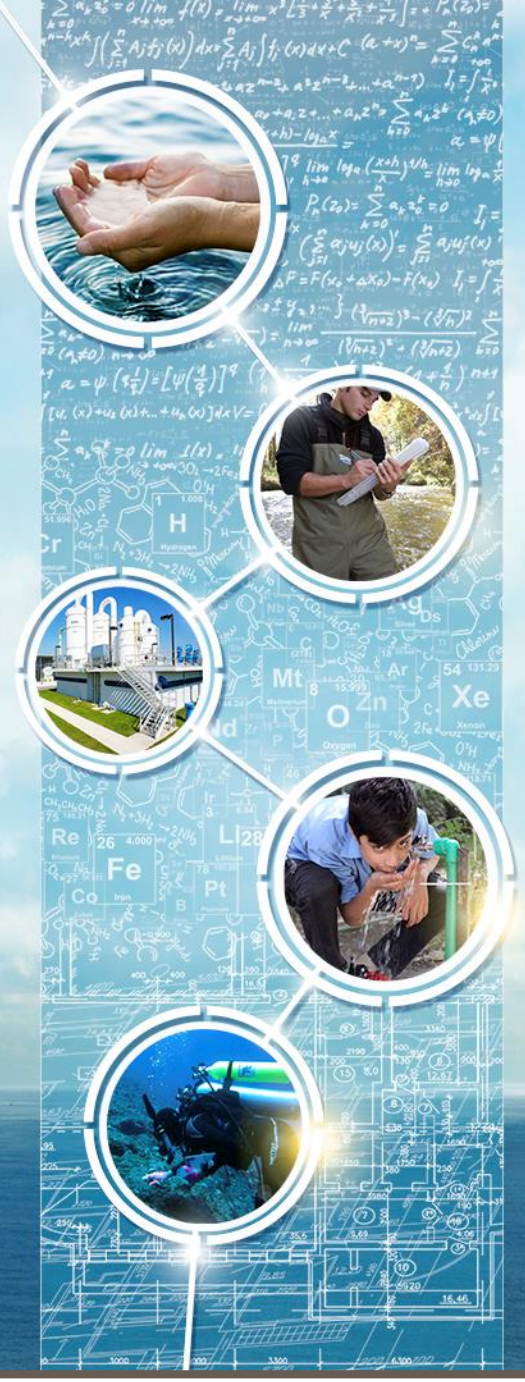

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Caloosahatchee River Basin Modeling Support – Task 1 Model Evaluations

March 11, 2016

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Project Background

Background

- During BMAP development, the stakeholders had concerns about the models used for the TMDLs:
  - Agricultural pumping for irrigation.
  - Streams with reversing flows.
  - Model time period.
  - Stations for calibration.
  - Outdated land use coverage.

- TMDLs developed using the following models:
  - Hydrologic Simulation Program – Fortran (HSPF).
  - Environmental Fluid Dynamics Code (EFDC).

Project Overview

- Tetra Tech and AMEC were contracted by the department to evaluate and revise the existing models.

- The project goals are to update the models for use in:
  - Refining the Caloosahatchee tidal estuary TMDLs that the department adopted in 2009.
  - Developing TMDLs for other impaired waterbodies within the basin.

Impaired Waterbodies

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WBID	Waterbody Segments	Waterbody Type	Impairment
3246	C-21 Canal	Stream	DO, Nutrients/Chla
3235D	Jacks Branch	Stream	Nutrients/Chla
3235G	Cypress Branch	Stream	DO
3235L	Townsend Canal	Stream	DO, Nutrients/Chla
3235B	Caloosahatchee River between S-79 and S-78	Stream	Nutrients/Chla
3237B	Long Hammock Creek	Stream	Nutrients/Chla
3237C	Lake Hicpochee	Lake	DO
3237D	Ninemile Canal	Stream	DO
3240A	Caloosahatchee (Tidal Segment 1) (TMDL Revision)	Estuary	Nutrients/Chla (2009 TMDL)
3240A2	Cape Coral	Stream	Historic Chla
3240A4	Deep Lagoon Canal	Estuary	DO, Nutrients/Chla
3240B	Caloosahatchee (Tidal Segment 2) (TMDL Revision)	Estuary	Nutrients/Chla (2009 TMDL)
3240C	Caloosahatchee (Tidal Segment 3) (TMDL Revision)	Estuary	Nutrients/Chla (2009 TMDL)
3240J	Billy Creek	Estuary	DO
3240Q	Popash Creek	Stream	DO, Nutrients/Chla

Project Timeline

- Task 1. Evaluate HSPF and EFDC Model Integrity and Development of Project Templates
  - Draft memo submitted to department on February 26th.
  - Site visit and stakeholder meeting March 9th through March 11th.
- Task 2. Evaluate Current HSPF Hydrology Calibration and Recalibration of HSPF Model
  - Draft memo due to department end of April 2016.
- Task 3. Evaluate HSPF Water Quality Model Calibration and Recalibration of HSPF Water Quality Model
  - Draft memo due to department in mid-July 2016.

Project Timeline, continued

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- Task 4. Convert the Existing Proprietary EFDC Model into a Public Domain Application and Incorporate the Light Module
  - Underway – Draft memo due to department today.

- Task 5. Evaluate the EFDC's Existing Hydrodynamic Model Calibration and Recalibration of EFDC Hydrodynamic Model
  - Draft memo due to department in mid-May 2016.

- Task 6. Evaluate the EFDC's Existing Water Quality Model Calibration and Recalibration of EFDC Water Quality Model
  - Draft memo due to department in mid-August 2016.

Project Timeline, continued

- Task 7. Create a Background Land Use Plus Lake Okeechobee Meeting its TMDL Scenario Run
  - Draft memo and model runs due to department in mid-October 2016.
- Task 8. Communications and Meetings
  - Occurs throughout to coordinate with the department and stakeholders.
- Task 9. Documentation Final Report
  - Draft report documenting revisions and recalibration of models due to department in early January 2017.
- Task 10. Training and Department Staff Support
  - Training and technological transfer for HSPF and EFDC models.
  - Project completed end of February 2017.

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Task 1 Findings

Task 1 Goals

- Review the HSPF and EFDC models for:
  - Conceptual structure.
  - Delineations.
  - Input files.
  - Parameterization.
  - Reaches with bidirectional flow.
- Review comments raised by stakeholders and identify steps to address concerns.
- Suggest possible model revisions and recalibration needs.
- Develop templates for evaluation comparisons, memos, and reports.
- Recommend model performance criteria.

Model Terminology

- Original Dynamic Solutions/CDM model – 2009 Model.
- Department's updated version – 2014 Model.
- Revised and recalibrated model – 2017 Model.

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HSPF Model Review

HSPF General Overview

- Structure simulates instream hydrology and water quality conditions for the Caloosahatchee River and its tributaries.
- Segmentation and hydraulics seem reasonable for the F-Table representation of reaches.
- Bidirectional flow is not represented in streams where it occurs.
- Meteorological data used in the model appears reasonable.
- Nine point sources are included, seven are reuse.
- Most of the hydrologic and sediment parameters are within recommended ranges.

Proposed Revisions

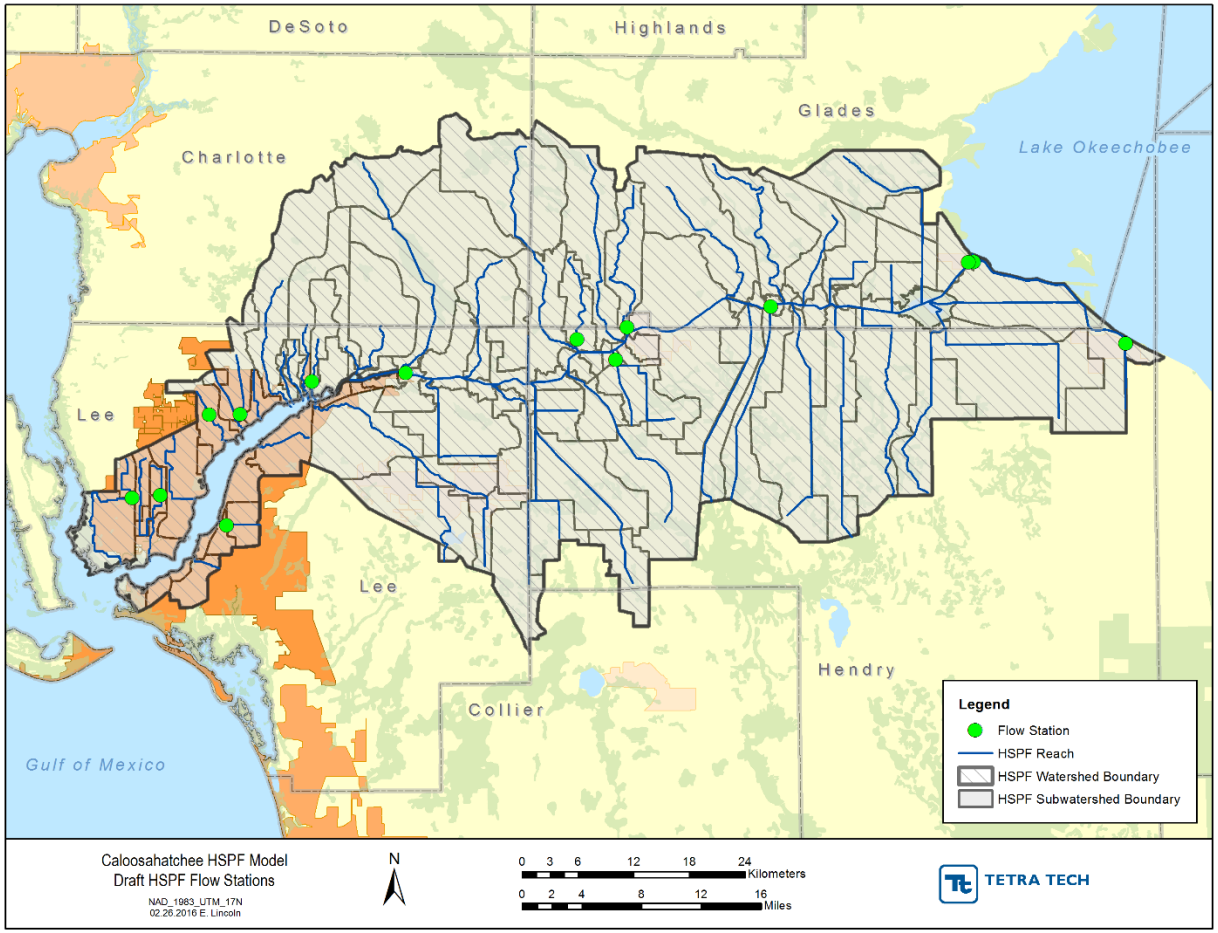
- Issue: HSPF simulation period ends in 2011.
  - Proposed Revision: Extend simulation through the end of 2014.
- Issue: Model watershed delineations and reach segmentation are not correct or adequate.
  - Proposed Revision: Modify the Deep Lagoon Canal watershed based on input from Lee County.
  - Proposed Revision: Delineate subbasins to flow and water quality calibration stations.
- Issue: Priority reaches with bidirectional flow.
  - Proposed Revision: Overlay simplistic EFDC model grid over critical HSPF model reaches upstream of S-77.
  - Proposed Revision: Extend current Caloosahatchee EFDC model grid to capture the bidirectional flows in priority reaches downstream of S-77.
    - Cape Coral canals, Billy's Creek, Orange River, and Yellow Creek.

Proposed Revisions, continued

- Issue: Septic systems are not represented.
  - Proposed Revision: Will include functioning and failing septic systems in HSPF model. Number and locations will be determined using FDOH and/or local county data.
- Issue: The incorrect NPDES permitted point sources are represented.
  - Proposed Revision: Only facilities with surface water discharges to freshwater streams will be included:
    - FL0037541 (Jahna Ortona Mine), FL0040088 (Cape Coral RO WTP), FL0040665 (Clewiston WWTF)
- Issue: The HSPF model needs to be calibrated to additional flow and water quality stations.
  - Proposed Revision: Identify approximately 20 calibration and 20 validation stations.

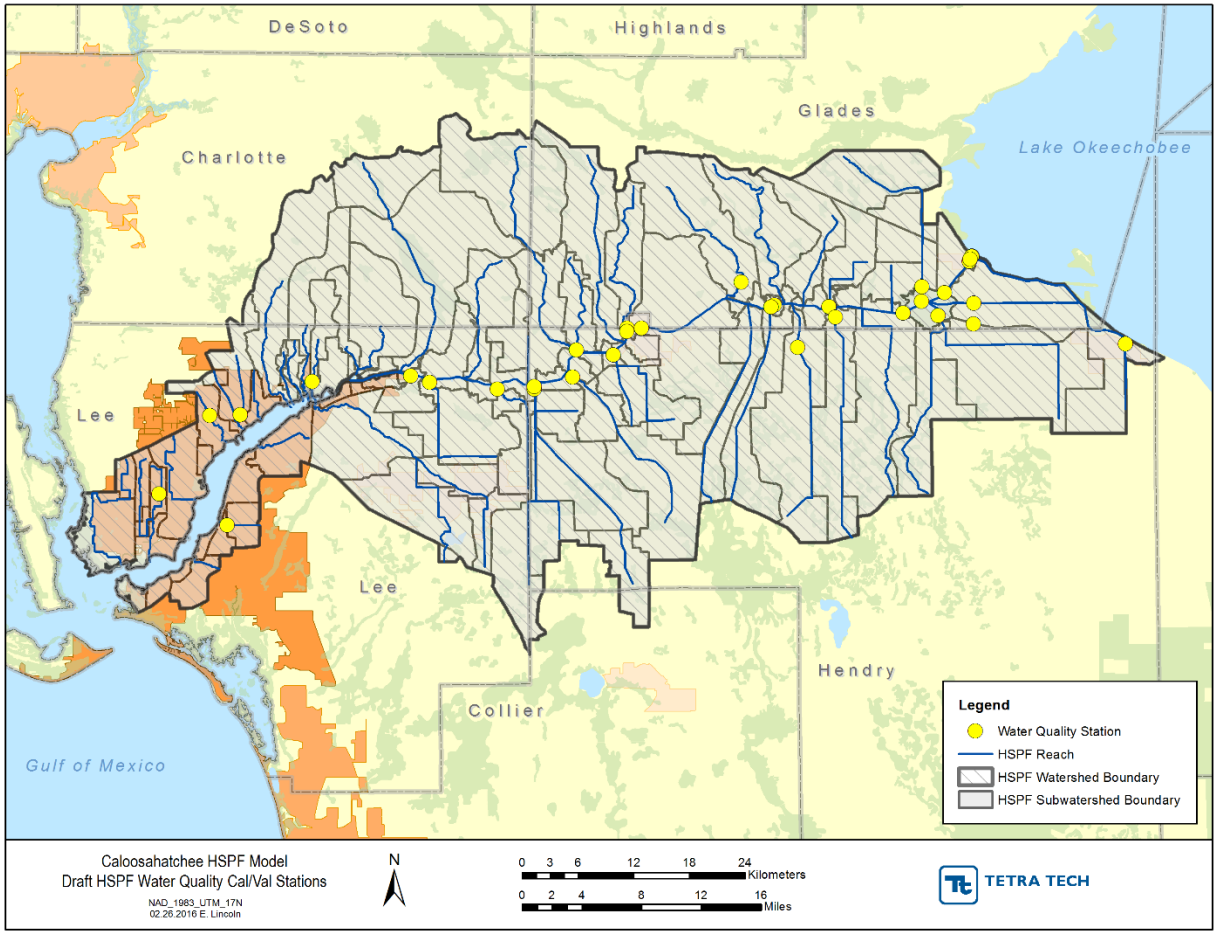
Stakeholder Input – Flow Stations

- 14 Flow Stations
  - 8 USGS stations and 6 DEP stations
  - 3 boundary condition stations (S-77 and S-79)
  - 3 have 13 data points (DEP stations)



Stakeholder Input – Water Quality Stations

- 43 Water Quality Stations
  - 28 unique locations
  - Co-located at flow stations
  - 27 stations have 5+ years of data



Proposed Revisions, continued

- Issue: Agricultural irrigation withdrawal sources and demand volumes may not be properly represented.
  - Proposed Revision: Update agriculture irrigation representation.
    - Use withdrawal source data from the department.
    - Input irrigation as point source applied to the land surface.
    - Represent irrigation as demand based on ag needs and precipitation.
- Issue: Uses SFWMD 2004 LULC and cropland/improved pasture land cover should be two separate land covers.
  - Proposed Revision: Use the SFWMD 2008-2009 LULC for the 2017 Model.
  - Proposed Revision: Cropland and improved pasture will be represented as two separate land covers.

Stakeholder Input – Land Use

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2007/2014 Model Land Use Classifications
SFWMD 2004 Coverage

Land Cover Class	Total Acreage	Percentage of Area
Low density residential	58,917	7%
Medium density residential	33,803	4%
High density residential	9,285	1%
Commercial/industrial	18,329	2%
Cropland/improved pasture	275,645	31%
Citrus	98,621	11%
Unimproved pasture	51,543	6%
Rangeland/open land	96,584	11%
Upland forests	73,205	8%
Wetlands/water	164,077	19%
Total	880,010	100%

Draft 2017 Model Land Use Classifications
SFWMD 2008/2009 Coverage

Land Cover Class	Total Acreage	Percentage of Area
Low Density Residential	78,640	9%
Medium Density Residential	41,135	5%
High Density Residential	9,927	1%
Commercial / Institutional / Transportation	14,128	2%
Industrial / Extractive	11,027	1%
Developed Open Space / Disturbed	22,730	3%
Cropland	108,492	12%
Citrus Groves / Other Groves	91,258	10%
Improved Pasture	129,448	15%
Rangeland / Unimproved Pasture / Shrub	102,762	12%
Upland Forests	120,622	14%
Wetlands	133,557	15%
Water	14,881	2%
Total[†]	878,607	100%

[†] Does not include 1,403 acres located in SWFWMD LULC shapefile

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EFDC Model Review

EFDC General Overview

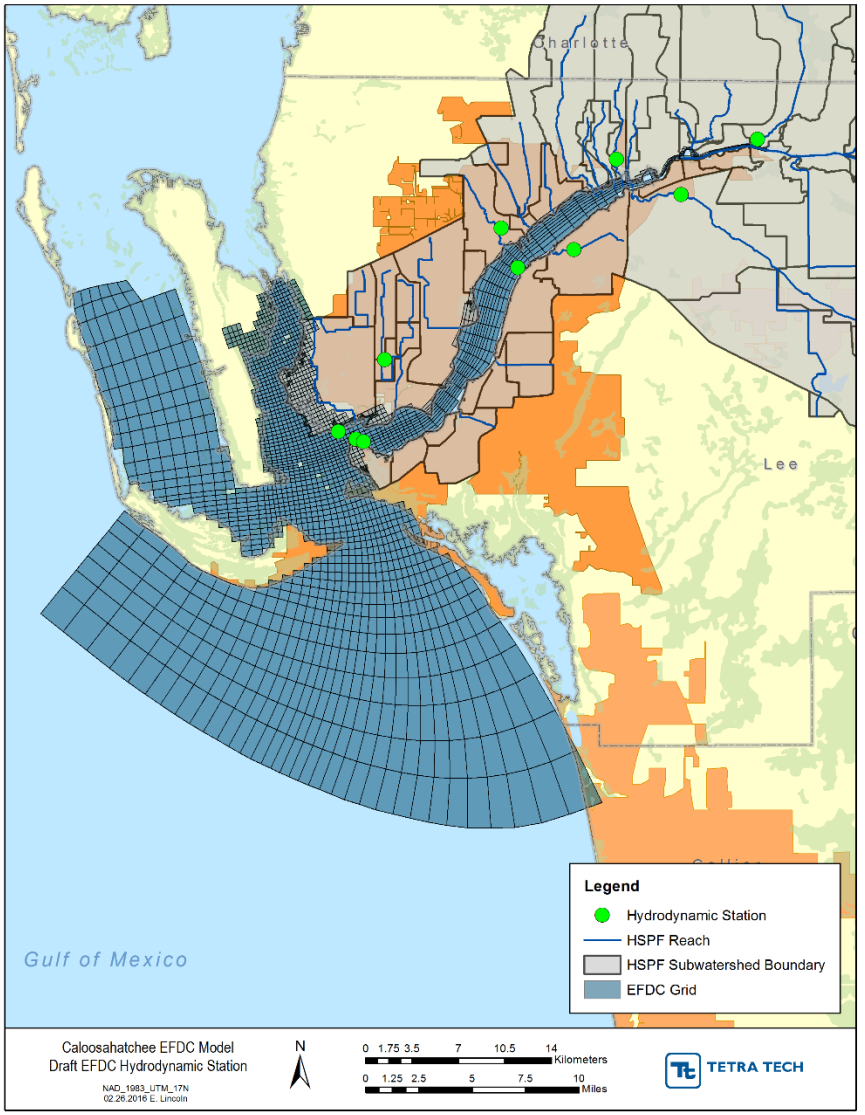
- The grid has a good spatial representation of the harbor and estuary areas.
- The current model is based on Dynamic Solutions' proprietary code.
- The grid includes boundary tidal cells for both the main waterbody and shallow marsh areas, which is causing some model instability.
- Some of the deep water model cells are not well connected to the channels, which could be causing issues with representing the salinity wedge.
- The marsh areas in model are much deeper than the depths indicated on the NOAA nautical charts.
- The 2009 and 2014 EFDC models are linked to the HSPF model and all the linkages seem to be correct.
- The water quality parameters are within expected normal ranges for southeastern estuaries.

Proposed Revisions

- Issue: EFDC simulation period ends in 2010.
  - Proposed Revision: Extend simulation through the end of 2014.
- Issue: The grid includes boundary tidal cells for the main waterbody and shallow marsh areas that vary between wet and dry conditions.
  - Proposed Revision: Apply tidal boundaries for Matlacha Pass and Pine Island Sound to cells in the open water area.
- Issue: A sigma grid of four layers is currently being used in the model.
  - Proposed Revision: Change to a multi-layer grid with variable layers. Shallow areas will have one vertical layer, deeper areas will have six vertical layers
- Issue: An insufficient number of water quality stations were used for model calibration.
  - Proposed Revision: Identify approximately 10 calibration and 10 validation stations.

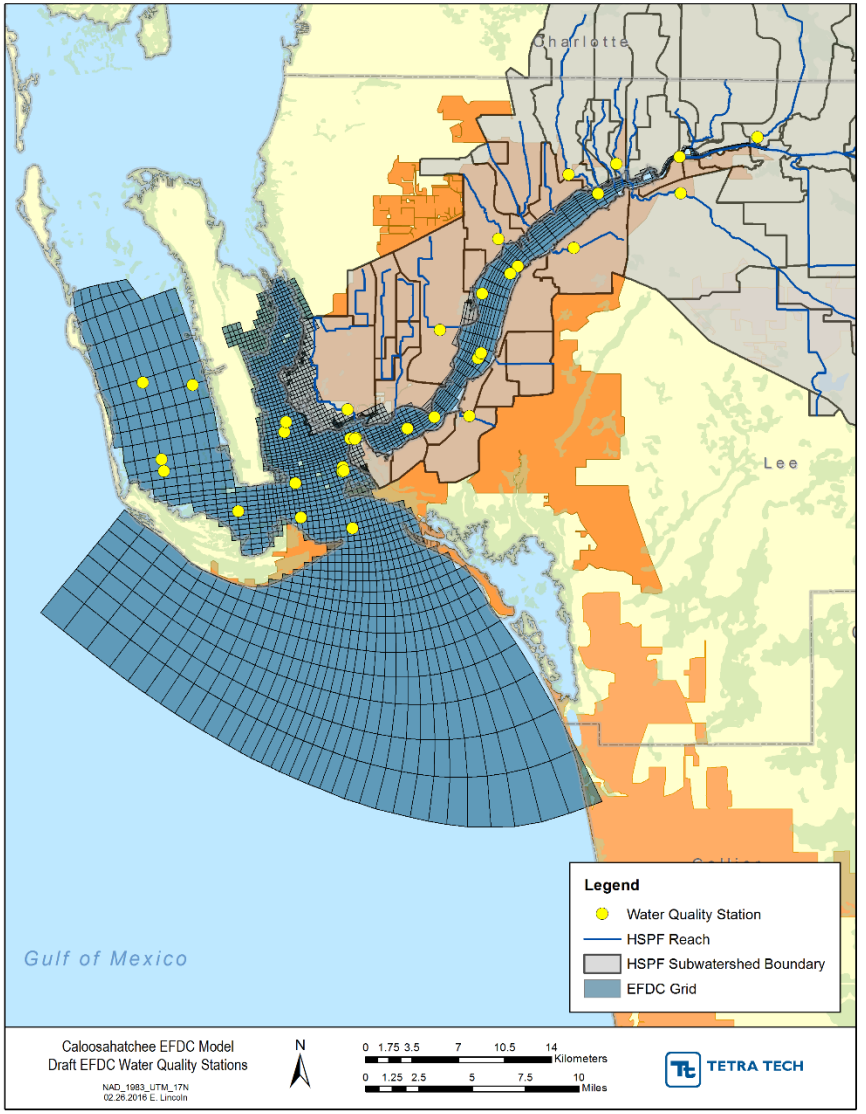
Stakeholder Input – Hydrodynamic Stations

- 10 Hydrodynamic Stations
  - All USGS stations
  - 9 unique locations
  - 6 located in expected grid extension locations
  - 3 have continuous temperature and salinity data



Stakeholder Input – Water Quality Stations

- 35 Water Quality Stations
  - 26 unique locations
  - 7 USGS co-locations
  - 9 located in expected grid extension areas
  - All have 4+ years of data



Proposed Revisions, continued

- Issue: The deep channels are not well connected, limiting salinity wedge movement.
  - Proposed Revision: Ensure channels are appropriately represented by deepening channel bottom elevations where appropriate.
- Issue: Model initial depths are not consistent with bottom elevations, causing instability.
  - Proposed Revision: Revise initial depths to follow the bottom elevation.
- Issue: Freshwater input flows are two to three times greater than the HSPF model flows.
  - Proposed Revision: Update freshwater input flows to match HSPF model flows.
- Issue: There is no vegetative resistance in current model setup.
  - Proposed Revision: Use approximately five depth zones (2009 Model has two zones) to adequately represent vegetative resistance in each area.

Proposed Revisions, continued

- Issue: Algal representation may not be adequate.
  - Proposed Revision: Use three algal classes, which is typical for southern waterbodies, and vary algal growth by zone.
- Issue: Current model uses proprietary version of EFDC.
  - Proposed Revision: Convert model to public domain code and include the light extinction equations.
- Issue: The representation of point source inputs can be improved.
  - Proposed Revision: Input tributary and point source parameters as concentrations instead of loads.
  - Proposed Revision: Add the FPL Fort Myers power plant to the EFDC model, as requested by FPL.
- Issue: Atmospheric deposition was not included in the model.
  - Proposed Revision: Include atmospheric deposition data from the nearest monitoring station.

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Next Steps

Next Steps

- Task 1 HSPF and EFDC Model Evaluation:
  - Stakeholder comments due to the department on Monday, March 14th.
  - The department will send all comments to Tetra Tech by March 18th.
  - Final memo delivered to the department on April 1st.

- Task 4 EFDC model conversion:
  - Draft memo and model files due to department Friday, March 11th.
  - Model update completed end of April.

Contacts

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