CALSIM II Sacramento River Basin Hydrology Enhancements

Andy Draper - Montgomery Watson Harza

Walter Bourez - MBK Engineers

February 26, 2004

CALSIM II Sacramento River Basin Hydrology Enhancements

- Current representation
- Problems

- Solutions
- Work completed
- Possible effects to CALSIM simulation
- Future direction

Issues

- Poor representation of water use in the Sacramento Valley means that Calsim II cannot be used with a high degree of confidence to provide absolute values of water supply reliability
- Coarse spatial resolution of the model makes Calsim II of limited value for the analysis of local projects

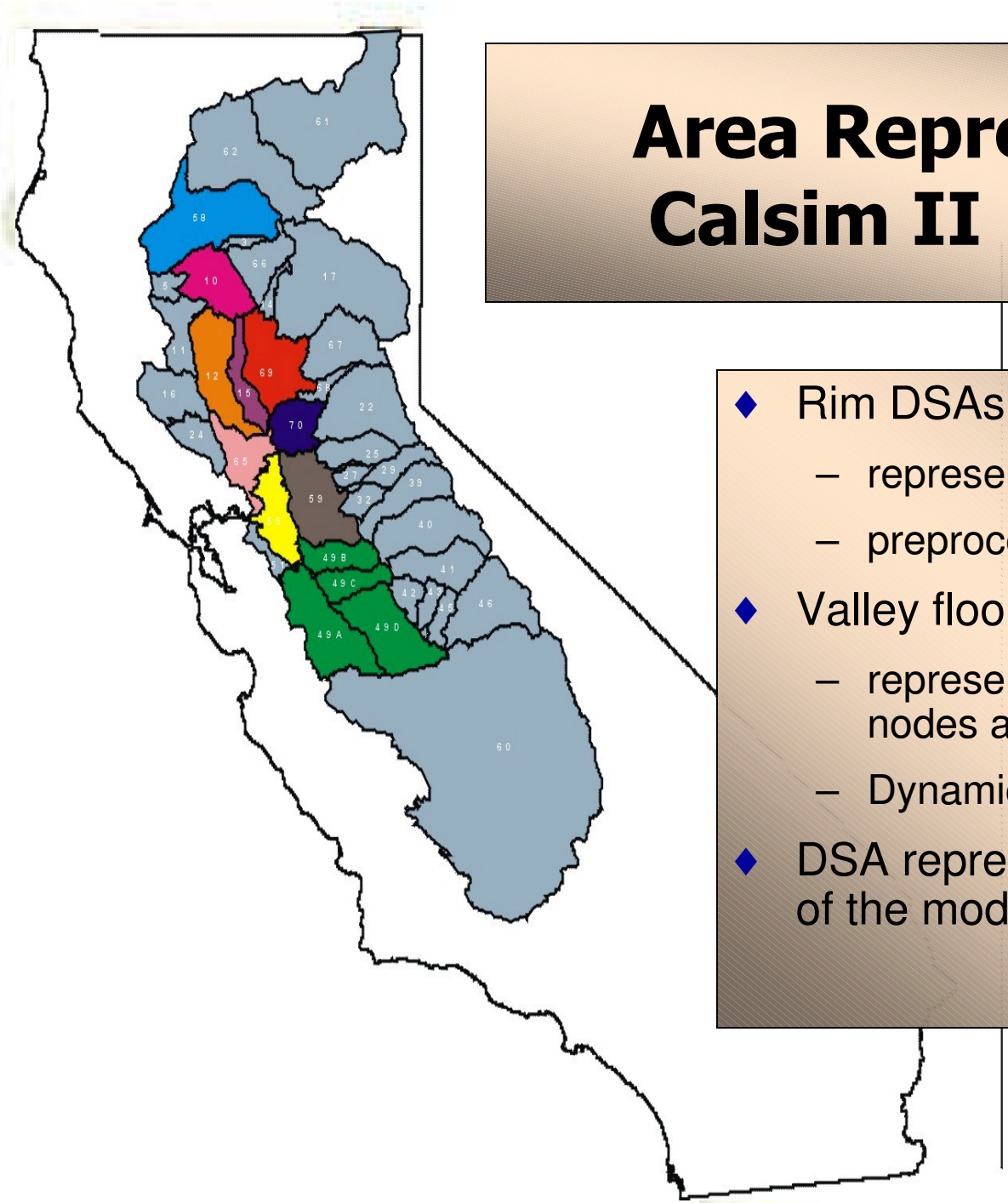
CALSIM II Sacramento River Basin Hydrology Enhancements

- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Work completed
- Possible effects to CALSIM simulation
- Future direction

Historical Perspective

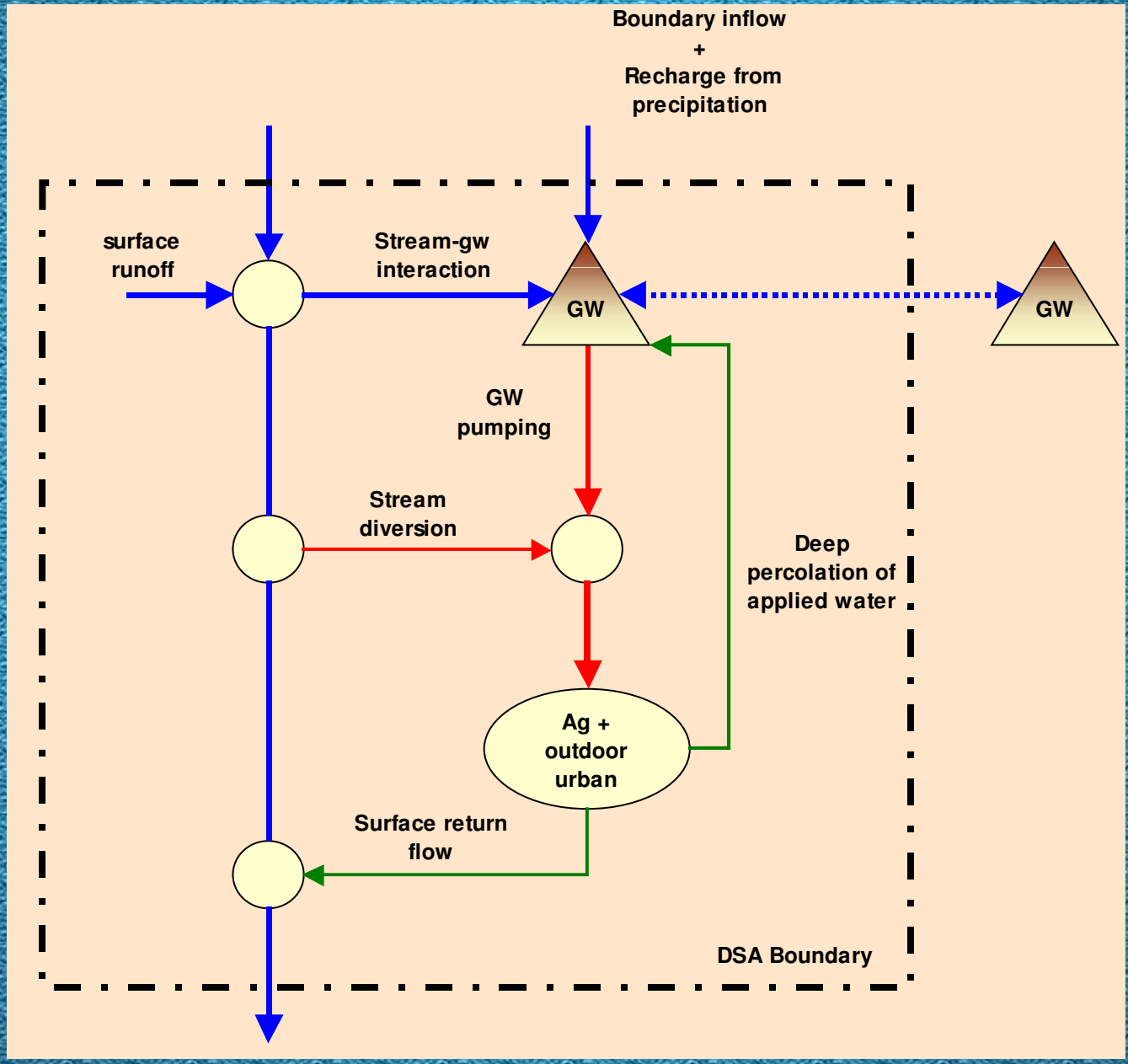
- Methods developed in late1950's early1960's
- Focus was on water supply
  - Mainly South of Delta Water supply
- Very large areas aggregated
- Methods, spatial resolution, and much of the data are still the same

Area Represented by Calsim II Hydrology



- Rim DSAs (in gray)
  - represented indirectly
  - preprocessed inflow to CalSim II
- Valley floor DSAs (in color)
  - represented directly by series of nodes and arcs
  - Dynamically simulated
- DSA represents spatial resolution of the model

Representation of Sacramento Valley in CalSim II



CALSIM II Sacramento River Basin Hydrology Enhancements

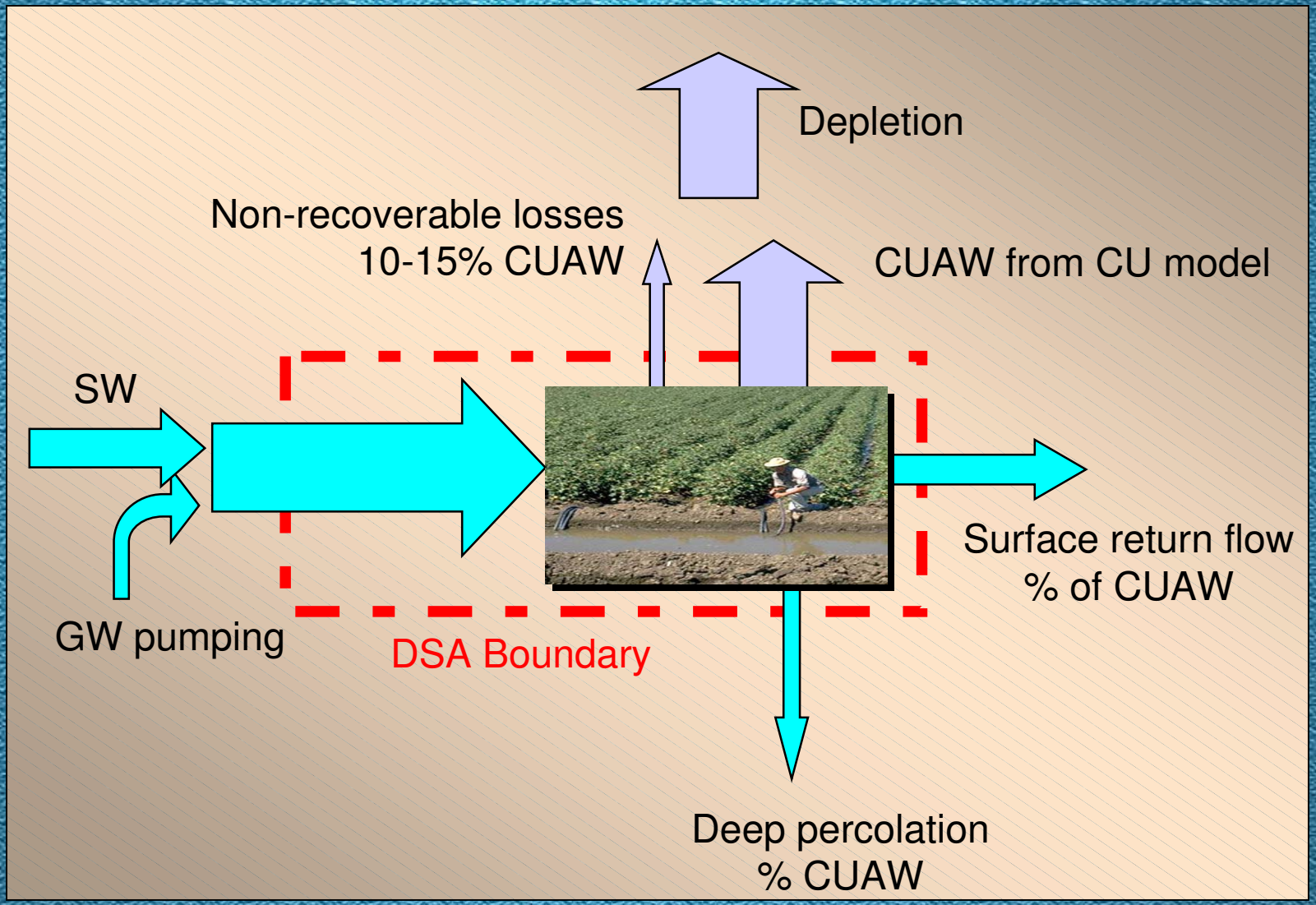
- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Work completed
- Possible effects to CALSIM simulation
- Future direction

Demand Sectors

- Sectors
  - Irrigated agriculture
  - Outdoor urban (irrigated landscape)
  - Indoor urban (residential, commercial, industrial)
  - Wildlife refuges
  - Environment (min. instream flow requirements)
- Outdoor urban aggregated with agriculture
- Indoor urban generally not modeled

  (exception Greater Sacramento Area)

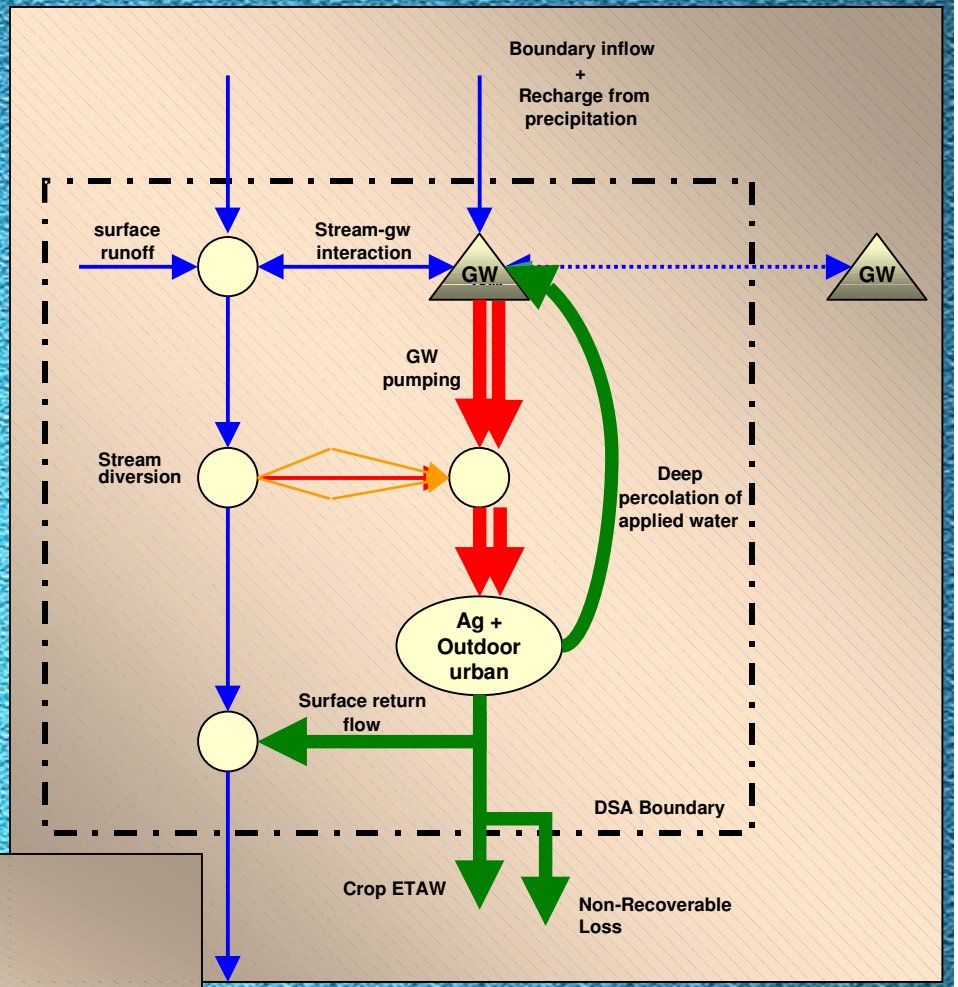
Components of Demand



Project vs Non-Project Demand

- Demand calculated for each DSA based on crop acreage
- DSA demand subsequently split into project and non-project
- Project Demands
  - Entitled to releases from project storage
  - Deliveries constrained to lower of land use based demand or contract allocation
- Non-Project Demands
  - Diversions constrained to lower of land use based demand or unimpaired river flow
  - Not entitled to releases from project storage

Model Inputs



- Stream diversion/pumping requirement
- Project:Non-project split
- Non-recoverable loss factor
- Surface return flow factor
- Deep percolation factor
- Maximum contract entitlement

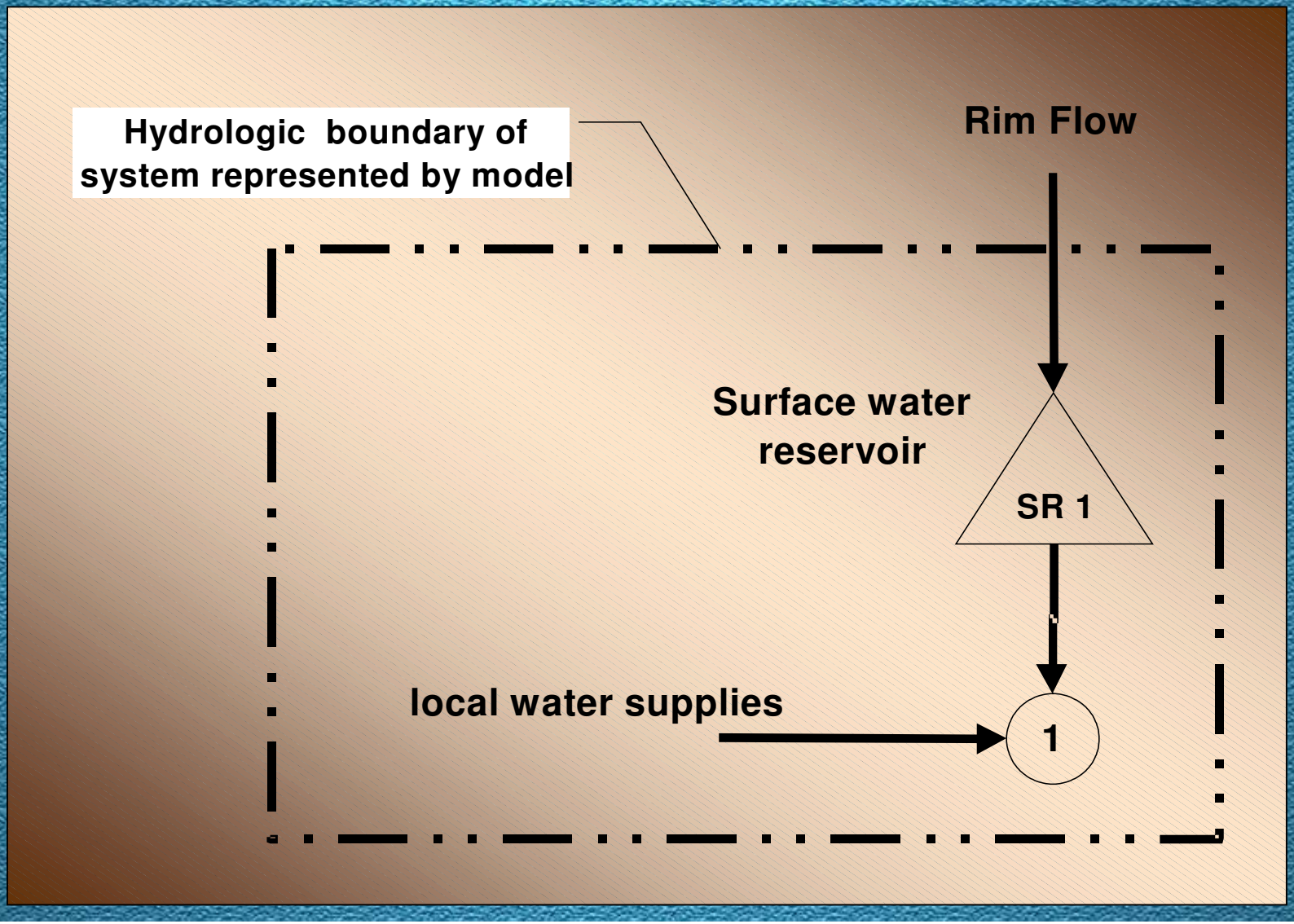
CALSIM II Sacramento River Basin Hydrology Enhancements

- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Work completed
- Possible effects to CALSIM simulation
- Future direction

Approach

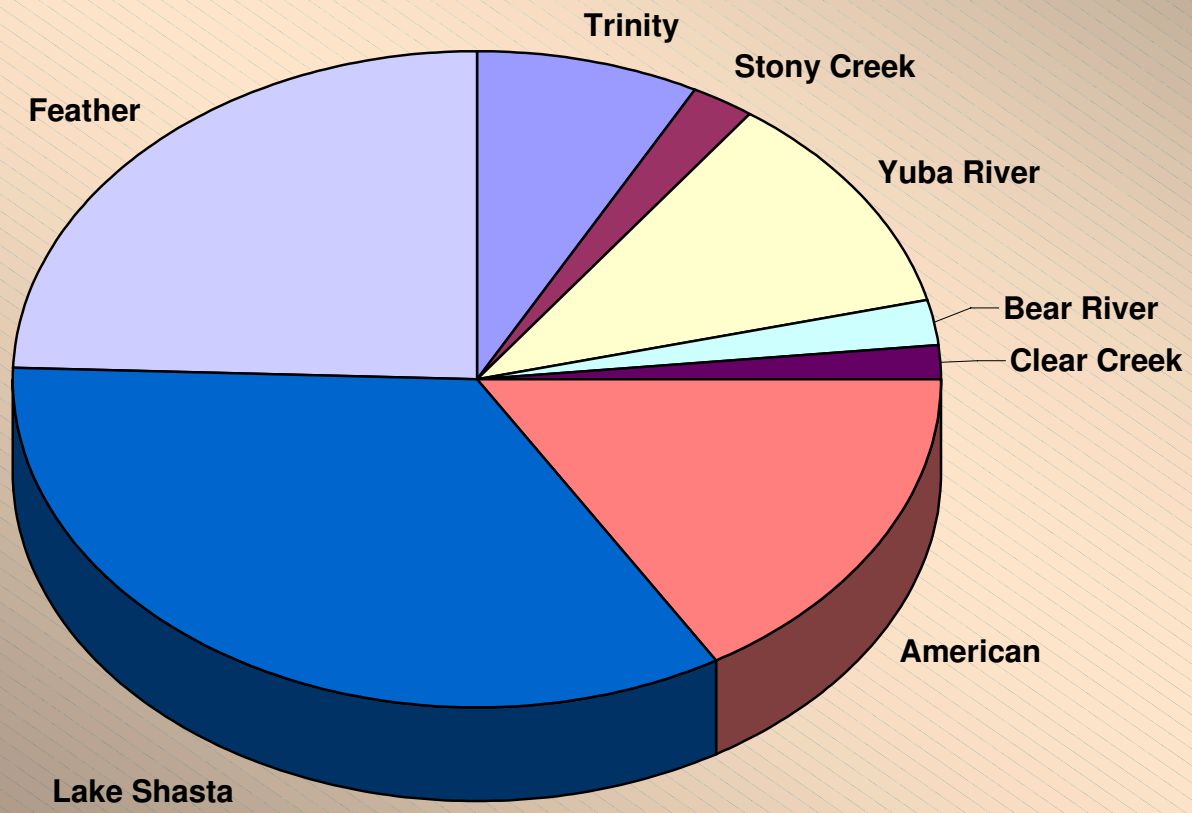
- Assume static land use, fixed water supply contracts and regulatory requirements for each year of simulation
- Use adjusted historical hydrology to represent probable range of hydrologic conditions
- Assume temporal and spatial distribution of precipitation same as historical
- Modify historical stream flows for impacts of land use change and upstream flow regulation

Rim Flows vs Local Water Supplies



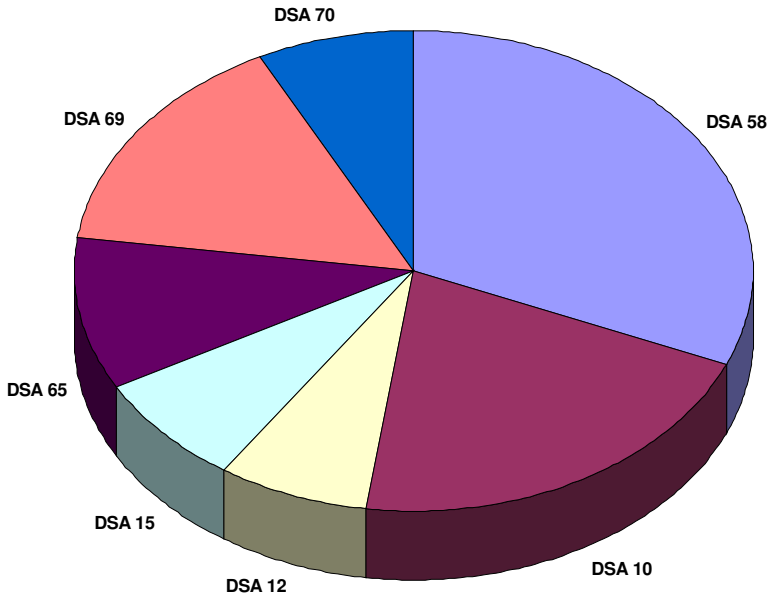
Rim Flows

Average Annual Inflow = 16,150 taf/yr

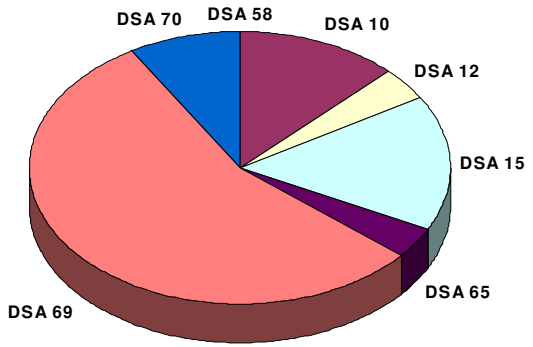


Local Water Supplies

Average Accretion = 6,420 taf/yr

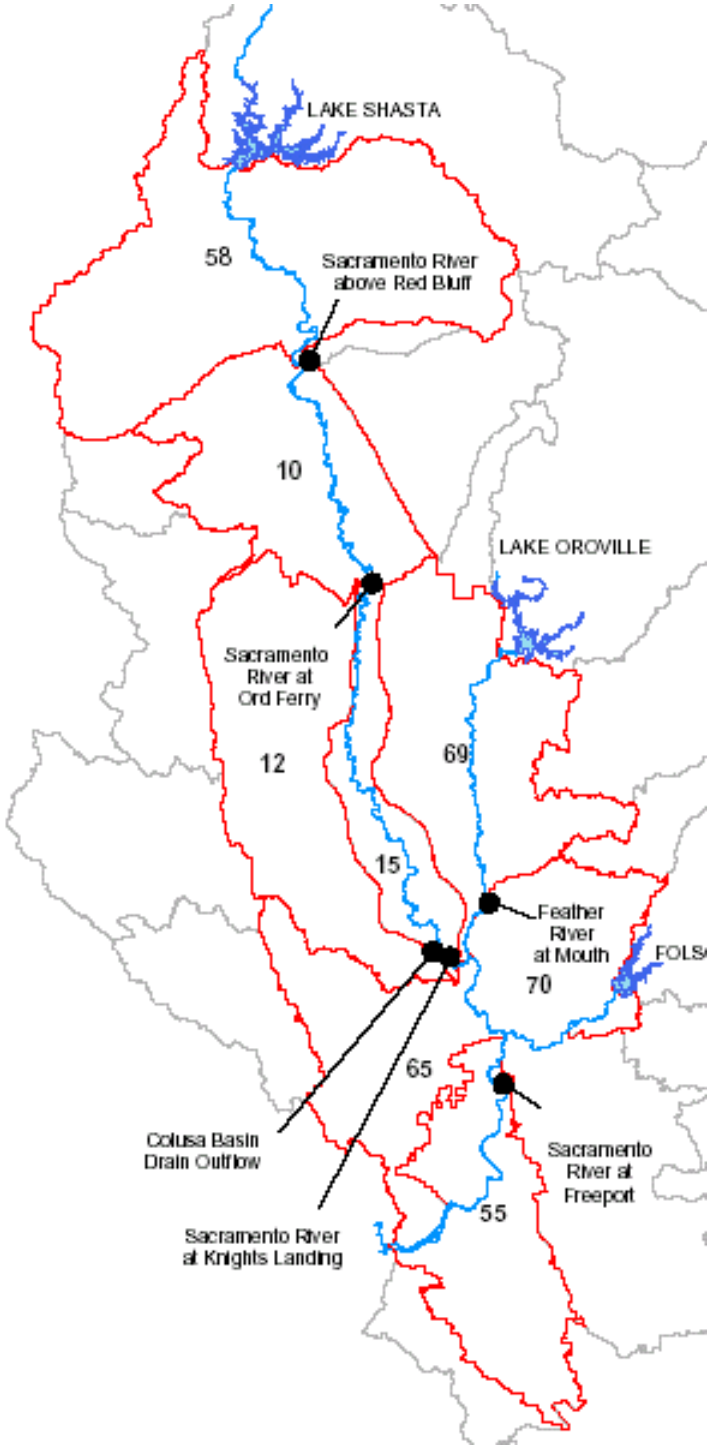


Average Depletion = 626 taf/yr



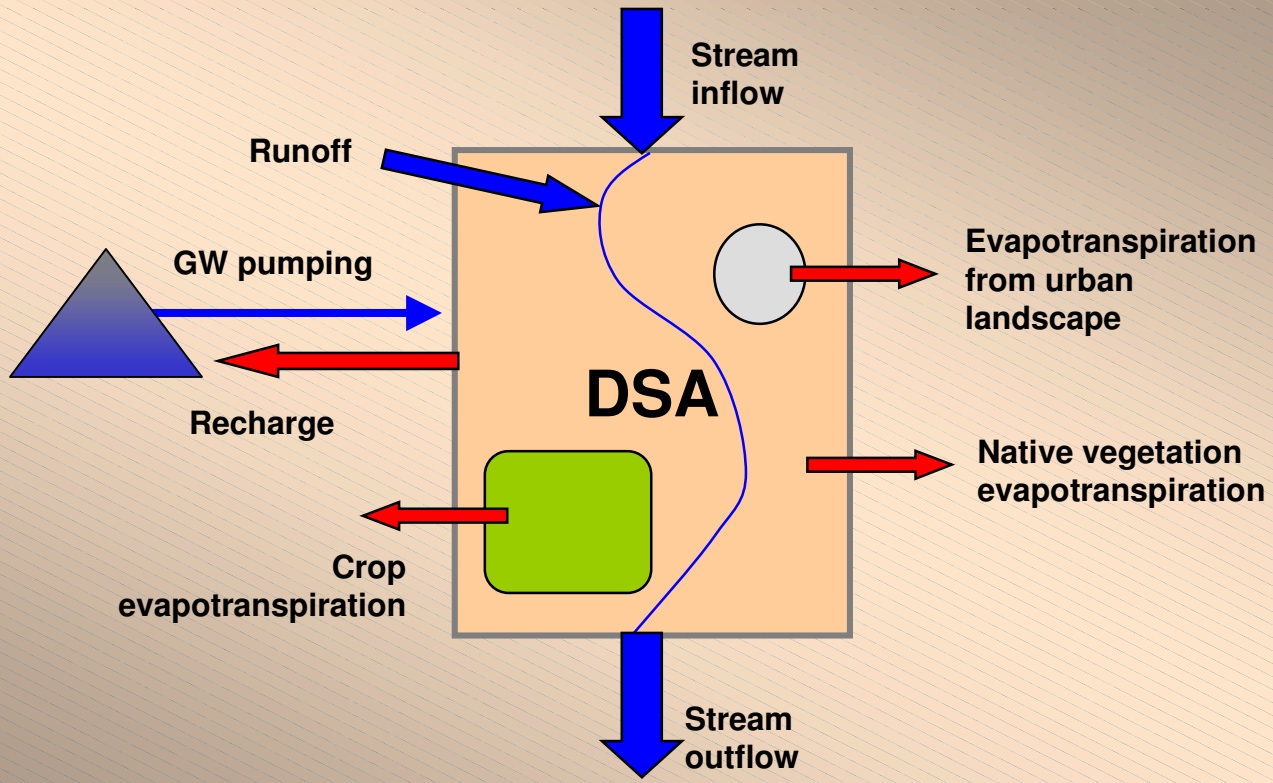
Local Water Supplies

- Time series of inflows to each of the seven Valley floor DSAs
- Calculated as closure term in hydrologic mass balance on each DSA
- Represents direct runoff from precipitation
- Includes all error terms

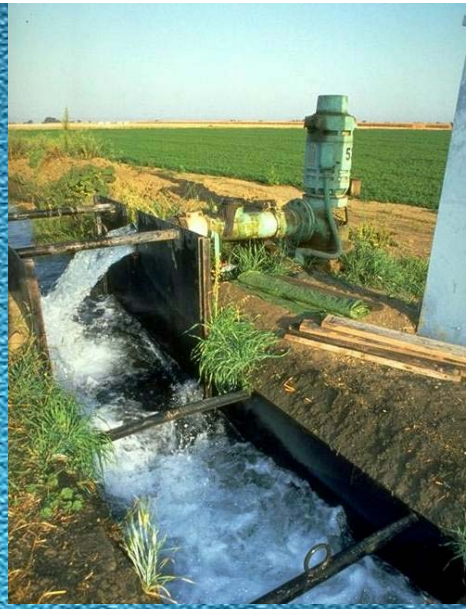


Hydrologic Mass Balance

- Historical Water Supply from mass balance
- Projected Water Supply= Historical Water Supply + Rainfall-Runoff Adjustment
- Contain errors in mass balance



Use of Groundwater



- Land-use base demands fully met
- Supply priorities for meeting demand
  - Minimum groundwater pumping
  - Surface water
    - up to the contract amount for project demand
    - and up to its availability for riparian demands.
  - Additional groundwater pumping for any unmet demand

CALSIM II Sacramento River Basin Hydrology Enhancements

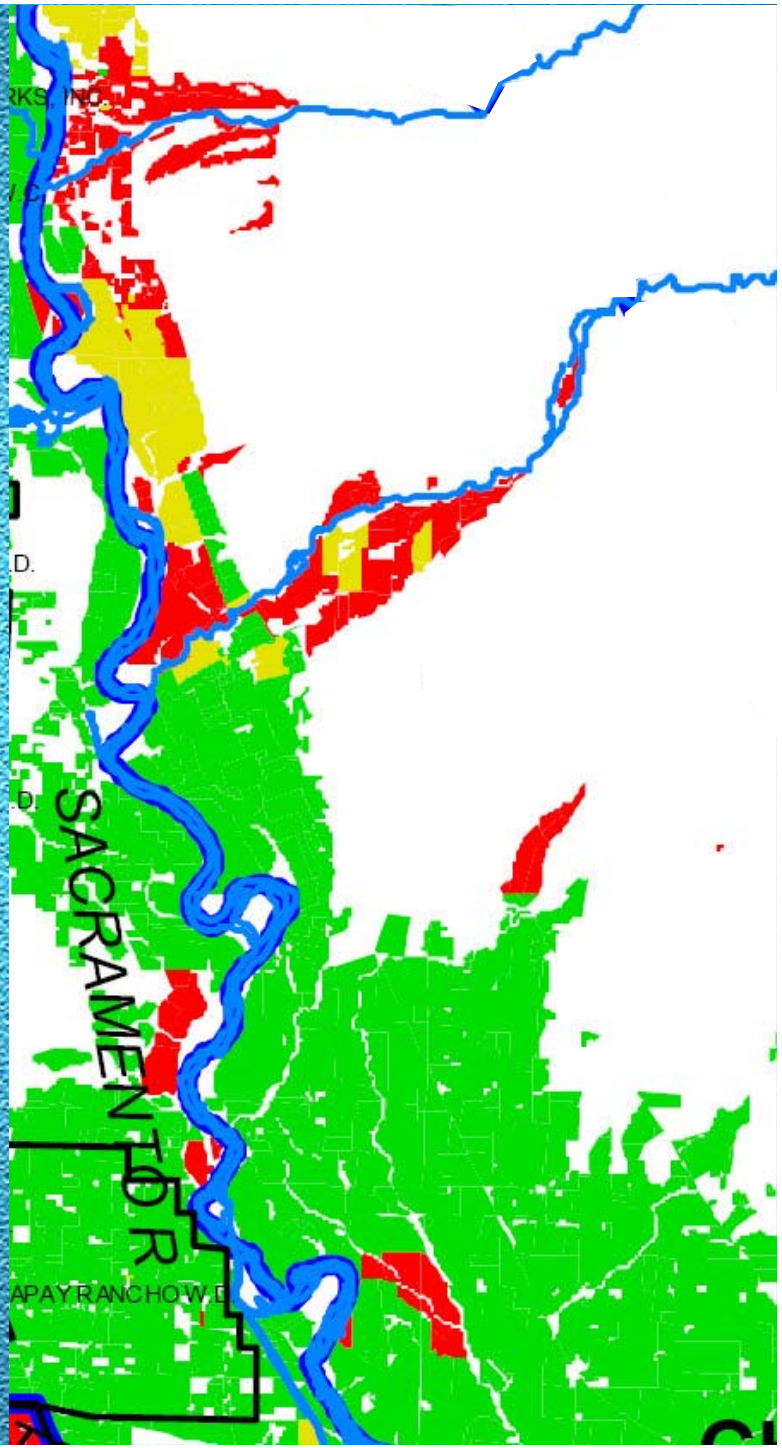
- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Work completed
- Possible effects to CALSIM simulation
- Future direction

Project Non-Project Demands

- Based on:
  - GIS land use data
  - Irrigation District boundaries
  - Unit crop ETAW
- Ratio of crop acreage within ‘project’ irrigation district to total crop acreage within DSA
- Acreage weighted by unit crop ETAW
- ! Assumes identical water use efficiency
- ! Short-form CVP contractors wrongly assigned to non-project as they lie outside of irrigation district
  - 68,000 ac
  - 245,000 af contract

Surface Water Groundwater Use

- Percentage groundwater use the same for project and non-project demands
- All diversions are from the major stream system (Sacramento River, Feather River and American River)
- Non-project demands are predominantly supplied by minor streams tributary to the Sacramento River. These supplies may be more restricted in dry years



Efficiencies

- DSA aggregate demand function of CUAW and regional efficiencies
- Efficiencies not related to on-farm water use
- No explicit representation of conveyance loss, operational spills, reuse
- Efficiency not dependent on source
- Basin efficiency is outdated (early 1970's)

Data Availability

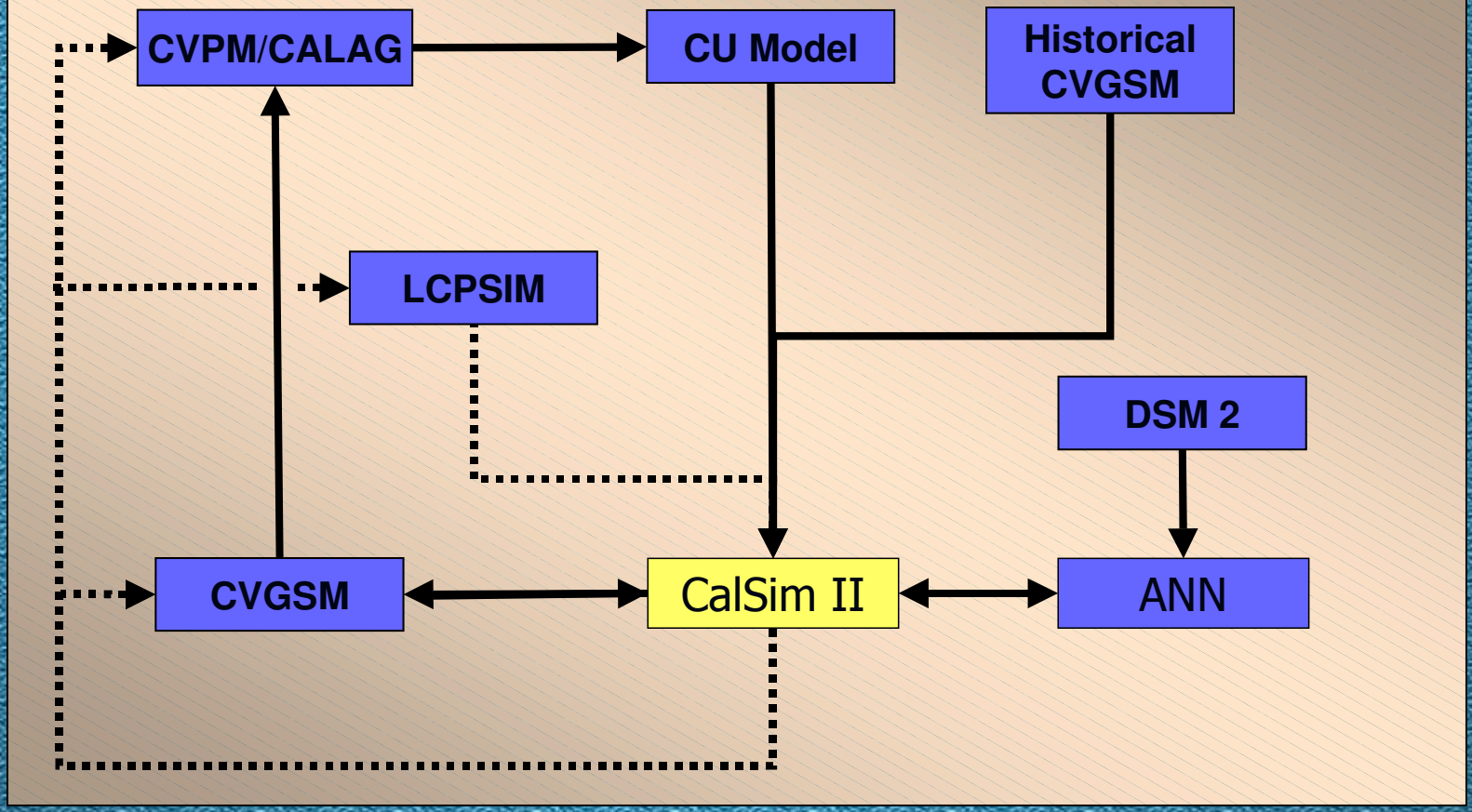
- Calsim II demands are not related to applied water demands at the farm level and district level, although most of the available data is at these scales rather than a regional level.

Water Conservation Measures

- Difficult to assess impacts of water conservation measures due to poor representation of efficiencies and losses.

Model Incompatibility

- Demands, deliveries, return flows are difficult to reconcile between models



Contract Allocation

- Spatial Resolution
  - Land use based demands for DSA
  - Contract allocations for individual contractors
- ! Contractors' demand assumed to be proportional to maximum contract entitlement

Sacramento Refuges

- Level 2 supplies approximately 190,000 af
- Estimate Historical Refuge Operation to Avoid Double Counting of Refuge Demand
- Develop Refuge Ponding Operation to Better Represent Return Flow Timing and Volume

Rice Water Demands

- Current rice acreage in the Sacramento Valley ~ 500,000 ac, ETAW ~ 3 ft
- In the 1990's 140-day variety most common
- ! Calsim II crop water use based on 160-day variety
- ! Rice Straw Burning Reduction Act 1991
- Update water requirements to account for:
  - Shorter growing season
  - Current ponding practices
  - Rice straw decomposition

CALSIM II Sacramento River Basin Hydrology Enhancements

- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Possible effects to CALSIM simulation
- Work completed
- Future direction

Solutions

- DWR recognizes these problems and is working on solutions
- Improvement of Sacramento Valley Hydrology
  - Work in 2003 funded by the California Bay-Delta Authority and South-Delta Improvement Program

Use of GIS to Define Areas

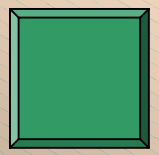
- Data from GIS
  - Ability to aggregate areas by
    - DSA
    - DAU
    - Planning Area
    - County
    - Water district
    - Land use type
    - Demand Type (Identified as part of this project)

Redefine DSA's

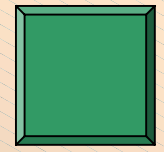
- Criteria
  - Water supply source
  - Use of return flows and drainage
  - Basin characteristics
- Various Demand Types Within Areas Are Addressed Separately
- Work Performed Using GIS

Spatial Resolution of Demand

- Replace existing DSA-level demand
- Differentiate demands by:
  - Contractor type
  - Source of water
  - Cropping pattern
  - Irrigation efficiency



Revised Areas

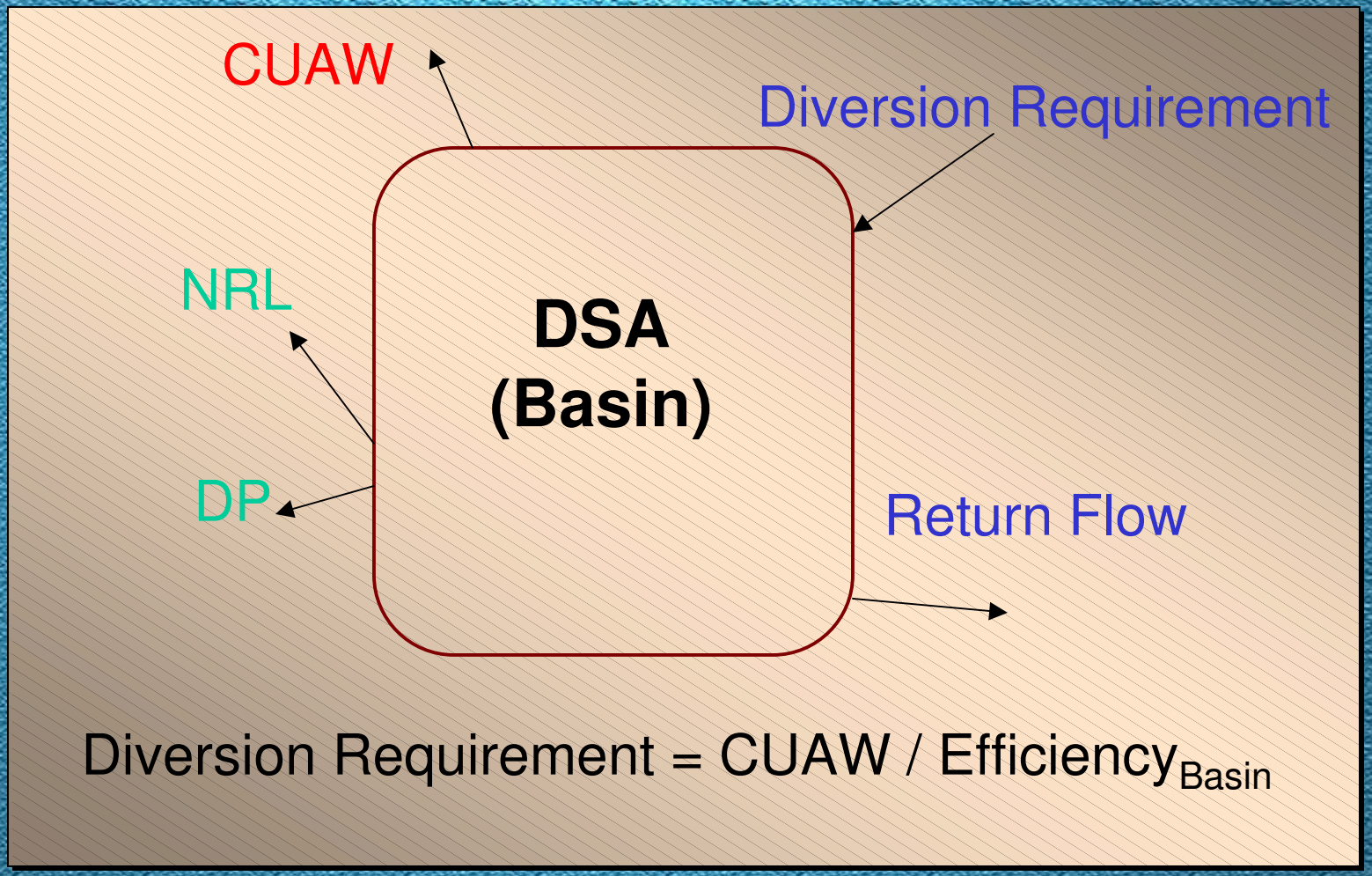


Land Use

Methodology Change In Hydrology

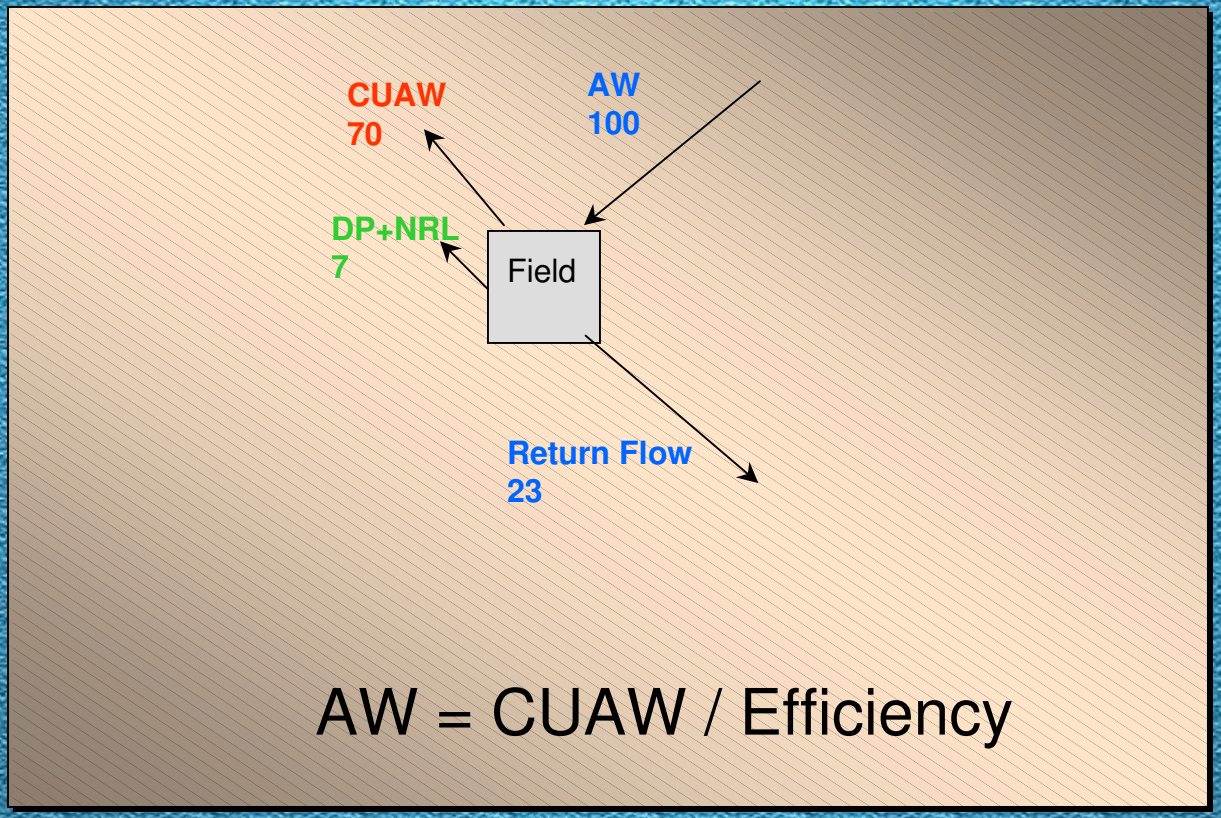
- Revised Method
  - More detailed information to relate CALSIM to CALAG
  - Estimate “on farm” applied water

Current Methodology of Demand Development

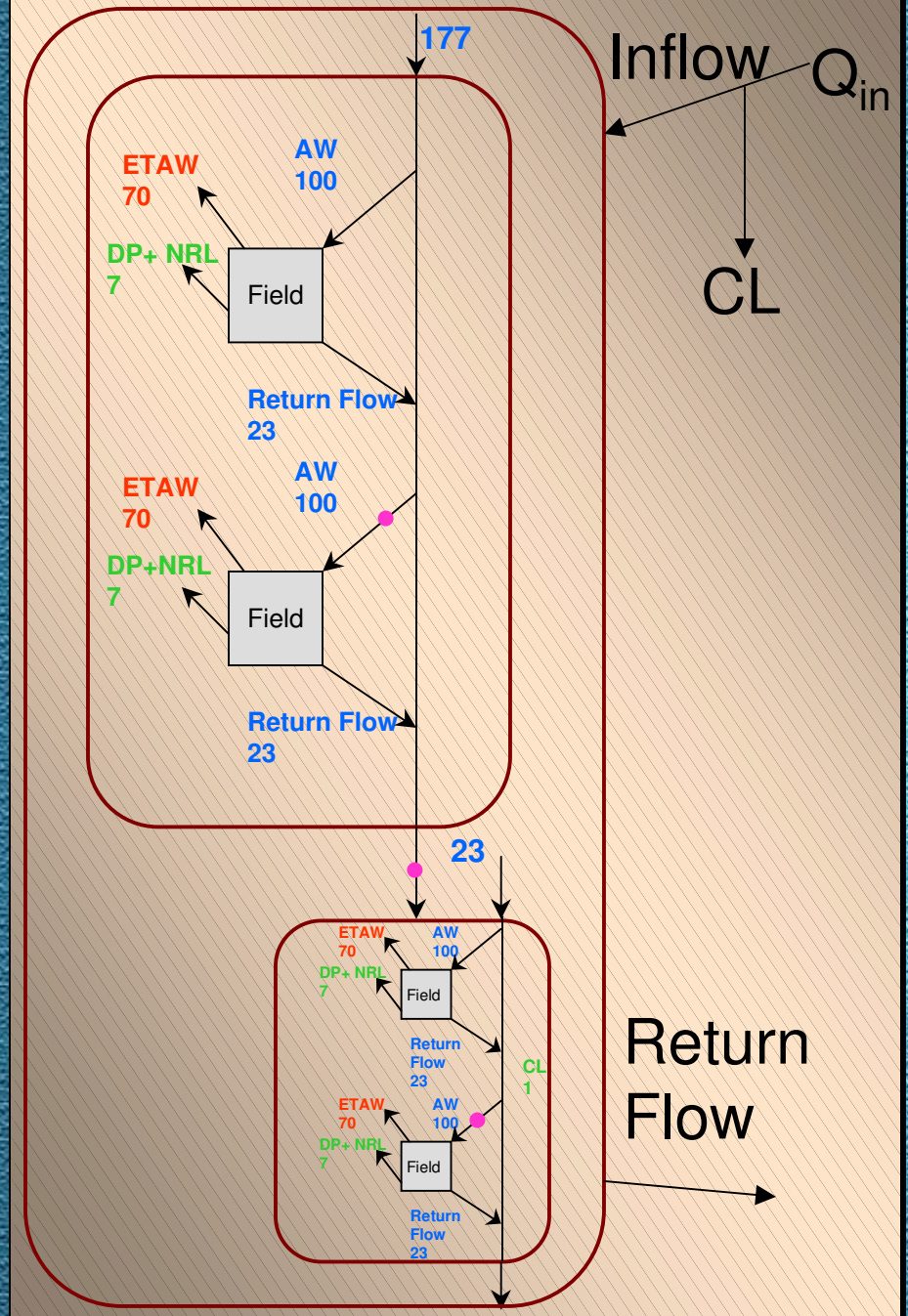


Diversion Requirement = CUAW / $\text{Efficiency}_{\text{Basin}}$

On Farm Applied Water



AW = CUAW / Efficiency



$$AW = CUAW / Eff_{Field}$$

$$Inflow = Q_{in} - CL$$
$$= CUAW / Eff_{Field} * RF$$

$$RF = Inflow / \ddagger Aw_i \quad (i = 1, \text{number of fields})$$

$$Inflow = Inflow_{Groundwater} + Inflow_{Surface\ Water}$$

$$Return\ Flow_{Basin} = Inflow - NRL_{Field} - CUAW - DP$$

$$Return\ Flow_{Basin} = Q_{in} - CL - NRL_{Field} - CUAW - DP$$

Q_{in}	= Basin Diversion Requirement or Supply into Basin
AW	= Applied Water
CUAW	= Consumptive Use of Applied Water
Eff_{Field}	= on Field Efficiency by Crop Type
RF	= Reuse Factor
NRL	= Non-Recoverable Loss
DP	= Deep Percolation
CL	= Conveyance Loss (DP + NRL)

Hydrologic Factors for Demand Development

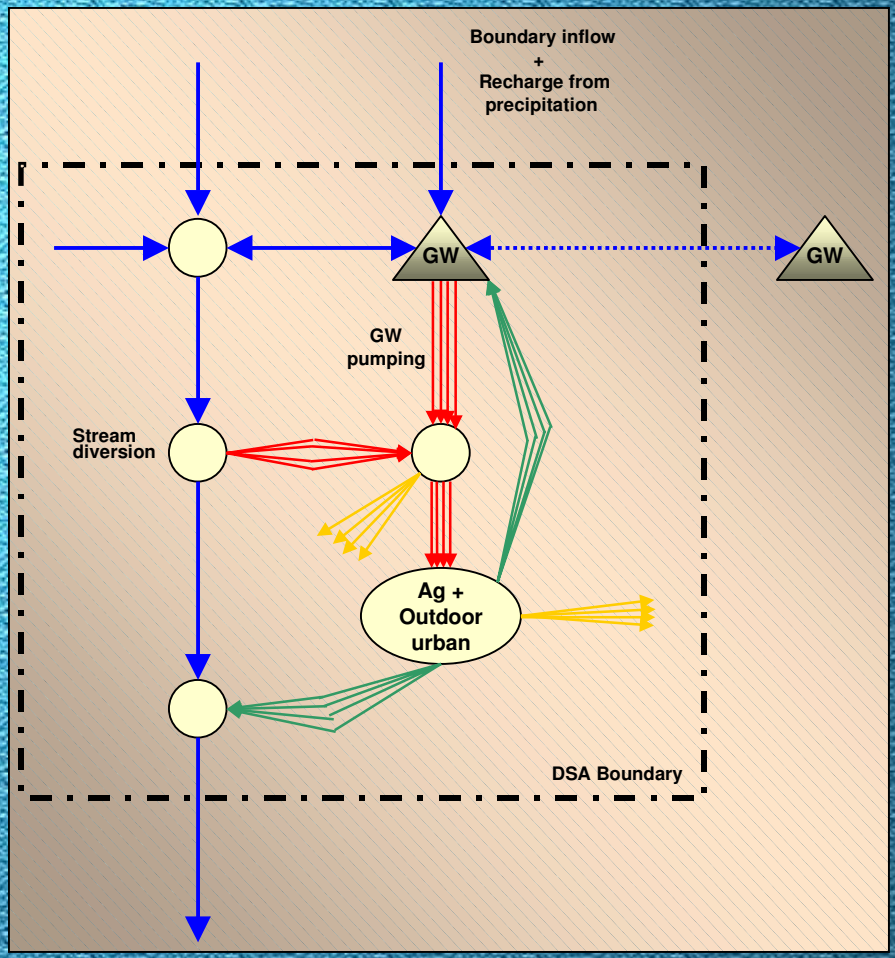
- Explicitly represent:
  - (CUAW) Crop consumptive use of applied water
  - On-farm non-recoverable losses
  - (ETAW/AW) On-farm application efficiency
  - District level reuse
  - Inter-district reuse
  - Recoverable conveyance losses
  - Non-recoverable conveyance losses

Revise Calsim II Schematic

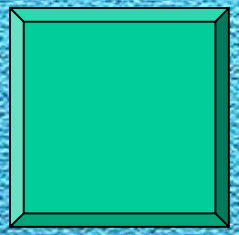
- Use existing schematic to extent possible
  - Include additional “Layering”
  - Attempt to maintain DSA layout
- Revise Feather River representation

New Representation Water Use within CALSIM

- Each contractor type or non-project diverter has associated:
  - stream diversions
  - groundwater pumping
  - consumptive use of applied water
  - return flows

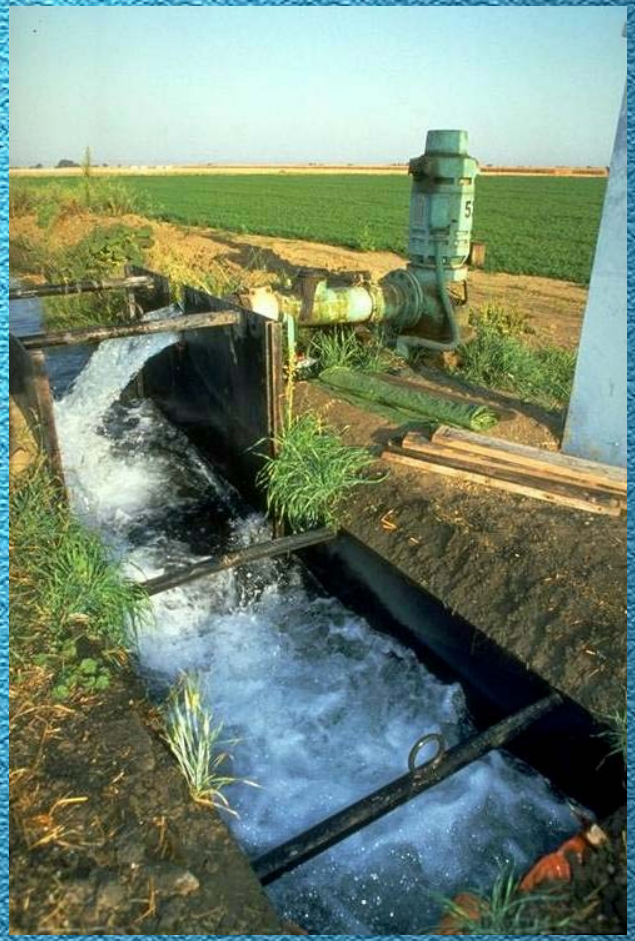


Revise Feather River representation



Refine Ground Water Operation

- GIS Information Contains Water Source Attribute
  - Surface vs. Ground water



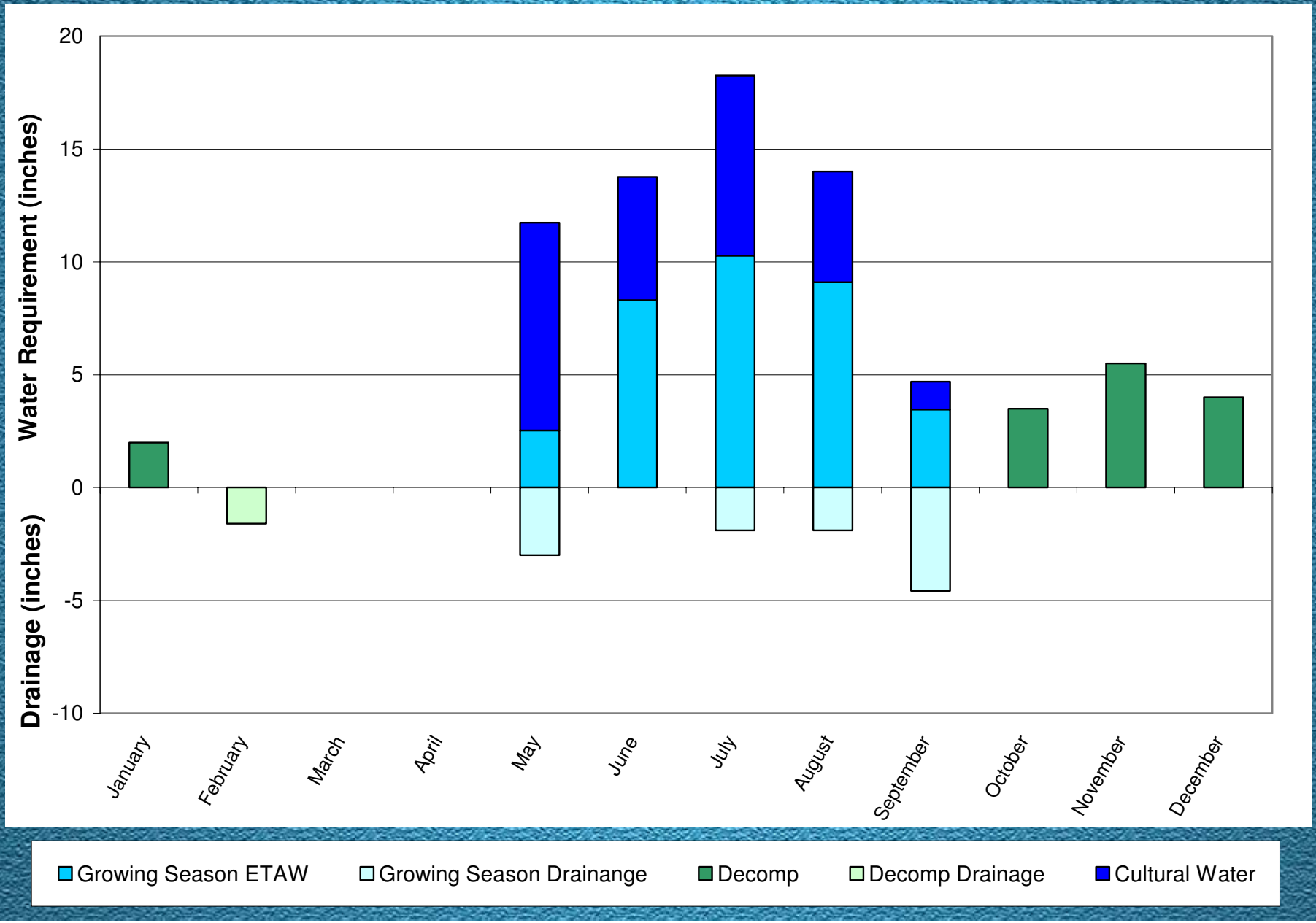
Revise Accretions / Depletions

- Precipitation Runoff and Additional Runoff Kept at DSA Level
- Separate Water Supply Within Each DSA Used to Satisfy Demands in Particular Redefined Area

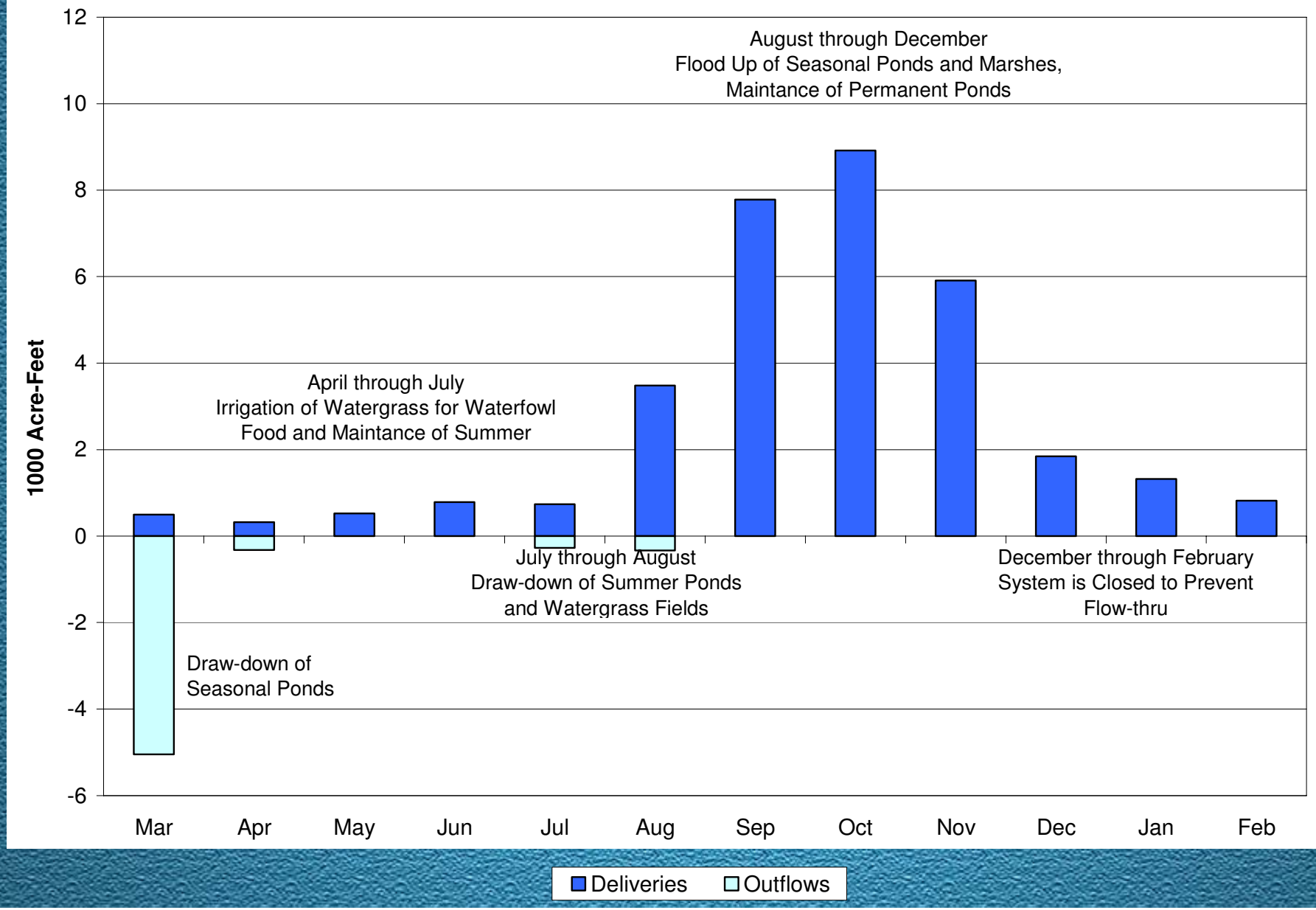
Rice Operation with Decomposition and Refuge Operation

- Represent Ponding Operation
- Development of Rice Decomposition Water Demand and Ponding
- Estimate Historical Refuge Operation to Avoid Double Counting of Refuge Demand
- Develop Refuge Ponding Operation to Better Represent Return Flow Timing and Volume

Rice Water Operations (Average of 1993-99)



Sacramento NWR Water Operations (Average 1993-99)



CALSIM II Sacramento River Basin Hydrology Enhancements

- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Possible effects to CALSIM simulation
- Work completed
- Future direction

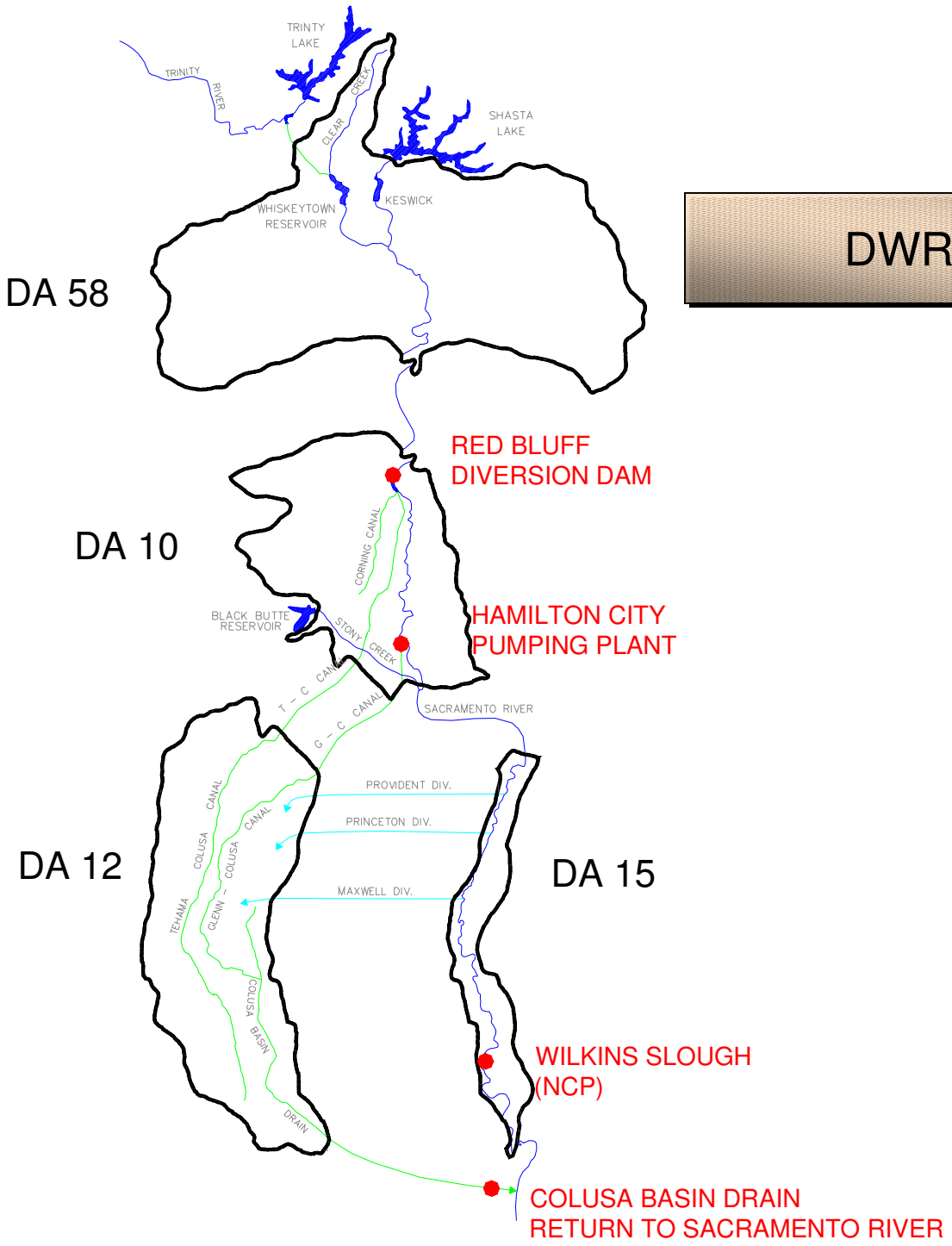
Potential Effect to CALSIM Simulation

- **Difficult to determine**
  - plus a couple 100,000 AF here
  - minus a couple 100,000 AF there
- Change in timing of flows
- Change in locations controlling operation
- Change in annual flow volumes

Potential Effect to CALSIM Simulation

- Depiction of physical system
- Hydrologic factors
- Ground water pumping
- Definition of project and non-project demands
- Rice operation and demands
- Refuge

DWR Sub-Basins

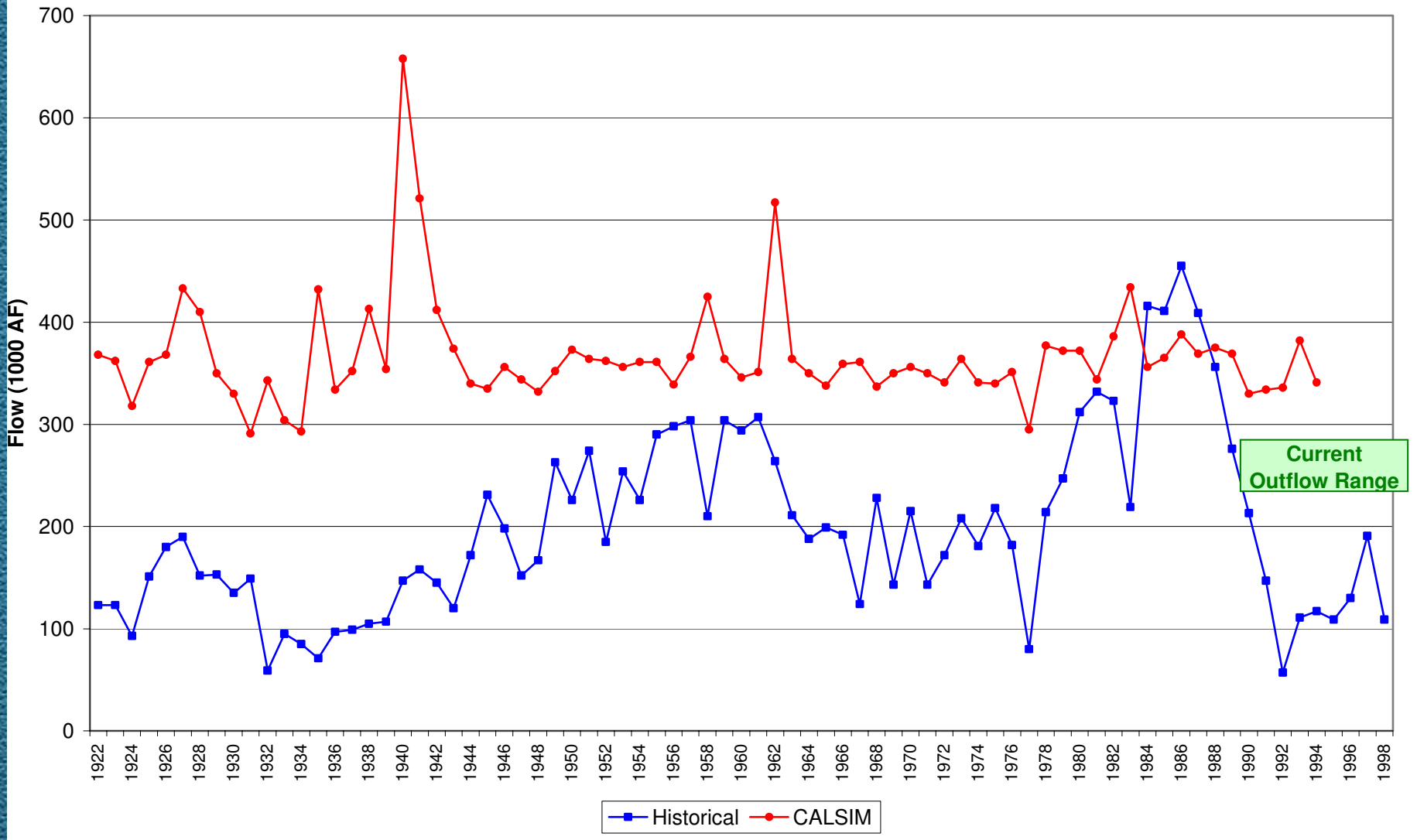


Basin Efficiency (%)

Based on 1966 – 1970 Historical Data

DSA	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
58	65	65	65	65	65	65	65	65	65	65	65	65
10	70	70	70	70	70	70	70	70	70	70	70	70
15	70	70	70	70	70	70	79	65	75	78	65	35
12	70	70	70	70	70	70	79	65	75	78	65	35
69	40	70	70	70	70	70	70	65	75	80	75	30

Colusa Basin Drain Outflow April - October Total Flow



CALSIM II Sacramento River Basin Hydrology Enhancements

- Current Representation
  - overview
  - demands
  - water supplies
- Problems
- Solutions
- Possible effects to CALSIM simulation
- Work completed
- Future direction

Work Completed

- Redefinition of DSA's
- Rice Decomposition Water Requirement
- Refuge Operation
- CALSIM – CALAG relationship
- Initial WRESL code

Future Direction

- How to complete project
- Interest in project
- Funding

Questions / Discussion