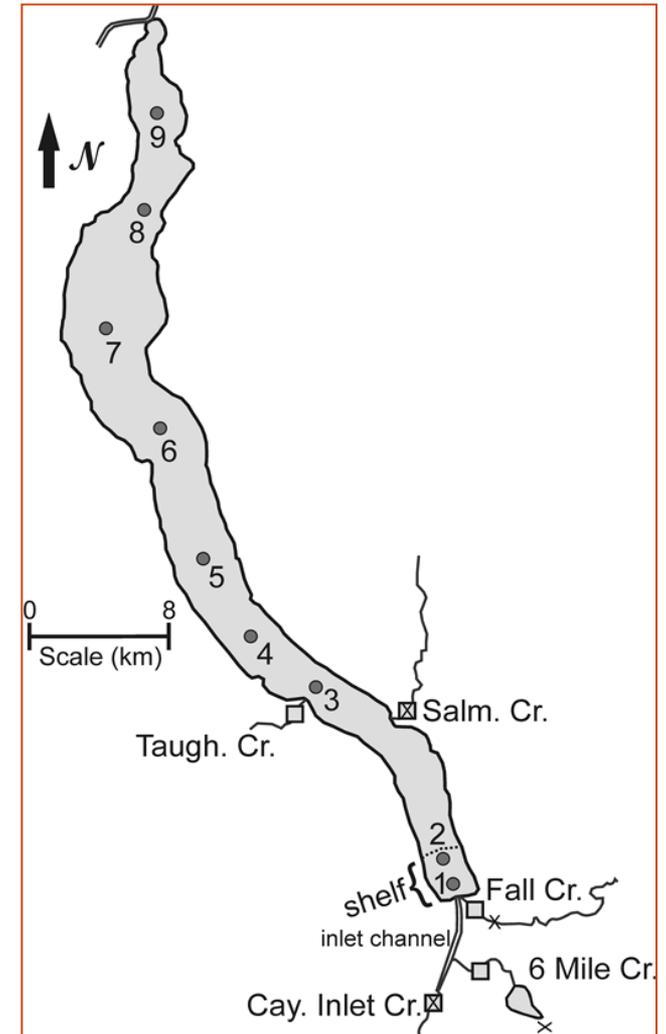


# B. Support of Project Elements by Participants

evolution from multiple NY initiatives

# NYSDEC partnership in study program design for Cayuga Lake study

- design/scope rigorously described in project QAPP, 2 phases
- key scope features
  - tributary inputs
    - specification of targeted tributaries (~ 60% of total)
  - ➔ multiple P bioavailability measurements per tributary
  - ➔ importance of runoff event sampling
    - parameter list
  - lake conditions
    - parameter list
    - sites
    - frequency
  - ➔ spatial scope of hydrothermal/transport submodel
- field program executed in 2013
- phase I report (approved) in 2014



# NYSDEC/UFI collaborations and work elements

- mostly unfunded Finger Lakes – wide surveys (5 times/summer, all lakes), 1996 and 2004



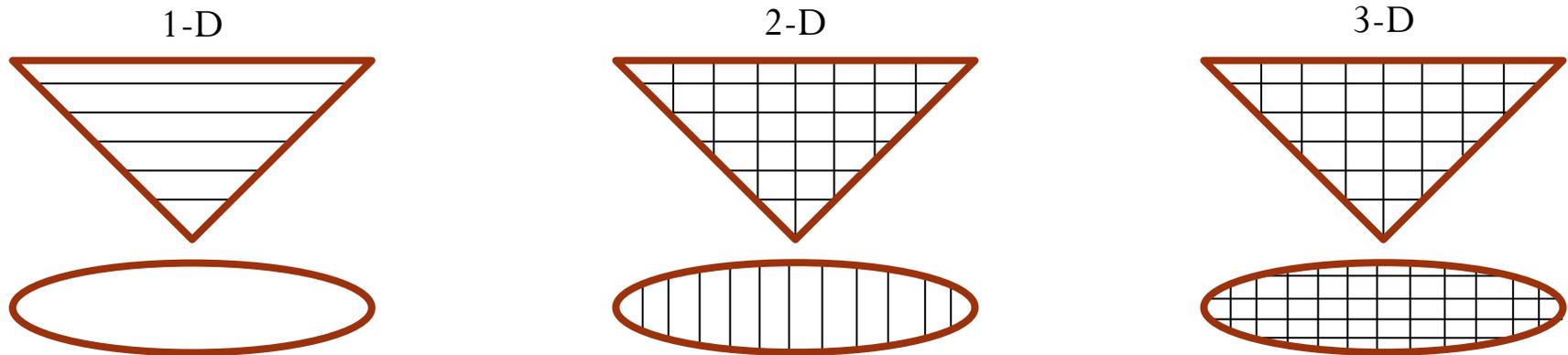
- analyses at UFI
- see paper, Peng and Effler, 2005  
*Hydrobiologia* 543:259–277

importance of  
minerogenic particles to  
optical water quality

- CSLAP
  - analyses of samples collected on ~120 lakes in New York by volunteers, since 2001 (funded)
  - FOLA and NYSDEC administered

# NYSDEC partnership in study program design for Cayuga Lake study: Spatial scale, dimensionality of hydrothermal/transport submodel

- dimensionality options – all 3 types set-up, tested, and approved for NYC reservoirs



- decisions often greatly influenced by spatial features of water quality concerns
- agreement that the primary spatial features of water quality was “shelf” vs. pelagic portions of lake, two-dimensional (2D)
- three-dimensional utilized for selected hydrodynamic issues (Cornell, T Cowen’s group)



complexity, computation demands for supporting data, the parsimony principle - factors

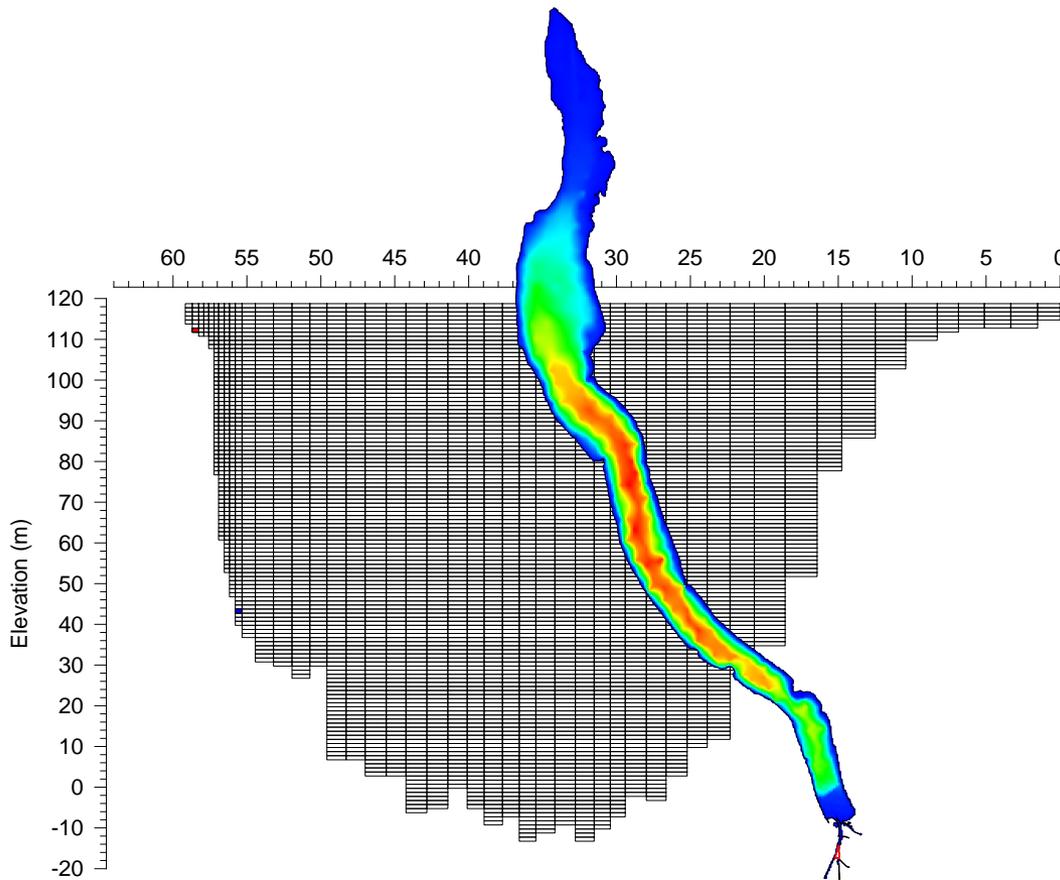
# Specific support for the set-up, testing, and application of W2/T for Cayuga Lake

Gelda et al. 2015

Testing and application of a two-dimensional hydrothermal/transport model for a long, deep, and narrow lake with moderate Burger number. *Inland Waters* (in press)

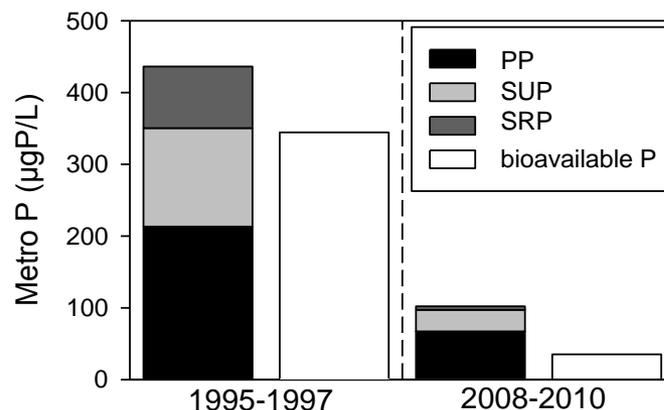
W2/T – embedded in CE-QUAL-W2  
*contribution #327 of UFI*

- substantial contributions beyond just another set-up
  - long-term testing
  - seiche activity
  - upwelling events on shelf



# NYSDEC previously approved process studies: Bioavailability of forms of P

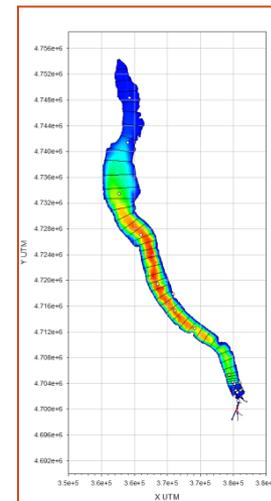
- NYC reservoirs
  - (e.g., Auer et al. 1998. *Lake Res. Manag.* 14:278-289)
- Onondaga Lake
  - Effler et al. 2002. *Lake Res. Manag.* 18:87-108
  - Effler et al. 2012. *Wat. Environ. Res.* 84:254-264
    - Metro P and lake rehabilitation – the extraordinarily low bioavailability of Actiflo effluent is key, to understanding positive response



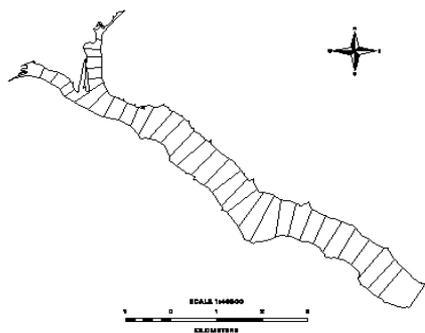
$$\text{TP} = \text{PP} + \text{TDP}$$
$$\text{TDP} = \text{SUP} + \text{SRP}$$

# USEPA previously approved research/modeling elements incorporated in Cayuga Lake program: hydrothermal transport submodel

1. P-eutrophication model for NYC reservoirs
  - FAD requirements, other; through NYCDEP
  - 2-D transport framework, W2-T



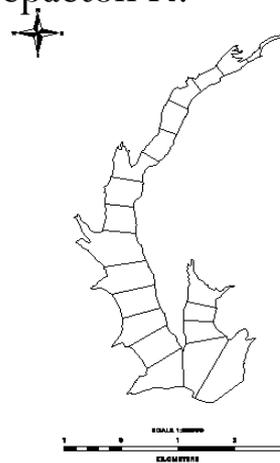
Rondout R.



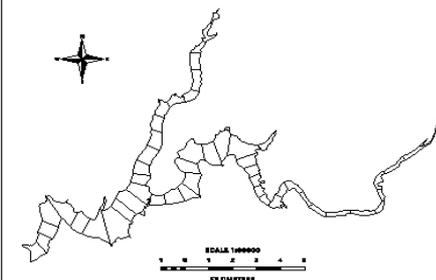
Neversink R.



Pepacton R.



Cannonsville R.

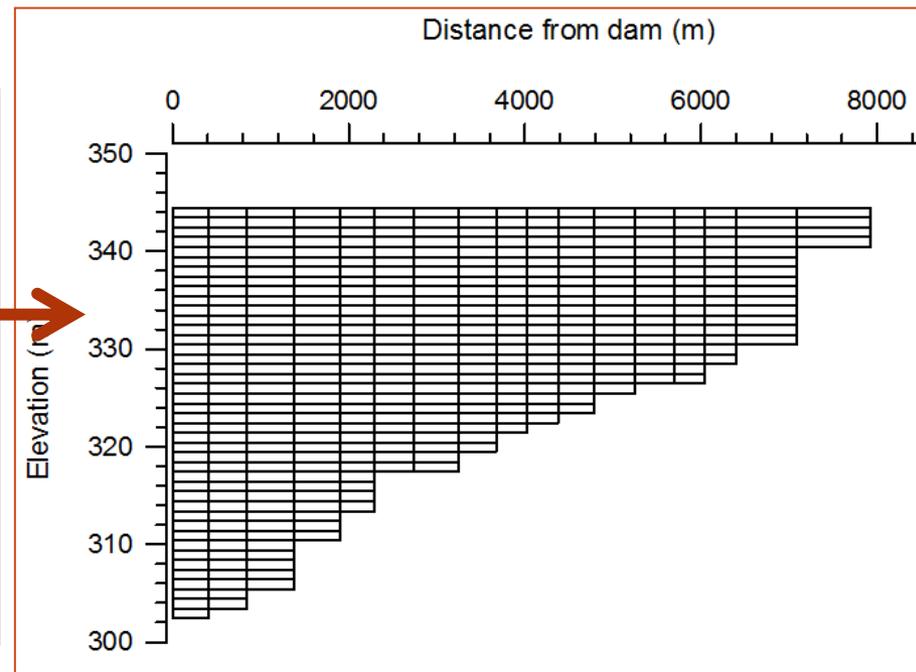
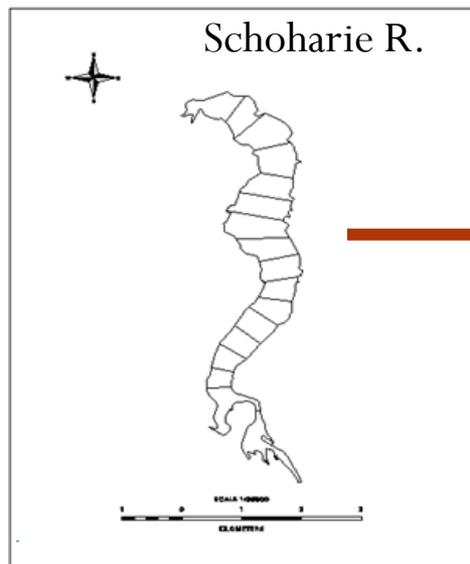
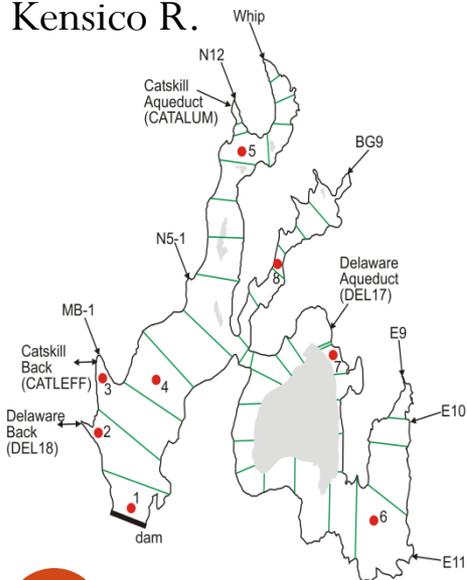


# USEPA previously approved research/modeling elements incorporated in Cayuga Lake program: hydrothermal transport submodel

## 2. turbidity ( $T_n$ ) model for NYC reservoirs

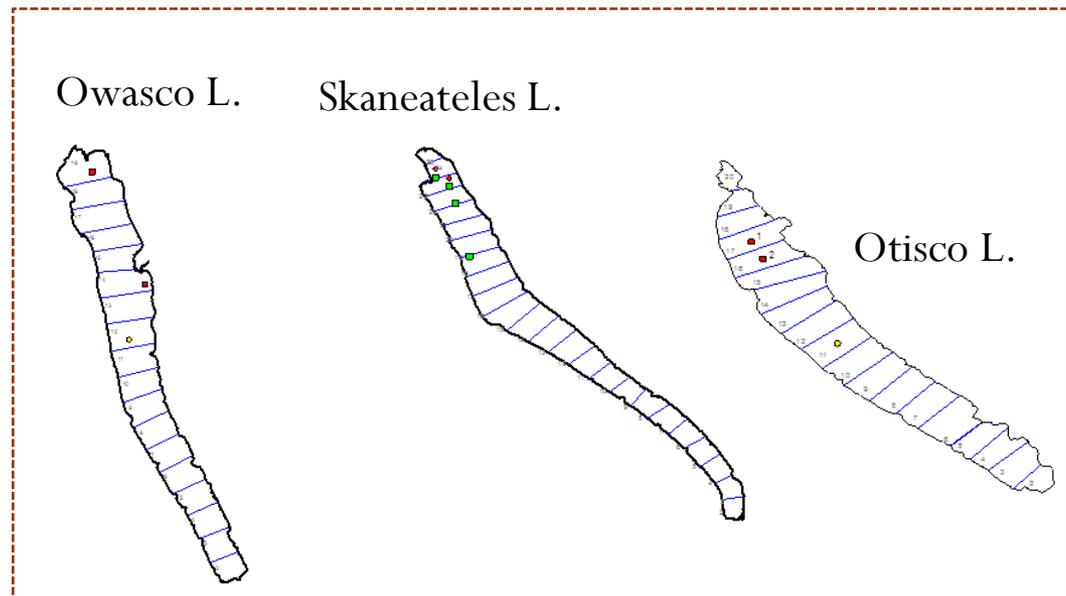
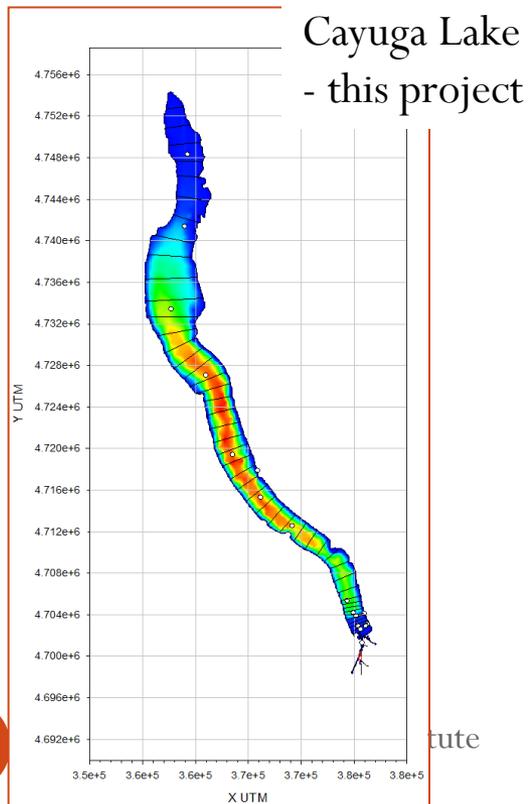
- runoff event-based sampling and  $T_n$  measurements
- FAD requirements, other; through NYCDEP
- operational support tool (OST) to protect Kensico Res. from turbidity
- 2-D transport framework, W2-T

Kensico R.



# USEPA previously approved research/modeling elements incorporated in Cayuga Lake program: hydrothermal transport submodel

3. Set-up, initial testing of hydrothermal transport model 2-D, W2-T
  - modeling initiative for eastern Finger Lakes

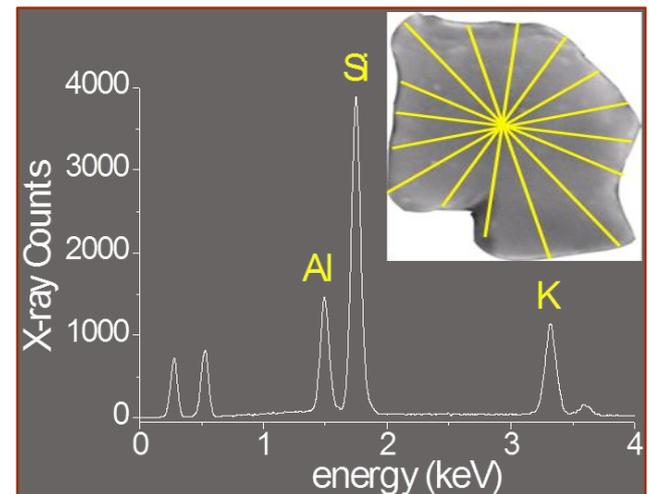
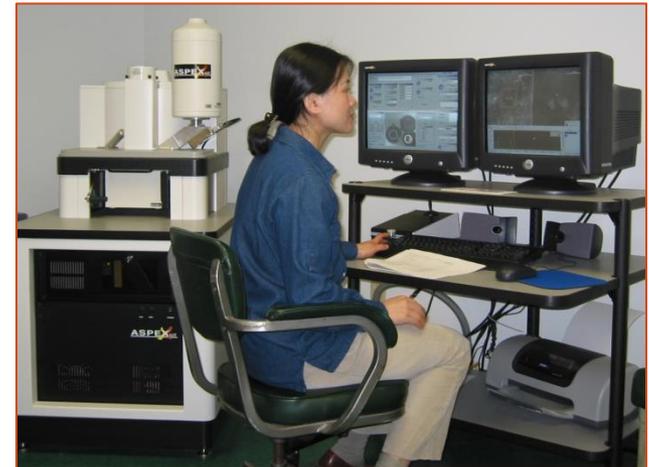


EPA Contract No. RB0912  
Syracuse COE

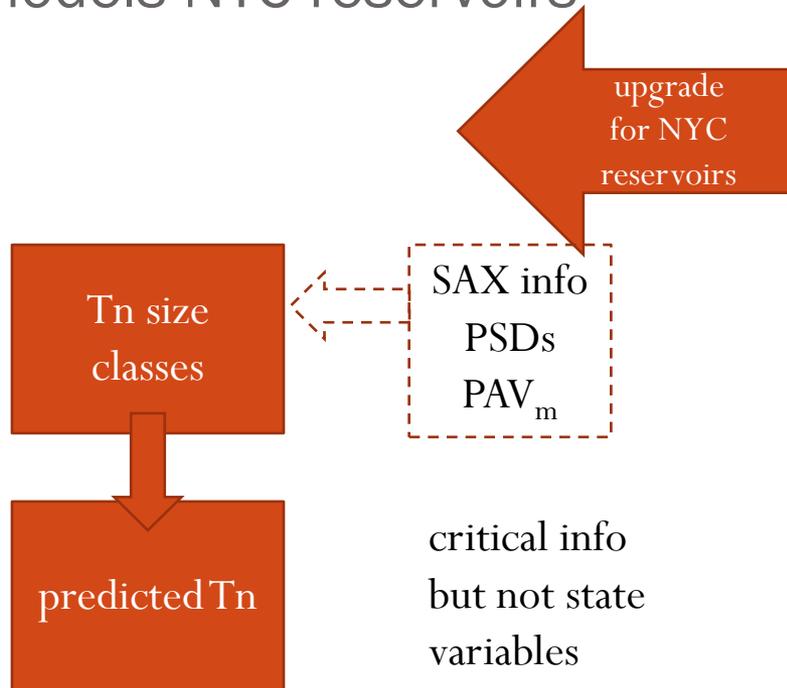
Congressman  
J. Walsh  
10/22/2015

# USEPA previously approved research/modeling elements incorporated in Cayuga Lake program: SAX-supported turbidity models for NYC reservoirs

- use of an individual particle analysis (IPA) technology
  - morphology and composition information for particles
  - scanning electron microscopy coupled with automated image and x-ray analyses (SAX)
- selected key findings
  - dominance of clay mineral particles (Cayuga L. also)
  - particle size distributions (PSDs) – recurring features
  - projected area of minerogenic particles ( $PA_m$ ) a central metric of these particle populations
- many of the reservoirs/tributaries characterized, emphasis on Catskill system

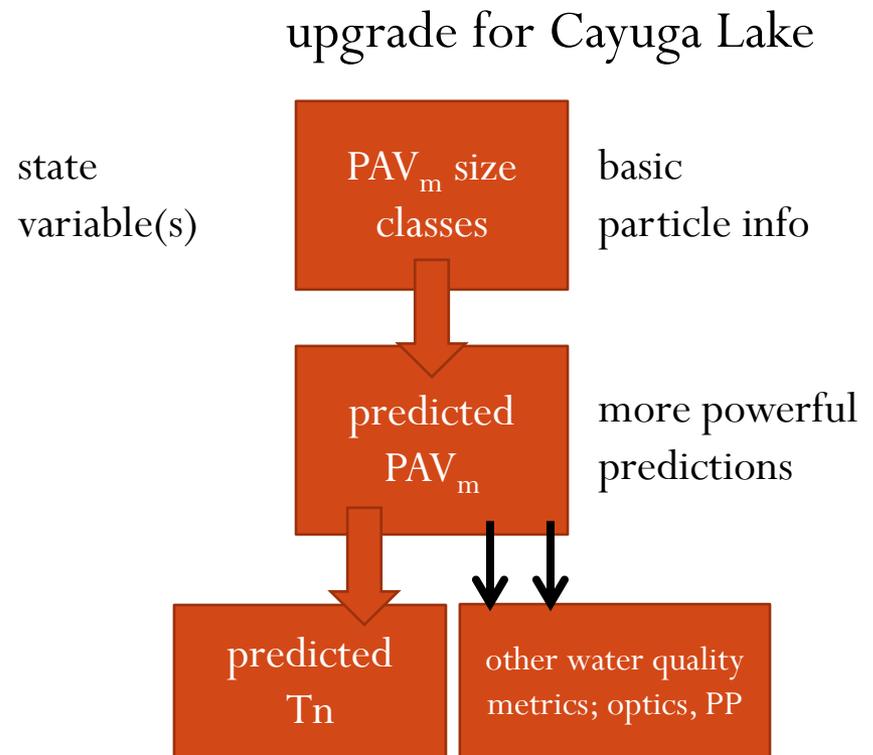


# USEPA previously approved research/modeling elements incorporated in Cayuga Lake program: SAX-supported turbidity models NYC reservoirs



share dependence on SAX data and representation of multiple size classes

- multiple NY reservoirs involved



# USEPA previously approved research/modeling elements incorporated in Cayuga Lake program: SAX-supported turbidity models for NYC reservoirs

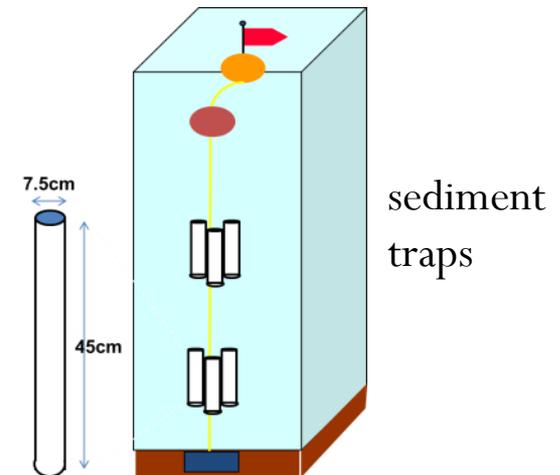
- turbidity ( $T_n$ ) model for NYC reservoirs
  - multiple size class components of  $T_n$
  - SAX data critical guidance on size class specifications
    - embedded, implicit to  $T_n$  models
    - explicit,  $PAV_m$  state variable for Cayuga Lake upgrade
  - integrated, along with W2/T into operation support tool (OST) to protect Kensico Res. from turbidity
  - turbidity model publications:
    - Schoharie Res.: Gelda and Effler, 2007. JEE ASCE 133:139-148.
    - Ashokan Res.: Gelda et al. 2009. JEE ASCE 135:885-995
    - Kensico Res.: Gelda et al. 2012. JEE ASCE 138:38-47
    - Rondout Res.: Gelda et al. 2013, Inland Waters 3:377-390

Schoharie Res.



# Cornell funding extras to enhance understanding and representation of system

- quantification of Inlet Channel effects
  - ADCP – Cowen's group
  - sonde – UFI
  - phase 2 work element
- sediment traps on shelf, UFI
- sonde deployment on shelf, UFI (T, SC, Tn)
- bioavailability measurements (beyond tribs and WWTPs)
  - LSC – TDP and SRP
  - shelf, post runoff event – PP
  - by Auer (MTU)



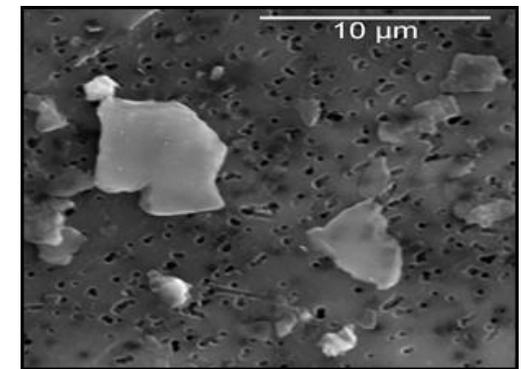
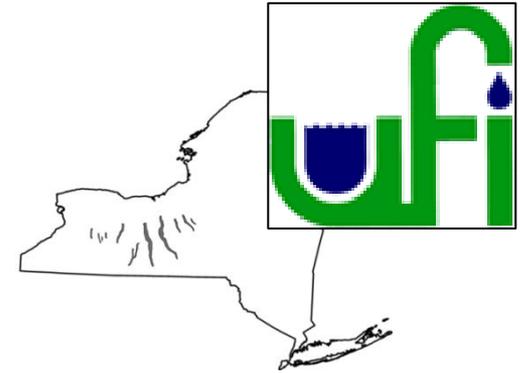
# Optics and NASA funding, convergence with Cayuga Lake Cornell study

- optical water quality metrics to be modeled in Cornell study (influenced by materials of interest; phytoplankton and mineral particles are central)
  - apparent optical properties (AOPs): Secchi depth (SD), turbidity (Tn), attenuation coefficient (k);
- optics submodel will represent relationships between optically active constituents (OACs; e.g., phytoplankton, mineral particles), inherent optical properties (IOPs) and above AOPs
  - $OACs \rightarrow IOPs \rightarrow AOPs$
- NASA grant – to advance remote sensing capabilities for inland waters, through similar to above mechanistic pathways
  - coverage of IOP measurements and interpretations
  - critical contributions to design and testing of optics submodel



# UFI's additional "voice" on Cayuga Lake: Basis

- UFI's goals for New York waters
- record of peer-reviewed publications on NY waters
  - presently at contribution No. 333 (see Attachments)
- pro bono work on the Finger Lakes
  - detailed surveys in 1996 and 2004 (collaborations NYSDEC)
- unfunded ongoing preparation of successful manuscripts for peer-reviewed journals, concerning Cayuga L.
  - these contributions establish credibility; i.e., (1) quality of work, (2) advancements in understanding, (3) non-advocacy, (4) support of key findings by experts outside of this arena
- unfunded measurements and professional time for Cayuga L. SAX-PAV<sub>m</sub> data for 1999-2006 period (see Effler et al. 2014)
  - key information for the contemporary lake issues
- experiences in environmental infrastructure issues



# Converging features for the participants in the Cayuga Lake water quality study



- familiarity and scientific support for key elements of the adopted approaches, TMDL analyses



- familiarity and scientific support for key elements of the adopted approaches, TMDL analyses



- support for approved study scope, extra elements, research contributions by faculty, monitoring for LSC facility



- leading conduct of the scientific program, the advantages for the arena of peer-reviewed publications, Finger Lakes history

recommendations for bioavailability measurements, runoff event monitoring, 2-D transport submodel, for this study

