

*... in Civilizations . . .*

**“Demography is Destiny”**

*French philosopher Auguste Comte*



WATER EDUCATION  
FOUNDATION

... but for California's historical development...

## “Geography is Destiny”

Theme: California's unique geography has played a fundamental role in shaping the state's development, and natural resource management challenges.



# Geography:

– Location of resources shaped California's development:

- Gold
- Arable land
- Early irrigation systems
- Natural harbors
- Film industry (locations and weather)
- WWII industrialization – economic geography

AND, WATER – distribution and demand has shaped development and its impact on natural environment



**The story of  
California is  
the story of  
water**





The Gold Rush was the start of a philosophy of putting California's water to work







# Hydraulic Mining

**1853** - Used powerful jets of water to blast away hillsides

**Malakoff Diggings** (South Yuba River) - mined 100,000 tons of gravel per day and used **16 billion gallons** (32,000 acre-feet) of water per year.

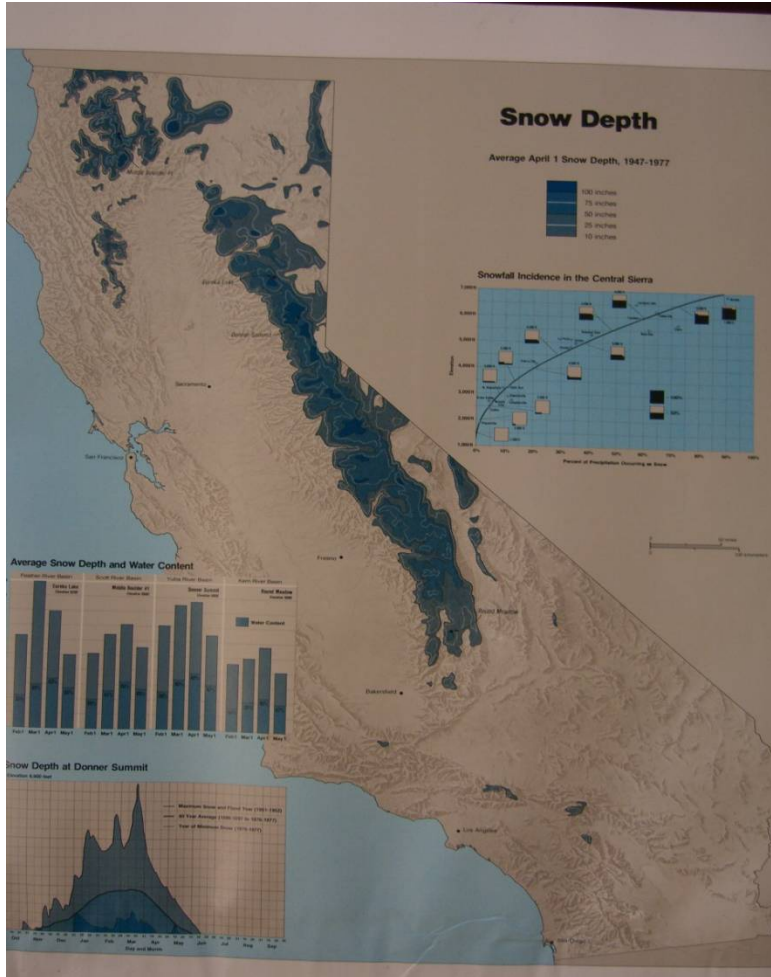
11 million ounces of gold (**worth \$9.7 billion**) by the mid-1880s.



Arteries of Commerce



# California Hydrology



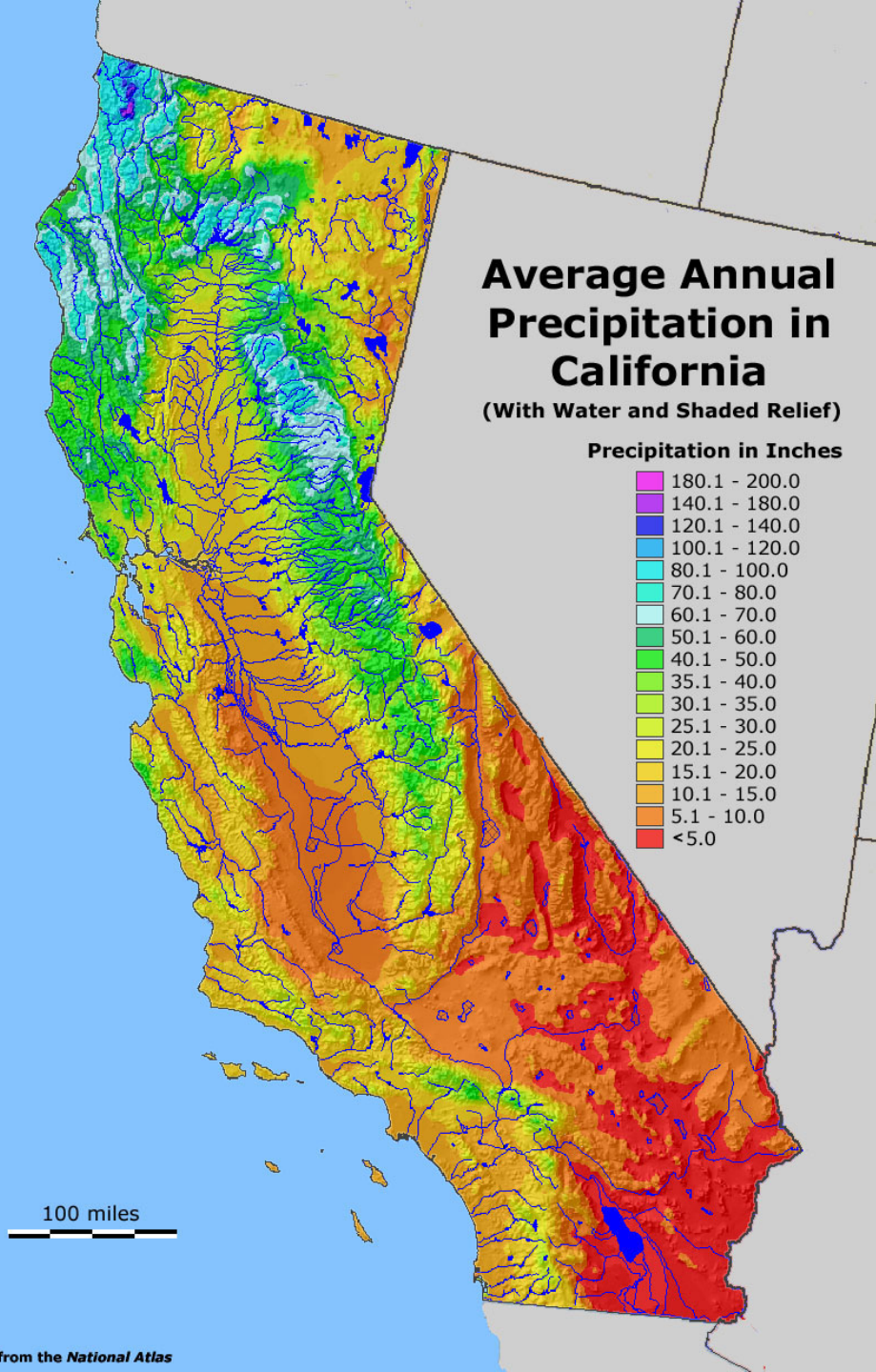
- 💧 Mediterranean climate – dry summers, mild winters
- 💧 In average year, 82 million acre-feet of water used:
  - 💧 Urban – 9 MAF
  - 💧 Agriculture – 34 MAF
  - 💧 Environment – 39 MAF



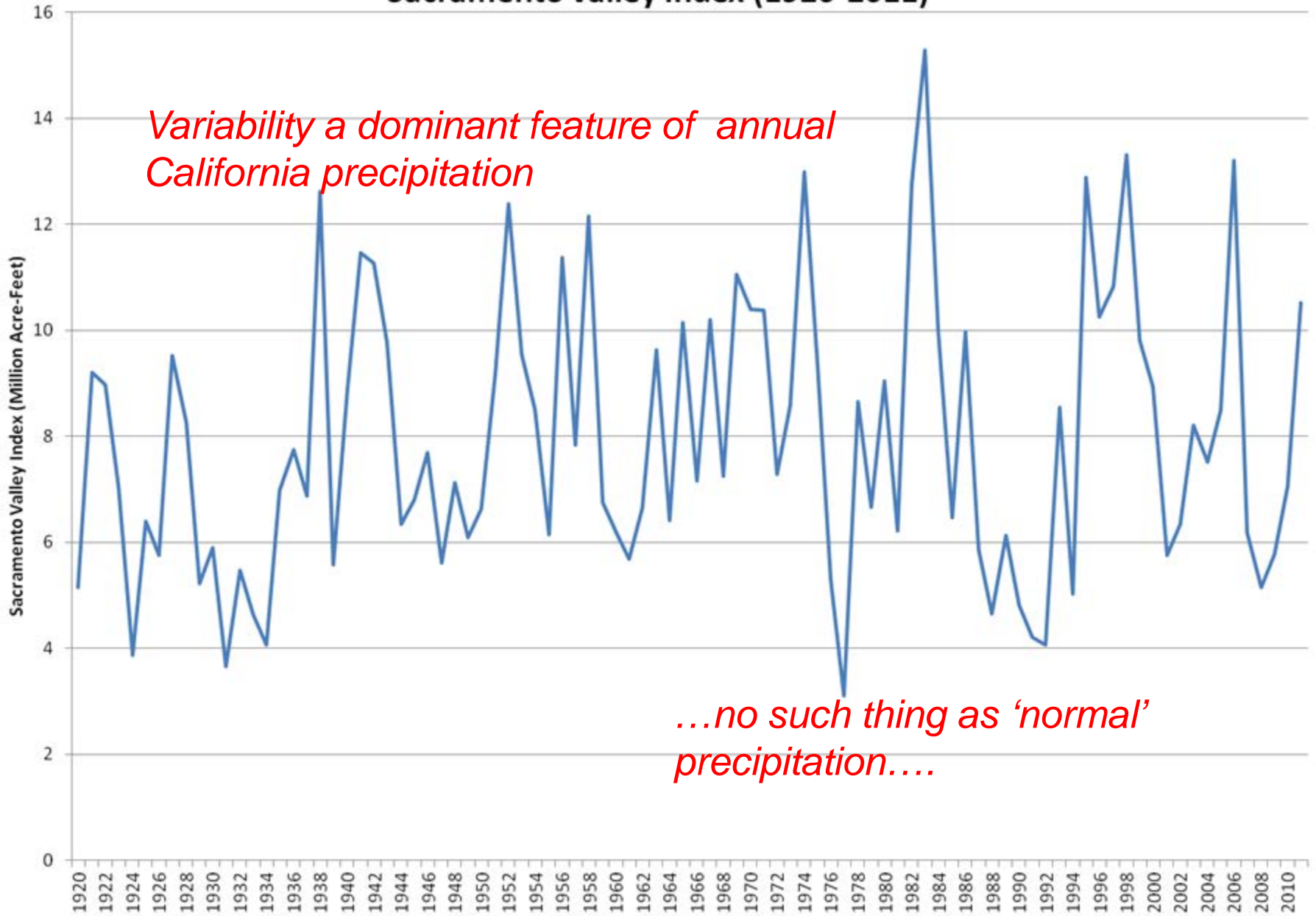
# California Hydrology

Wet in north  
Dry in south

Greatest population  
in south



# Sacramento Valley Index (1920-2011)

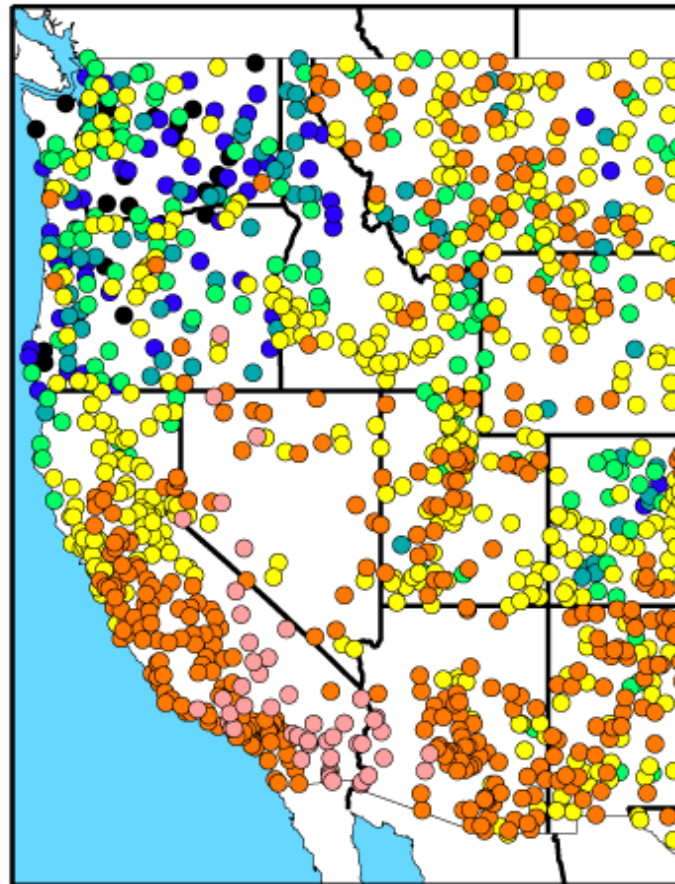


*Variability a dominant feature of annual California precipitation*

*...no such thing as 'normal' precipitation....*

# Just a few storms each year are the core of California's water supplies

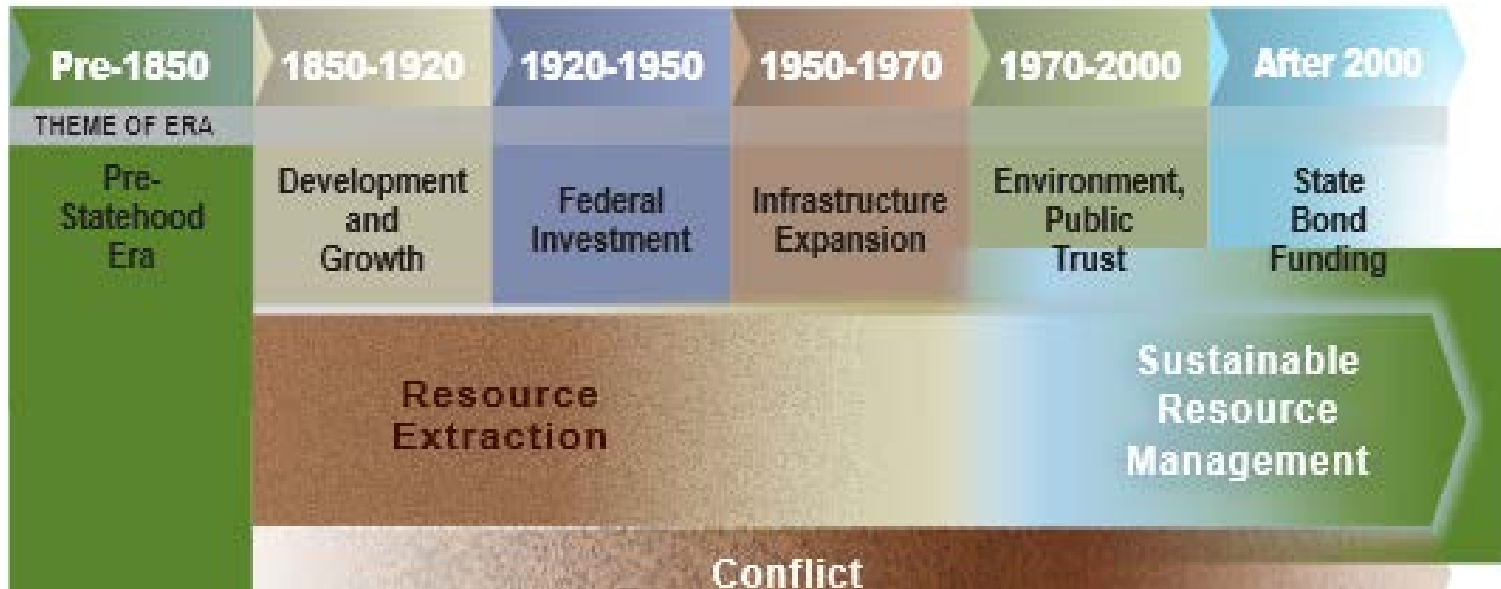
c) AVERAGE NUMBER OF DAYS/YR TO OBTAIN HALF OF TOTAL PRECIPITATION, WY 1951-2008



days/year



# How Our Past Shaped the 21st Century



# The Great Projects



They were built to alleviate drought. They were built to protect against floods. And as California boomed, projects were built to generate electricity and move the water from where it occurred to where it could provide the most benefit for a booming economy – in the fields and cities.

At the turn of the century, John Muir played an influential role in gaining national park status for the beautiful Yosemite Valley. But the conservationist – standing posed with President Theodore Roosevelt high above Yosemite Valley – failed to win protection for another valley just to the north, the Hetch Hetchy Valley.

The city of San Francisco selected Hetch Hetchy in 1901 as the place to dam the Tuolumne River, conveying

its pristine water by gravity to San Francisco.

Controversy over developing the valley, which was within the confines of Yosemite National Park, brewed for decades with the fight against the project led by conservationist and Sierra Club founder Muir.

In 1913, Congress passed the Raker Act, authorizing the project. Muir died two years later and in 1923, with completion of O'Shaughnessy Dam, the Hetch Hetchy Valley was flooded. •

# California Water Development



**Hetch Hetchy System**

**San Francisco PUC**

**1913 - Raker Act**

**Los Angeles Aqueduct**

**Los Angeles DWP**

**1913**

**Mokelumne River Aqueduct**

**East Bay MUD**

**1929**

**Central Valley project**

**U.S. Bureau of Reclamation**

**1940 (C.C. Canal first)**

**Colorado River Aqueduct**

**MWD of So. Cal.**

**1941**

**State Water Project**

**California DWR**

**1960 - Burns Porter Act**

# Federally Funded Projects

💧 35 federally funded dams, reservoirs and canals. Built by U.S. Army Corps of Engineers and U.S. Bureau of Reclamation



Shasta Dam

💧 Central Valley Project (CVP), begins on the Sacramento River at Shasta Dam and ends near Bakersfield.





# Federally Funded Projects - CVP



- 💧 90% used to irrigate farms in Central Valley

- 💧 Some water to urban residents in the Bay Area

## Financing

- 💧 1902: Reclamation Act – 160 acre service limitation
- 💧 1982: Act increased service limitation to 960 acres
- 💧 1992: CVPIA added environment as specific purpose created water account for environment



# Committed to the State Water Project



Governor Pat Brown was elected in 1958.

Gov. Brown made authorizing, financing, and building the State Water Project a priority of his administration.

***“I was absolutely determined that I was going to pass this California water project.”***



# Burns-Porter Act



1959 - The state Legislature authorized construction of the State Water Project through the California Water Resources Development Bond Act, also known as the Burns-Porter Act

# State-Funded Projects - SWP



*Gov. Pat Brown at Oroville Dam*

1961 – construction begins

Facilities were built from north to south – Oroville Dam to Southern California.

The State Water Project is the largest state-financed water project ever built.



# State Water Project



- 💧 SWP includes 34 storage facilities; 20 pumping plants; 4 pumping-generating plants; 5 hydroelectric power plants; and about 700 miles of open canals and pipelines.
- 💧 Planned to deliver 4.2 MAF/year; currently delivers less than 3.0 MAF/year – reliability diminished due to lack of construction of some planned facilities and new regulatory requirements.
- 💧 About 30% of deliveries to agriculture in the San Joaquin Valley and 70% to urban Southern California, Bay Area and Central Coast.

# Financing the SWP

- 💧 1960 - \$1.75 billion bond
- 💧 29 contractors pay all costs, including bond interest, energy and transmission charges per Water Supply Contracts
- 💧 No acreage limitations



San Luis Reservoir

# Water and Energy

- 💧 20% of state's electricity is used to bring water to consumers and send it away for sewage treatment.
- 💧 SWP is single-largest power consumer in California
- 💧 SWP is the fourth-largest power generator in California, generating about two-thirds of electricity to run its facilities.



Hyatt Powerplant below Lake Oroville is in a cavern the size of two football fields.

# Operation of the CVP/SWP

- Upstream reservoirs capture water during wet season and snow runoff
- Stored water released to meet regulatory requirements and water deliveries to SWP customers
- Coordinated Operations Agreement
  - Joint responsibilities for Delta Water Quality Management
  - Sharing of access to unregulated surplus flows in Delta.





# Operation of the CVP/SWP

- Water delivered to service areas by contract, subject to agreements with *senior* rights holders
  - *Sacramento River Settlement Contractors (CVP)*
  - *San Joaquin River Exchange Contractors*
  - *North Delta Water agency (SWP)*
  - *City of Sacramento*
  - Project contractors:
    - Tehama Colusa Canal, Sacramento area contractors, Contra Costa WD,
    - Export service: San Luis Delta Mendota Water Authority, Santa Clara Valley WD, EBMUD
- Reservoir storage, natural river conditions and regulatory requirements determine water available for export

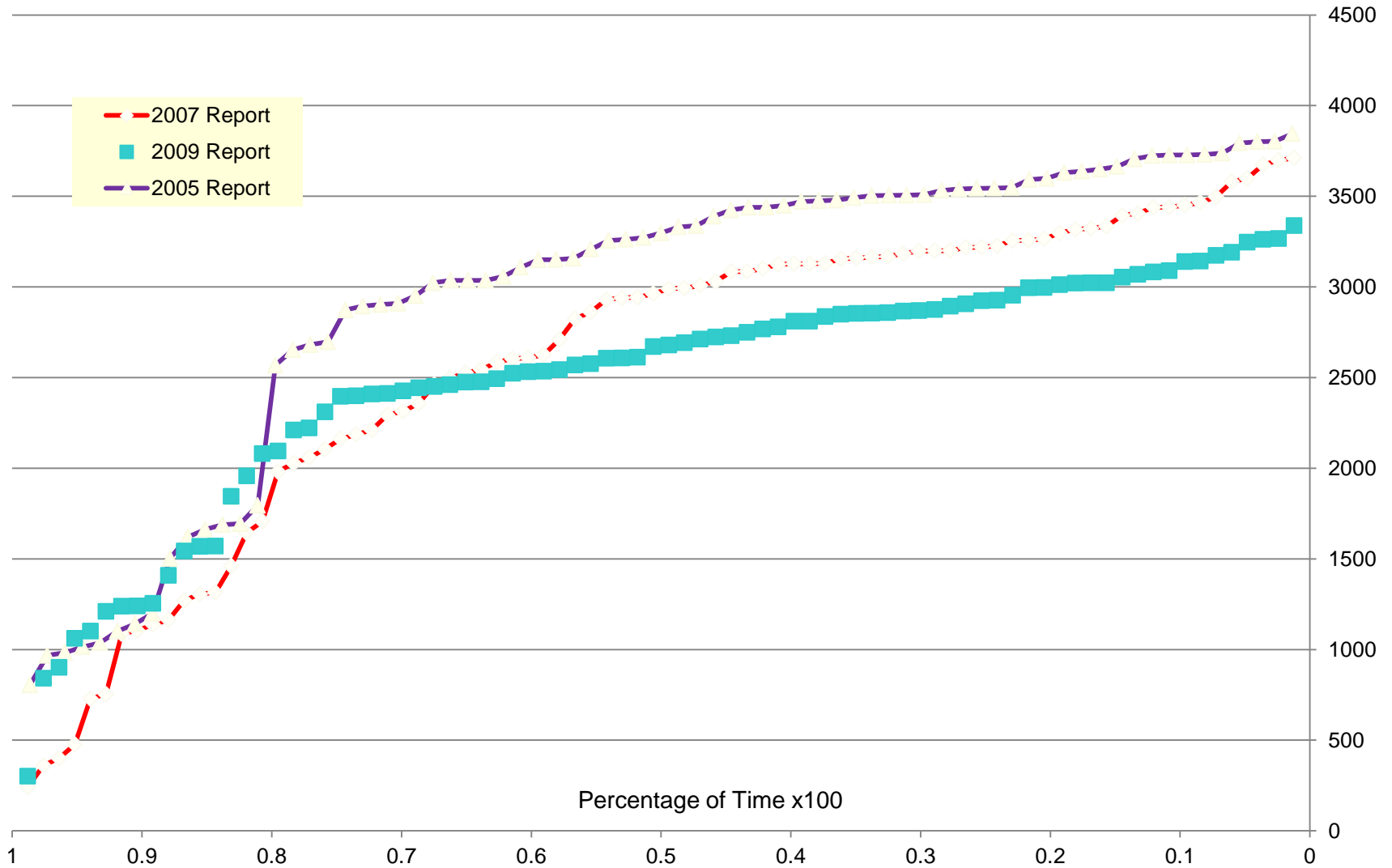


# Operation of the CVP/SWP

- Export supply determined by:
  - Snowpack
  - Reservoir storage
  - Instream flow requirements
  - Delta flow/water quality/fish protection regulations
  - Export pumping capacity
- If demand or available storage capacity exists and there is pumping capacity within requirements, water can be pumped.
- Over past decades, shift from demand limited system to regulatory constrained system.



# Regulatory Restrictions Have Degraded SWP Water Reliability

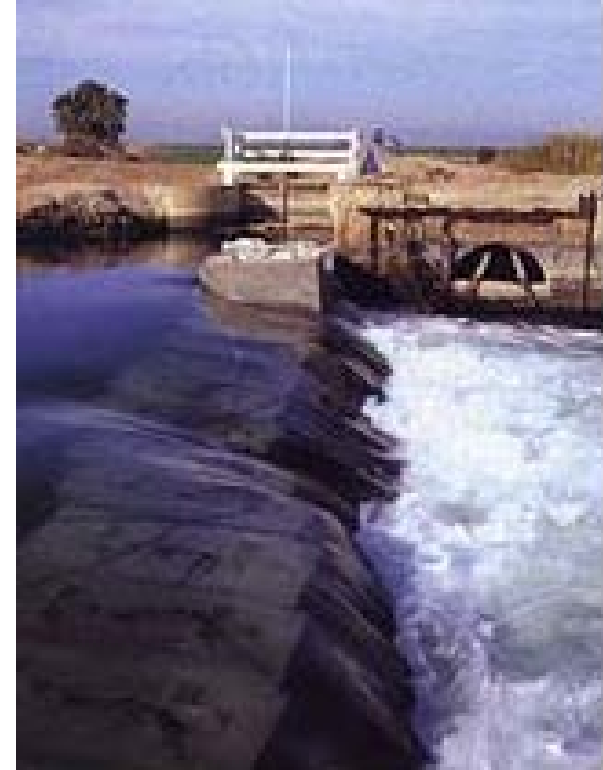


# Locally Funded Projects

600 cities and local agencies provide water through local projects and imported supplies.

Local systems:

- 💧 San Francisco's Hetch Hetchy Project
- 💧 East Bay Municipal Utility District's Pardee and Camanche Reservoirs and Aqueducts
- 💧 Los Angeles' Owens Valley and Los Angeles Aqueduct
- 💧 Metropolitan's Colorado River Aqueduct & Diamond Valley Lake



# Hetch Hetchy

## **Raker Act (1913)**

- Federal lands in the Sierra Nevada Mountains, including Hetch Hetchy Valley in Yosemite, used to build the water system
- The Bay Area Water Supply and Conservation Agency (BAWSCA)
- 1.7 million citizens and businesses



# More Local Systems

- 💧 Metropolitan Water District of Southern California - largest local district
  - operates Colorado River Aqueduct.
- 💧 Other local projects serve farmers, such as Glenn-Colusa Canal in the Sacramento Valley.



Diamond Valley Lake (MWD photo)





# Major Water Projects





# Environmental Protection Law



American River

- 💧 1972 State Wild and Scenic Rivers Act - no dams or diversion facilities on the Smith River and parts of Klamath, Trinity, Van Duzen, Scott, Eel, Salmon, Feather and American
- 💧 In 1980, some rivers added to the Federal Wild and Scenic Rivers System
- 💧 Today parts of other rivers included

# Environmental Protection Law

- Federal and State Endangered Species Acts
- Federal Energy Regulatory Commission
- Clean Water Act
- Porter Cologne water quality act
- Fish and Game code

# Groundwater

Groundwater exists in aquifers – water bearing permeable rock or unconsolidated gravel, sand or silt

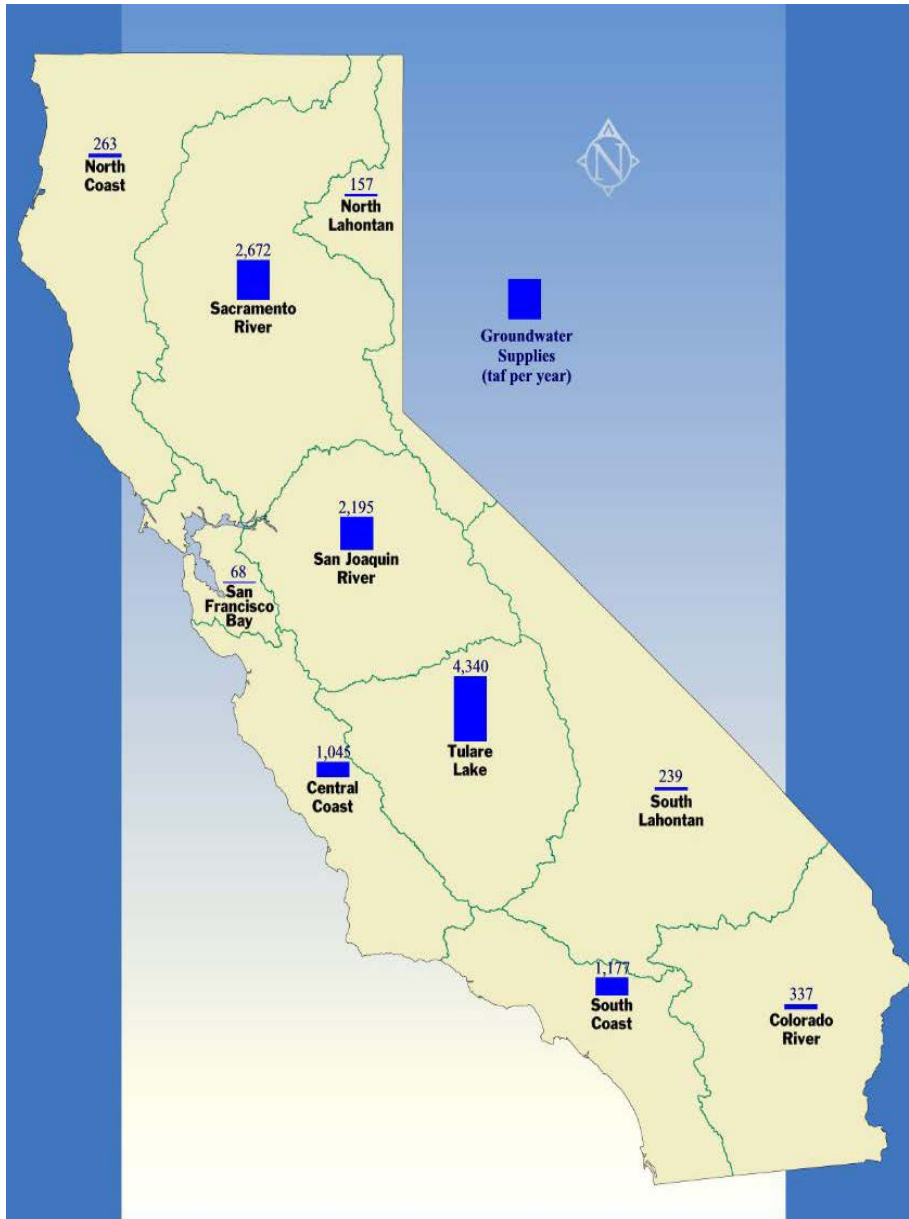
💧 About 30% of state's ag and urban water supply comes from groundwater in normal years; more in dry years.

💧 California uses more groundwater than any other state – about 40% of population gets drinking water from groundwater

💧 Groundwater that is “conjunctively managed” with surface water is an important source of ag supply



# Groundwater Supplies



Where is the groundwater?

More than 400 groundwater basins hold about 850 MAF of water. Only a fraction of that total minority that is economically usable.



# Groundwater Overdraft

Overdraft is taking more water out of an aquifer than is recharged over a long term (multi-year) time span

- 💧 Historical overdraft in Central Valley led to construction of Central Valley Project
- 💧 NASA - Central Valley has pumped enormous amounts of groundwater from 2003-2009 - 24.3 million acre feet since 2003 – enough to fill Lake Powell, 2<sup>nd</sup> largest reservoir in USA
- 💧 Even greater amounts pumped during recent historic drought.

*USGS scientist shows overdraft in San Joaquin Valley, 1970s*



# Groundwater Management

- 💧 In Southern California, many groundwater basins have been adjudicated, with courts establishing the pumping rights of many parties.
- 💧 Historic regulation of groundwater – 2014 Sustainable Groundwater Management Act provides local authority and responsibility to manage groundwater.



# Groundwater Pollution

Pollution is a serious threat. All the state's groundwater basins are contaminated to some degree.

- 💧 Trichloroethylene (TCE) - Used in adhesives, lubricants, paint products, pesticides, adhesives, rug-cleaners
- 💧 Perchlorate - Primary ingredient of solid rocket propellant
- 💧 Methyl tertiary butyl ether (MTBE) - added to gasoline to reduce air pollution in 1990s.
- 💧 Groundwater overdraft can mobilize polluted groundwater



# Flood Management

## 💧 Floodplain Management

- In next 25 years population increase of about 14 million. Development will impact floodplains

## 💧 Levee Repairs

- Nearly 250 levee repair sites identified and work progressing

## 💧 Climate Change

- Warming ocean water and melting ice = sea level increase by 1.6 feet by 2050 along coastlines. By 2100 sea rise could be more than 3 feet. Recent warming running ahead of predictions and estimates may be low





# Flood Management: Levees

## 2005 – Hurricane Katrina

## 2006 – California Reacts to Flood Risk

Gov. Schwarzenegger declares a State of Emergency for California's levee system

- Flood Bonds passed

## 2012 – Central Valley Plan

Strategic Plan for improving flood management in Central Valley

## 2013 – Statewide Plan

Strategic Plan for improving flood management statewide



# Diversifying Water Supply

- Governor Brown's California Water Action Plan founded on "all of the above" approach to improving water supply reliability
- State guidelines for Integrated Regional Water Management Plans require analysis of:
  - Ocean Desalination
  - Wastewater Recycling
  - Water Conservation
  - Stormwater Capture
  - Water Transfers

# Ocean Desalination

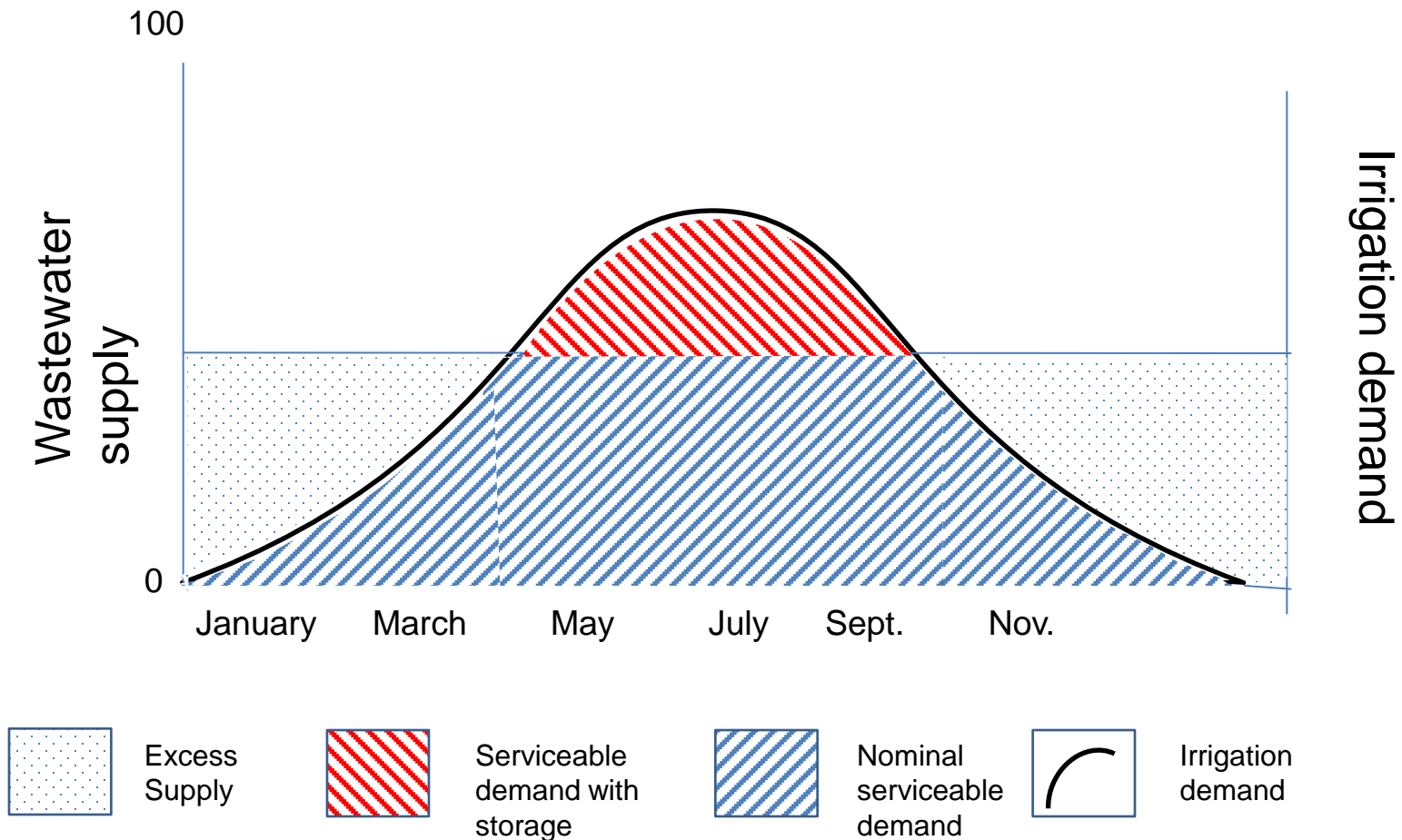
- Popularly viewed as ‘ultimate’ solution
- Process is reliable but expensive
- Energy/Green House Gas considerations
- Limited application
  - For additional baseload supply where imported water is expensive and unreliable
  - For isolated coastal urban locations
- Uneconomic for agriculture or urban irrigation
- Expect more, but limited application in future

# Wastewater Recycling

Process of recycling treated sewage for non-potable and potable uses

- Requires separate plumbing system for non-potable applications
- Economic justification includes consideration of reliability and offset in treated wastewater disposal costs
- Expect more in future, particularly with incentive of state and federal cost shares

# Conceptual Recycled Water Potential Typical Urban Location



# Water Conservation

- Reduction in use/demand management
- Role in water supply reliability planning – long term efforts
- Role in drought response – temporary use reductions
- Long term efforts cause ‘demand hardening’, limiting easy drought response
- Historic drought fueled movement for “Making conservation a California Way of Life”

# Stormwater Capture

- Generally focused on urban areas
- Receiving re-look as other sources less available, costs rise
- Very site specific: capture opportunities, storage opportunities, treatment issues
- Link to sustainability planning – limiting hardscape, local water retention, infiltration strategies

# Water Transfers

- Where one entity with excess supply transfers to another in need
- Common inter and intra-district strategy in agriculture
- Increasingly a way to shore up urban supplies
- Transfers using CVP/SWP infrastructure
  - Temporary land fallowing
  - Transfers from water storage
- Complicated due to legal and physical constraints



# Water Transfers

- Legal issues:
  - Real water test
  - Source of water and water rights:
    - location, pre-'14 water right no SWRCB jurisdiction, lead agency under CEQA is transferring agency; one-year exemption
    - If a post-'14 water right SWRCB lead agency and exempt from CEQA for one year transfer 'SWRCB equivalent process'
- Physical issues: can you move it through the Delta?

# Summary

- California's historical development and its supporting water development was shaped by our unique geography
- Development and management of water supply in California involves a complex mix of Federal, State, Local and private interests operating under an increasingly complicated regulatory regime seeking balancing of water demands with natural resource protection
- Water supply planning has evolved from "gap analysis" to "risk analysis" and an integrated water management approach that values diverse portfolios to maintain supply reliability
- A growing population, competing demands, and climate change effects will make water resources management an ongoing challenge