

Modeling Changes in Infiltration in the Lower Santa Cruz River

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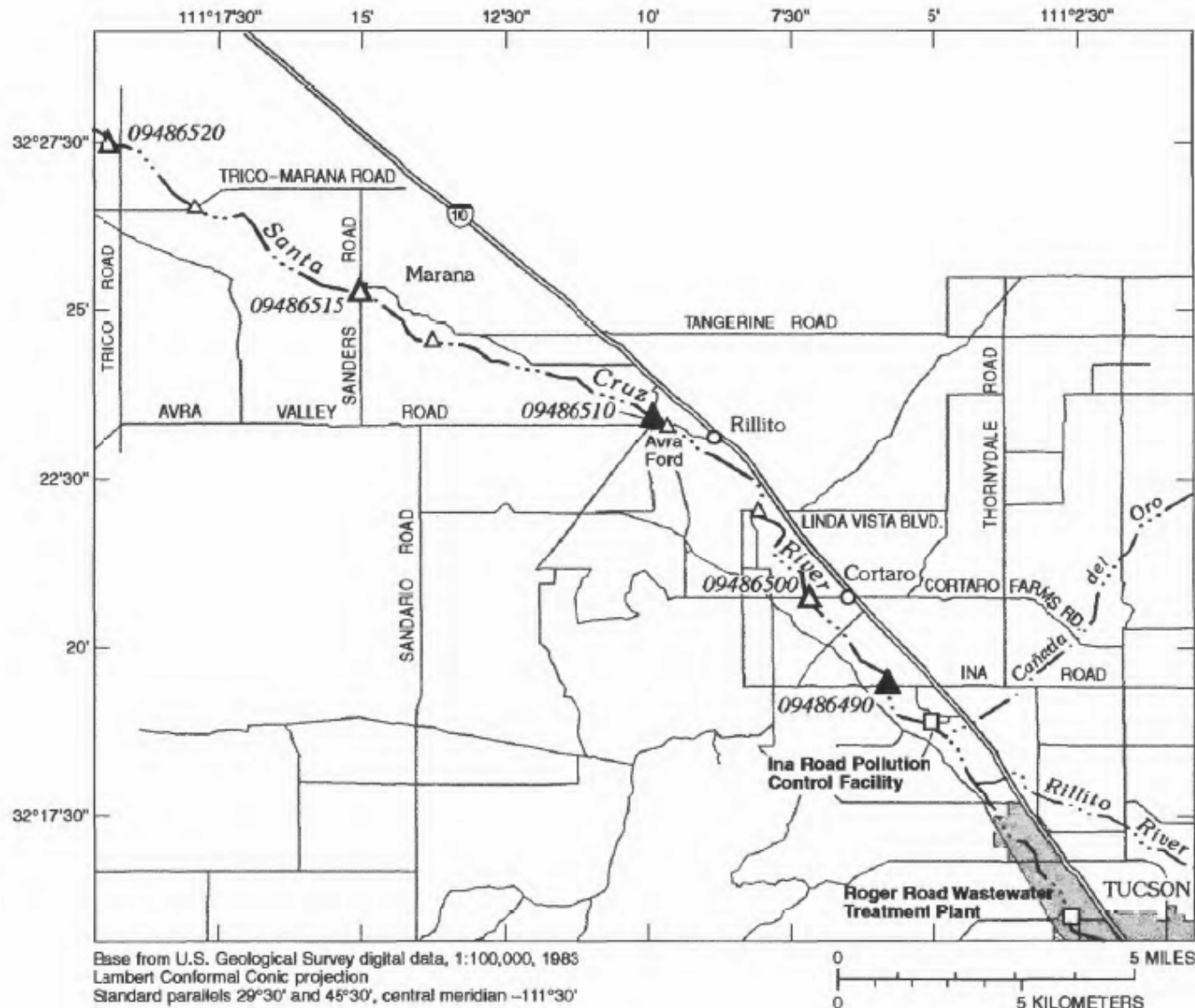
Pima County Regional
FLOOD CONTROL
D I S T R I C T

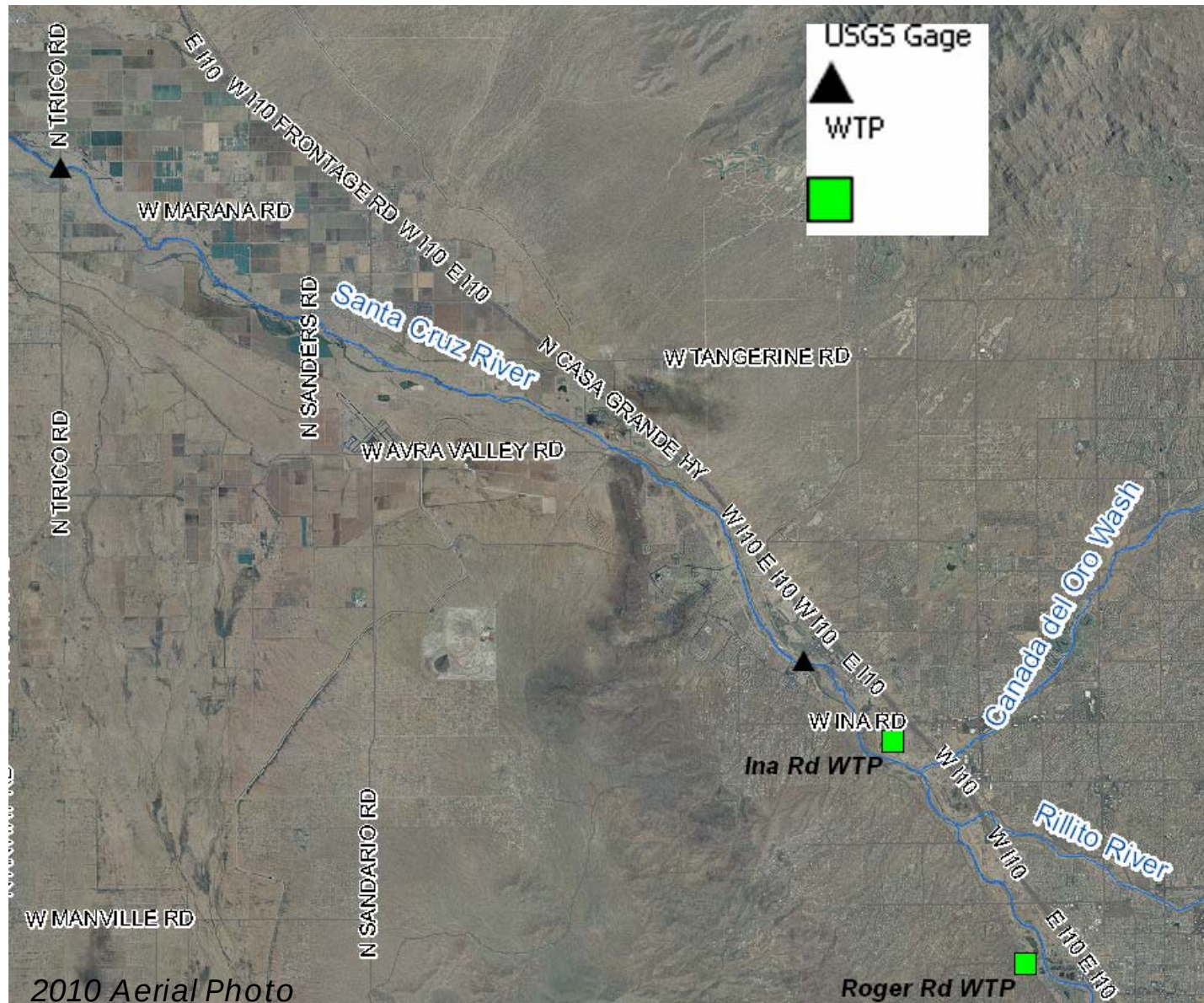


Outline

- Infiltration Studies from the mid-1990s
 - Gaylean (1996)
 - Lacher (1996)
- Importance of Scouring Events
- Infiltration Modeling with Kineros2 by Lacher
- Infiltration Parameters for Kineros2 in 2010 - reproducing the 1996 study using recent data

Treatment Plants and Gauging





Effluent-Dependent Lower Santa Cruz River



Gaylean, 1996

Water Year	Effluent Discharged (ac-ft)	Infiltration (ac-ft)	Percent Infiltrated
1991	46,600	41,890	90%
1992	49,380	43,640	88%
1993	50,620	45,670	90%

Gaylean, K. 1996. *Infiltration of Wastewater Effluent in the Santa Cruz River Channel, Pima County, Arizona*. USGS Water Resources Investigations Report 96-4021

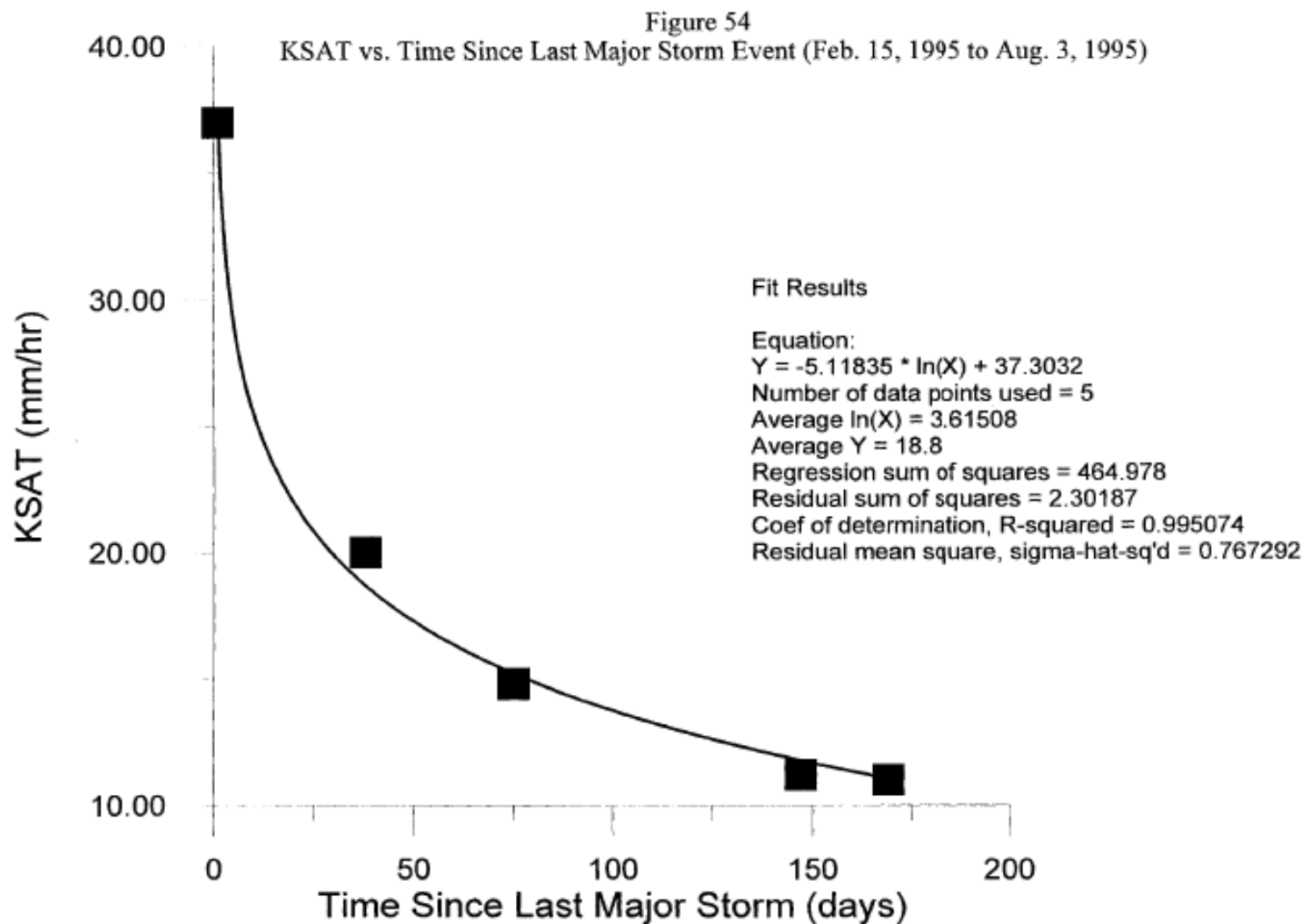
Managed Recharge Project

Water Year	Effluent Discharged (ac-ft)	Recharge (ac-ft)	Percent Infiltrated
2004	55,903	21,960	39%
2005	53,287	21,620	41%
2006	53,102	22,370	42%
2007	52,390	28,701	55%
2008	53,523	38,073	71%
2009	52,404	28,773	55%
2010	51,632	25,436	49%
2011	49,500	22,268	45%

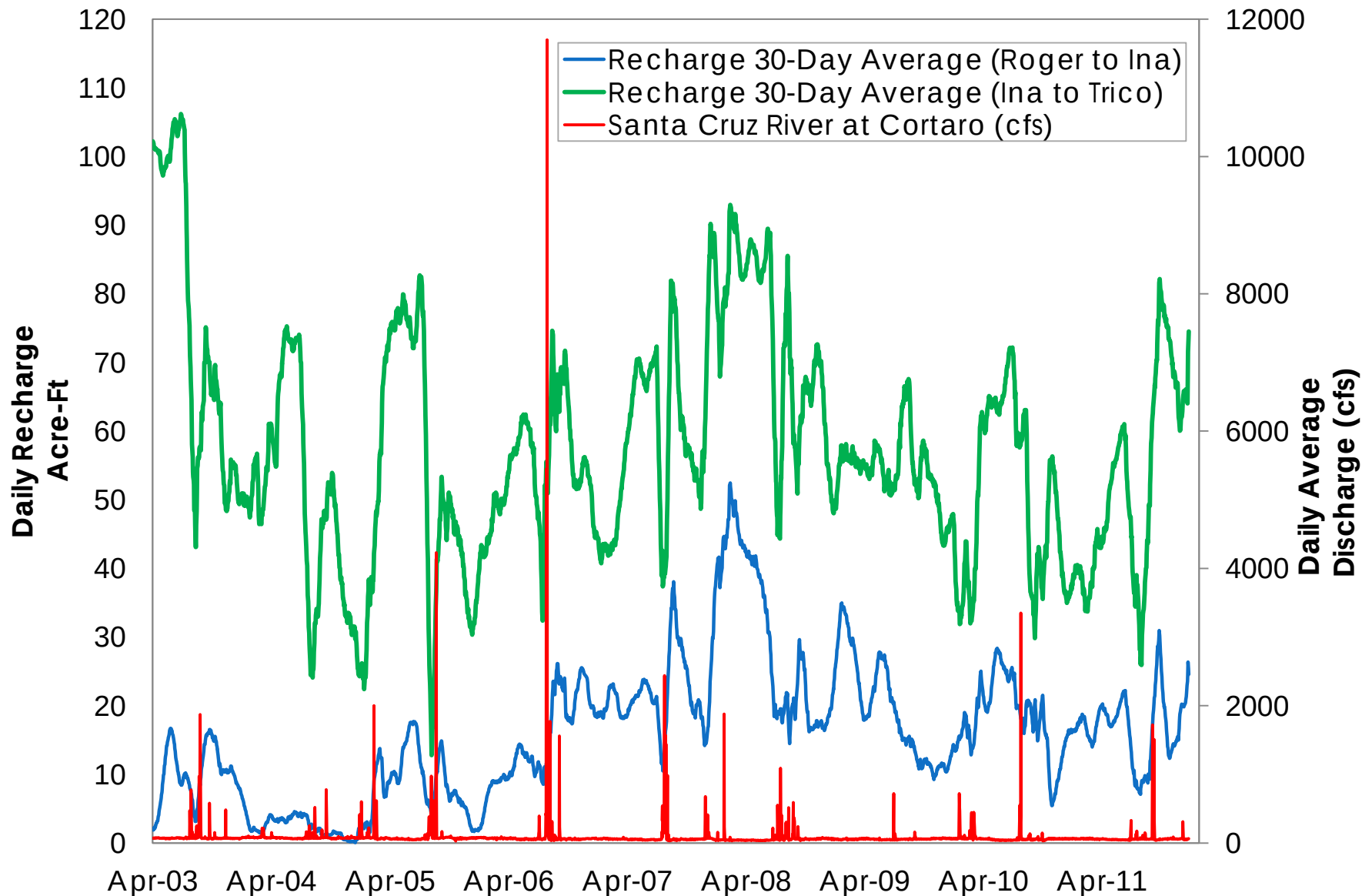
Lacher, 1996

- Used Kineros2 Model to Estimate Infiltration Rates
- Variation in Saturated Hydraulic Conductivity
 - (K_s - 0.51 to 1.4 in/hr [13-37 mm/hr))
- Found decreased K_s with time

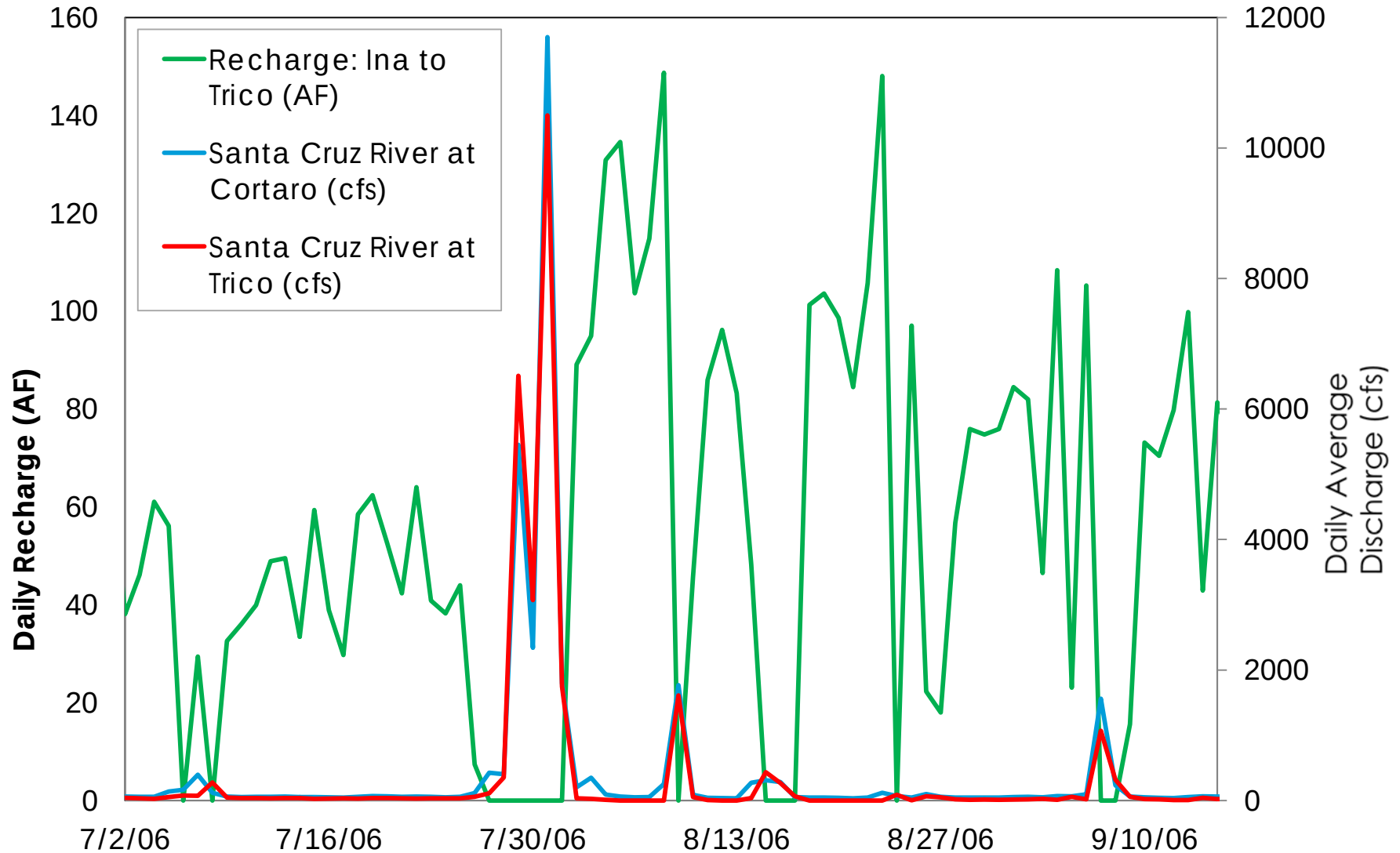
Decreasing Ks vs Time (Lacher, 1996)



Recharge and Flow Rates



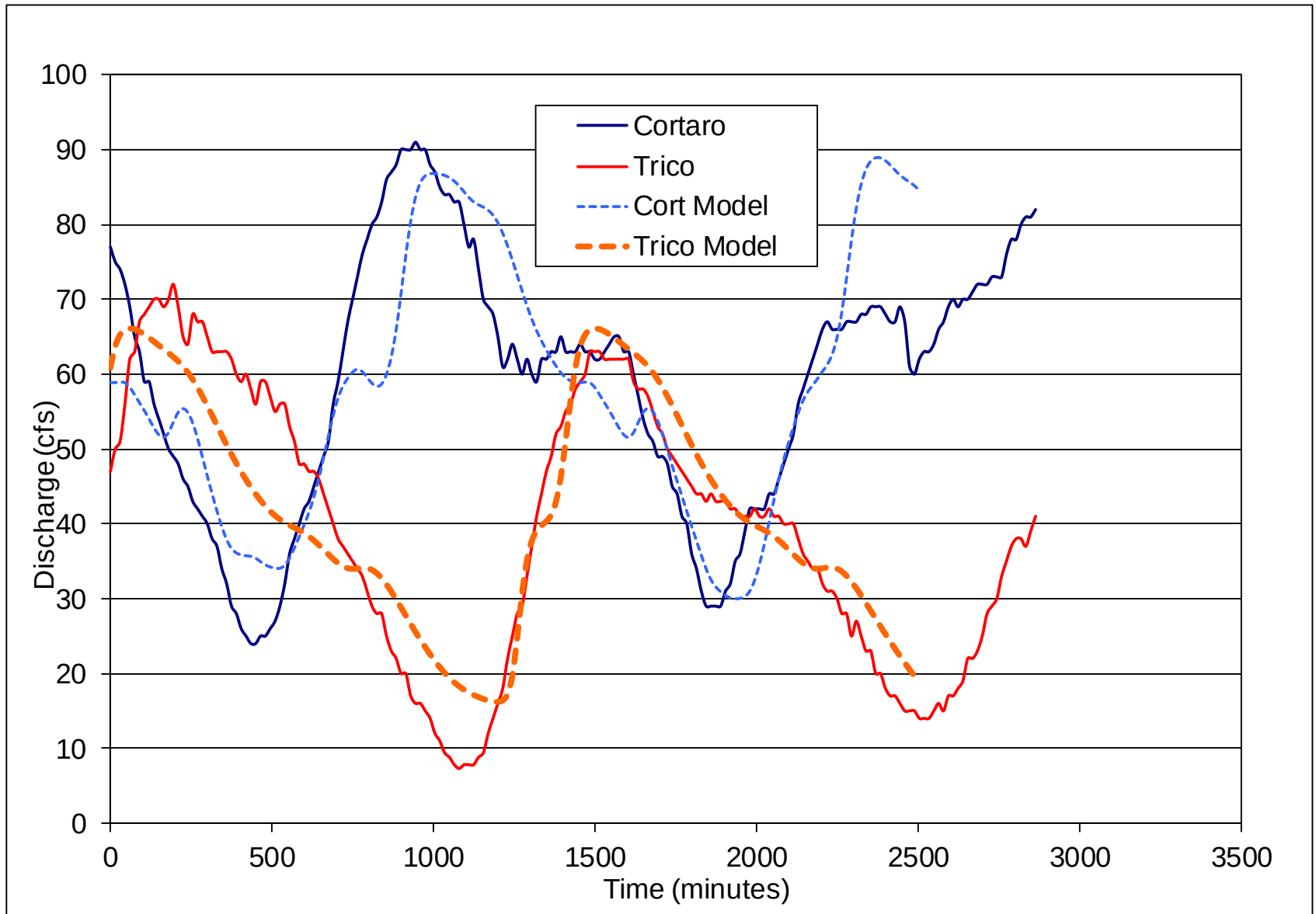
Summer 2006



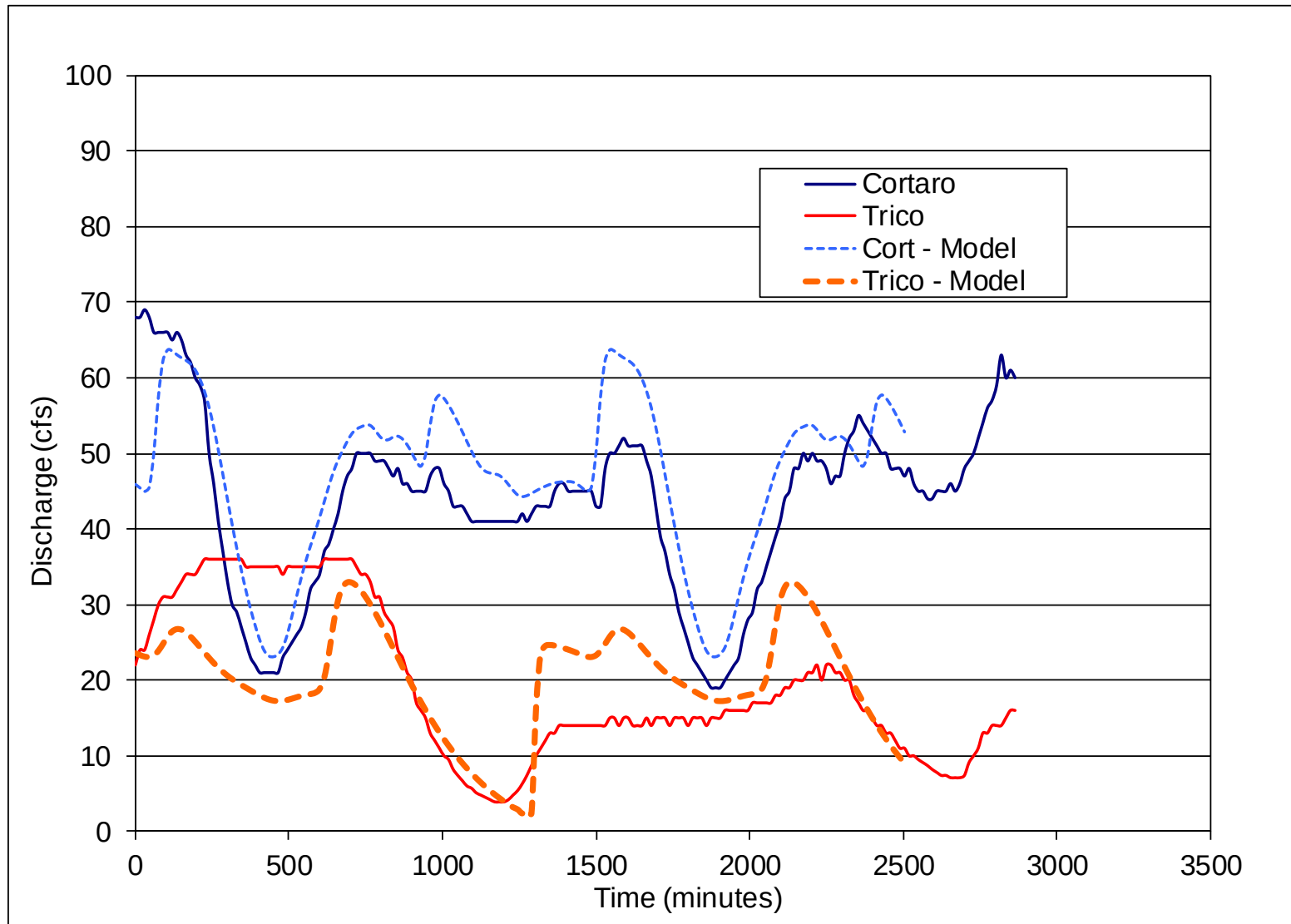
Reproduce Methods of Lacher using Flow Data from 2010

- Determine Kineros2 Geometry Using 2010 air photos and field cross-sections.
- Initial Parameter Values from Lacher, 1996.
- Determine Optimal Parameter Values for Ks using the SCEUA optimization routine .

Kineros 2 Simulation Nov. 22, 2010



Kineros2 Simulation May 5, 2010



Optimal Parameter Set (Ks ~1/2 Lacher, 1996 values)

Event	Ks (in/hr)	Man 'n'	Cortaro		Trico	
			RMSE (cfs)	NSE	RMSE (cfs)	NSE
19-Feb-10	0.38	0.028	15.0	0.42	7.3	0.65
5-May-10	0.36	0.026	12.8	0.11	9.0	0.25
17-Aug-10	0.48	0.025	8.3	0.61	6.7	0.51
22-Nov-10	0.25	0.028	10.2	0.66	7.2	0.84

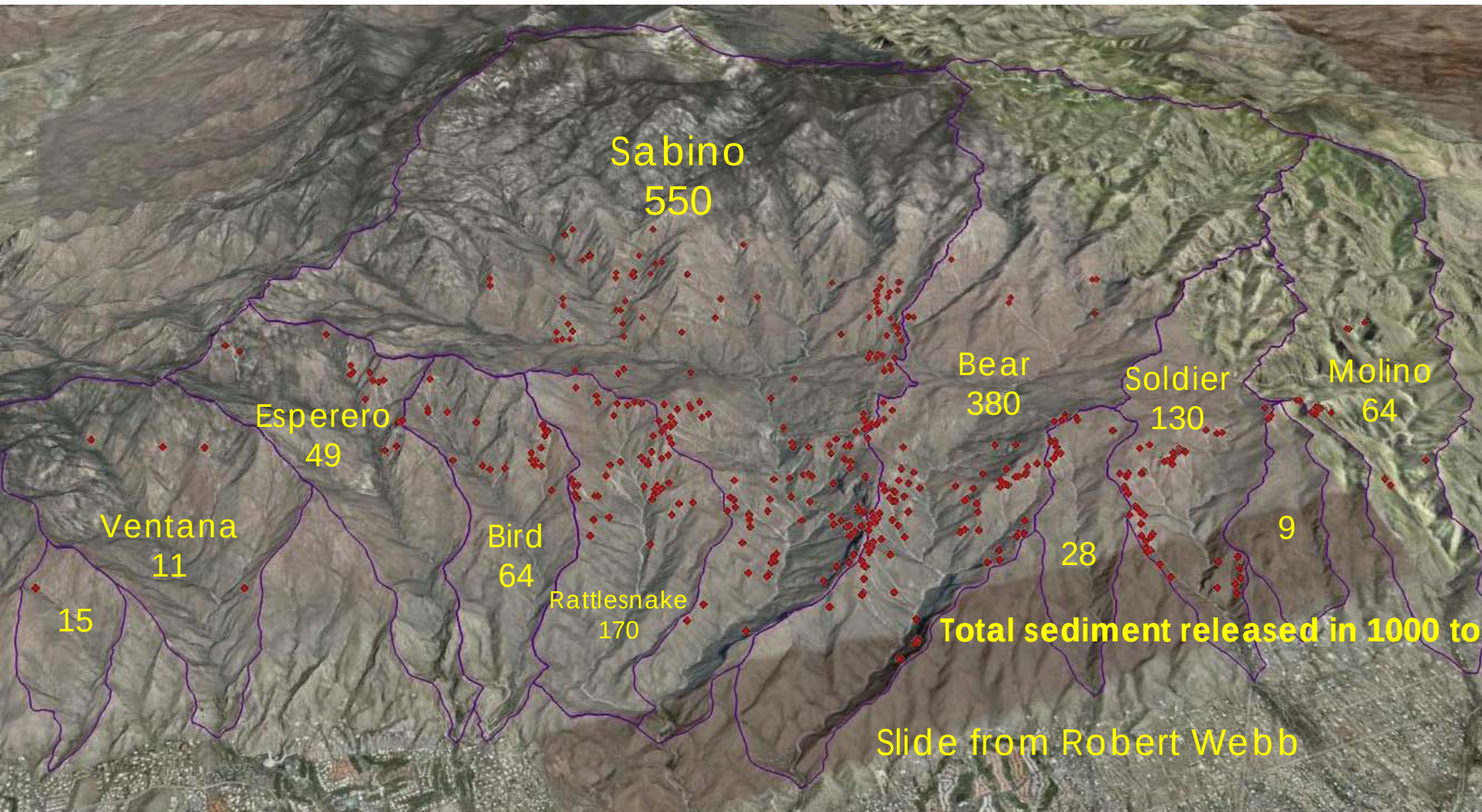
What is Going On?

Some Observations & thoughts

- Fires (2003 Aspen Fire, 2002 Bullock Fire)
- Debris Flows (2006)
- Increasing Salts in Influent
(~300ppm in 1999 to about 450 today and rising)

Sediment Released by Slope Failures

- 1.5 million tons of sediment released in 11 drainages
- 527,000 tons fine enough to be transported by flooding
- 10 times what is typically eroded in 1 year (~40,000 tons)



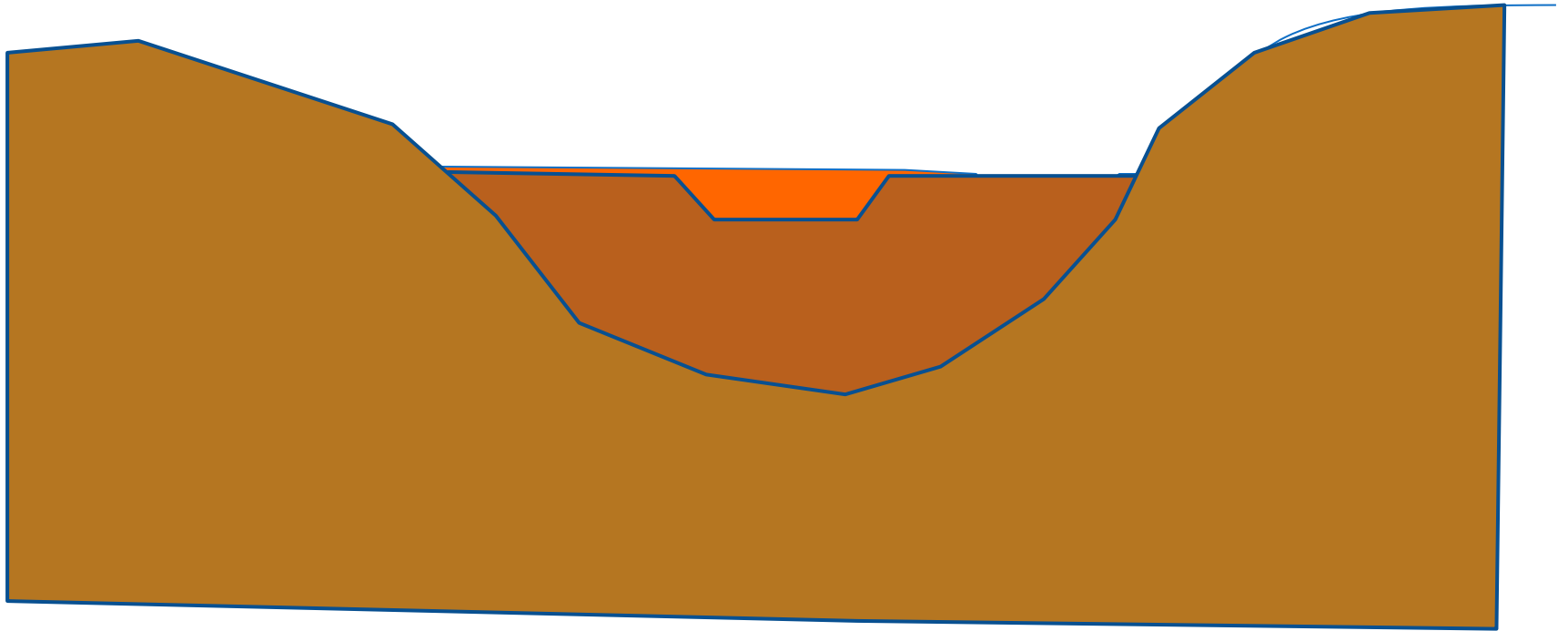
Rilling and Erosion Following Aspen Fire July, 2003



Debris Flow #7, Sabino Canyon

While the boulders are impressive, the most important part of debris flows is the fine-grained matrix. It allows the debris flow to transport those boulders long distances.

Large Events May Scour and Deposit Finer Material on Recessional Limb



Conclusions

- Marked decrease in infiltration rates.
- This may be attributed to change in channel sediment brought on by large sediment laden flows.
- High nutrient loads contribute to the forming of the clogging layer.
- Increase in salt content may exacerbate the clogging problem, especially with finer grained soil and higher clay contents.