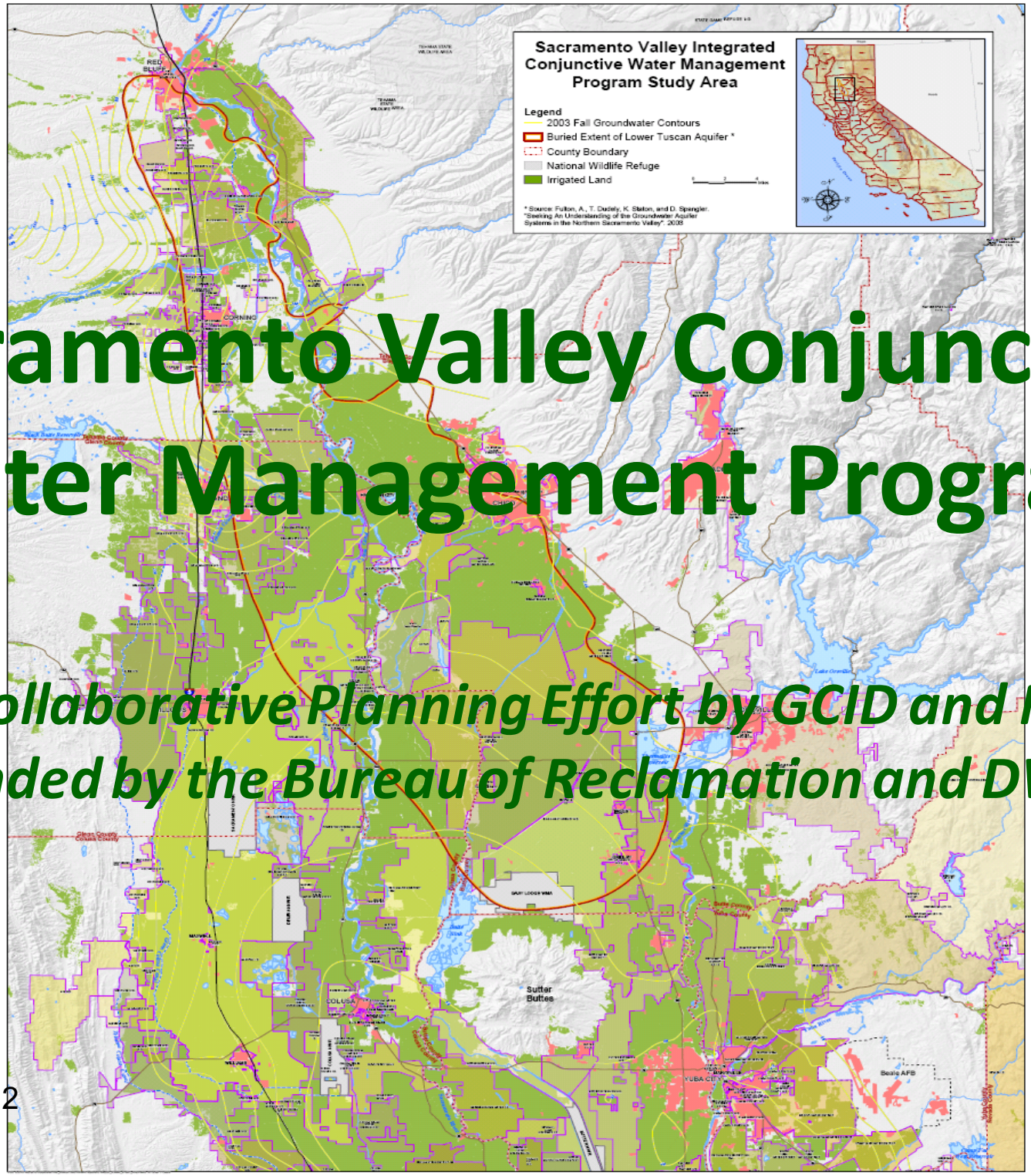
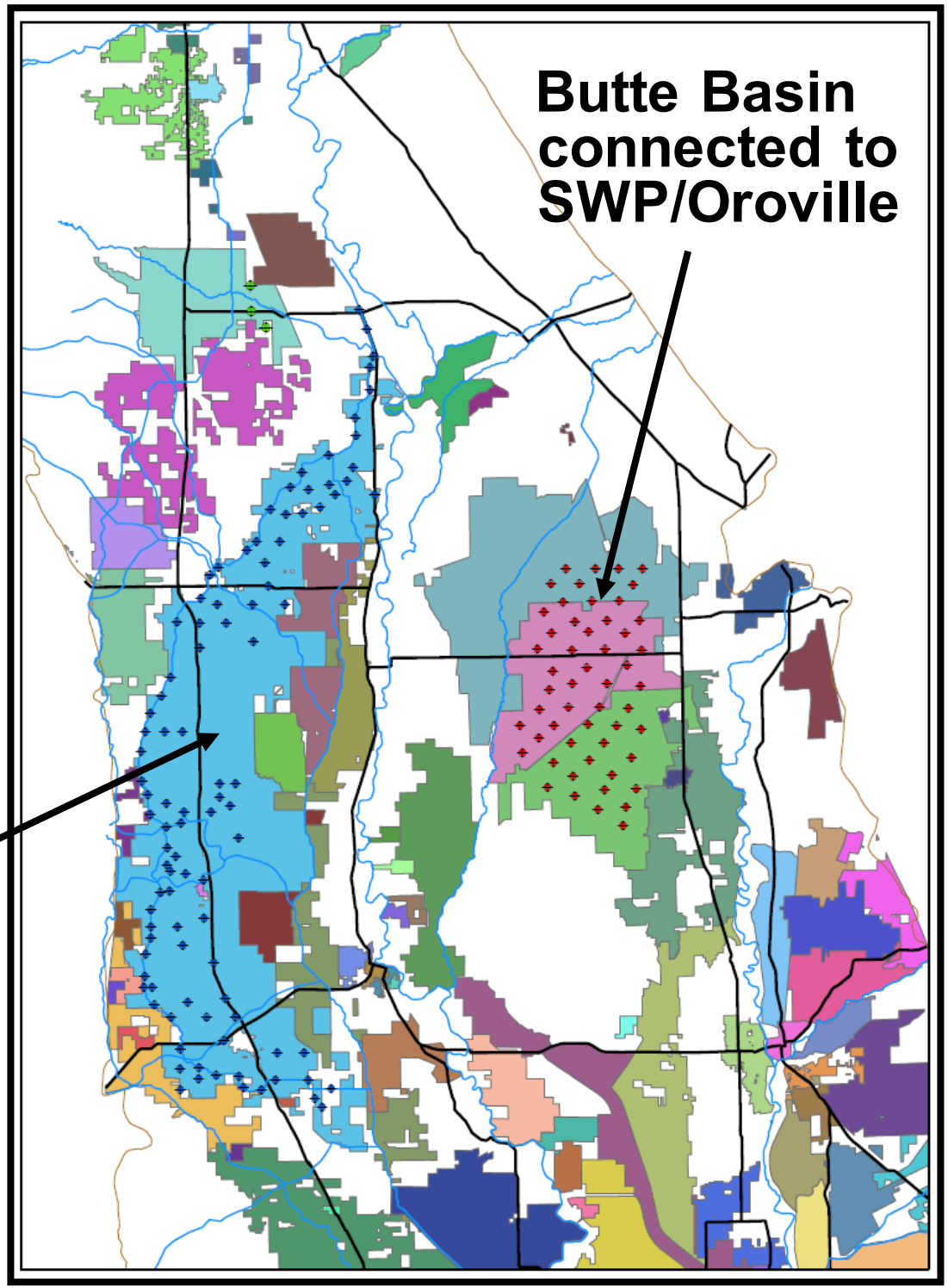


Sacramento Valley Conjunctive Water Management Program

A Collaborative Planning Effort by GCID and NHI

Funded by the Bureau of Reclamation and DWR

Two Sites Selected for Modeling



August 8, 2012

Reoperate Reservoirs with Backstopping by Groundwater Integration

- **Capture the fraction of the runoff hydrograph not now controlled for beneficial use by increasing flood reservation**
- **Dedicate this "surplus" water to environmental flows and improved water supply**
- **Payback reservoir in dry years with groundwater substitution (also looked at crop idling)**
- **Incidental flood control benefits**
- **Incidental climate resilience benefits**

Project Design Principles

- Honor all existing CVP and SWP water supply obligations operational constraints
- Achieve net environmental benefit
  - Tradeoffs among alternative environmental water uses
  - Account for impacts of additional pumping on fish-critical streams
- Hold other GW users harmless: avoid, minimize, or mitigate impacts
- Generate net economic benefits

STORAGE RESERVOIRS IMPAIR NATURAL FLOWS IN TWO WAYS

1. **FLOW DEPLETION**

2. **FLOW ALTERATION**

COMBINED EFFECTS: FRESHWATER ECOSYSTEMS ARE THE MOST IMPAIRED ON THE PLANET

= EXTINCTION CRISIS

ENVIRONMENTAL FLOWS

OLD PARADIGM: **"MINIMUM INSTREAM FLOWS"**

NEW PARADIGM: **MORE VARIABLE FLOWS – MIMIC NATURAL PATTERNS**

RECONNECT RIVERS TO THEIR HISTORIC FLOODPLAINS

SPECIFYING ENVIRONMENTAL FLOW REQUIREMENTS

- **MAGNITUDE**
- **DURATION**
- **FREQUENCY**
- **TIMING**
- **REACH [SEQUENTIAL USE?]**

Environmental Flow Objectives

- Geomorphic
  - Single day large event
  - February or March
- Riparian establishment
  - Five day large flow with 60 day recession
  - April start
- Flood plain inundation
  - Single day large event with 45 day recession
  - Between February and April
- Spring pulse flow
  - Simulate more natural spring runoff period

Improve In-Valley Water Supply

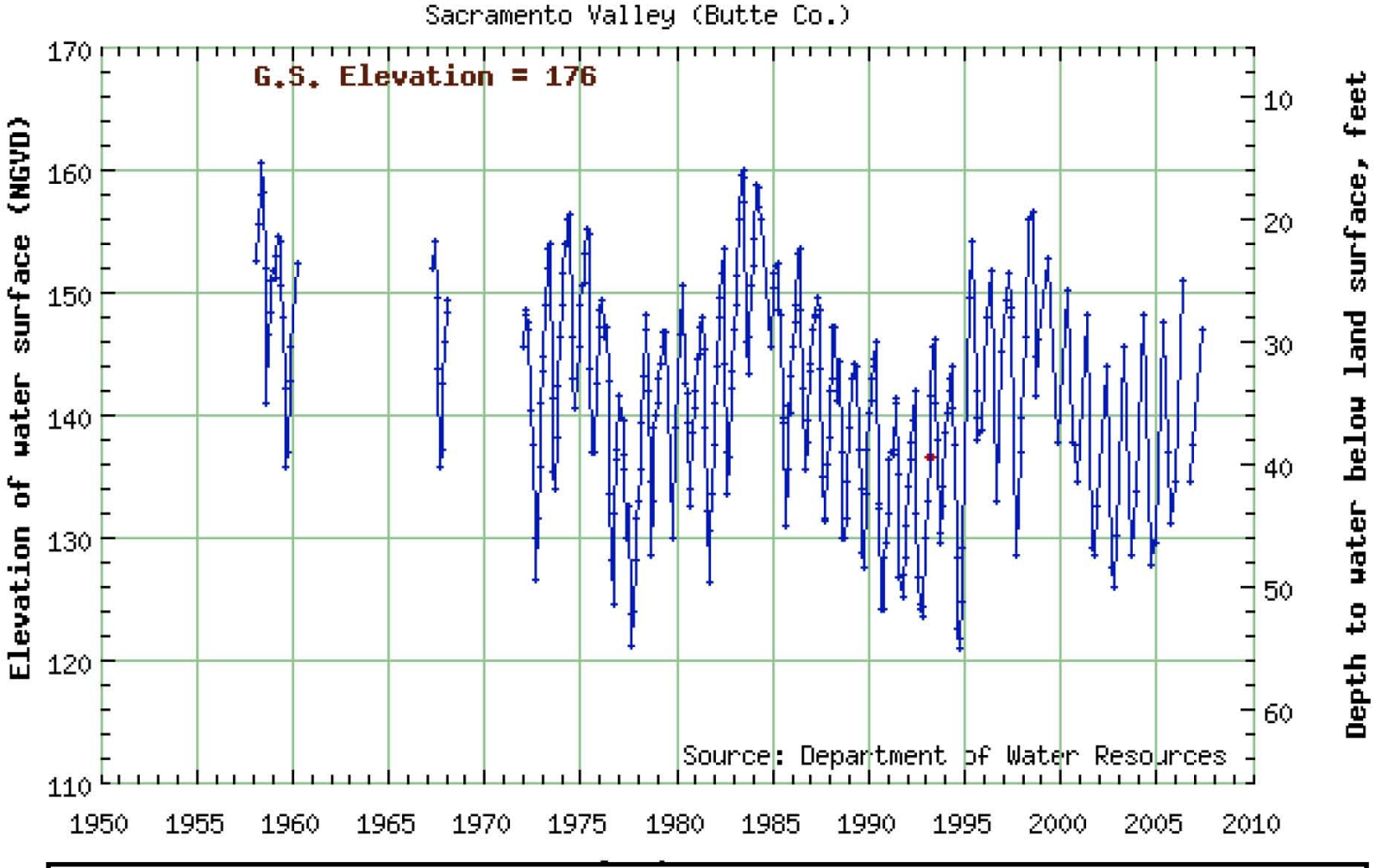
- Historical unmet agricultural surface water demands used as surrogates for additional in-Valley water needs
  - Central Valley Project (CVP) water supply contractors along Tehama-Colusa Canal
  - Feather River water rights holders subject to shortages in dry years
  - Minimize crop idling and groundwater pumping

Additional water supplies could be used for any purpose.

Options Considered for Paying Back the Reservoirs

Options	Limiting Factors
1. Active groundwater recharge	• Lack of persistent cones of depression
2. Pumping groundwater within cooperating districts	• Costs of mitigation of groundwater impact • Keswick minimum release requirements for temp control
3. Crop idling in cooperating districts	• Timing for decisions make this inefficient • Keswick minimum release requirements for temp control

Typical Sacramento Valley GW Hydrograph (Butte Co.)



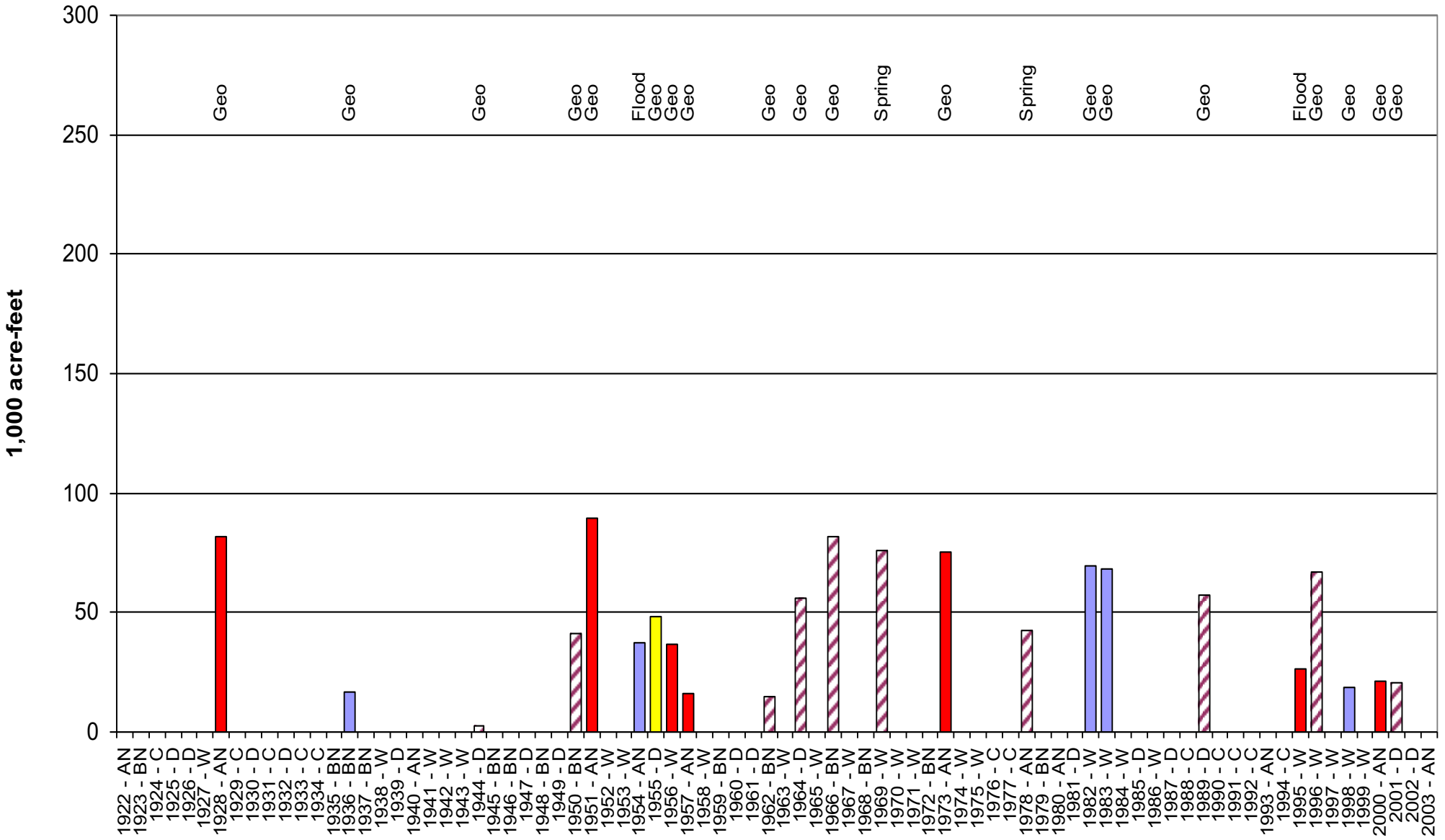
Early Finding: Traditional water banking generally not viable in the Sacramento Valley due to lack of aquifer storage space.

Project Scenarios Evaluated

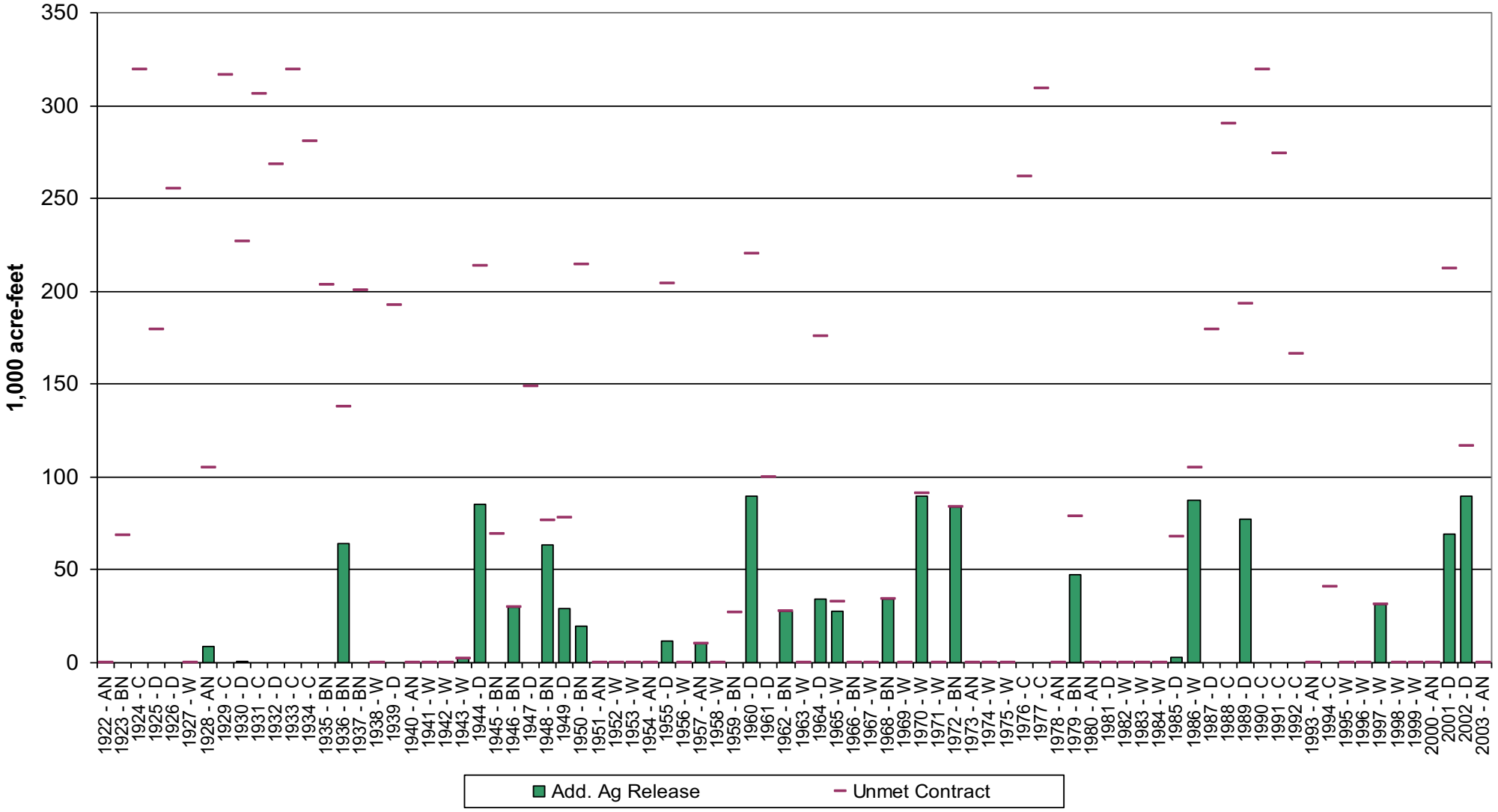
Scenario	Groundwater Pumping Capacity (thousand acre-feet)			Pumping Season
	GCID (CVP)	Butte Basin (SWP)	Total	
1	100	50	150	summer
2	200	100	300	summer
3	100	50	150	fall
4	100	50	150	summer & fall

All scenarios modeled with an existing (shallow) and new (deep) well field to reveal range of potential impacts to streams and existing pumpers.

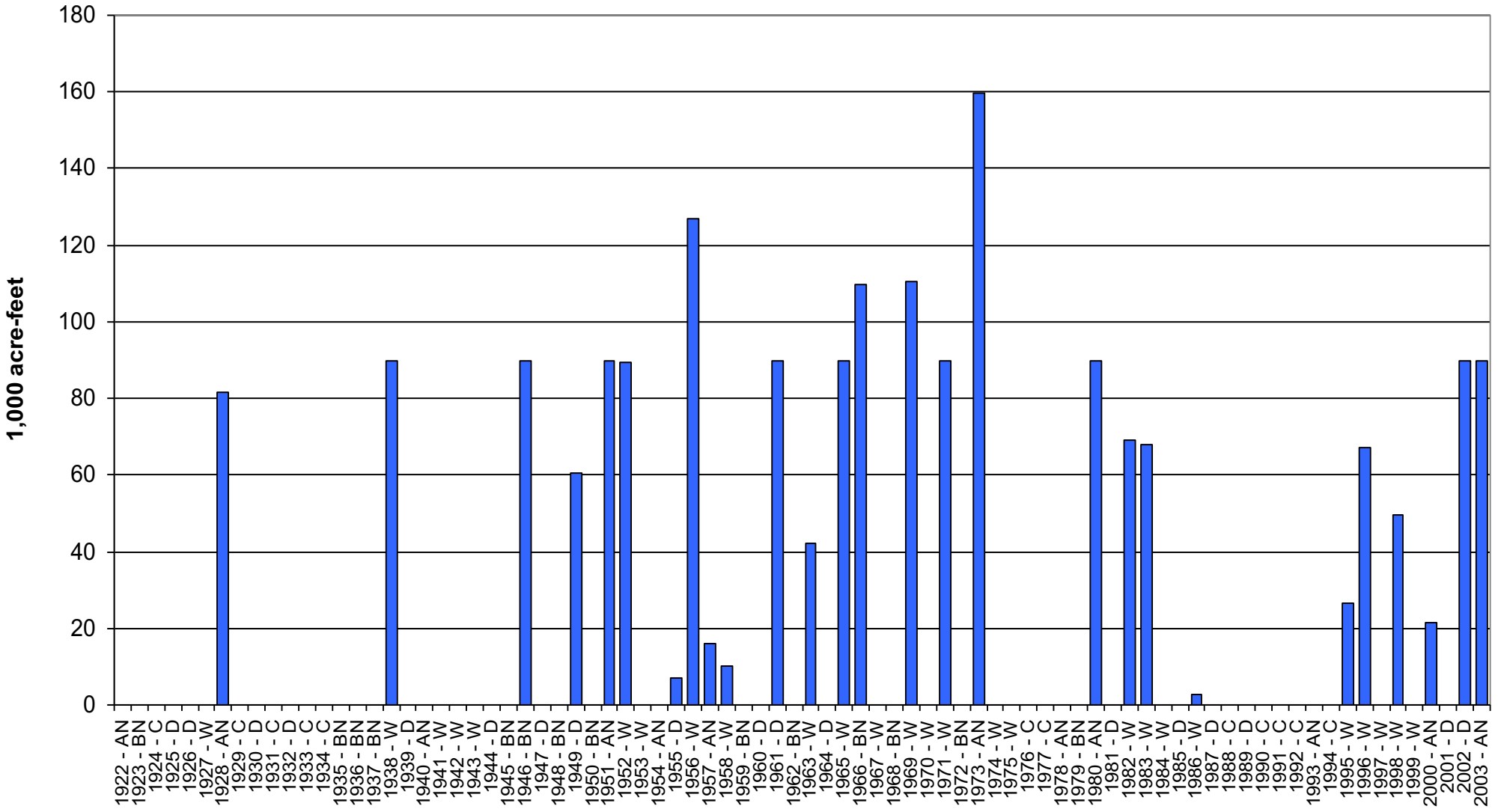
Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Environmental Flow Releases



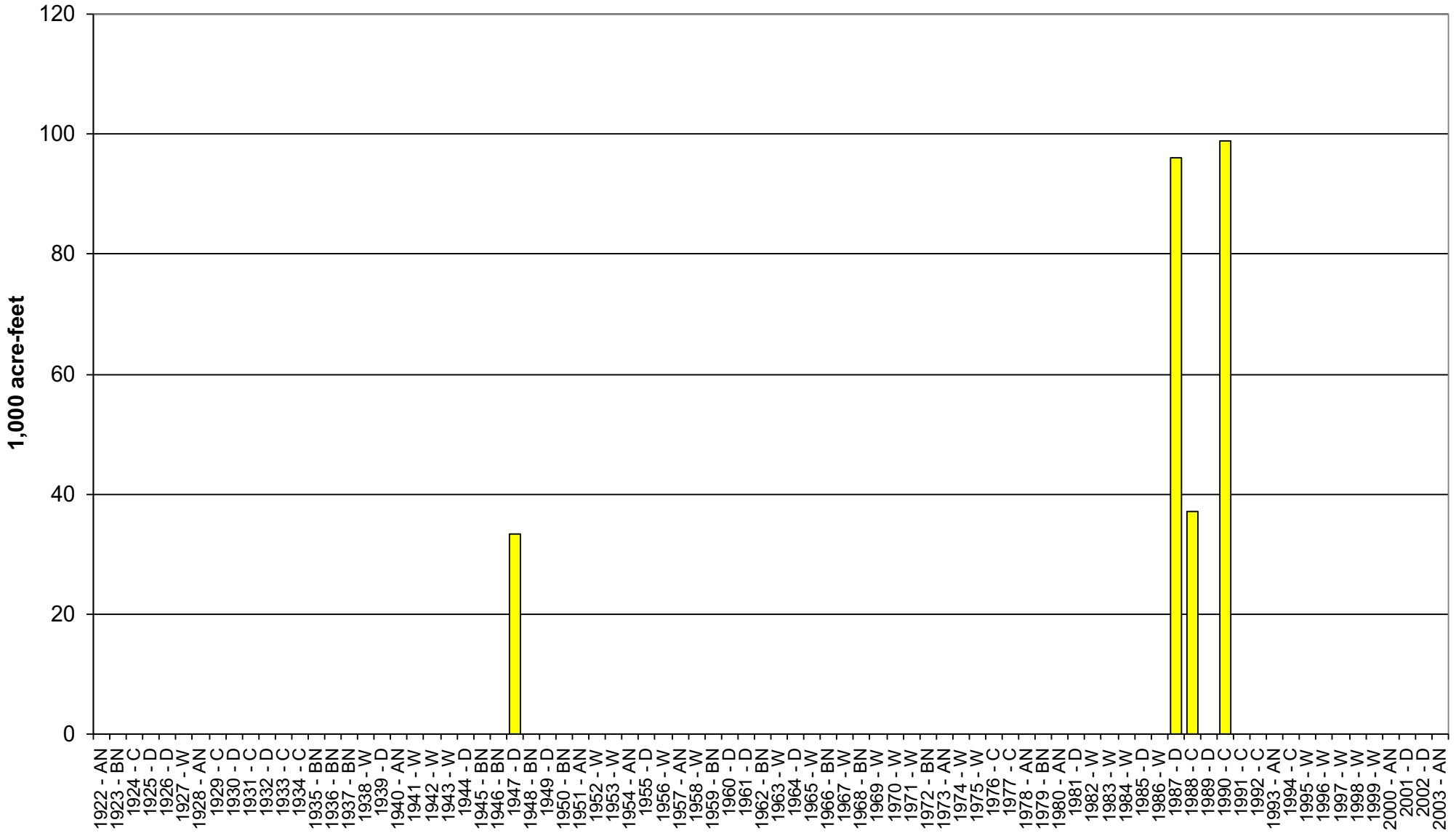
Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Sac River Agricultural Deliveries



Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Refill from Surplus Surface Water



Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Refill from Groundwater Pumping



Scenario Performance 1922-2003

(Table ES-3 from Draft Final Report)

Scenario	Project/System	Payback Pumping Capacity (TAF)	Environmental Benefits			Agricultural Benefits		
			Number of Years	Avg in Yrs of Occurrence (TAF)	Avg Over All Yrs (TAF)	Number Of Years	Avg in Yrs of Occurrence (TAF)	Avg Over All Yrs (TAF)
1, 3 and 4	GCID/CVP Lake Shasta-Sac R	100	23	46	13	24	46	14
1, 3 and 4	Butte Basin/SWP Lake Oroville-Feather R	50	28	21	7	30	27	10
2	GCID/CVP Lake Shasta-Sac R	200	40	96	47	24	75	22
2	Butte Basin/SWP Lake Oroville-Feather R	100	44	43	23	30	52	20

Findings & Conclusions

- Core concept of reservoir reoperation is feasible:
  - Refill is mostly from surplus surface flows
  - Reservoir payback required in some years
- Project generates appreciable new water
  - Shasta: 27 TAF to 69 TAF annually
  - Oroville: 17 TAF to 43 TAF annually

  (Neglecting effects of minimum reservoir releases for temperature control)

Findings & Conclusions

- Reservoir payback strategies
  - Groundwater banking in Sacramento Valley not feasible at this time
  - Pumping in GCID for Shasta payback and in Butte Basin for Oroville payback is feasible and impacts to existing pumpers and streams are manageable
  - Crop idling (as evaluated) is not feasible due to timing of decisionmaking
  - Groundwater banking south of Delta not evaluated

Findings & Conclusions

- Effectiveness of all payback mechanisms is constrained during periods when temperature releases exceed releases for downstream demands
- Conservative operation of Shasta and Oroville to minimize risk of temperature stresses on fish reduce opportunities to make other environmental releases, also for fish benefits

Further Investigation

Further Investigation: Technical

- Reconcile tradeoffs among environmental project functions
- Refine reservoir operation rules based on temperature modeling
- Explore south of Delta groundwater banking as a reservoir payback mechanism and costs

Reoperate Shasta and/or Oroville Reservoirs to capture additional flood waters—dedicate to e-flows and water supply

Payback Options (~15% of years when refill inadequate)		
	Without Isolated Delta Conveyance	With Isolated Delta Conveyance
Already Assessed	• Sac Valley GW Banking • GW substitution • Crop Idling	
Not Yet Assessed	• Sites reservoir • Delta island storage	• South of delta GW banking • South of delta surface banking • MWD svc area storage

Linkage to System Reoperations Program

Legislation: Senate Bill X2 1

(Water Quality, Flood Control, Water Storage, and Wildlife Preservation - Perata, 2008)

- Authorized DWR to conduct planning and feasibility studies to identify potential options for the reoperation of the state's flood protection and water supply systems that will optimize the use of existing facilities and groundwater storage capacity.

- The studies shall incorporate appropriate climate change scenarios and be designed to determine the potential to achieve the following objectives…

Simultaneous Objectives:

- Water supply reliability
- Flood hazard reduction
- Ecosystem protection and restoration

By

- Integrating flood protection and water supply systems
- Reoperating existing system in conjunction with effective groundwater management
- Improving existing water conveyance systems

Source: California Department of Water Resources System Reoperation Program Phase 1 - Plan of Study

Reoperation Building Blocks

- Re-operate reservoirs
- Integrate groundwater and surface water
- Water transfers
- Change points, timing and/or volume of diversions
- Change flow regimes (stream flow patterns)
- Reactivate floodplains
- Retrofit dams
- Inter-connect conveyance
- Augment storage at existing reservoirs
- Fish passage facilities
- Desalinization

Why South of Delta GW Banking is Promising

- Avoid impacts on Sac Valley GW Users
- Extract and use banked water at times of greatest need and economic value
- No increase in Sac Valley exports
- Avoid operational losses for IDC by-pass flows by “riding on the back” of PRE exports

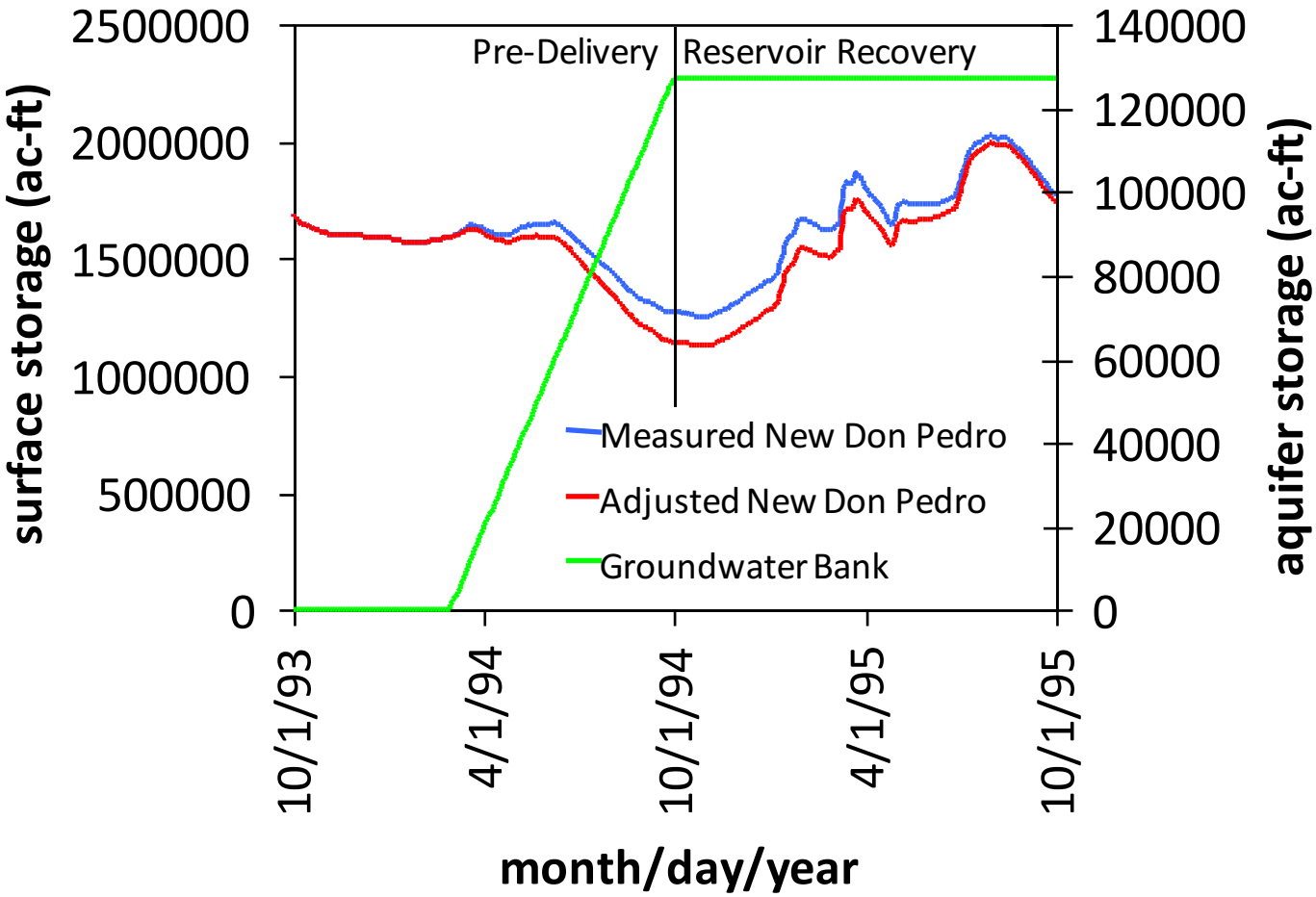
Big Question

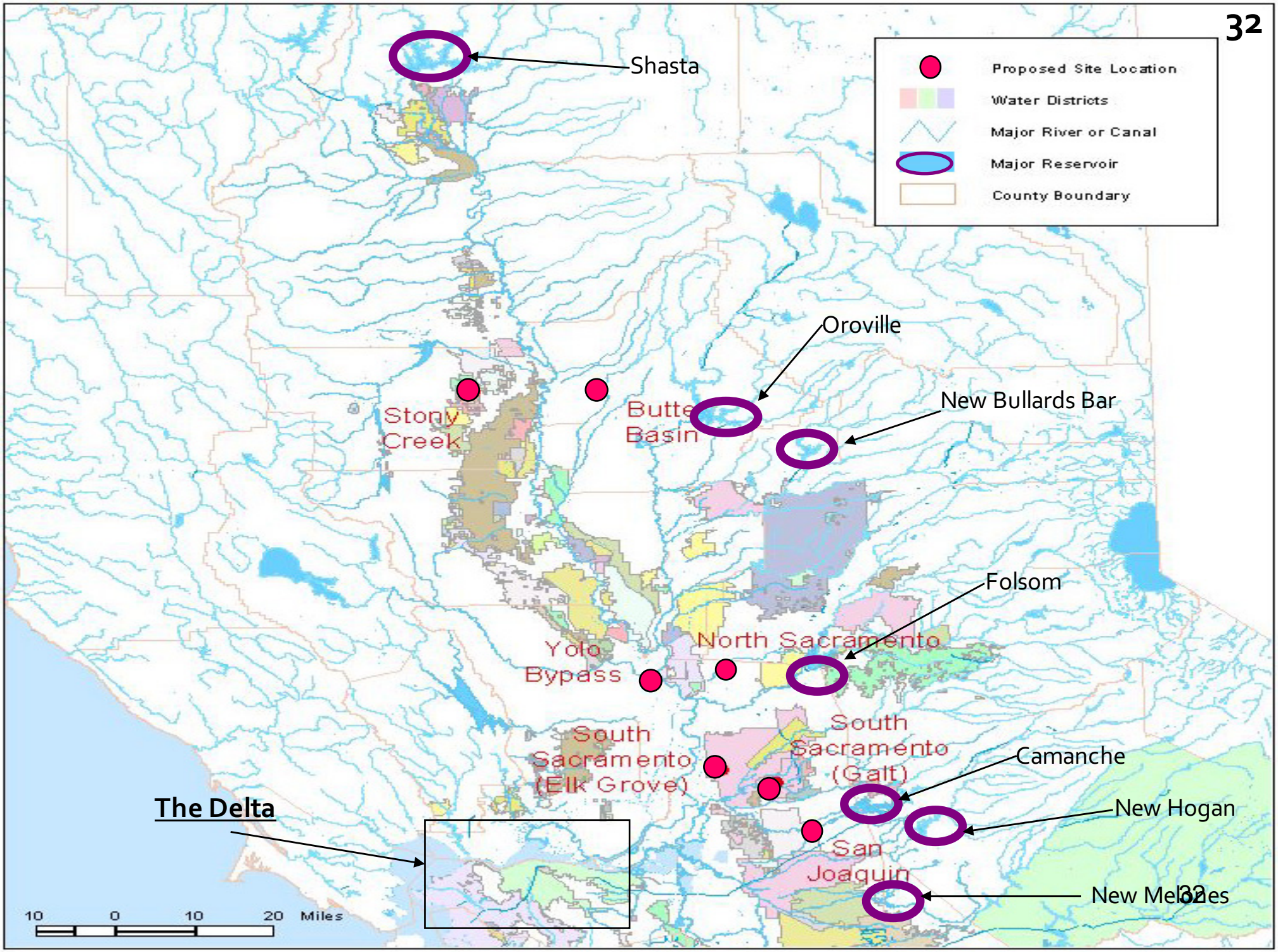
This option converts Delta outflow to Delta exports:

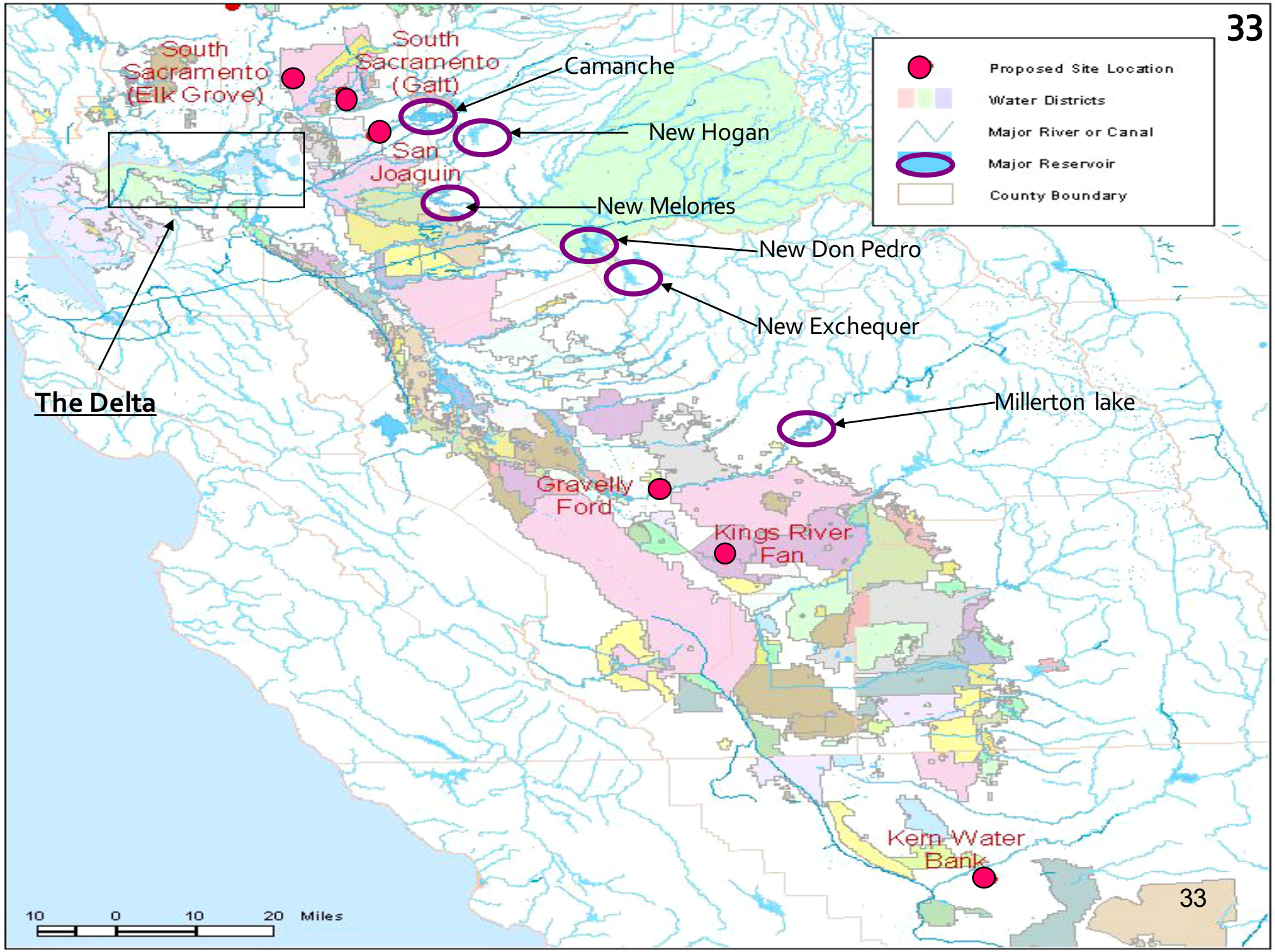
- **Is the value of improved flows in Sacramento and Feather Tributaries larger than the value of Delta outflows during the flood season?**

Modes of Groundwater Banking

NHI Approach




Shasta
Proposed Site Location
Water Districts
Major River or Canal
Major Reservoir
County Boundary
Oroville
New Bullards Bar
Stony Creek
Butte Basin
Folsom
North Sacramento
Yolo Bypass
South Sacramento (Elk Grove)
South Sacramento (Galt)
Camanche
New Hogan
The Delta
San Joaquin
New Melones
10 0 10 20 Miles


South Sacramento (Elk Grove)
South Sacramento (Galt)
Camanche
New Hogan
San Joaquin
New Melones
New Don Pedro
New Exchequer
The Delta
Millerton lake
Gravelly Ford
Kings River Fan
Kern Water Bank
Proposed Site Location
Water Districts
Major River or Canal
Major Reservoir
County Boundary
10 0 10 20 Miles

Average Annual Yield Estimates for Eleven Regulated Tributaries of the Central Valley

River	Reservoir	NHI Estimates	USACE Estimates	
		New Yield (TAF)	New Yield	Increase in Flood Storage
Sacramento	Shasta	196.8		
Feather	Oroville	126.9	148	29%
Yuba	New Bullards Bar	144.5	120	71%
American	Folsom	80.4	211	31%
Mokelumne	Camanche	69.4		
Calaveras	New Don Hogan	25.4		
Stanislaus	New Melones	65		
Tuolumne	Don Pedro	77.9	160	36%
Merced	McClure/New Exchequer	108.1	92	28%
Upper San Joaquin	Millerton/Friant	100	322?	71%?
King's River	Pine Flat	108		
TOTAL:		1102.4		

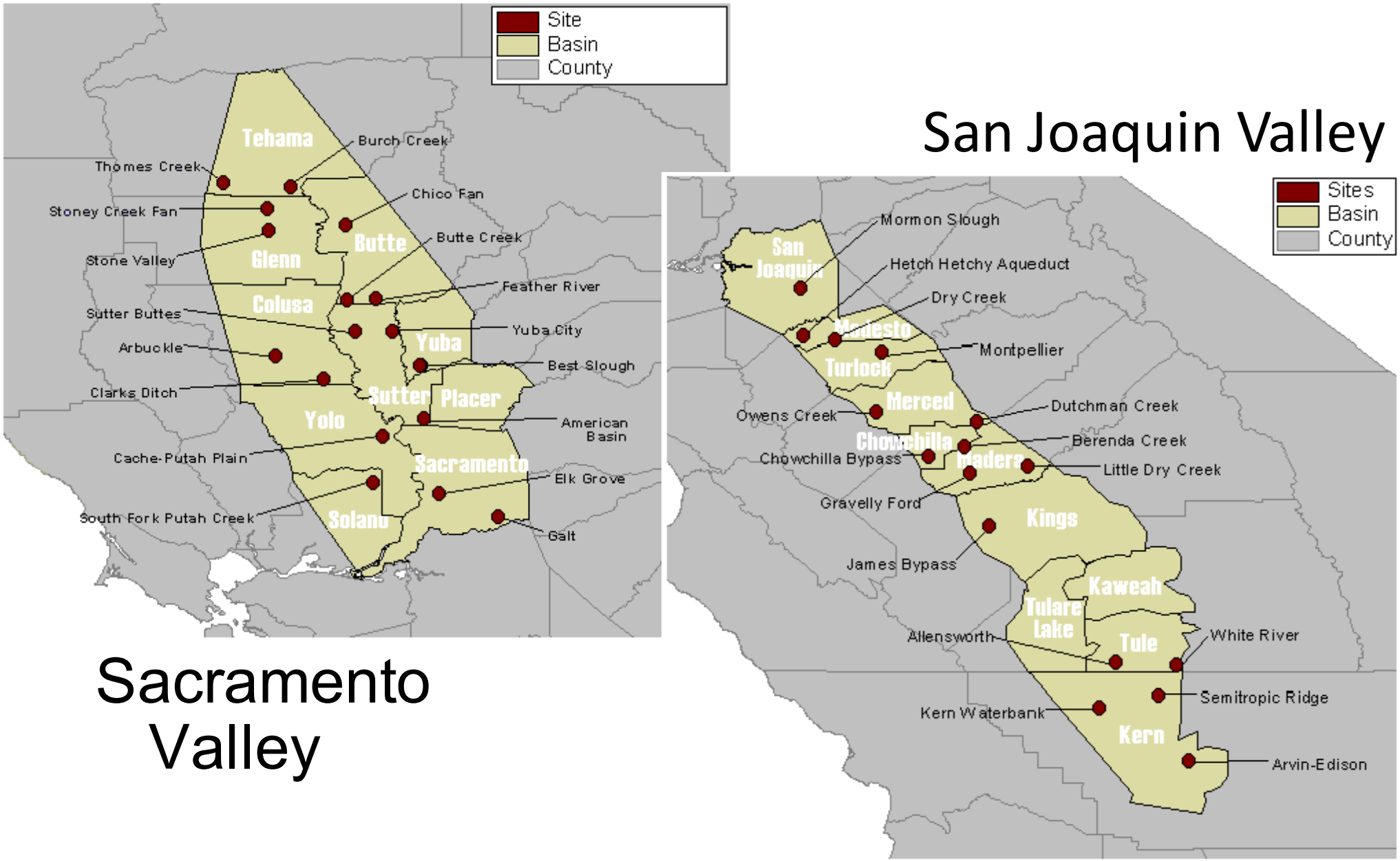
Factors Taken Into Account

- Pre-existing rights & entitlements
- Prescribed environmental flows
- Temperature regulation

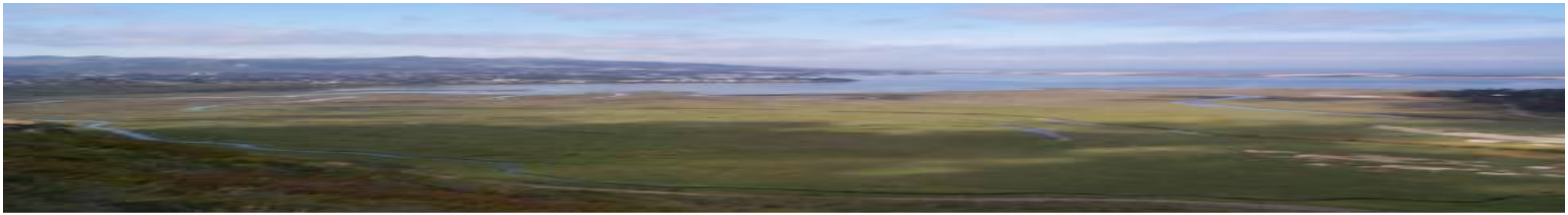
Factors NOT Taken Into Account

- Delta transfer constraints

Potential Groundwater Banking Sites



Sacramento Valley



Feasibility Requirements for *In Lieu* Storage

- Extend water district to encompass groundwater use area

OR

- Develop groundwater in surface water irrigation district

AND

- Adequate aquifer storage space

Promising Central Valley DAUs