Establishing TMDLs for Multi-Use Reservoirs

2004 National Monitoring Conference

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State of Alabama

ADEM

Overview of Presentation

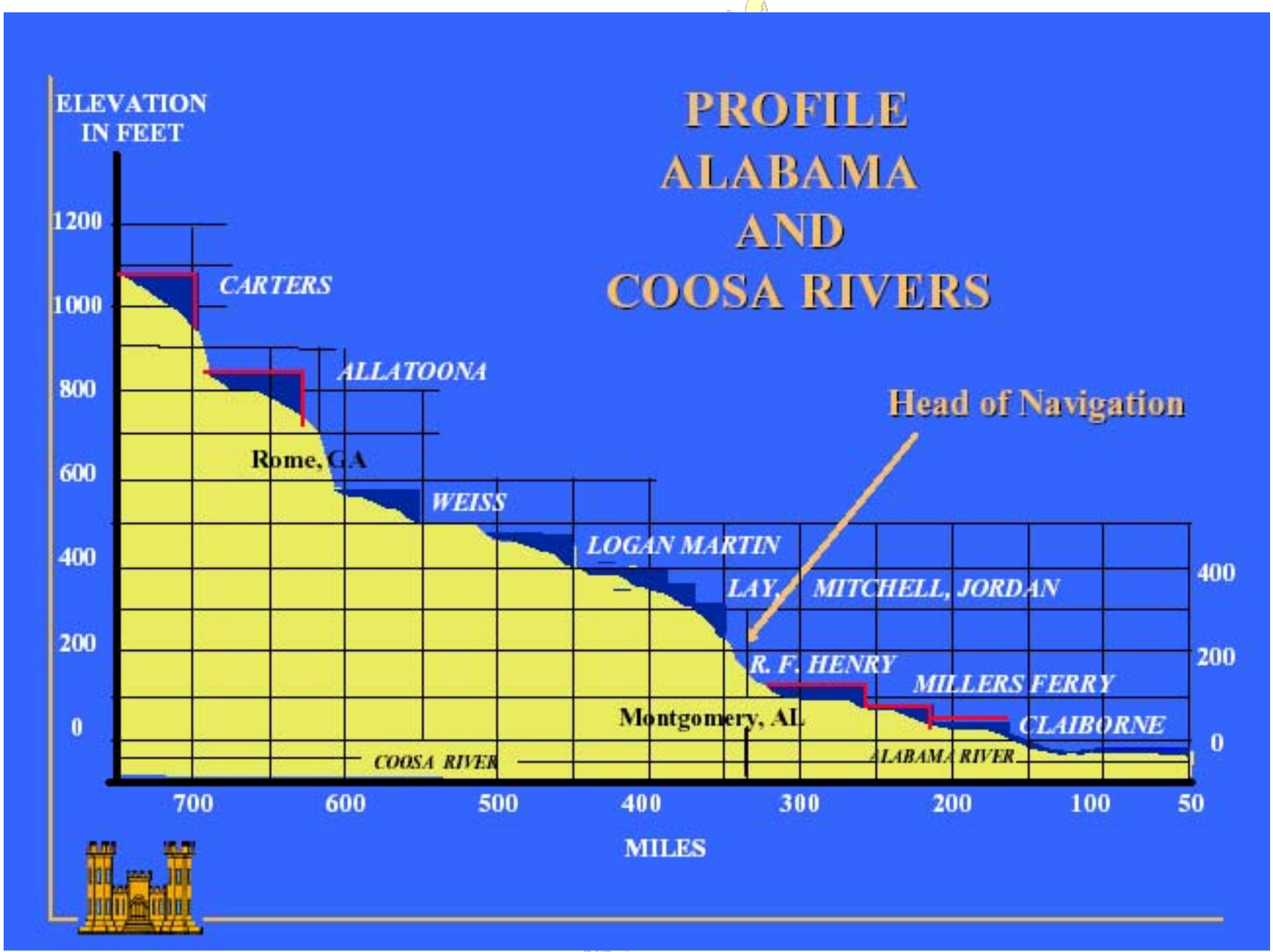
- TMDL Approach
- Tools Used in TMDL Analysis
- Case Study: Logan Martin
- Model Simulations
- TMDL Findings
- Questions???

TMDL Approach

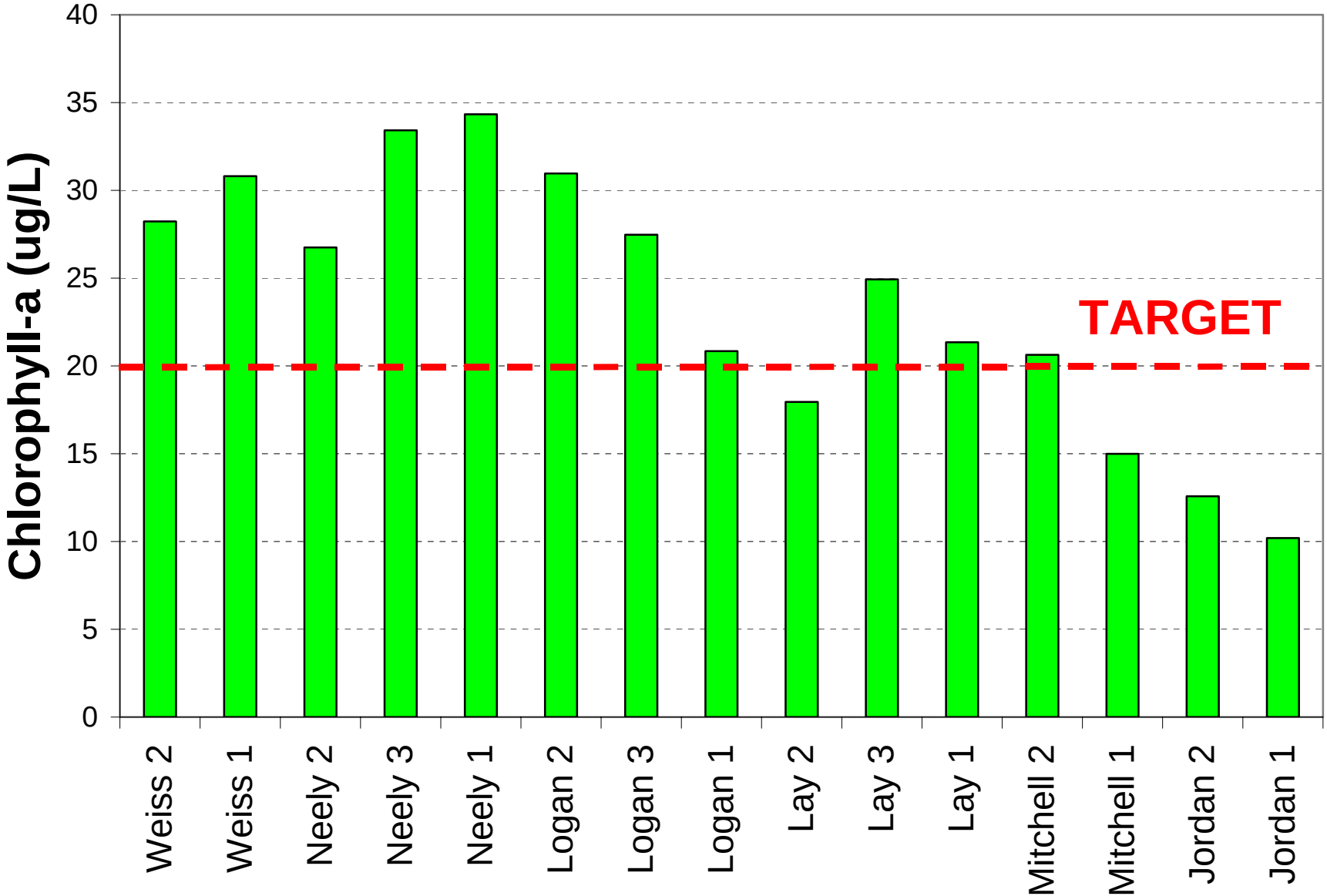
- Determine watershed loads
- Calibrate hydrodynamics
  - Water level
  - Temperature
- Calibrate water quality
  - Dissolved oxygen
  - Nutrients
  - Chlorophyll-a
- Determine TMDL target
  - Growing season average of chlorophyll-a at the forebay
- Run load reduction scenarios

TMDL Approach cont'd

- Numeric Criteria established for 22 lakes thus far.
- TMDL based on chlorophyll a targets established on a lake specific basis
  - Growing Season Mean, Photic Zone
  - Location specific compliance point, not lake wide
- Total Phosphorus (TP) is the causal parameter being used to manage algal growth.
- Dynamic Modeling Tools to Develop TMDLs
  - WRDB, EFDC, WASP, LSPC

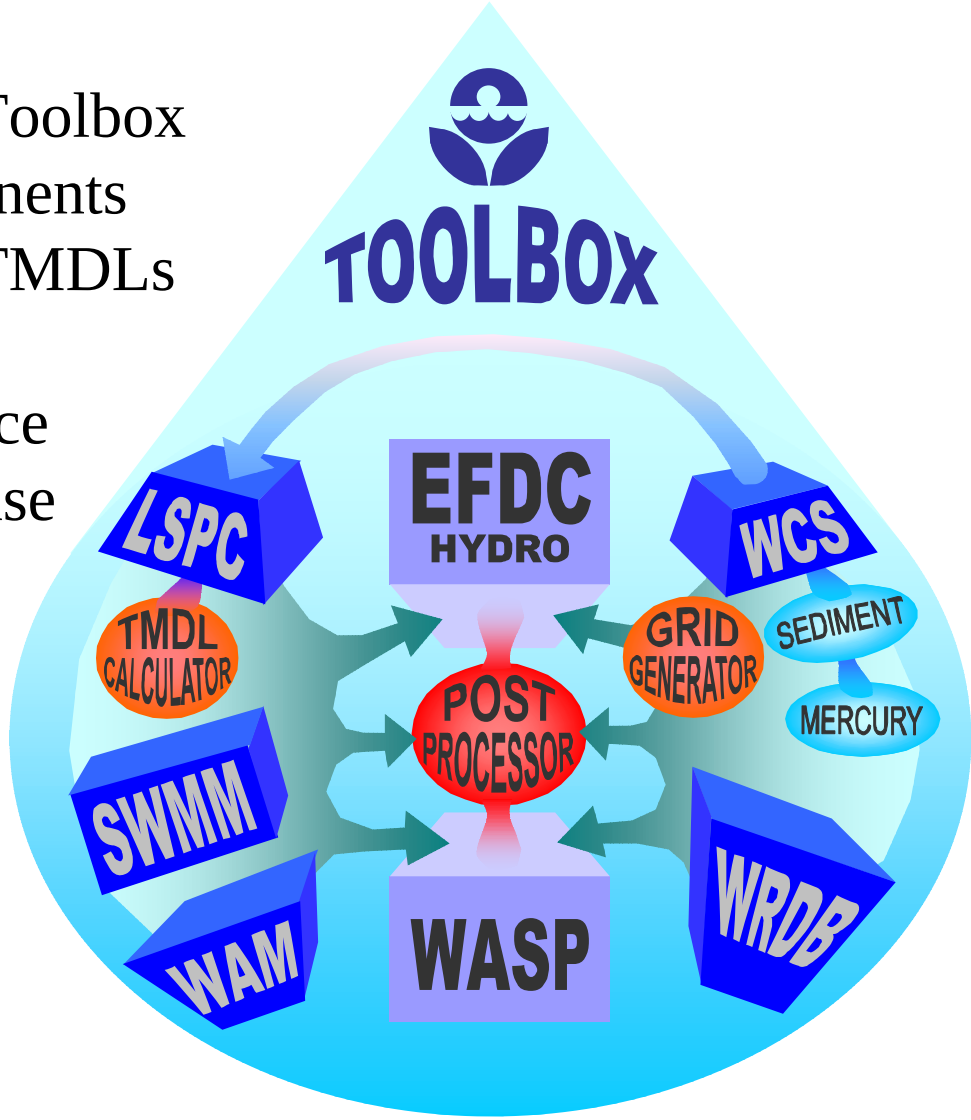

PROFILE
ALABAMA
AND
COOSA RIVERS
ELEVATION
IN FEET
1200
1000
800
600
400
200
0
CARTERS
ALLATOONA
Rome, GA
WEISS
LOGAN MARTIN
LAY
MITCHELL, JORDAN
R. F. HENRY
MILLERS FERRY
CLAIBORNE
Head of Navigation
Montgomery, AL
COOSA RIVER
ALABAMA RIVER
400
200
0
700
600
500
400
300
200
100
50
MILES

Longitudinal Algal Trends



Modeling Toolbox

- EPA Modeling Toolbox
- Modular Components
- Tested through TMDLs
- Plug and Play
- Common Interface
- Common Database
- Includes LSPC
- Public Domain
- Open Codes



Modeling Tools Used for Lake/Reservoir Nutrient TMDLs

- **Database Management**
  - Water Resources Database (WRDB)
- **Watershed Model**
  - Loading Simulation Program C++ (LSPC)
- **Hydrodynamic Model**
  - Environmental Fluid Dynamics Code (EFDC)
- **Water Quality Model**
  - Water Quality Analysis Simulation Program (WASP 6.1)

Database Management

- Water Resources Database (WRDB)
- Free software available at **www.wrdb.com**
- Developed by EPA Region 4 and GAEPD
- Archival dataset that is transferable
- Statistical and plotting capabilities

WRDB Statistics for Coosa River TMDLs

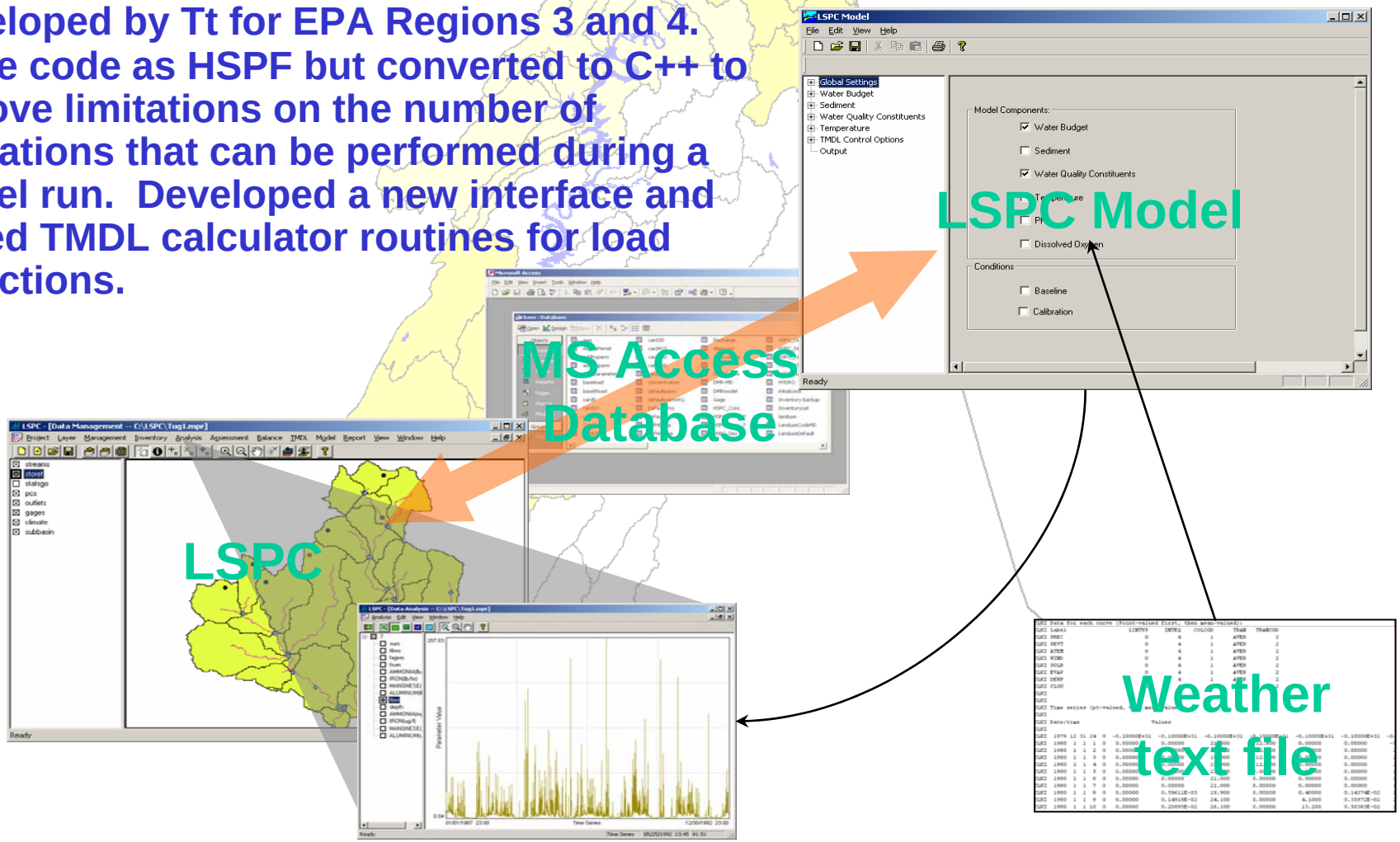
- Datasets: water quality, flow, and meteorological
- Agencies: ADEM, Alabama Power, EPA, USGS
- 2,988,438 records
- 693 stations
- 97 parameter types

Watershed Model

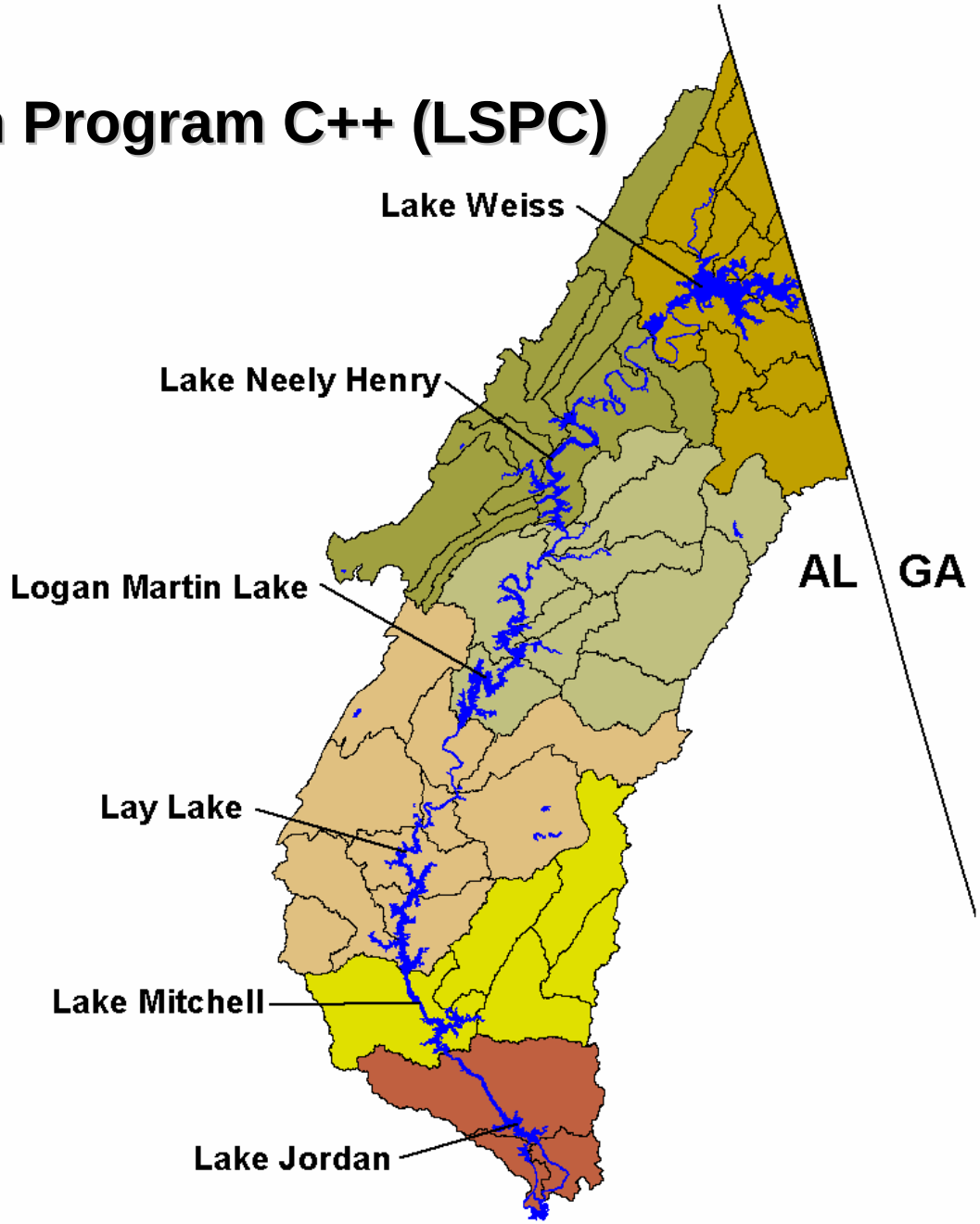
LSPC = Loading Simulation Program in C++

Model Description

Developed by Tt for EPA Regions 3 and 4. Same code as HSPF but converted to C++ to remove limitations on the number of operations that can be performed during a model run. Developed a new interface and added TMDL calculator routines for load reductions.



Watershed Model
Loading Simulation Program C++ (LSPC)

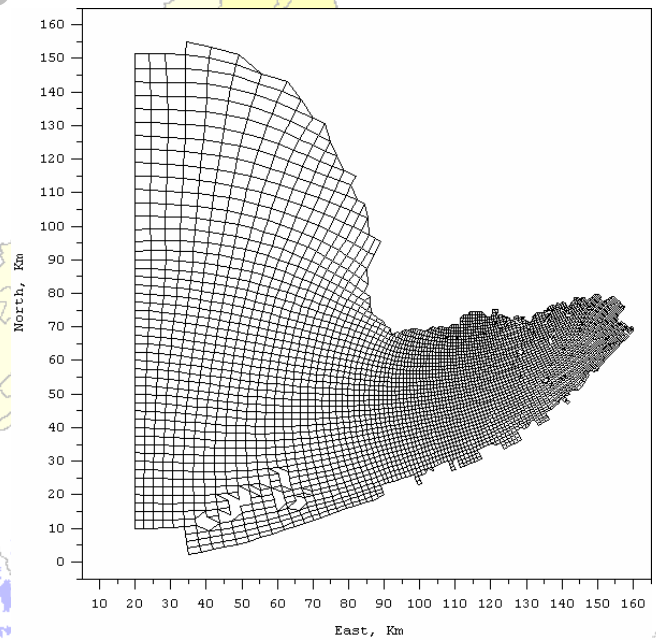


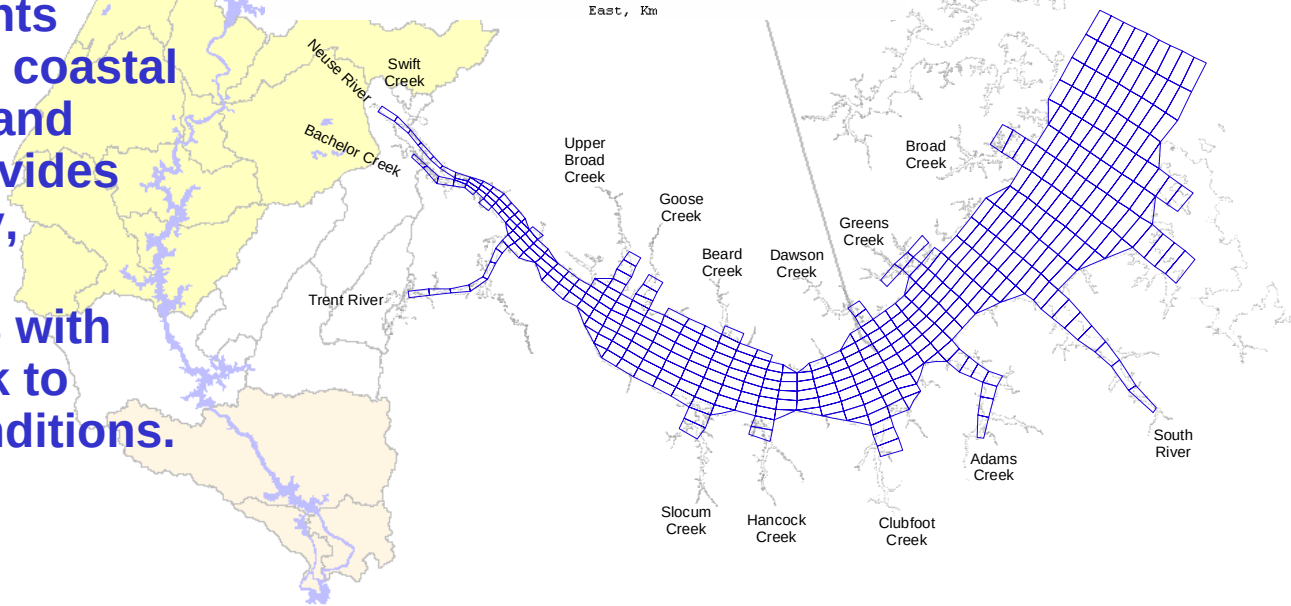
Hydrodynamic Model

EFDC = Environmental Fluid Dynamics Code

Model Description

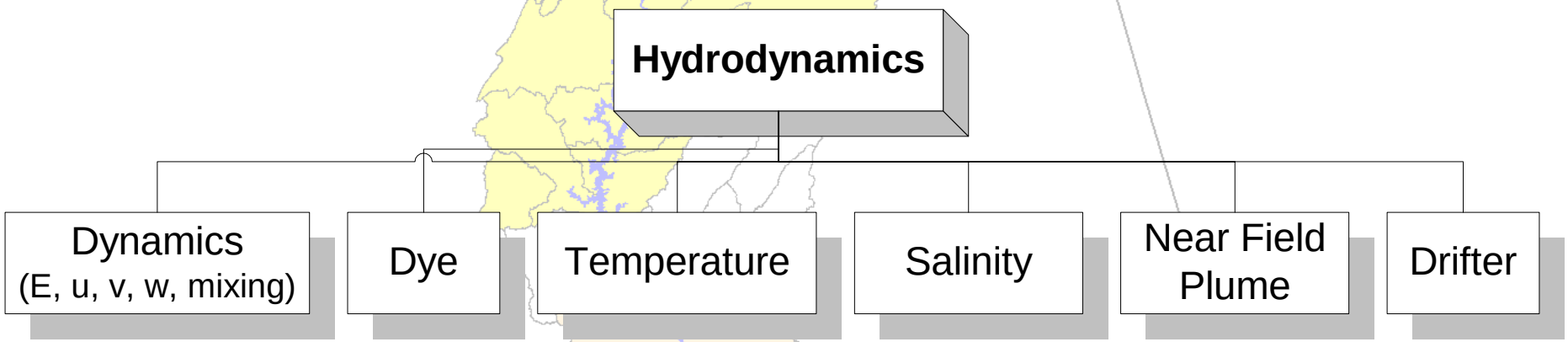
EFDC Hydro is a 2-D/3-D orthogonal curvilinear grid hydrodynamic model. EFDC can solve for the circulation and transport of material in complex environments including, estuaries, coastal embayments, lakes and offshore. It also provides solutions for salinity, temperature, and conservative tracers with full density feedback to handle stratified conditions.





EFDC

- Fully Three-Dimensional with 2-D and 1-D Options
- Boundary Fitted Curvilinear Grid
- Includes Turbulence Closure Model
- Highly Efficient Semi-Implicit Solution

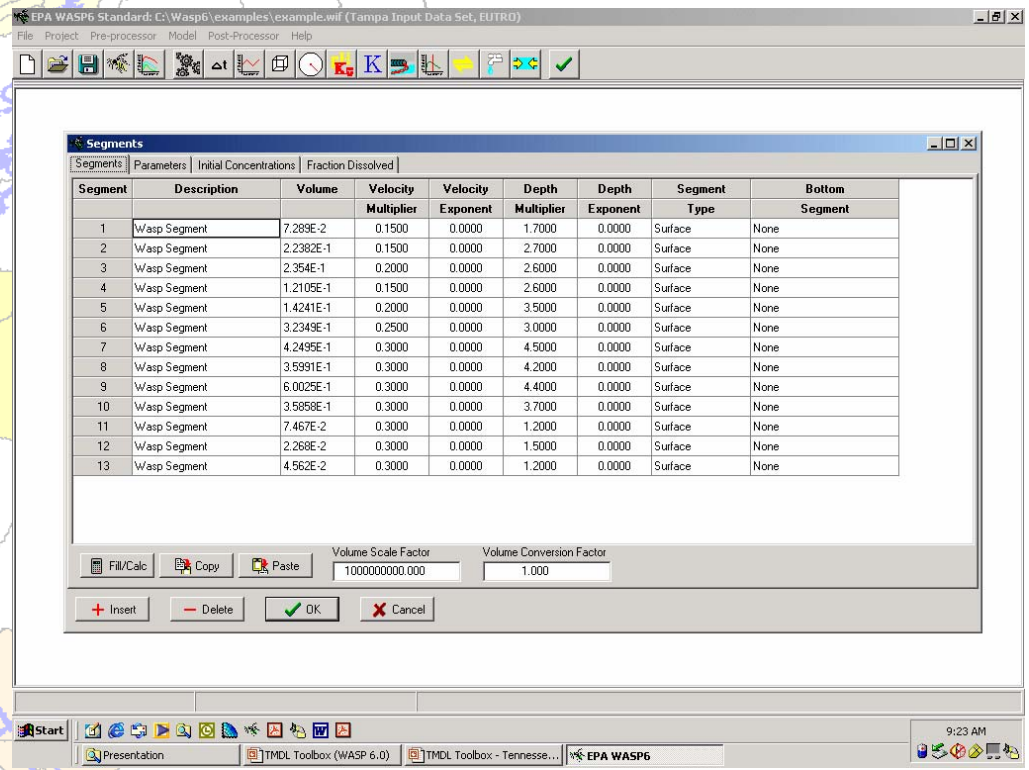


Lake Water Quality Model

WASP = Water Quality Analysis Program

Model Description

WASP 6.1 is a windows based, dynamic, compartment, modeling program for aquatic systems, including both the water column and the underlying benthos. The time varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program.

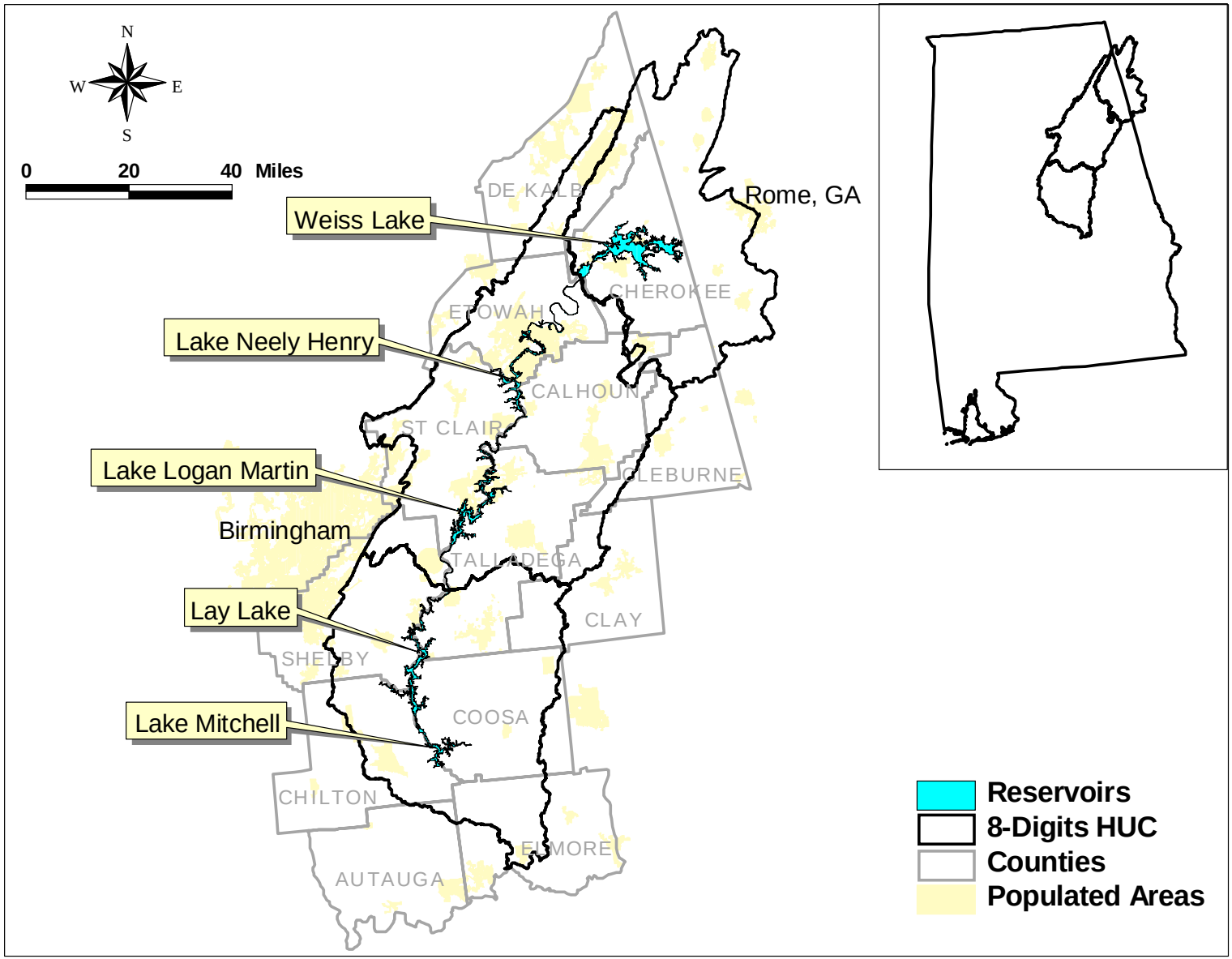


Segment	Description	Volume	Velocity Multiplier	Velocity Exponent	Depth Multiplier	Depth Exponent	Segment Type	Bottom Segment
1	Wasp Segment	7.289E-2	0.1500	0.0000	1.7000	0.0000	Surface	None
2	Wasp Segment	2.2382E-1	0.1500	0.0000	2.7000	0.0000	Surface	None
3	Wasp Segment	2.354E-1	0.2000	0.0000	2.6000	0.0000	Surface	None
4	Wasp Segment	1.2105E-1	0.1500	0.0000	2.6000	0.0000	Surface	None
5	Wasp Segment	1.4241E-1	0.2000	0.0000	3.5000	0.0000	Surface	None
6	Wasp Segment	3.2349E-1	0.2500	0.0000	3.0000	0.0000	Surface	None
7	Wasp Segment	4.2495E-1	0.3000	0.0000	4.5000	0.0000	Surface	None
8	Wasp Segment	3.5991E-1	0.3000	0.0000	4.2000	0.0000	Surface	None
9	Wasp Segment	6.0025E-1	0.3000	0.0000	4.4000	0.0000	Surface	None
10	Wasp Segment	3.5858E-1	0.3000	0.0000	3.7000	0.0000	Surface	None
11	Wasp Segment	7.467E-2	0.3000	0.0000	1.2000	0.0000	Surface	None
12	Wasp Segment	2.268E-2	0.3000	0.0000	1.5000	0.0000	Surface	None
13	Wasp Segment	4.562E-2	0.3000	0.0000	1.2000	0.0000	Surface	None

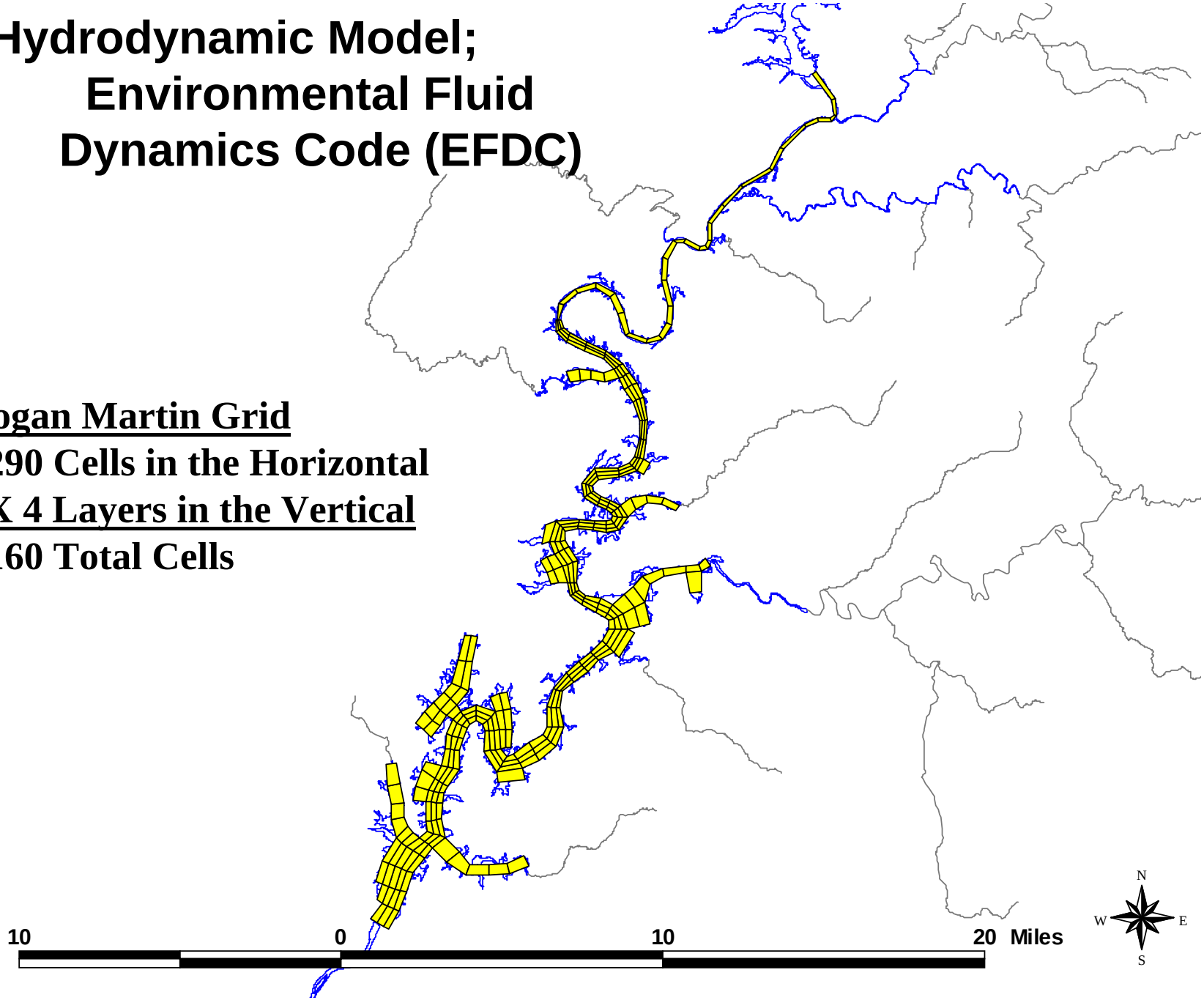
WASP

- Directly Coupled to Hydrodynamics
- Very flexible, almost any geometry can be modeled
- 8 State Variables for Eutrophication Model Including:
  - Chlorophyll-a
  - Biochemical Oxygen Demand
  - Dissolved Oxygen
  - Organic Nitrogen
  - Nitrate-Nitrite
  - Ammonia
  - Organic Phosphorus
  - Orthophosphate

Case Study: Logan Martin Lake



Hydrodynamic Model; Environmental Fluid Dynamics Code (EFDC)



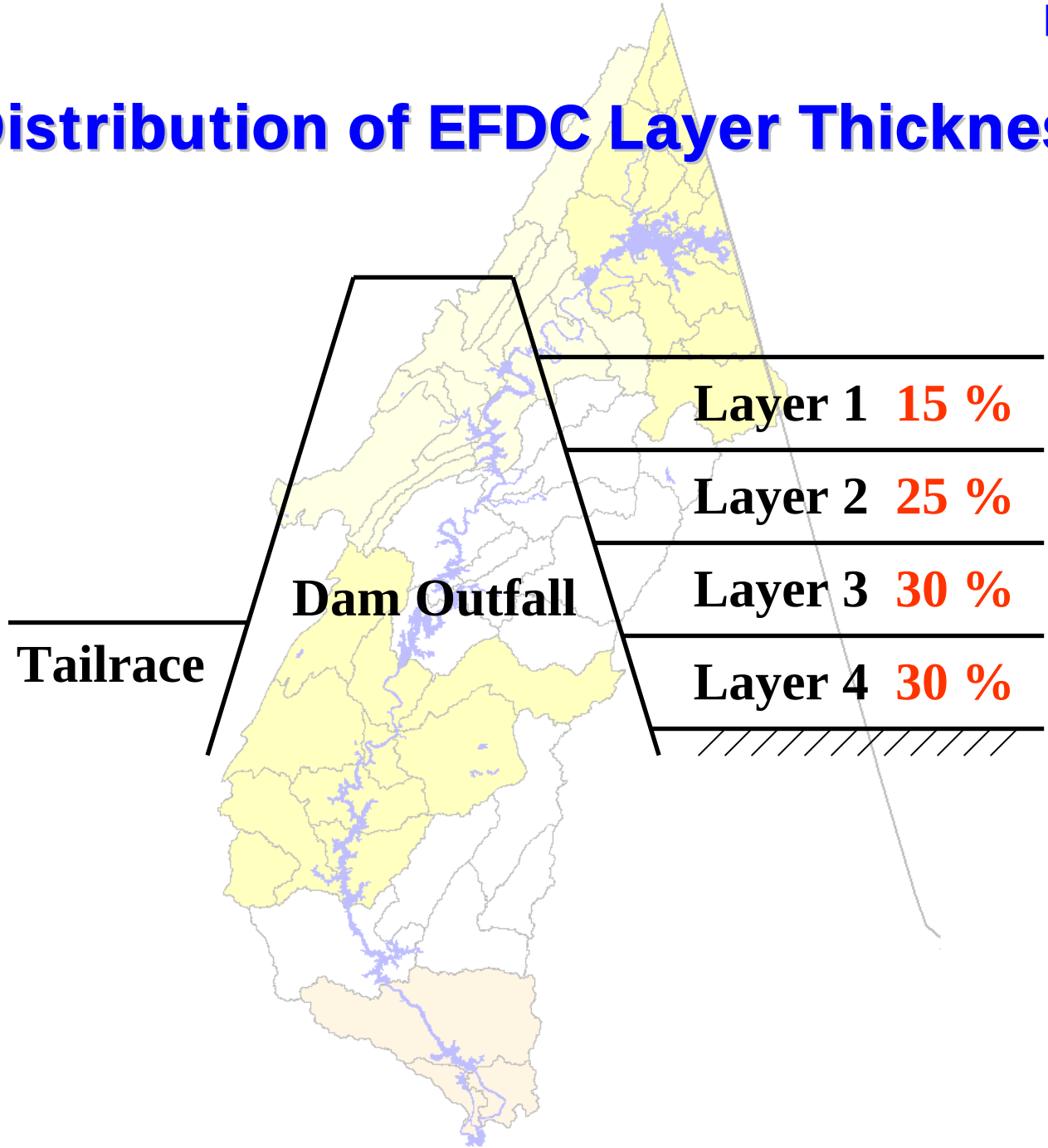
Logan Martin Grid

290 Cells in the Horizontal

X 4 Layers in the Vertical

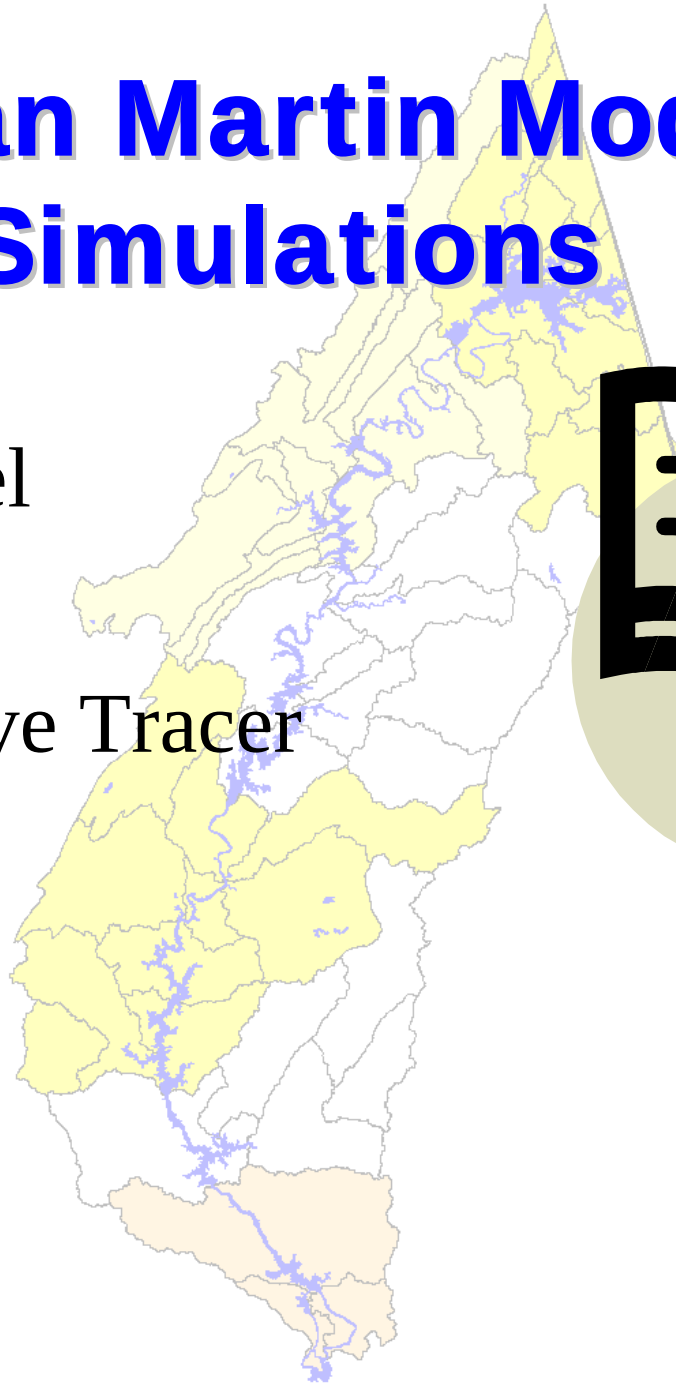
1160 Total Cells

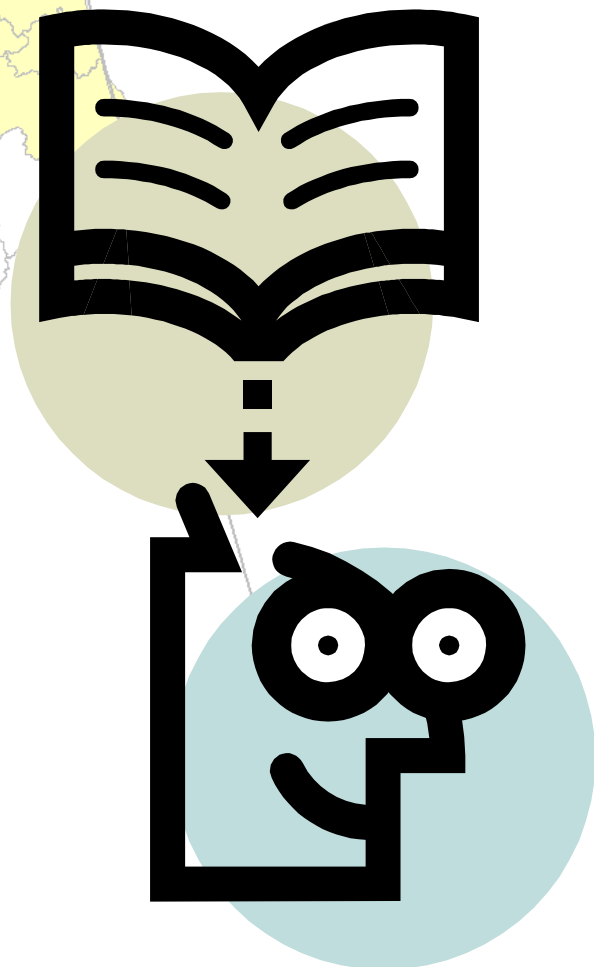
Distribution of EFDC Layer Thickness



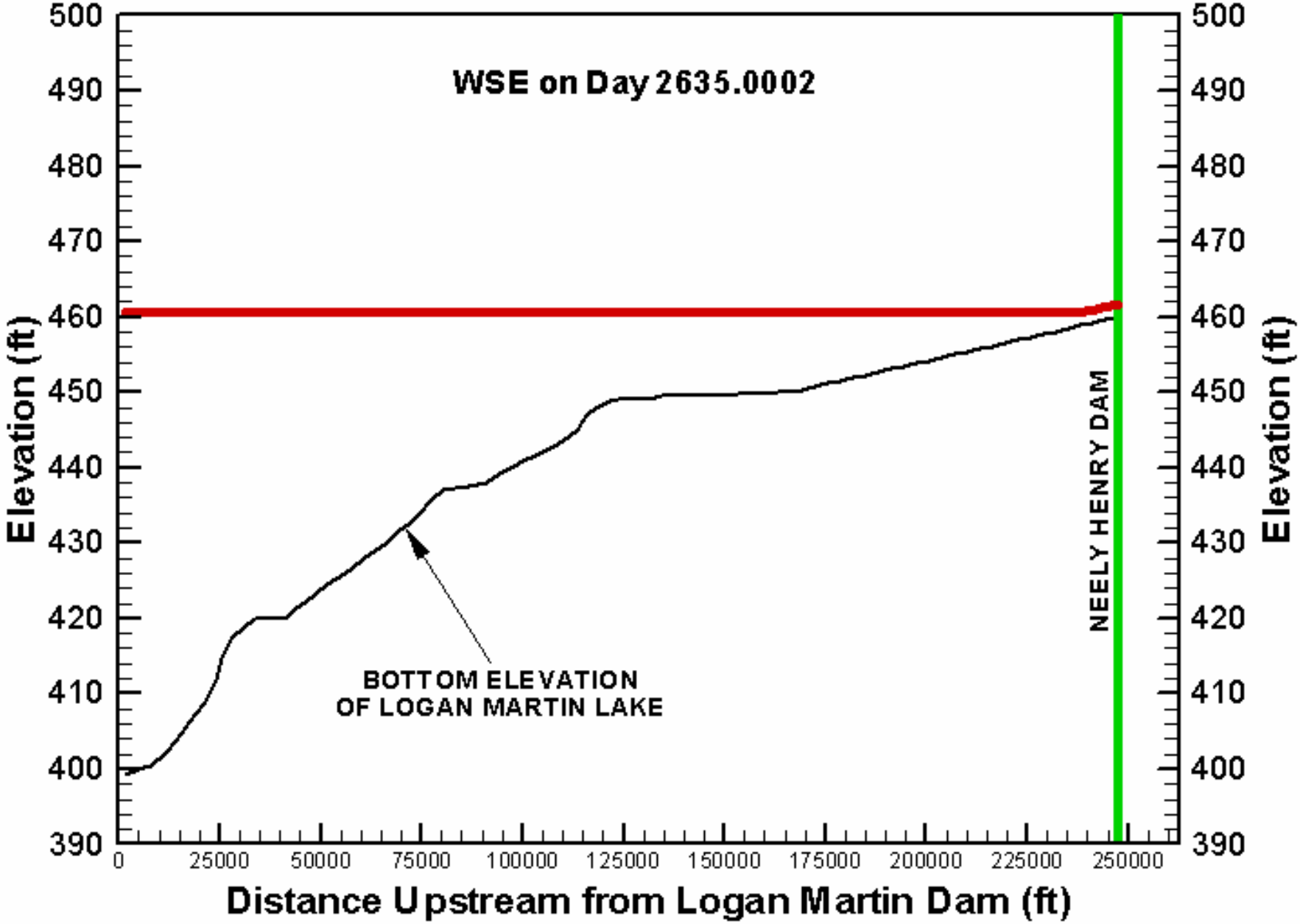
Logan Martin Model Simulations

- Water Level
- Algae
- Conservative Tracer





1997 WATER SURFACE ELEVATION FOR LOGAN MARTIN LAKE



TMDL Findings

- State of Georgia's Problem ☺
- TP Reductions @ AL/GA Stateline on the Coosa River is the Key!!
- Weiss Lake (dry year-2000)
- Neely Henry (wet-normal year-1997)
- Re-Evaluate EPA's Weiss Lake TMDL Model
- Will Enable ADEM to Refine/Establish Numeric Nutrient Criteria for Coosa System

Any
Questions???