

California Extreme Precipitation Symposium 2012  
The 1861-1862 Floods: Informing Decisions 150 Years Later

# Understanding the Sacramento River Valley Before Levees and Dams

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City of Sacramento 1850



Central Valley Tule Marsh

**nhc**  
northwest hydraulic consultants

water resource specialists

# Introduction

## 3 Main Topics

- Natural Geomorphic Function of the Sacramento River Valley in early 1800s
- Historical and Geomorphic Context of the 1862 Flood
- Integration of Geomorphic Function into the Sacramento River Flood Control Project Design

## Sacramento River Valley and Watershed



Source: Wikimedia Commons



# Sacramento River Valley Timeline

**Topic 1: Natural Geomorphic Function of the Sacramento River Valley in early 1800s**

**1800 - Natural River System**

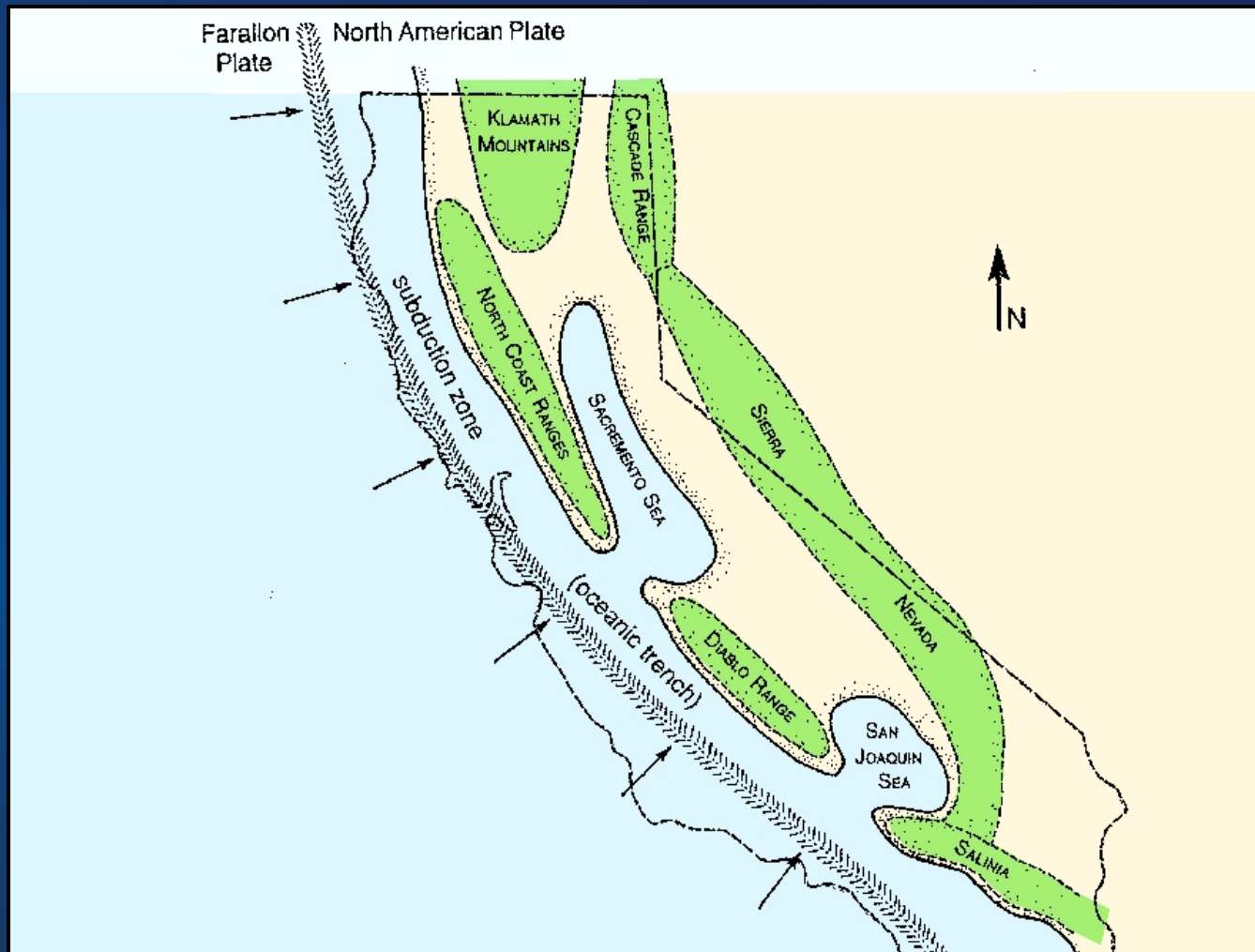
**....but first a brief stop in the mid-Oligocene  
(30 million years ago)**

**1800**

**1900**

**2000**

# The Sacramento River Valley is an Inland Sea... ...30 million years ago (mid-Oligocene)



Source: The Jepson Manual (1993)



# Sacramento River Valley Timeline

**Topic 1: Natural Geomorphic Function of the Sacramento River Valley in early 1800s**

**1800 - Natural River System**

....now back to the early 1800s

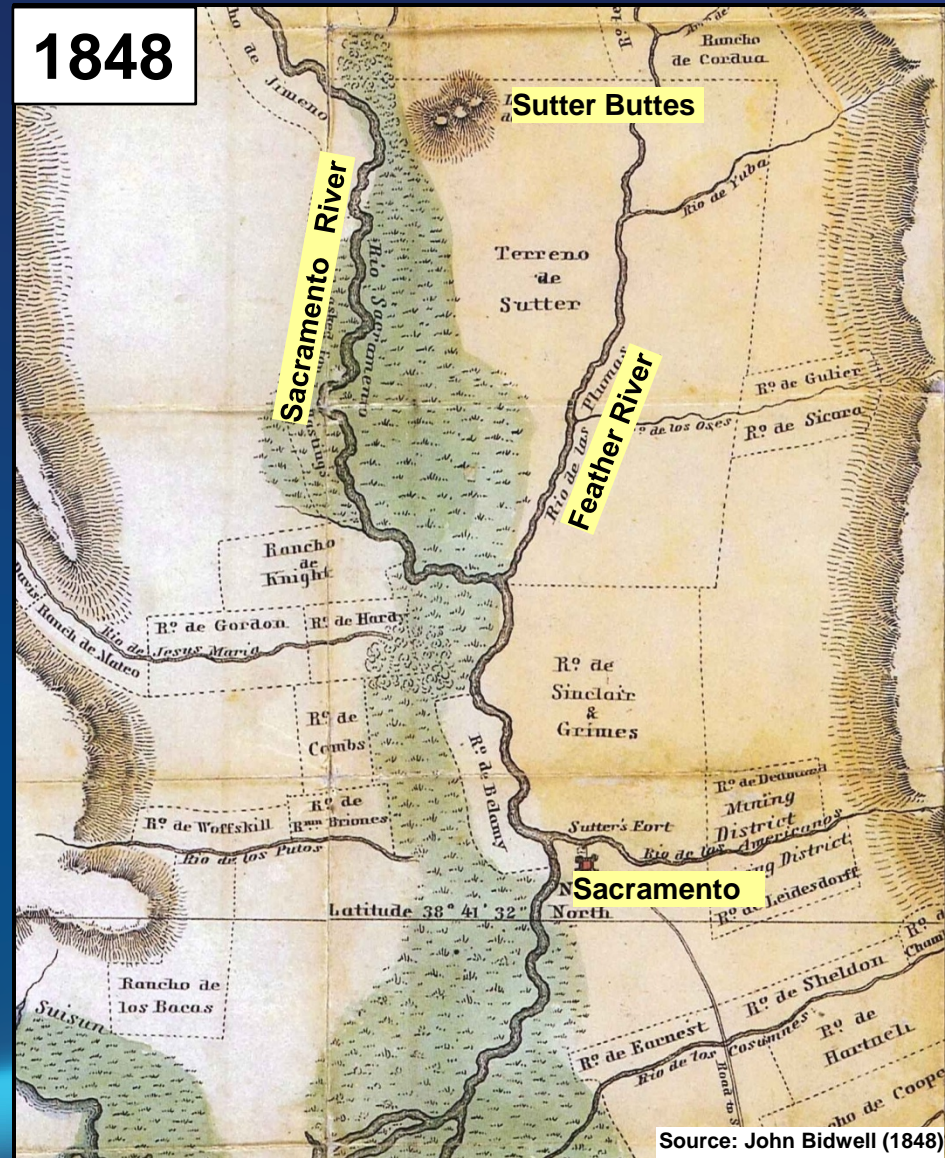
1800

1900

2000

## 1800 – Natural River System

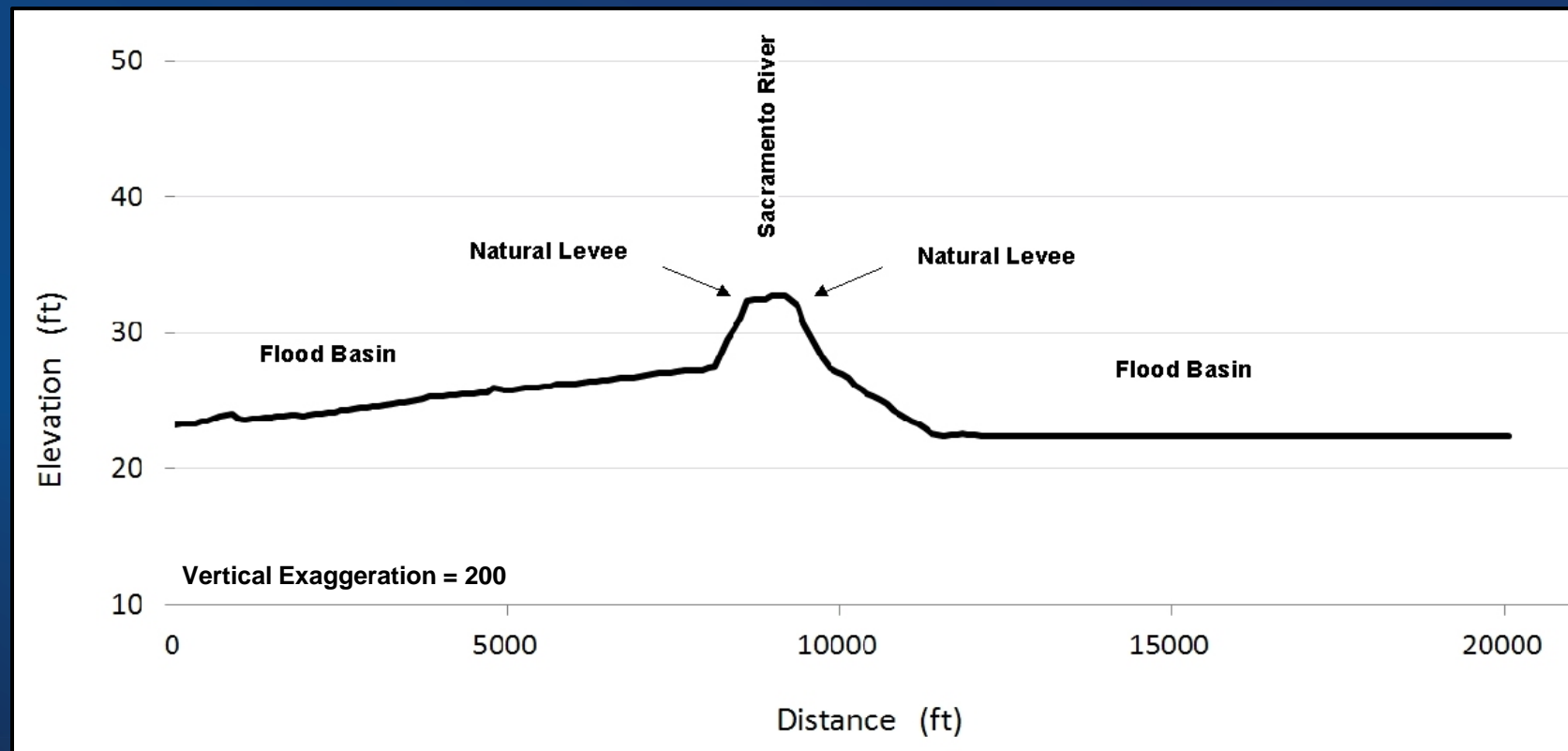
- ➔ **30 million years later, the Sacramento Valley is still an aggrading system.**
- ➔ **Sacramento and Feather Rivers are sediment delivery system of modern era.**
- ➔ **Sacramento and Feather Rivers lack capacity to convey seasonal floods and regularly overtop.**



**Source: John Bidwell (1848)**

# 1800 – Natural River System

- Sacramento Valley cross-section shows natural river levees and near-bank deposits at higher elevation than adjacent flood basins
  - Preferential sediment deposition next to river (coarser material)
  - Fine material deposits in flood basins (fertile agricultural soils)

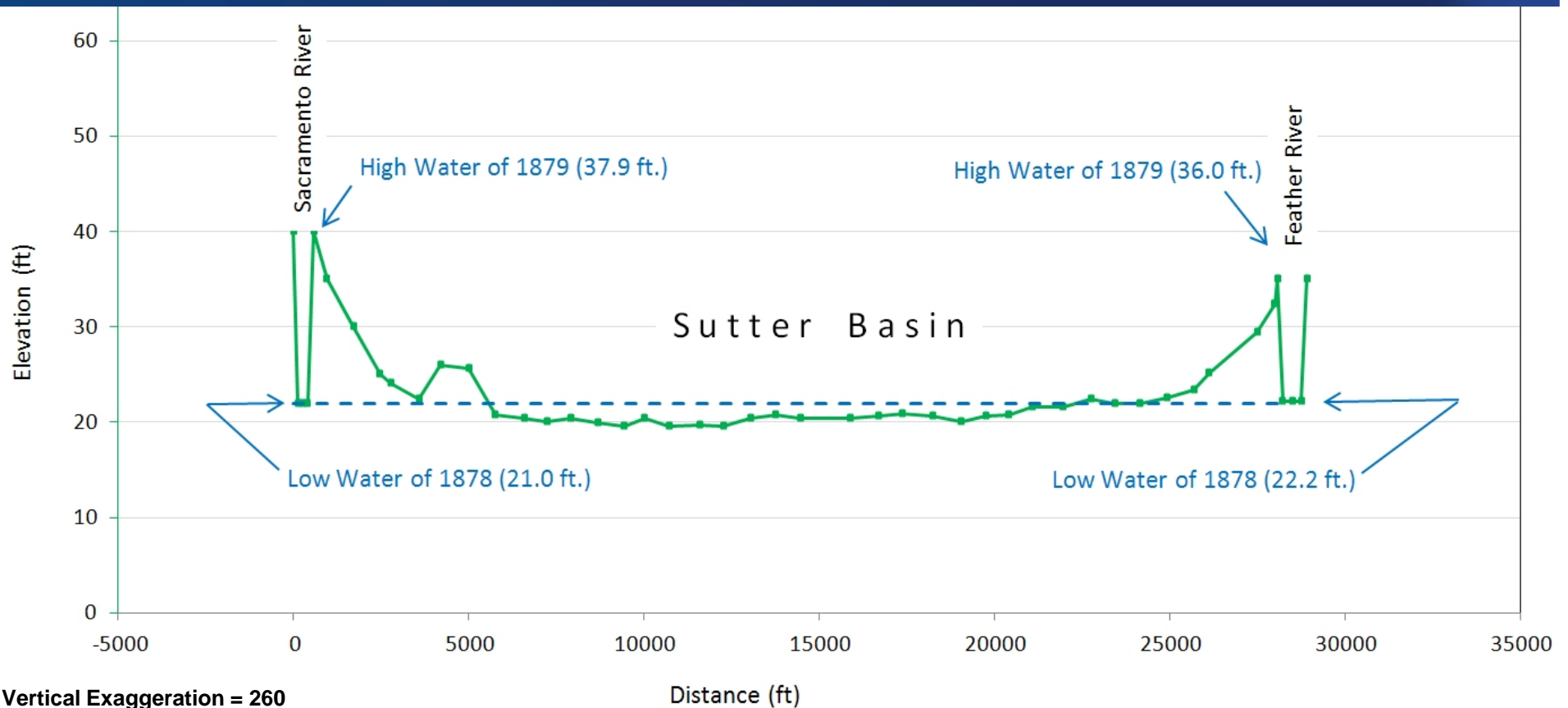


Source: (National Elevation Dataset)



# 1800 – Natural River System

→ 1895 surveys show low water elevations in rivers above the basin floor.



Source: (California Commissioner of Public Works, 1895)

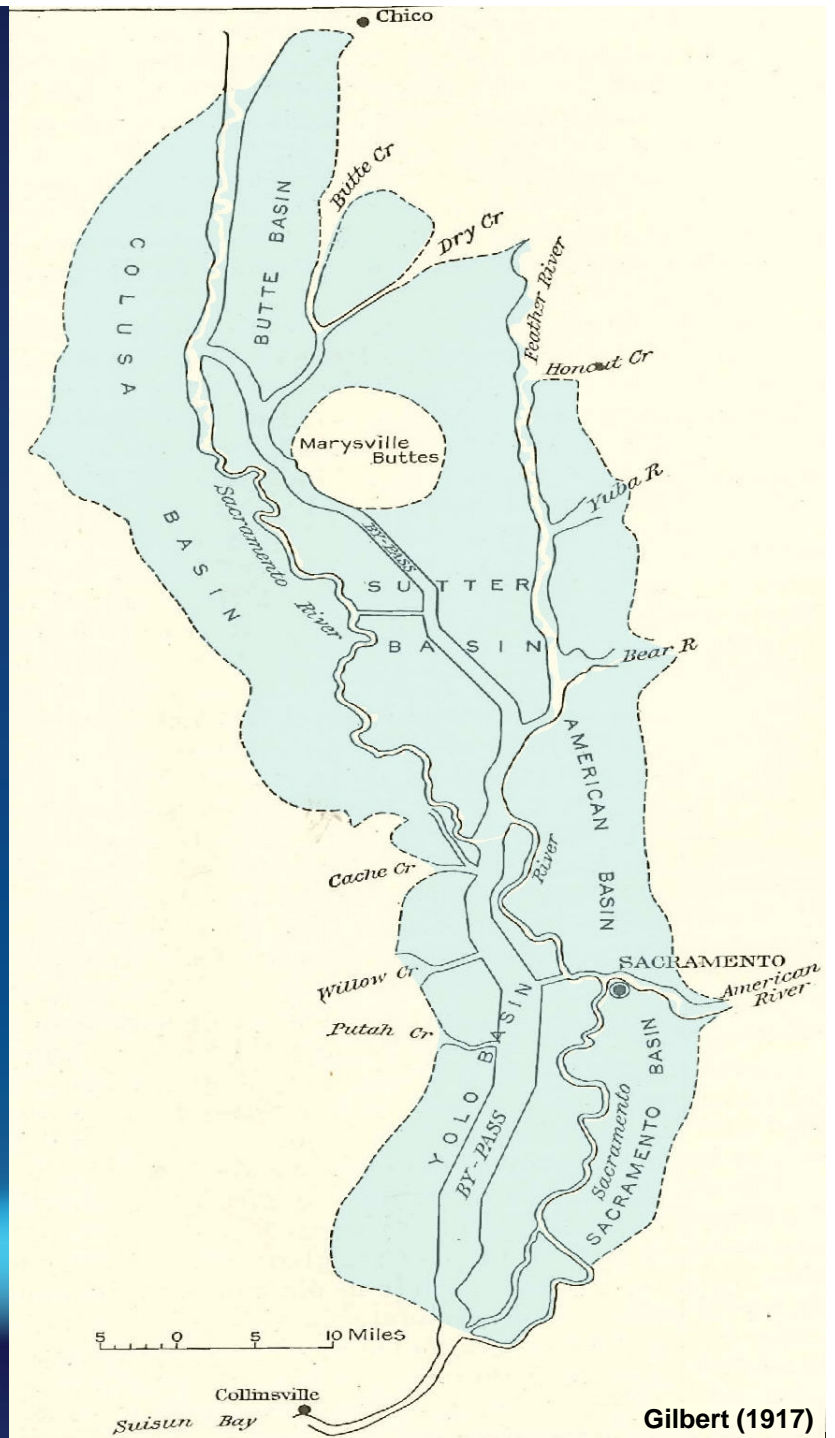
Location is 3.5 miles north of Knights Landing in an east – west alignment.



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# Sacramento River Flood Basins

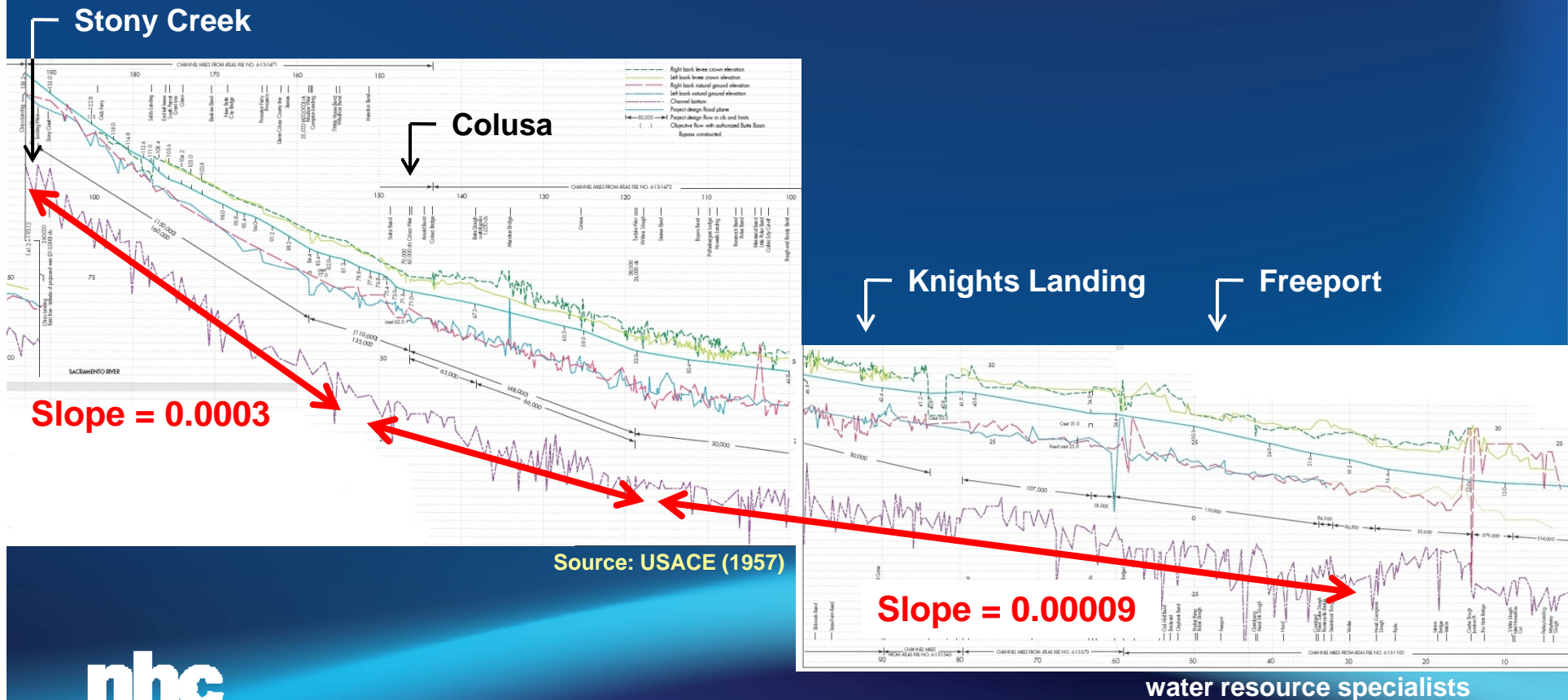
→ 2,131 square miles of flood basins  
defined by G.K. Gilbert in 1917.



# 1800 – Natural River System

→ Reasons for downstream decline in Sacramento River flow capacity include:

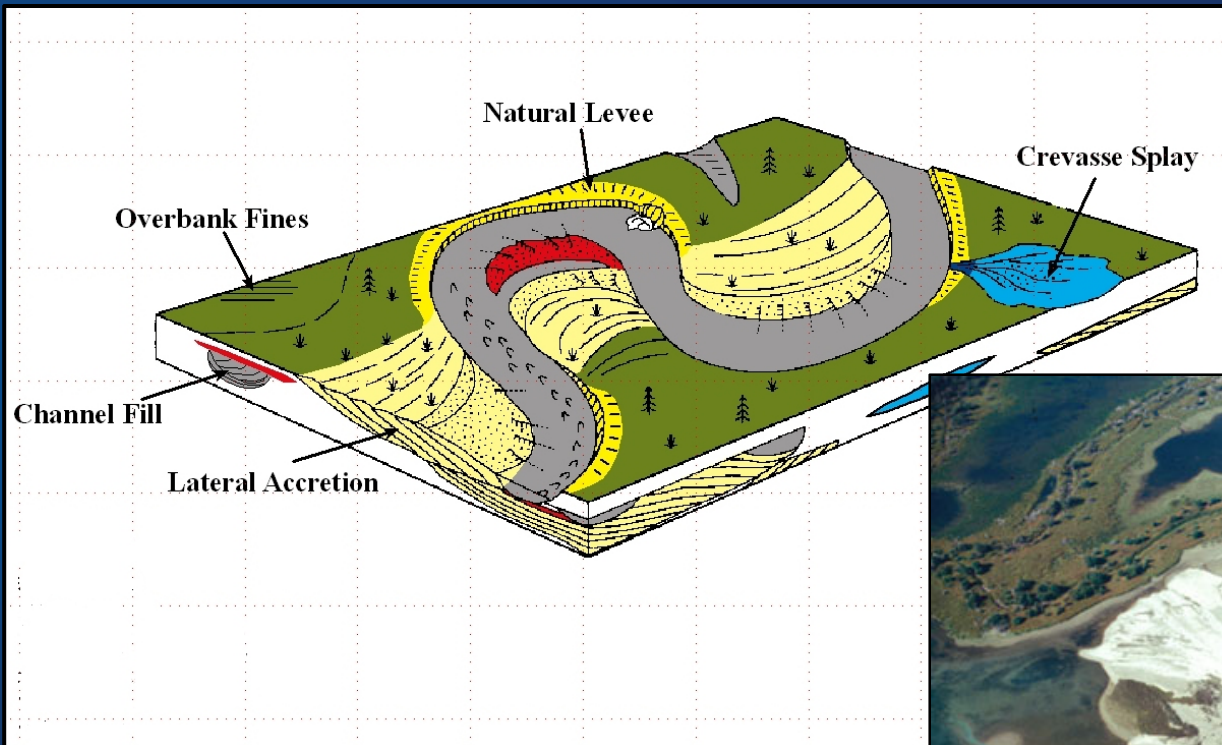
- Loss of flow to adjacent flood basins
- Geologic controls
- Decline in slope





# 1800 – Natural River System

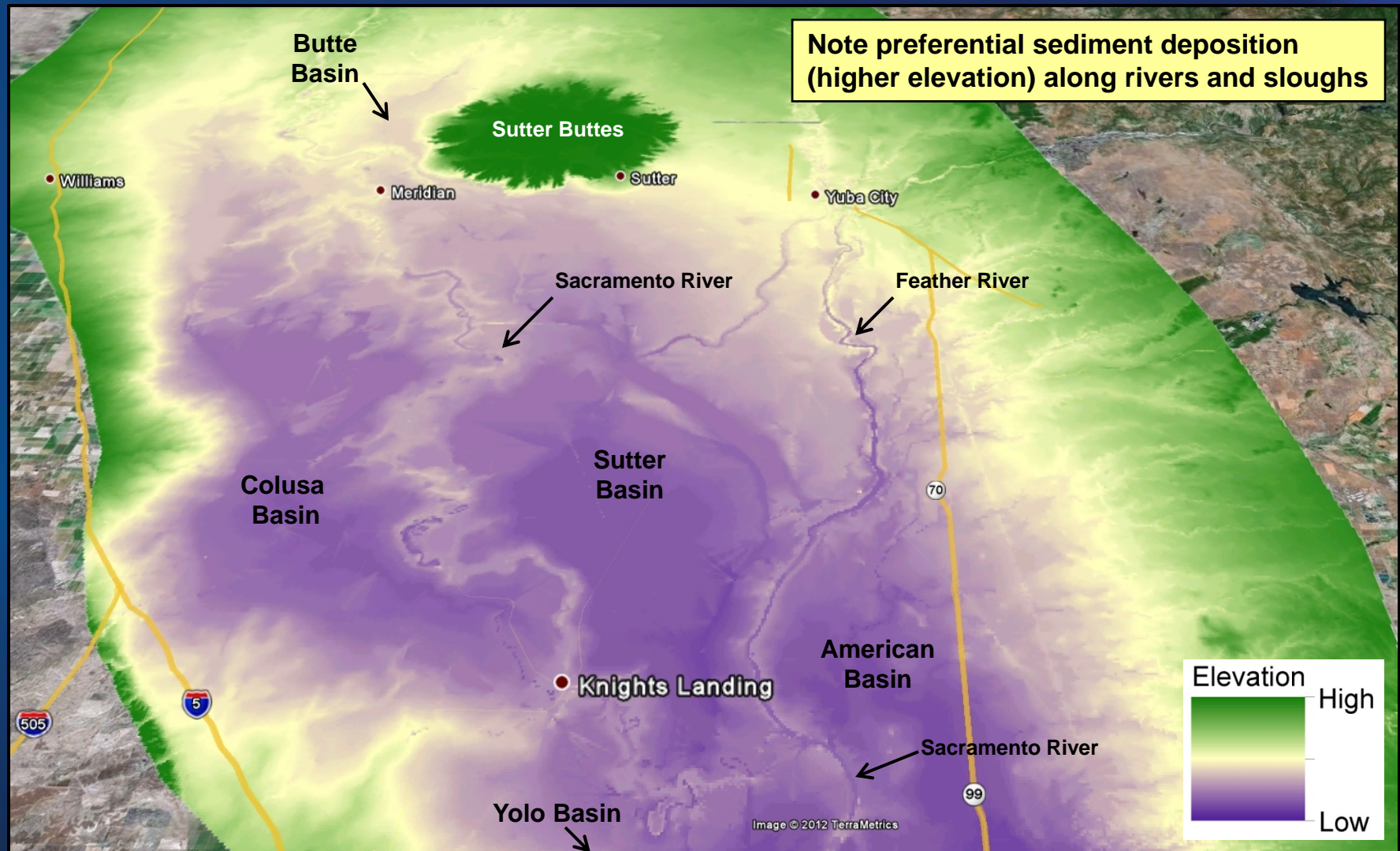
- Conceptual Diagram of Geomorphic Units along the Sacramento River
- Meandering River Model



Modified from Miall (1996)



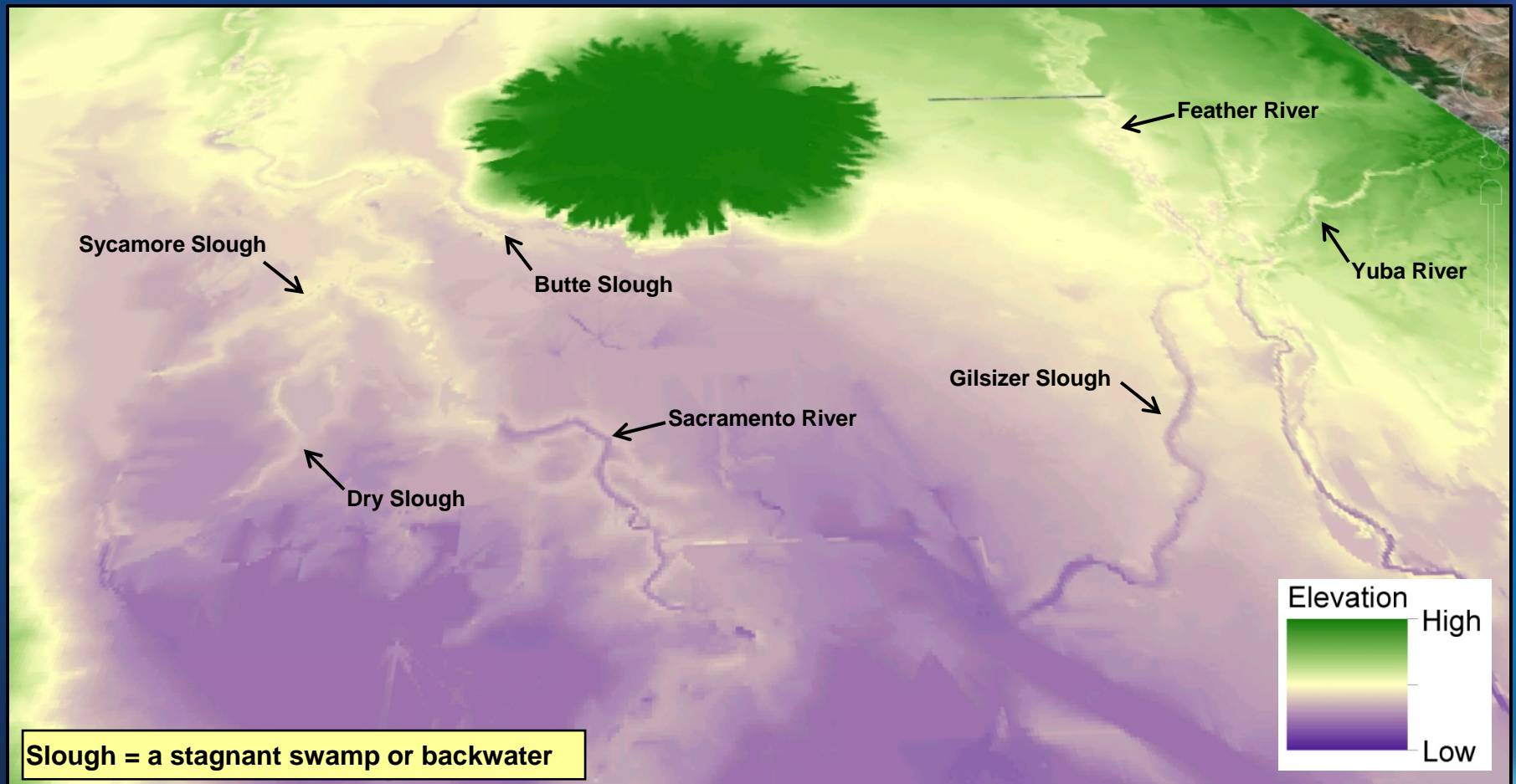
# The Surficial Expression of Sacramento Valley Sedimentation Processes in 1800 – Rivers and Flood Basins





# The Surficial Expression of Sacramento Valley Sedimentation Processes in 1800 - Sloughs

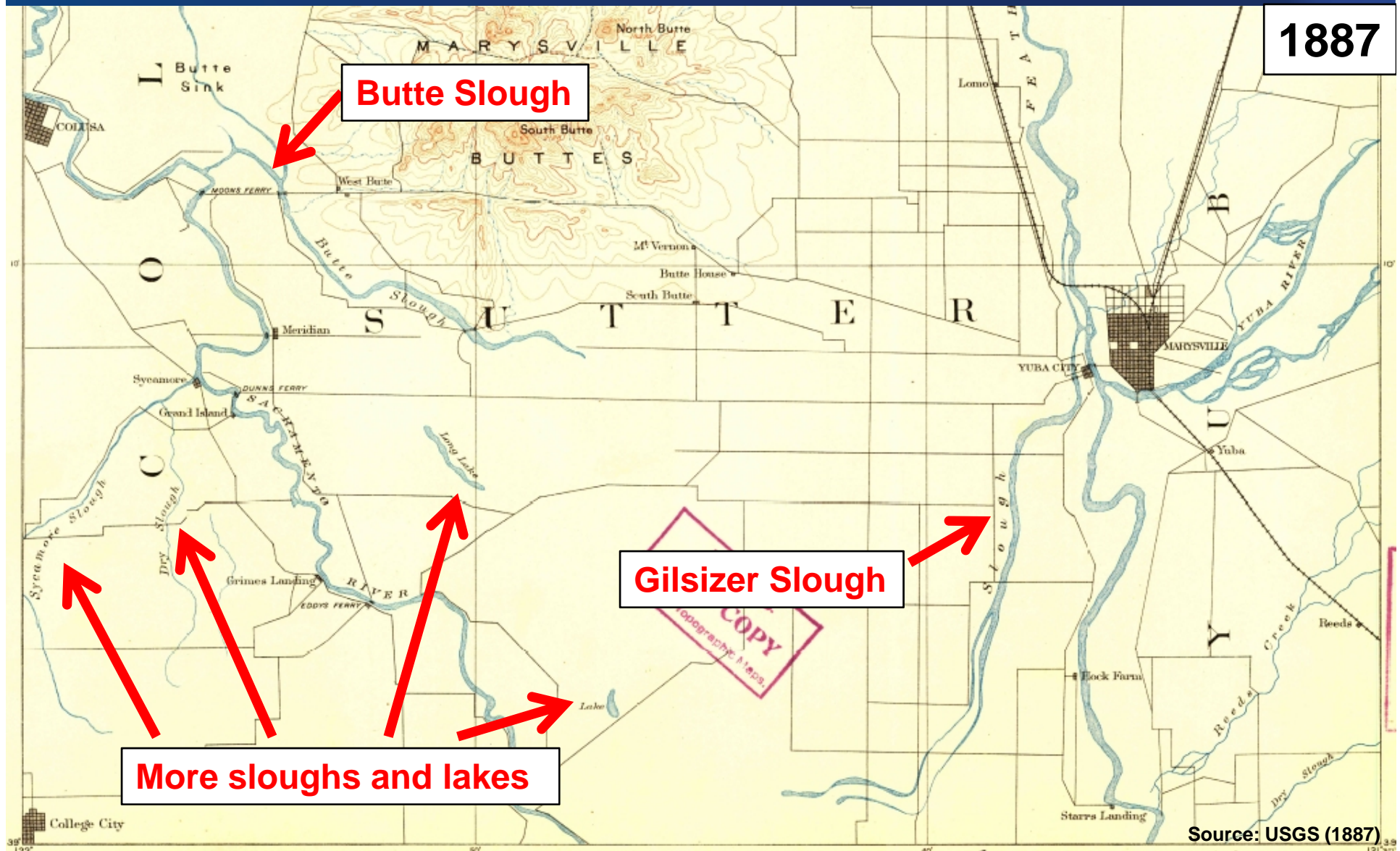
- Sloughs are a primary conveyor of flow and sediment from rivers to flood basins.
- Larger sloughs were named by early settlers.





# 1800 – Natural River System

→ Sloughs and lakes are readily seen on the early USGS central valley topo maps.





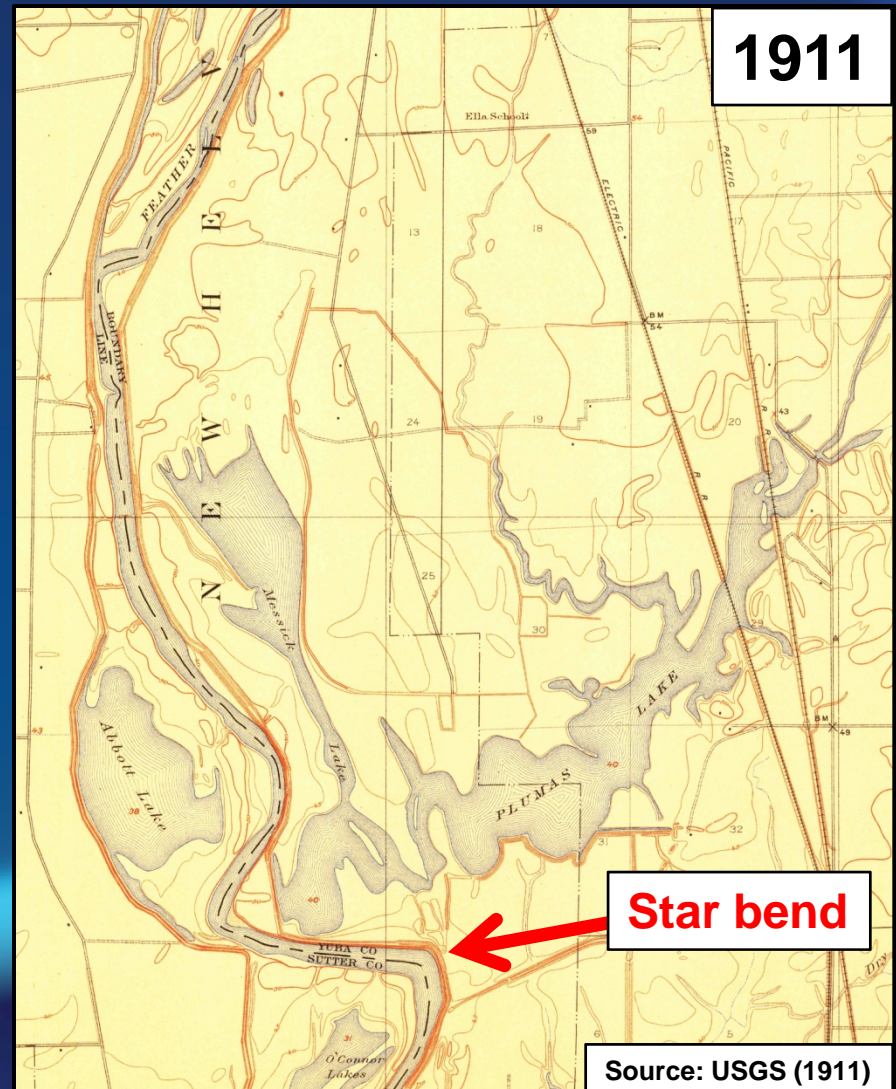
# 1800 - Natural River System

➔ Larger and more famous flood basin lakes of the Sacramento Valley

## Bush Lake in American Basin



## Plumas Lake on Feather River





# 1800 – Natural River System

- Very large floods such as the Great Flood of 1907 turned the Sacramento Valley into an “inland sea”.

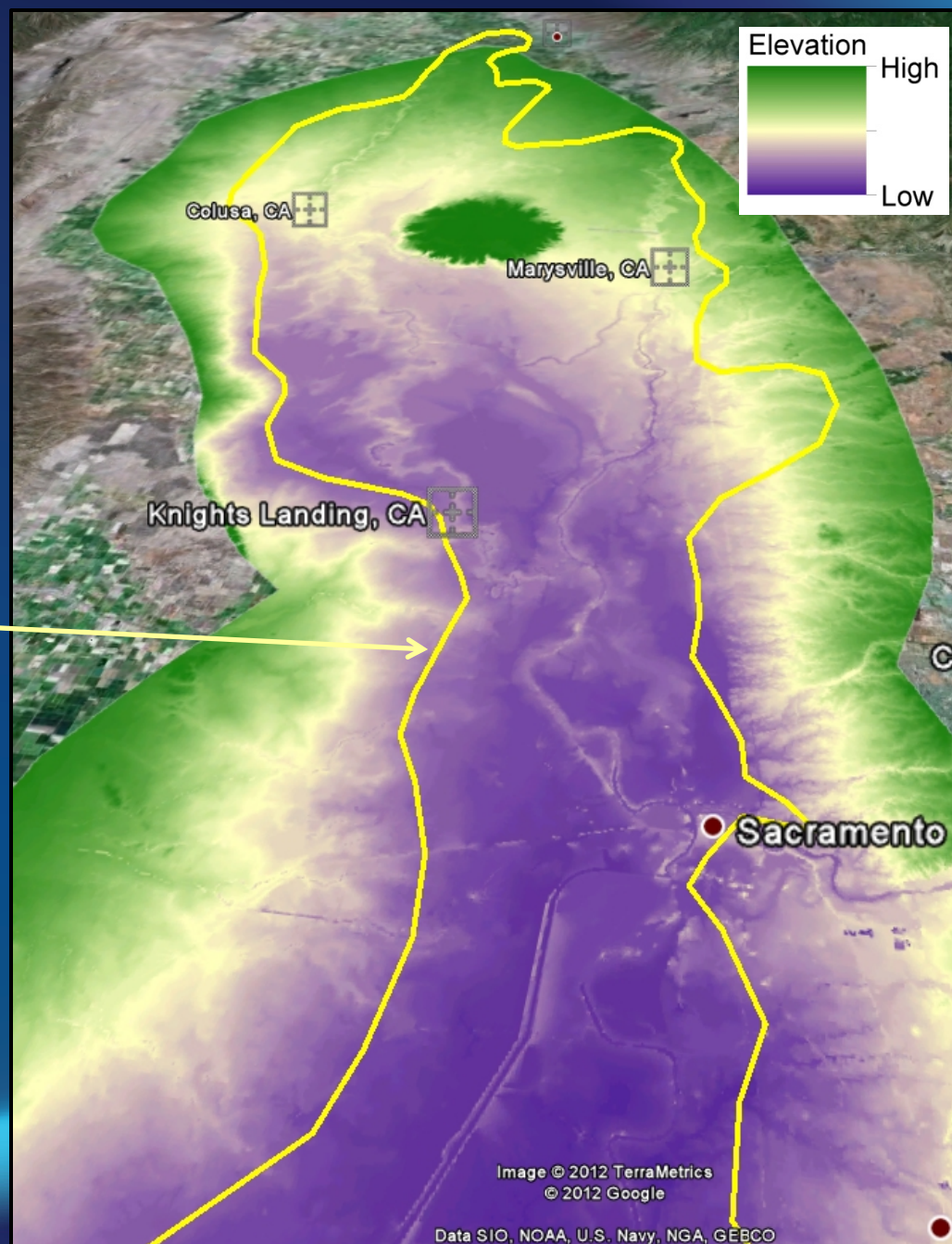
## Maximum extent of the Great 1907 Flood

USGS estimated 1907 Sacramento River peak flow into Suisun Bay to be 600,000 cfs.

(Source: Taylor, 1913)

For comparison, the 1986 estimate was 650,000 cfs.

(Source: DWR Bulletin 69-86)

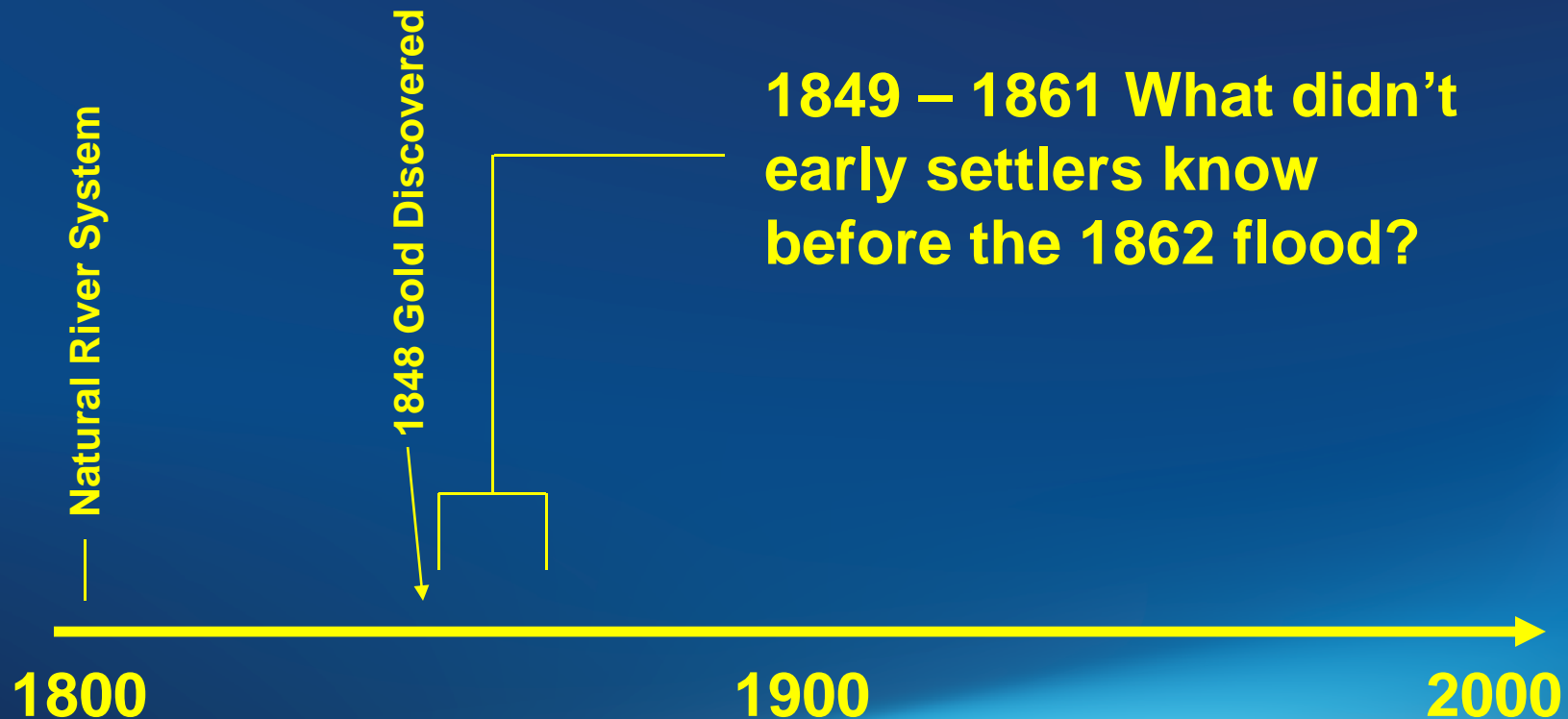


Source: NED and Google Earth



# Sacramento River Valley Timeline

## Topic 2: Historical and Geomorphic Context of 1862 Flood



# Historical Context for Early Settlers Before 1862 Flood – Gold Rush Era

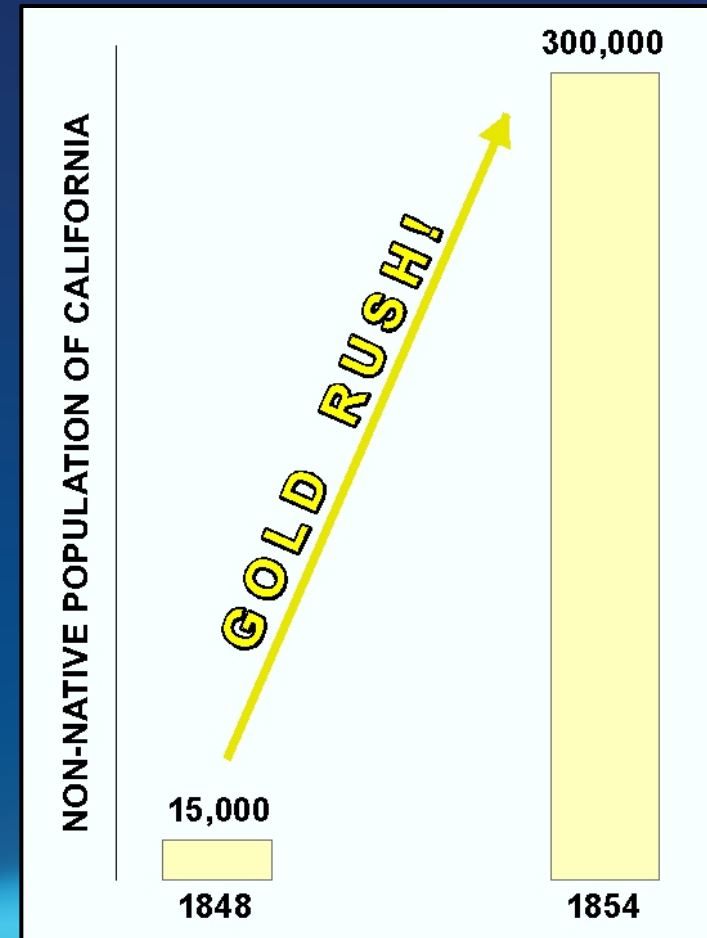
→ 1847 San Francisco Population = 500



Port of San Francisco in 1850

→ 1850 San Francisco Population = 21,000

→ 1870 San Francisco Population = 150,000





# Historical Context for Early Settlers Before 1862 Flood



The City of Sacramento Waterfront during the Great Flood of 1850



# Historical Context for Early Settlers Before 1862 Flood

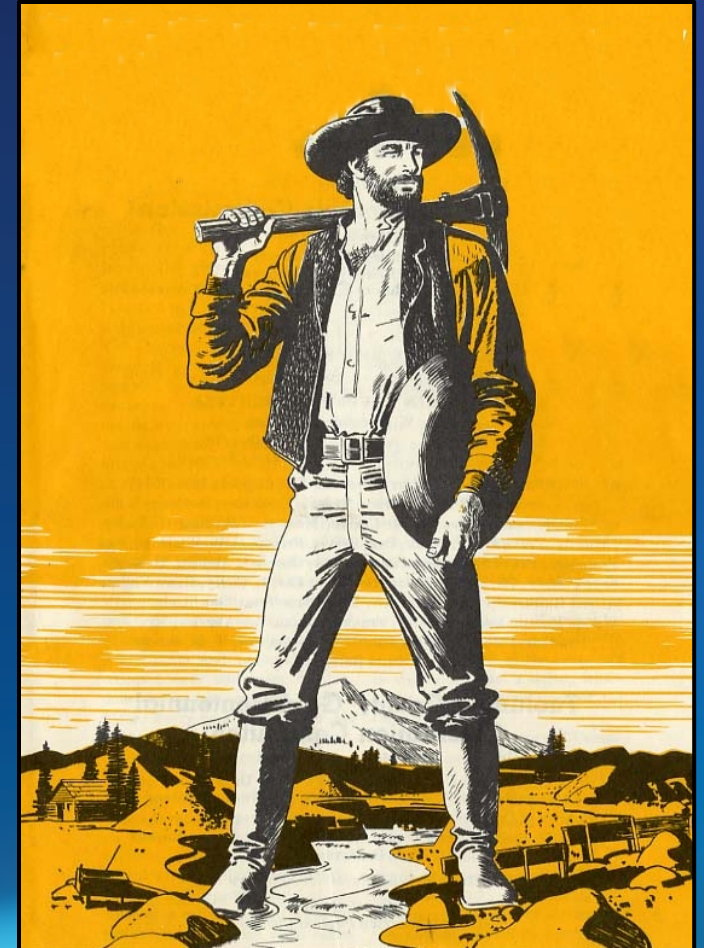
		Drainage area above station (square miles).	Maximum flood dis- charge (cubic feet per second recorded).
Mississippi at Vicksburg.....	Peak / BA	1,100,000	1,777,000
Mississippi above Missouri River.....	1.6	165,000	366,000
Missouri.....	2.2	527,000	546,000
Columbia.....	1.0	237,000	1,390,000
Ohio.....	5.8	201,700	1,233,000
Arkansas.....	6.1	186,300	440,000
Red River.....	2.4	90,000	210,000
Sacramento.....	2.3	26,000	1600,000
	23.1		

<sup>1</sup> Estimated, 1907–1909.

Source: 'Floods of the Sacramento and San Joaquin Watersheds' (Taylor, 1913)

# Historical Context for Early Settlers Before 1862 Flood

- The response by early settlers was:
  - Build levees in hindsight...high enough to protect from the last “big flood”.
  - Frontier mentality...protect yourself and let the people downstream worry about protecting themselves.
  - Result: Fragmented system of inadequate flood protection that persisted for decades.





# The 1862 Flood

- A very large flood that created an “inland sea”
- Unprecedented, but most settlers here only 10 – 15 years.
- Historical accounts from 1805 describe a previous very large “inland sea” flood.
- Subsequent “inland sea” floods in 1879, 1907, and beyond demonstrate that 1862 was not a one-time occurrence.

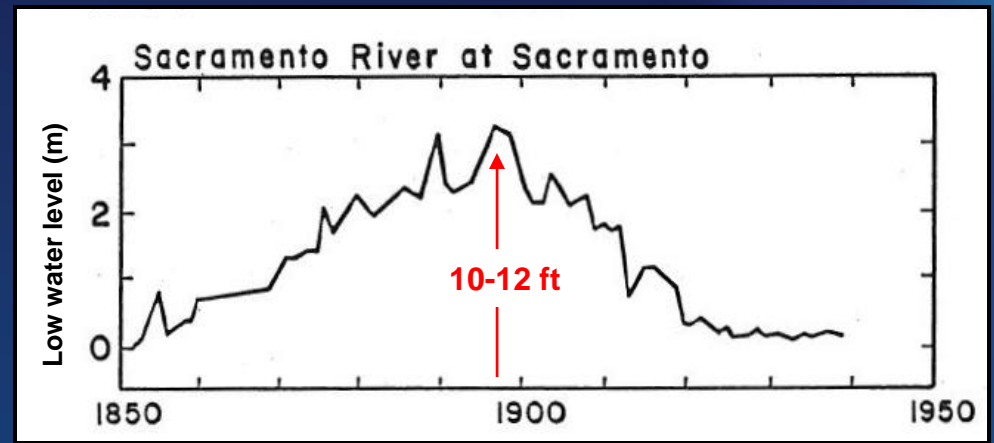


1862 Flooding in Sacramento

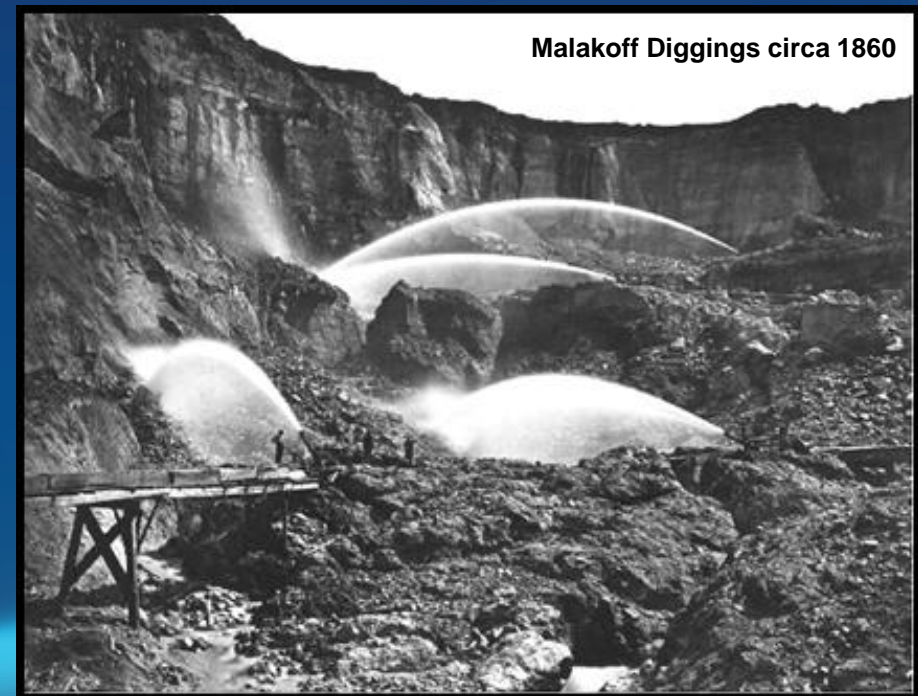


# Hydraulic Mining

- Ongoing from 1853 to 1884
- Mining debris worsened 1862 flooding by choking rivers with sediment.
- Total impact: 1.3 billion cubic yards entered Sacramento River system from 1853 to early 1900s.
- Today, major rivers and sediment loads have adjusted to pre-mining levels, for the most part.

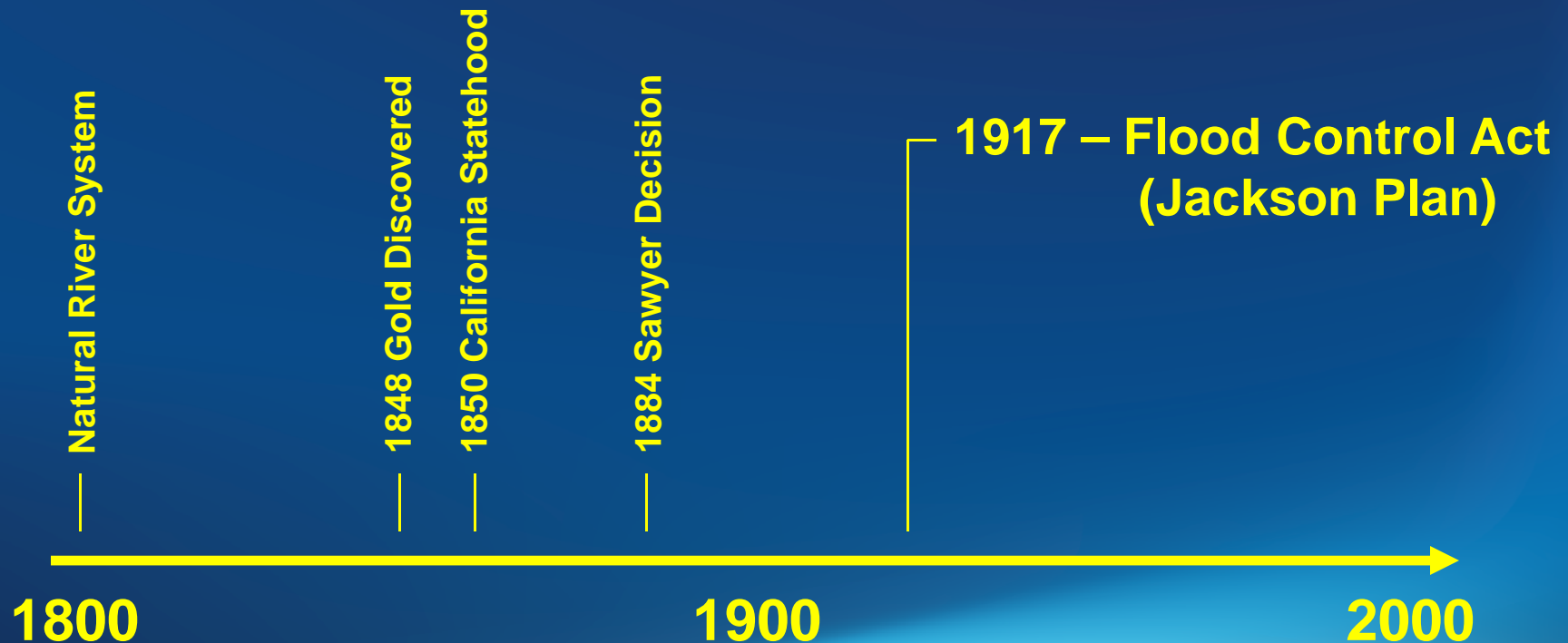


Rise & fall of annual low water level (Meade 1982)



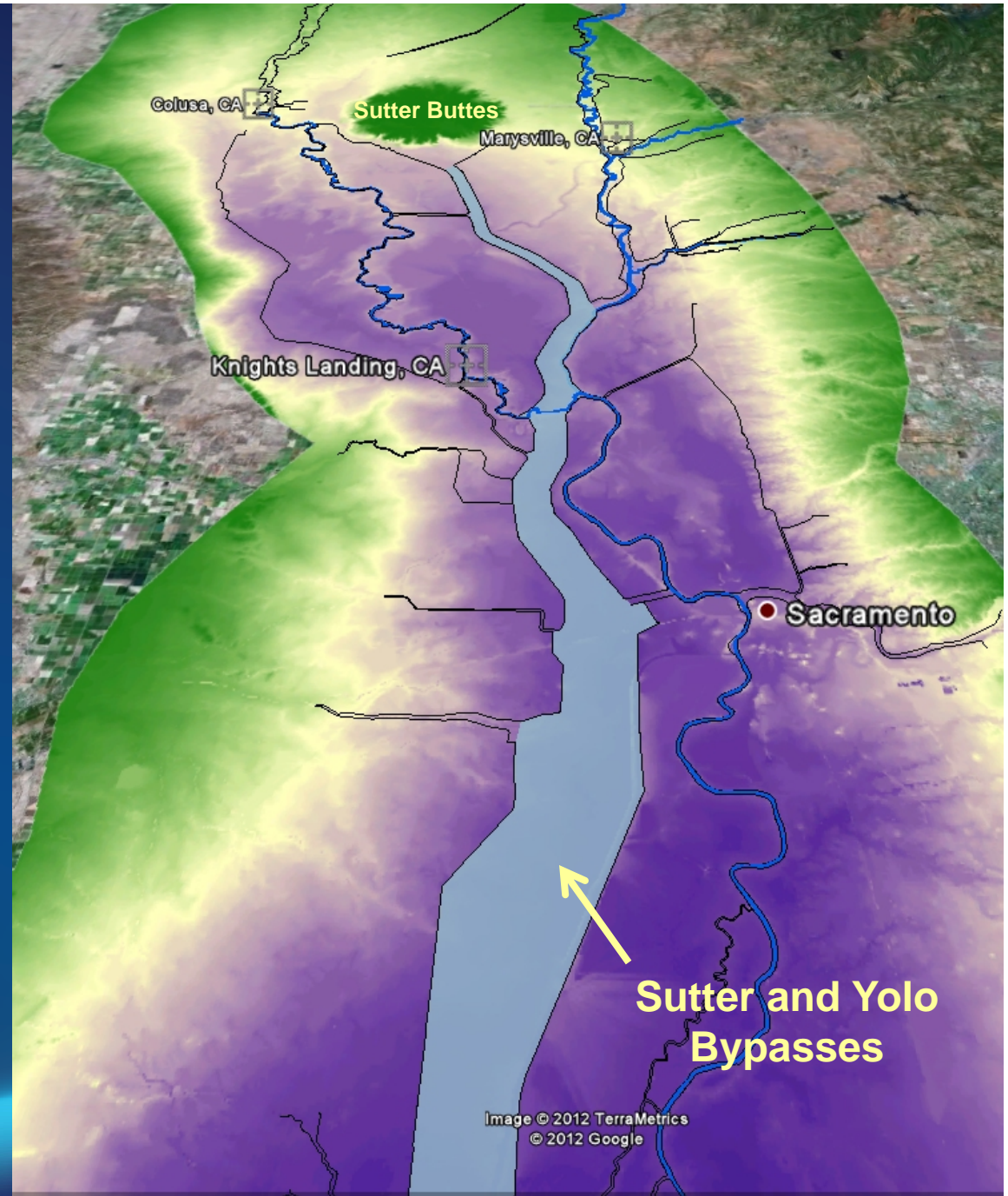
# Sacramento River Valley Timeline

## Topic 3: Integration of Geomorphic Function into the Sacramento River Flood Control Project design



# Integration of Geomorphic Function into the Sacramento River Flood Control Project Design

- The modern day levee and bypass system routes flood flows through the historic flood basins
- System of weirs mimic function of sloughs and crevasses by routing flows from rivers to flow bypasses
- Result is that the majority of flood flows are not carried by lower Sacramento River but through flood basin bypasses, just as in the early 1800s



Source: NED and Google Earth



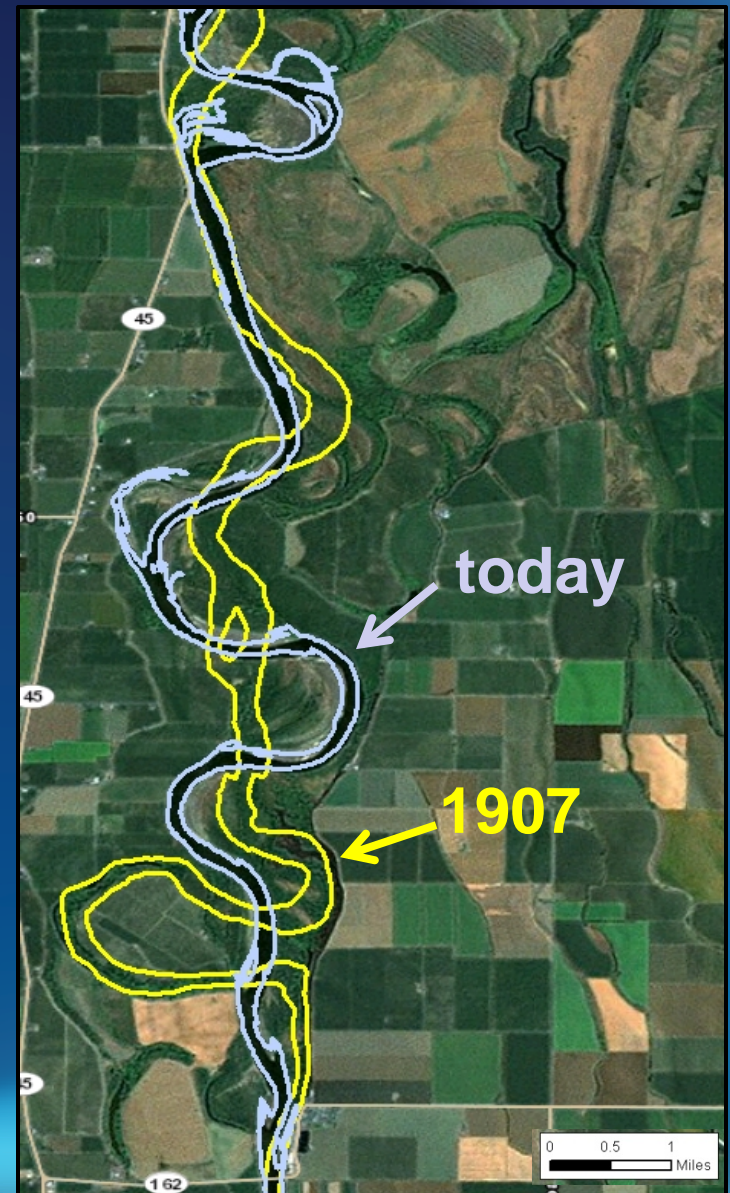
# Summary

- Before levees and dams, seasonal floods on the Sacramento River would regularly inundate adjacent flood basins.
- Very large floods (such as in 1862) would 'fill' the Sacramento Valley.
- Early settlers lacked an appreciation of this process, and of the extremes in annual flow variability and flood magnitude found on the Sacramento River system.
- The modern flood control system mimics natural geomorphic function by routing seasonal floods through the Sutter and Yolo bypasses.

# 1800 – Natural River System

- Natural rivers are not static, they are always moving and evolving.
- The Sacramento River is a meandering river system. It has shifted 100s to 1000s of feet over the last 100 years.
- This leads to varying types of sedimentary deposits (geomorphic units) that characterize deposits the river leaves behind.

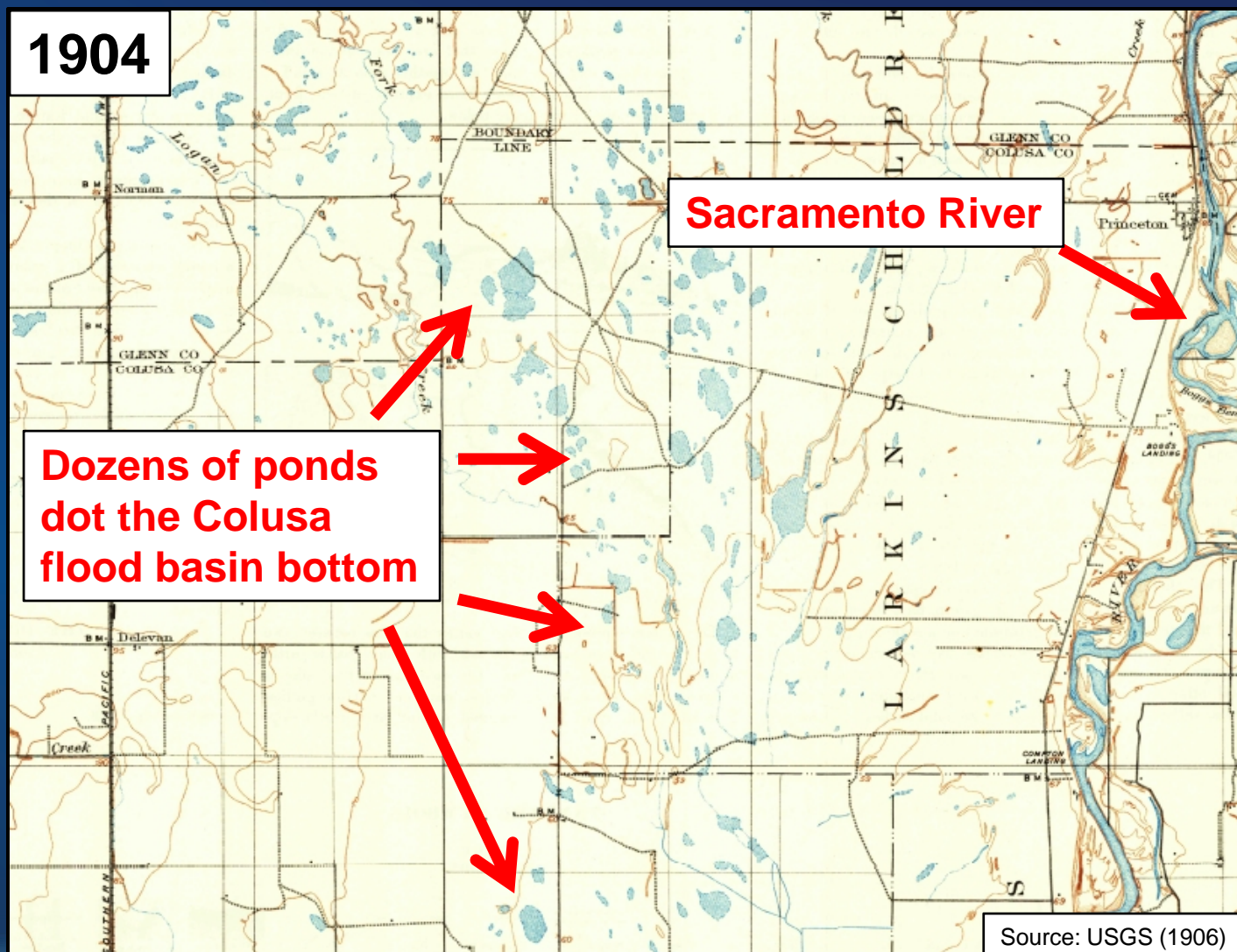
Sacramento River East of Willows



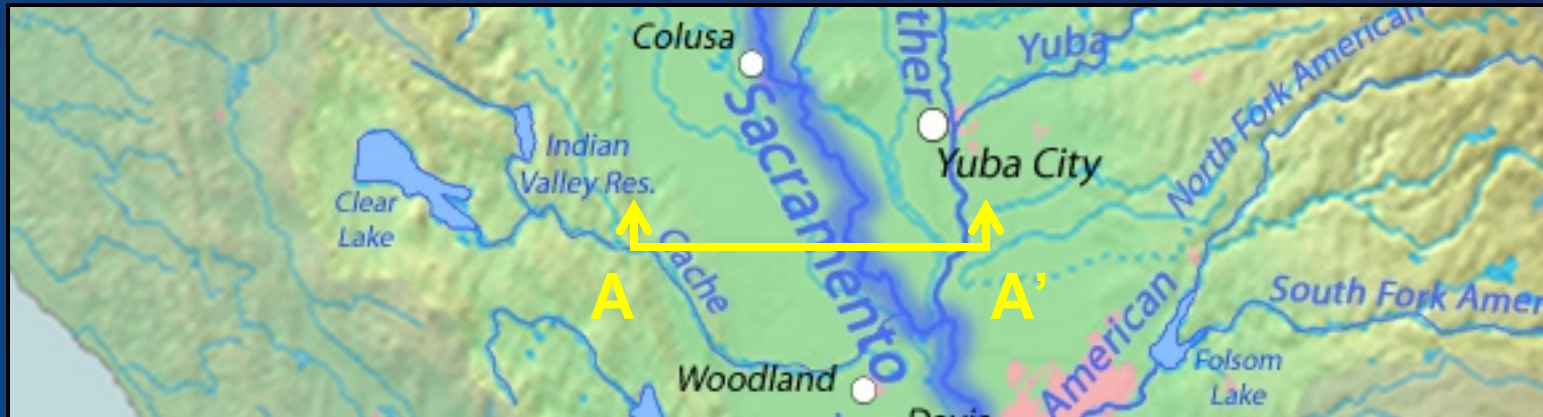


# 1800 – Natural River System

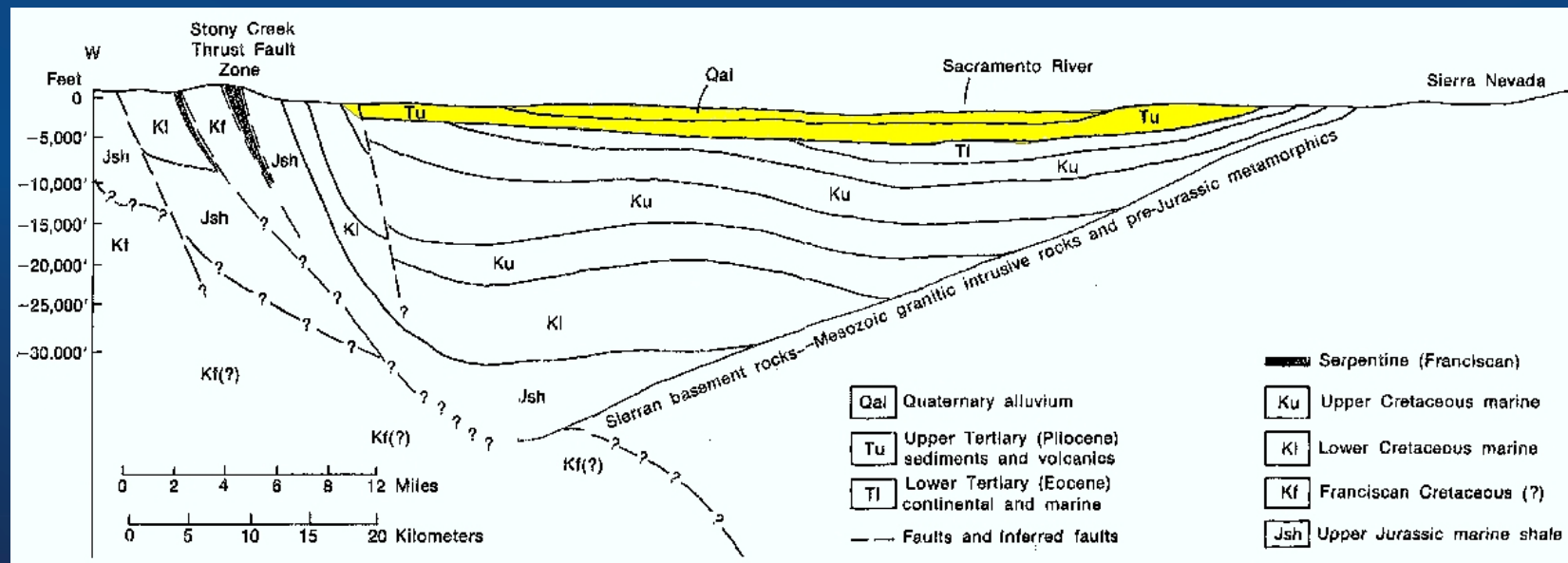
- ➔ Numerous seasonal and perennial lakes and ponds occupy low points in flood basins



Since then, several thousand vertical feet of deposition has occurred, filling the inland sea.



A



A'

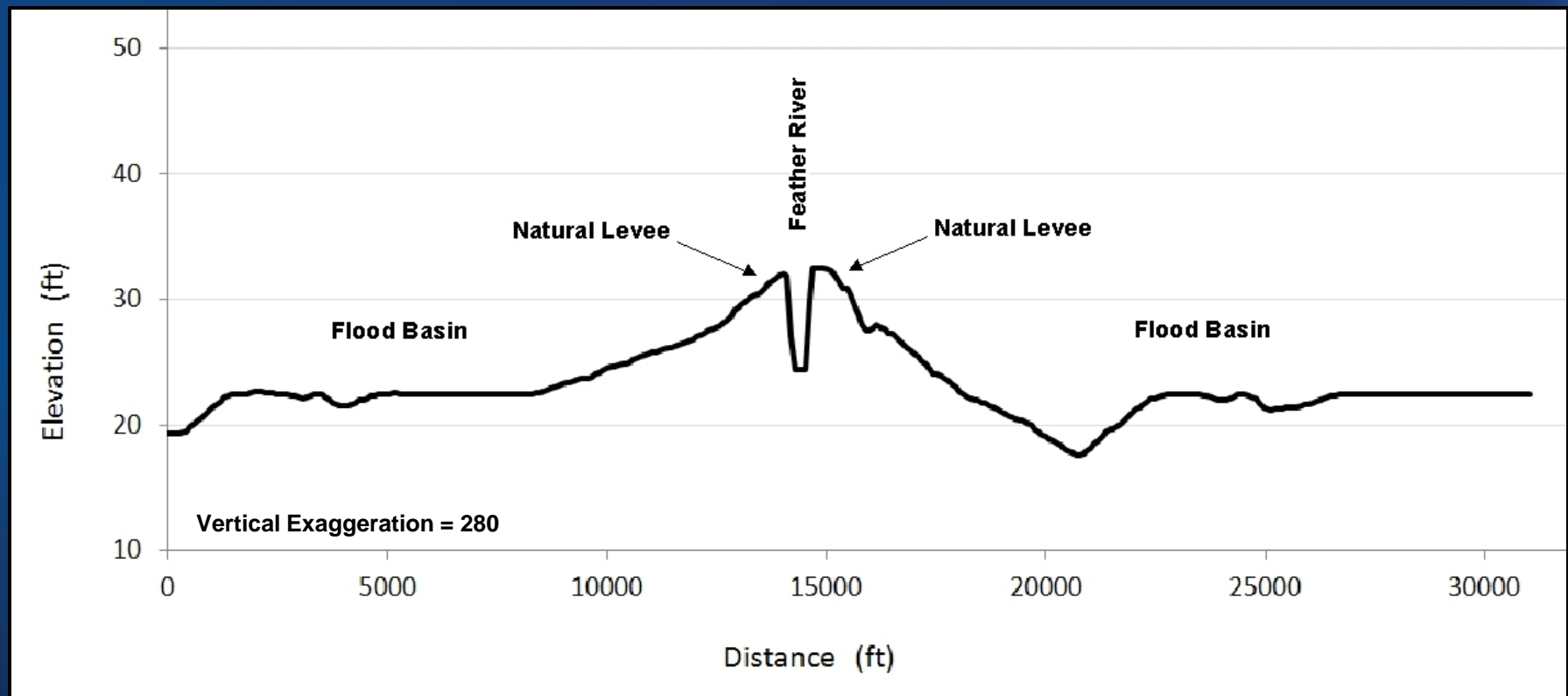
Source: Norris and Webb (1990)

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# 1800 – Natural River System

→ The same is true for the Feather River.



Source: (National Elevation Dataset)



