Gila-San Francisco Decision Support Tool to address the impact of 2004 Arizona Water Settlement Act

Natural History of Gila Symposium
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Outline

- Background
- Decision Support Tool
- Examples

Disclaimer: the results presented herein are illustrative and preliminary. They cannot be distributed without the consent of the GSF modeling team.

Gila Water Settlements in a Snapshot

- 1964 Gila River Apportionment

  US Supreme Court adopted a stipulation to allow equitable apportionment of Gila River between AZ and NM. NM beneficial use of Gila water (totaling 30,000 AF/yr) is declared and enforced by the OSE.

- 1968 Central Arizona Project (CAP)

  NM is allowed an additional 180,000 AF over any running 10-yr period. This provision did not allow funding for NM to divert add'l 18,000 AF/yr, and did not allow diversion over objections of Sr. downstream users.

- 2004 Arizona Water Settlement Act (AWSA)

  180,000 AF is reduced to 140,000 AF.

  Funding is provided to NM to administer its CAP water. ($66-128 million starting in 2012)

  Consumptive Use and Forbearance Agreement (CUFA) spells out the terms of NM diversion without objections of downstream users.

Gila-San Francisco Modeling Team was formed in September, 2005

- Team has endured despite various political and funding changes.
- Bi-weekly virtual meetings via WebEx.
- Team is comprised of local, state, and federal organizations.
- Decision support tool has been conceptualized and built based on System Dynamics.

So-called "GSF Decision Support Tool"

- The tool is being tested and modified accordingly.

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Key Contributors Span A Wide Range of Interests

active

- Municipality of Silver City
- The Nature Conservancy
- Gila Conservation Coalition
- Black Range Resource Conservation & Development
- Cliff/Gila Farm Bureau
- Charlotte Franky (intern)
- Bureau of Reclamation
- New Mexico Interstate Stream Commission
- Sandia National Laboratories

- Municipality of Deming
- Office of State Engineers, Deming
- Gila-San Francisco Water Commission
- Soil and Water Commission representatives from Grant, Catron, and Luna Counties
- US Fish and Wildlife Service

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Tool Provides an Interface Between Human & Natural Systems

Stakeholders, Decision Makers, Public

SCENARIO BUILDING: ***WHAT IF…***

GSF Decision Support Tool

DEMAND

2004 AWSA

population

industry

minimum flow

agriculture

GEOHYDROLOGY

coupled surface water

& groundwater

riparian

evapotranspiration

SYSTEM DYNAMICS

dynamic simulation

time delay

feedback

CLIMATE

hydrograph

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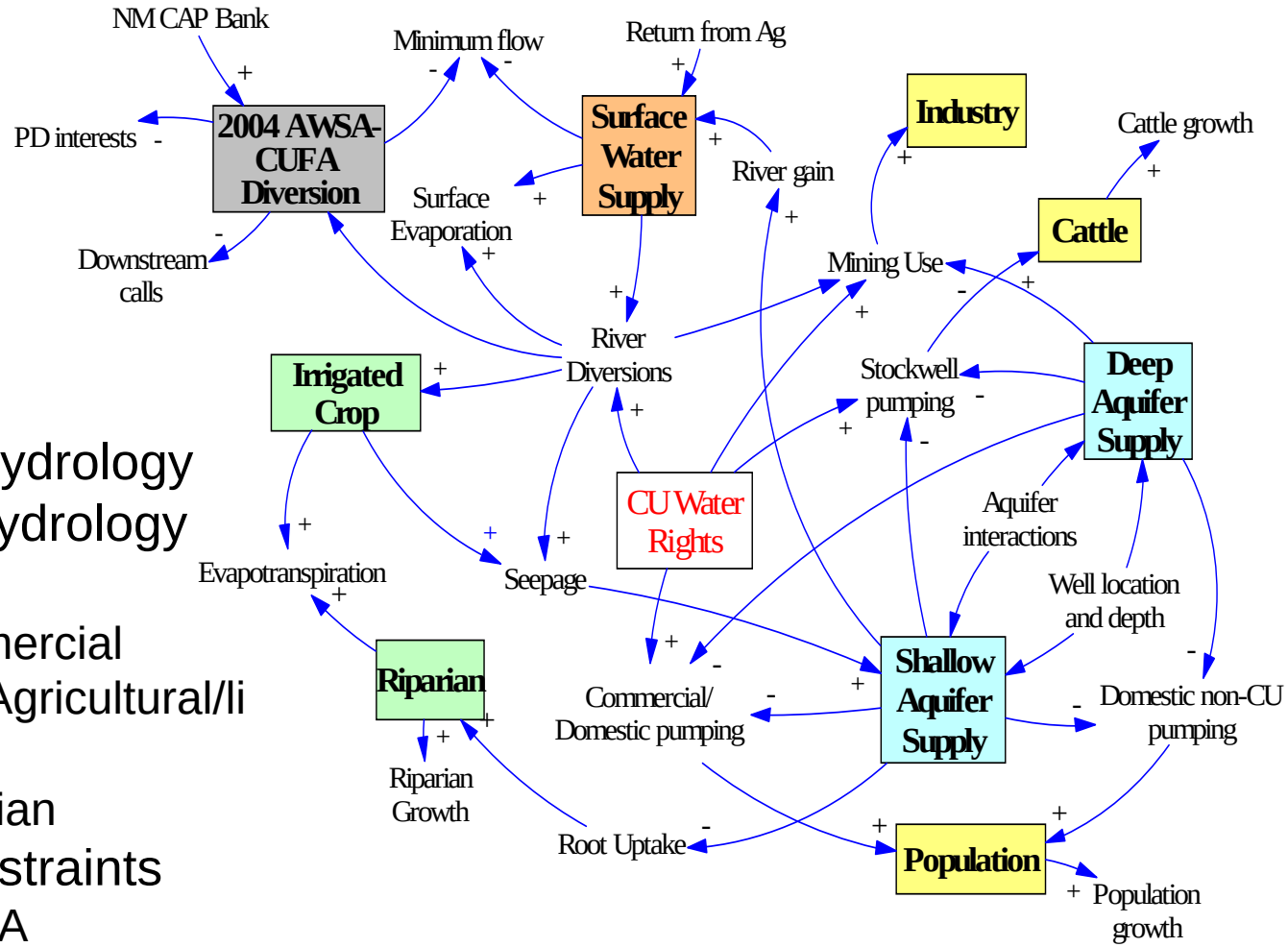
System Dynamics is used for modeling intricate coupling between physical and social systems

Overall Influence Diagram



- Surface water hydrology
- Ground water hydrology
- Water demand
  - Residential/commercial
  - Industrial/miningAgricultural/livestock
  - Evaporative/riparian
- Institutional constraints
  - CUFA, ESA
- Watershed hydrology

□ = stock in units of water volume

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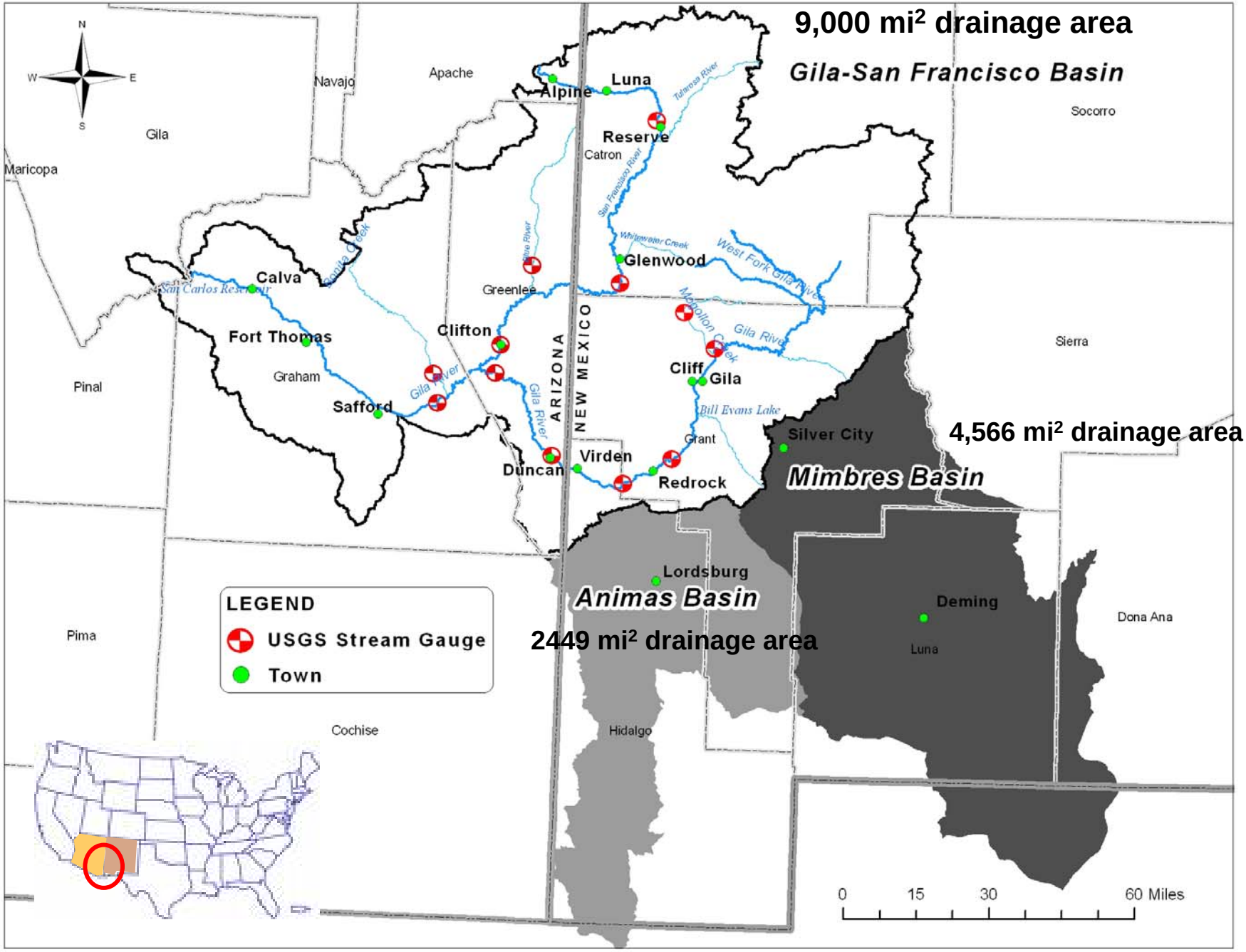
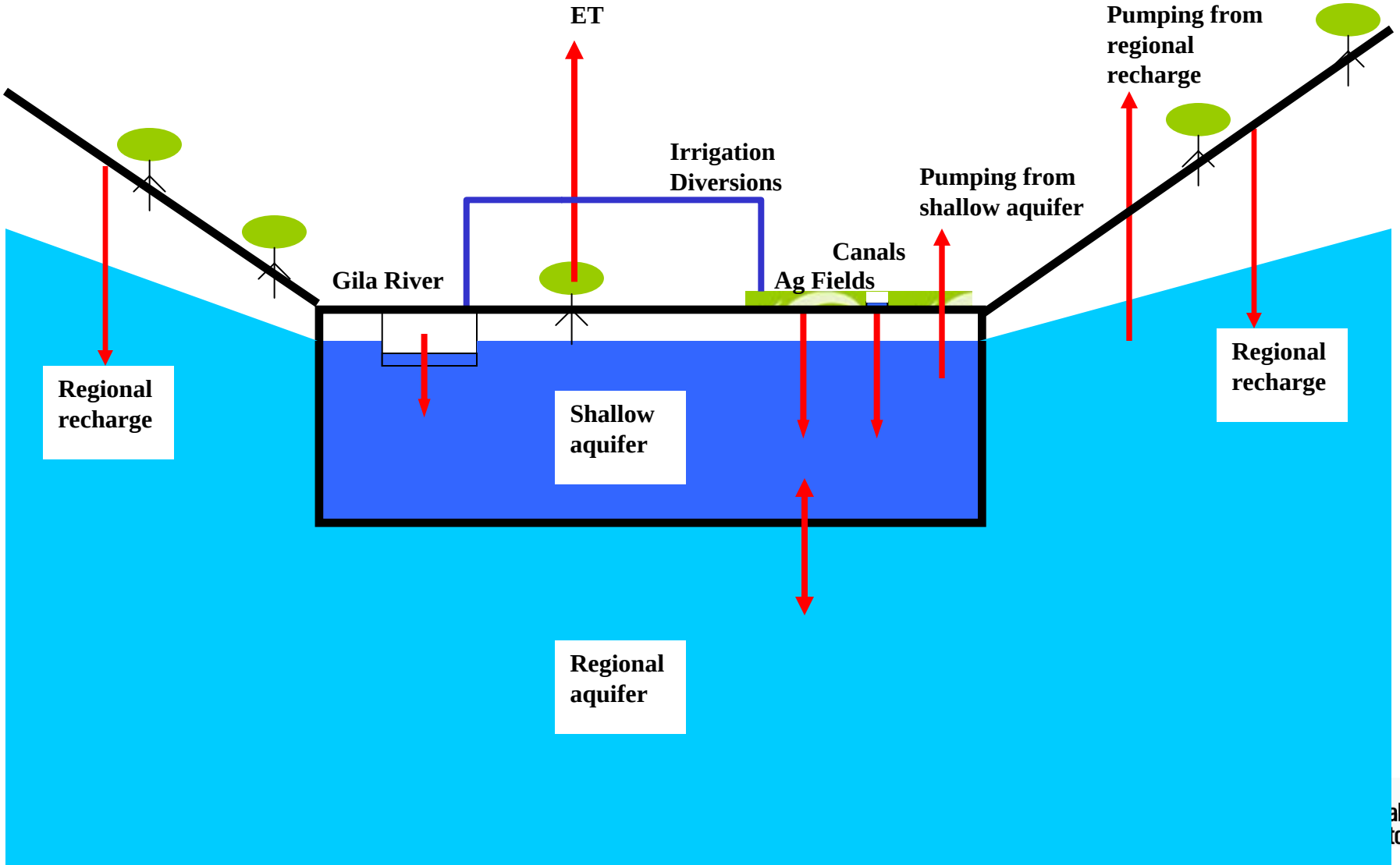
How Boundaries are Defined in the Tool

- Hydrogeology
  - Surface Water ***"reach"***: SF river (3) and Gila river (4)
  - Groundwater ***"basin"***: Mimbres, Gila-SF, and Animas
- Political
  - ***County***: Grant, Luna, Hidalgo, and Catron
  - ***Municipality***: SC, Deming, Columbus, Lordsburg, Bayard, Hurley, Glenwood, Reserve, Cliff-Gila, Santa Clara.
  - ***Rural*** = (County – Municipality)
- Water Rights
  - Domestic consumptive use
  - Domestic Non-consumptive use (DNC)
  - Sector-based: Mining, Commercial, Agriculture, Livestock

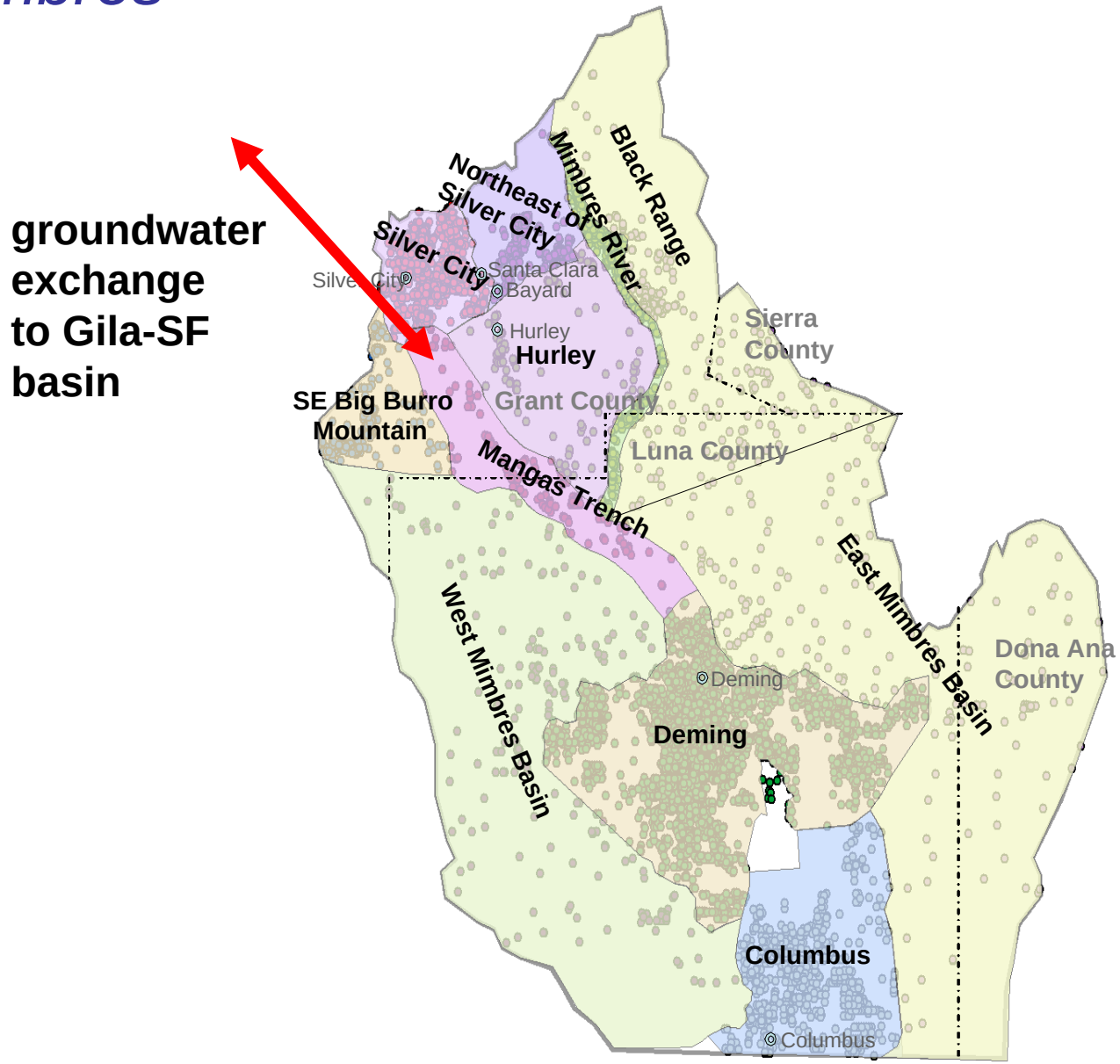
Study Area


9,000 mi² drainage area
Gila-San Francisco Basin
4,566 mi² drainage area
Mimbres Basin
Animas Basin
2449 mi² drainage area
N
S
E
W
Navajo
Apache
Gila
Maricopa
Pinal
Pima
Cochise
Hidalgo
Luna
Dona Ana
Sierra
Socorro
Catron
Graham
Alpine
Luna
Reserve
Glenwood
Greenlee
Clifton
Calva
Fort Thomas
Safford
Duncan
Virden
Redrock
Cliff
Gila
Silver City
Lordsburg
Deming
San Carlos Reservoir
Bill Evans Lake
Tularosa River
San Francisco River
Whitewater Creek
West Fork Gila River
Gila River
Mogollon Creek
Eagle Creek
Blue River
ARIZONA
NEW MEXICO
LEGEND
USGS Stream Gauge
Town
0
15
30
60 Miles

GSF Basin
SW/GW Coupling Within Each Reach



Groundwater demand by Sub-basins in Mimbres



Key Data Sources

- GSF Modeling Team
- GIS Watershed Mapping
- GIS Temperature data
- USGS data
- Southwest New Mexico Regional Water Plan (01/2005)
- OSE WATERS database
- OSE annual hydrographic survey for Ag and non-Ag use
- Balleau GW Assessment (2/2006)
- Luna County Irrigation survey
- Individual contributors: Ellen Sole

Objectives

- Given various constraints, how much water is available from where, when and to what purpose?
- Given various constraints, how much water is in demand from where, when and to what purpose?
- What are the tradeoffs among various approaches to managing this water?

SCENARIO BUILDING: ***WHAT IF…***

INPUT → **GSF Decision Support Tool** → **OUTPUT**

•Daily temperature
•USGS daily gauge reading (historical=>future)
•New Mexico CUFA constraints
•*Surface water demand*
•*Groundwater demand*
•*Instream Flow Requirement*
•*Growth trends*

adjustable by users to study different scenarios

•Ag Consumptive use
•Non-Ag demand by sector
•New Mexico Potential Diversion per 2004 AWSA -CUFA

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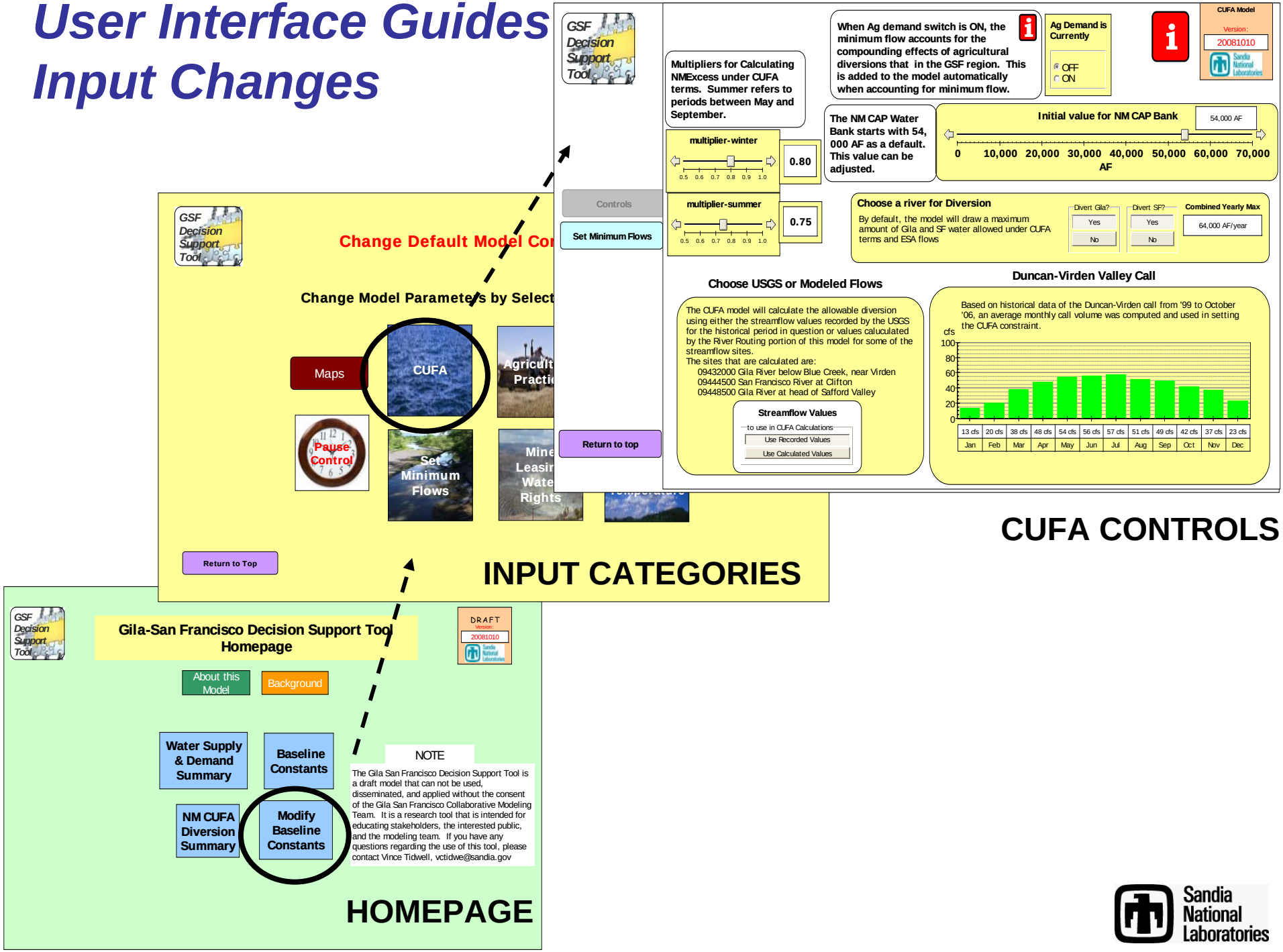
User Interface Guides
Input Changes



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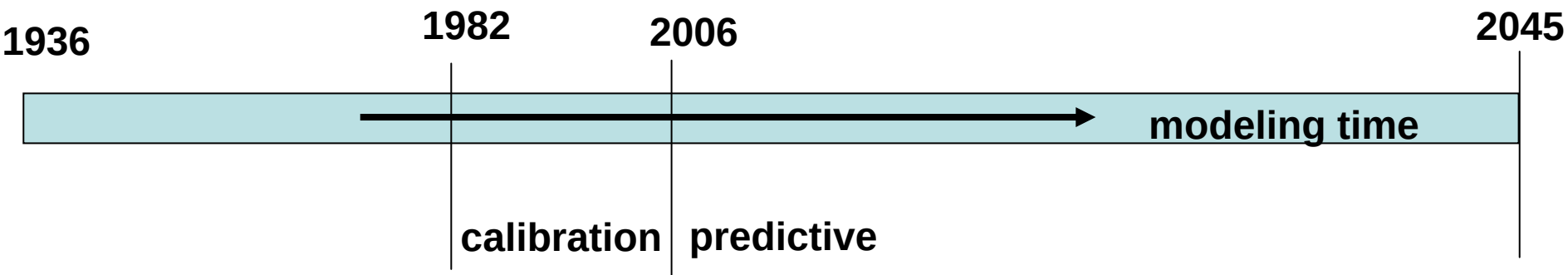
Predictive Horizon uses historical hydrographs plus hypothetical demand.



- Historical data are used to tune the demand and supply to gain confidence.
- Projections into the future can change based on scenarios.
- Predictive mode is driven by two scenarios.

a) Repeat of historical hydrographs and project future demands.

1980 → 2005 1980 → 2005

b) URGWOP sequence of hydrographs and project future demands.

→

('82,'88,'92,'76,'89,…,'84,'92,'88,'91,'82)

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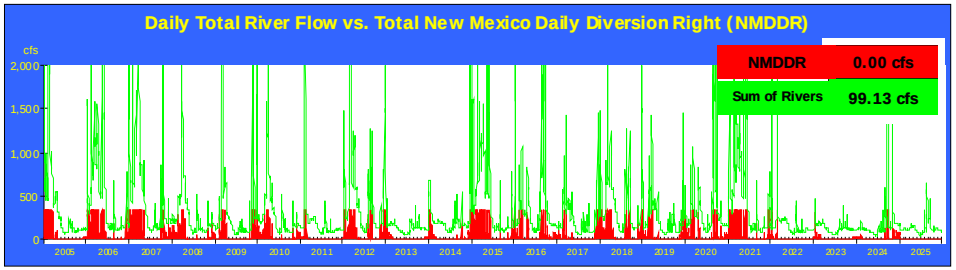
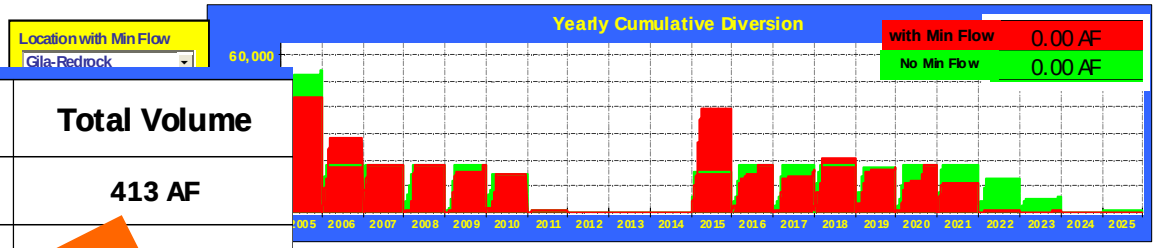
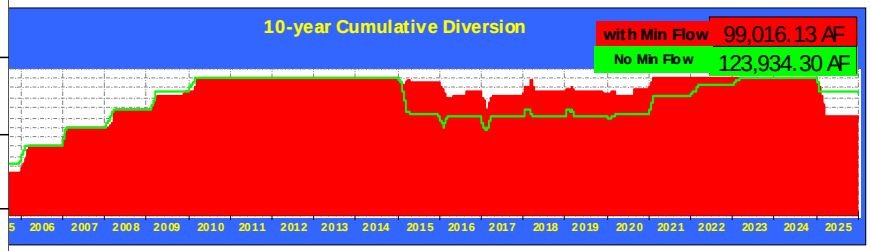
Results + Insights

20-year Summary – SF Diversion OFF







Gila GW	Avg Annual Rate	Total Volume
Domestic Wells	20 AF/year	413 AF
DNC Wells	1,818 AF/year	83 AF
Municipality	657 AF/	4,241 AF
GW to Mimbres	9	17,865 AF
Commercial	2,183 AF/year	45,880 AF
Livestock	3,206 AF/year	67,283 AF
Mining	392 AF/year	8,367 AF
Supplemental Ag	4,692 AF/year	81,525 AF

Illustration

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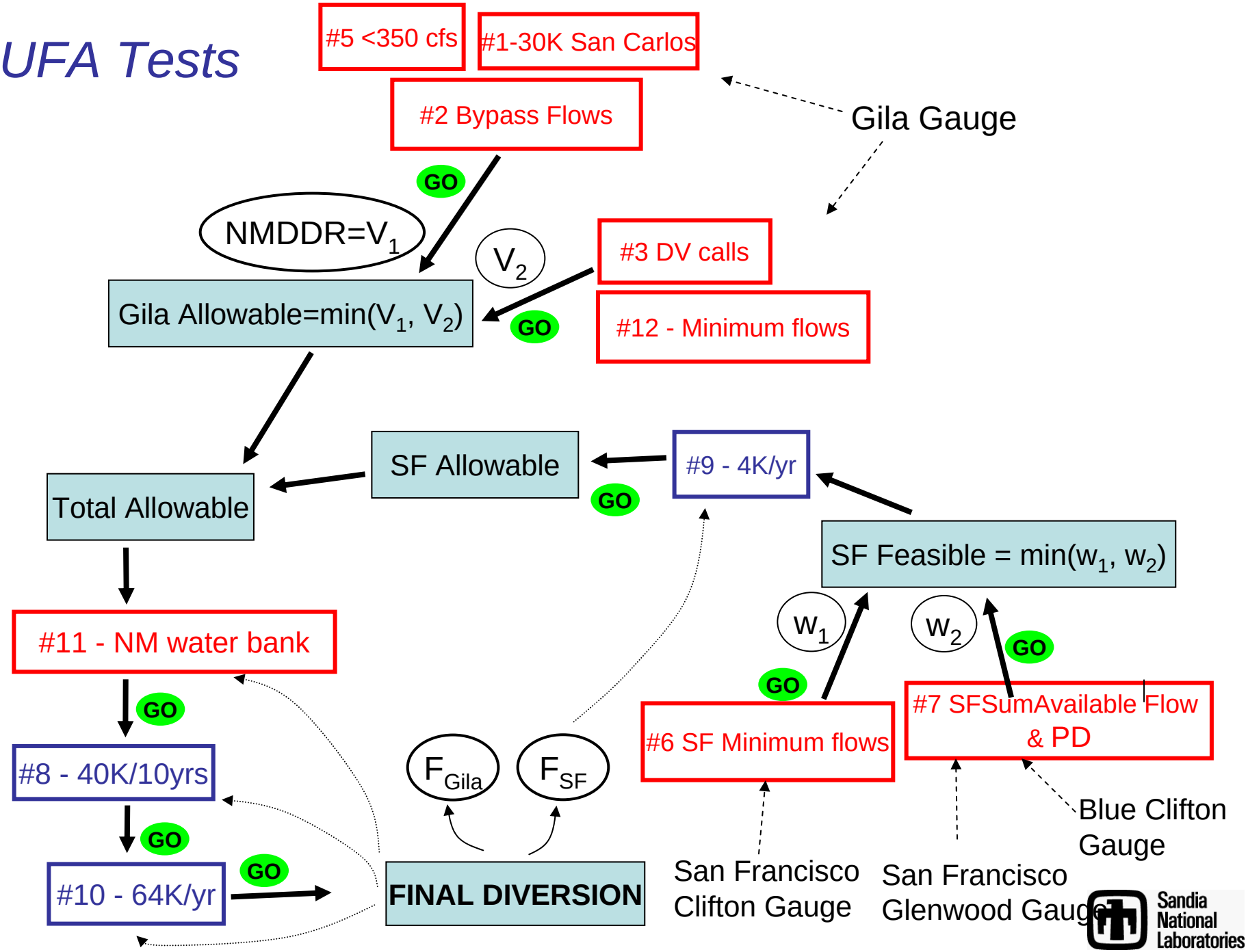
Key Questions

- Given various constraints, how much water is available from where, when and to what purpose?
  - example => CUFA diversion
- Given various constraints, how much water is in demand from where, when and to what purpose?
- What are the tradeoffs among various approaches to managing this water?

CUFA Tests


#5 <350 cfs
#1-30K San Carlos
#2 Bypass Flows
Gila Gauge
GO
NMDDR=V_1
V_2
#3 DV calls
Gila Allowable=min(V_1, V_2)
GO
#12 - Minimum flows
SF Allowable
#9 - 4K/yr
Total Allowable
GO
SF Feasible = min(w_1, w_2)
#11 - NM water bank
w_1
w_2
GO
GO
GO
#7 SFSumAvailable Flow & PD
#6 SF Minimum flows
#8 - 40K/10yrs
F_{Gila}
F_{SF}
GO
Blue Clifton Gauge
#10 - 64K/yr
GO
FINAL DIVERSION
San Francisco Clifton Gauge
San Francisco Glenwood Gauge
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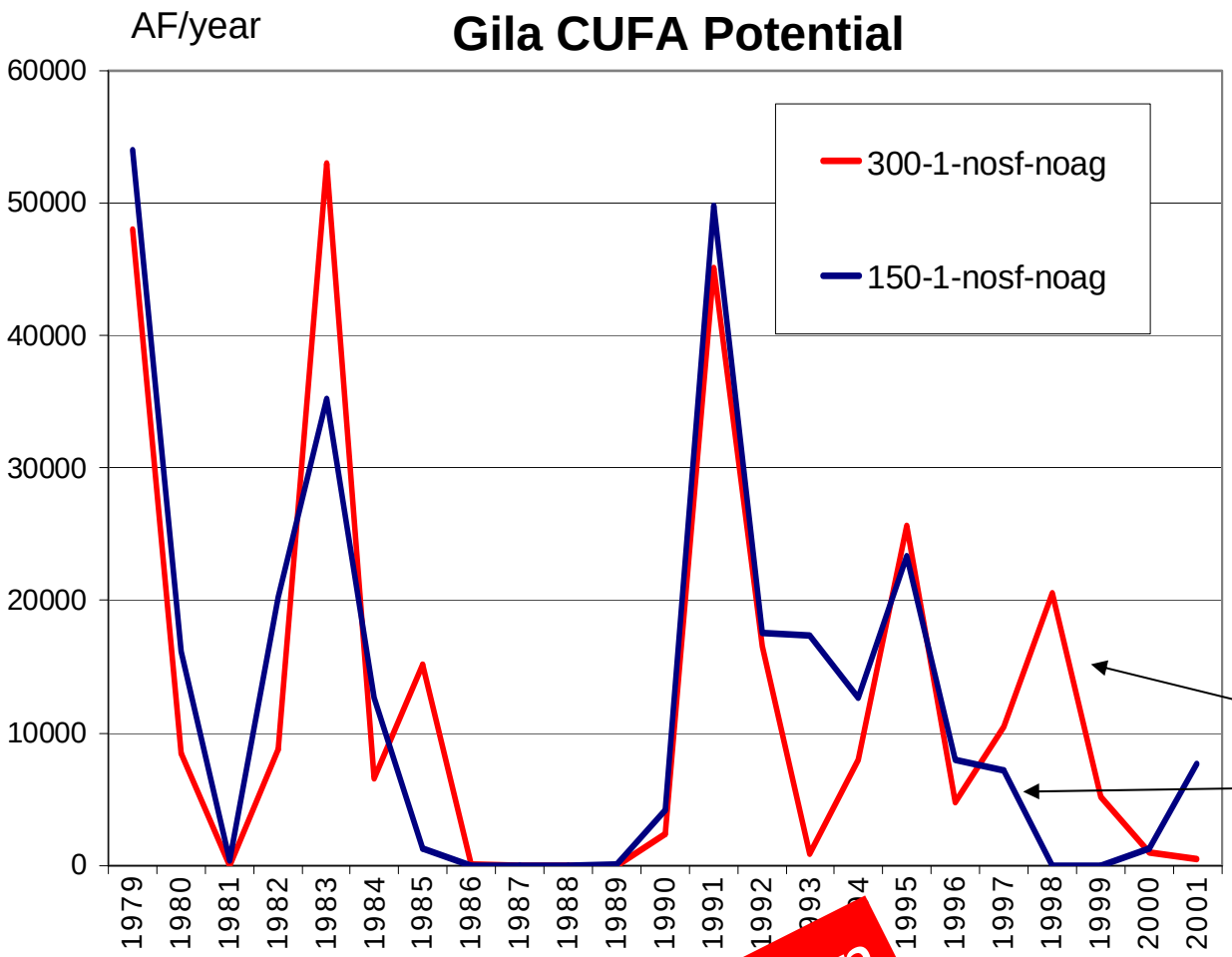
Sensitivity of CUFA Diversion relative to amount of Minimum Flow in the Gila



Key Insight:
The sensitivity to the amount of minimum flow is small.

Some years the diversion is higher even with higher minimum flow constraint.

annual average

12,211 AF/yr

12,559 AF/yr

Illustration

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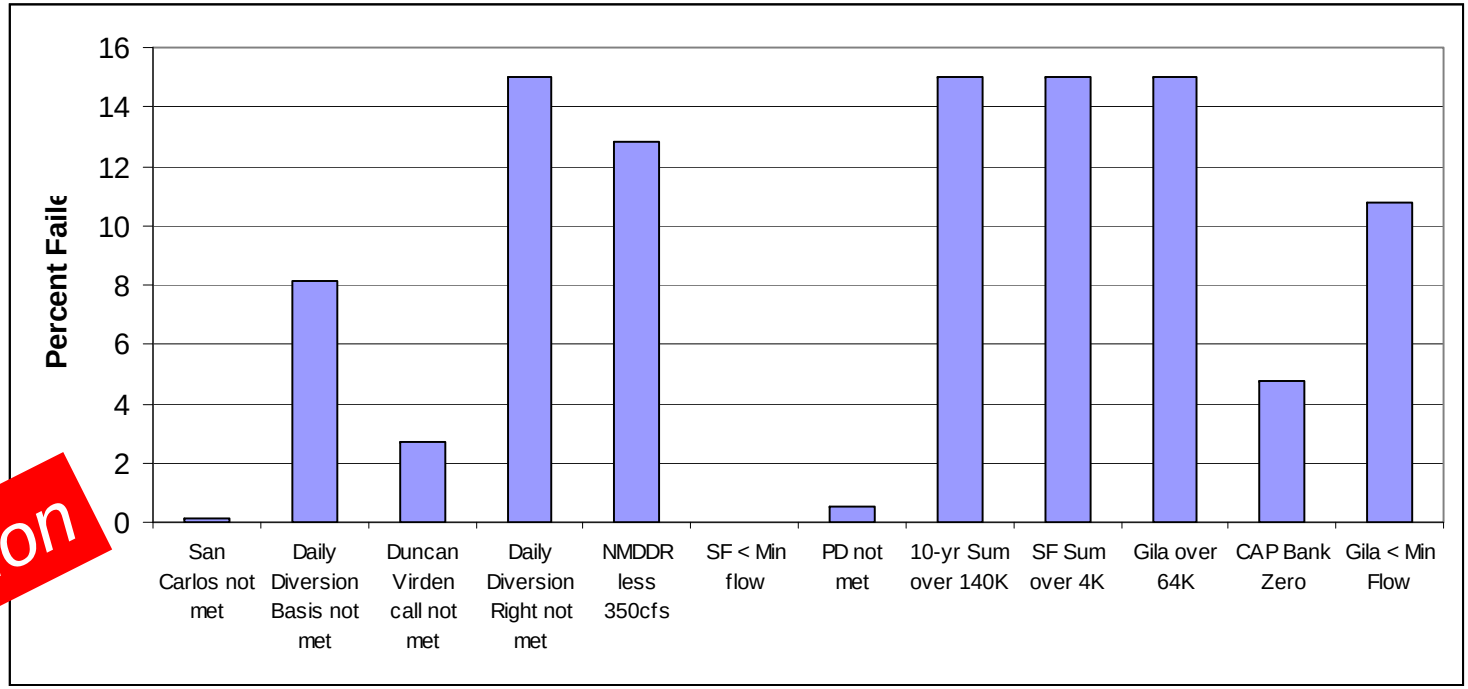
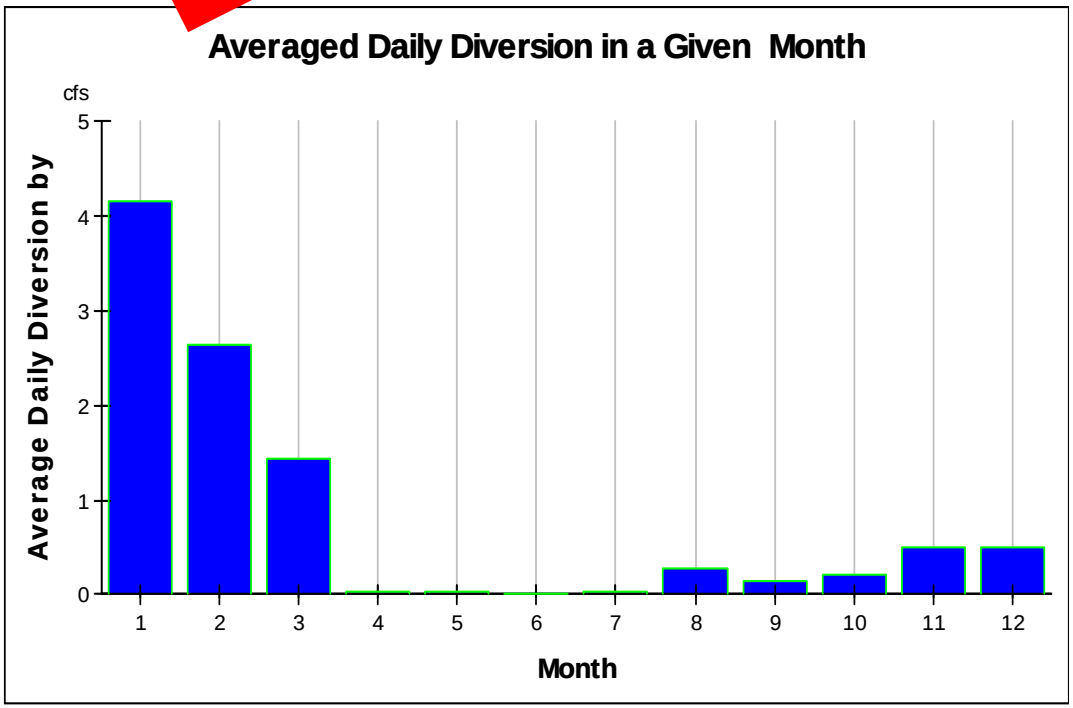


Illustration



Key Insight:
Cumulative constraints dominate the ability to divert.

Potential diversion occurs during winter months.

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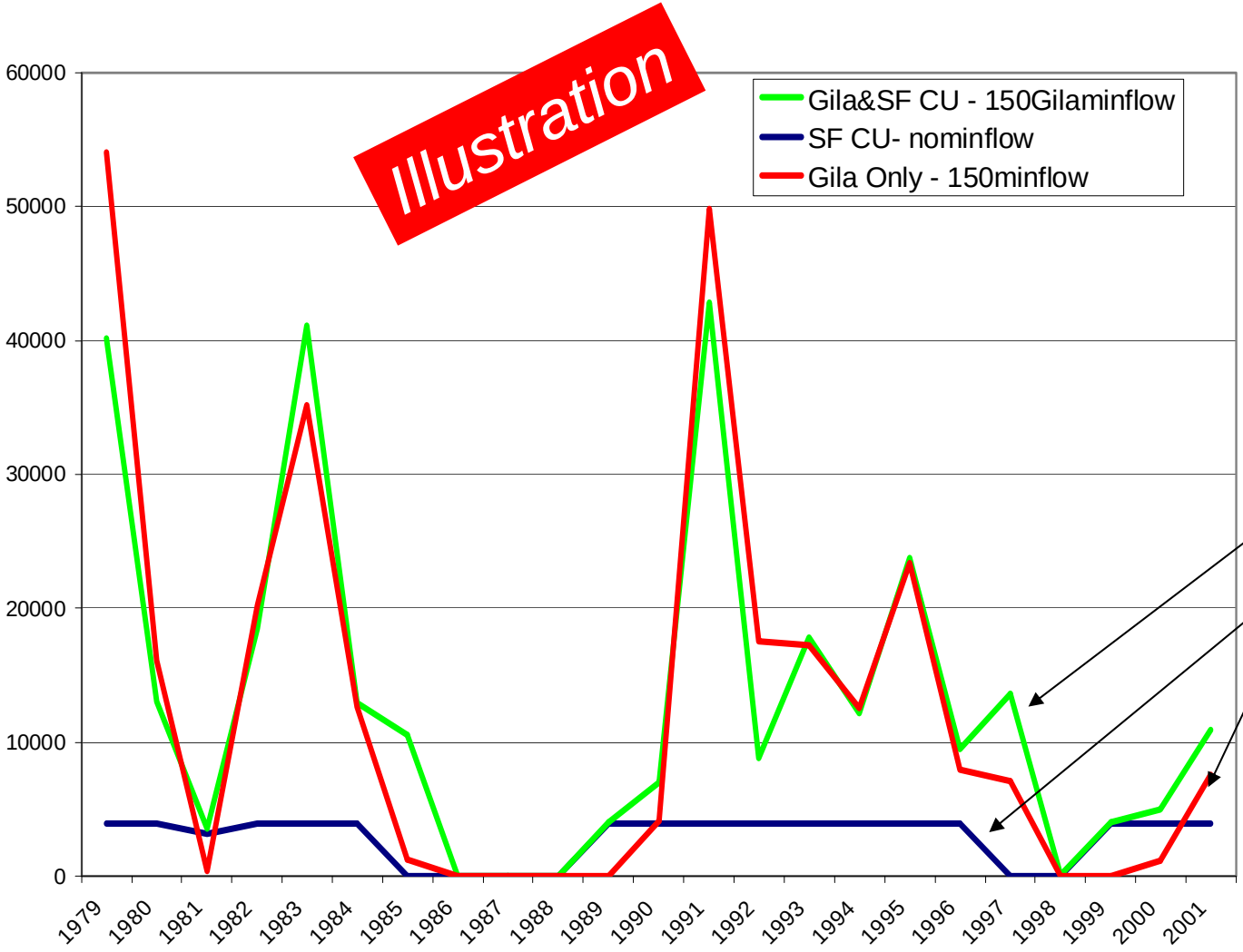
Distribution of SF river potential and Gila river potential for CUFA



Average annual

13,042 AF/yr

2,922 AF/yr

12,559 AF/yr

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Key Questions

- Given various constraints, how much water is available from where, when and to what purpose?
- Given various constraints, how much water is in demand from where, when and to what purpose?

  example => agriculture
- What are the tradeoffs among various approaches to managing this water?

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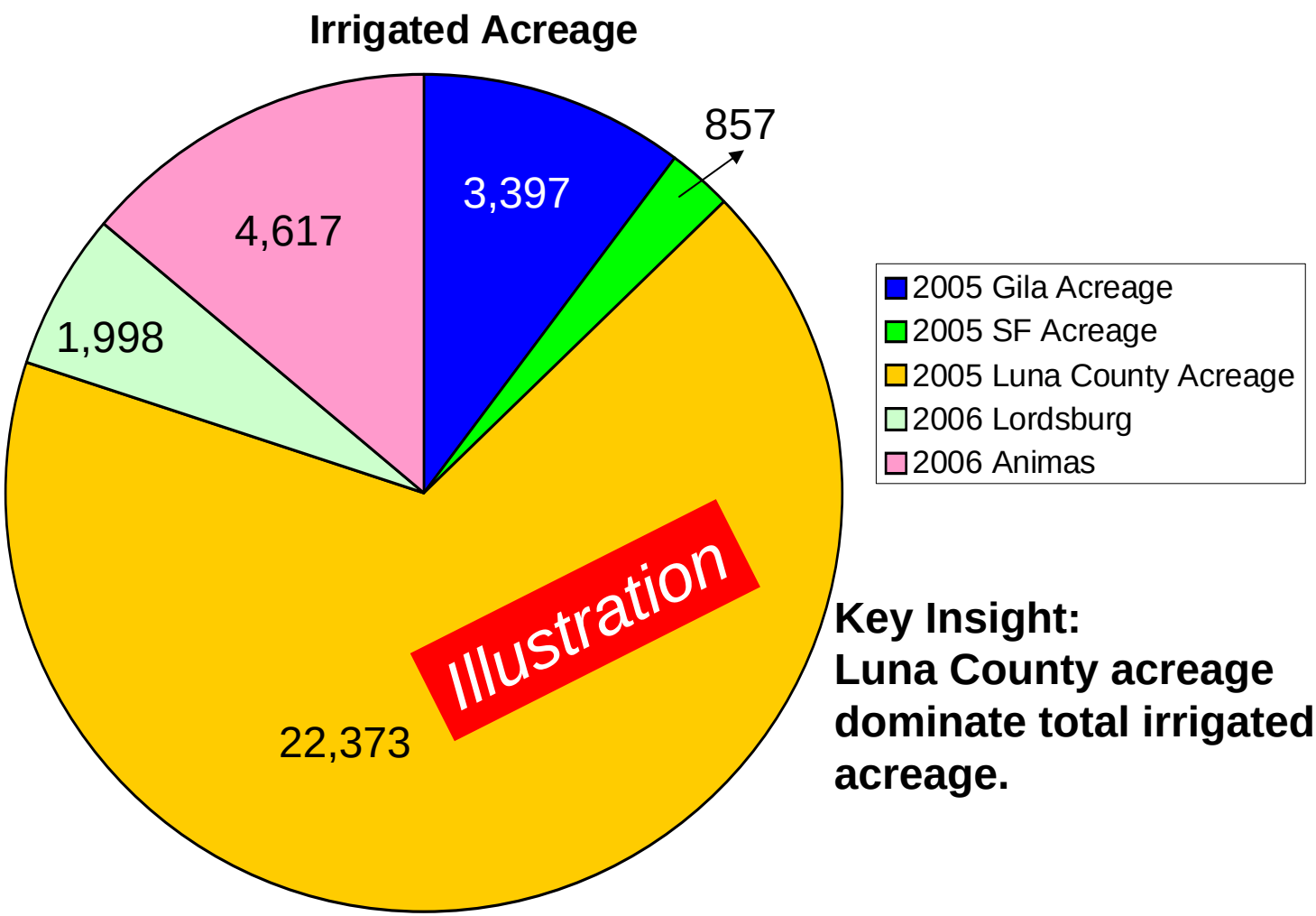

Key Insight:
Luna County acreage dominate total irrigated acreage.

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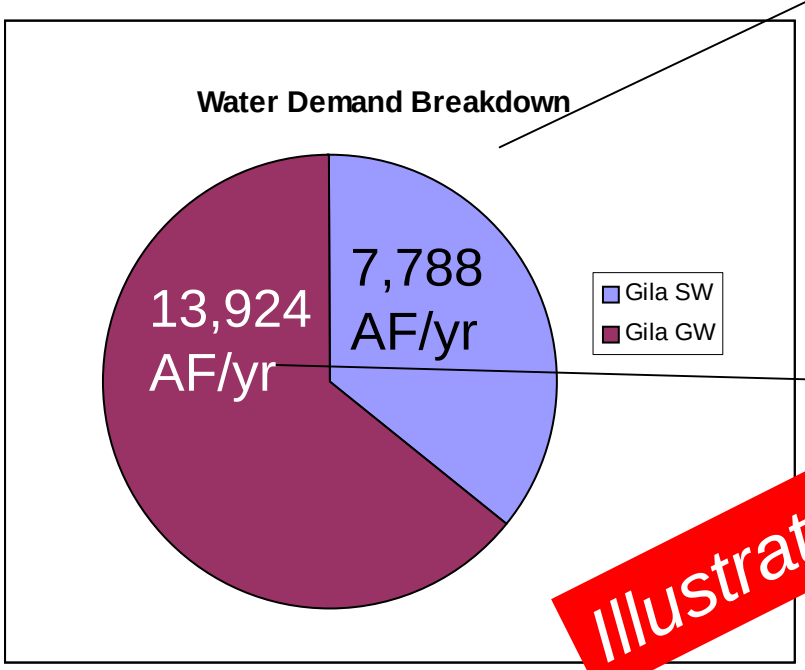
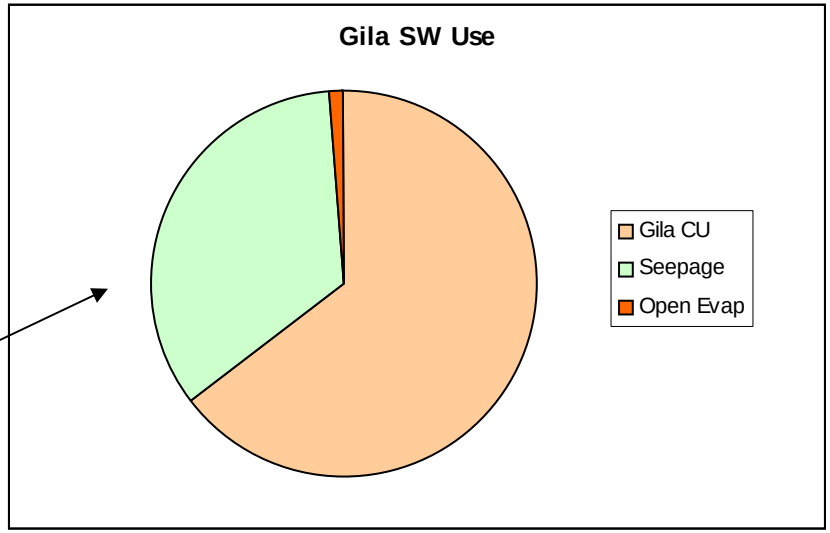
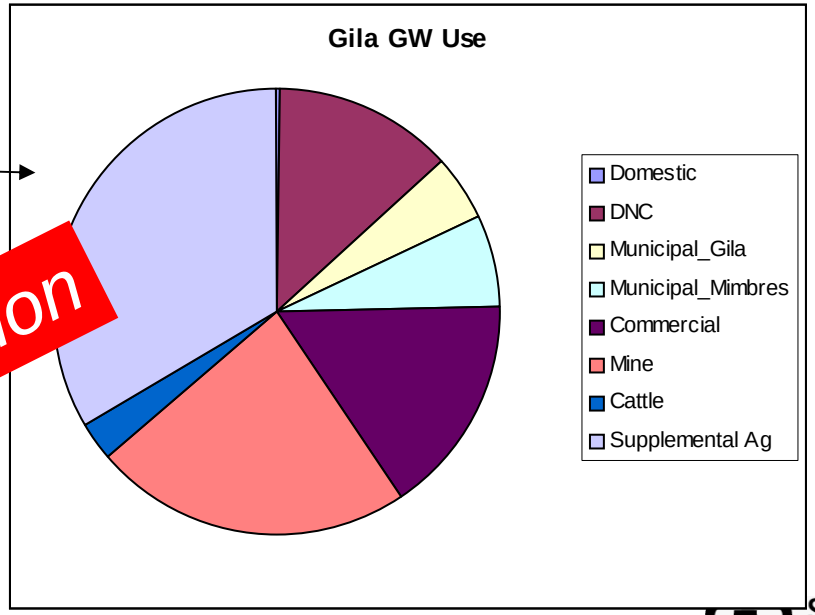
Gila Water Demand

Key Insight:
Groundwater demand is 2x the surface water demand.







Illustration

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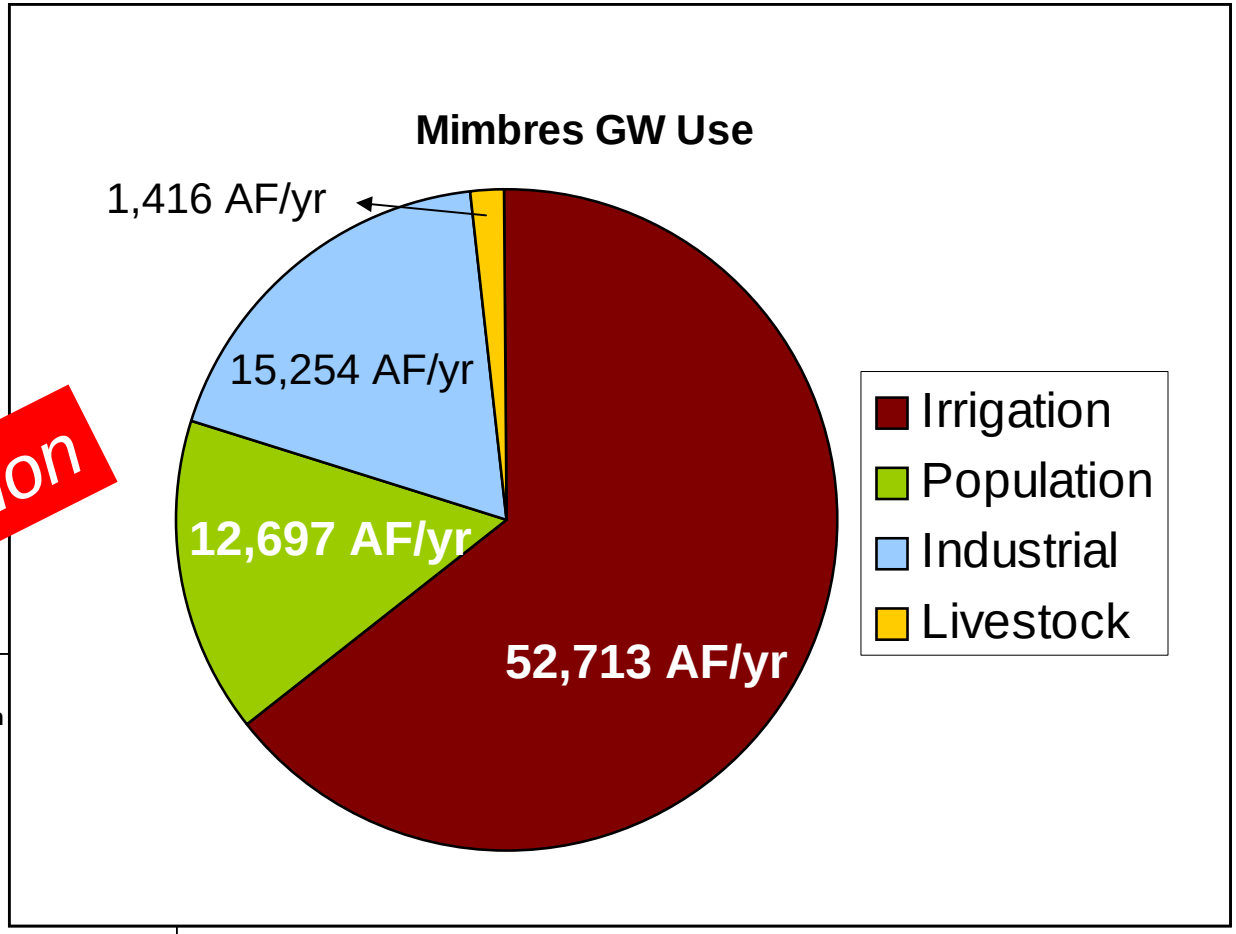
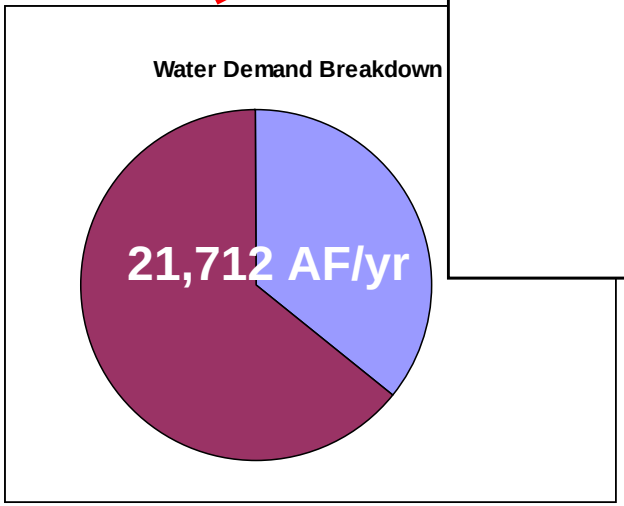
Mimbres Water Demand



Illustration



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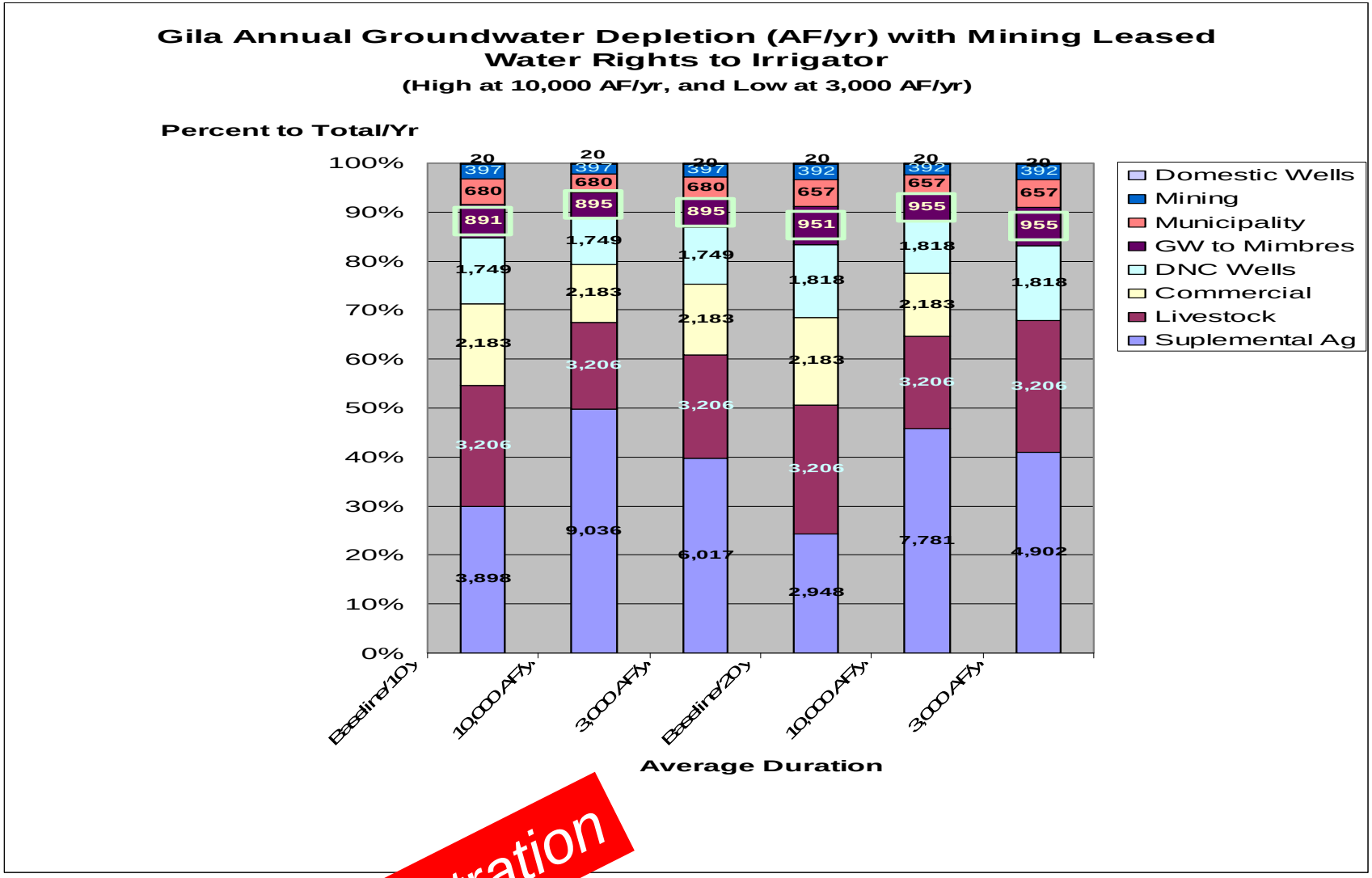
Key Questions

- Given various constraints, how much water is available from where, when and to what purpose?
- Given various constraints, how much water is in demand from where, when and to what purpose?
- What are the tradeoffs amongst various approaches to managing this water?

  example => PD leased water to irrigation

Mining Leased Water to Irrigator

(High at 10,000 AF/yr, and Low at 3,000 AF/yr)



Illustration

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Work in Progress

- More verification is needed due to the possible permutations on input changes.
- Build more scenarios/examples.
  - Conservation measures.
  - Ecological Demand.
- Continue with sensitivity analysis.
- Hold workshops to broaden user communities.
- Currently not for public release.
- New membership is welcome.

Thank You

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