Lake Tohopekaliga Nutrient Reduction Plan

Model Selection

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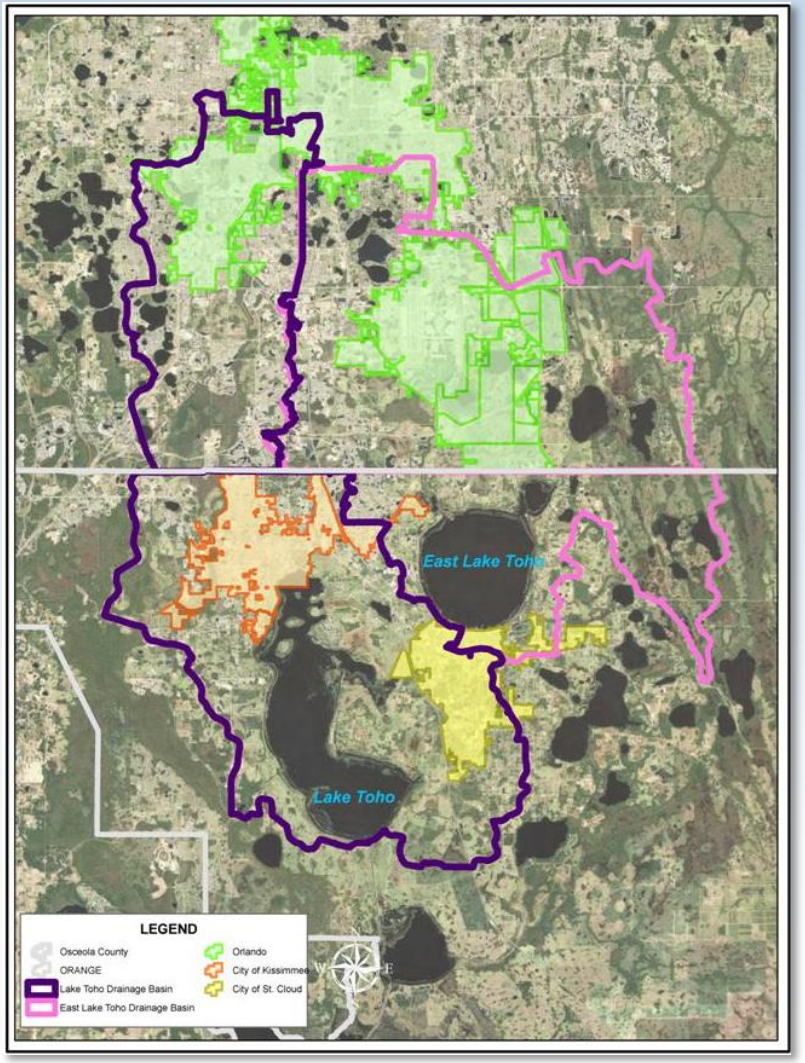
CDM

Nutrient Reduction Plan (NRP) Modeling: Goals

- Establish baseline conditions for the Lake Toho Watershed
- Estimate existing annual *stormwater-related* anthropogenic pollutant land-based loads generated from land surface (i.e., loads that stakeholders can control)
- Define existing loads by jurisdiction
- Evaluate load reduction associated with planned projects/activities
- NRP modeling *will not* be used for the following:
  - Setting water quality targets
  - Determining load allocations

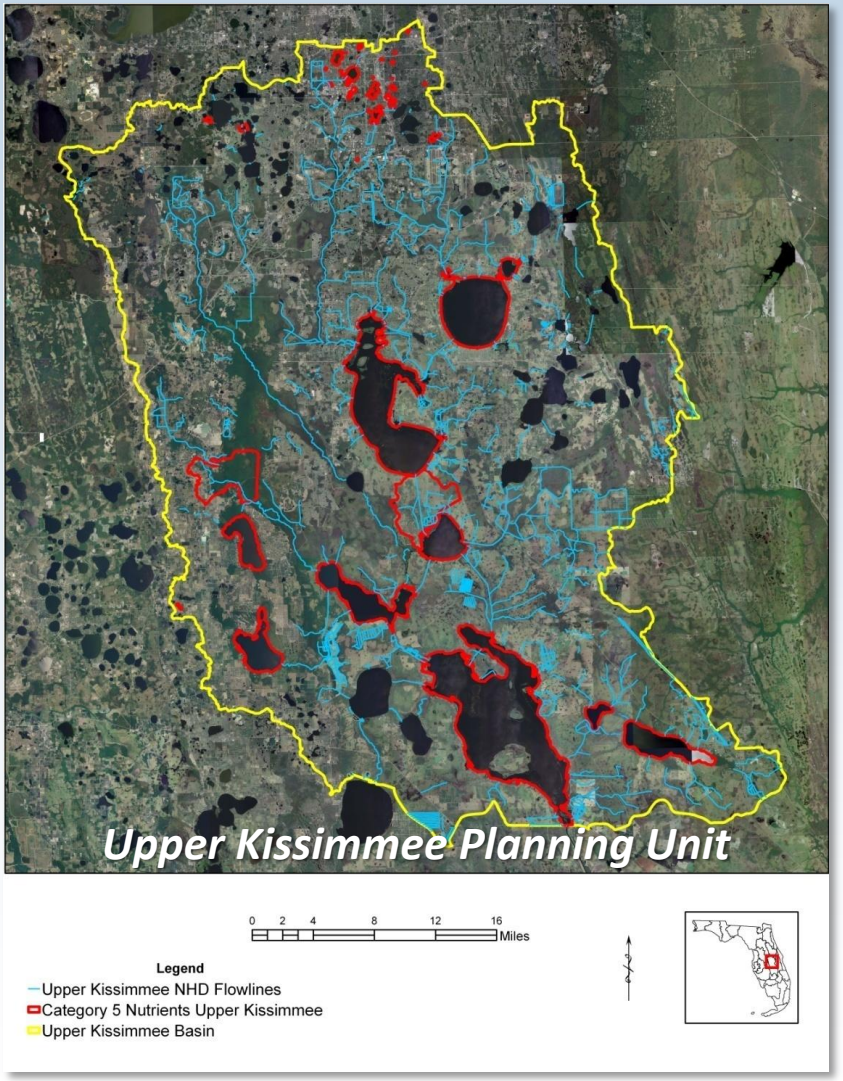
Modeling Tool Options

- Pollutant load analysis (land use based wash-off model)
  - Average annual model
  - Average rainfall, runoff, pollutant concentration
- Hydrological Simulation Program- Fortran (HSPF) model (Upper Kissimmee River Basin TMDL)
  - Continuous simulation model
  - Multi-year rainfall time series, pollutant buildup-washoff calculation



Existing Models

- Kissimmee River Watershed TMDL Model
  - HSPF
  - FDEP still in the process of developing TMDLs
- SFWMD – Proposed internal project using Watershed Assessment Model (WAM)
- Others?



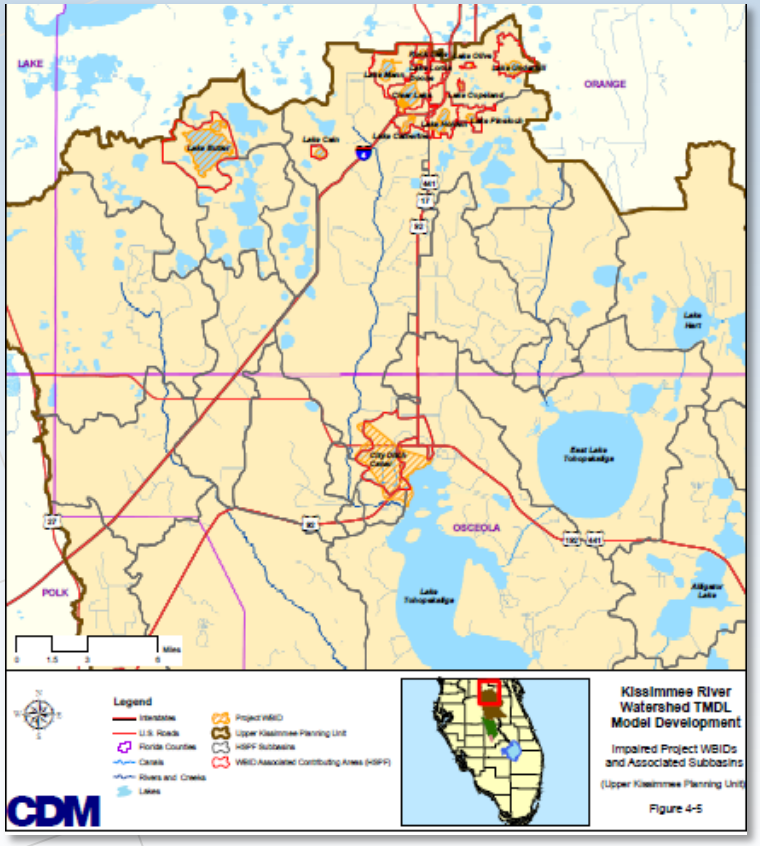
HSPF Kissimmee River Watershed TMDL Model Development Background – Model Considerations

- Watershed data
  - Land use, soils, hydrography, topography, meteorology, and groundwater data
- Water quantity data
  - Flows, stages, control structures, and significant basin transfers/diversions
- Water quality data
  - Ambient receiving water data and watershed land-based load data
- Pollutant sources
  - Point sources
  - Non-point sources (septic tanks, atmospheric deposition)

HSPF Kissimmee River Watershed TMDL Model Development Background

- Developed to establish the TMDL for several impaired water bodies at the time of development (2008)
  - Lake Toho and East Lake Toho not on the list at that time
- Data analysis and evaluation focused on 11-year period from 1996 through 2006
  - Calibration: 1997 through 2000
  - Validation: 2001 through 2006
- Models were calibrated and validated to observed flows, stages, and various water quality constituents
- Year 2000 land uses were used

HSPF Kissimmee River Watershed TMDL Model Development Background (*cont.*)



- Rock Lake
- Lake Lorna Doone
- Lake Mann
- Lake Catherine
- Lake Cain
- Lake Underhill
- Lake Olive
- Lake Copeland
- Lake Holden
- Lake Pineloch
- Lake Davenport
- Clear Lake
- Lake Butler
- City Ditch Canal
- Lake Cypress
- Lake Marian
- Lake Jackson
- Lake Kissimmee

HSPF Kissimmee River Watershed TMDL Model Development Background (cont.)

- Other lakes including Lake Toho and East Lake Toho were modeled
- Model results were not calibrated (for water quality) to observed data
- Performed some comparisons to make sure model results were reasonable

HSPF Kissimmee River Watershed TMDL Model Development Background (cont.)

- Urban Best Management Practices (BMPs)
  - Comprehensive coverage not available at the time of HSPF model development
  - "Estimation" of BMPs
  - All urban development after 1984 has implemented BMPs
  - GIS processing of historical (1988) and existing land uses (2000)
  - Developments created during the 1984-1988 period are not accounted for
  - Does not provide information about the BMP type utilized
  - BMPs were not explicitly evaluated due to limited available data

HSPF Kissimmee River Watershed TMDL Model Development Background (*cont.*)

- Agricultural BMPs
  - Local IFAS and FDACS offices were contacted
  - Agricultural BMPs by geographic location not available at time of model development

HSPF Kissimmee River Watershed TMDL Model Development Background (*cont.*)

- Impacts associated with septic tanks were not explicitly evaluated
  - Septic tank coverage, failure rate, and loading data very limited at the time of HSPF model development

HSPF Kissimmee River Watershed TMDL Model Development Background (*cont.*)

- Land-based loads
  - Average annual constituent loads for various land use types and soil groups
  - Represents land-based, interflow and base flow loads (i.e., total load to receiving water).

	Soil Group	Average Annual Loads (lb/ac/yr)							
		Ortho P	Ammonia N	Nitrate N	CBOD	Refractory Organic N	TSS	Total P	Total N
Commercial / Industrial	A	1.03	0.7	4.3	60	4.4	330	1.58	11.9
	B	1.05	0.7	4.3	61	4.4	334	1.61	12.0
	C	1.07	0.8	4.4	62	4.5	338	1.63	12.2
	D	1.09	0.8	4.5	63	4.5	344	1.66	12.3
Cropland / Improved Pasture	A	0.18	0.1	0.8	14	2.4	1	0.30	3.9
	B	0.49	0.3	1.8	39	3.4	48	0.84	7.0
	C	0.75	0.4	2.7	58	4.4	111	1.28	9.9
	D	1.22	0.7	4.5	90	6.1	264	2.05	15.1
High Density Residential	A	0.69	0.5	3.0	41	3.6	206	1.07	8.8
	B	0.75	0.5	3.1	45	3.7	215	1.16	9.2
	C	0.80	0.6	3.3	48	3.8	226	1.24	9.7
	D	0.84	0.6	3.5	52	3.8	242	1.31	10.0
Low Density Residential	A	0.24	0.2	1.2	17	2.5	42	0.39	4.6
	B	0.35	0.3	1.5	26	2.7	57	0.58	5.5
	C	0.44	0.3	1.8	33	2.9	77	0.74	6.5
	D	0.53	0.4	2.1	41	3.0	104	0.90	7.2
Medium Density Residential	A	0.41	0.3	1.9	26	2.9	104	0.65	6.2
	B	0.50	0.4	2.1	34	3.1	116	0.80	6.9
	C	0.58	0.4	2.4	40	3.3	132	0.94	7.7
	D	0.65	0.5	2.6	46	3.3	156	1.07	8.3
Forest / Rangeland	A	0.05	0.0	0.3	4	1.4	0	0.08	1.9
	B	0.08	0.1	0.5	6	1.7	8	0.13	2.5
	C	0.12	0.1	0.7	8	1.9	20	0.19	3.1
	D	0.18	0.2	1.0	12	2.1	42	0.29	3.8
Unimproved Pasture	A	0.11	0.1	0.7	8	2.0	0	0.18	3.1
	B	0.20	0.2	1.0	16	2.2	18	0.34	4.0
	C	0.30	0.2	1.4	23	2.6	42	0.51	5.2
	D	0.43	0.3	2.0	32	2.9	87	0.72	6.5
Wetlands	A	—	—	—	—	—	—	—	—
	B	—	—	—	—	—	—	—	—
	C	—	—	—	—	—	—	—	—
	D	0.05	0.1	0.4	4	1.4	9	0.09	2.1

HSPF Kissimmee River Watershed TMDL Model Development Background (*cont.*)

- Receiving water processes
  - Sediment transport
  - Water temperature
  - DO and CBOD simulation
  - Nitrogen and phosphorus simulation
  - Phytoplankton simulation
- Water quality calibration and validation
  - Only impaired waters at the time of analysis underwent calibration/validation
  - Only those waterbodies are included in the output for the current version of the HSPF model

HSPF Hybrid Approach to Modeling the Lake Toho Basin

1. Use the HSPF model to generate land-based loading rates
2. Determine attenuation factors based on lake residence times within the existing model
3. Develop land-based loading rates with attenuation factors applied
4. Compile existing land use, soils, jurisdictional boundaries
5. Define BMP tributary areas
6. Perform GIS based exercise using info. from steps 3, 4 & 5 to generate attenuated land-based loads per jurisdiction

HSPF Model

Advantages

- Already developed
- Robust
- Public domain software
- Can provide attenuated loads
- Tool could have future value

Disadvantages

- Complex
- Requires proficient users
- Watershed representation currently not broken out by jurisdiction
- Does not account for existing BMPs
- Would need FDEP's permission to use HSPF model
- Modeling will need to be accepted by the Stakeholders

WMM Background

- Planning level tool
- Developed to estimate the relative changes in nonpoint source pollutant loads (average annual or seasonal) due to changes in land use or from the cumulative effects of alternative basin management decisions (e.g., treatment BMPs)
- Originally developed for FDEP - modified to Windows-based version for the Rouge River National Wet Weather Demonstration Project
- Public domain software (http://www.rougeriver.com/proddata/wmm.html)

WMM Data Requirements

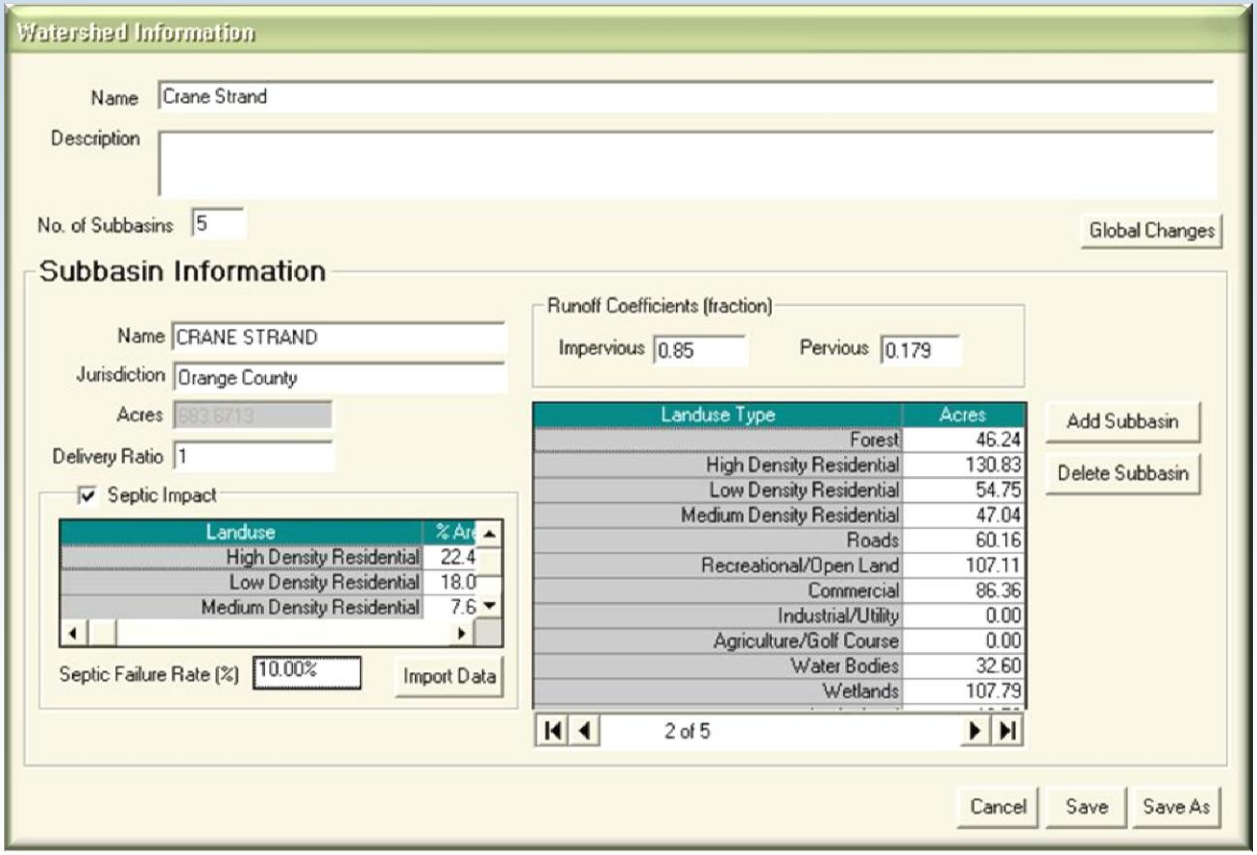
- Basins
- Land use
- Hydrologic data (average annual rainfall, pervious and impervious runoff coefficients)
- Event mean concentrations (EMCs)
- Suspended fraction
  - Delivery ratio calculation
- Septic tank (optional)
  - Considers failure rates and associated land uses
- Baseflow (optional)

WMM Data Requirements *(cont.)*

- BMPs
  - Considers type and removal efficiency
- Soil types
  - Pervious runoff coefficient
- Point sources
  - Point source concentration
  - Point source flow (mgd)

WMM Data Requirements *(cont.)*

- Jurisdictional boundaries can be accounted for in the input



WMM Output

- Output provided in lbs/year

Name	Jurisdiction	Tributary Area	DCIA (ac)	DCIA (%)	Loading Factor	Parameter	Units	Stormwater	Baseflow	Point Source	CSO	Total	Storm Water with BMPs	CSOs with Controls	Total with Controls	Reduction (%)
Altn01	Bay Co	6,125	318	5.2		Flow	(ac-ft/yr)	6,072	25,927	0	0	32,000	6,072	0	32,000	0.0
Altn01	Bay Co	6,125	318	5.2	medium	BOD	lbs/yr	49,365	0	0	0	49,365	49,365	0	49,365	0.0
Altn01	Bay Co	6,125	318	5.2	medium	Cd	lbs/yr	11	0	0	0	11	11	0	11	0.0
Altn01	Bay Co	6,125	318	5.2	medium	COD	lbs/yr	8.73E+005	0	0	0	8.73E+005	8.73E+005	0	8.73E+005	0.0
Altn01	Bay Co	6,125	318	5.2	medium	Cu	lbs/yr	216	0	0	0	216	216	0	216	0.0
Altn01	Bay Co	6,125	318	5.2	medium	DP	lbs/yr	1,174	564	0	0	1,738	1,174	0	1,738	0.0
Altn01	Bay Co	6,125	318	5.2	medium	F-Coli	counts/yr	8.81E+013	5.18E+006	0	0	8.81E+013	8.81E+013	0	8.81E+013	0.0
Altn01	Bay Co	6,125	318	5.2	medium	NO23	lbs/yr	5,525	8,886	0	0	14,411	5,525	0	14,411	0.0
Altn01	Bay Co	6,125	318	5.2	medium	Pb	lbs/yr	578	0	0	0	578	578	0	578	0.0
Altn01	Bay Co	6,125	318	5.2	medium	TDS	lbs/yr	1.55E+006	3.81E+006	0	0	5.36E+006	1.55E+006	0	5.36E+006	0.0
Altn01	Bay Co	6,125	318	5.2	medium	TKN	lbs/yr	16,254	7,687	0	0	23,941	16,254	0	23,941	0.0
Altn01	Bay Co	6,125	318	5.2	medium	TP	lbs/yr	1,747	846	0	0	2,593	1,747	0	2,593	0.0
Altn01	Bay Co	6,125	318	5.2	medium	TSS	lbs/yr	3.84E+005	2.82E+005	0	0	6.66E+005	3.84E+005	0	6.66E+005	0.0
Altn01	Bay Co	6,125	318	5.2	medium	Zn	lbs/yr	796	0	0	0	796	796	0	796	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7		Flow	(ac-ft/yr)	39,502	1.5E+005	0	0	1.9E+005	39,502	0	1.9E+005	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	BOD	lbs/yr	4.82E+005	0	0	0	4.82E+005	4.82E+005	0	4.82E+005	0.1
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	Cd	lbs/yr	84	0	0	0	84	83	0	83	0.3
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	COD	lbs/yr	5.73E+006	0	0	0	5.73E+006	5.73E+006	0	5.73E+006	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	Cu	lbs/yr	2,200	0	0	0	2,200	2,199	0	2,199	0.1
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	DP	lbs/yr	9,241	3,329	0	0	12,569	9,237	0	12,566	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	F-Coli	counts/yr	1.77E+015	3.06E+007	0	0	1.77E+015	1.77E+015	0	1.77E+015	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	NO23	lbs/yr	36,348	52,426	0	0	88,774	36,327	0	88,752	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	Pb	lbs/yr	4,622	0	0	0	4,622	4,606	0	4,606	0.3
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	TDS	lbs/yr	9.89E+006	2.25E+007	0	0	3.24E+007	9.89E+006	0	3.24E+007	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	TKN	lbs/yr	1.04E+005	45,352	0	0	1.50E+005	1.04E+005	0	1.50E+005	0.0
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	TP	lbs/yr	14,413	4,993	0	0	19,406	14,402	0	19,395	0.1
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	TSS	lbs/yr	3.08E+006	1.66E+006	0	0	4.75E+006	3.08E+006	0	4.74E+006	0.1
BCk01	Bay Co, Cedar Grove, Panama City, Calhoun Co	36,133	2,765	7.7	medium	Zn	lbs/yr	7,431	0	0	0	7,431	7,422	0	7,422	0.1

Pollutant Load Model

Advantages

- Relatively simple to develop and use
- Can be broken out by jurisdiction
- Evaluates land-based loads (main objective of NRP)
- Public domain software
- Smaller learning curve

Disadvantages

- Simplistic
- Planning level tool
- Represents only the land-based loads, not attenuated loads
- Not to be used for establishing water quality targets or allocations
- May not have value in the long-term

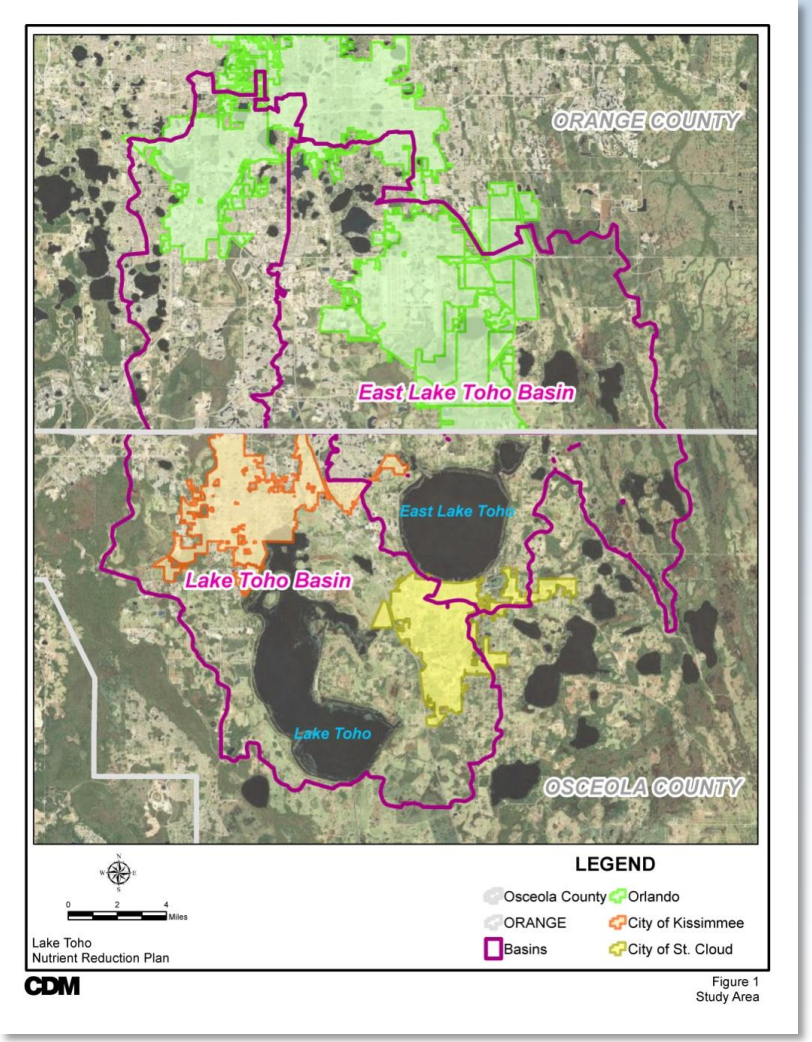
Other Critical Success Factors (Hybrid Approach)

Criteria	HSPF	WMM
Model setup time	Low to Moderate	Moderate
Model run time	Moderate	Low
Level of effort in calibration	Low	Low
Technical defensibility	High	Moderate

Questions and Discussion

Including East Lake Toho in the NRP

- Entire watershed area
  - 445 square miles (285,055 acres)
- Lake Toho (immediate) basin
  - 235 square miles (150,363 acres)
  - 52.8 percent
- East Lake Toho basin
  - 210 square miles (134,693 acres)
  - 47.2 percent



Stakeholder Distribution - Entire Lake Toho Basin

Stakeholder	Lake Toho & East Lake Toho	% Area
City of Orlando	33,363	11.7%
Orange County	93,881	32.9%
Osceola County	120,231	42.2%
City of Kissimmee	13,481	4.7%
City of St. Cloud	9,990	3.5%
GOAA	13,111	4.6%
FDOT	1,000*	0.4%
	285,057	100%

* Assumed

Stakeholder Distribution - Lake Toho Basin (immediate)

Stakeholder	Lake Toho & East Lake Toho	% Area
City of Orlando	14,074	9.3%
Orange County	37,265	24.7%
Osceola County	77,494	51.4%
City of Kissimmee	13,153	8.7%
City of St. Cloud	8,377	5.6%
GOAA	--	--
FDOT	500*	0.3%
	150,363	100%

* Assumed

Major Surface Water Inputs to Lake Toho

- Shingle Creek [Orange County, City of Orlando, Osceola County, City of Kissimmee, RCID (intermittently)]
- City of Orlando, GOAA, Osceola County, City of Kissimmee, City of St. Cloud
  - Boggy Creek and Lake Hart basins
- Other contributing stormwater sources (local, agricultural)

How Should East Lake Toho Be Considered?

- Point source discharge to Lake Toho (WMM)
  - Average annual flow rate
  - Average annual nutrient concentrations
- Represent East Lake Toho subbasin in its entirety
  - Perform loading analysis
  - Impaired for nutrients (TSI) with medium priority for TMDL development (5 to 10 years)

Advantages/Disadvantages of East Lake Toho Inclusion

Advantages

- Establishes baseline loading for entire watershed area
- Projects planned in ELTW will have calculated reduction credits
- Projects within ELTW can receive credit under both LT and ELT impairments

Disadvantages

- Higher level of effort

Advantages/Disadvantages of East Lake Toho Exclusion (i.e., Point Source)

Advantages

- Minimal effort

Disadvantages

- Will require sufficient historical records (flow and water quality) to estimate point source load
- Point source load is a constant
- Project load reductions in ELTW cannot be translated into an attenuated load reduction (i.e., point source load calculation)
- Stakeholders within both basins will not know the total jurisdictional load contribution within entire watershed

East Lake Toho Inclusion

- Other considerations
  - A 47 percent reduction in area does not translate to a 1:1 reduction in level of effort for the NRP effort

Questions and Discussion