

# Frenchman Valley Appraisal Study

DNR and USBR

# Purpose

- Develop and evaluate alternative water management scenarios which may assist partners/stakeholders in future planning
- To determine if there is a need for further Federal involvement in participating in a cost-share Feasibility Study

# Objectives

- Optimize the economic and environmental benefits of the water resources in the study area
  - Optimize economic benefits of surface and groundwater irrigation in the study area
  - Optimize economic benefits of Enders Reservoir for recreation, fish and wildlife
  - Evaluate environmental benefits of recreation, fish and wildlife
  - Evaluate economic benefit of flood control provided by Enders Dam
  - Provide alternative water management scenarios to aide partners/stakeholders in future planning

# Study Partners

- US Bureau of Reclamation
- NDNR
- Frenchman Valley ID
- Hitchcock & Red Willow ID
- Riverside ID
- Middle Republican NRD
- Upper Republican NRD
- Nebraska Game & Parks Commission

# Study Area

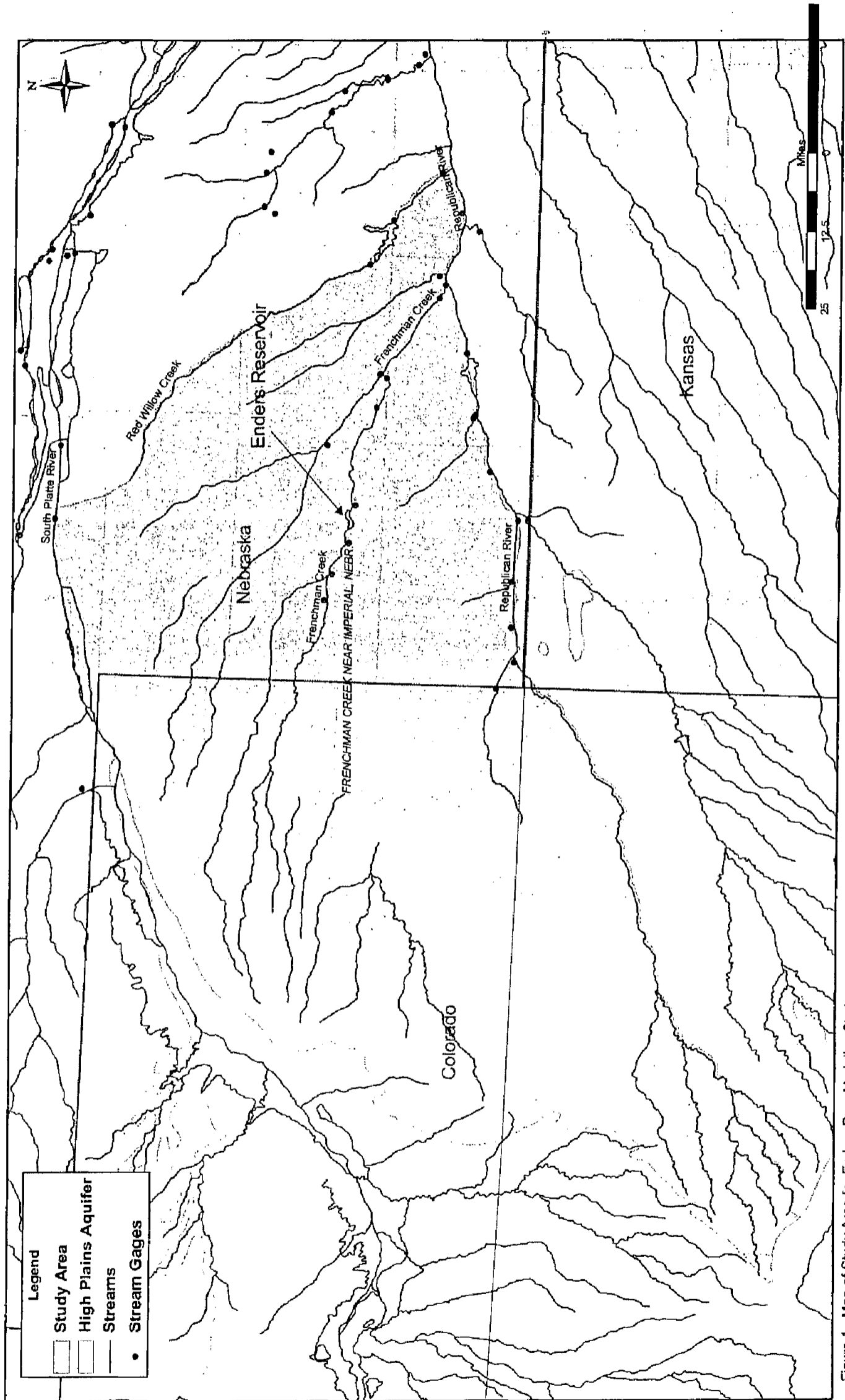


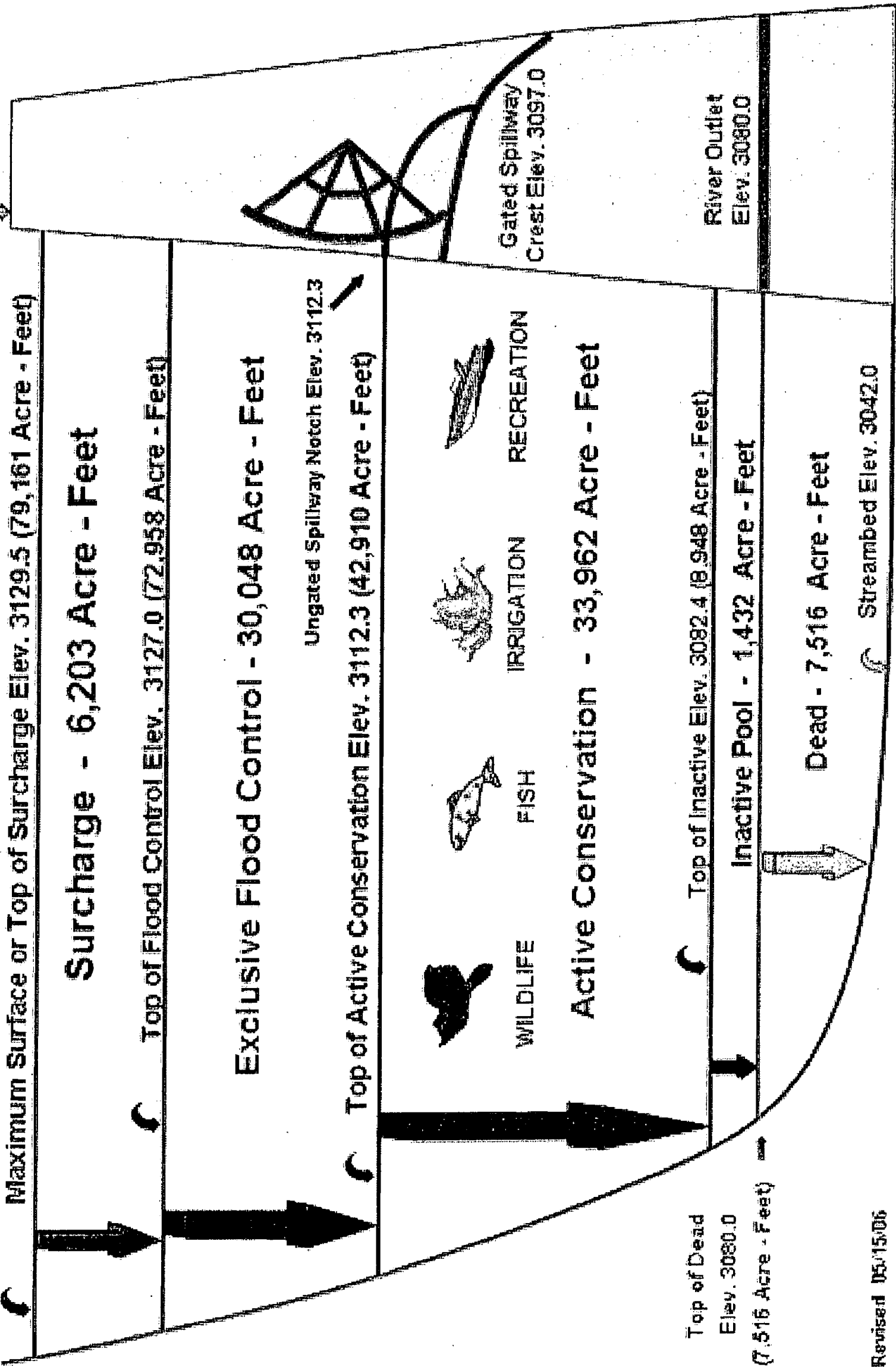
Figure 1. Map of Study Area for Enders Dam Modeling Study.

# History

- Frenchman Valley ID organized in 1911 – 140 cfs natural flow right
- Enders Reservoir completed in 1951
- H&RW ID organized in 1955 – junior natural flow right
- Both irrigation districts hold 1950 storage water rights
- Water first delivered from Enders to FVID in 1958 and to H&RWID in 1961

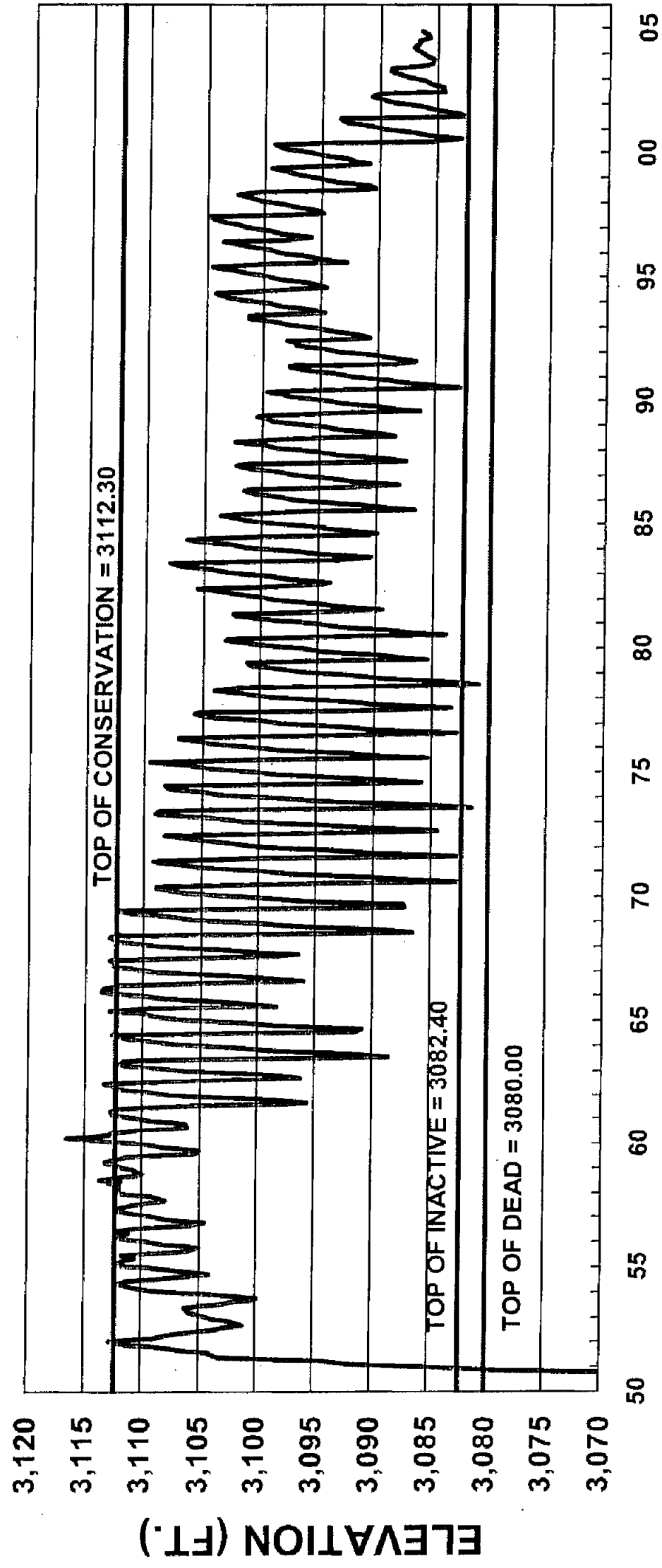
# ENDERS RESERVOIR ALLOCATIONS

Dam Crest  
Elev. 3137.5



Revised 05/15/06

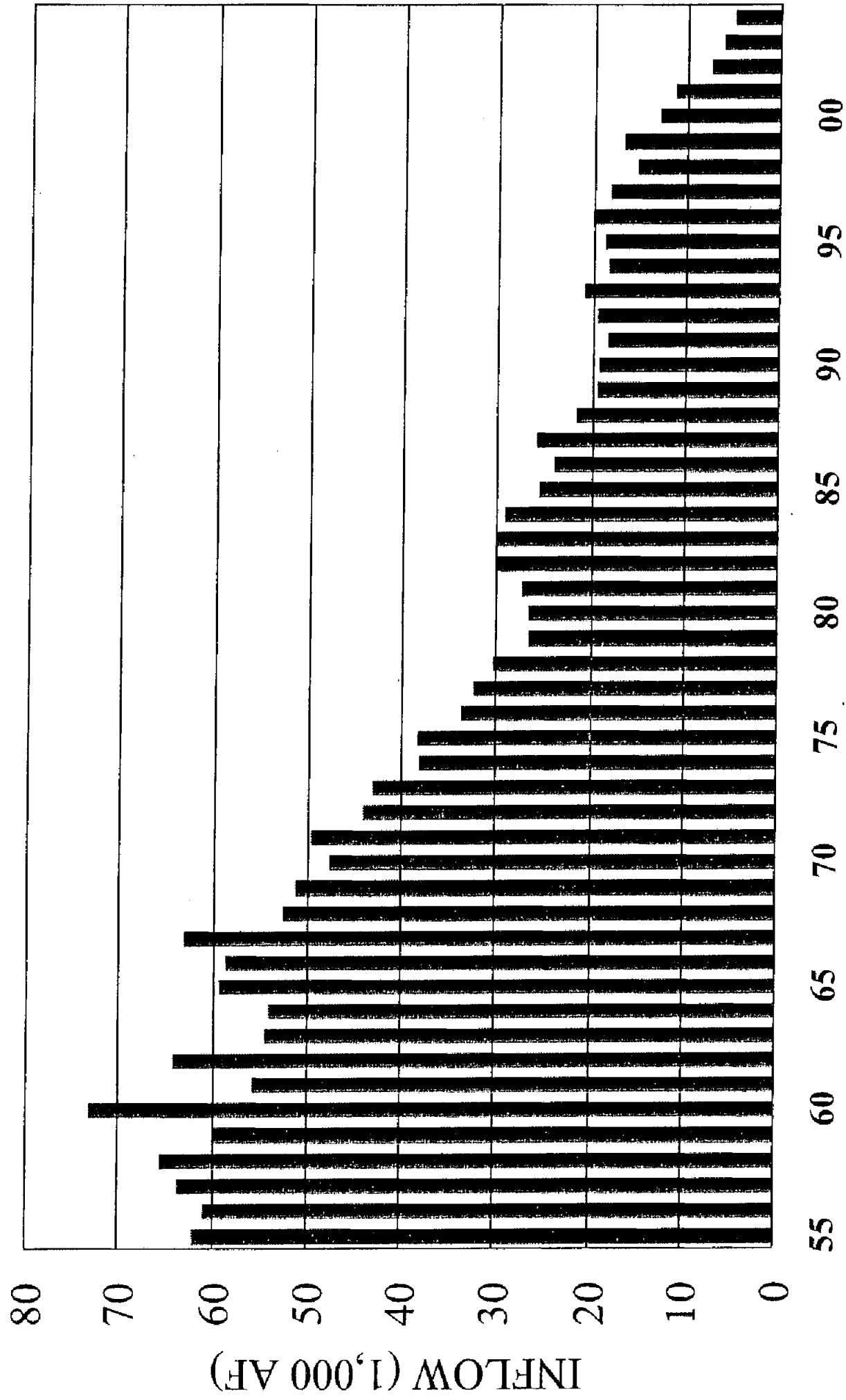
**ENDERS RESERVOIR  
END OF MONTH ELEVATION**



**OCT 1950 THROUGH DEC 2004**

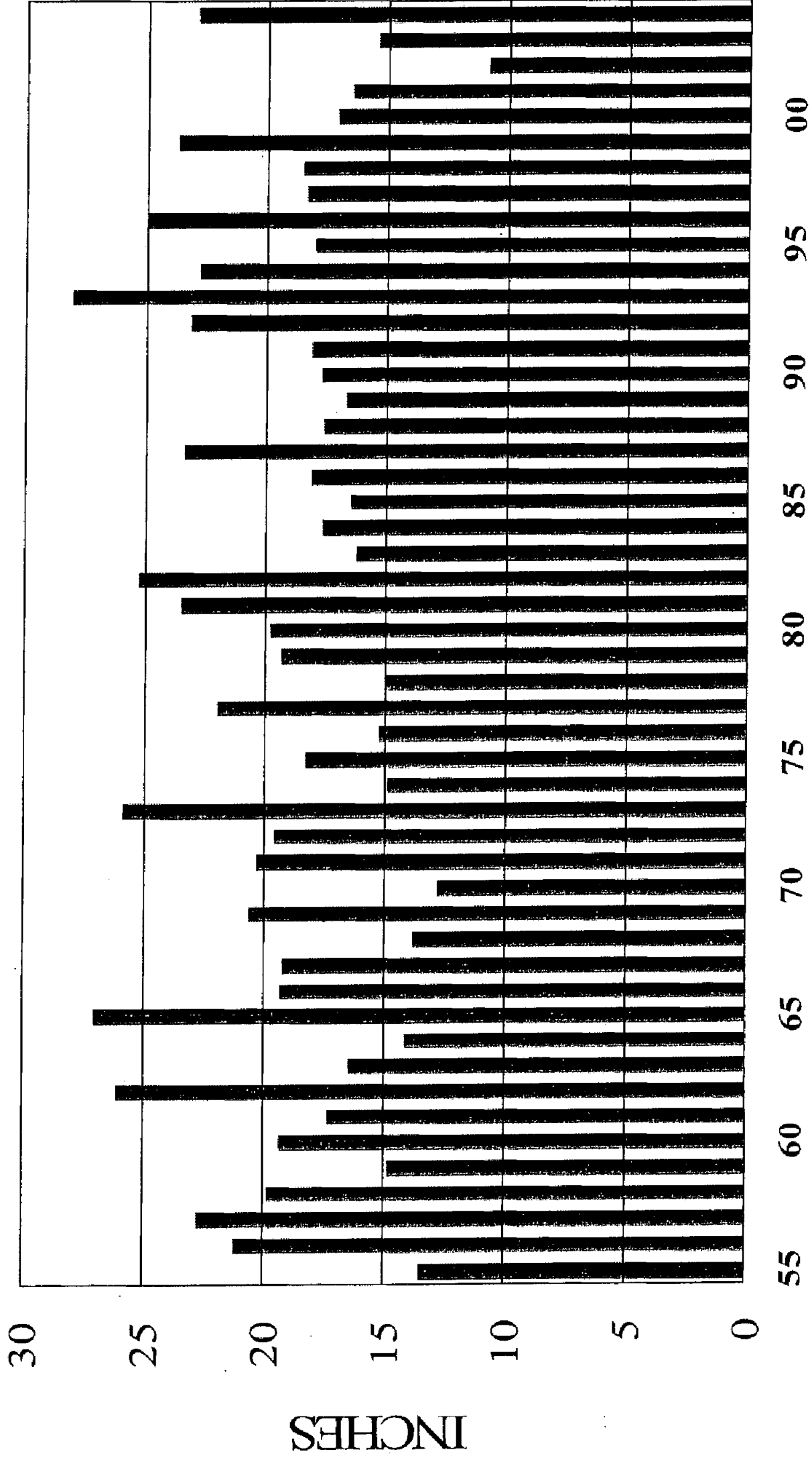


# ENDERS RESERVOIR YEARLY HISTORICAL INFLOW



1955 THROUGH 2004

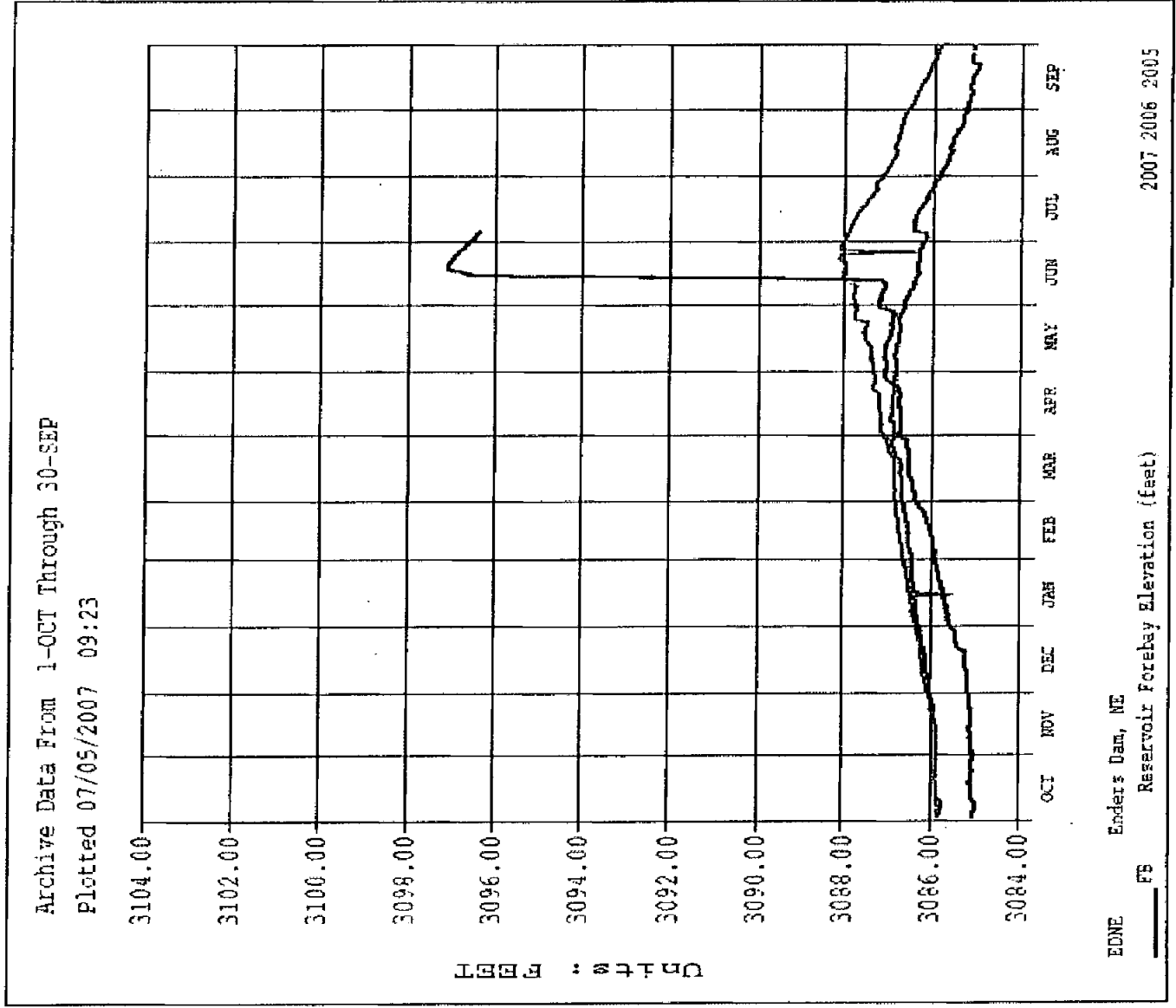
# ENDERS DAM YEARLY PRECIPITATION



1955 THROUGH 2004

# Since 2004

- Reservoir levels near base of conservation pool
- Region above Imperial received 6-12 inches of rain in June 2007
- Brought reservoir up around 10 ft
- Conservation pool now about 50% full



# Problems

- Water demands exceed available supplies
- Declining Streamflows above and below Enders, affecting:
  - Irrigation Districts
  - Federal Investment
  - Groundwater Recharge
  - Recreation
- Compact Compliance
- Declining Groundwater Levels
- Water Quality

# Potential Opportunities

- Continue existing surface water irrigation operations
- Utilize Enders storage to provide intentional groundwater recharge
- Utilize Enders for recreation, fish and wildlife
- Utilize Enders for NE Compact compliance
- Increase restrictions and/or provide incentives to reduce groundwater consumption and improve streamflows
- Implement some combination of the above

# Scope of Work

- Phase I – Preliminary Groundwater Modeling Phase
  - Utilize RRCM to simulate a limited set of rainfall and water use scenarios
  - NDNR lead - complete
- Phase II – Secondary Groundwater Modeling Phase
  - Use results of Phase I to determine desired model refinements and define additional model scenarios
- Phase III – Resource Optimization Studies

# Overview – Phase One

- Simulate the baseflows in Frenchman Creek under a dry, average, and wet climate scenario.
- Pumping based on historical use during a dry, average, or wet year on a per acre basis.
- 2005 level of irrigated acres are used
- Pumping levels are capped where needed based on current allocations.
- Reduce pumping within climate scenarios to meet target river flows

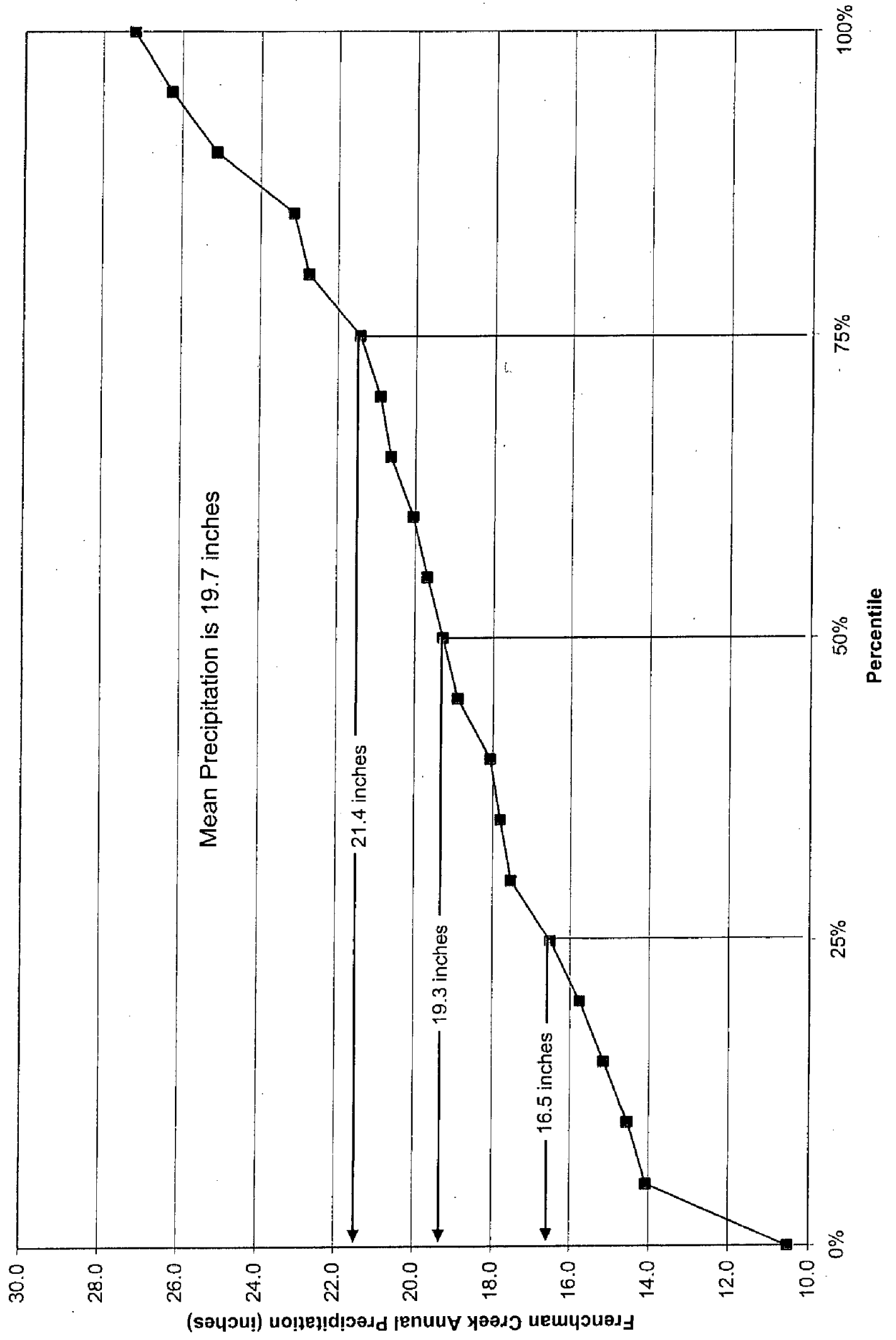




# Precipitation Scenarios

- Based on the period of record for the six Compact rain gauges within the Frenchman Basin – Holyoke, Madrid, Imperial, Wauneta, Palisade, Culbertson
- “Dry” – 25<sup>th</sup> percentile rainfall
- “Average” – 50<sup>th</sup> percentile rainfall
- “Wet” – 75<sup>th</sup> percentile rainfall

# Basin Precipitation Statistics



# Selection of Years to Model

- Choose a year to repeat in order to capture irrigation behavior under each climate condition.
- Average conditions – DNR previously had completed a scenario that repeats 1988-1991, for Frenchman Basin these years had average precip. of 19.7 inches.
- Dry Scenario – Basin had average precip. of 16.2 inches in 2000.
- Wet Scenario – Basin had average precip. of 21.7 inches in 1987.

# More Details for Model Scenarios

- Groundwater exclusive, groundwater commingled, and surface water commingled inputs were based a year chosen to represent climate condition (both for NE and the other states)
- Surface water exclusive inputs and recharge from canal seepage were based on 2005 conditions
- Evapotranspiration and reservoir levels were based on 1988-1991 conditions
- NE municipal pumping from 2004 was used

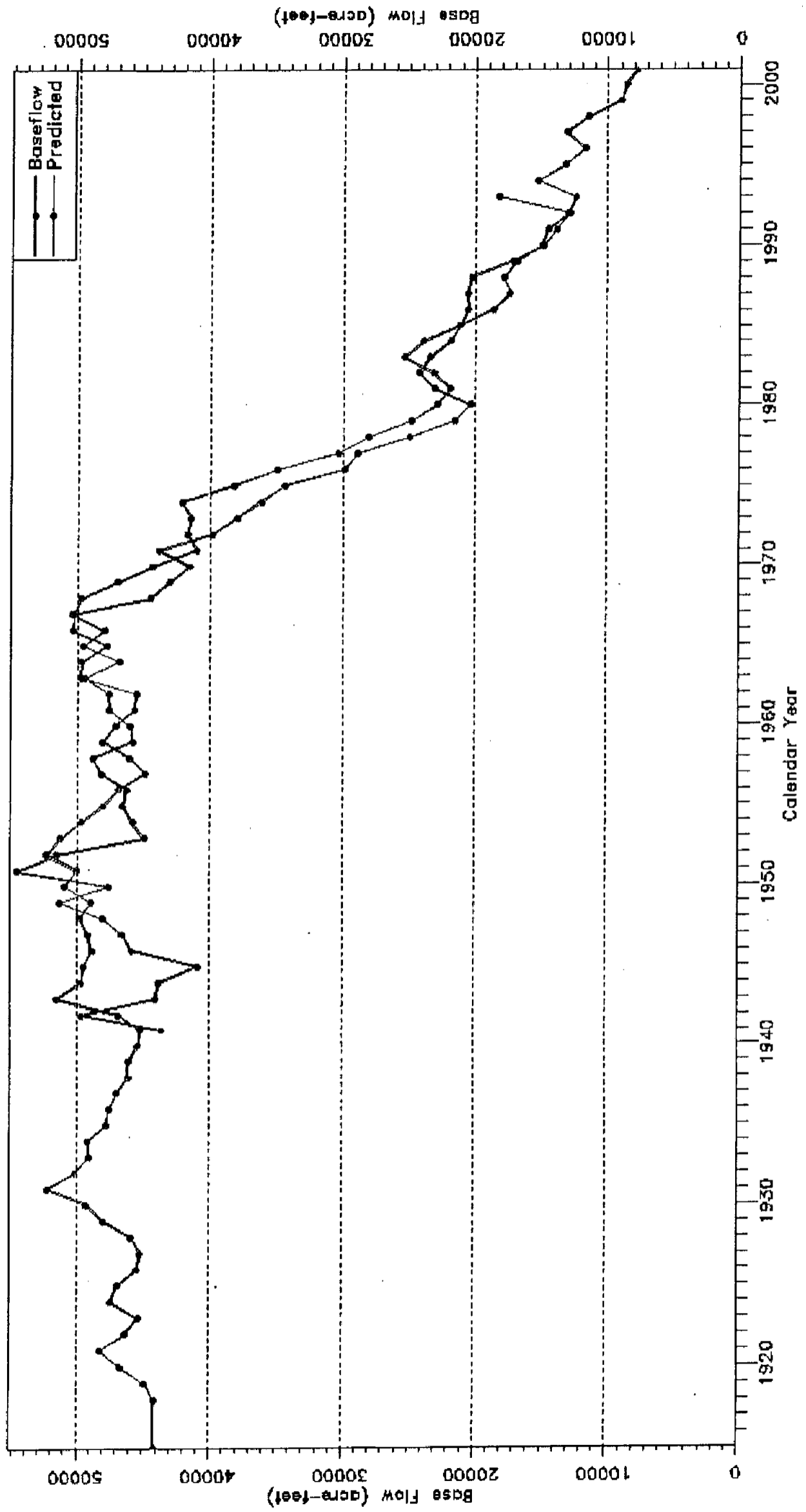
# Phase I Results

- Imperial Gage – Inflows to Enders
- Palisade Gages (Frenchman and Stinking Water Creek) – Total natural flows available at Culbertson Diversion Dam
  - Below Enders Only
  - Total including above Enders (i.e. assume Enders is bypassed)
- Culbertson Gage – Riverside ID and discharge to mainstem

# Imperial Gage Analysis

- Two Target Levels – based on recreation and wildlife
  - 3089.4 ft
  - 3099 ft
- Target inflows based on these levels and the following deliveries
  - None
  - 3” FVID
  - 3” FVID and H&RW
  - 6” FVID
  - 6” FVID and H&RW

# Model Calibration at Imperial



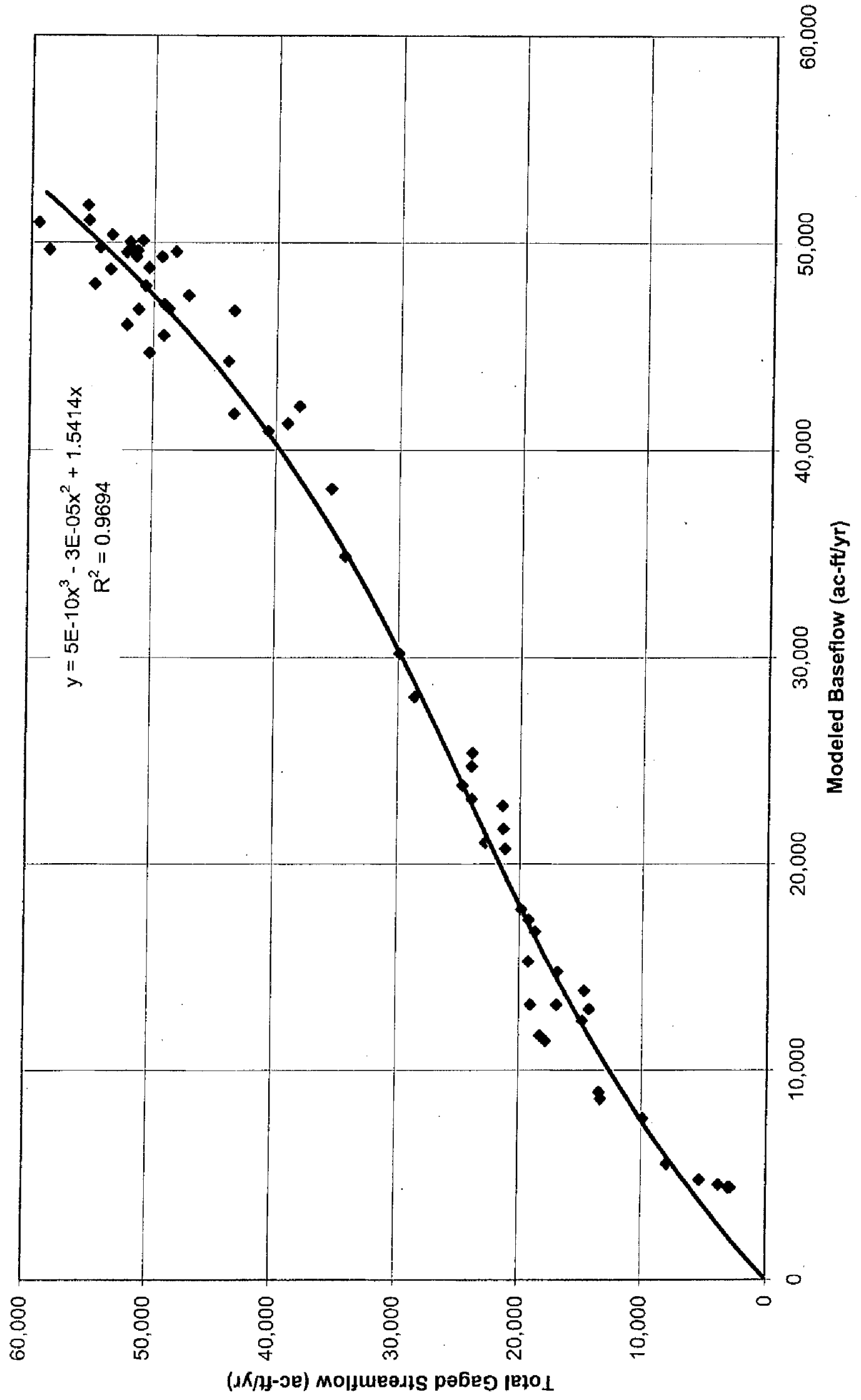
# USBR Enders Supply Model

- Used to determine the necessary inflows for each combination of target water levels and deliveries
- The table below is for both irrigation districts
- USBR supplied separate model for FVID only

Enders Shutoff Content	Inches from Enders	Estimated Delivery Efficiency	Inches From		Loss to Headgate Pickup	Storage for 1" Delivery	Enders Storage Needed	Enders		Total Inflow Needed
			Pickup	Pickup				Estimated Seepage	Estimated Evap	
3089.40	0	50.0%	0.00	0.00	65.0%	5438	0	2534	2904	5438
14,009	3.00	50.0%	0.24	0.24	65.0%	5438	15031	2534	3758	21324
	6.00	50.0%	0.47	0.47	65.0%	5438	30063	2534	4442	37039
	9.00	50.0%	0.71	0.71	65.0%	5438	45094	2534	4783	52412
	12.00	50.0%	0.94	0.94	65.0%	5438	60126	2534	5125	67785
3099.00	0.00	50%	0.00	0.00	65.0%	5438	0	2896	4100	6996
23,789	3.00	50%	0.24	0.24	65.0%	5438	15031	2896	5125	23052
	6.00	50%	0.47	0.47	65.0%	5438	30063	2896	5808	38767
	9.00	50%	0.71	0.71	65.0%	5438	45094	2896	6492	54482
	12.00	50%	0.94	0.94	65.0%	5438	60126	2896	7175	70197



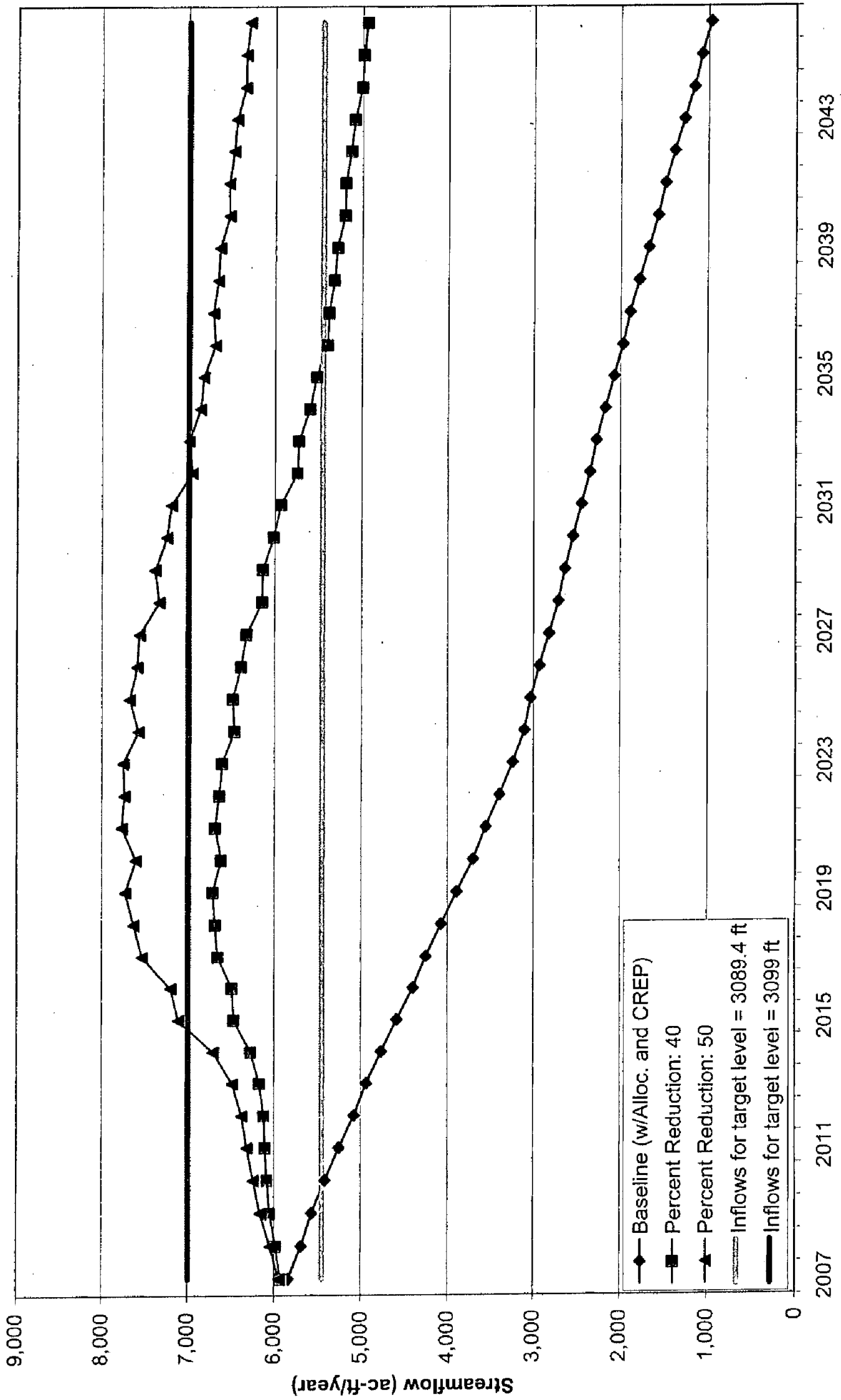
# Regression to relate modeled baseflow at Imperial to total streamflow at Imperial



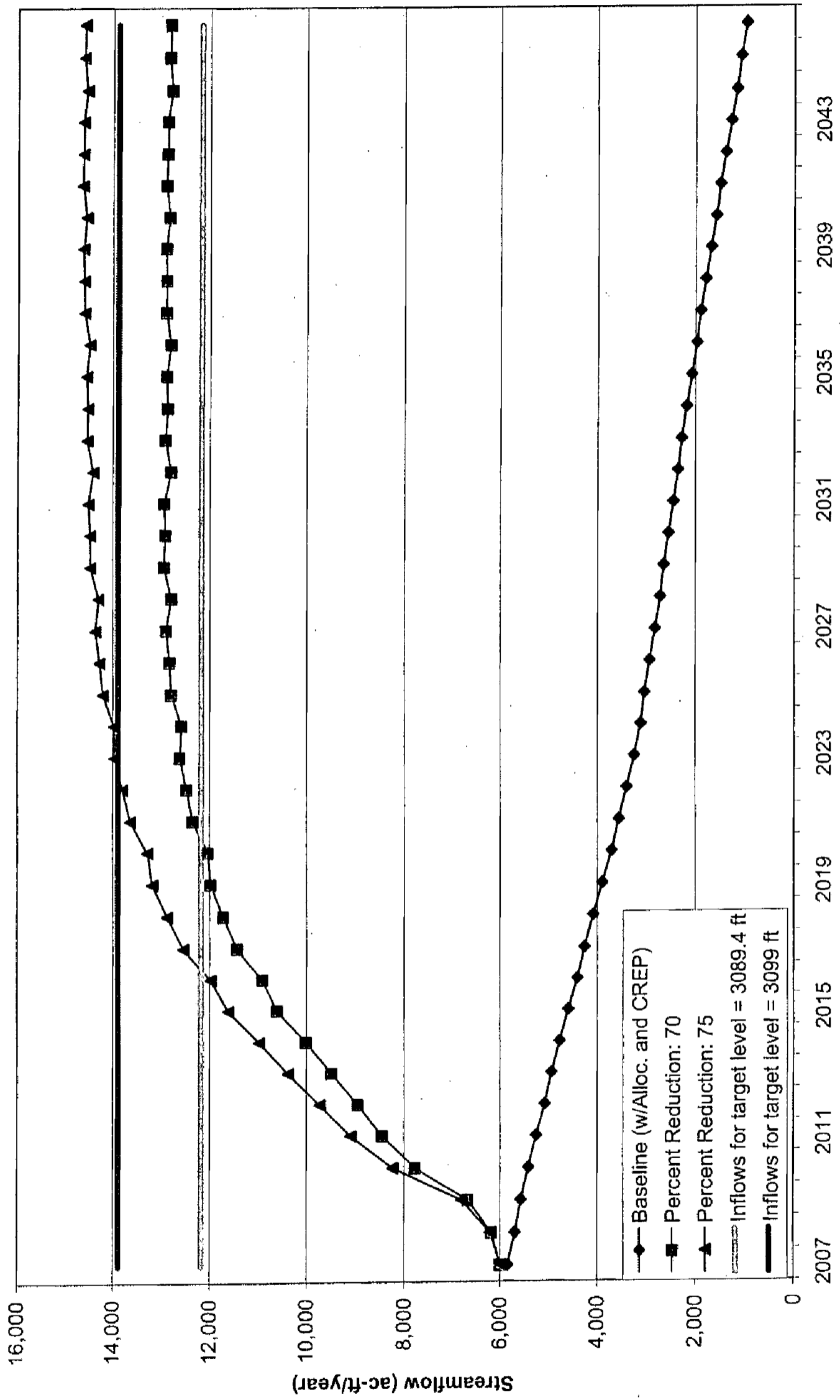
# Imperial Gage Results

- For each climate scenario, the impact reduction achieved with a 20%, 50%, and 100% reduction in pumping was modeled.
- The results were interpolated to 5% increments.
- Then the percent reduction that best balanced the inflows to the target level over the long term was determined
- The following five slides graphically demonstrate the results for the Dry scenario.
- The remaining graphed results for the other climate scenarios and gage analyses are presented in the attached Appendix.

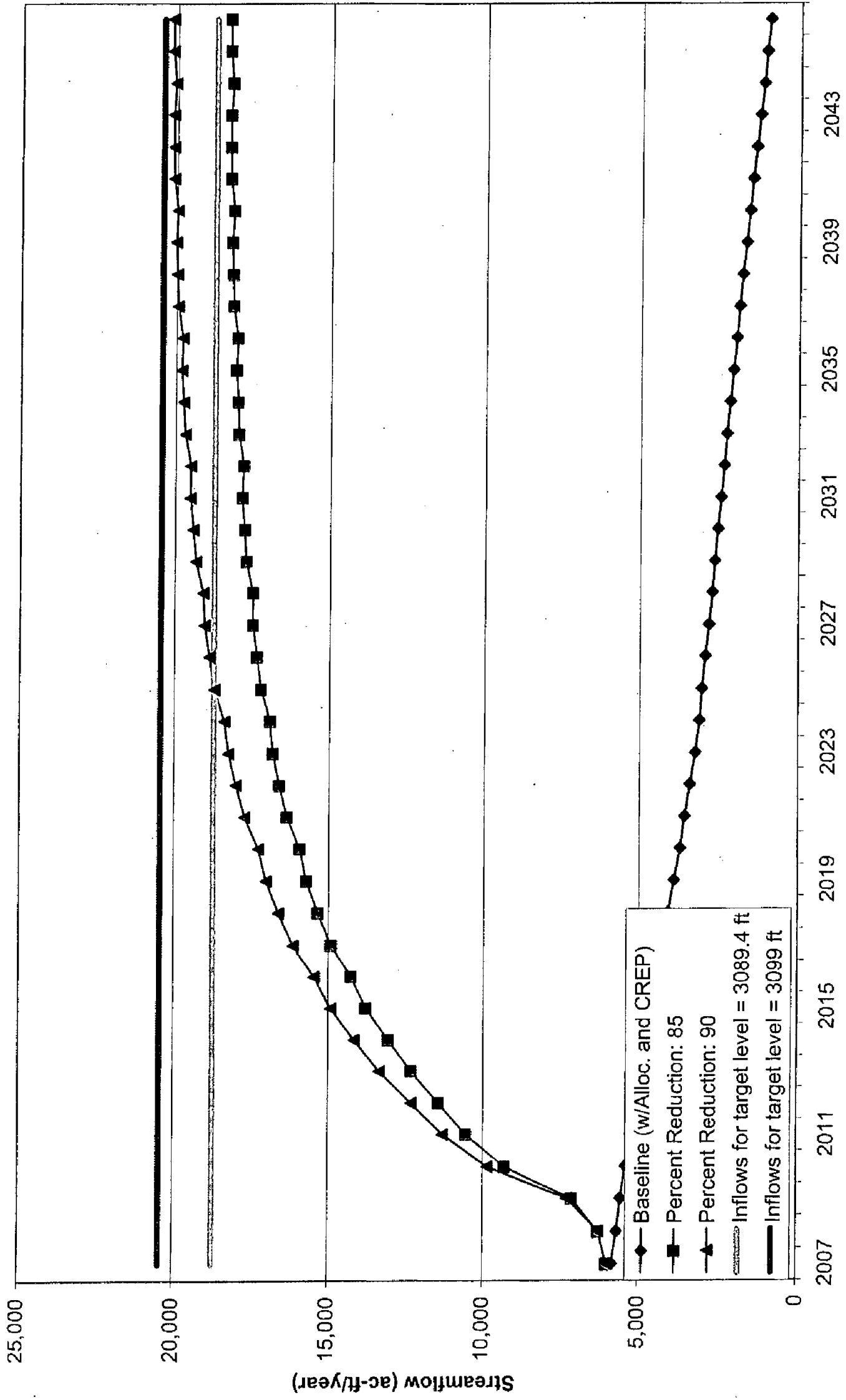
Dry Scenario - Imperial Gage - Target Levels only



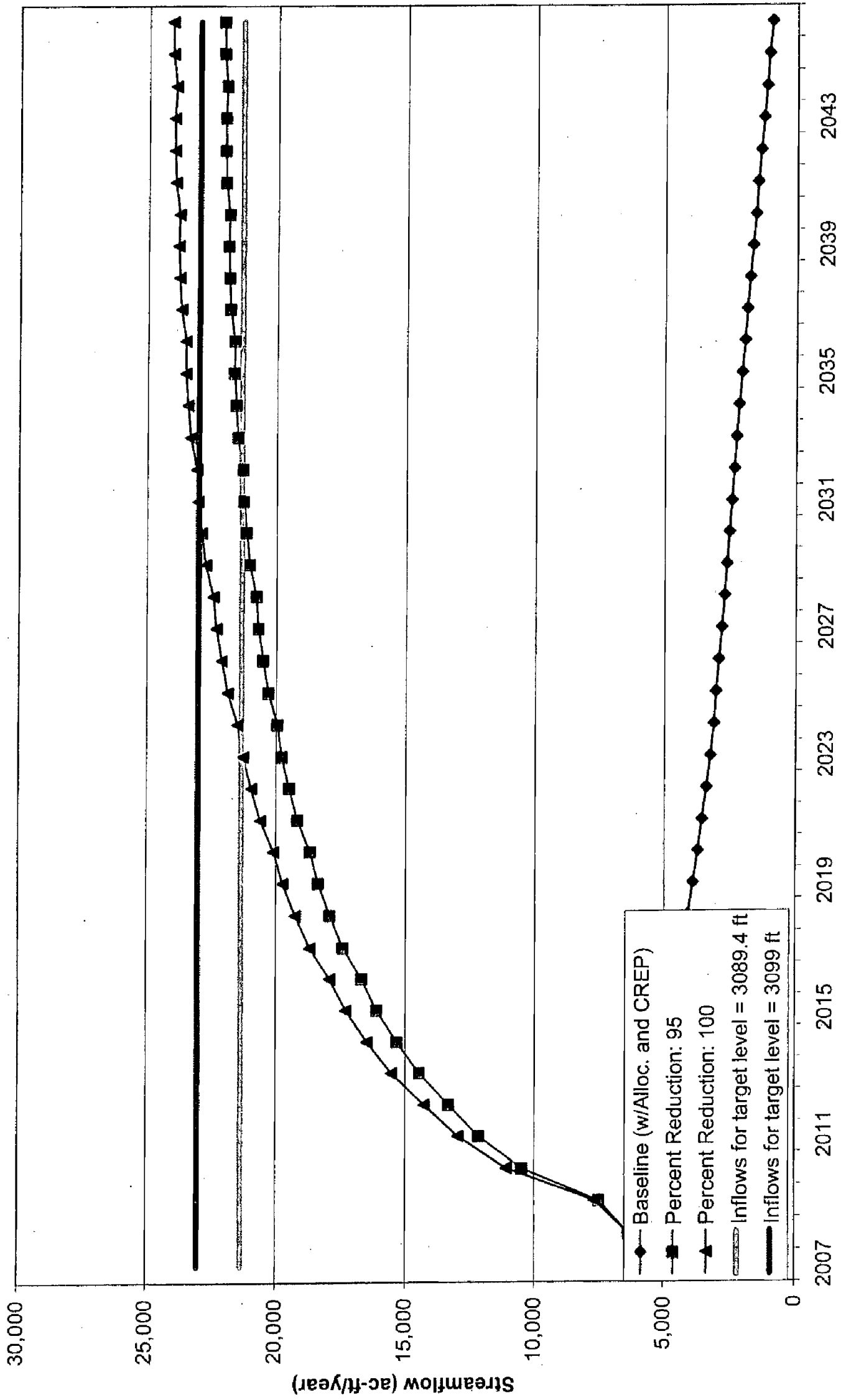
Dry Scenario - Imperial Gage - Deliver 3 inches, FVID only



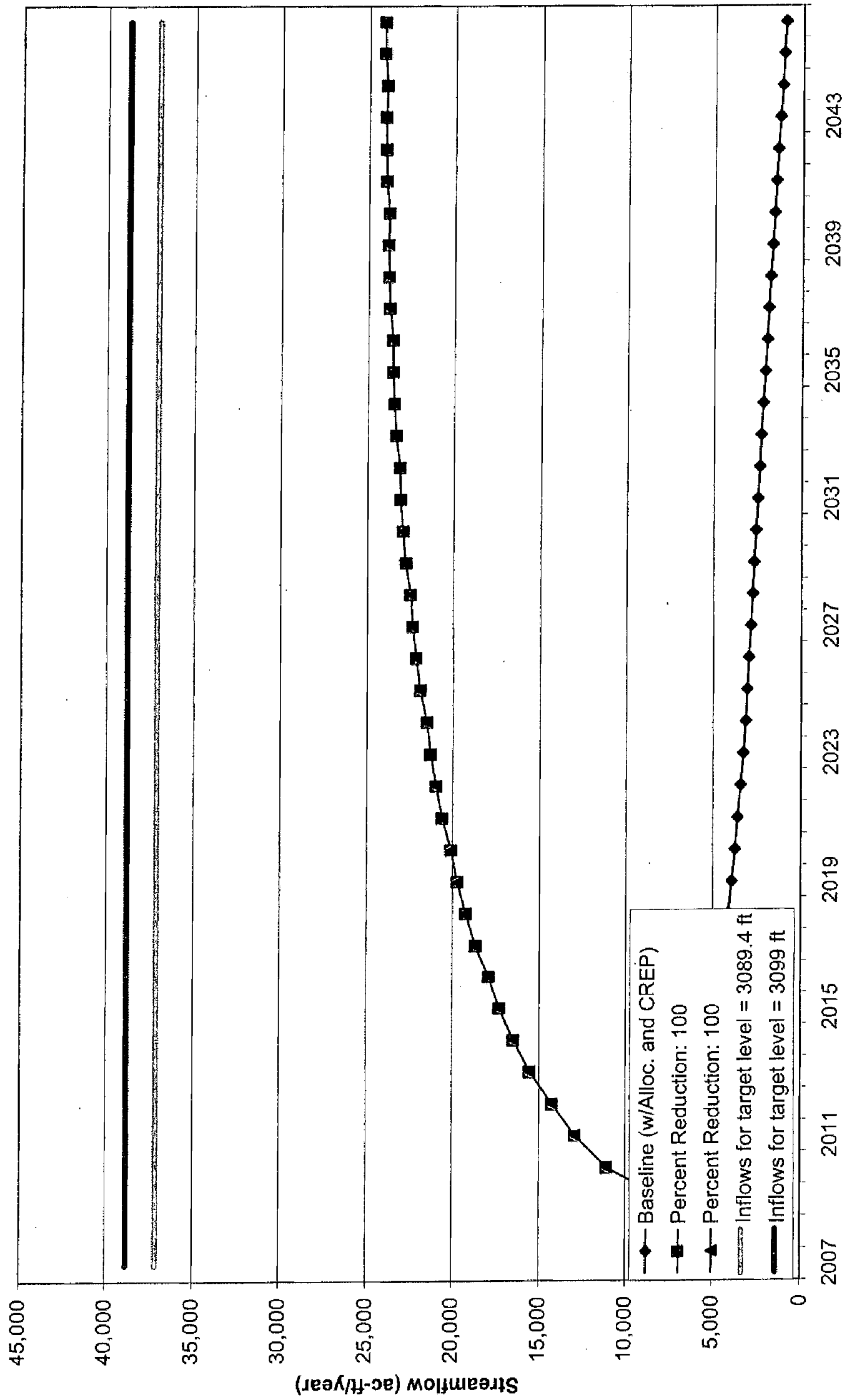
Dry Scenario - Imperial Gage - Deliver 6 inches, FVID only



### Dry Scenario - Imperial Gage - Deliver 3 inches, Both Districts



### Dry Scenario - Imperial Gage - Deliver 6 inches, Both Districts



# Pumping Reductions Needed to Meet Target Flows at Imperial

	Dry	Average	Wet
3089.4 – No Deliveries	40%	20%	20%
3099 – No Deliveries	50%	25%	25%
3089.4 – 3" FVID	70%	45%	40%
3099 – 3" FVID	75%	50%	45%
3089.4 – 6" FVID	85%	65%	60%
3099 – 6" FVID	90%	70%	65%
3089.4 – 3" Both Districts	95%	75%	65%
3099 – 3" Both Districts	100%	80%	70%
3089.4 – 6" Both Districts	**	**	**
3099 – 6" Both Districts	**	**	**

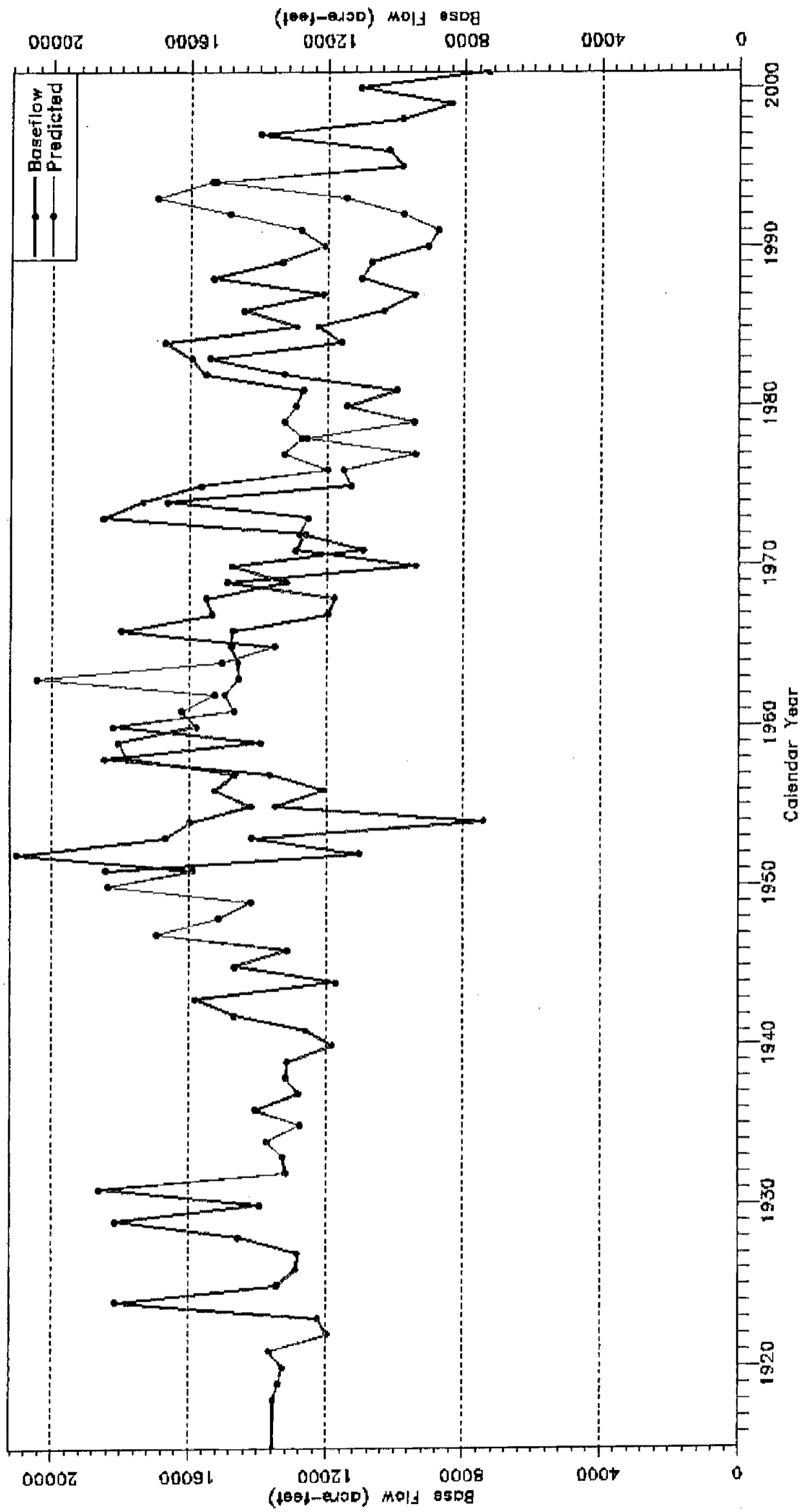
\*\* Target not met with 100% reduction



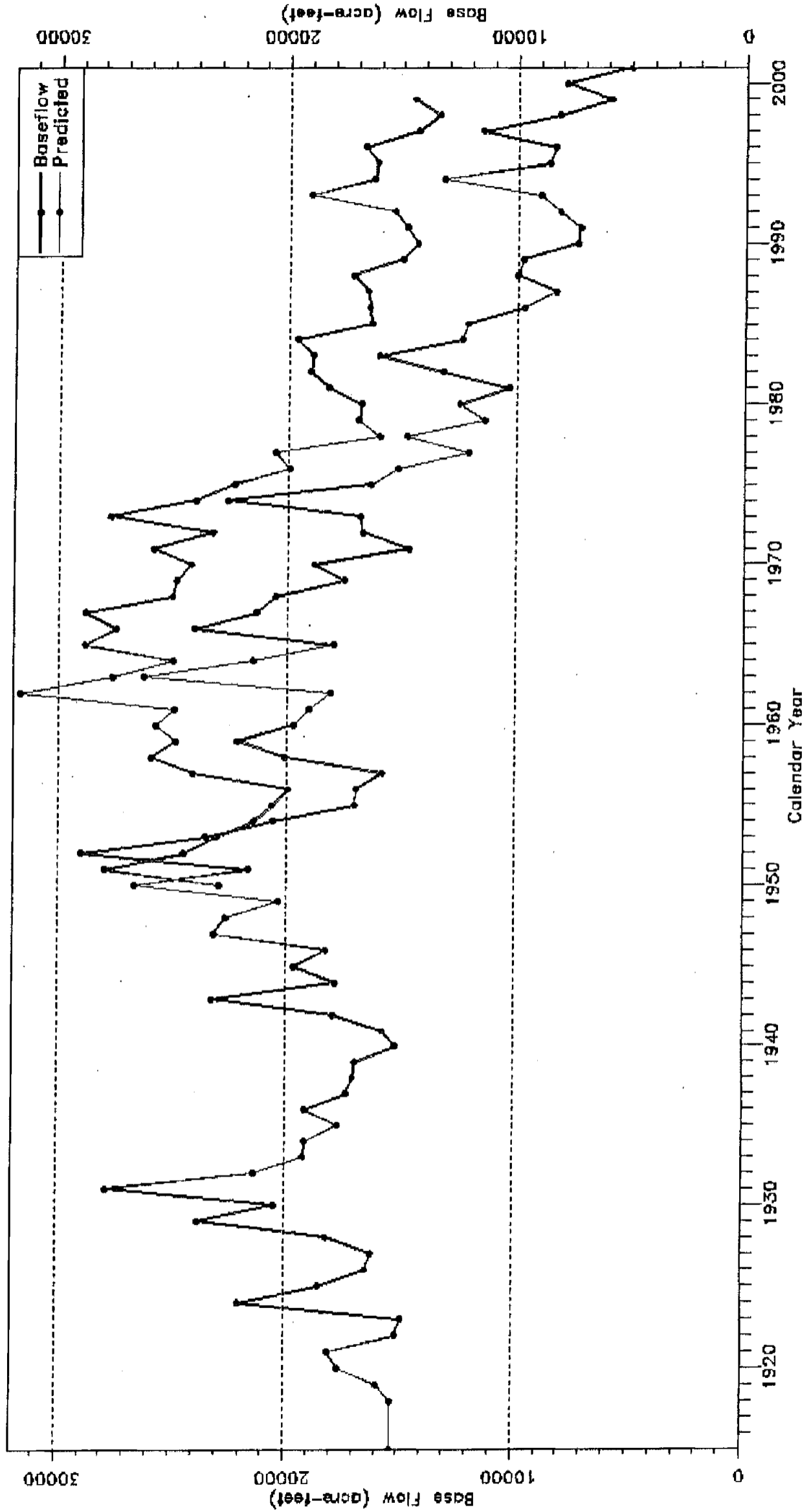
# Palisade Gage Analysis

- Looking at reductions needed to supply natural flows to FVID under two scenarios
  - Natural flows below Enders only – Natural flows below Enders and from Stinking Water Creek
  - Natural flows with Enders bypassed – Total Natural Flows above Culbertson Diversion Dam
- The “Enders Bypassed” scenario accounts for needed Enders inflows to maintain level at top of inactive
- Assumes a 50% canal efficiency
- Assumes 50% of streamflow occurs during the irrigation season

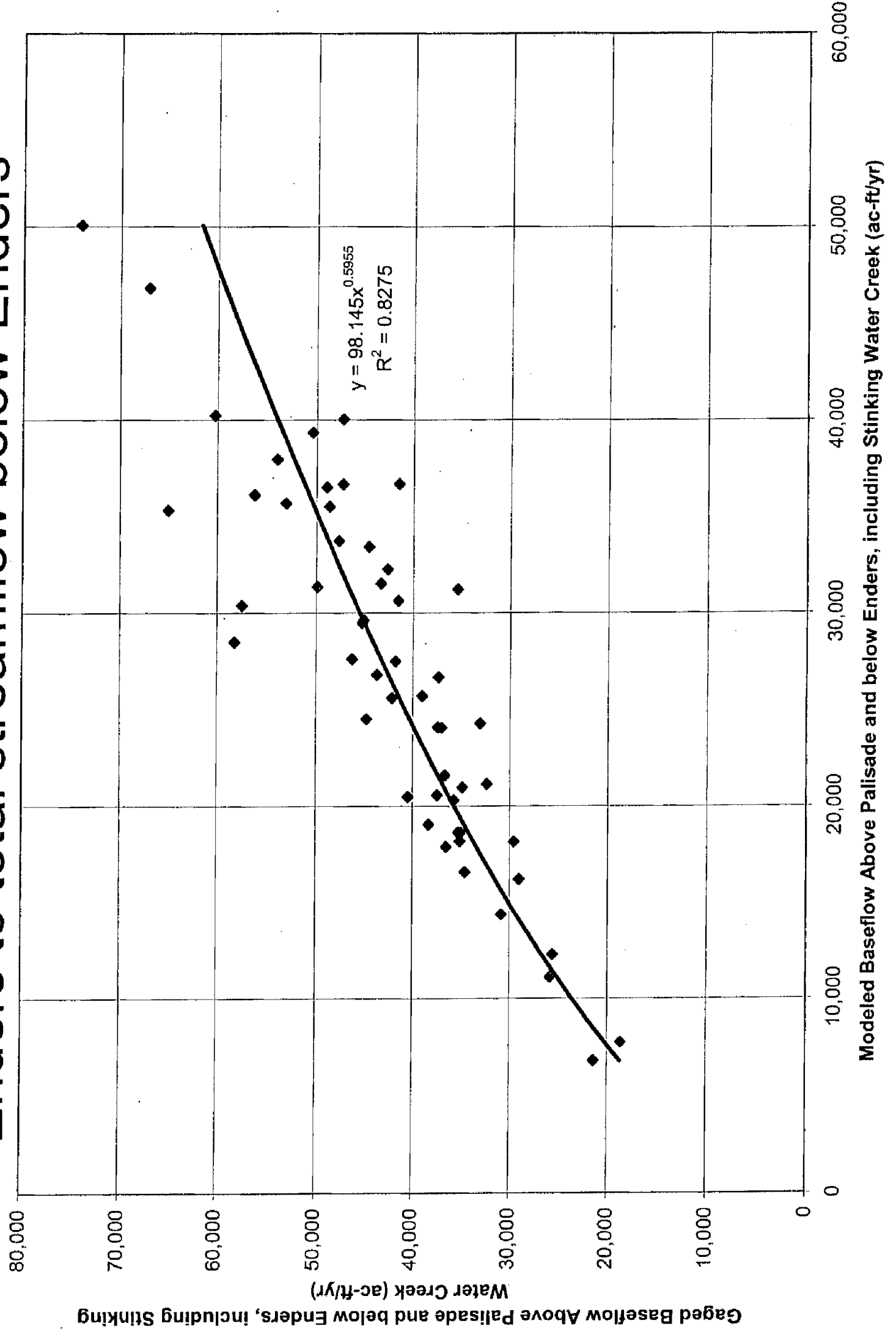
# Model Calibration at Frenchman Palisade Gage



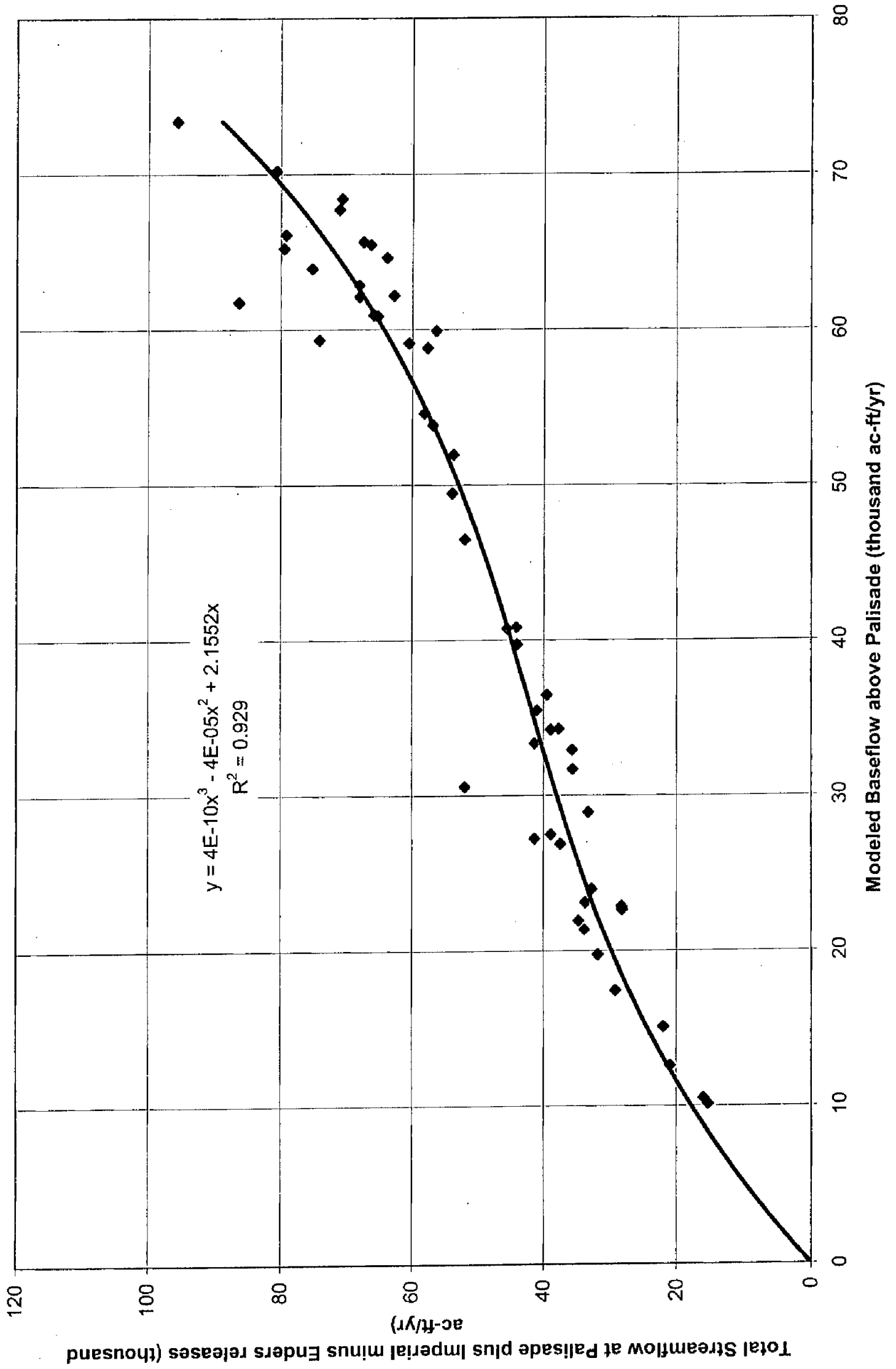
# Model Calibration at Stinking Water Palisade Gage



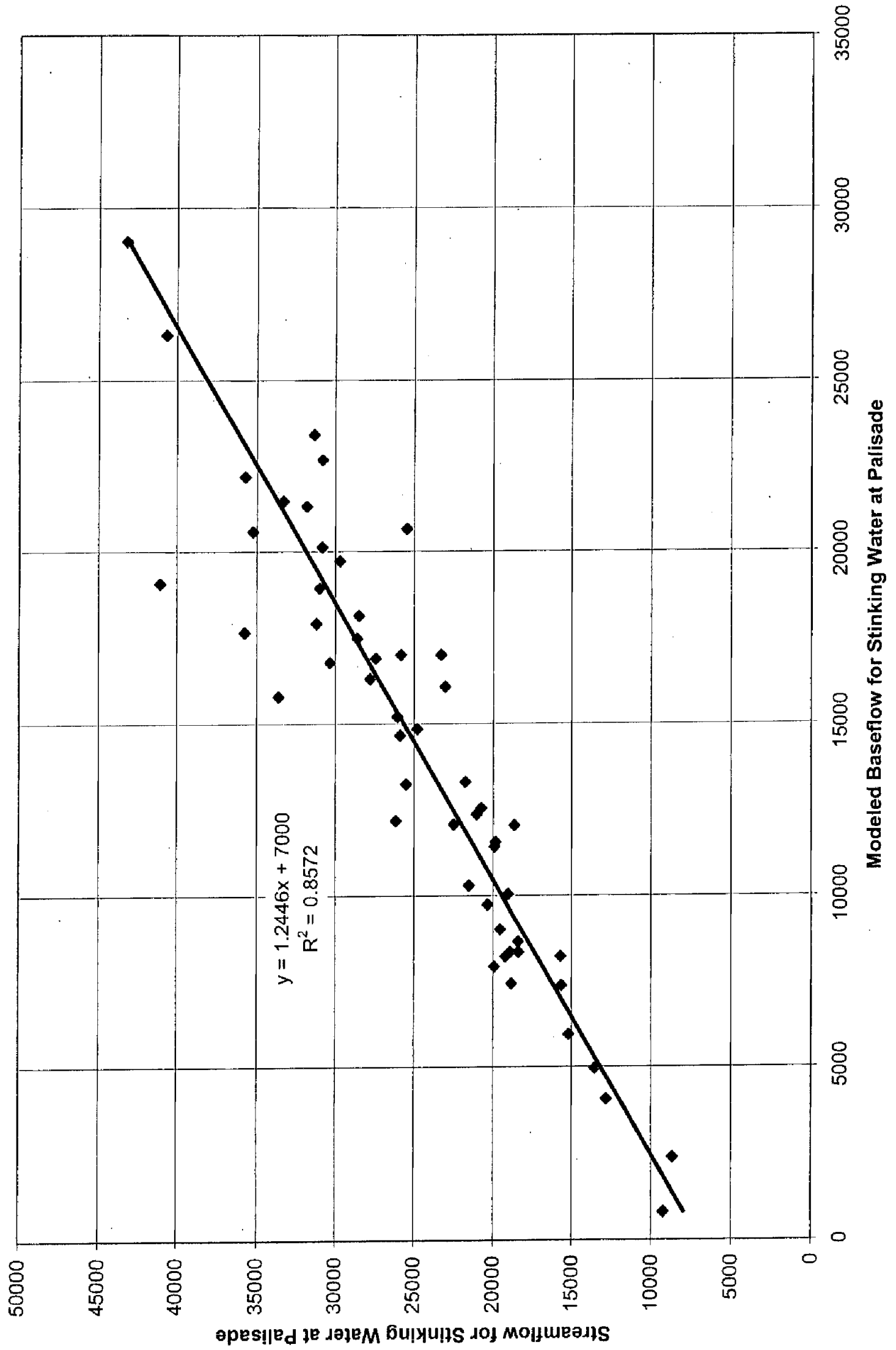
# Regression used to relate modeled baseflow below Enders to total streamflow below Enders



# Regression used to relate modeled baseflow to total streamflow for Frenchman Creek above Palisade (including above Enders)



# Regression used to relate modeled baseflow to total streamflow for Stinking Water Creek above Palisade



# Summary – Palisade Gage

Pumping reductions needed to make target deliveries to FVID from natural flows occurring below Enders only (i.e. Enders storing all inflows for deliveries not included in the inch totals below)

	Dry	Average	Wet
3" – FVID w/ storage	5%	0%	0%
6" – FVID w/ storage	45%	0%	0%
9" – FVID w/ storage	65%	45%	30%
12" – FVID w/ storage	85%	65%	60%

# Summary – Palisade Gage

Pumping reductions needed to make target deliveries to FVID from natural flows occurring above and below Enders (i.e. Enders bypassing all inflows)

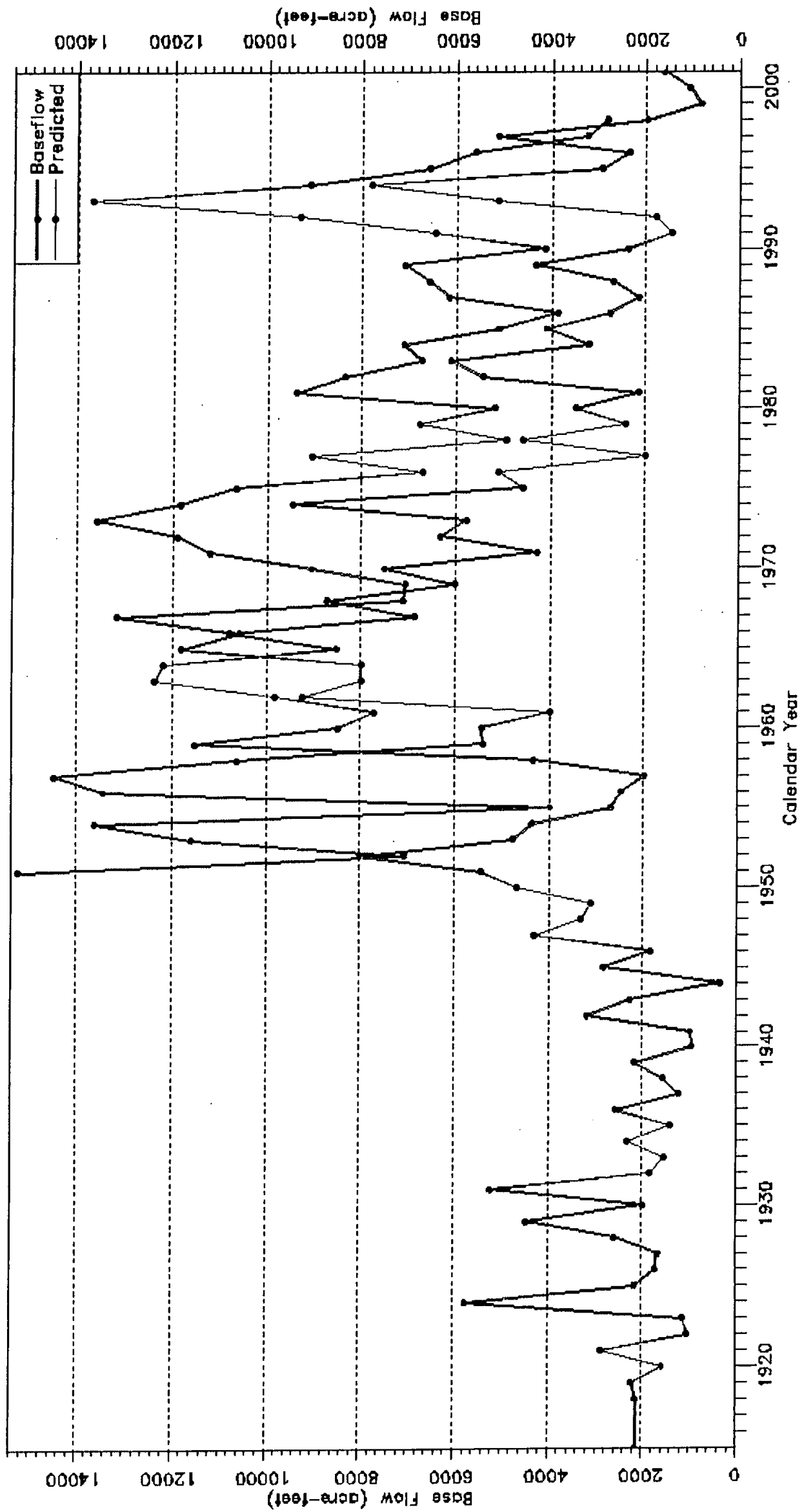
	Dry	Average	Wet
3" – FVID w/o storage	10%	0%	0%
6" – FVID w/o storage	50%	0%	0%
9" – FVID w/o storage	70%	30%	15%
12" – FVID w/o storage	90%	45%	35%



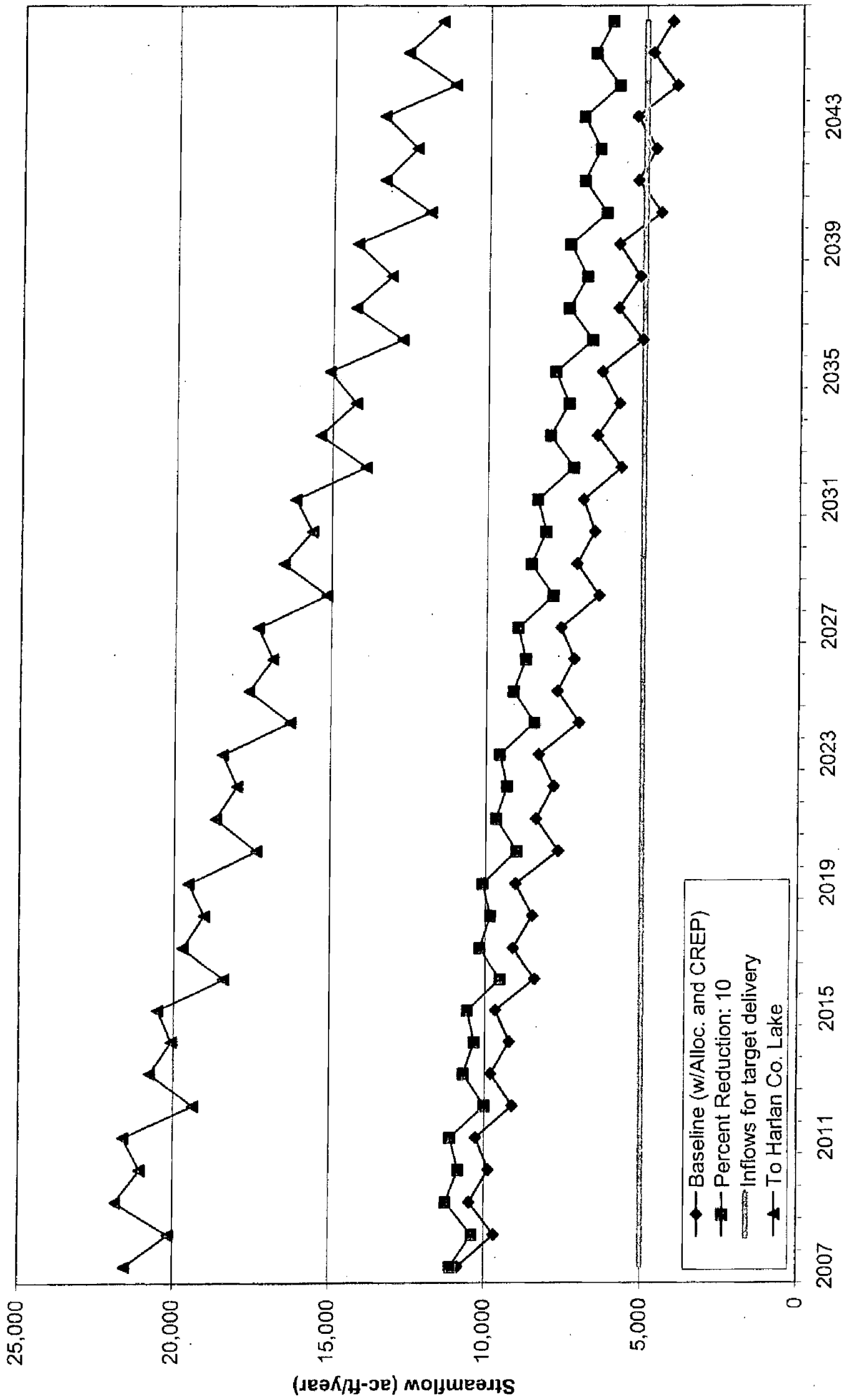
# Culbertson Gage Analysis

- Applies The same reductions needed to meet target natural flows at Palisade without Enders storage.
- Adds Riverside Irrigation District with same deliveries as FVID for the target streamflows
- Meant to show the streamflows that would reach the mainstem (and potentially Harlan County Lake) under these reduction and delivery scenarios
- Historically, Frenchman Creek has accounted for about one third of the inflows to Harlan County Lake
- Example graphs for Dry Scenario shown below, all graphs included in Appendix

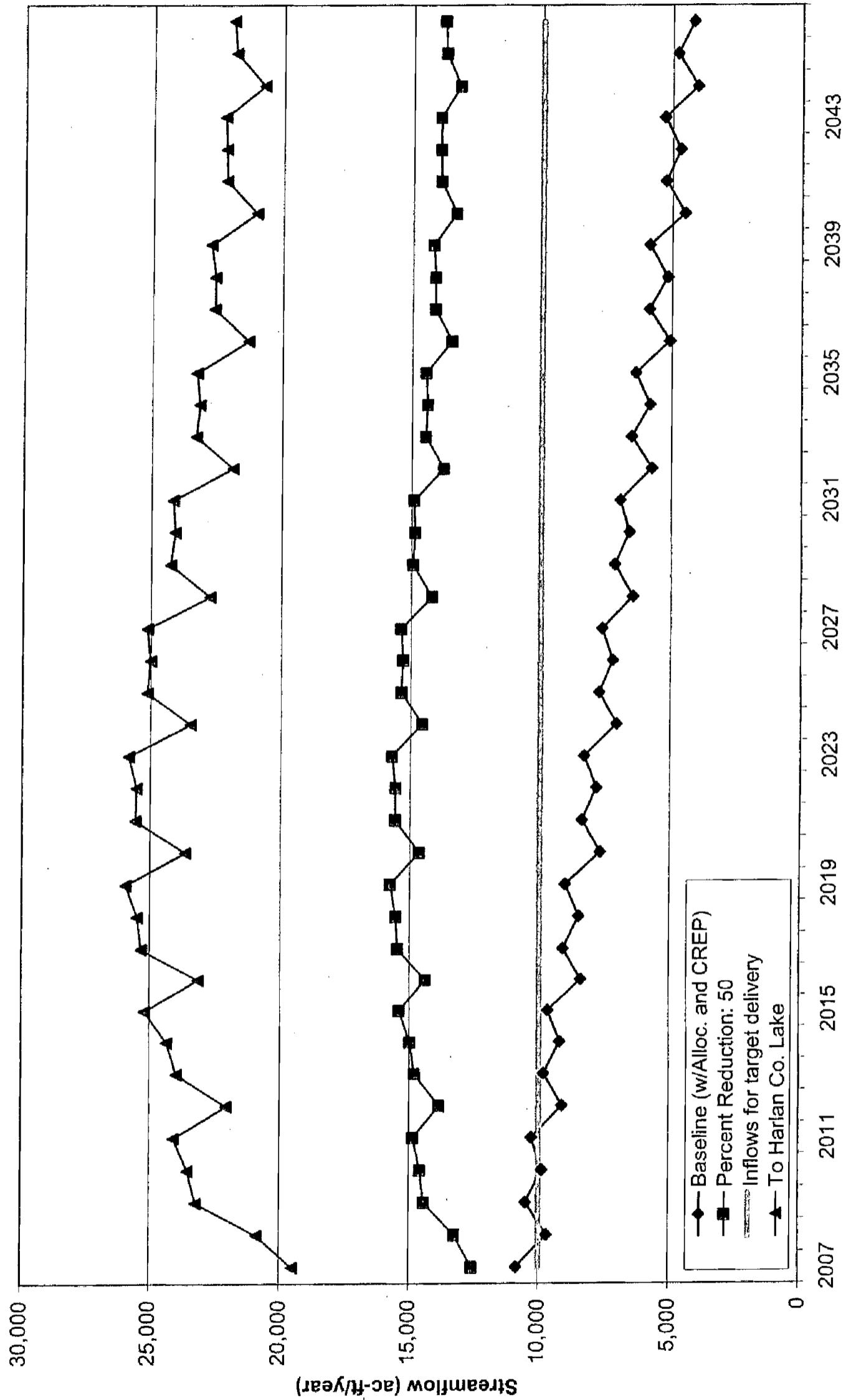
# Model Calibration for Culbertson Gage



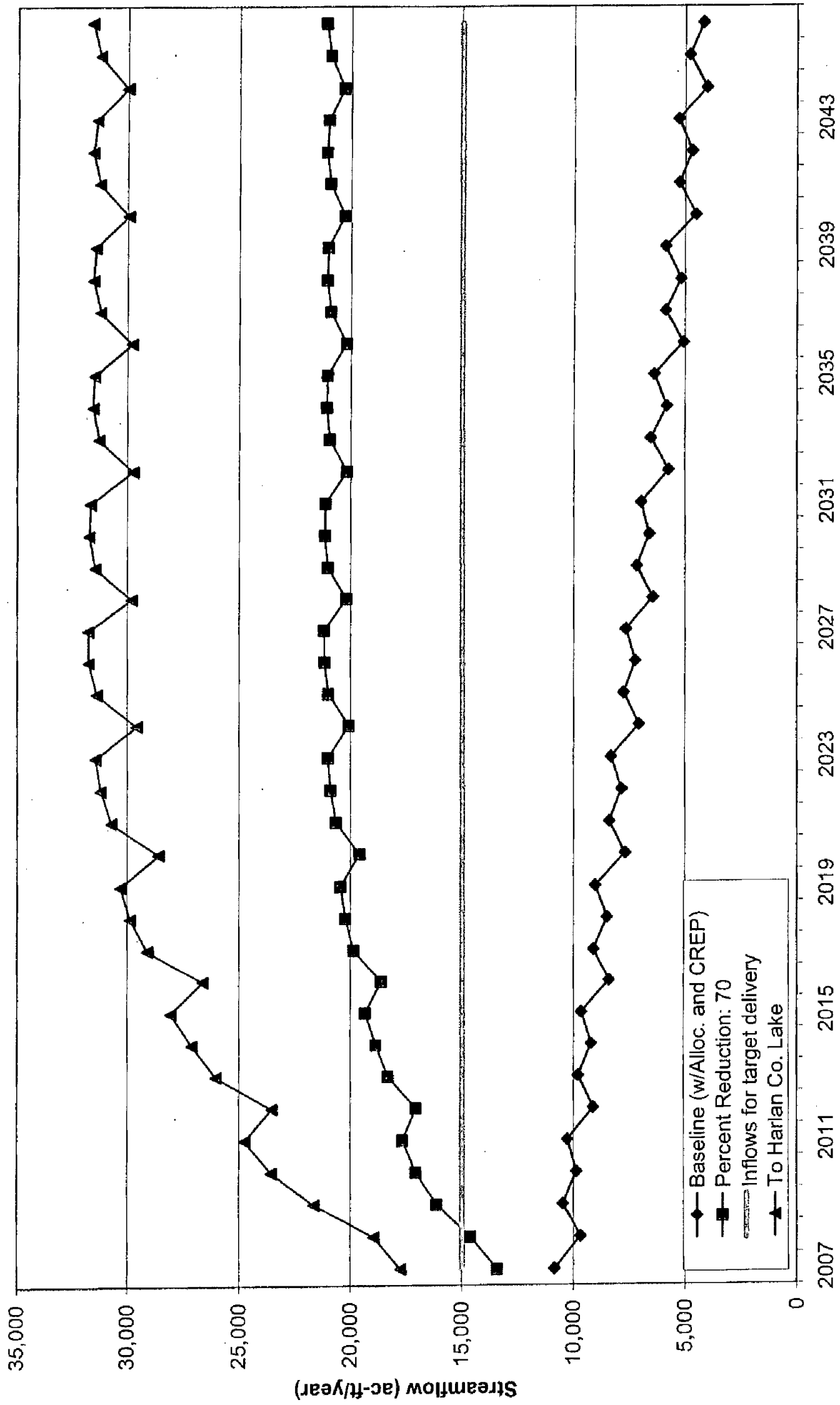
Dry Scenario - Culbertson Gage, No Enders Storage - Deliver 3 inches, FVID and Riverside ID



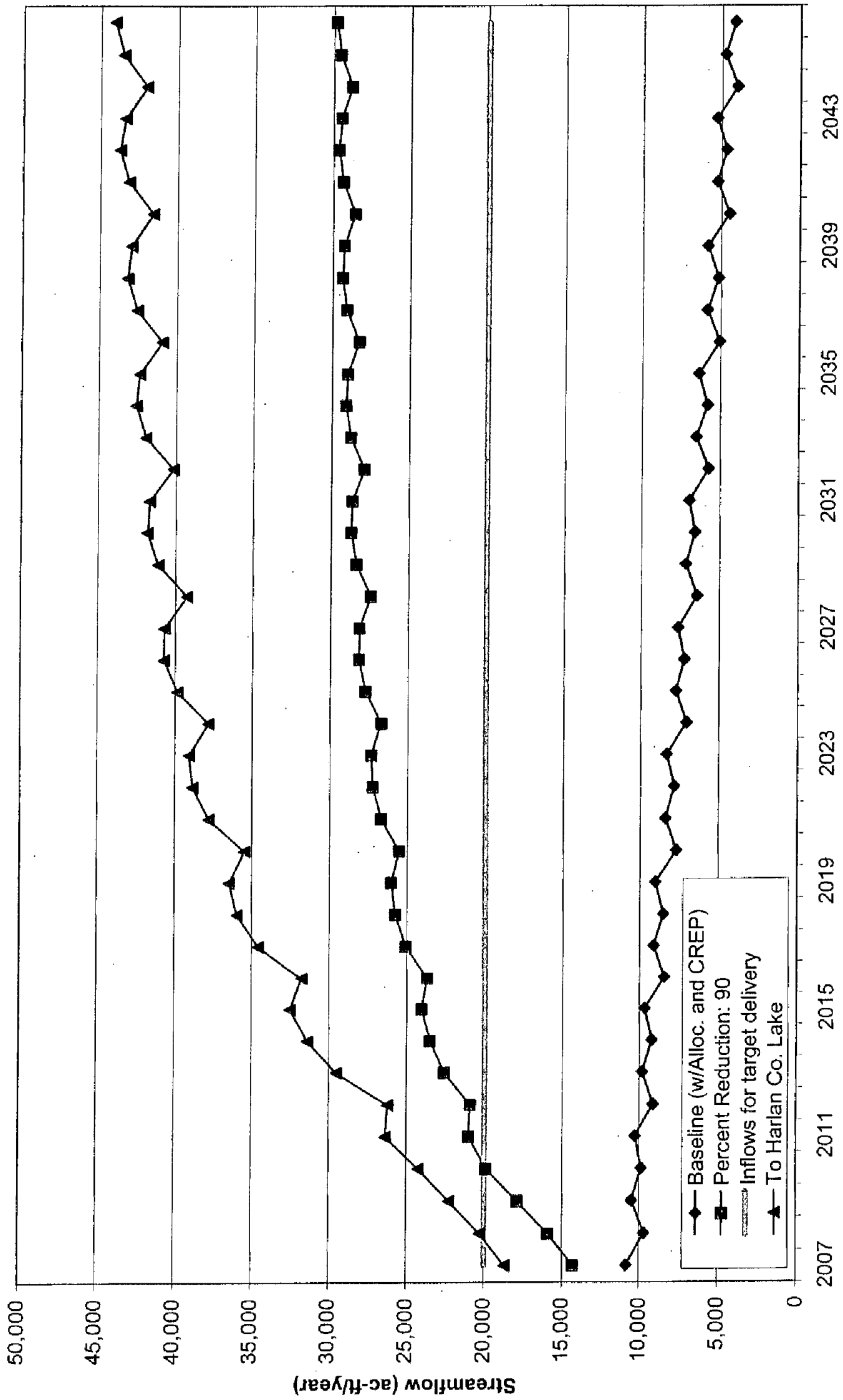
**Dry Scenario - Culbertson Gage, No Enders Storage - Deliver 6 inches, FVID and Riverside ID**



Dry Scenario - Culbertson Gage, No Enders Storage - Deliver 9 inches, FVID and Riverside ID



**Dry Scenario - Culbertson Gage, No Enders Storage - Deliver 12 inches, FVID and Riverside**  
ID



# Summary and Conclusions

- The potential for increased streamflow in Frenchman Creek was simulated under three climate scenarios – dry, average, and wet.
- The reductions in pumping required to meet target inflows to Ender's and target flows at the Culbertson Diversion Dam were determined
- Under most scenarios, significant reductions in pumping were required to meet streamflow targets.
- Some target streamflows were not attainable even with 100% reductions in groundwater pumping.

## Conclusions Cont.

- Very drastic pumping reductions were required to achieve reasonable levels of deliveries to H&RW ID
- Under average conditions, a 45% reduction in pumping should allow FVID and Riverside ID to deliver ~12 inches (whether or not Enders is storing or passing inflows)
- This pumping reduction would result in about 30kAF discharging to the mainstem