

# *The Historical Conditions Report of the Lower Santa Cruz River*



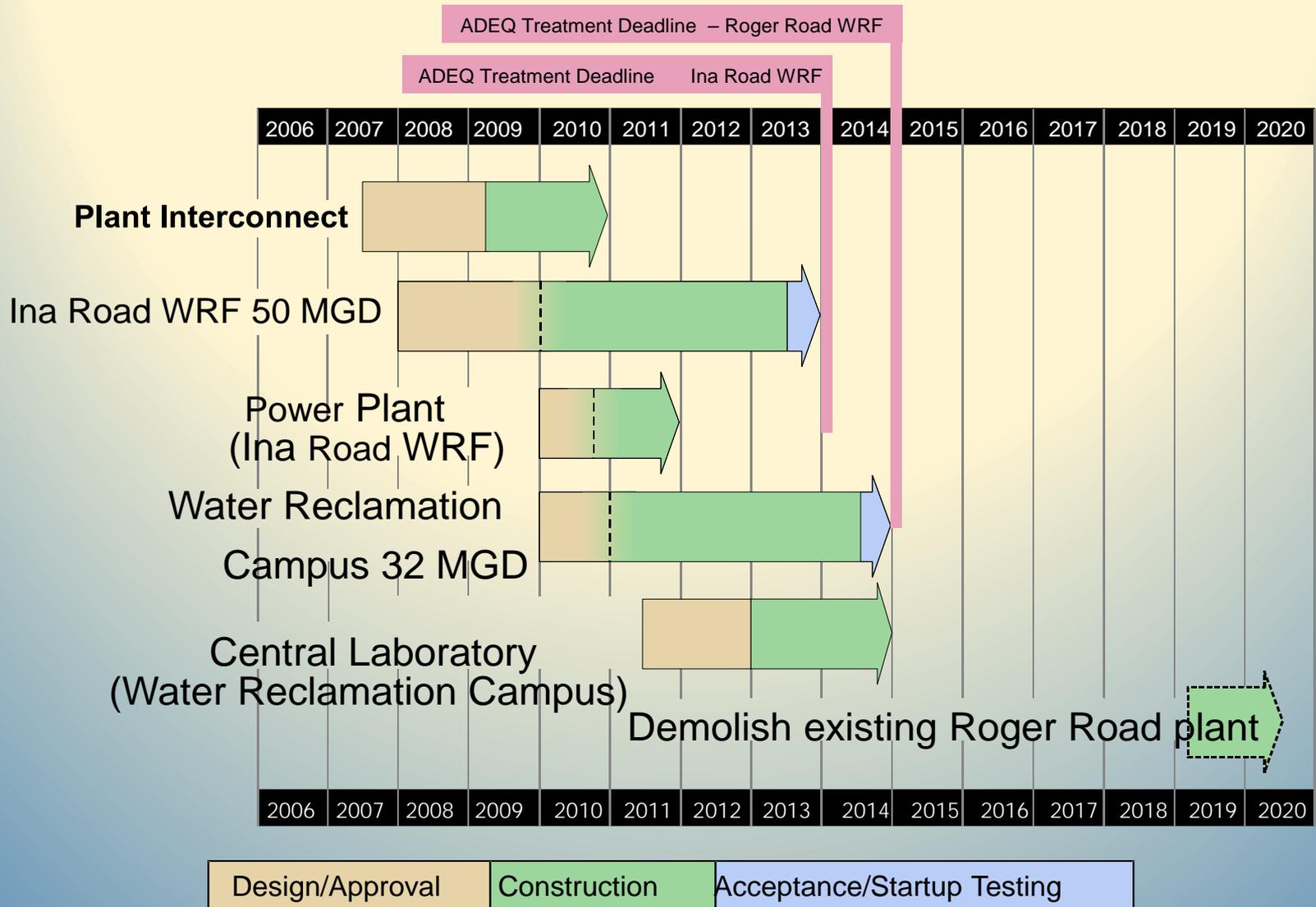
Evan Canfield  
Akitsu Kimoto  
Jacob Prietto  
James Dubois  
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# Report Outline

- Introduction
- Water
- Geomorphology
- Vegetation
- Water Quality
- Macroinvertebrates
- Anticipated Changes in LSCR
  - Possible Impacts of Water Quality upgrades
  - Possible Changes in Water Supply

# ROMP Implementation Schedule



# Origin of the Report

- RFCD Director Suzanne Shields asks me to write a report on impact of ROMP upgrades to:
  - Pima County water supply (i.e. potential for improved recharge)
  - RFCD Infrastructure (1999 modeling study of effluent flows said)
    - Ina to Cortaro: 7-13 feet (downstream of the Ina Rd grade control had deep scour)
    - Cortaro to Avra Valley: 5-7 feet



**2011-2015**

***Action Plan for Water Sustainability***



A City of Tucson and Pima County  
Cooperative Project

# Pima County/City of Tucson Planning Study

## Goal

### **Respect for the Environment Goal #4:**

Ensure the future of riparian and aquatic habitat along the effluent-dependent reach of the Santa Cruz River

## Action Plan

### **Respect for the Environment Program #4:**

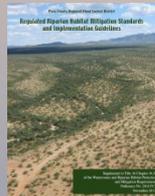
**'Lower Santa Cruz River  
Management Plan'**

(2011-2015)

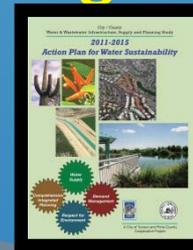
# Relevance of *Historical Conditions* Report with Other Efforts

**EPA Wetland  
Program:  
'Reviving River'  
Annual Report  
of Indicators**

**Regulatory:**  
Refine the Existing  
Wetland (Riparian)  
Program  
(Title 16.30)



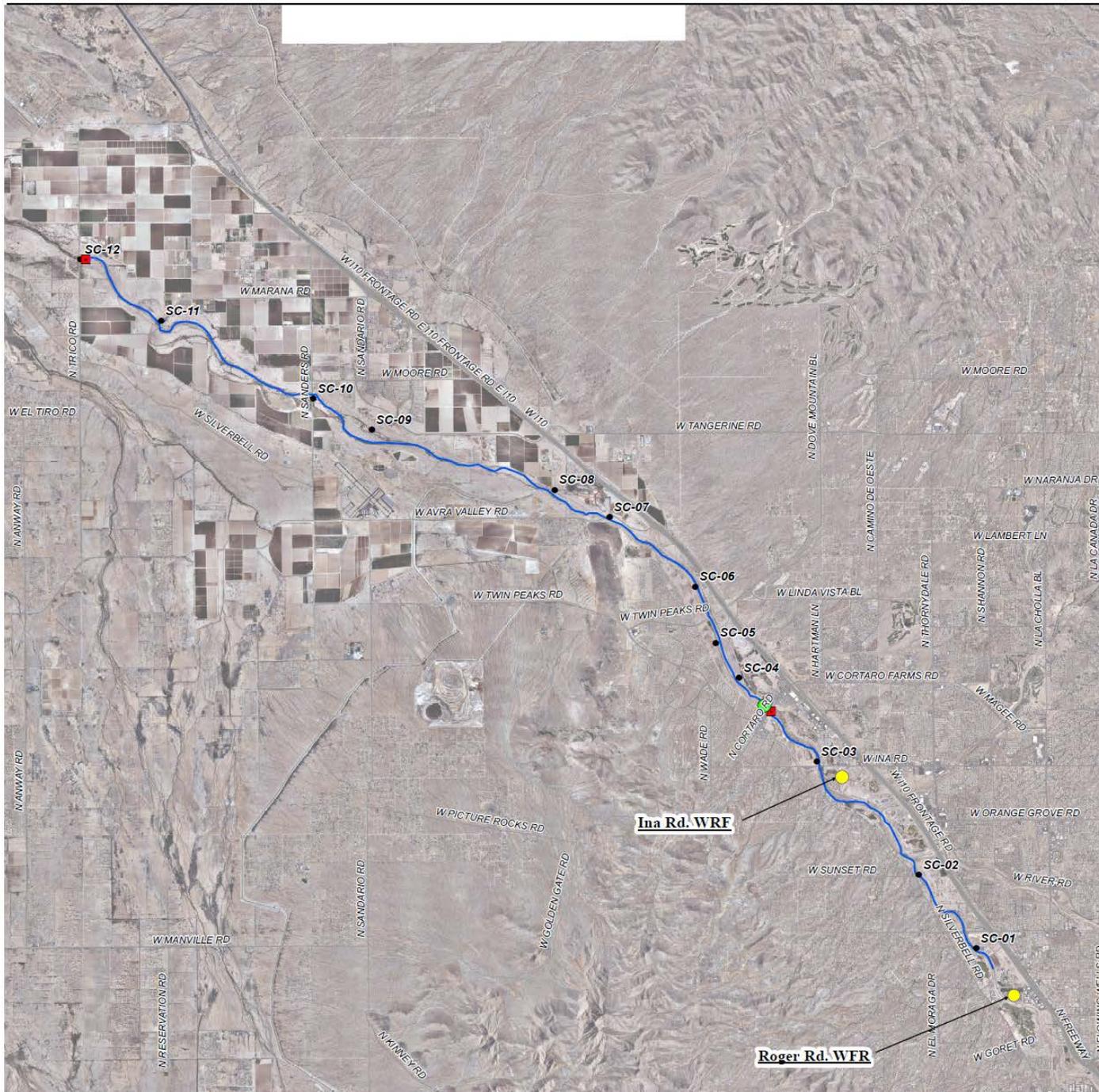
**Planning:  
Development of  
a Lower Santa  
Cruz River  
Management**



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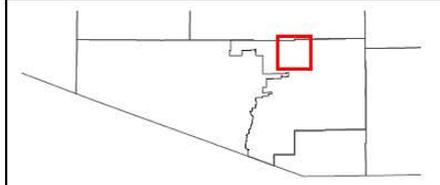
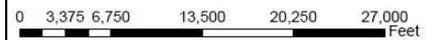
## Map 2 Lower Santa Cruz River Sampling Site



- ADEQ Sampling Sites
- USGS Stream Gauge
- RWRD Sampling Sites
- Study Reach (Lower Santa Cruz River)

Aerial photo was taken in 2011

1 inch = 3,000 feet



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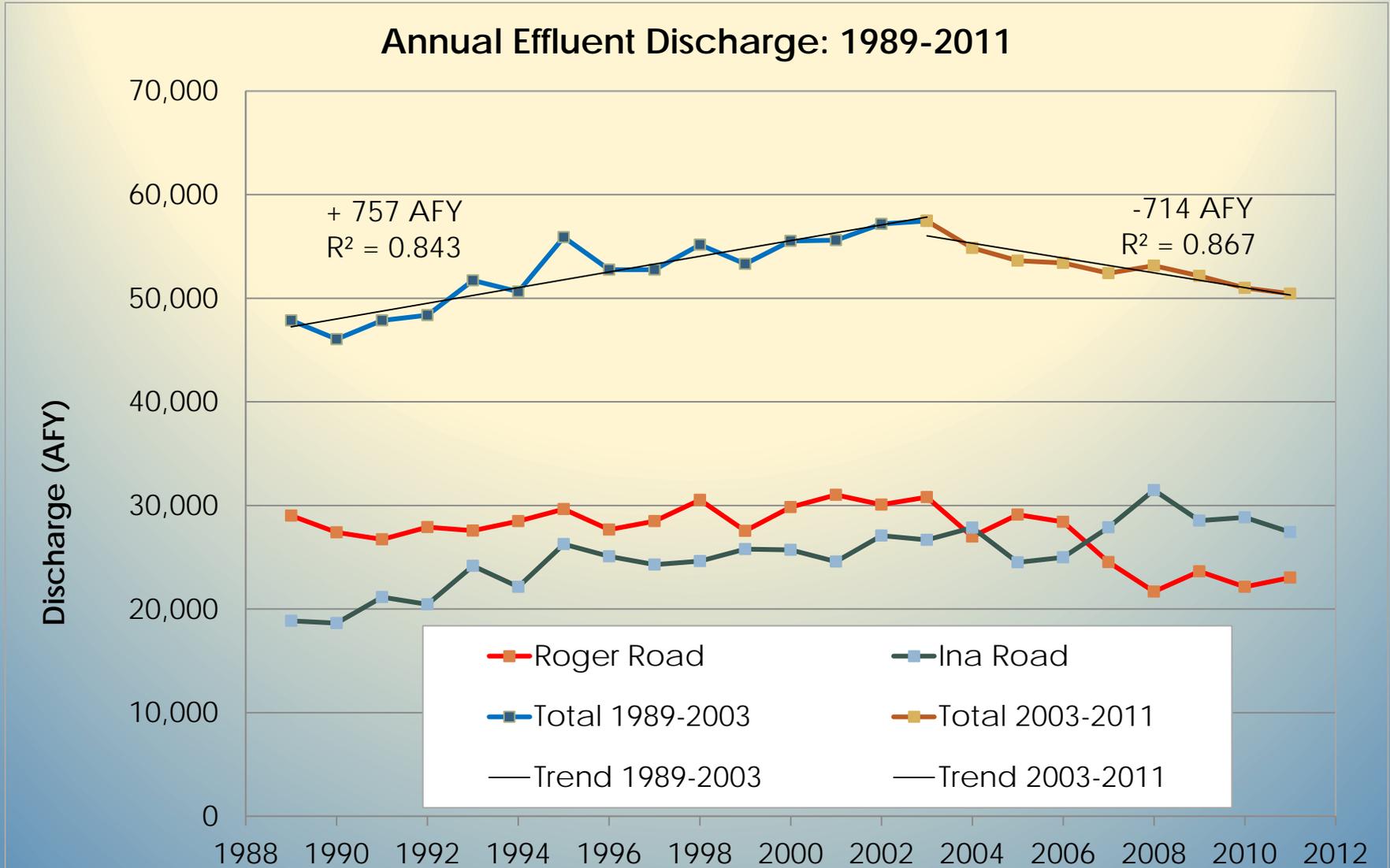
Pima County Regional Flood Control  
17 East Congress Street - 3rd Floor  
Tucson, Arizona 85701-1207  
602.243.1900 - FAX: 602.243-1821  
http://www.pfcd.pima.gov



# History of Flow in Effluent Dependent Reach

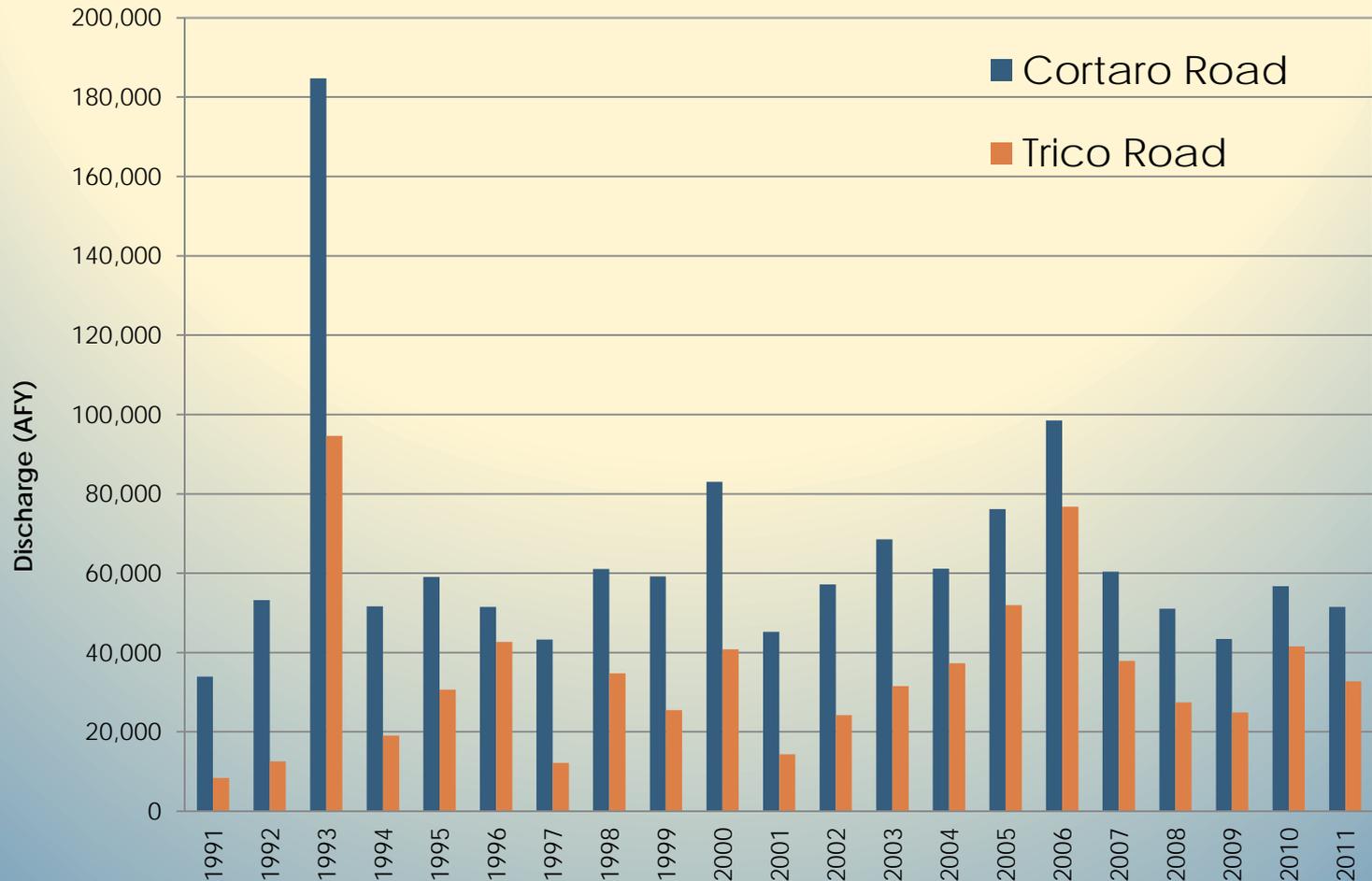
- 1973 - Discharge from Roger creates perennial flow at Cortaro gauge
- 1977 - Discharge from Ina adds to perennial flow at Cortaro gauge
- 1985 - Classified as '*Effluent – Dominated Water*' (EDW) because over 75% of flow in a typical year is effluent

# Effluent Inflow Peaked in 2002 and is now declining



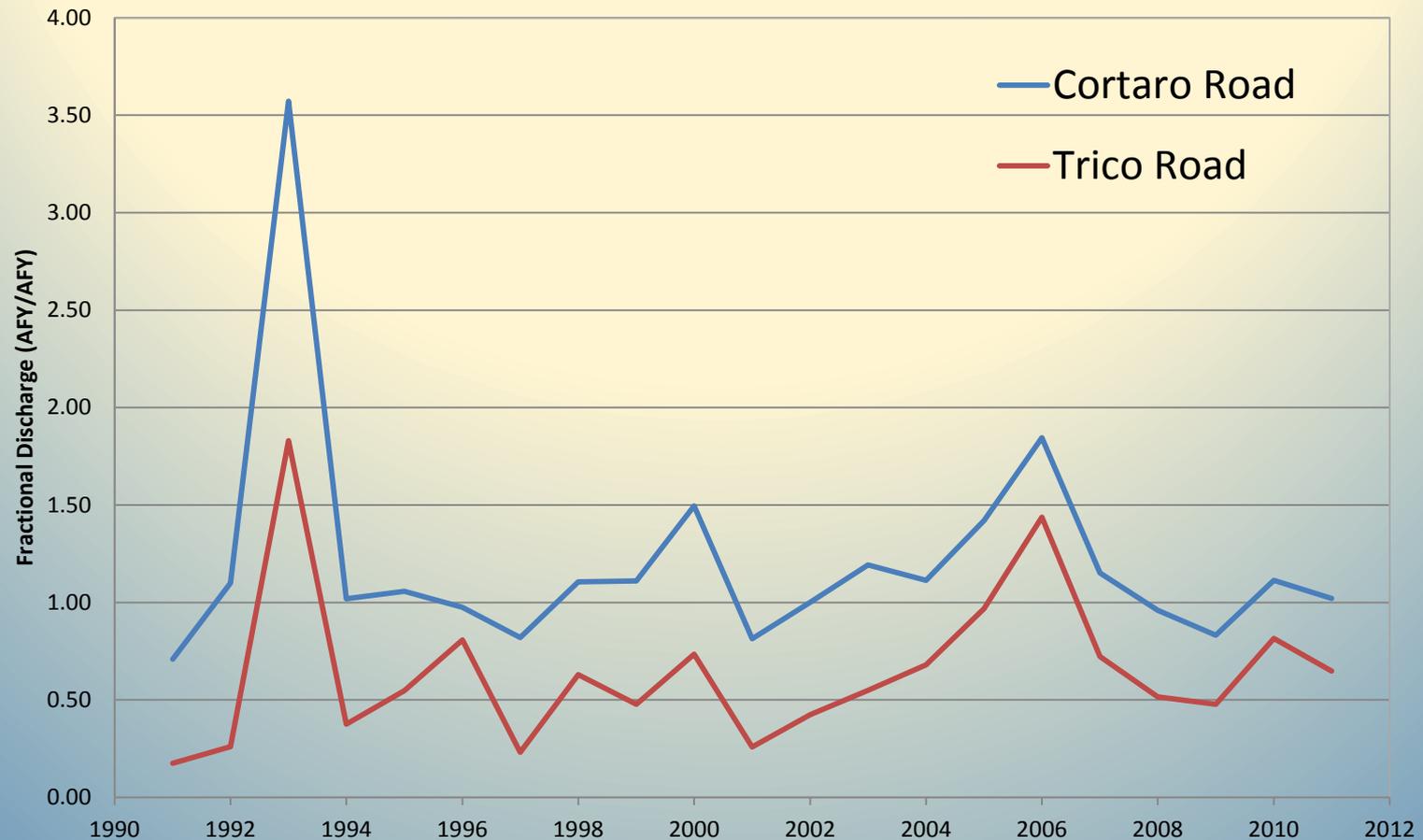
# Annual Flows Greater at Ina than Trico Rd

Annual Mean Discharge: 1991-2011

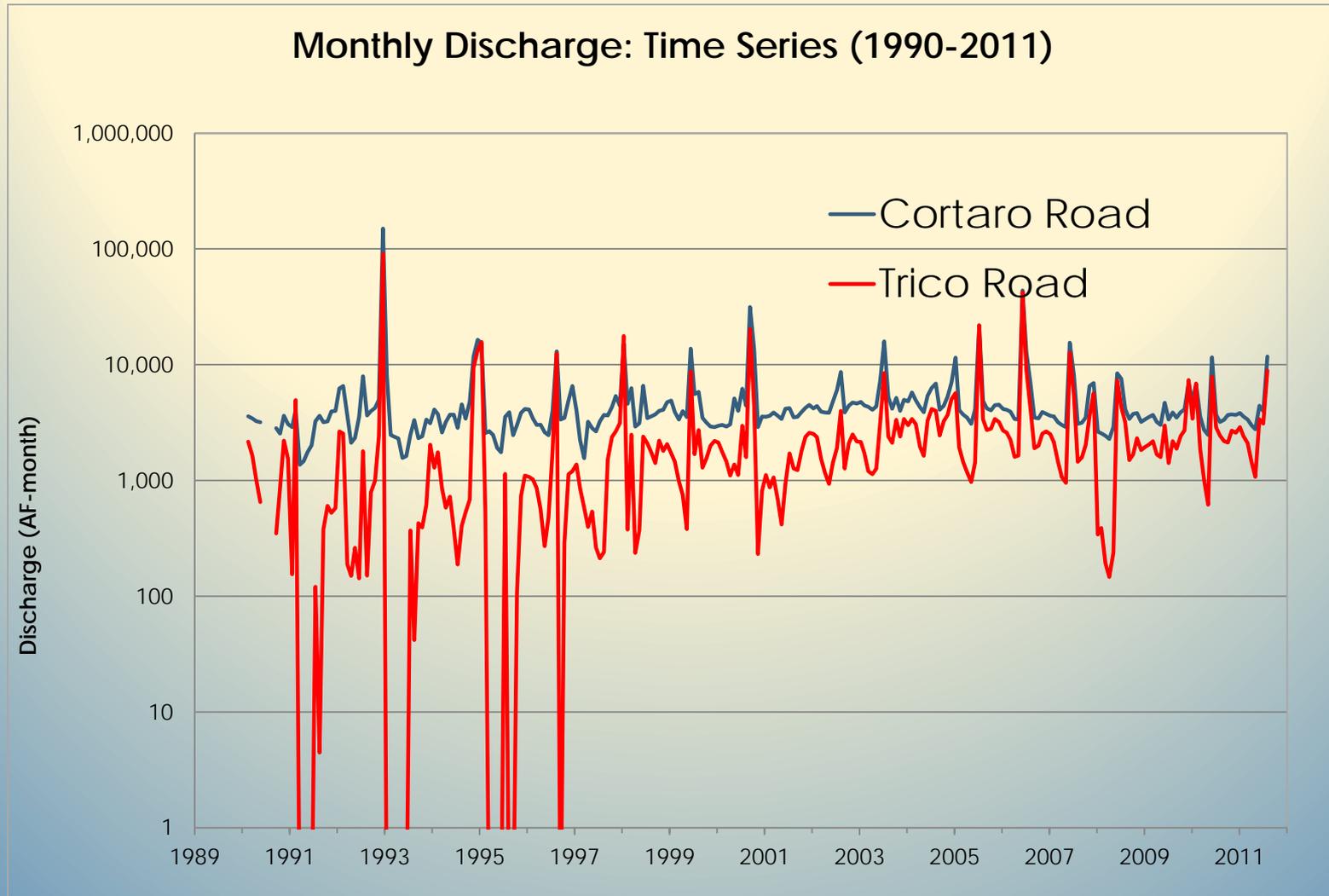


# Fraction of Effluent Discharge to Annual Flow

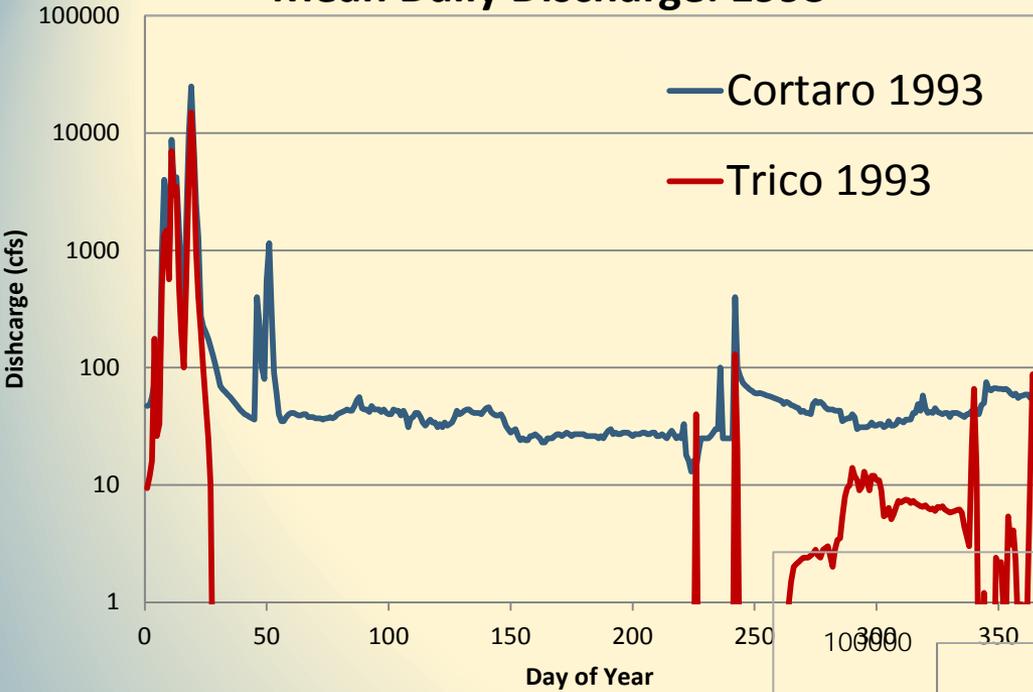
**Fractional Annual Discharge: 1991-2011**  
**(Lower Santa Cruz River/Total Effluent)**



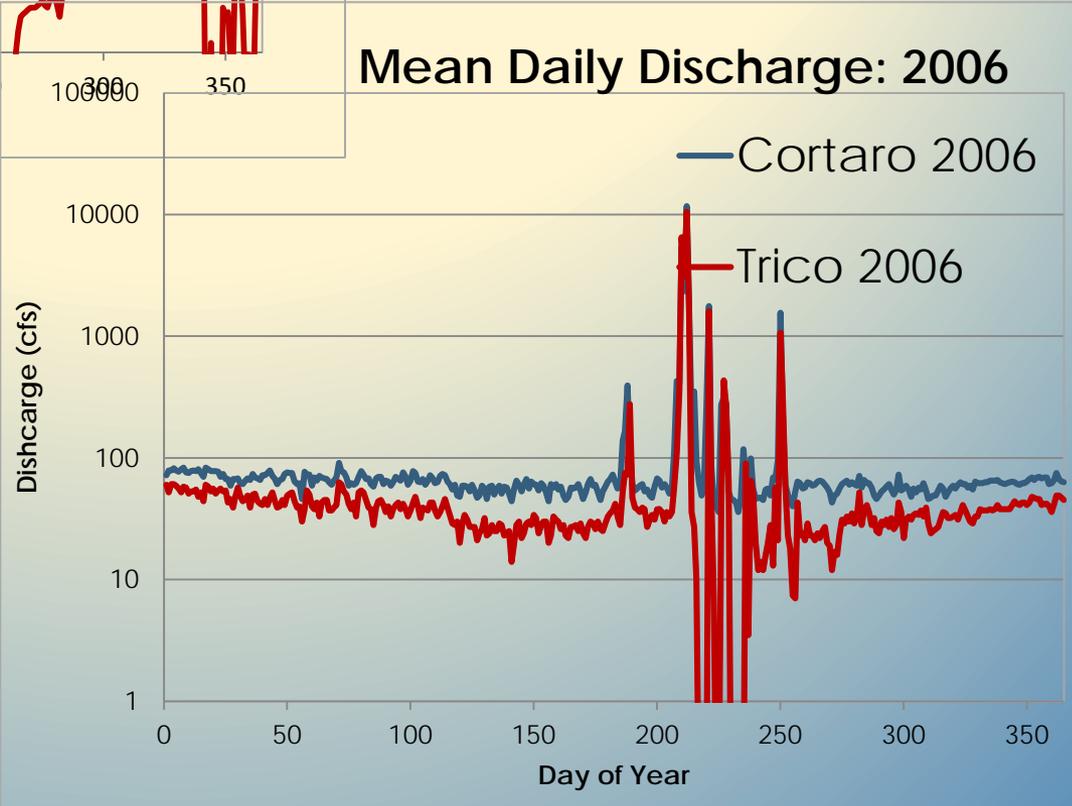
# Difference in Monthly Discharge between Cortaro and Trico is Diminishing



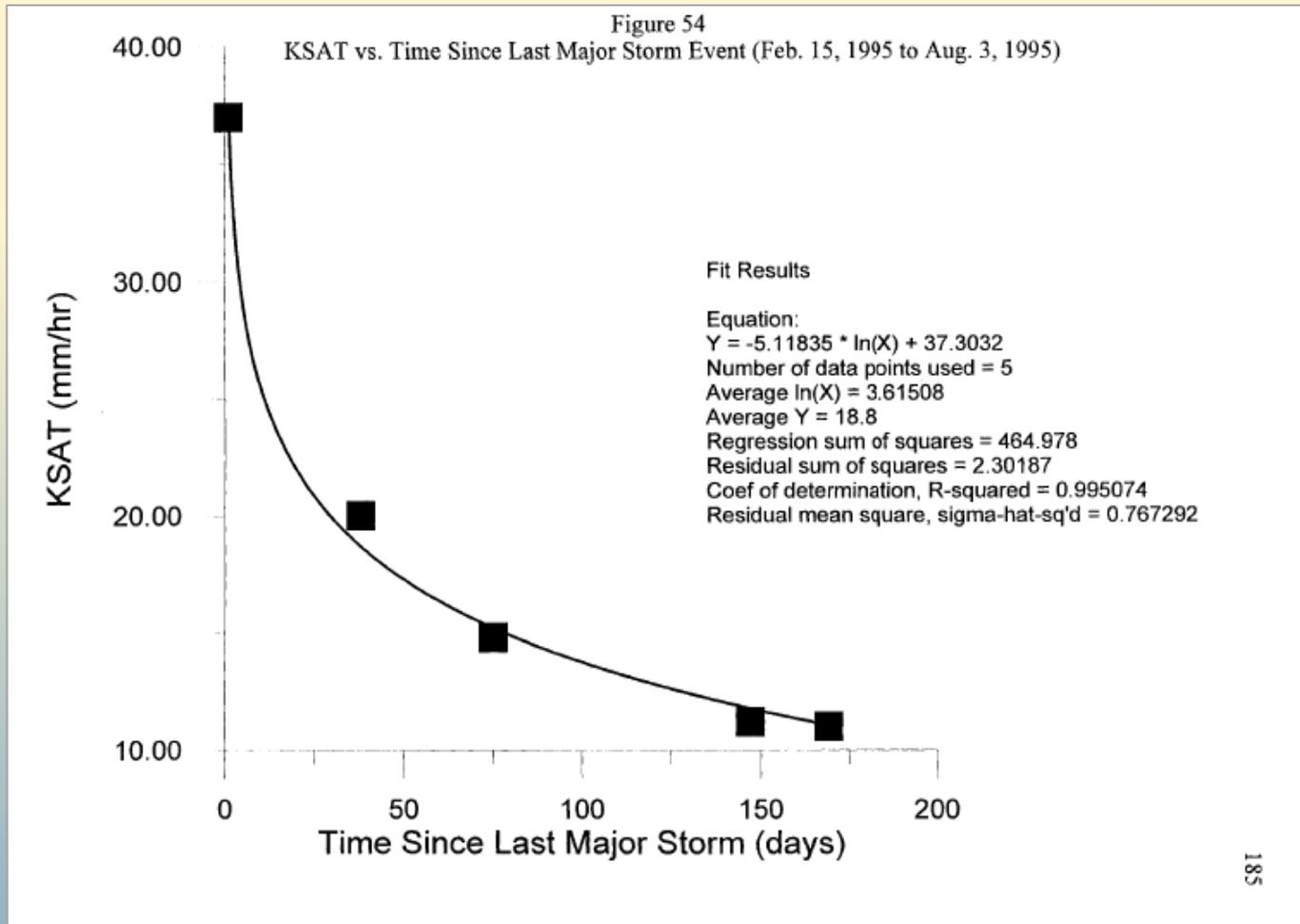
### Mean Daily Discharge: 1993



### Mean Daily Discharge: 2006

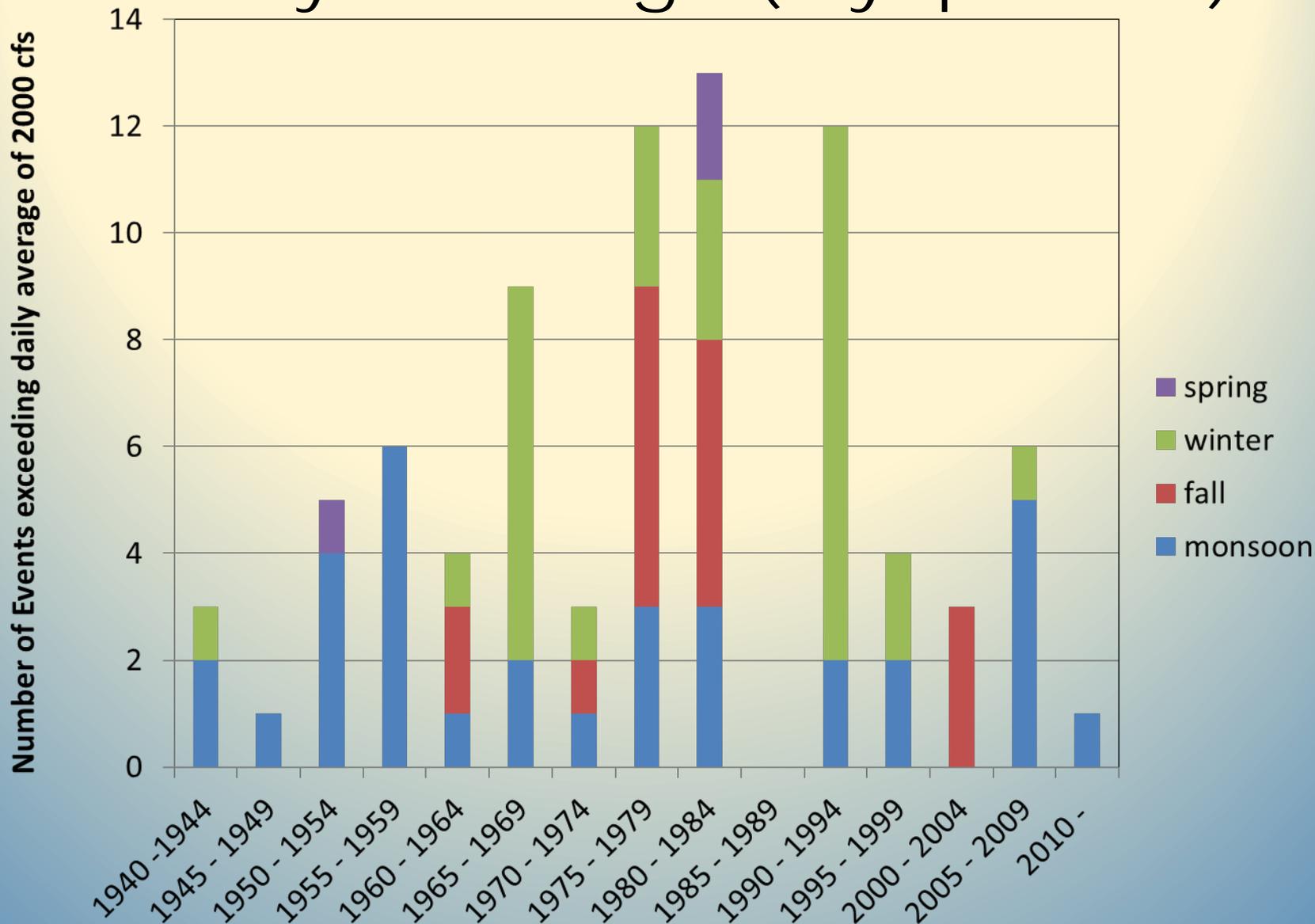


# Saturated Hydraulic Conductivity (Ks) Declines with Time Since Last Major Storm



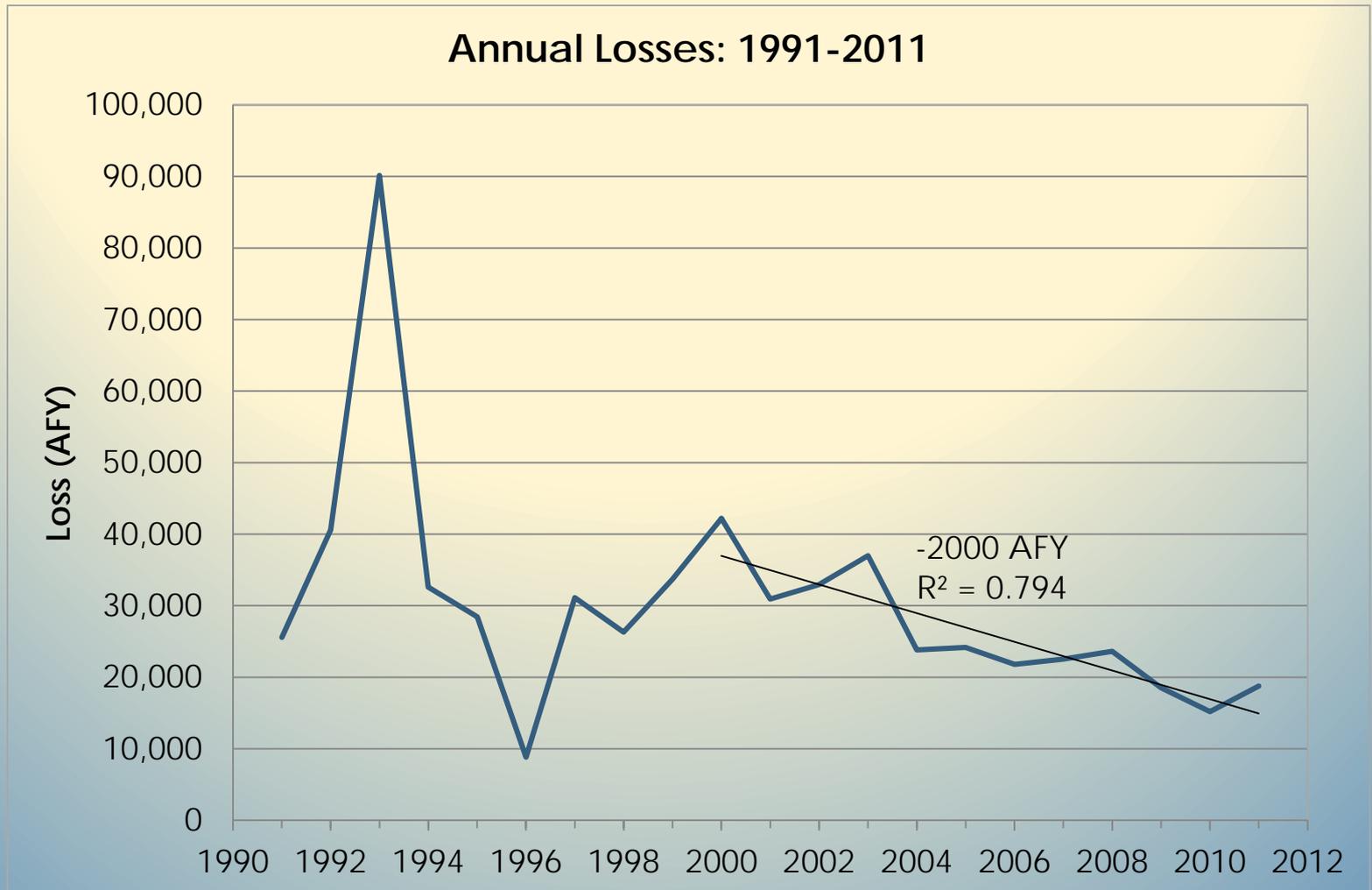
Lacher, Laurel J. (1996) PhD Dissertation, Department of Hydrology and Water Resources, University of Arizona.

# Number of Events Exceeding 2000 cfs Daily Discharge (5-yr periods)



# Annual Losses Have Been Decreasing

difference between flow at Cortaro and Trico getting smaller

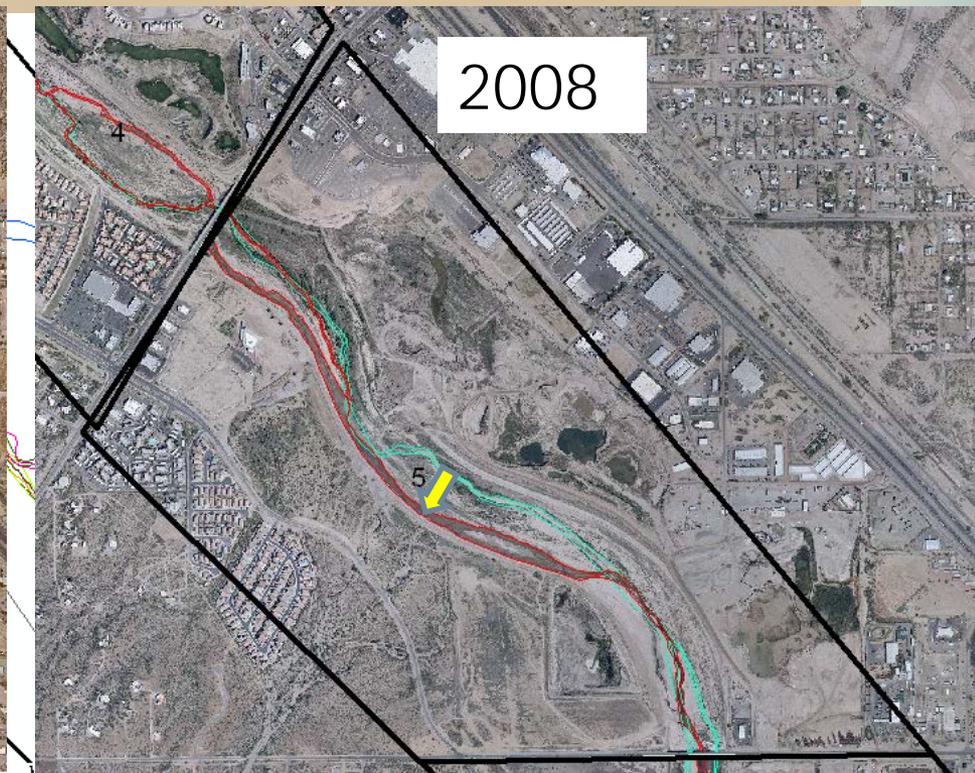
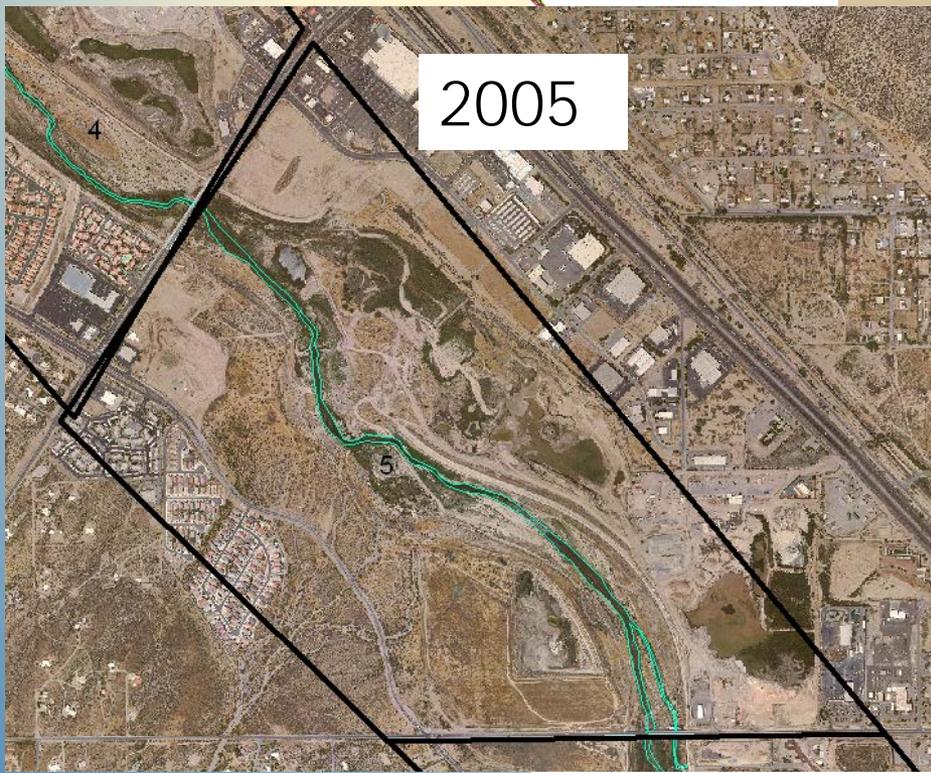
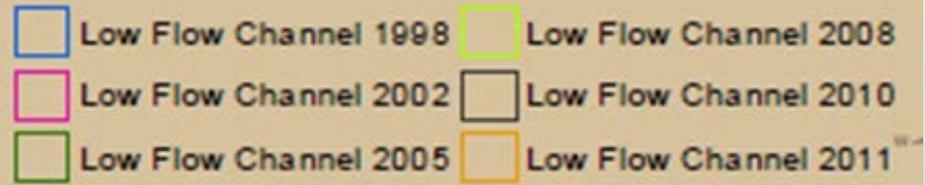


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# Major Location Change Effluent Flow between Ina - Cortaro

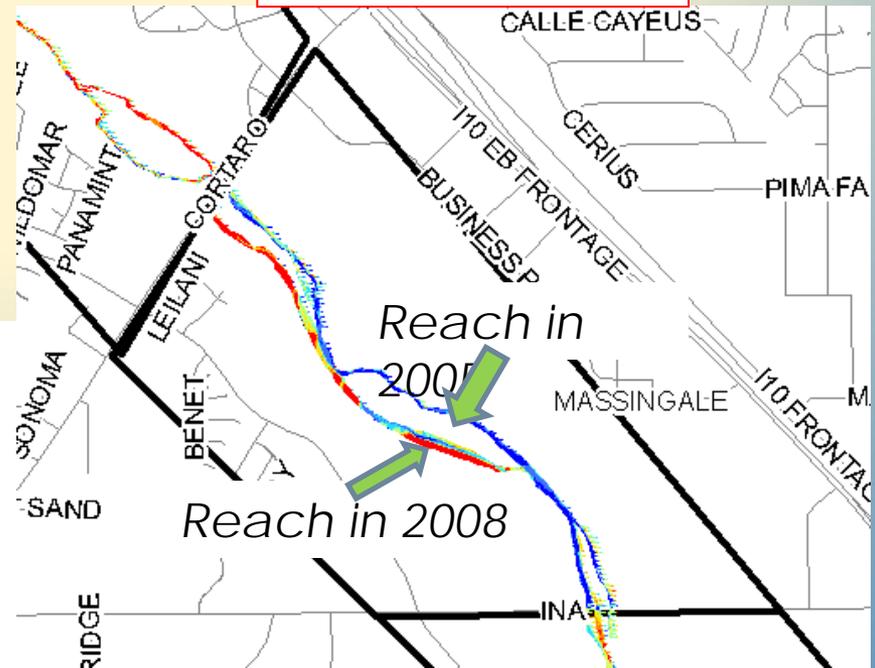


# Large Channel Bed Elevation Change Effluent Channel between Ina-Cortaro

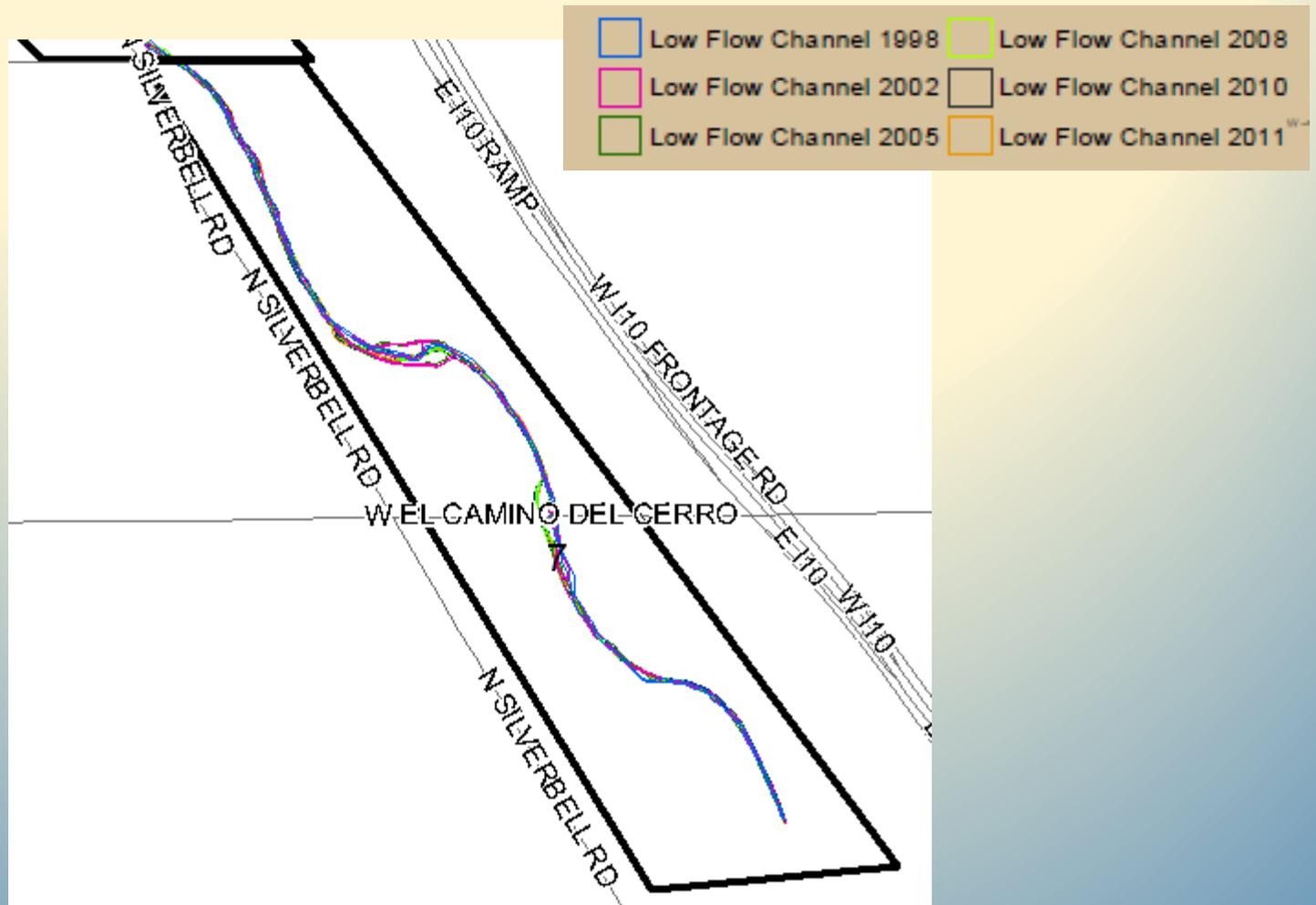
1998-2005



2005-2008



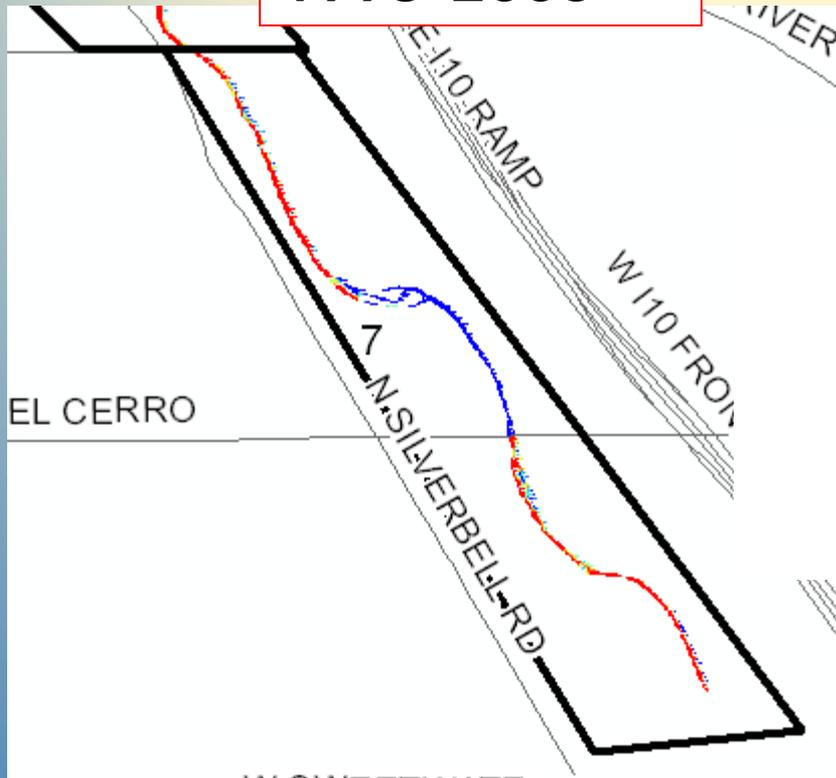
# Minor Location Change Effluent Flow between Sunset- Sweetwater



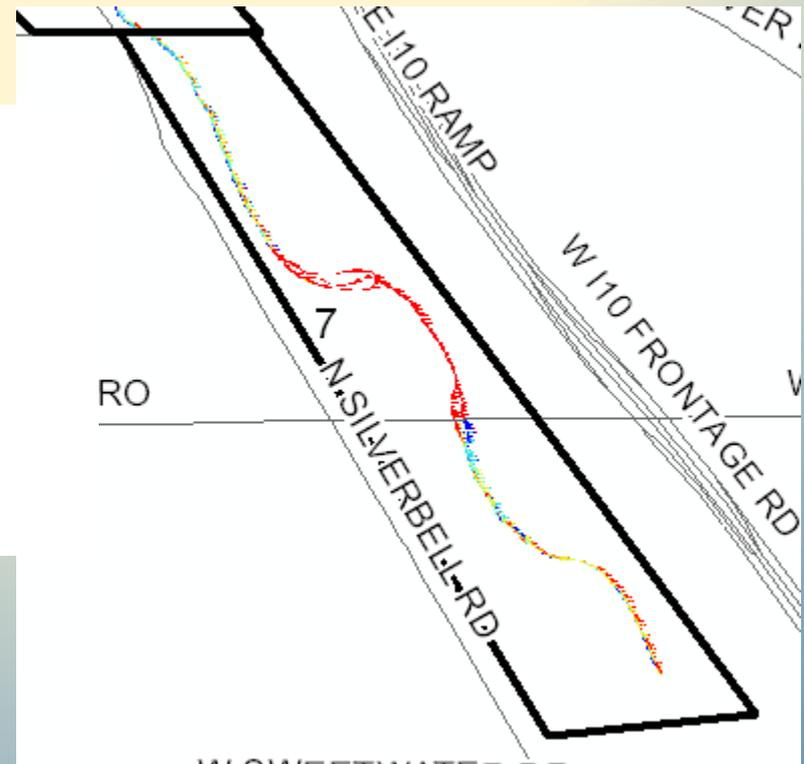
# Large Channel Bed Elevation Change Effluent Channel between Sunset- Sweetwater

- *Minor Location Change but Relatively Deep Erosion/Deposition*

1998-2005



2005-2008





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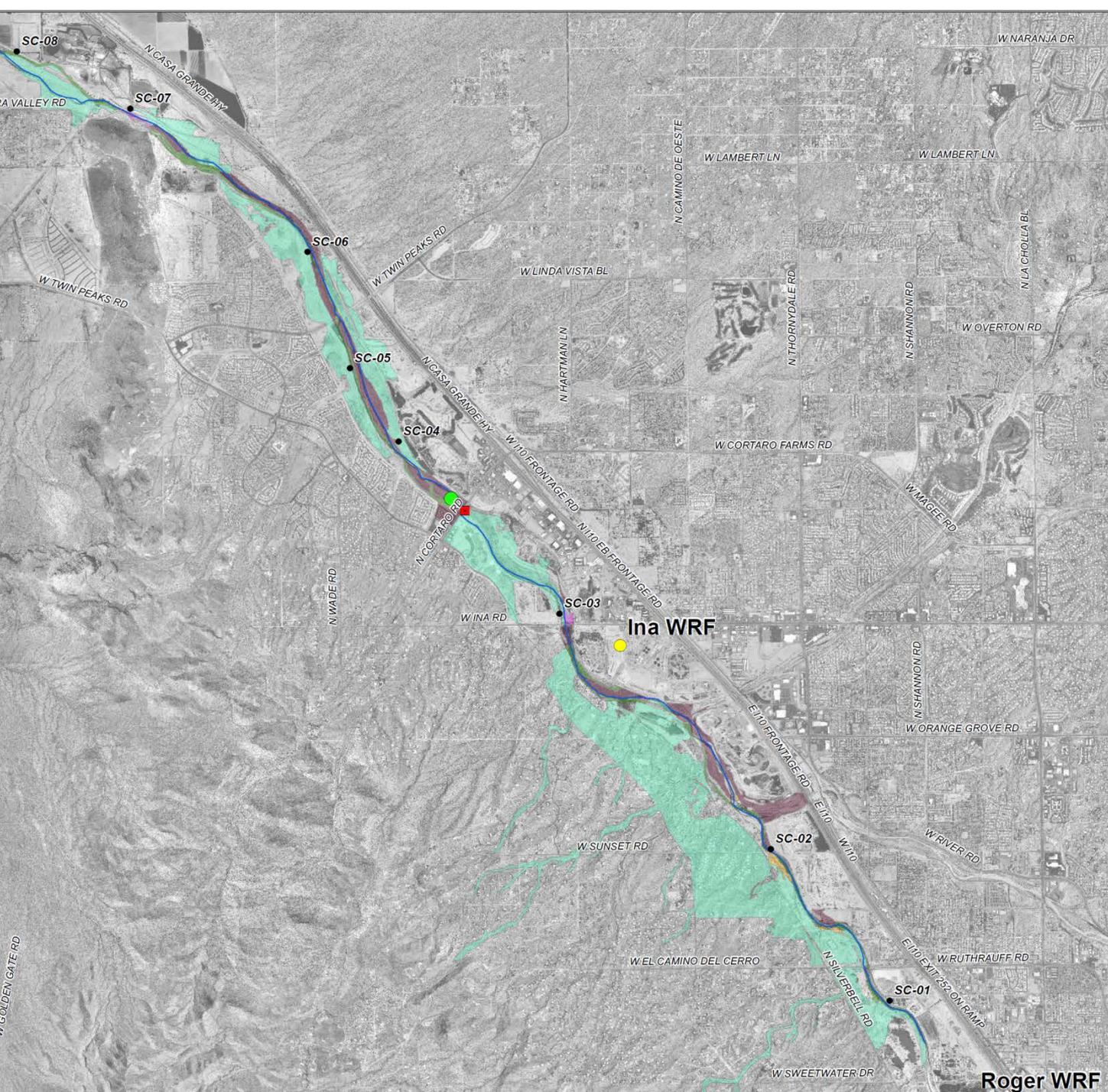
# Vegetation – the Good

- Today the project reach supports some of the most extensive and productive wetland plant communities in Pima County, and the structure and composition of the plant communities in the floodplain compares favorably to other southern Arizona valley bottom streams.
- Gormally (2002) found that effluent is associated with increased plant diversity, richness, cover and incidence of exotic plants relative to ephemeral reaches.

# Vegetation – the Bad

- Mauz (2002) found that about half the species identified in 1909 have been extirpated. Native floodplain grasses are nearly absent.
- Several plant communities such as Sonoran cottonwood-willow and mesquite forests, and saltbush desert scrub have been disproportionately diminished in areal extent by historic land use and water resource use along the LSCR.

# Lower Santa Cruz River Vegetation



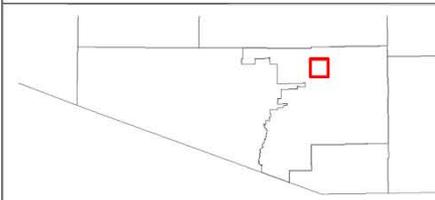
- WRFs
- ADEQ Sampling Sites
- USGS Stream Gauge
- RWRD Sampling Sites
- Study Reach (Lower Santa Cruz River)

## Vegetation Classification

- Cottonwood-Willow Series
- Mesquite Series
- Sonoran Deciduous Riparian Scrub
- Sonoran Desertscrub
- Sonoran Interior Strand

Aerial photo was taken in 2011

1 inch = 1,500 feet



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Pima County Regional  
**FLOOD CONTROL**  
DISTRICT



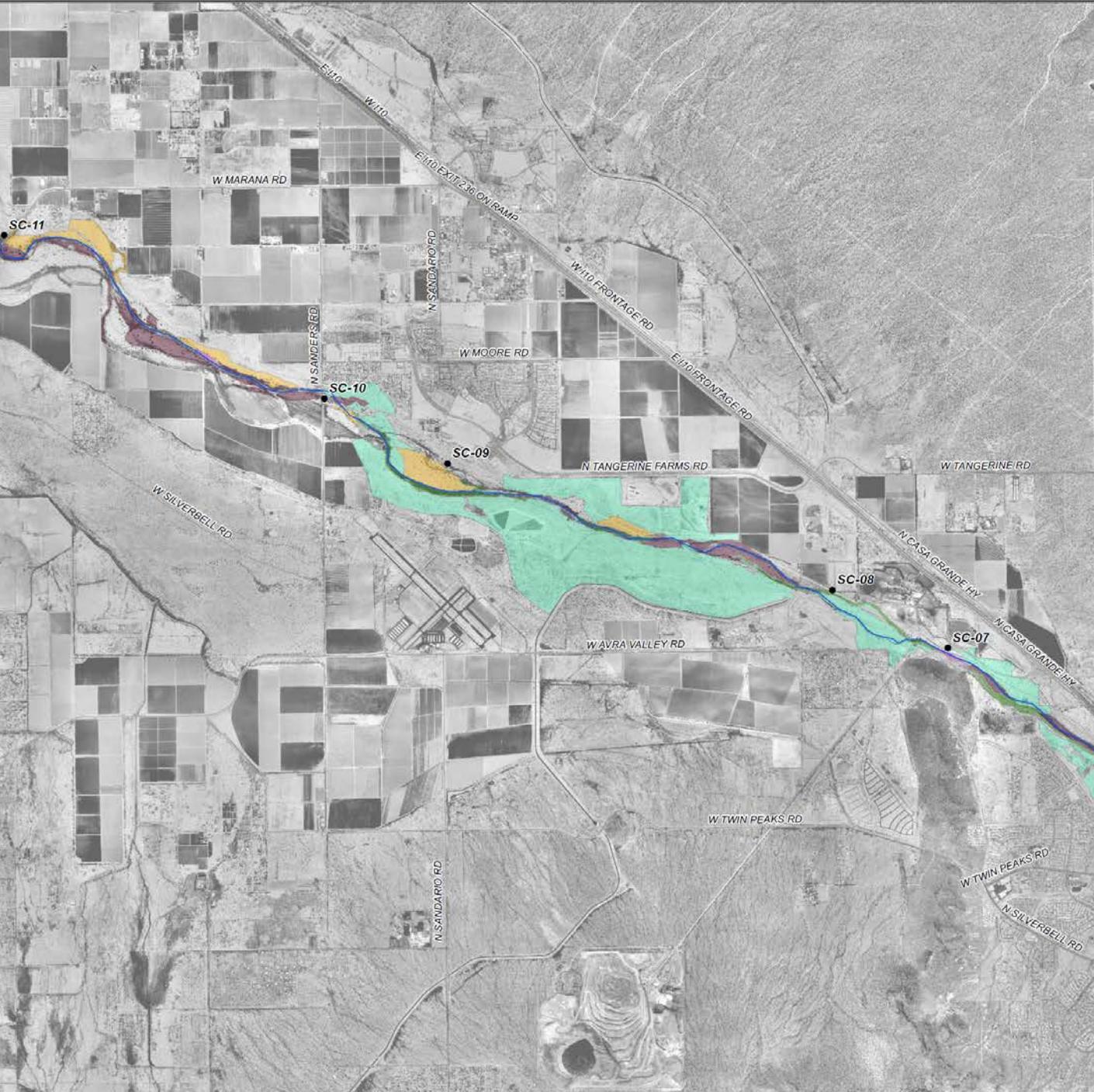
Date:



Roger WRF



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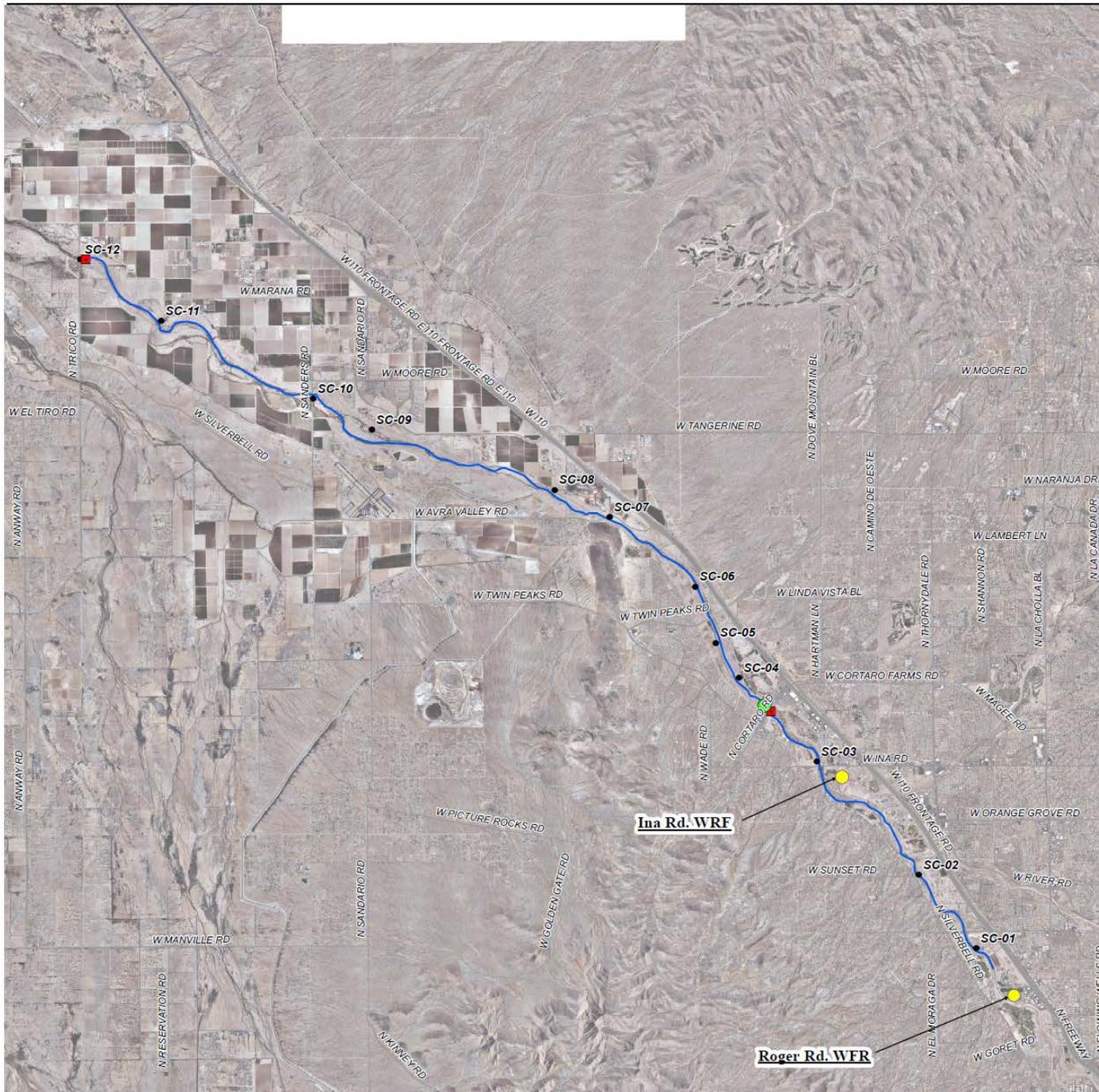
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# Historical Data Used in Report

Parameters	RWRD Data	ADEQ Data
Sodium	X	X
Calcium	X	X
Magnesium	X	X
Bicarbonate	X	X
Chloride	X	X
Sulfate	X	X
Total Dissolved Solid	X	X
Total Kjeldahl Nitrogen	X	X
Ammonia	X	X
Nitrate and Nitrite	X	X
Total Phosphorus		X
Dissolved Oxygen	X	X
Temperature		X
pH		X

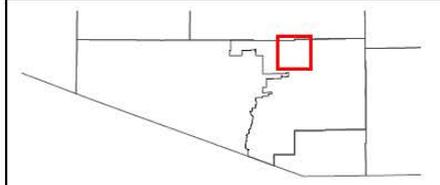
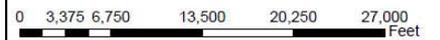
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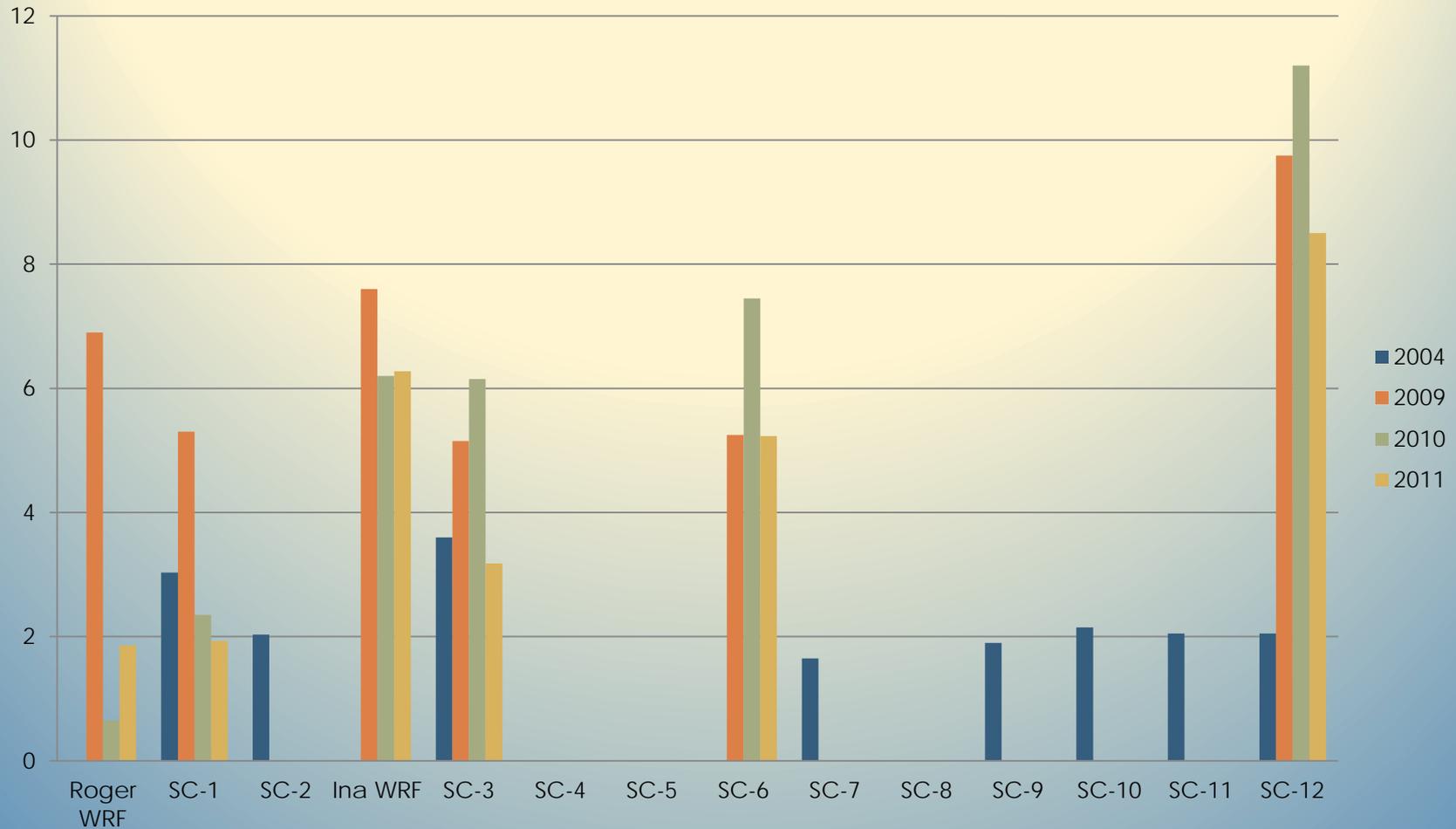
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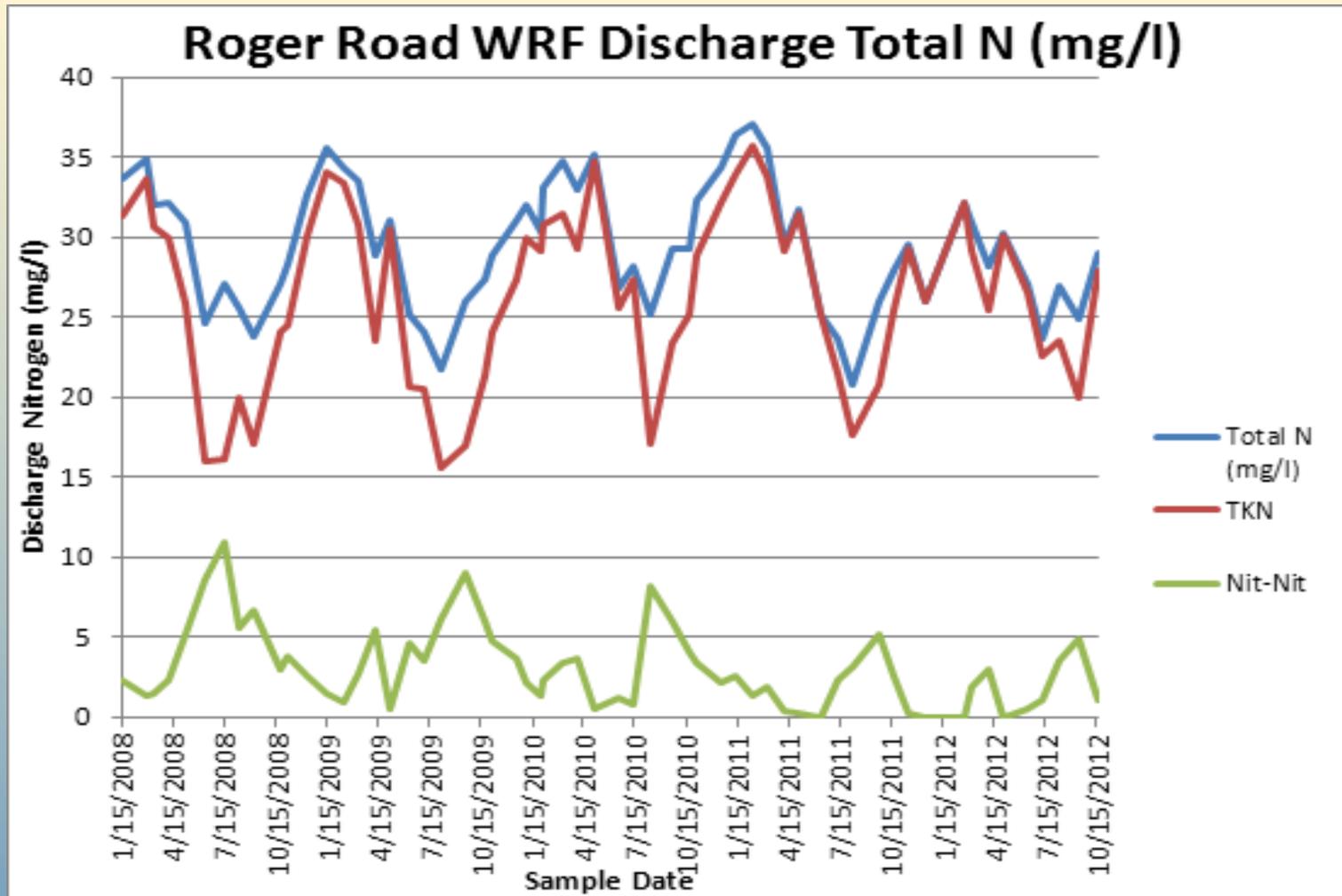
# Increasing Nitrate and Nitrite Downstream

(a result of TKN conversion to Nitrate and Nitrite)

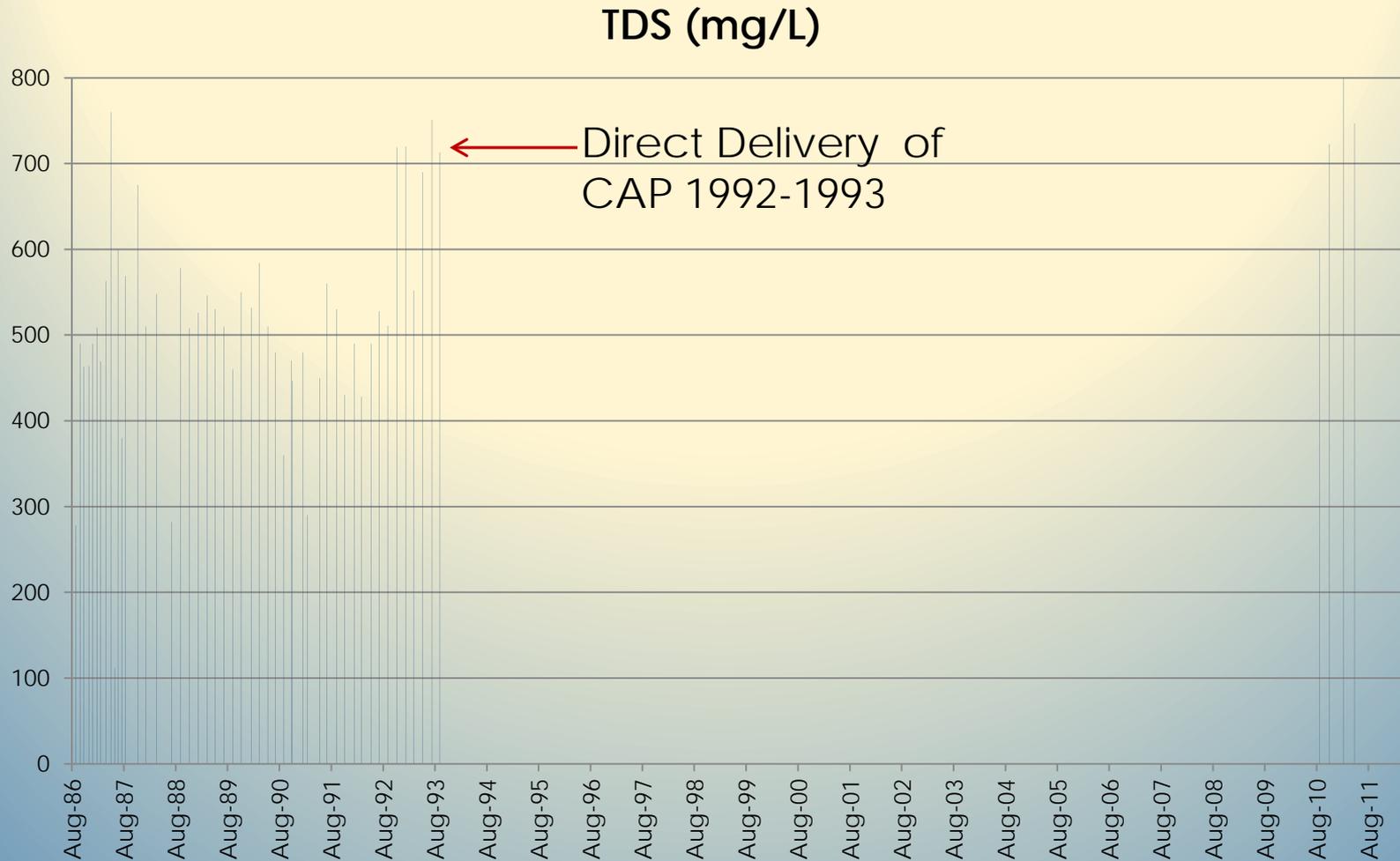
Nitrate and Nitrite (mg/L)



# Nitrogen Species Discharge from Roger Rd



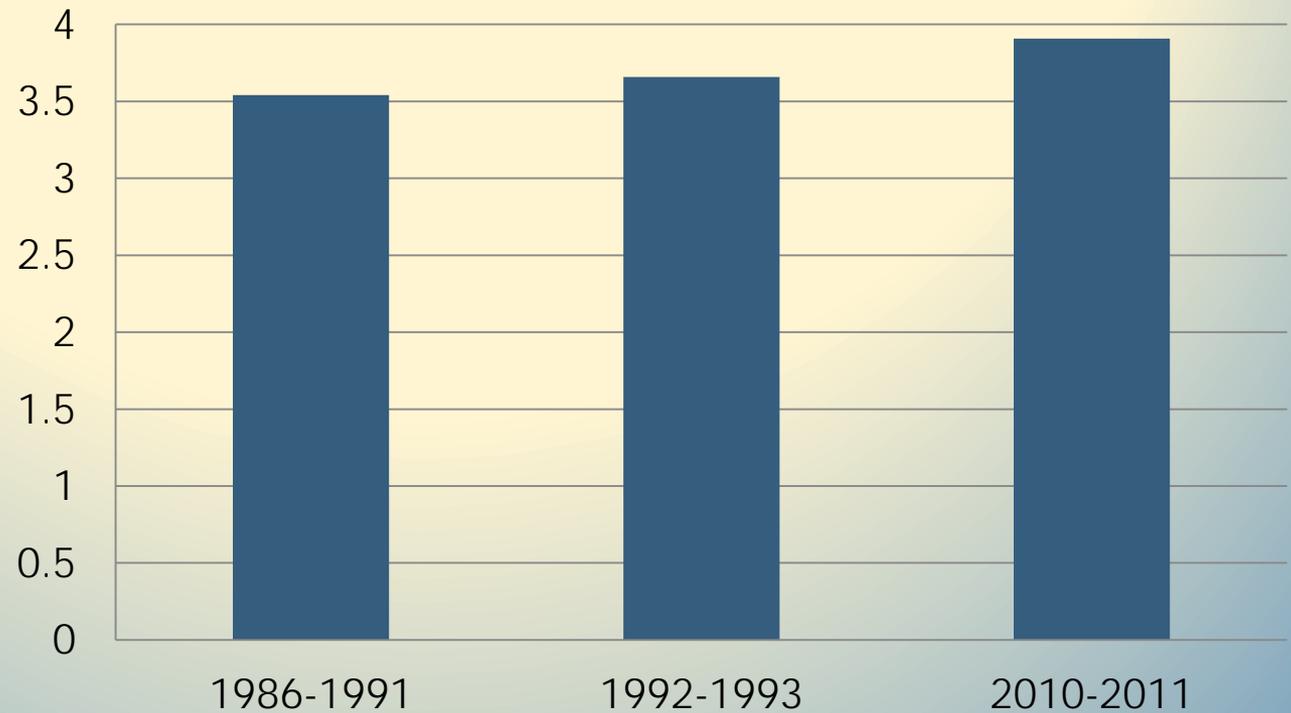
# Total Dissolved Solids in LSCR (from ADEQ site near Cortaro Rd)



# Increasing Sodium Adsorption Ratio

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+}] + [Mg^{2+}]}{2}}}$$

Average SAR



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*'..low species richness consistent with a stream with poor water quality (ADEQ, 1990).'*

- Studies have recognized a lack of suitable substrate for macroinvertebrates (WERF 2000, Walker et. al 2005)
- Water quality is not conducive to a more diverse population of macroinvertebrates, specifically:
  - High Ammonia and Total Kjeldahl Nitrogen
  - Low Dissolved Oxygen decreasing with distance from outfall.

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# Expected Water Quality Changes from ROMP

	Existing Concentration (mg/liter)		Anticipated Concentration (mg/liter)	
	Ina Rd WRF	Roger Rd WRF	Ina Rd WRF	Roger Rd WRF
Nitrogen	26	31	2.5	2.3
Phosphorus	3.4	4	< 1	< 1
BOD	12	10	2.4	2.7
TSS	7	16	3.1	3.3

*Data Source: RWRD, Compliance and Regulatory Affairs Office, April 2011*

# Expected Effects of Water Quality Changes on Physical Processes

- Reduction of the biotic component of the clogging layer, and associated interstitial trapping of fines (Case, 2012).
- Increased infiltration
  - More water availability closer to point of generation
  - Less water available at the distal end of the reach.
- Reduced biotic cohesion
  - Less trapping of small particles in the schmutzdecke.
  - Change in sediment transport characteristics of the effluent flows.

# Possible Effects of Water Quality Changes on Biota

- Vegetation
  - Change in access to water because of improved infiltration characteristics.
    - More access close to outfalls
    - Less access at distal end of reaches
  - Reduced nitrogen loading may cause some shifts in the composition of wetland forbs.
  - Increasing the salt load may favor tamarisk.
- Macroinvertebrates
  - Possible increased diversity because of less ammonia, TKN, dissolved oxygen and mean diel dissolved oxygen (Walker et al, 2005).

**2005**

~70,000 AFY Effluent  
Generated

Metropolitan  
Sewer Service  
Area

18,942 AFY

Ina Road WRF  
24,939 AFY

Roger Road WRF  
43,625 AFY

49,621 AFY

Randolph  
Park WRF  
3,362 AFY



TOHONO O'ODHAM NATION  
SAN XAVIER DISTRICT

**2030**

~ 95,000 AFY Effluent  
Treatment Capacity

Metropolitan  
Sewer Service  
Area

Plant  
Interconnect

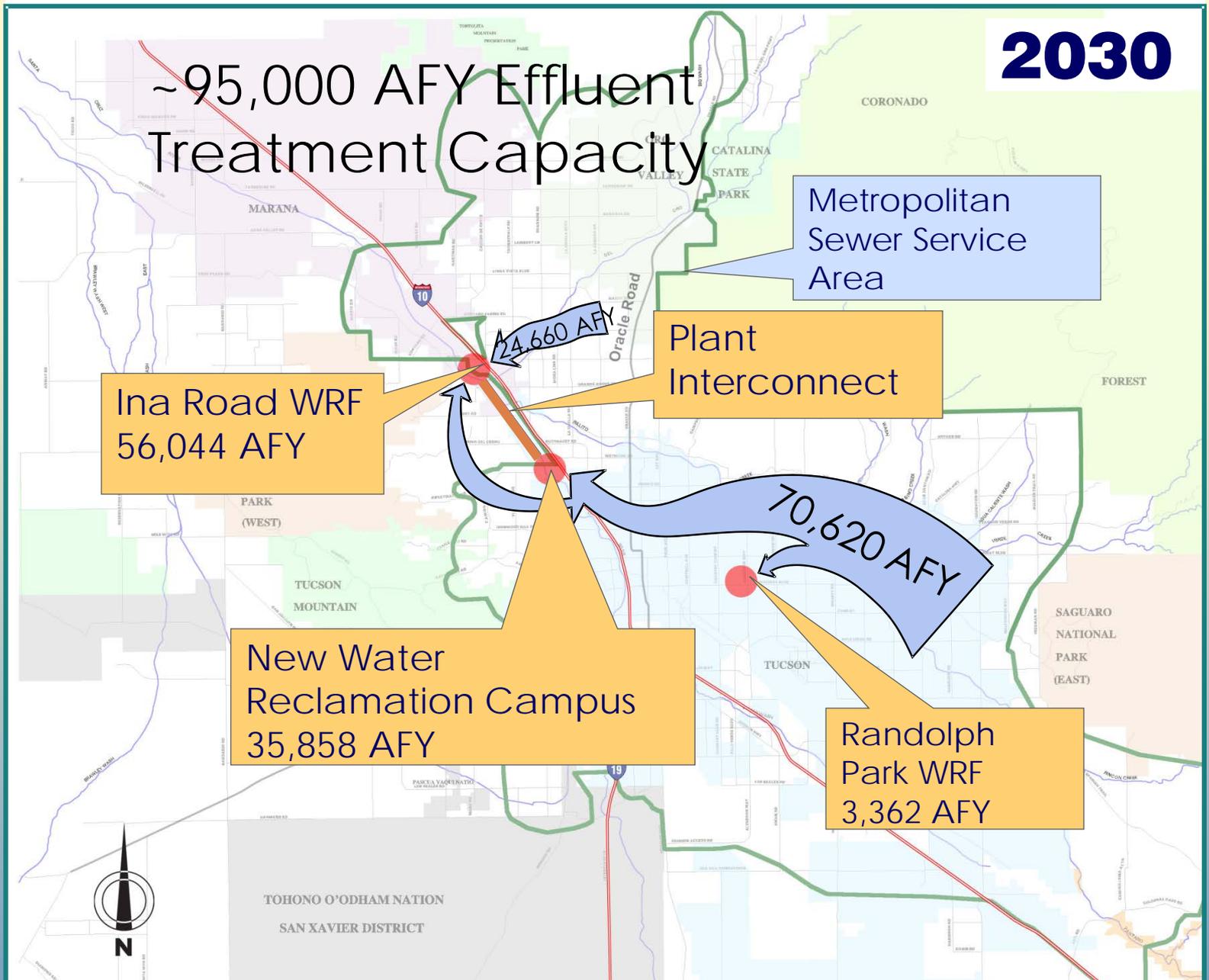
Ina Road WRF  
56,044 AFY

New Water  
Reclamation Campus  
35,858 AFY

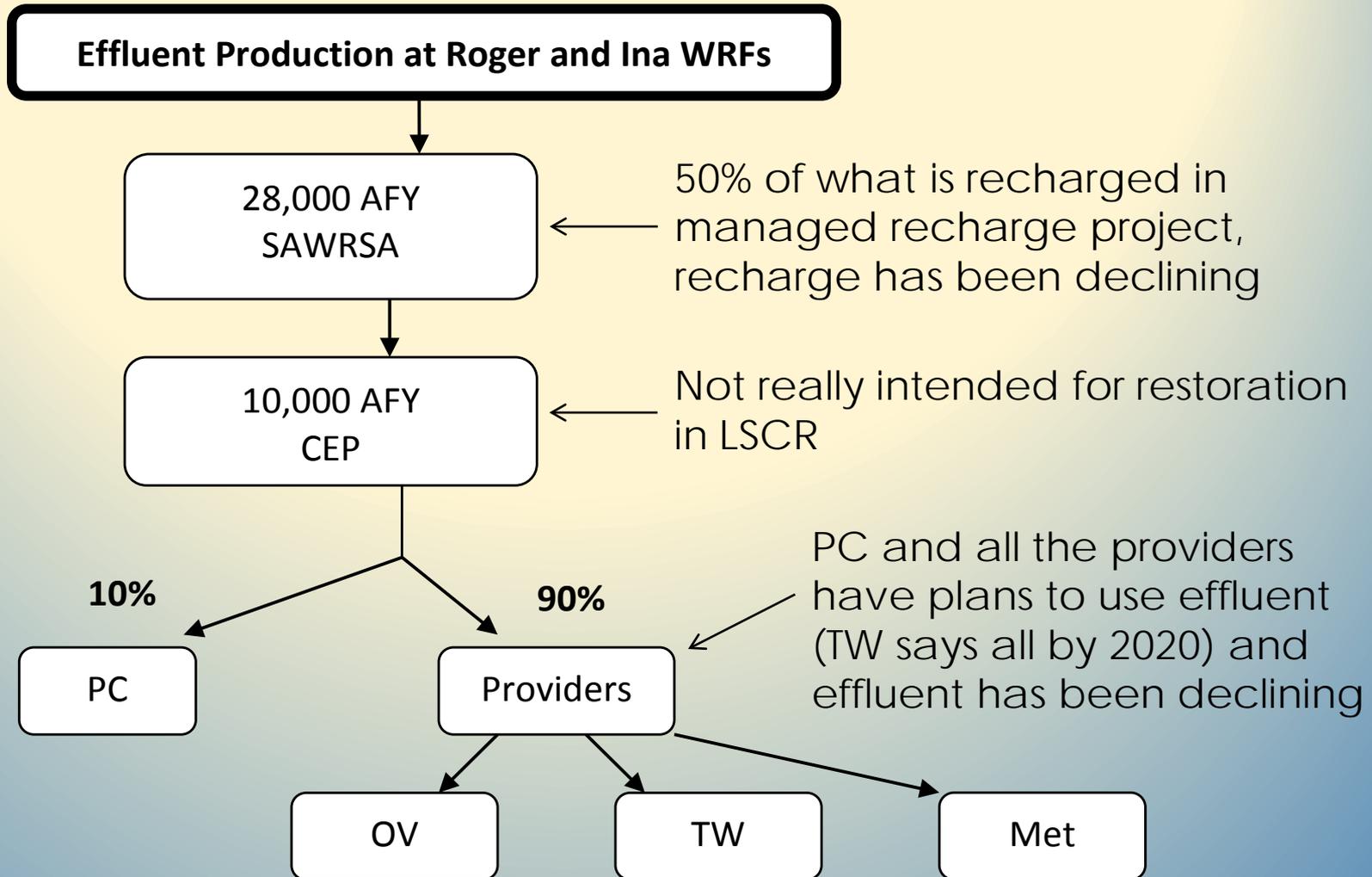
70,620 AFY

Randolph  
Park WRF  
3,362 AFY

24,660 AFY



# Anticipated Changes in Supply



# Questions?

