LINKED SURFACE WATER AND GROUNDWATER MODEL FOR SAN ACACIA REACH AS A TOOL TO SUPPORT DECISION MAKING ANALYSIS

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ABSTRACT

Under the Rio Grande compact, New Mexico is obligated to deliver a specified amount of water to satisfy water portion of the demands above Ft. Quitman and below Elephant Butte Reservoir in New Mexico, Texas, and Mexico. This indicates that a finite amount of water is available for depletion in NM including agricultural irrigation, habitat preservation, and domestic use. New Mexico delivers water to Elephant Butte Reservoir through the Rio Grande Floodway and Low Flow Conveyance Channel (LFCC). The LFCC, constructed during the 1950s to provide an efficient conveyance of water to the reservoir, was fully operational from 1959 to 1986. Currently, no flow is diverted to the channel, and it functions passively as the main drain for the system from San Acacia to Elephant Butte Reservoir. Most recently, decision makers are reviewing the operation of the LFCC to achieve the most benefit of the channel.

The NM ISC has developed a dynamically linked surface water and groundwater numerical model to assist in the decision making process. The model simulates the surface water system including irrigation canals and drains, riparian evapotraspiration, interaction between surface water and groundwater, and the shallow/ deep groundwater system. The model was calibrated to surface water flows and groundwater elevations. Four management strategies were developed considering a range of diversions to the LFCC varying from no diversion to a maximum capacity of 2000 cfs. The results indicate that diverting water to the LFCC up to 2000 cfs would maximize conveyance efficiency (maximize delivery to the reservoir). Alternatively distributing the water at San Acacia between the river floodway and the LFCC increases depletions by riparian communities.

Objective

To develop a model to assist decision makers in selecting an alternative for future operation of the Low Flow Conveyance Channel:

The selected alternative must:

- *Provide water to senior water right holders*
- *Maintain New Mexico's ability to meet its downstream obligations.*
- *Maintain certain flows in the river channel to benefit the endangered species.*

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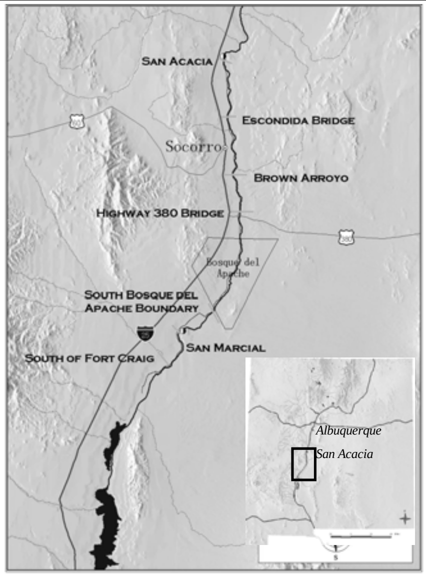
Background



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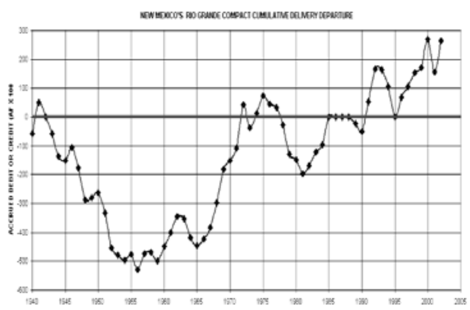
Background (Cont'd)

-The Low Flow Conveyance Channel was constructed as part of the Middle Rio Grande Project during 1950's to efficiently convey surface water to Elephant Butte Reservoir after the flood of 1942.

- It was operated from 1959 to 1986.

- Since 1986 the LFCC has served as the main drain in San Acacia Reach.



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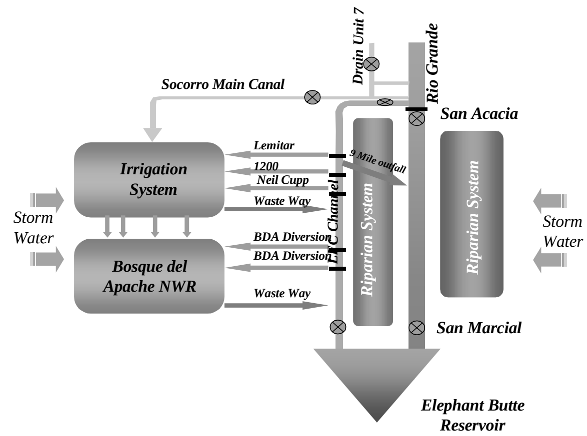
Schematic of the Flow System



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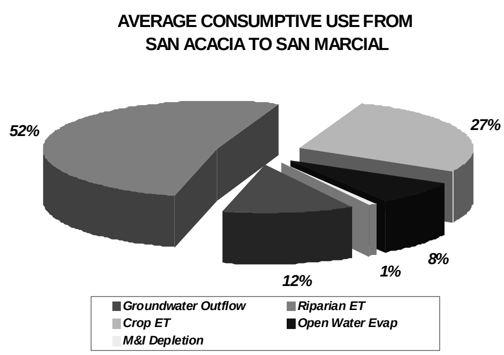
San Acacia to San Marcial Depletions



Average CU 123,000 acre-feet

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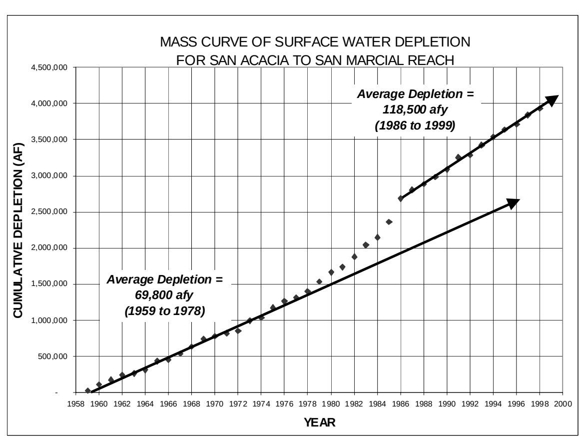
SW System Depletions Through Time



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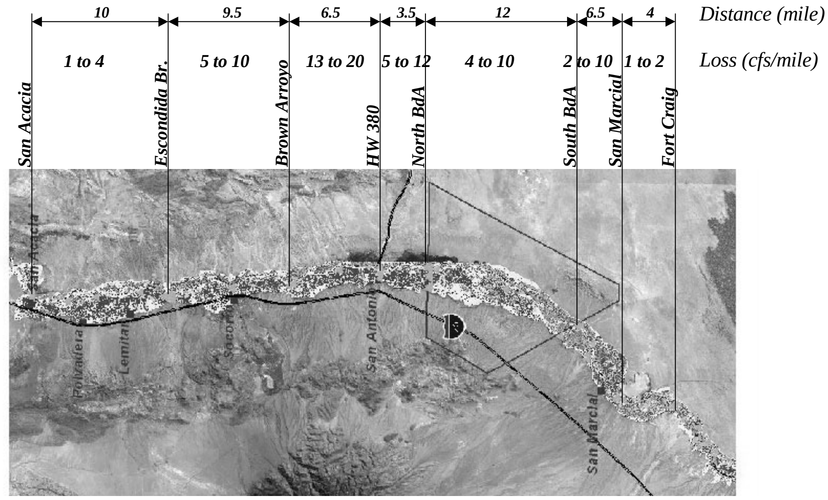
Seepage Run Results (River Losses)



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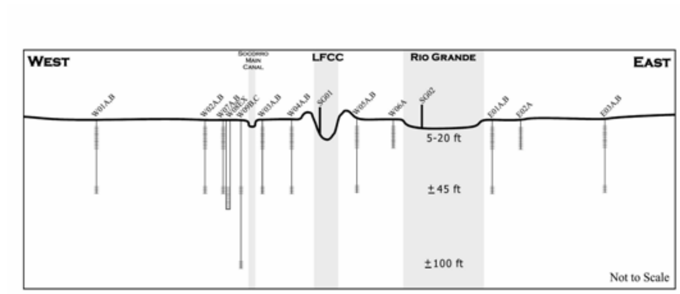
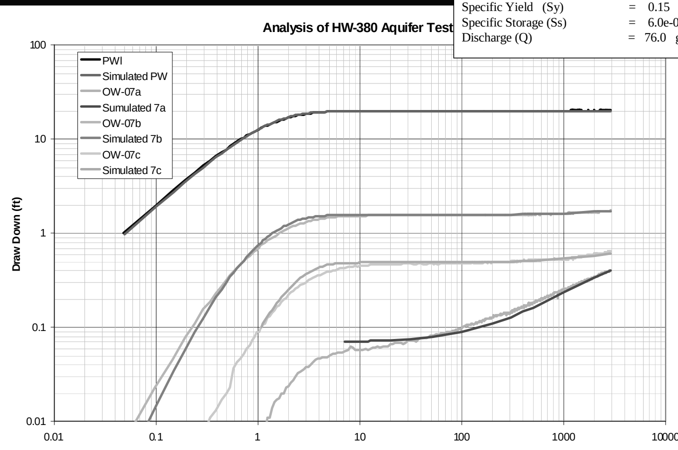
Monitoring System



Aquifer Test shallow Alluvium

H. Hydrauic Conductivity (Kx)	=	72.0 ft/day
V. Hydraulic Conductivity (Kz)	=	3.6 ft/day
Kh : Kz	=	20 : 1
Specific Yield (Sy)	=	0.15
Specific Storage (Ss)	=	6.0e-07 1/ft
Discharge (Q)	=	76.0 gpm



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Equations of Physical System

SW Continuity Equation:

$$B\frac{\partial Z}{\partial t}+\frac{\partial Q}{\partial x}+q=0$$

SW Momentum Equation:

$$\frac{1}{gA}\frac{\partial Q}{\partial t}+\frac{2\beta Q}{gA^2}\frac{\partial Q}{\partial x}-\frac{\beta Q^2}{gA^3}\frac{\partial A}{\partial x}+\frac{\partial Z}{\partial x}$$

$$+\frac{k}{A^2R^{4/3}}Q|Q|-\frac{\xi B}{gA}U_a^2\cos\alpha\ =0$$

SW/GW Interaction:

$$q\ =\ \frac{K'}{b'}B\,(Z-h)$$

Groundwater Flow Equation:

$$\frac{\partial}{\partial x}(K_x\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(K_y\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(K_z\frac{\partial h}{\partial z})-q=S_s\frac{\partial h}{\partial t}$$

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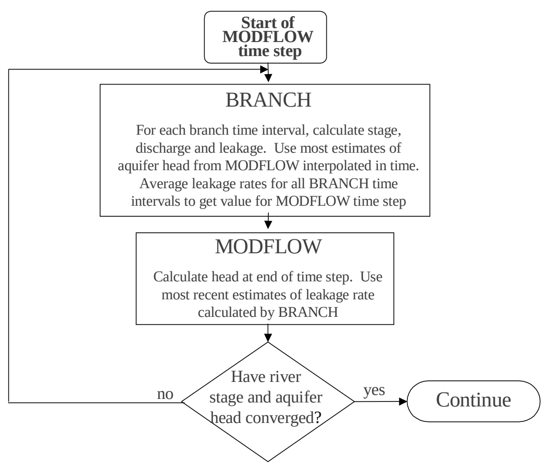
SW / GW Link



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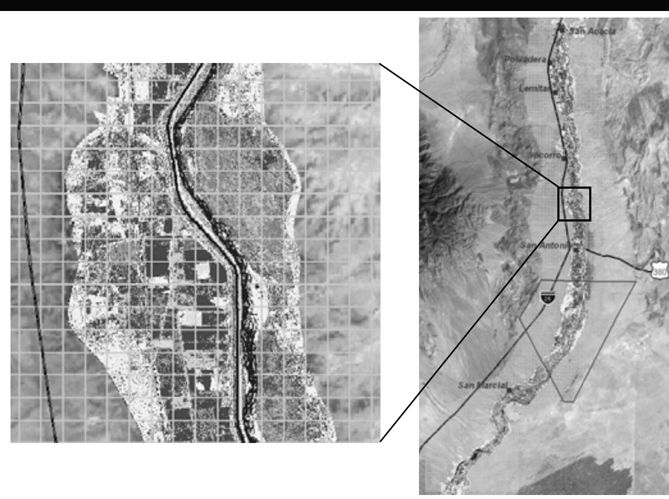
Numerical Model Grid



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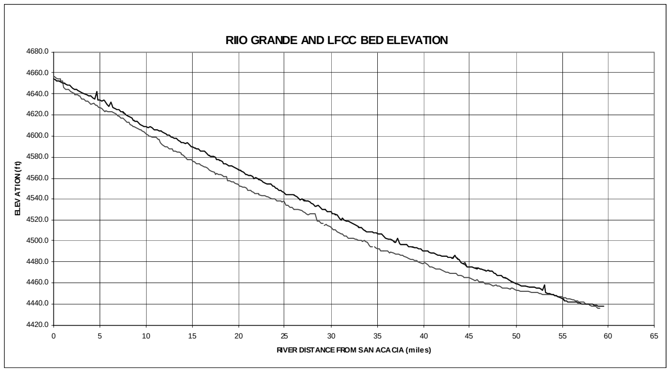
Rio Grande and LFCC Bed Elevation



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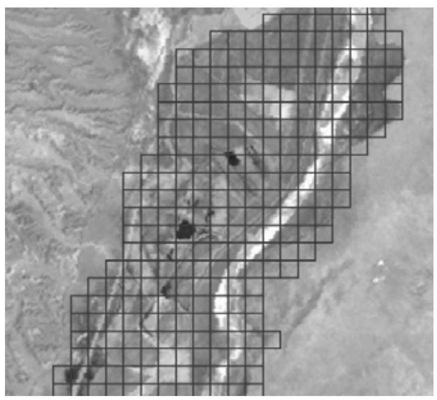
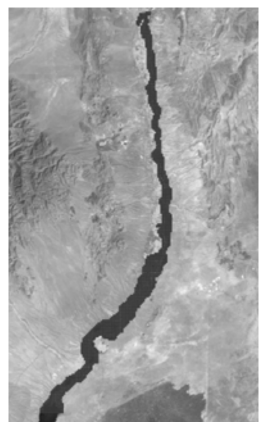
Riparian Evaptranspiration





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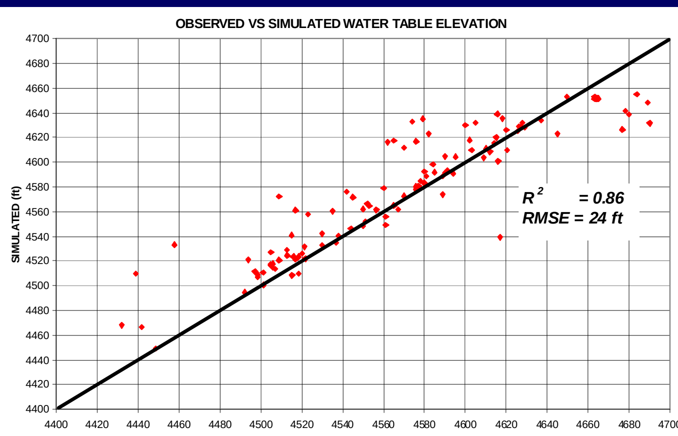
Simulated VS Observed Water Elevation



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Simulated Water Table Map

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LFCC Operation (Transient Runs)

Operation Scenarios:

1- No diversion to LFCC

2- Max diversion of 500 cfs and min of 100 cfs

3- Max diversion of 1000 cfs and min of 100 cfs

4- All flow diverted to LFCC with a max of 2000 cfs

Hydrology of year 2001 was used in all scenarios

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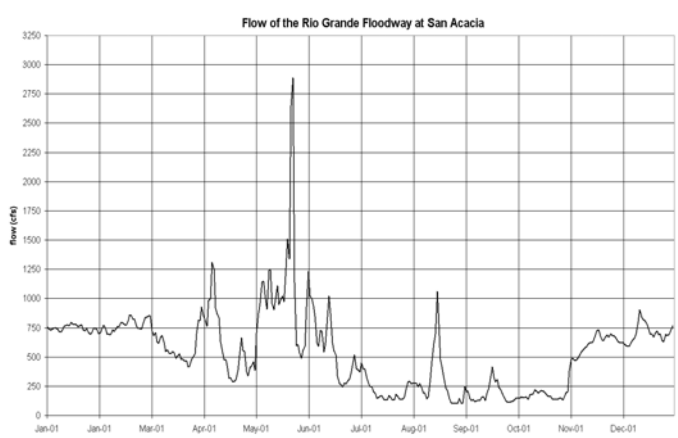
Inflow at San Acacia



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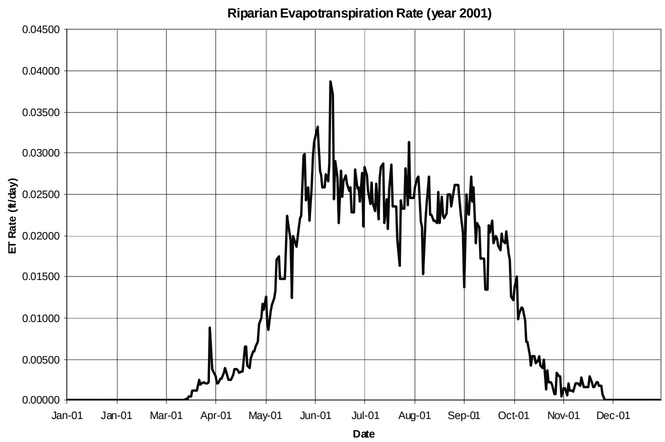
Riparian Evapotranspiration



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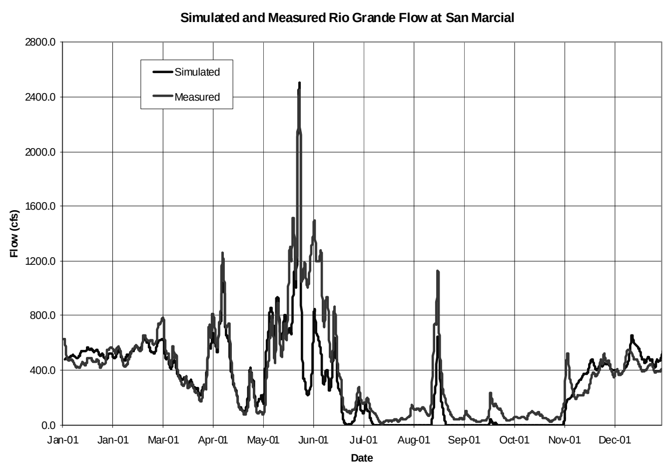
Rio Grande Flow at Sam Marcial



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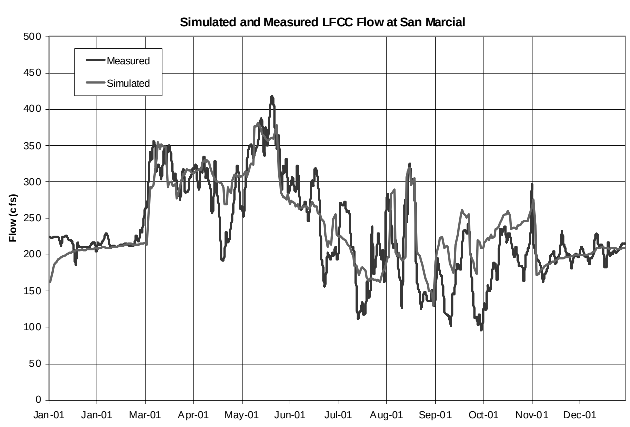
LFC Channel flow at San Marcial



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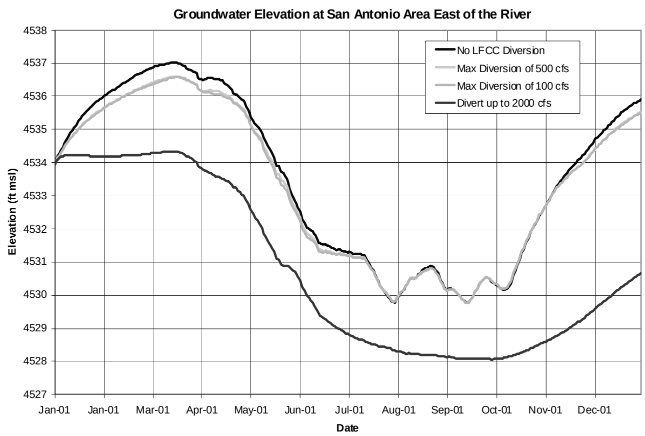
Groundwater Elevation



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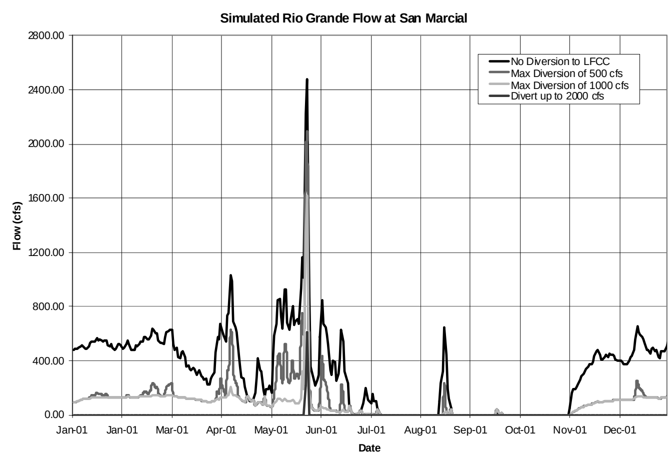
Results: River Flow at SM



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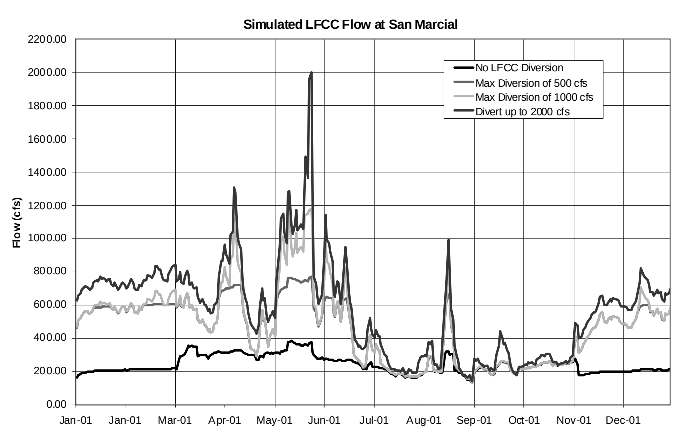
Results: LFCC Flow



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Results

Scenario	RIO Grande		LFCC		Socorro Main	Total		Depletion	ET
	Inflow af	Outflow af	Inflow af	Outflow af	Inflow af	Inflow af	Outflow af	af	af
No Diversion to LFCC	394,328	228,868	-	173,494	112,000	506,328	402,362	103,966	66,950
Max Diversion 500 cfs	201,459	76,933	192,869	321,218	112,000	506,328	398,151	108,177	69,330
Max Diversion 1000 cfs	174,389	54,538	219,939	343,310	112,000	506,328	397,848	108,480	69,601
LFCC up to 2000 cfs	3,055	1,656	391,273	418,276	112,000	506,328	419,932	86,396	53,096

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Concluding Remarks

For this specific year (2001-hydrology) and given the model input conditions:

1- There is not a significant difference in depletions between current operation of the LFCC as a drain and a maximum diversion between 500 cfs to 1000 cfs.

2- Operating the LFCC up to its maximum capacity (2000 cfs) provides the most efficient way to convey water to Elephant Butte because evapotranspiration losses are reduced.

More analysis needs to be done to reinforce the above conclusions, specifically an analysis that seeks to maintain the flow targets of the current biological opinion.

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