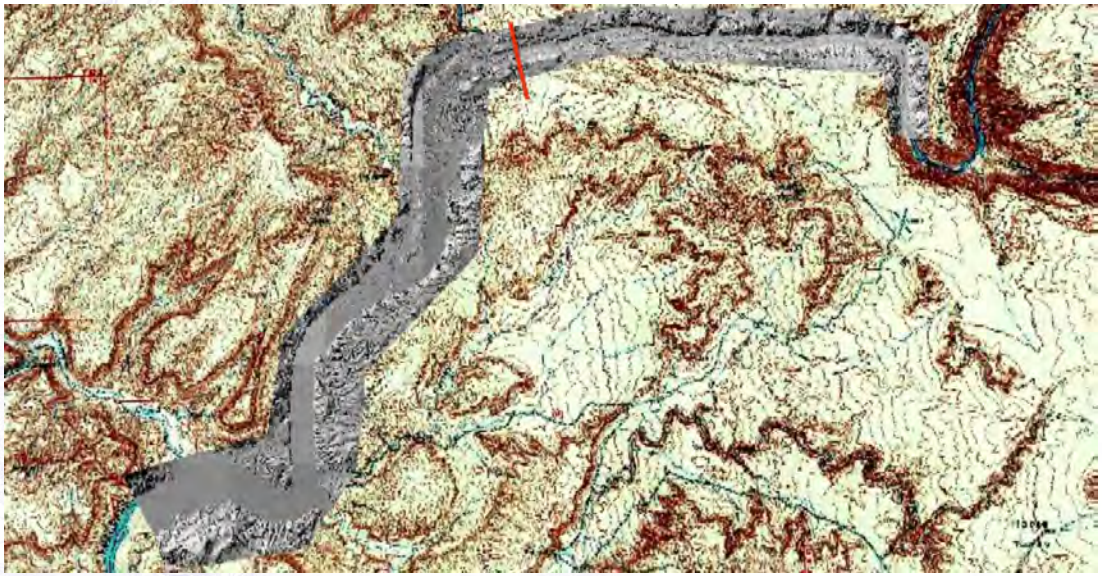

Section 286
2005 LiDAR
1952 USGS survey
Lake Powell full pool
(1127.76 m = 3700')
1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
elevation (meters)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
distance (meters)
Sediment depth: 33.4m (~110ft)
Historic river channel

Section 300

2005 LiDAR

1952 USGS survey

Lake Powell full pool
(1127.76 m = 3700')



elevation (meters)

1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

distance (meters)

Sediment depth: 47.82m (~157ft)

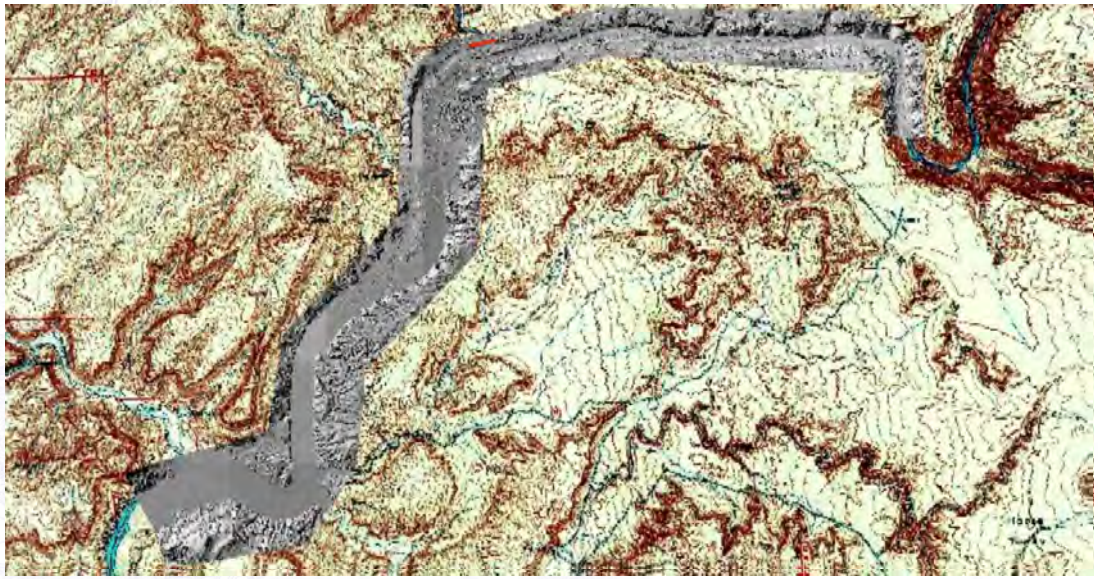
Historic river channel

Section 801 - Mouth of the Dirty Devil River

2005 LiDAR

1952 USGS survey

Lake Powell full pool
(1127.76 m = 3700')



elevation (meters)

1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000

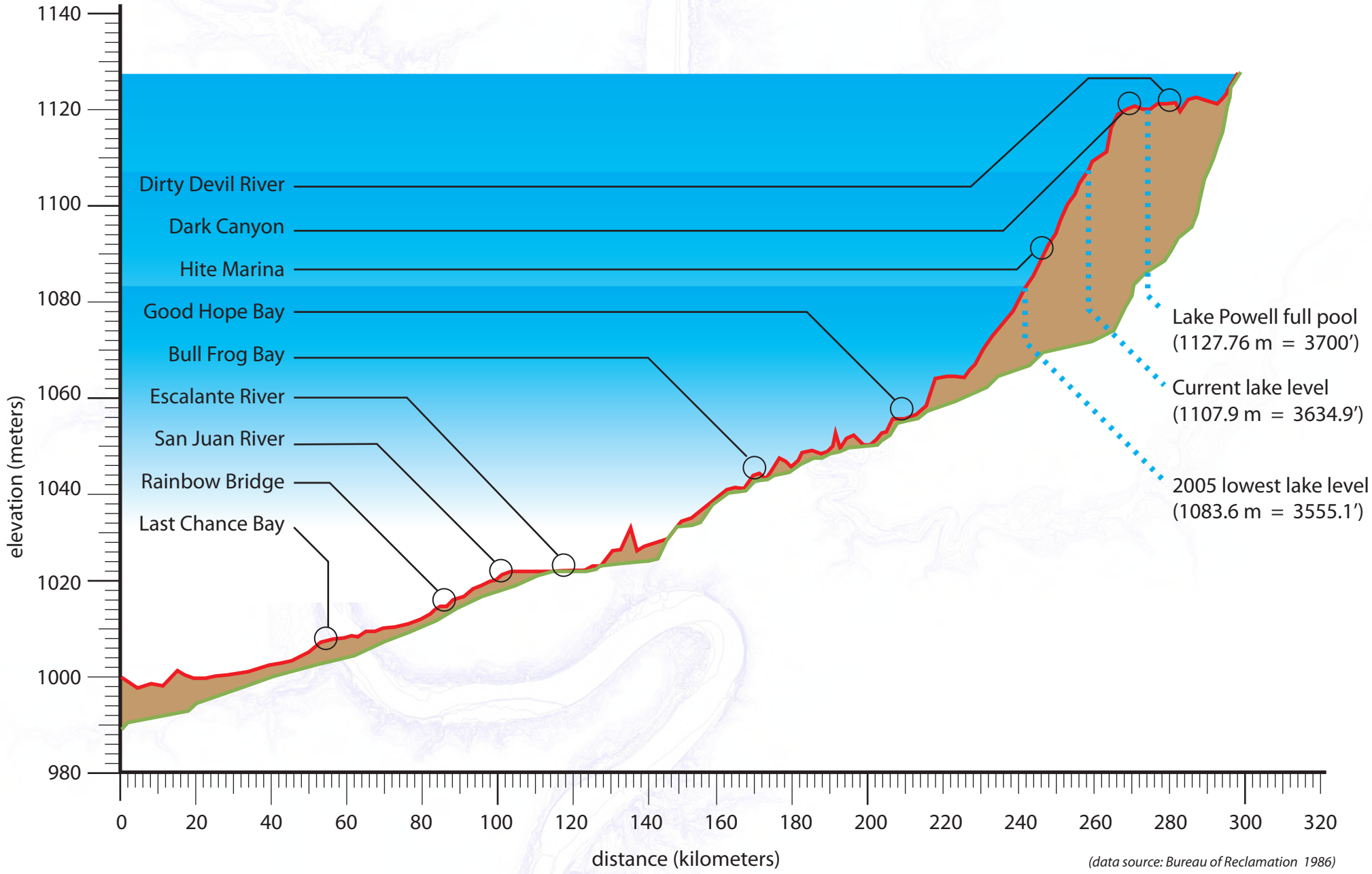
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

distance (meters)

Sediment depth: 41.8 m (~137ft)

Historic river channel (Dirty Devil River)

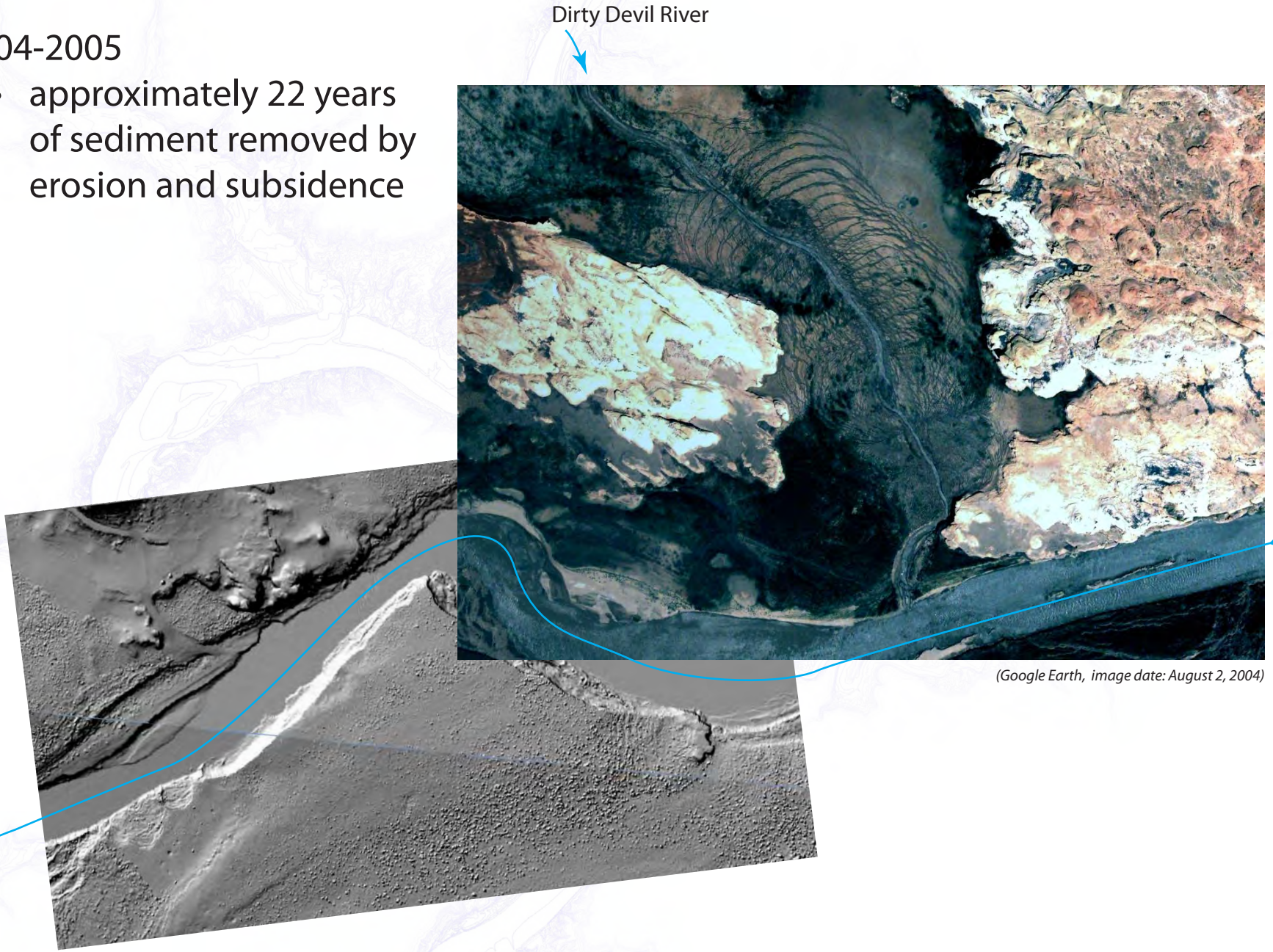
Sediment storage



(data source: Bureau of Reclamation 1986)

Sediment mobilization

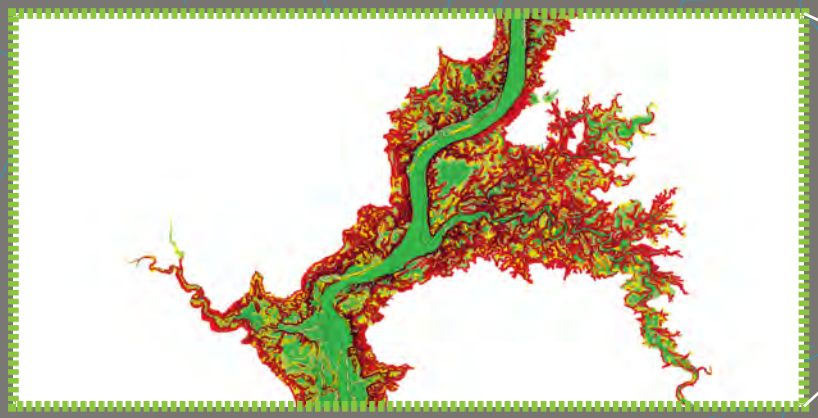
» 2004-2005
  - approximately 22 years of sediment removed by erosion and subsidence



(Google Earth, image date: August 2, 2004)

(data source: NCALM; James P. Evans, Utah State University 2005)

Revegetation study area



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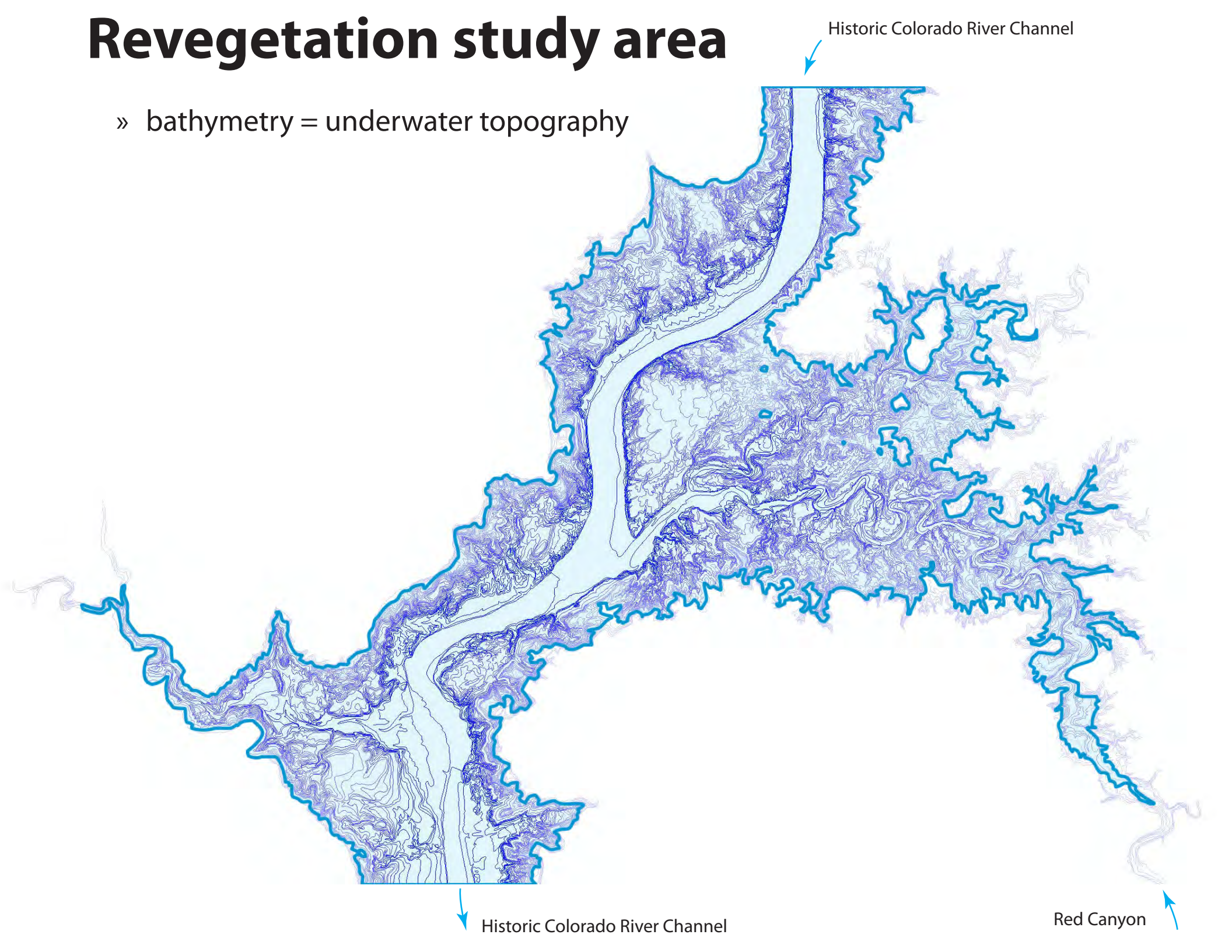
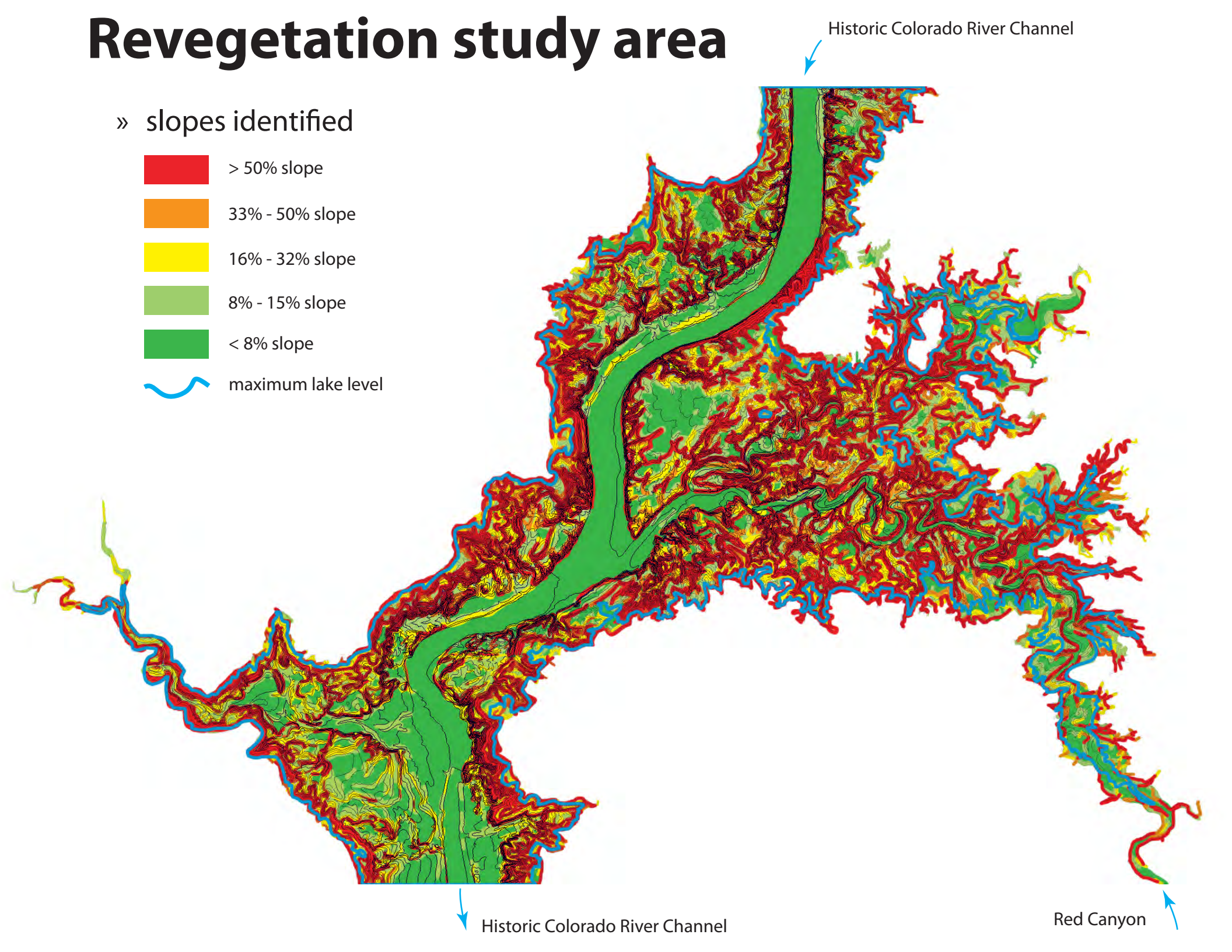
Revegetation study area

» bathymetry = underwater topography

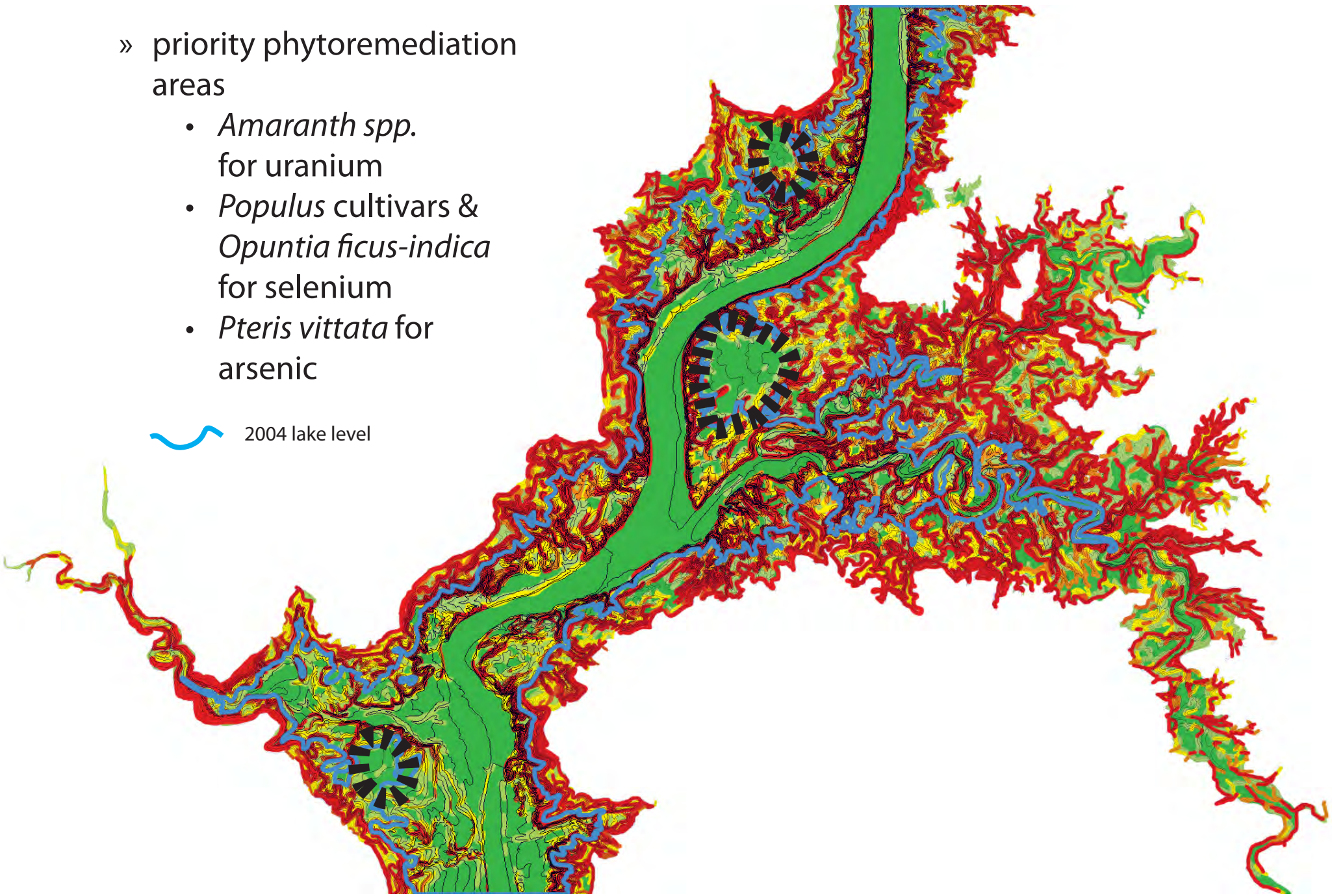


Revegetation study area

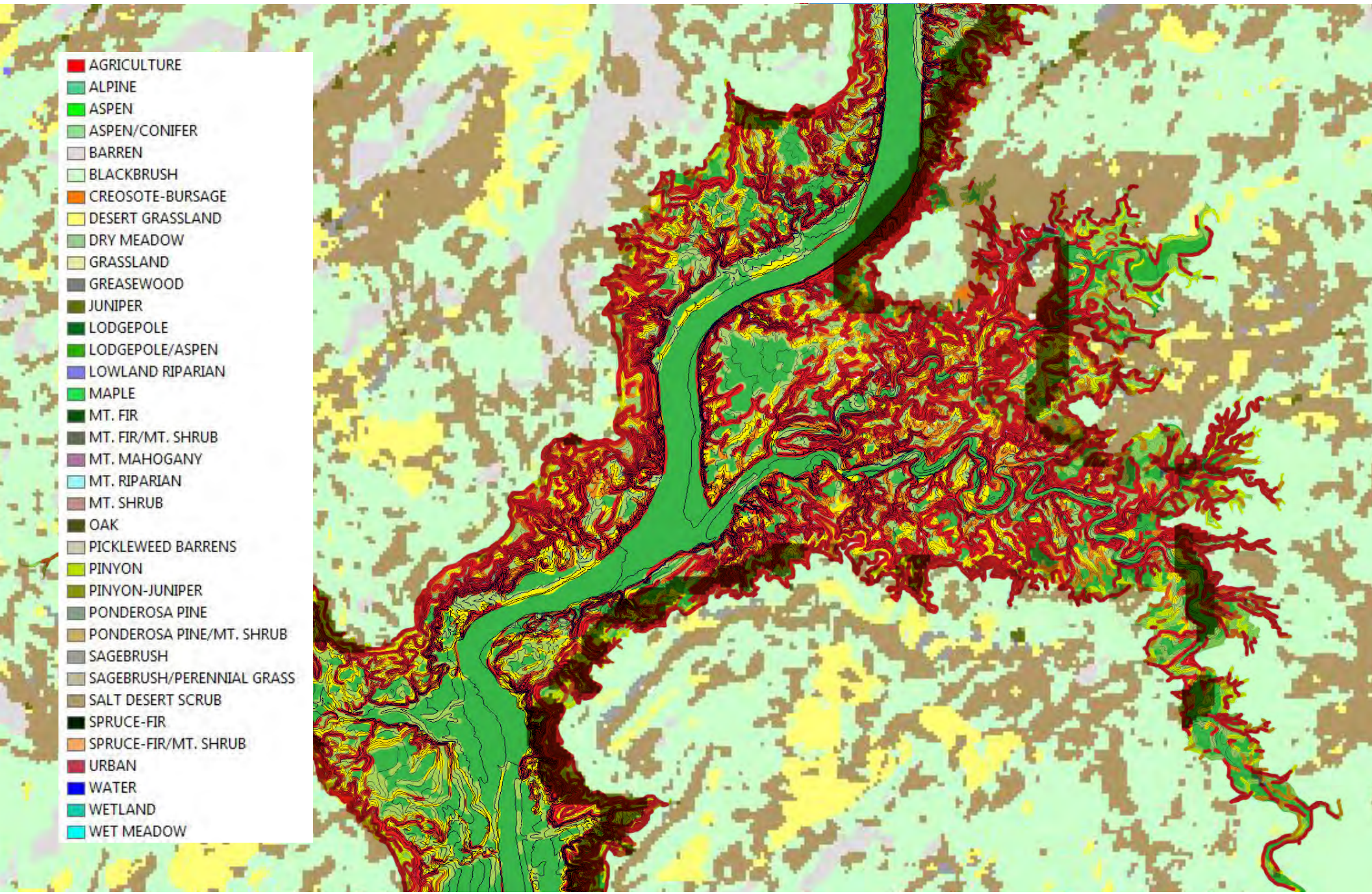


Revegetation study area

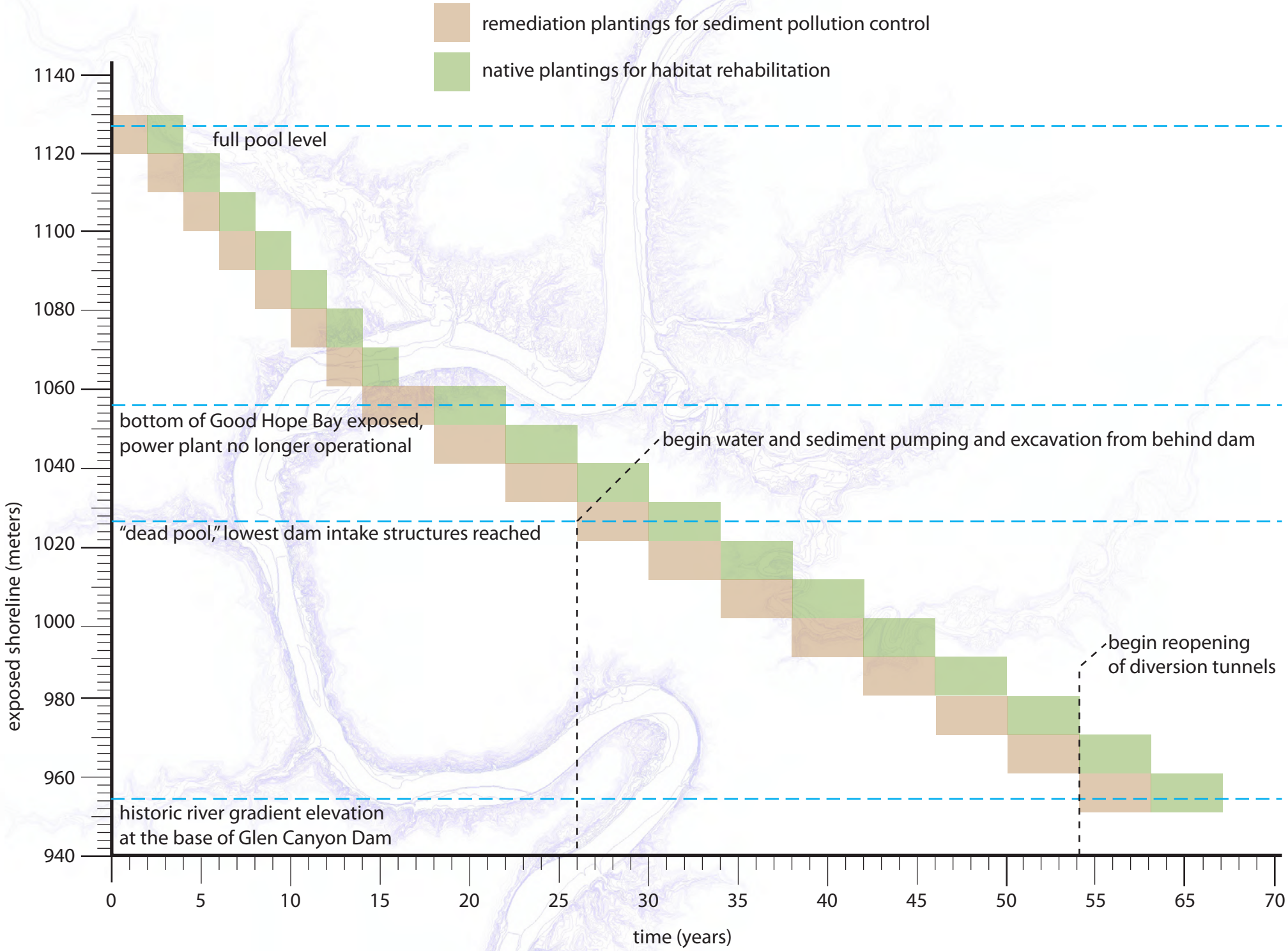
- priority phytoremediation areas
  - *Amaranth spp.* for uranium
  - *Populus* cultivars & *Opuntia ficus-indica* for selenium
  - *Pteris vittata* for arsenic



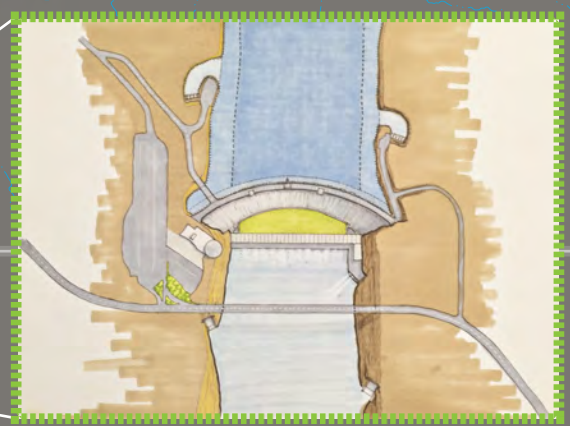
Revegetation study area



Revegetation timeline



Glen Canyon Dam eco-engineering



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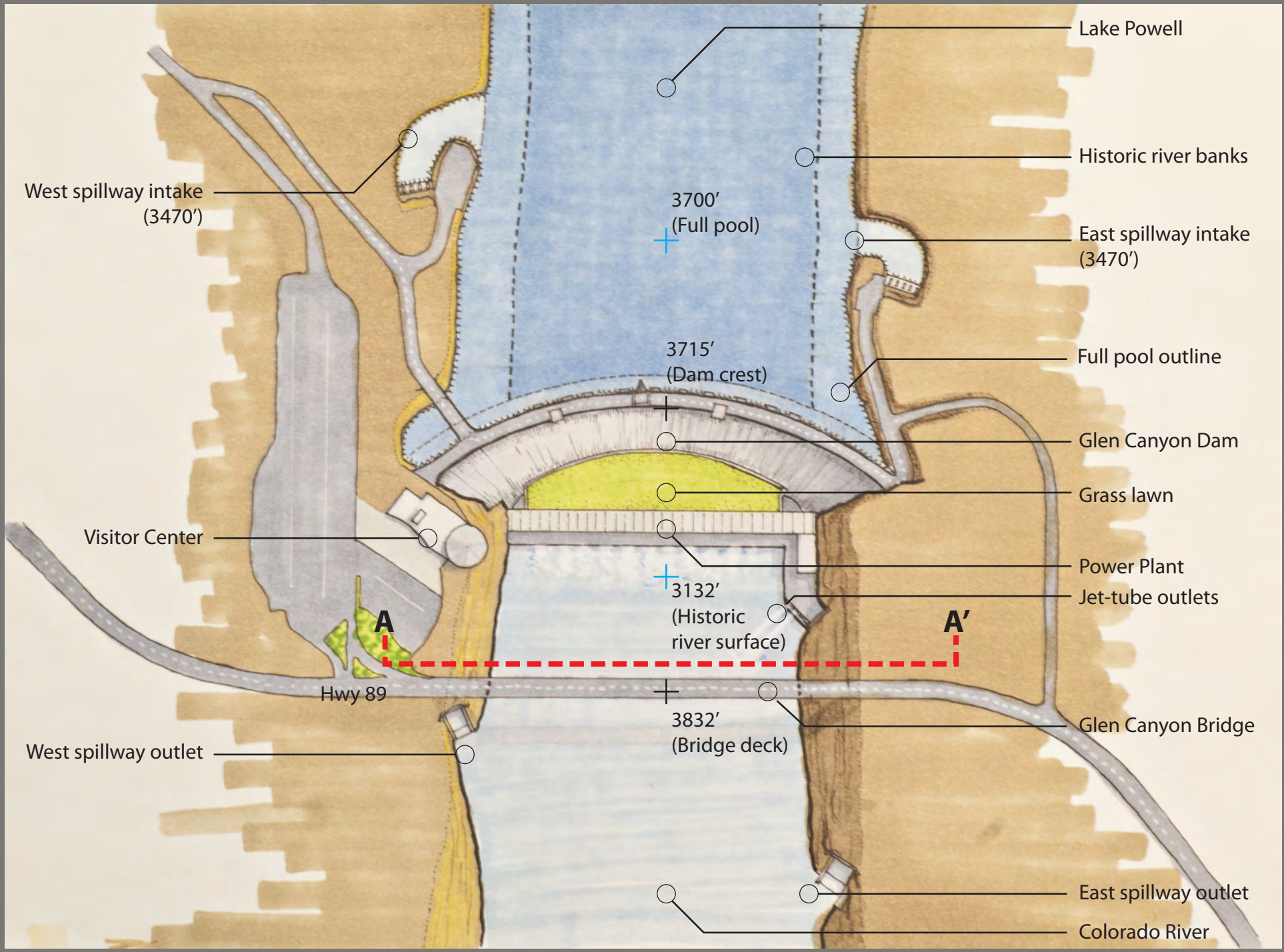
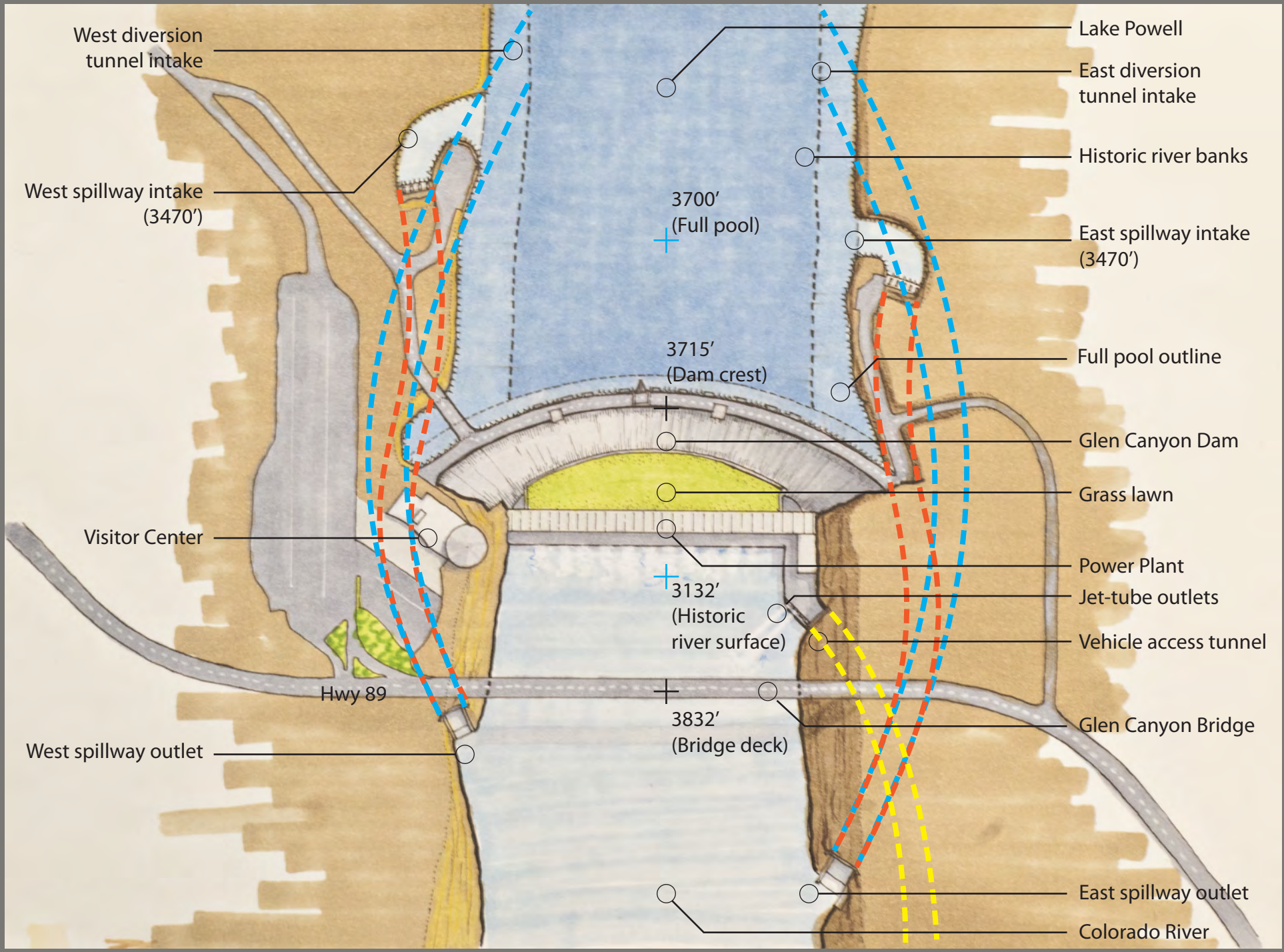
Glen Canyon Dam

access tunnel

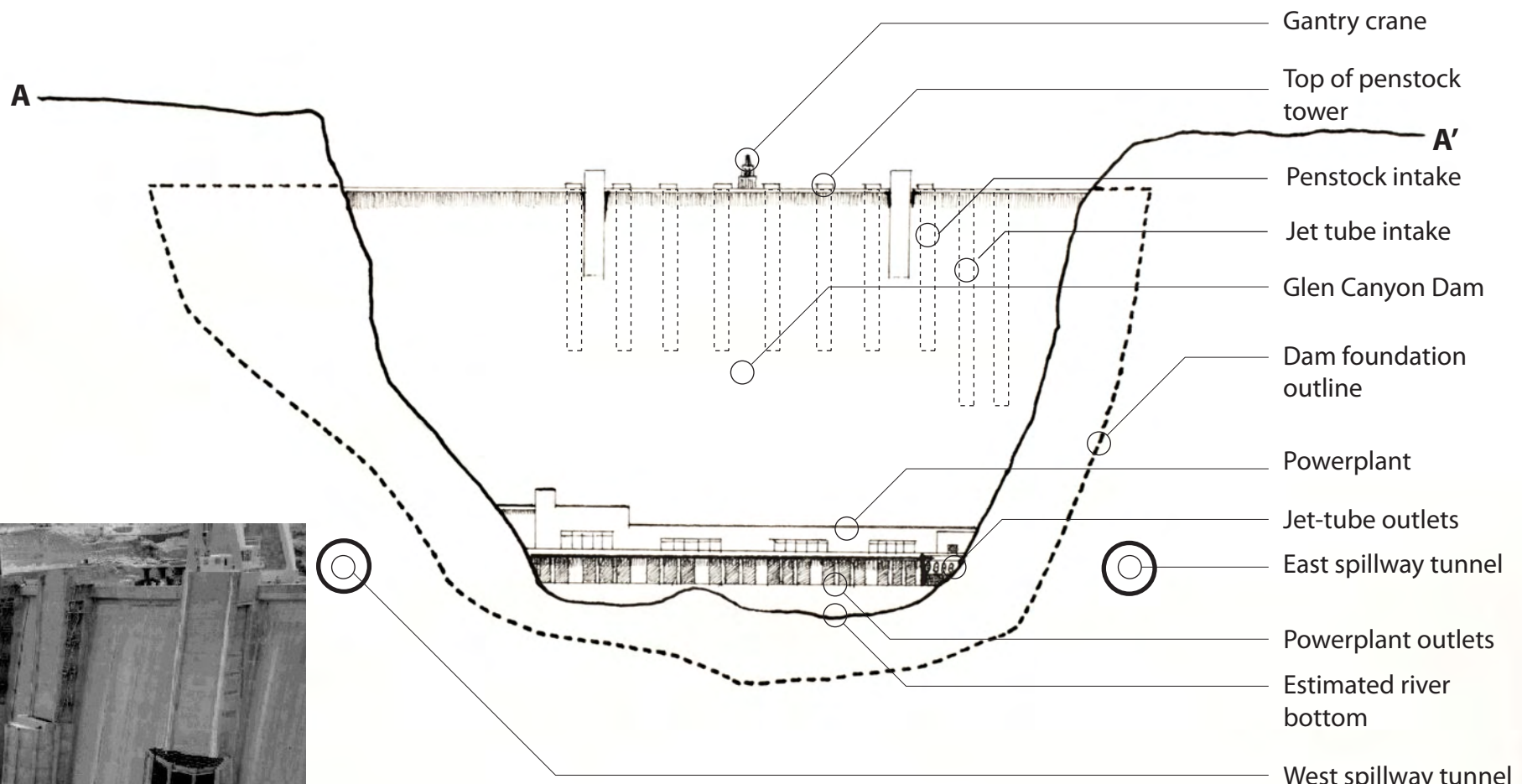
Dam plan

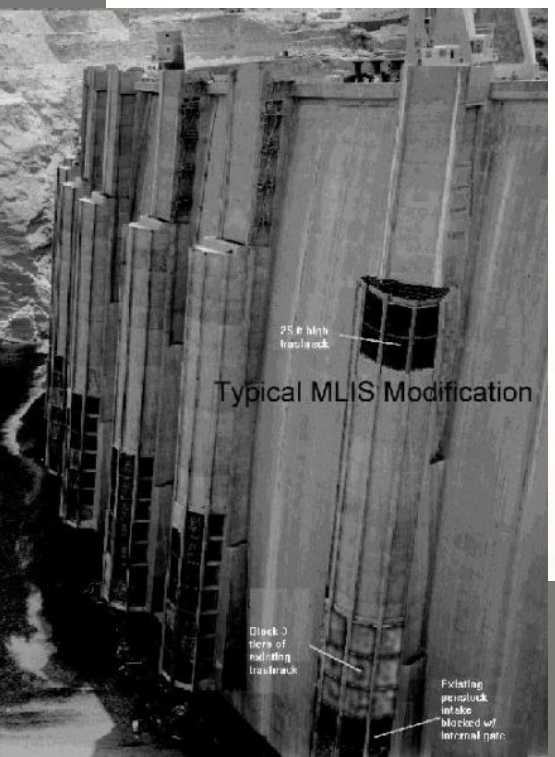

Lake Powell
Historic river banks
West spillway intake
(3470′)
3700′
(Full pool)
East spillway intake
(3470′)
3715′
(Dam crest)
Full pool outline
Glen Canyon Dam
Grass lawn
Visitor Center
Power Plant
3132′
(Historic
river surface)
Jet-tube outlets
A
A′
Hwy 89
3832′
(Bridge deck)
Glen Canyon Bridge
West spillway outlet
East spillway outlet
Colorado River

Dam plan


West diversion tunnel intake
West spillway intake (3470′)
Visitor Center
Hwy 89
West spillway outlet
Lake Powell
East diversion tunnel intake
Historic river banks
3700′ (Full pool)
East spillway intake (3470′)
3715′ (Dam crest)
Full pool outline
Glen Canyon Dam
Grass lawn
Power Plant
3132′ (Historic river surface)
Jet-tube outlets
Vehicle access tunnel
3832′ (Bridge deck)
Glen Canyon Bridge
East spillway outlet
Colorado River

Dam section/elevation south





view of intake structures on upstream side of dam

(Bureau of Reclamation 1999)

Dam detour

- » reopen existing diversion tunnels
- » expand and lower west tunnel to recreate historic river channel gradient
- » the dam remains as an artifact and tourist destination