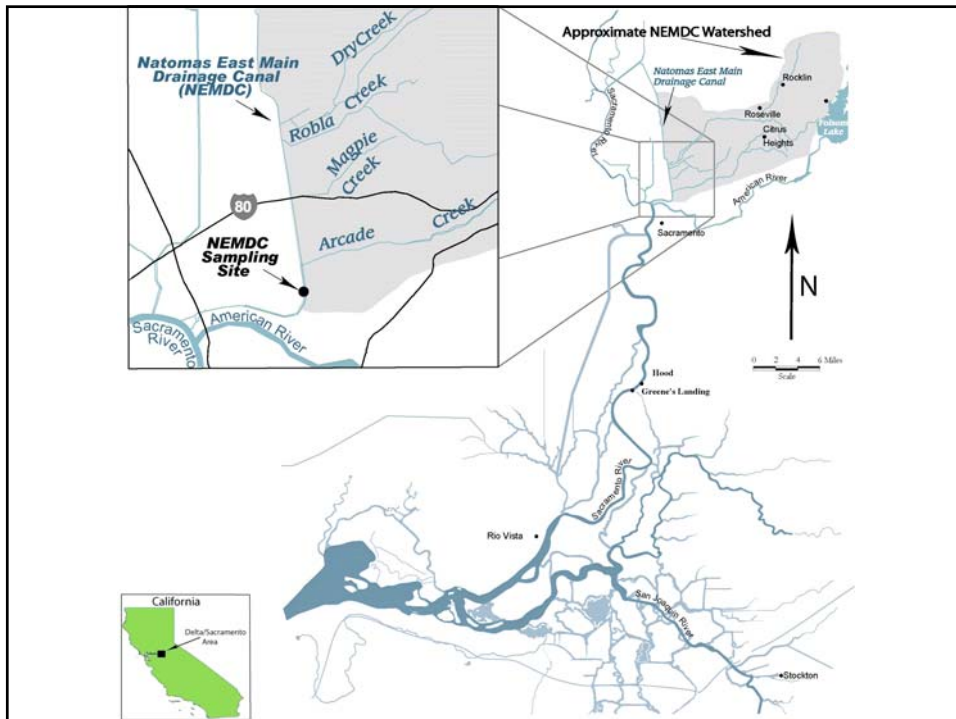# Organic Carbon Loads to the Sacramento River from a Rapidly Urbanizing Watershed in Sacramento's Metropolitan Area
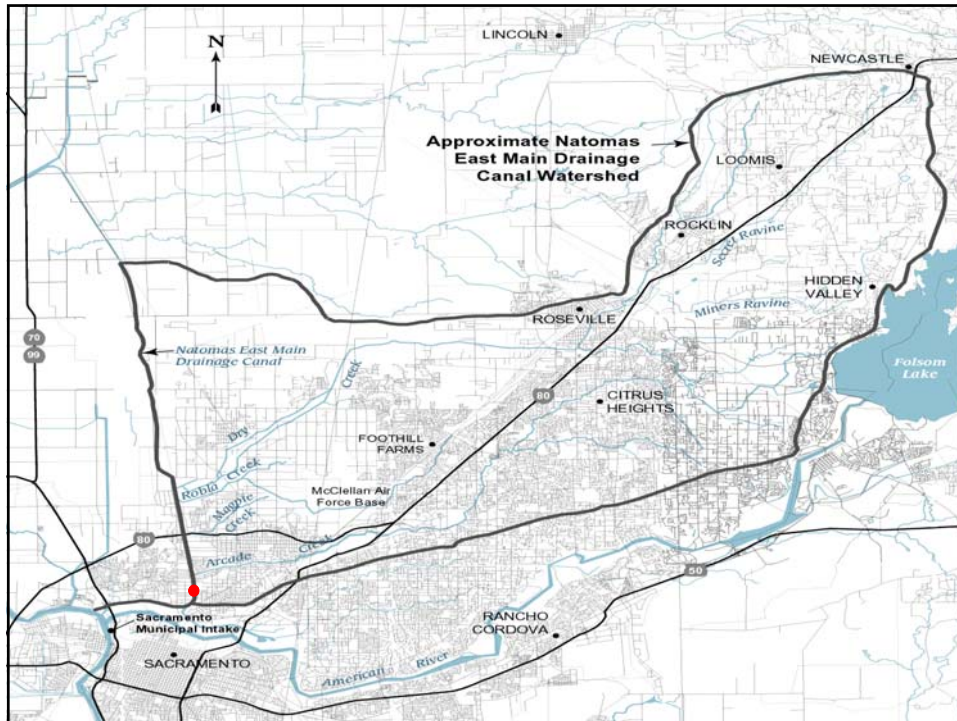
CBDA Science Conference October 5, 2004

Michael Zanoli, Department of Water Resources, Division of Environmental Services

James Sickman, University of Florida, Soil and Water Science Department

Howard Mann, P.E., Consulting Engineer

Organic Carbon Loads and Urban Sources - Why NEMDC?

- Need for understanding sources and loads of DBP-precursors such as organic carbon

- Rapid growth in Delta and tributaries = more urban runoff and wastewater treatment plant effluent

- Site of concern in CALFED Water Quality Program Plan

- Need baseline data to evaluate land use changes

- Data for input and validation of DWRs Delta Simulation Model (DSM2) modeling of loads at drinking water intakes
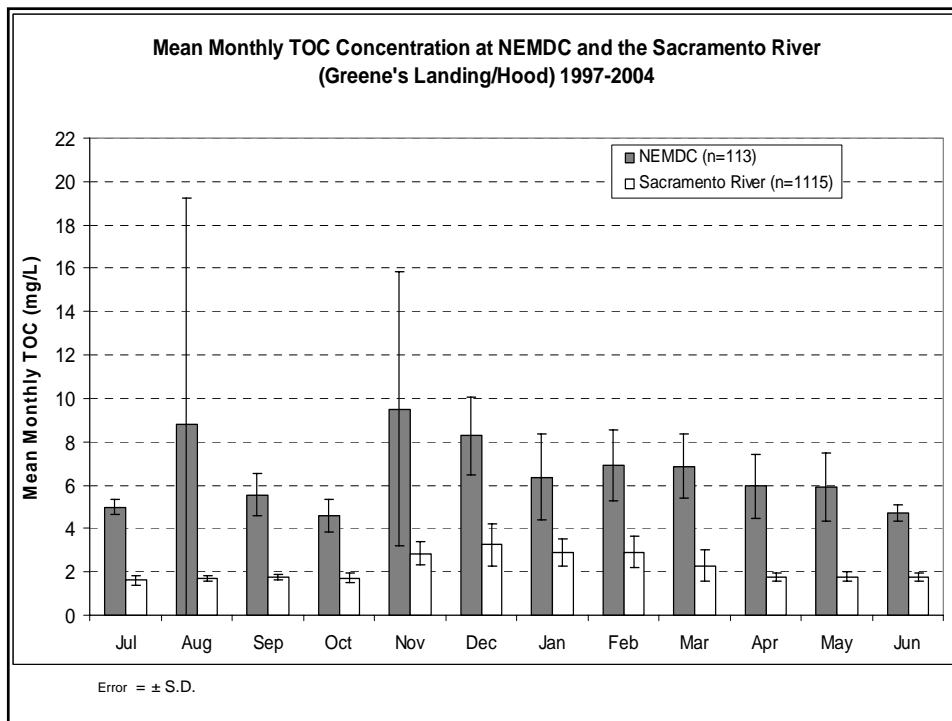
Methods

$$L_{TOC} = \int_t TOC(t) \times Q(t) \times n$$

Load (kg/day)
Q = Flow (cfs)
TOC (mg/L)
n = conversion factors

Flow and TOC data collection:

- Event-based monitoring - 5 criteria

- Stage measurement (wire weight gage)

- TOC/DOC grab sampling & analysis

Mean Monthly TOC Concentration at NEMDC and the Sacramento River
(Greene's Landing/Hood) 1997-2004

Error = ± S.D.

Flow Data

- Real-time stage data from lower Arcade Creek station
  (reported every 15 min - 1 hour)

- Good correlation with NEMDC stage for 3 WY's ($r^2 > 0.97$)

- Calculate daily average NEMDC stage

- Q's determined from daily average NEMDC stage using rating table (based on 21 actual discharge measurements)

TOC Concentrations

- Load Estimation methods (in order of complexity)
  - Simple averaging
  - Ratio estimators
  - Regression estimators (i.e., rating curve)

- **Beale's Ratio Estimator** -
  works well with abundant flow data
  but few TOC concentrations

  $$TOC_{conc} = Q_a \left(\frac{\bar{l}}{\bar{q}} \right) \left(\frac{1 + \frac{1}{N} \frac{\text{cov}(l, q)}{\bar{l}\bar{q}}}{1 + \frac{1}{N} \frac{\text{var}(q)}{\bar{q}^2}} \right)$$
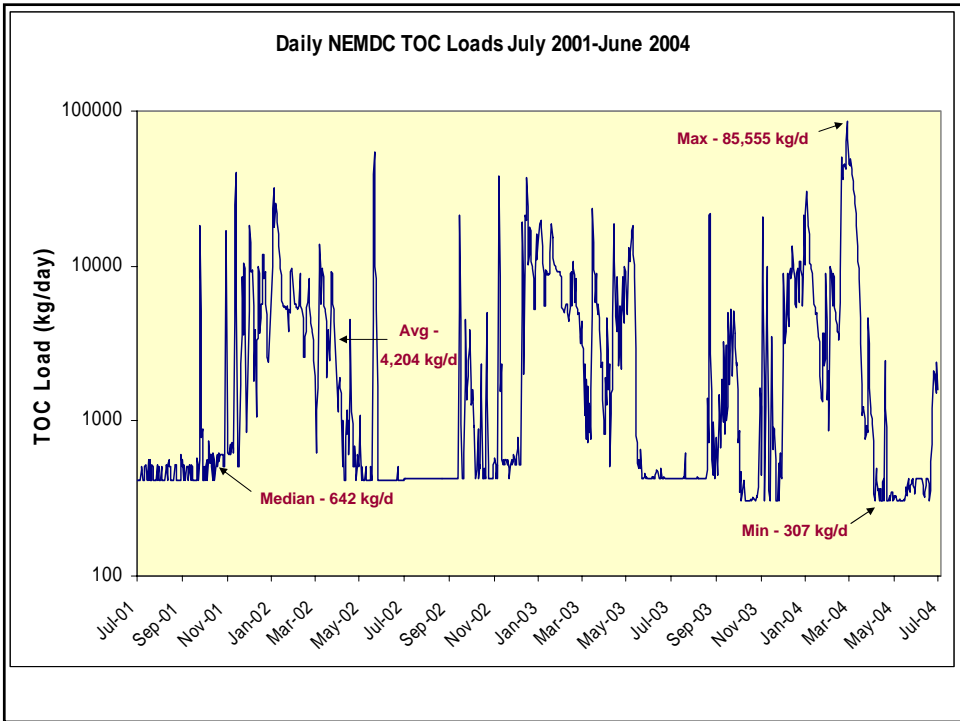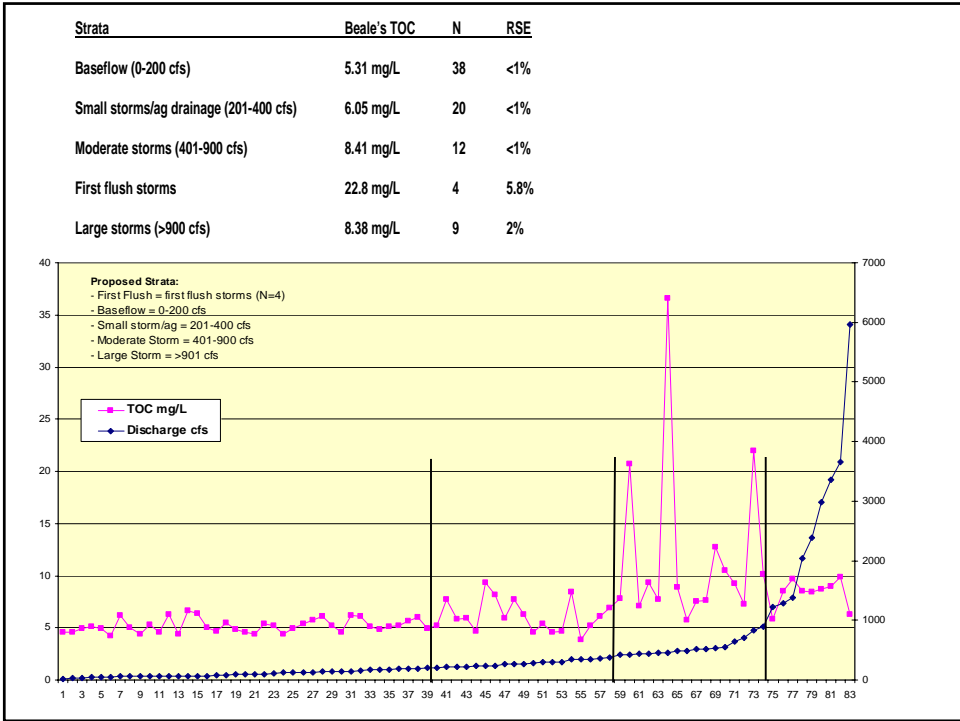
  Q_a = Total flow
  $\bar{q}$ = average measured flow
  l = ind. sampled TOC conc
  $\bar{l}$ = average sampled TOC conc
 q = ind. measured flow

  - Several forms used
  - 83 actual samples collected
  - Stratify flow/concentration data
  - Calculate TOC value for each strata and apply to daily flow data with missing chemistry

Strata	Beale's TOC	N	RSE
Baseflow (0-200 cfs)	5.31 mg/L	38	<1%
Small storms/ag drainage (201-400 cfs)	6.05 mg/L	20	<1%
Moderate storms (401-900 cfs)	8.41 mg/L	12	<1%
First flush storms	22.8 mg/L	4	5.8%
Large storms (>900 cfs)	8.38 mg/L	9	2%

Proposed Strata:
- First Flush = first flush storms (N=4)
- Baseflow = 0-200 cfs
- Small storm/ag 201-400 cfs
- Moderate Storm 401-900 cfs
- Large Storm = >901 cfs

- TOC mg/L
- Discharge cfs

Daily NEMDC TOC Loads July 2001-June 2004

Max - 85,555 kg/d

Avg - 4,204 kg/d

Median - 642 kg/d

Min - 307 kg/d

TOC Load (kg/day)

TOC Export (Yield) Rates

| Source	Global Range [a]		
	Arid/Semi-desert	Temperate	Wet/Tropical
	100-500	1000-8500	7000-20000
NEMDC		**3301**	
Arcade Creek (USGS)			12070
Verde River (AZ)	200		
Lanyang Hsi (Taiwan)			8700

(a) from Thurman, E.M., 1985
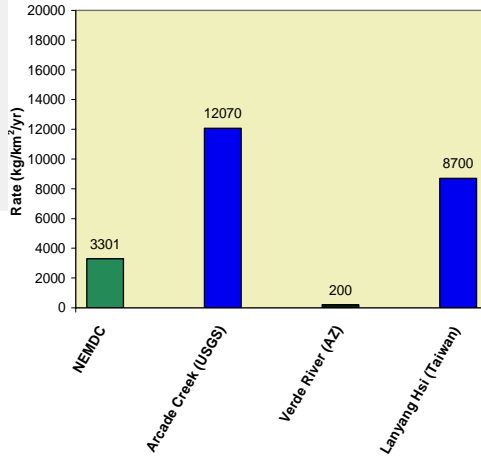
■ Arid/Semi-Desert 100-500 kg/km^2/yr
■ Temperate 1000-8500 kg/km^2/yr
■ Wet/Tropical 7000-20000 kg/km^2/yr

Daily NEMDC Contribution to Total Sacramento River TOC Load

July 2001 - June 2004

Number of Days TOC Load Contributions to the Sacramento River were at or above 5%, 10%, and 20%

	Load Contribution		
	5%	10%	20%
NEMDC	124	36	17

n = 1080

8
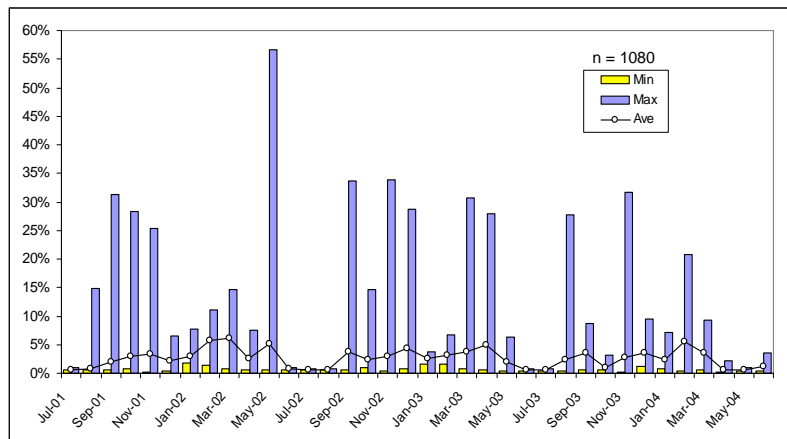
Conclusions

- NEMDC discharge can contribute substantial TOC loads to Sacramento River during storm events, especially in initial fall storms

- Cumulative discharges from urban sources in high-growth areas in the Delta and it's tributaries could be significant TOC loading sources for DW intakes during these storm events

- With current and projected growth, more study needed on urban sources and the potential effects of land use change on DW quality