

# Potential Soil Transport of 17 $\beta$ -Estradiol In a Beneficial Reuse System Land-applying Class B Municipal Biosolids for Forage Production in Central Texas



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## BENEFIT ENDPOINTS & ASSESSMENT:

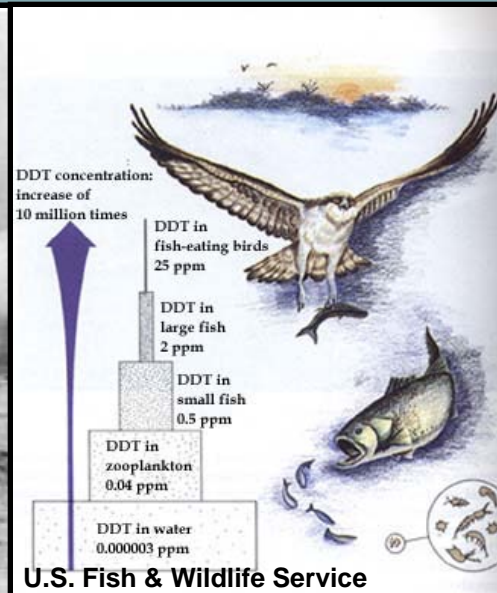
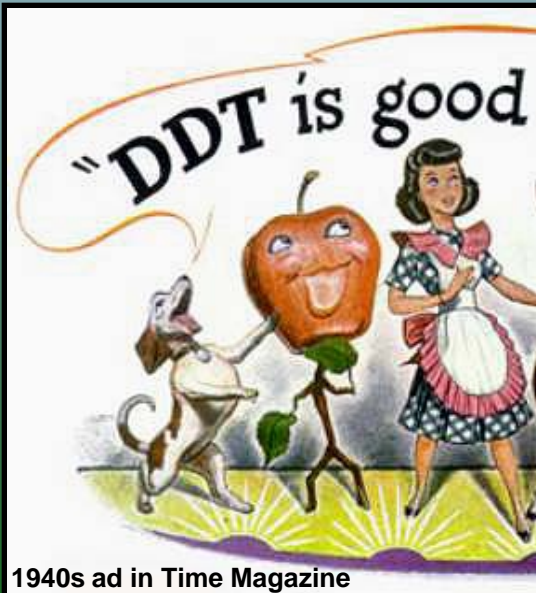
- Human health risks
- Drinking water treatment costs
- Dose-response functions
- Criteria exceedence frequencies



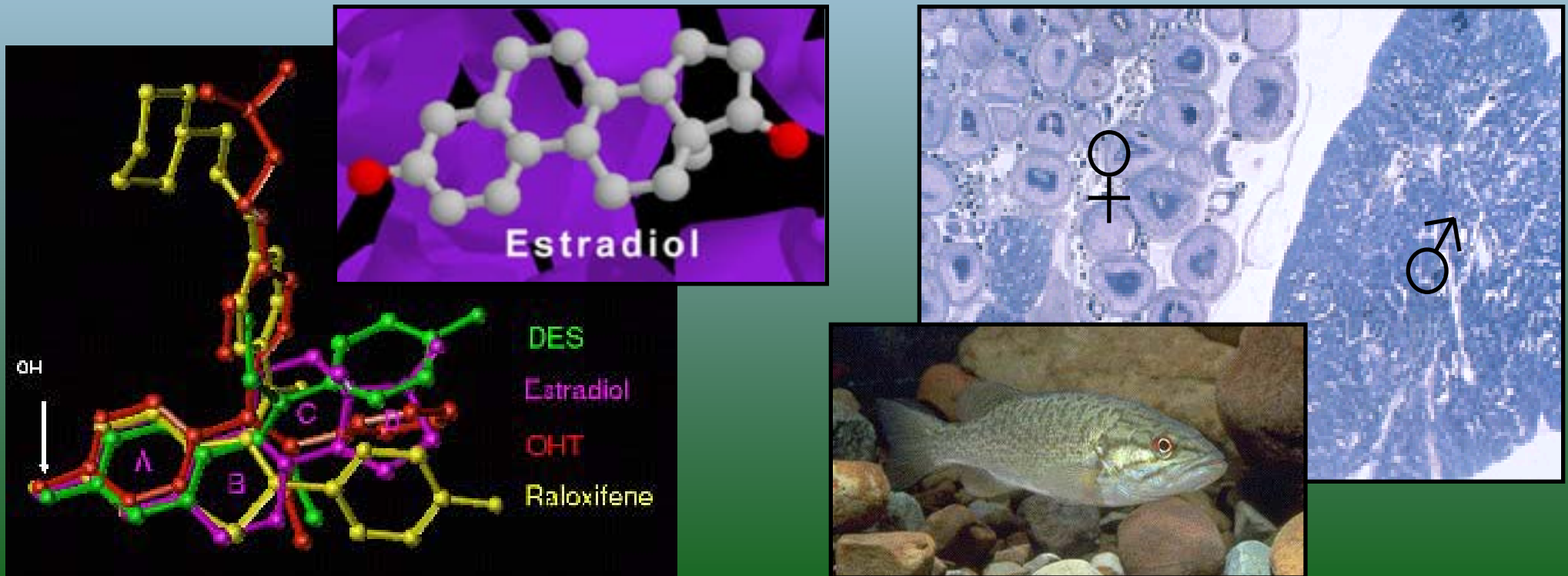


- Emerging contaminants
  - “Emerging” since *Silent Spring*, but can measure now
  - > 90,000 specific compounds in sewage
  - Few organic contaminants are regulated

DDT = Dichlorodiphenyltrichloroethane



- Endocrine disrupting compounds (EDCs) of concern
  - Pharmaceuticals, food preservatives, household chemicals, personal care products, flame retardants
  - More regulations being proposed worldwide on EDCs



## MODEL GOALS:

- Transport
- Transformation
- Bioaccumulation

## MODEL CHALLENGES:

- Data acquisition
- Analytical standardization
- Uncertainty

## Occam's Razor (Law of Parsimony)

*Pluralitas non est ponenda sine neccesitate*

“Entities should not be multiplied unnecessarily.”

## U. S. EPA HAWQS PROJECT:

- Hydrologic and Water Quality System (HAWQS)
- Regional / national assessments of water quality
  - Large-scale TMDL assessments

## MODELED CONSTITUENTS (7):

- Sediment, Pathogens, Nutrients, Metals, Dissolved O<sub>2</sub>
- Persistent, Bioaccumulative, Toxic Substances (PBTs)
  - Pesticides, pharmaceuticals, personal care products, etc.
- Emerging Toxic Substances (ETSs)

## **CURRENT SUB-BASIN COMPONENTS:**

- Hydrology
- Weather
- Sedimentation
- Soil temperature
- Crop growth
- Nutrients (C, N, P)
- Pesticides, Bacteria
- Agricultural management

## **UNDER DEVELOPMENT:**

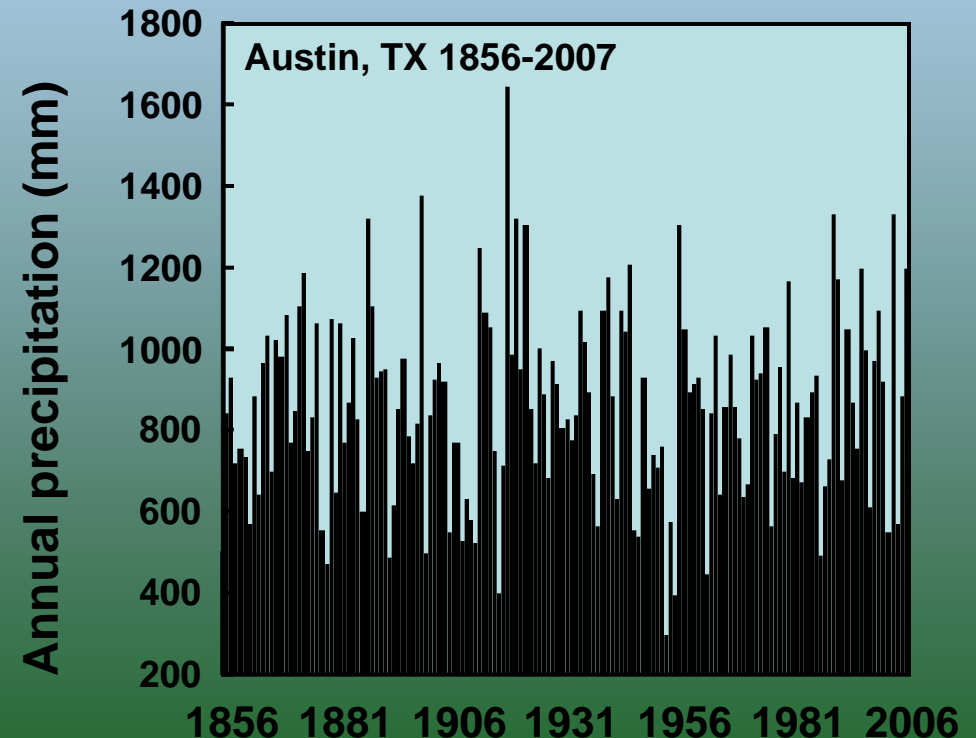
- Trace metals (Cd, Cu, Ni, Pb, Zn; As, Fe, Hg)
- Emerging contaminants (PPCPs, EDCs, etc.)

## MODEL GOALS:

- **Transport & fate controlled by:**
  - **Solubility**
  - **Volatility**
  - **Biodegradability**
- **Climate and management impacts**



- Few long-term studies under operational settings
  - Couple field studies with lab experiments, modeling
  - Potential impacts of stochastic climate events





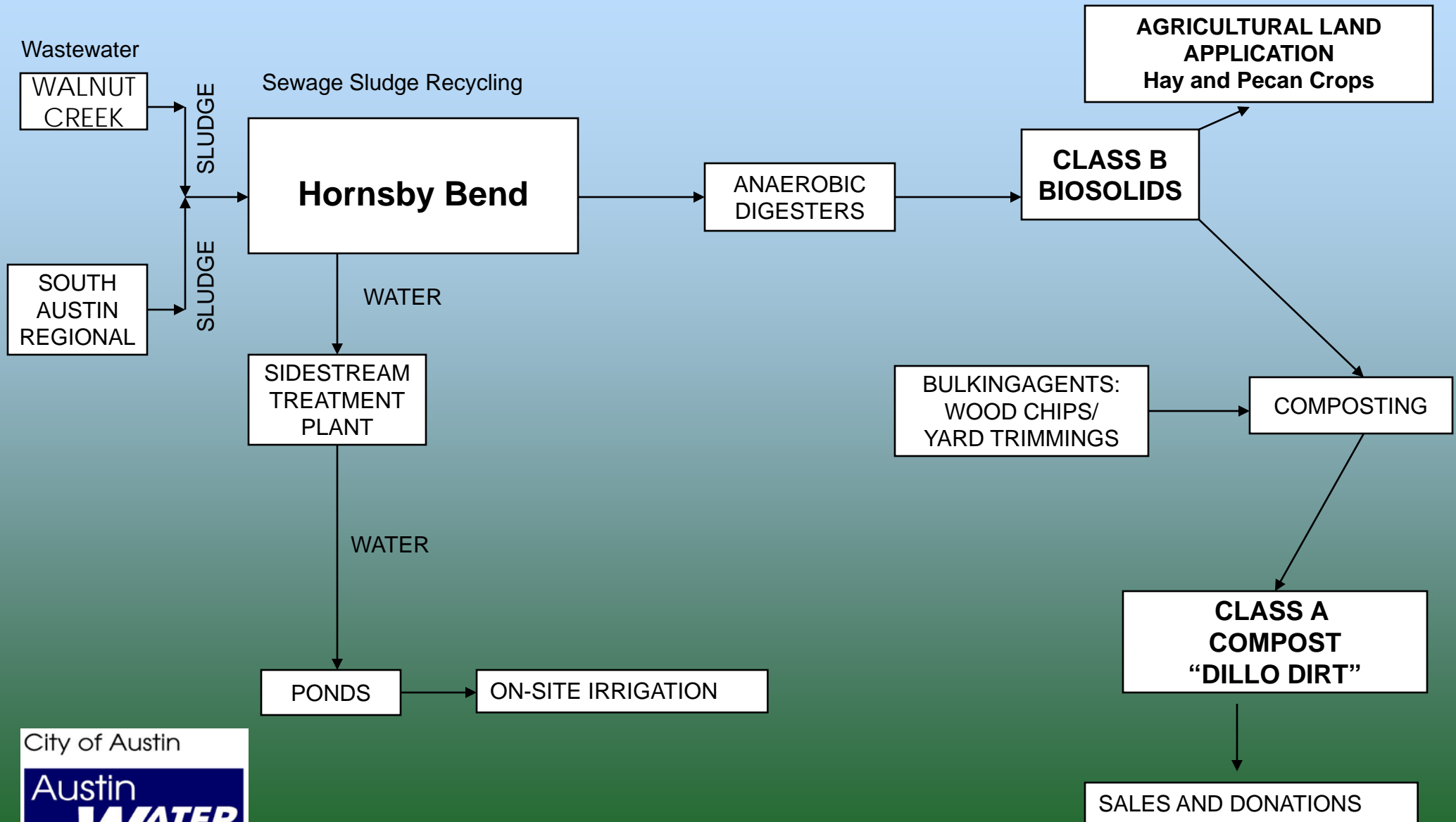
# Modeling Beneficial Reuse

## HBBMP: Hornsby Bend Biosolids Management Plant



- >1200 acre, zero-discharge facility in Austin, TX
- Revenue from forage production, Dillo Dirt™
- Important Bird Area of North America
- State of Texas' 2009 top-ranked "Green Project"

# AWU HORNSBY BEND BIOSOLIDS MANAGEMENT FACILITY





# Water - Treatment Ponds 185 acres

- Water moves by gravity
- Pond Ecosystem treats water
- All water recycled – no discharge to the river





# Biosolids Recycling

## First Method - Land Application

Onsite farm – 600 acres



# **Irrigation**

**all water from treatment**



# **Hay Production**

**Recycles nutrients from  
biosolids and water**





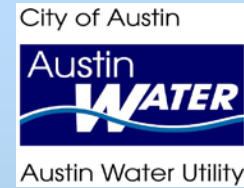
# AWU Center for Environmental Research

## MISSION

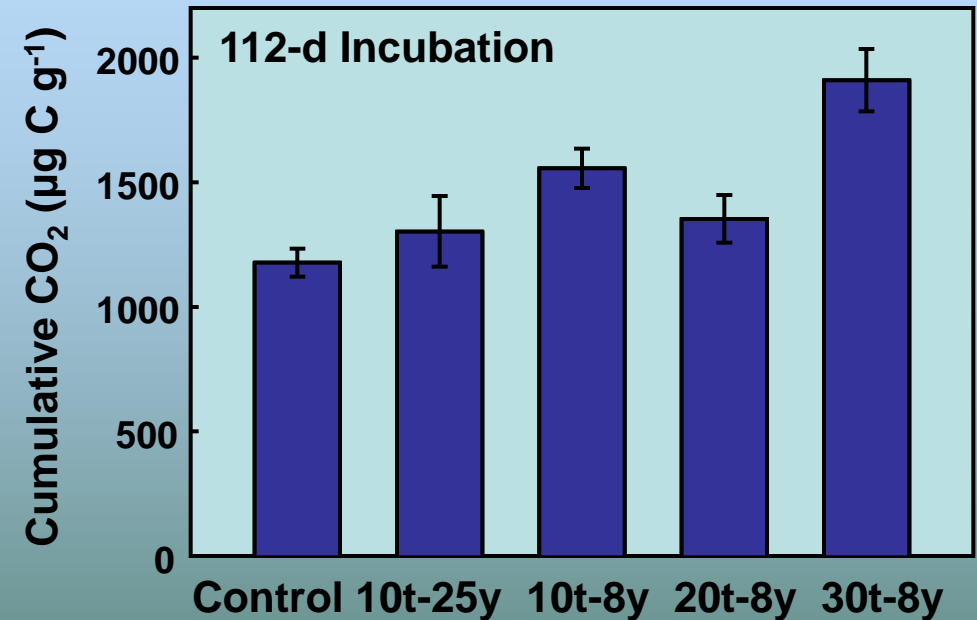
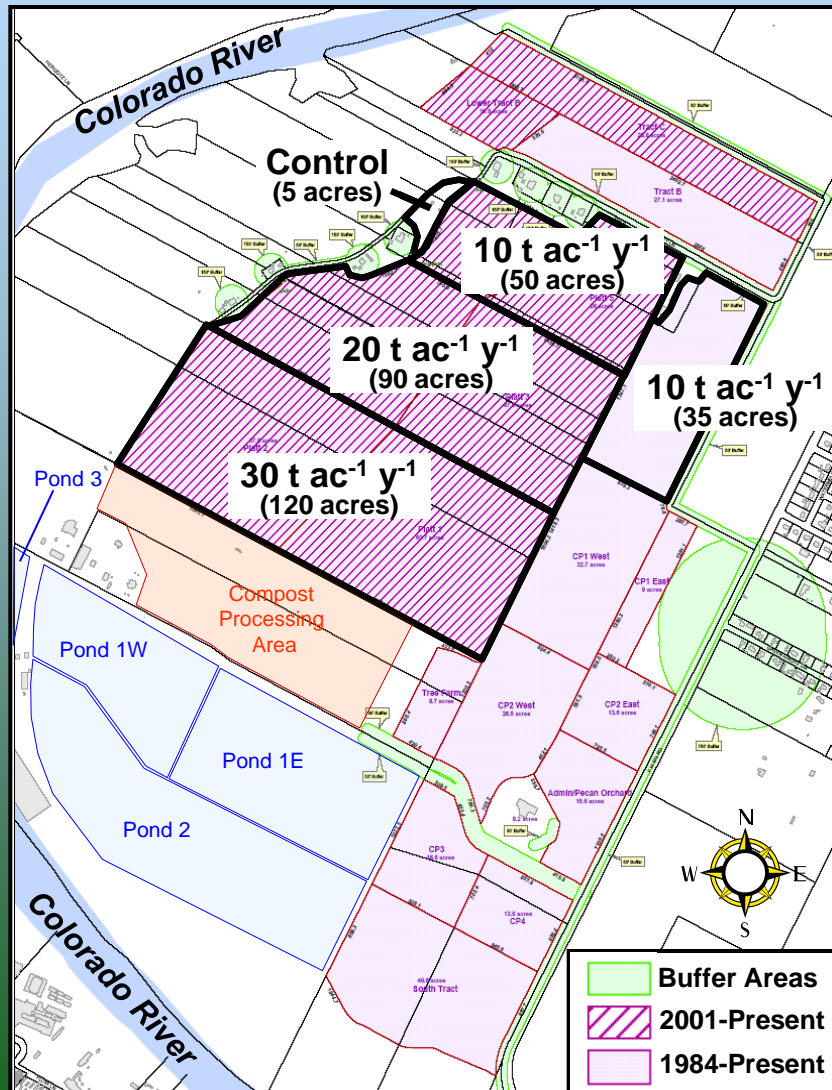
- Urban Ecology and Sustainability
- Research and Education

## PARTNERS

- Austin Water Utility
- University of Texas
- Texas A&M University



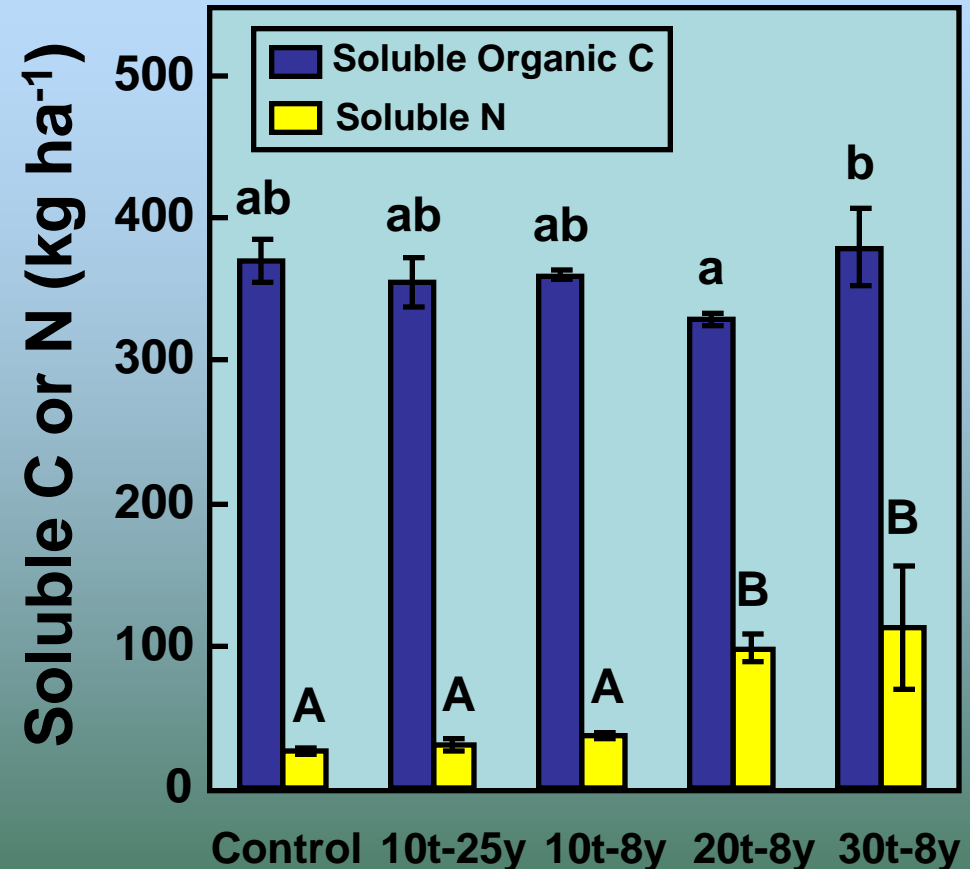
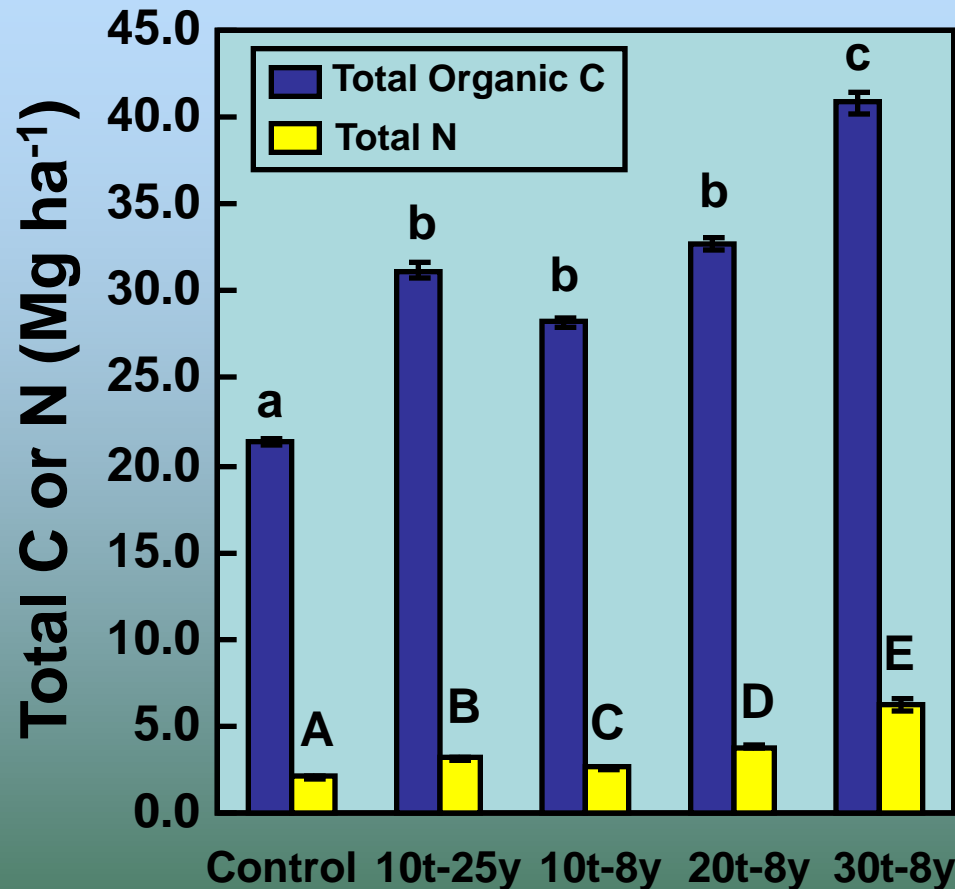
## HBBMP: Hornsby Bend Biosolids Management Plant



- Soil respiration increases in more recently treated fields and with application rate
- C source or sink: Respiratory losses vs. C transfer into soil C

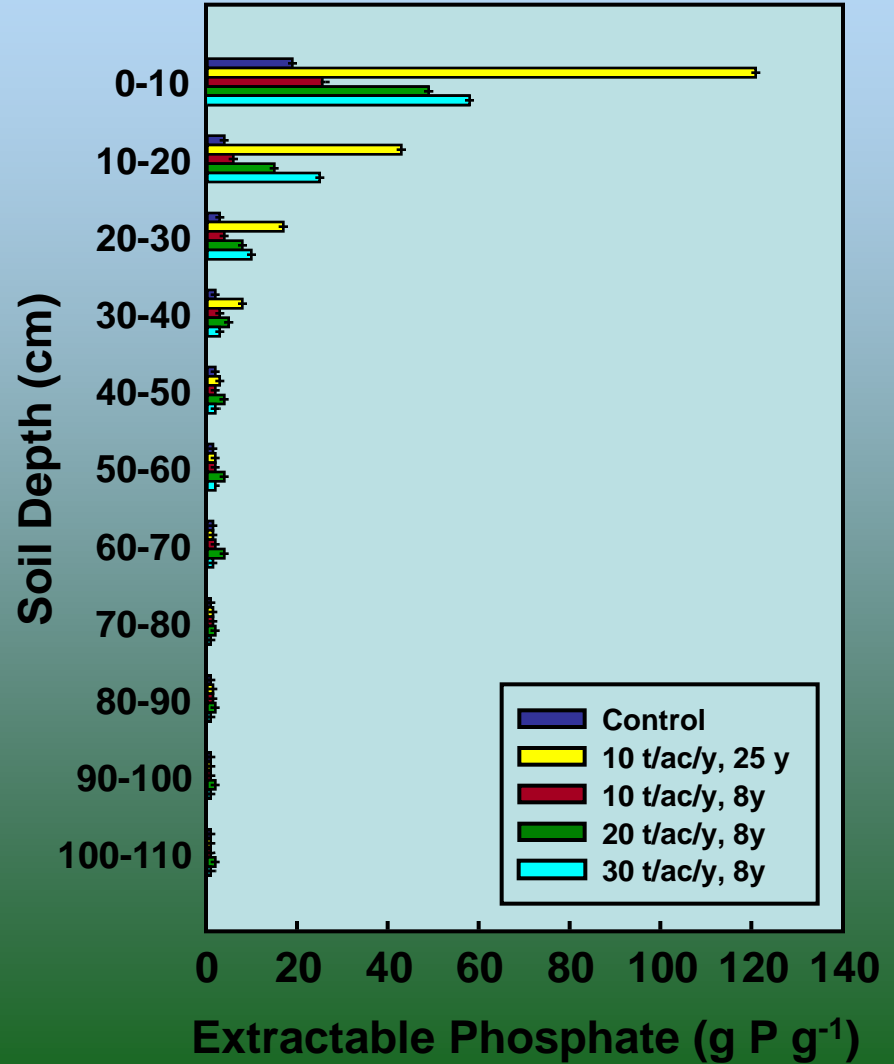
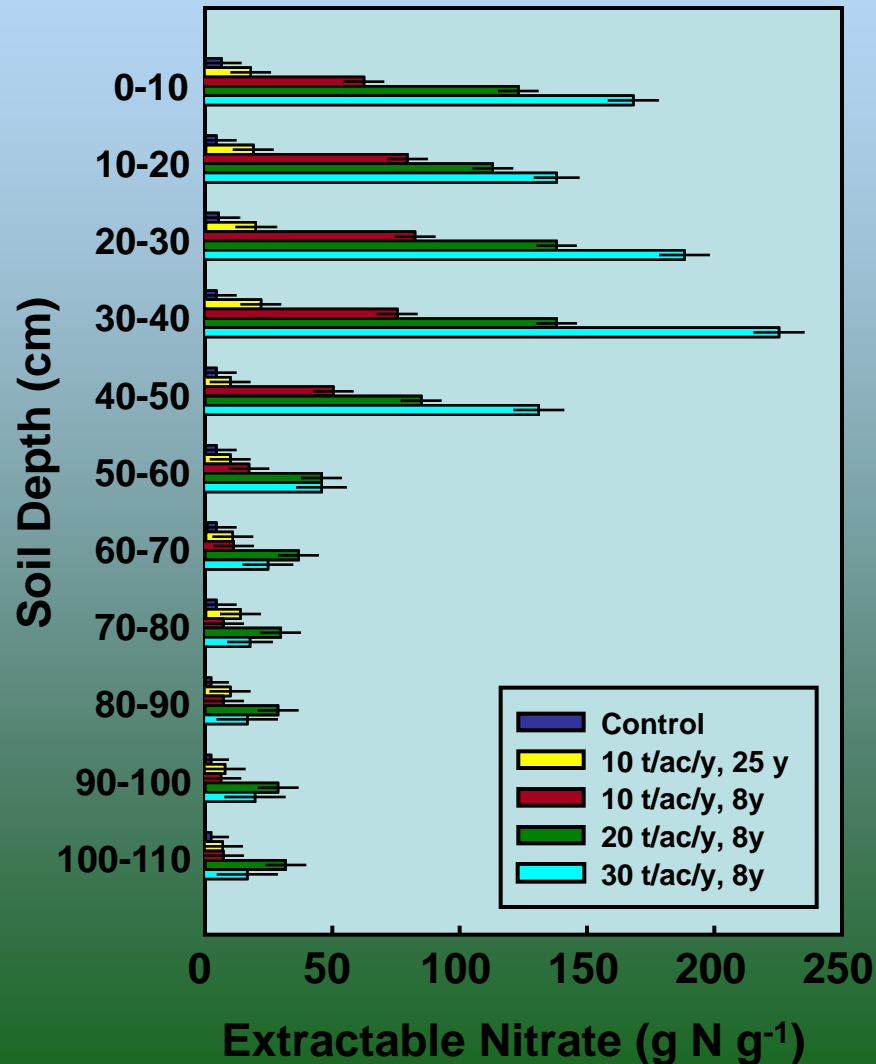


# HBBMP INITIAL SOIL C & N, 0-10 cm



- TC, TN, SN increased, but SOC relatively similar
- Microbes stimulated by high water-soluble C availability and adequate N supply

## HBBMP: Hornsby Bend Biosolids Management Plant

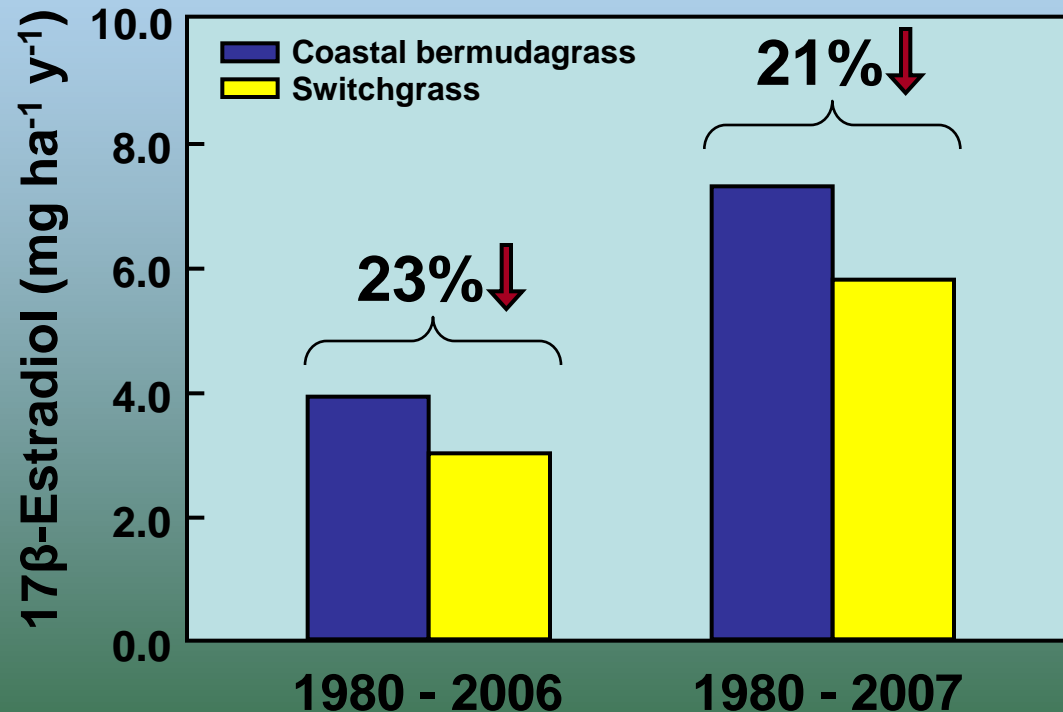




# 17 $\beta$ -Estradiol Simulation

## EFFECTS OF CROPPING SYSTEM AND RAINFALL:

Leaching from Bergstrom silt loam (0-23 cm), 10 dt biosolids ac<sup>-1</sup> y<sup>-1</sup>



- *Inclusion of 2007 rainfall year increased annual leaching of 17 $\beta$ -estradiol from surface soils by 90%*

## CONCLUSIONS & FUTURE DIRECTIONS

- Land-applying biosolids increases soil CO<sub>2</sub> effluxes
- Nutrient movement in soil depends on rate & history
- Intact soil columns, chemical fate in wildlife
- Biofuel production via beneficial reuse (Nolanville, TX)
- Develop sustainable, economically and ecologically sound land-based biosolids recycling programs via beneficial reuse



# ACKNOWLEDGMENTS

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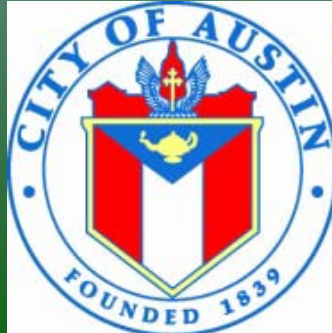
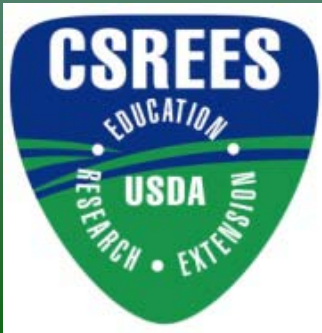
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