Florida Department of Environmental Protection

Indian River Lagoon Total Maximum Daily Load (TMDL) Refinement

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Topics

- **Request for nutrient TMDL refinement for the Indian River Lagoon.**
- **Refinement of TMDL targets.**
- **Spatial Watershed Iterative Loading (SWIL) model.**
- **Summary.**

Request for IRL TMDL Refinement

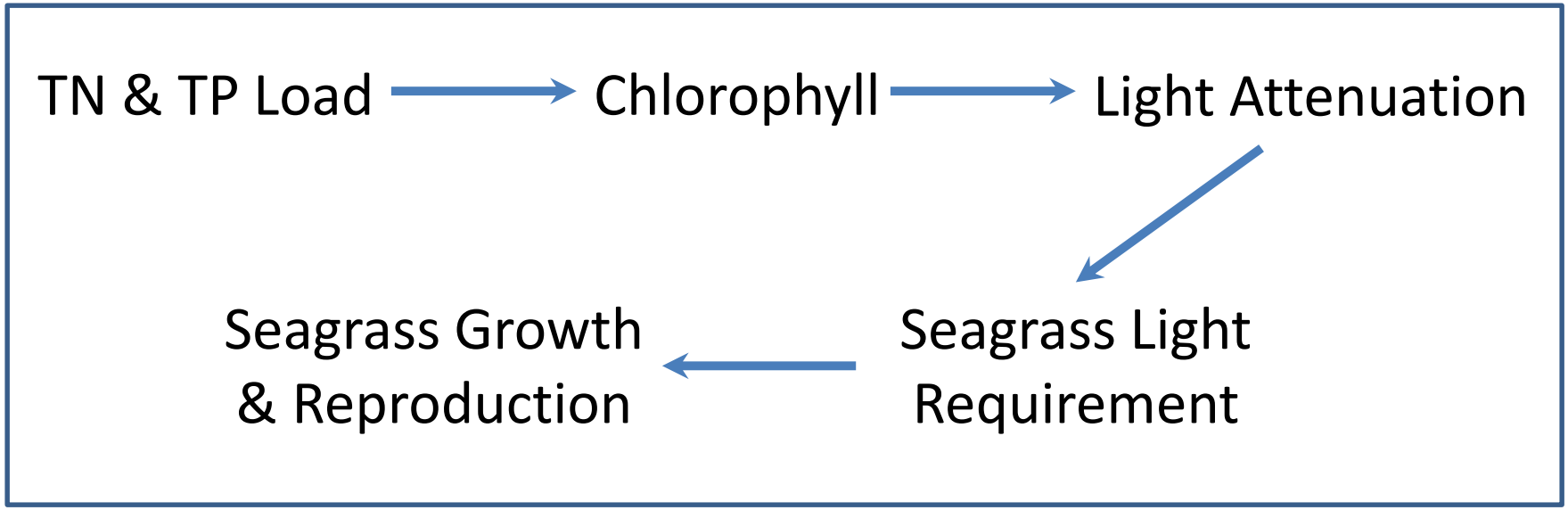
- **Nutrient and dissolved oxygen TMDLs for the main stem of the Indian River Lagoon (IRL) system became effective in March 2009.**
- **During the development of the basin management action plan (BMAP), comments about the TMDLs were raised by stakeholders.**
- **Since mid-2011, many meetings, teleconferences, documents/comments/responses, and email exchanges have taken place between Brevard County/local consortium/consulting companies and Florida Department of Environmental Protection (FDEP)/St. Johns River Water Management. District (SJRWMD) regarding TMDL refinements.**
- **TMDL refinement discussions are focused on two major aspects:**
    - **TMDL target refinement; and**
    - **TMDL load simulation refinement.**

TMDL Target Refinement Discussions

TMDL Target Refinement

- **In late 2012, FDEP received a Technical Approach Document (TAD) from Brevard County about the approach to be used to refine the TMDL nutrient target setting.**
- **The TAD described:**
  - **A conceptual model characterizing the nutrient impact in the IRL system that provided the basis on using the chlorophyll as a benchmark to set the nutrient targets.**
  - **Nutrients, chlorophyll, and seagrass temporal trends in the IRL system to identify a "reference time period" (2001 to 2008) to set the chlorophyll a target.**
  - **Functional relationship between nutrients and chlorophyll to be used to set the nutrient target.**
  - **Potential inter-segments nutrient transfer to refine the nutrient mass-balance budget.**

Brevard County Proposed Conceptual Model



Brevard County suggested that:

While the model used in the previous TMDLs provided a direct link from total nitrogen (TN) and total phosphorus (TP) loads to resultant depth targets, it is inherent in the model that the only impact that reductions in TN and TP loads can have directly upon depth limits, or light limitation, is through changes in chlorophyll a.

FDEP Concerns

- **The conceptual model assumed that the only impact of nutrients on the seagrass community is through chlorophyll while, in reality, nutrients may also impact epiphytes and macro-algae, which in turn, may influence the seagrass distribution.**
- **The existing TMDLs based on the seagrass pollutant load reduction goal (PLRG) uses a holistic approach that links seagrass dynamics directly to the nutrient loads, implicitly taking into consideration of all the interactions among system components.**
- **Using a reductionistic approach to study the dynamics of all individual system components may not be supported by data availability.**
- **Setting nutrient targets only based on chlorophyll may not address all aspects of the nutrient impact on the seagrass community. Seagrass parameters need to be included in target setting.**
- **Setting 2001-2008 as the "reference period" should be supported by evidence that seagrass not only recovered during this period, but also met the restoration target.**
- **Seagrass matrices should be explicitly included in the target setting process.**

Brevard County Revised TAD

- In June 2013, FDEP received the revised TAD from Brevard County.
- The revised TAD proposed to:
  - Change the "reference time period" approach to "reference time/segment" approach to define the reference condition.
  - Define the "reference condition" based on three criteria:
    1) Site-specific seagrass depth and water clarity targets to achieve 20% of surface light at the mean depth of the deep edge of seagrass beds;
    2) Chlorophyll a concentration not to exceed 20 ug/L > 10% of the time based on annual data; and
    3) Dissolved oxygen (DO) not less than 4.0 mg/L or 42% saturation as a water column average 90 percent of the time.
  - Use 1996 – 2008 as the period of record for selecting the "reference condition" time/segments.
  - Define the target chlorophyll a, TN, and TP concentrations based on the "reference time/segment" data.
  - Use the target chlorophyll a and the functional relationship between chlorophyll a and TN and TP loads to define the TN and TP loading targets.

FDEP Concerns About the Revised TAD

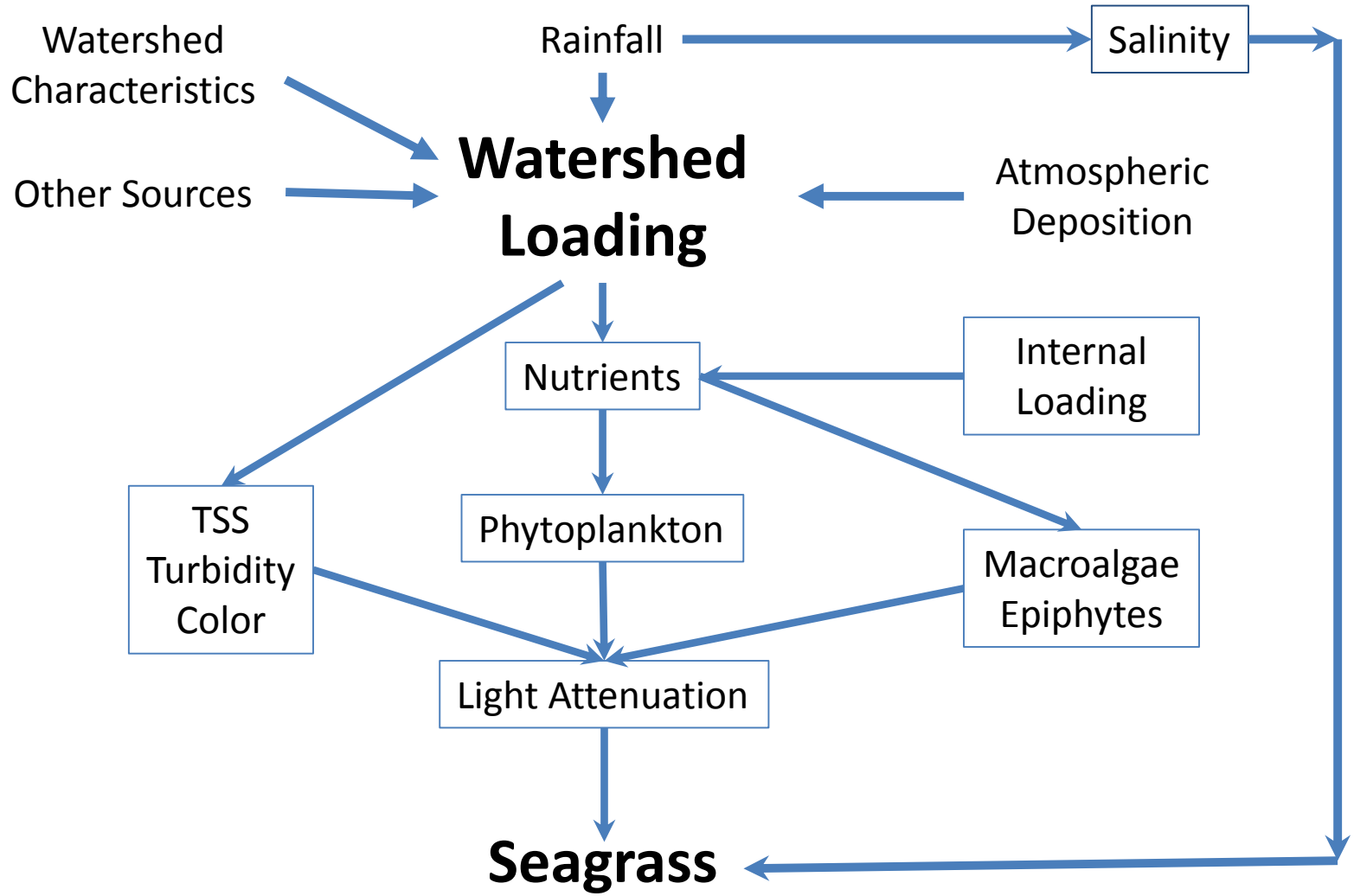
- **No seagrass matrices were included in the nutrient targets setting.**
- **Selecting the "reference condition" based on the water column percent light attenuation assumes that the only impact that nutrients may have on the seagrass community is through influencing the water column processes (e.g. chlorophyll concentration), which precludes the other primary producer components also impacted by nutrient loads and may influence seagrass community through non-water column processes (e.g. epiphytes and macro-algae).**
- **When IRL waters were verified for seagrass impairment, only two lagoon segments were listed for chlorophyll impairment. The threshold used at the time is 11 ug/L. Using 20 ug/L to select the reference condition is not sufficiently protective for seagrass communities.**

FDEP Concerns About the Revised TAD

- **FDEP also presented to the County that the chlorophyll a concentrations in "reference condition" time/segment were not significantly different from the non-reference condition time/segment, suggesting chlorophyll a alone might not be the best indicator to characterize the health condition of seagrass community.**
- **FDEP reiterated its stance in a meeting with Brevard County in September 2013 that seagrass matrices should be explicitly included in the target setting.**
- **Brevard County/Consultant agreed to revise the conceptual model at the meeting.**

Brevard County Revised Conceptual Model

Discussion at the Brevard/FDEP August 20, 2014 Meeting



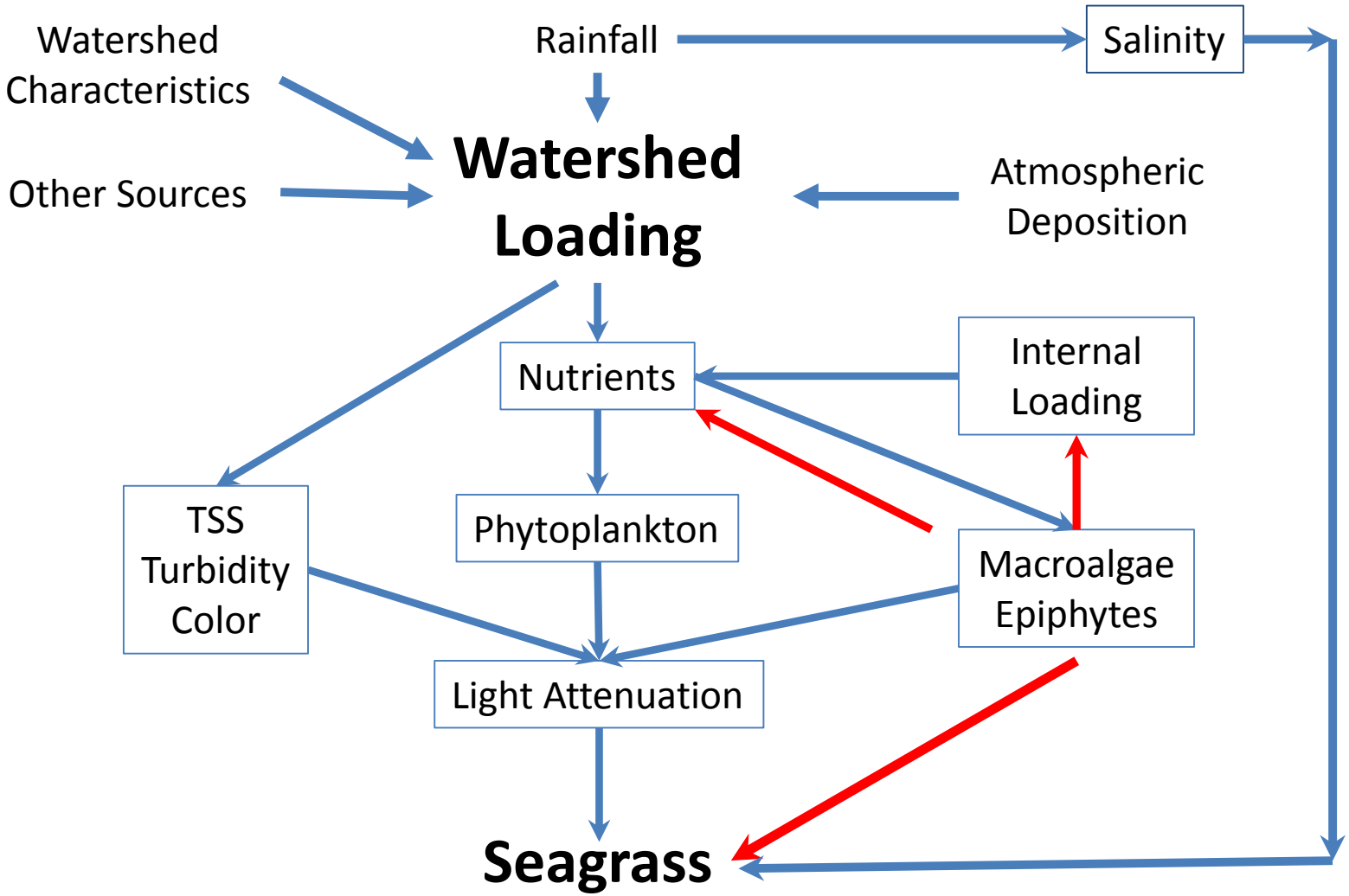
Brevard County Revised Conceptual Model

- **Added macro-algae/epiphyte components into the model.**
- **Called for including nutrient loads from all sources into the consideration of the functional relationship among nutrient loads and biological responders:**
  - **Watershed nonpoint source loads;**
  - **Point source loads;**
  - **Atmospheric direct deposition;**
  - **Ground water seepage loads;**
  - **Internal loads; and**
  - **Possible inter-segment nutrient transfer.**
- **Use a hydrodynamic model [Curvilinear Hydrodynamics in 3-Dimensions (CH3D) or Environmental Fluid Dynamics Code (EFDC)] to estimate inter-segment transfer.**
- **Explore using a mass-balance approach to estimate internal loads.**

The Need to Re-Analyze The Nutrient-Seagrass Functional Relationship

- **Also, at the meeting in August 2014, the County called for using lagoon segment-specific loading results to conduct the analysis on the functional relationship, instead of combining lagoon segments into sub-lagoons.**
- **More seagrass data have been collected and the expanded data set and period of record warrant re-analyzing the seagrass depth-limit vs. nutrient load relationship.**
- **The County also called for using nutrient loads normalized using the volume or area of receiving lagoon segments to conduct the functional relationship analyses instead of using the nutrient loads normalized with watershed areas.**
- **The high sensitivity of the regression to some data points and "outliers," and the frequency of data points falling outside the predicted confidence intervals caused high uncertainty in the relationship model.**

FDEP Comments on The Revised Conceptual Model



FDEP Comments on The Revised Conceptual Model

- **A link should be established directly between the macro-algae/epiphytes component and seagrass.**
- **The impact of macro-algae/epiphytes on seagrass may not be directly quantifiable by just looking at the water column light attenuation.**
- **The impact of macro-algae on seagrass could be positive (when macro-algae reduce water column nutrient concentration through process like reducing nutrient resuspension) or negative (when increasing nutrient in the water column through massive macro-algae die-out).**
- **Again, FDEP cautioned that using the reductionistic approach to examine the characteristics of each system components may not be supported by the data availability.**
- **FDEP welcomed the County's effort to include all nutrient sources into consideration.**
- **Seagrass should be included explicitly in the target setting.**

FDEP Comments on Re-Analyzing The Functional Relationship

- **FDEP realized the uncertainty of the existing regression equations that are associated with the low degree of freedom caused by the lack of data at the time the TMDLs/PLRGs were developed.**
- **FDEP agreed that more data should be included to re-analyze the functional relationship.**
- **Seagrass matrices should be part(s) of the regression analyses.**
- **FDEP clarified that, besides the seagrass depth-limit, other seagrass matrices, including seagrass coverage, density, distance to the deep edge of canopy, maximum depth, etc. could also be included in the analyses.**
- **FDEP also raised a question, since nutrient from all sources will be included in the analyses, whether we should re-consider the previous decision that the data from the bloom period should be excluded.**

The Same Revised Conceptual Model Was Presented to Both SJRWMD and FDEP on November 18, 2014

- This meeting also discussed how to include seagrass matrices into the functional relationship analyses.
- Combining all the seagrass matrices into a single one seagrass index for the functional relationship analyses was discussed at the meeting.
- Another suggestion was to include different seagrass matrices separately in the multivariate regression analyses, and gradually remove the non-responding seagrass matrices and keep the most sensitive one(s).
- SJRWMD suggested that seagrass coverage data should be preferred over the transect data because it is hard to interpolate the transect data into seagrass coverage characteristics.
- The meeting also discussed using possible multiple lines of evidence approach to set the target. Other than seagrass matrices, results from an optical model currently under development by SJRWMD may also be used for target setting.

Other Topics Covered in The Meeting on November 18, 2014

- **How to quantify the atmospheric deposition loading.**
- **Update on the SWIL model development.**
- **Potential reassessment of the existing lagoon segmentation system for target setting process.**
- **SJRWMD's efforts in developing the EFDC hydrodynamic model and possible use of this model to estimate the inter-segment nutrient transfer.**
- **A mass-balance approach to estimate the possible internal nutrient loads.**

Other Topics Covered in The Meeting on November 18, 2014

- **Brevard County and consultants will explore ways to interpret macro-algae data into nutrient impact.**
- **It was agreed that the refined TMDLs will address the long-term average trend of the seagrass community. Occasional phenomenon such as the super algal bloom will not be covered by the refined TMDL. The data range used for the target setting will be from 1995 through 2010. The bloom period data will be excluded.**
- **Next meeting among Brevard/consultants and SJRWMD/FDEP will be held in January 2015.**
- **In January, Brevard County will present preliminary results on the seagrass matrix analyses.**

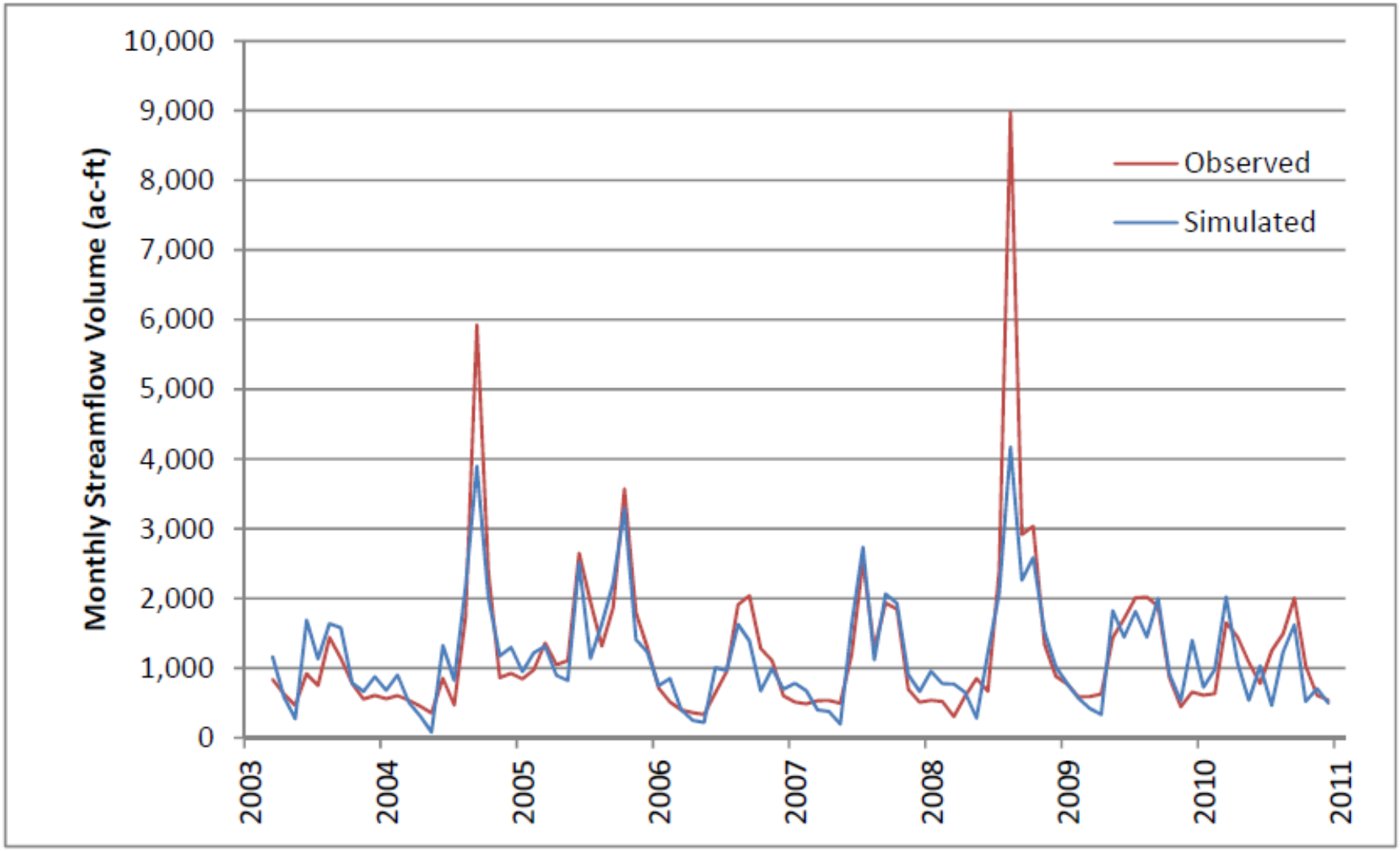
TMDL Loads Simulation Refinement

SWIL Model Development and Refinement

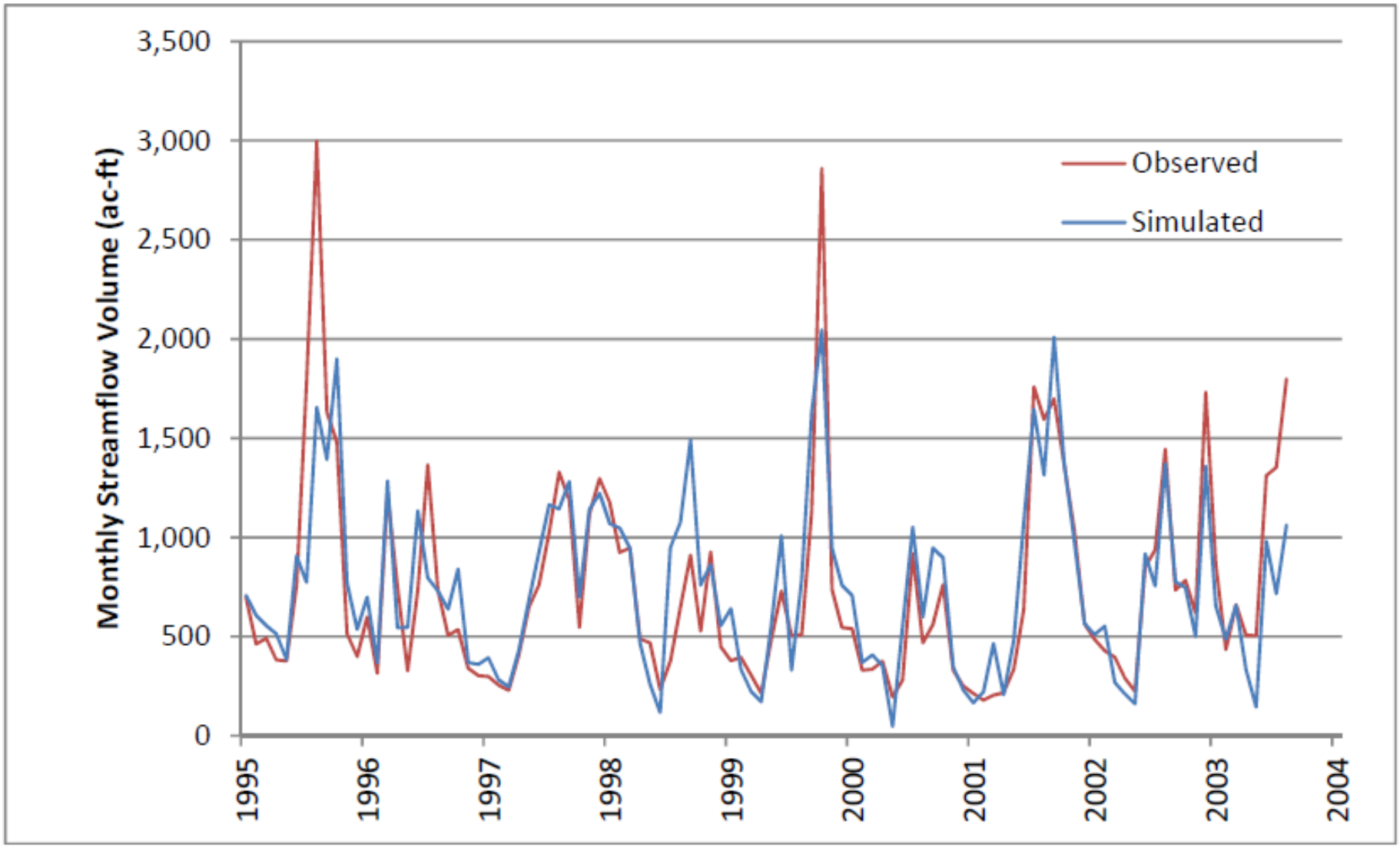
SWIL Model Develop and Refinement

- **FDEP reviewed the technical report from the Environmental Research & Design (ERD) on the theoretical frame work of the SWIL model and provided comments and feedback.**
- **FDEP reviewed the SWIL model structure and Python coding from Applied Ecology, Inc. (AEI) and provided feedback.**
- **FDEP found SWIL model improved the watershed loading simulation in numerous regards:**
  - **Enhanced the rainfall data spatial resolution to address the spatial heterogeneity of the rainfall in the Indian River Lagoon.**
  - **Took into consideration of the soil antecedent moisture condition when simulating the runoff.**
  - **Simulated the surface runoff and baseflow load separately.**
  - **Used data from multiple sources to verify the land use accuracy.**
  - **Updated soil information from the Natural Resource Conservation Service (NRCS) 1999 soil data to 2010 data.**
  - **Simulated monthly flow and loads instead of just annual.**

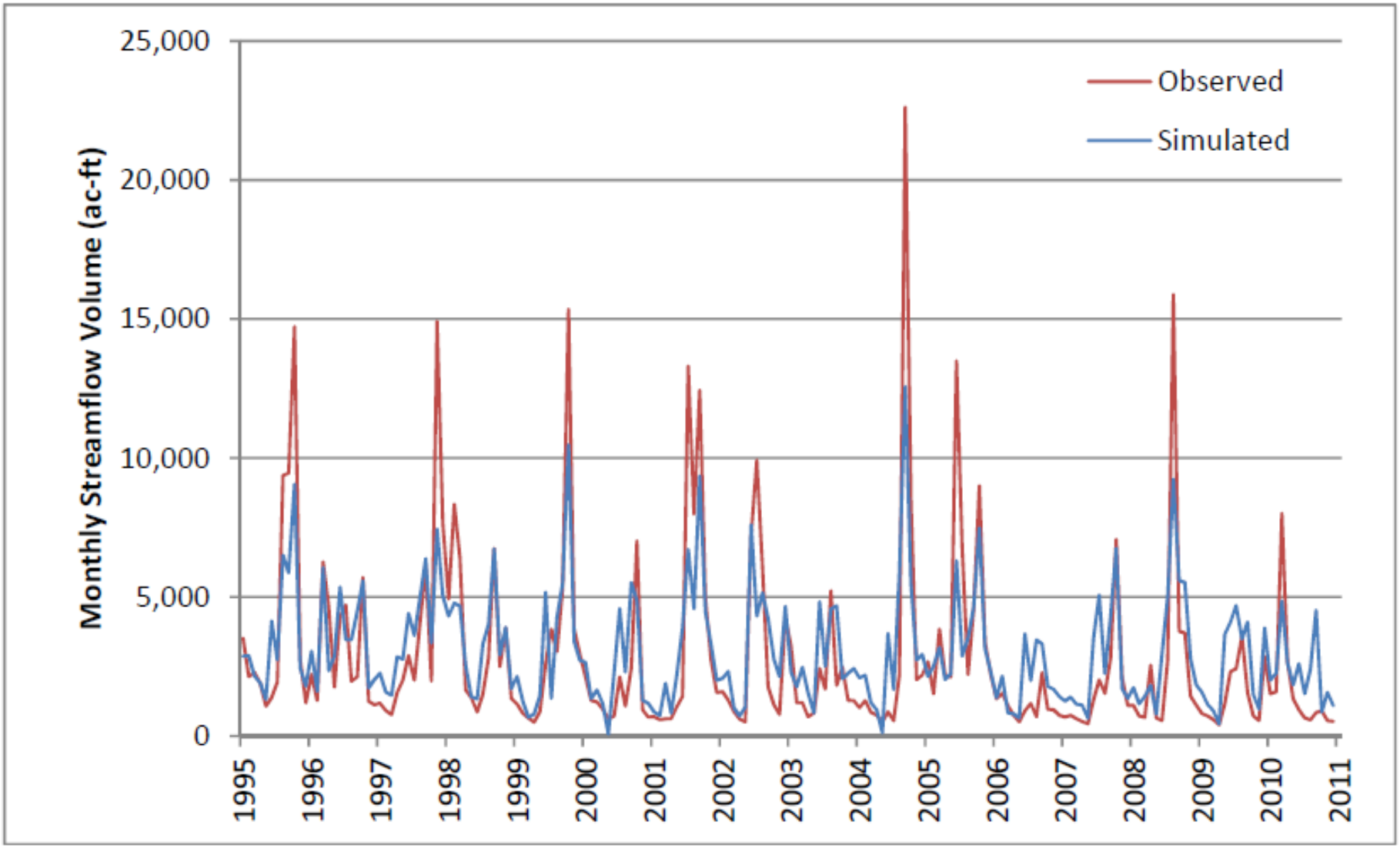
Crane Creek Total Flow Calibration



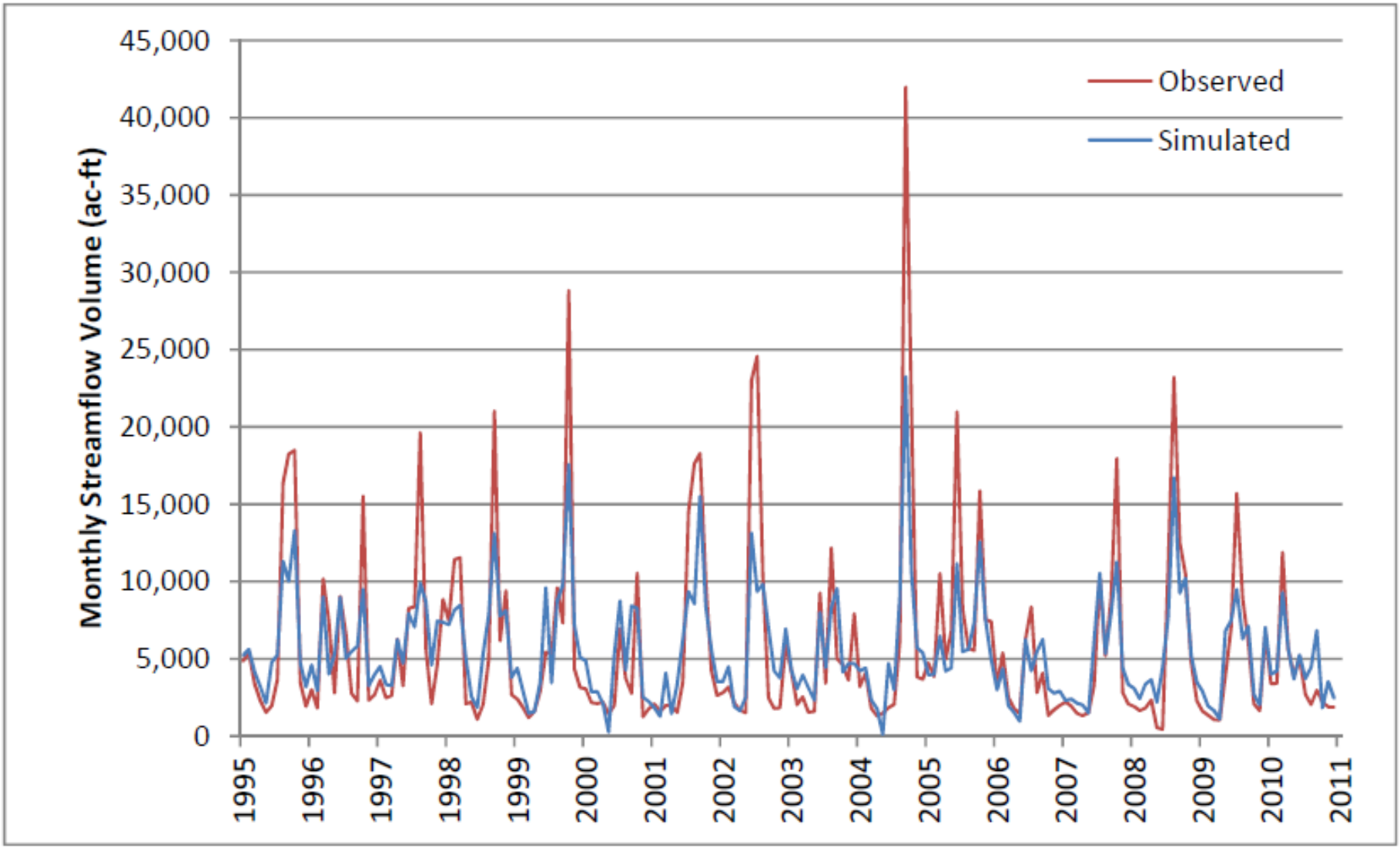
Hickory Creek Total Flow Calibration



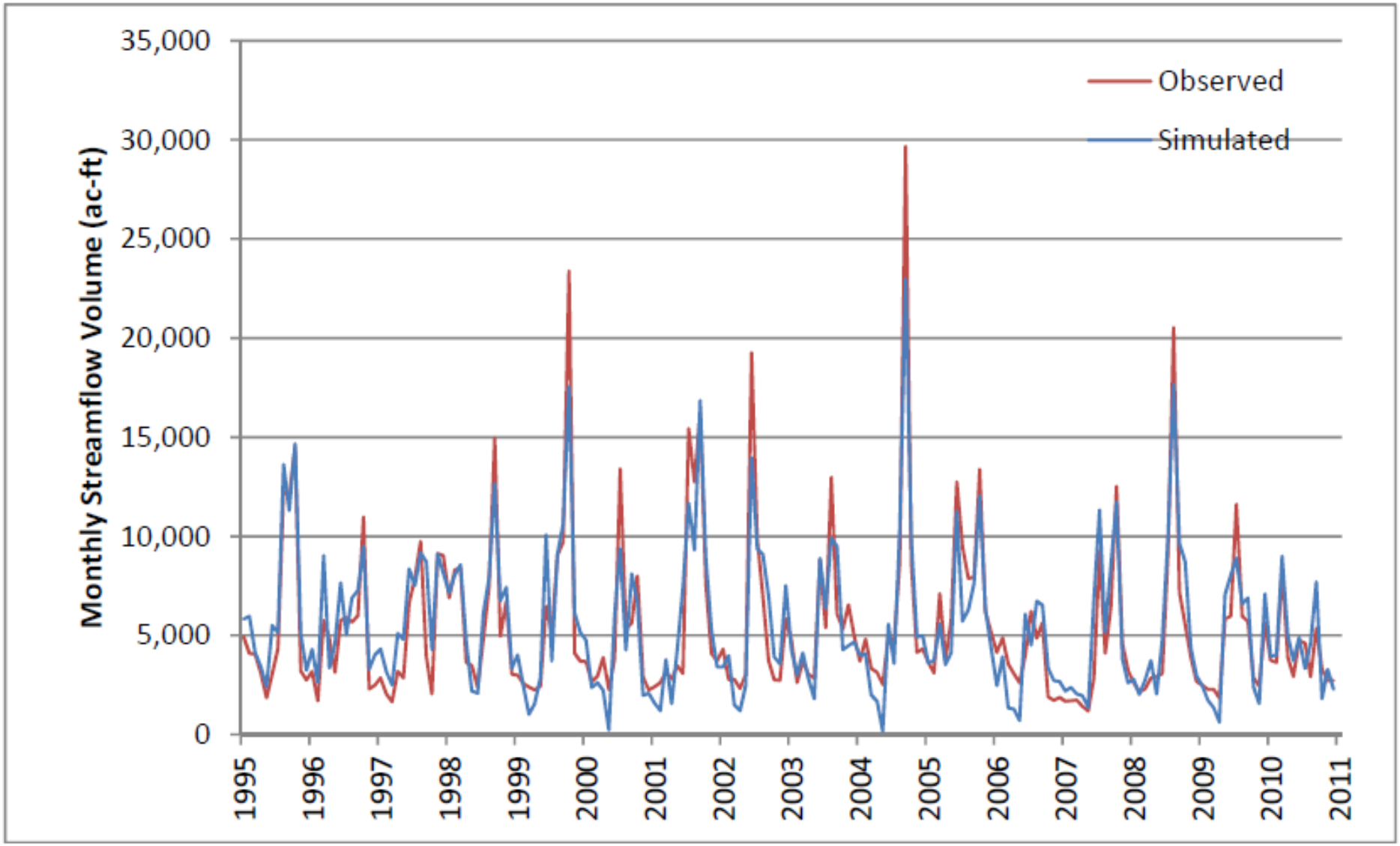
North Prong Total Flow Calibration



South Prong Total Flow Calibration



Fellsmere Total Flow Calibration



No Water Quality Calibration Has Been Provided So Far

Other Discussions

- Double-counting BMP treatment efficiency.
- Inconsistency between the equation and parameter values used in the model and those included in the modeling report.
- Upland loading vs. water land use loading.
- Sensitivity of model coding to the version change of ArcGIS.
- How to get the model to run more efficiently.
- To calibrate the model results, watersheds of calibration stations have to be incorporated into the model as part of the model source data set.
- There is no easy way to allocate the simulated load results to just any jurisdiction boundaries. Jurisdiction boundaries have to be added before running the model as model inputs or the model has to be reset to simulate the jurisdictional loads.
- Some model assumptions may need to be tested in the future with more data collection. For example, the mass-balance approach to estimate the baseflow contribution.

Summary of the TMDL Refinement Process To Date

Summary

- **The target refinement process will include seagrass matrices into the functional relationship analyses.**
- **Multiple seagrass matrices will be explored to identify the most responsive one to nutrient loads.**
- **Multiple lines of evidence approach will also be considered.**
- **Nutrient loads from as many sources will be included in the analyses.**
- **Nutrient data from the recent bloom period will not be included in the TMDL refinement process.**

Summary

- **FDEP welcomes Brevard County's effort in developing and refining the SWIL model.**
- **Based on information from AEI, significant improvements have been made to refine the SWIL model, such as converting the tool box + Python code model into a Python code only model, which greatly improved the model performance efficiency.**
- **All comments provided by FDEP have been addressed in the model code revision.**
- **ERD has refined the runoff coefficient from long-term average monthly runoff coefficient to monthly runoff coefficient to improve the flow simulation.**
- **Water quality calibration is now underway.**
- **The next meeting to review the latest analyses will be held in January 2015.**

Florida Department of Environmental Protection

Indian River Lagoon (IRL) Basin Management Action Plans (BMAPs)

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December 5, 2014





Agenda

- Update on credit for new nutrient reduction projects.
- Update on 2013 seagrass mapping.

New Nutrient Reduction Projects Credit

Summary of Initial Efficiencies

BMP	TN Reduction Efficiency	TP Reduction Efficiency
Septic tank phase out	ArcNLET Model	ArcNLET Model
Denitrification wall	BMPTrains Model	BMPTrains Model
Biosorption activated media (BAM)	BMPTrains Model	BMPTrains Model
Muck removal	Guidance document	Guidance document
Aquatic harvesting	Guidance document	Guidance document
Green roof	45% (without cistern) 60% (with cistern)	N/A
Rain garden	30%	30%
Tree box	38%	50%
Bioswale	38% (Nitrate)	9%
Buffers	22% (less than 40 m) 27% (greater than 40 m)	N/A

Summary of Initial Efficiencies, continued

- Living shoreline
- Macroalgal harvesting
- Natural wetlands as filters
- Oyster reefs
- Seagrass planting
- Code changes/Economic incentives
- Reclaimed water
- Enhanced education
- Plugging artesian wells
- Retention of larger storm events

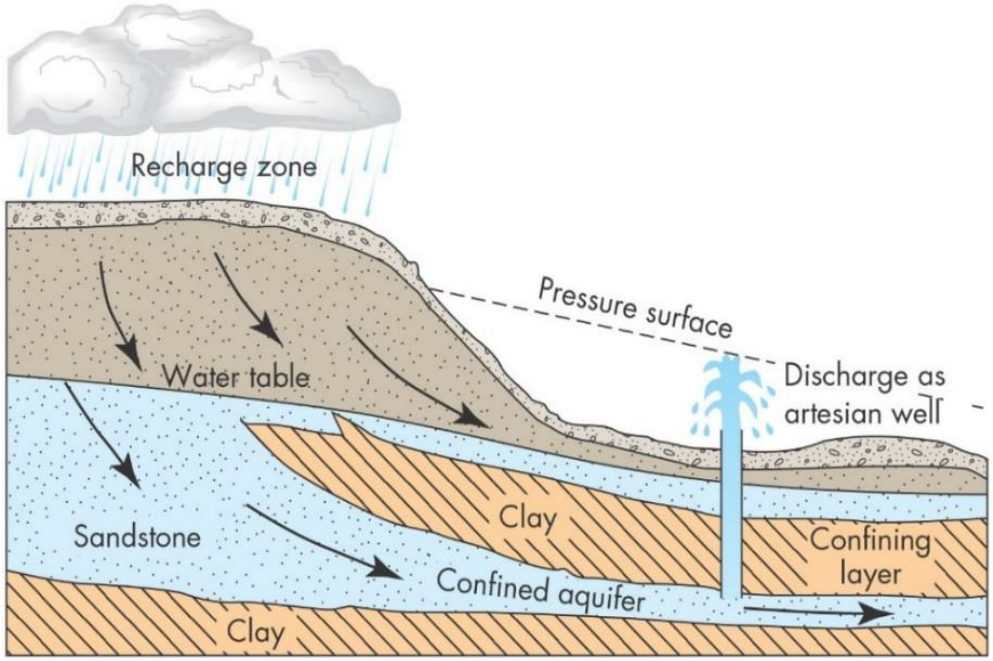
New Information

- July meeting - Several stakeholders noted that they had additional information about some of the BMPs.
- Since that time, FDEP received information from stakeholders on:
  - Plugging artesian wells
- FDEP has also done research on oyster reefs

Plugging Artesian Wells

- **What is an artesian well?**
  - Well working by natural pressure: well drilled through impermeable rocks into strata where water is under enough pressure to force it to surface without pumping.

- **Description of BMP:**
  - Plugging abandoned, free-flowing, artesian wells to reduce nutrient impacts.



(b)

Plugging Artesian Wells, continued

- Brevard County & Satellite Beach submitted information for consideration.
- FDEP contacted SJRWMD concerning artesian well plugging program.
- Based on the information and discussions plugging artesian wells:
  - Helps with water quantity but reductions are limited.
  - Helps prevent saltwater intrusion
- FDEP is open to reviewing additional data, if available.

Oyster Reefs

- Oysters are filter feeders and remove suspended solids from the water column.
- Nitrogen removed is partially via sequestration of nitrogen in both the shell and tissue mostly from denitrification services that the oysters provide.
- FDACS Aquaculture Division:
  - State agency experts.
  - FDEP reached out for assistance.

Oyster Reefs, continued

- Based on conversations with FDACS, denitrification through oysters:
  - Requires large amounts/high density of oysters to uptake nitrogen and then be harvested.
  - Shells/tissue should not be returned to water.
- Oysters can contribute to nutrient reduction but reductions are limited, variable, and under studied at this time.
- Based on literature the potential nutrient removal efficiencies provided by oysters is small for a basin wide approach but may have larger impacts on a local scale.

Oyster Reefs, continued

- FDEP is open to reviewing additional data, if available.
- FDACS recommends that when testing oyster nutrient sink capabilities, the test sites should be in approved shellfish waters to avoid human consumption concerns.
  - FDACS Aquaculture Division has maps of approved areas.

Next Steps

- FDEP would like to work with stakeholders to:
  - Refine efficiency numbers
  - Determine efficiencies for BMPs that cannot be quantified at this time. Data related to these projects should be submitted to FDEP.
  - Collect information on new projects and work with stakeholders to ensure proper monitoring

2013 Seagrass Mapping

Seagrass Evaluation

- Evaluation of seagrass depths for compliance with targets = two step process:
  - Uses last four mapping years of data 2007, 2009, 2011, and 2013.

- Step 1 Cumulative frequency distribution analysis (in progress):
  - Compliance = at least 50% or more of the assessment years' frequency distribution curve (including its 50th percentile value) lies on or to the right of the TMDL depth limit target curve.

- Step 2 Median seagrass depth comparison:
  - Compliance = three of the four assessment years' medians must meet or exceed the TMDL median.

Seagrass Evaluation

- When a project zone is both Step 1 and Step 2 compliant, it is considered to be meeting the TMDL seagrass depth limit target. If a project zone fails to meet either Step 1 or Step 2, it is not considered to be meeting the TMDL seagrass depth limit target for that set of assessment years.

Step 2 Assessment – BRL

Year	BRL A Median Depth (meters)	BRL B Median Depth (meters)
TMDL Median	1.58	1.41
2007	1.81*	1.32
2009	1.78*	1.32
2011	0.71	0.62
2013	0.81	0.84
Step 2 Compliant?	No	No

* Meets or exceeds the TMDL median

Step 2 Assessment – North IRL

Year	North A Median Depth (meters)	North B Median Depth (meters)
TMDL Median	1.44	1.51
2007	1.23	1.39
2009	1.17	1.39
2011	1.05	0.93
2013	1.02	1.17
Step 2 Compliant?	No	No

* Meets or exceeds the TMDL median

Step 2 Assessment – Central IRL

Year	Central A Median Depth (meters)	Central SEB Median Depth (meters)	Central B Median Depth (meters)
TMDL Median	1.27	1.20	1.15
2007	1.39*	1.27*	1.27*
2009	1.32*	1.27*	1.34*
2011	0.96	0.89	0.97
2013	1.14	0.99	1.09
Step 2 Compliant?	No	No	No

* Meets or exceeds the TMDL median

Seagrass Acreages by Project Zone - BRL

Mapping Year	BRL A Acres of Seagrass by Year	BRL B Acres of Seagrass by Year
2003	11,877	9,392
2005	11,869	9,309
2006	12,184	10,580
2007	12,201	11,829
2009	12,291	11,516
2011	2,127	1,030
2013	3,399	2,052

Seagrass Acreages by Project Zone - North IRL

Mapping Year	North A Acres of Seagrass by Year	North B Acres of Seagrass by Year
2003	14,630	5,688
2005	14,673	5,648
2006	15,047	6,063
2007	15,229	5,854
2009	14,753	5,969
2011	13,167	2,275
2013	12,679	3,831

Seagrass Acreages by Project Zone – Central IRL

Mapping Year	Central A Acres of Seagrass by Year	Central SEB Acres of Seagrass by Year	Central B Acres of Seagrass by Year	Fort Pierce Acres of Seagrass by Year
2003	2,006	3,308	2,559	2,914
2005	1,976	3,414	2,576	2,814
2006	2,063	3,686	3,001	2,877
2007	2,307	3,789	3,786	2,886
2009	2,225	3,643	3,462	2,882
2011	229	1,250	1,357	2,515
2013	860	1,507	1,889	2,782

Questions on Seagrass Mapping

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