The Historical Conditions Report of the Lower Santa Cruz River

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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
Ina Road WRF 50 MGD

Power Plant
(Ina Road WRF)

Water Reclamation
Campus 32 MGD

Central Laboratory
(Water Reclamation Campus)

Demolish existing Roger Road plant

Design/Approval
Construction
Acceptance/Startup Testing
Origin of the Report

- RFC D 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)
  - RFC D 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
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
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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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 Effluent Discharge: 1989-2011

- Roger Road
- Ina Road
- Total 1989-2003
- Total 2003-2011

Trend 1989-2003
Trend 2003-2011
Annual Flows Greater at Ina than Trico Rd

Annual Mean Discharge: 1991-2011

- Cortaro Road
- Trico Road
Fraction of Effluent Discharge to Annual Flow

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

Cortaro Road
Trico Road
Difference in Monthly Discharge between Cortaro and Trico is Diminishing

Monthly Discharge: Time Series (1990-2011)
Saturated Hydraulic Conductivity (Ks) Declines with Time Since Last Major Storm

Figure 54
KSAT vs. Time Since Last Major Storm Event (Feb. 15, 1995 to Aug. 3, 1995)

Fit Results

Equation:
Y = -5.11835 * ln(X) + 37.3032

Number of data points used = 5
Average ln(X) = 3.61508
Average Y = 18.8

Regression sum of squares = 464.978
Residual sum of squares = 2.30187
Coef of determination, R-squared = 0.995074
Residual mean square, sigma-hat-sq'd = 0.767292

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

- Spring
- Winter
- Fall
- Monsoon
Annual Losses Have Been Decreasing

difference between flow at Cortaro and Trico getting smaller

Annual Losses: 1991-2011

-2000 AFY

R² = 0.794
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Major Changes (Red):
Sanders- Avra Valley (2)
Cortaro- Sunset (5 and 6)

Minor Changes (Blue):
Trico-Sanders (1)
Sunset-Sweetwater (7)
Major Location Change
Effluent Flow between Ina – Cortaro

2005

2008
Large Channel Bed Elevation Change
Effluent Channel between Ina-Cortaro

1998-2005
Reach in 1998
Reach in 2005

2005-2008
Reach in 2005
Reach in 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

Small Channel Bed Elevation Change
Effluent Channel between Trico - Sanders

- Minor Location Change
- Shallow 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.
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### Historical Data Used in Report

<table>
<thead>
<tr>
<th>Parameters</th>
<th>RWRD Data</th>
<th>ADEQ Data</th>
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<tr>
<td>Calcium</td>
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<tr>
<td>Total Dissolved Solid</td>
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<tr>
<td>Total Kjeldahl Nitrogen</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Ammonia</td>
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<td>Nitrate and Nitrite</td>
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<tr>
<td>Total Phosphorus</td>
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<tr>
<td>pH</td>
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Increasing Nitrate and Nitrite Downstream (a result of TKN conversion to Nitrate and Nitrite)
Nitrogen Species Discharge from Roger Rd
Total Dissolved Solids in LSCR (from ADEQ site near Cortaro Rd)

TDS (mg/L)

Direct Delivery of CAP 1992-1993
Increasing Sodium Adsorption Ratio

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

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<tr>
<th>Year Range</th>
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<tr>
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<td>1992-1993</td>
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<tr>
<td>2010-2011</td>
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</table>
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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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<table>
<thead>
<tr>
<th></th>
<th>Ina Rd WRF</th>
<th>Roger Rd WRF</th>
<th>Ina Rd WRF</th>
<th>Roger Rd WRF</th>
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</table>

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).
~70,000 AFY Effluent Generated

- Ina Road WRF 24,939 AFY
- Roger Road WRF 43,625 AFY
- Randolph Park WRF 3,362 AFY

Metropolitan Sewer Service Area

2005
~95,000 AFY Effluent Treatment Capacity

- Ina Road WRF 56,044 AFY
- New Water Reclamation Campus 35,858 AFY
- Randolph Park WRF 3,362 AFY
- Plant Interconnect
- Metropolitan Sewer Service Area

2030
Anticipated Changes in Supply

Effluent Production at Roger and Ina WRFs

- 28,000 AFY SAWRSA
  - 50% of what is recharged in managed recharge project, recharge has been declining

- 10,000 AFY CEP
  - Not really intended for restoration in LSCR

PC and all the providers have plans to use effluent (TW says all by 2020) and effluent has been declining
Questions?