Task SEGDO1

Develop Dissolved Oxygen Model

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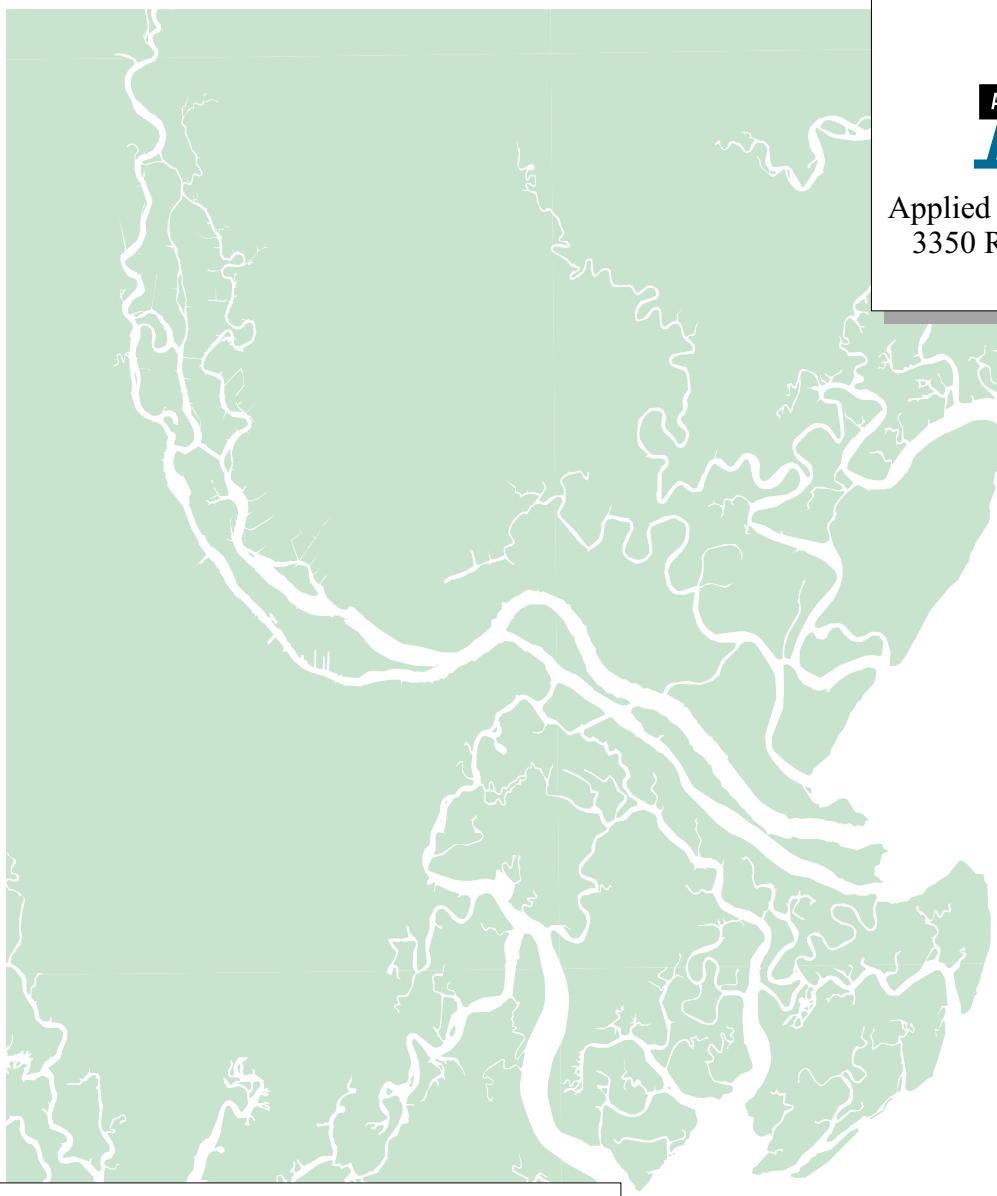

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TASK SEGDO1

Develop Dissolved Oxygen Model

The following outline for Task SEGDO1, Develop Dissolved Oxygen Model, is being presented to the Stakeholder Evaluation Group (SEG) as a draft task statement for review, modification and approval. The particular components of this task are based on the input received for the Tier I Environmental Impact Statement (EIS) and agency comments to date. This task encompasses the development of the tools to be used in evaluating the potential dissolved oxygen impacts. Additional tasks will be presented for impact evaluations.

1.0 Task Goals

The goal of this task is to develop a calibrated dissolved oxygen model to evaluate the impacts of the proposed deepening upon the dissolved oxygen balance within the Lower Savannah River. The dynamic conditions in the estuarine portion of the Savannah River result in a wide range of dissolved oxygen levels. Concerns have been raised that further deepening of the navigation channel may result in lower dissolved oxygen concentrations due to reduced velocities and increased stratification. The model will be needed to evaluate the project impacts under pre-defined critical conditions.

The dissolved oxygen model will be utilized to define the impact of the proposed deepening on the spatial and temporal concentrations of dissolved oxygen within the primary study area. Project effects on dissolved oxygen levels will be evaluated under critical conditions to determine the impact to aquatic species. Although the dissolved oxygen model will extend from Clyo down, for the purposes of this task, the primary study area extends from I-95 to the mouth of the Savannah River below Fort Pulaski, and includes the Middle River, the Back River, the Little Back River, and the South Channel. Overlap will exist between the model developed under this Task and a model being developed by EPA for the upper Savannah River. Figure SEGDO1-1 presents the extents of the system to be modeled under this Task.

2.0 Project Need

The dissolved oxygen model developed under the Tier I EIS was a simplified model whose purpose was to isolate the net impact of the proposed deepening under a set of representative summer conditions. During the public comment period, concerns were raised as to the capability of this simplified model to more completely address the true impacts of the deepening on the absolute levels of dissolved oxygen under a set of critical conditions. The comments focused specifically on the use of literature values for specific rates, kinetic constants, and boundary conditions, the simplified nature of the model, and the use of representative rather the critical conditions for impact evaluation. The comments focused on the following issues:

- Quantification of the characteristics and temporal variability of the point source loads within the study area.
- Quantification of the total loads entering the estuarine portion of the system from the upstream basin.
- Quantification of the influx of loads through the offshore and adjacent tributary boundaries.

- Quantification of the interactions between the surface waters and the wide expanse of adjacent marshes in the Savannah National Wildlife Refuge (SNWR).
- Quantification of the site-specific interaction between the surface waters and the bottom sediments, i.e. sediment oxygen demand (SOD) and benthic flux rates.
- Quantification of the site-specific reaeration rates.
- The grouping of all oxygen demanding loads into one BODU value rather than isolating the NBODU and CBODU.
- The model not accounting for the primary productivity within the system.

Under Task SEGP312 a data collection program has been identified that provides the site-specific data for input into the dissolved oxygen model. The model will be calibrated to this data set and provide a tool sufficient for use in evaluating all aspects of the potential impacts to dissolved oxygen. The model kinetics and inputs will be evaluated through a technical review group of the SEG to assure that all critical processes have been identified and properly simulated. This will provide an accurate assessment of the impacts of the proposed project on the dissolved oxygen balance within the Lower Savannah River.

3.0 Proposed Scope

To address the issues raised under Section 2.0, and to address inputs received to date from agency personnel, this Task has been broken down into the following 8 components:

- Literature and Historic Data Review to Identify Critical Biogeochemical Processes to be Considered
- Preliminary Model Set-up, Refinement, and Testing using Existing Data
- Analysis of 1999 Data to Verify Critical Biogeochemical Processes to be Considered
- Calibration of Thermal Component of Hydrodynamic Model
- Determination of Model Input Conditions for 1999 Calibration
- Determination of Baseline and Allowable Ranges of Model Kinetic Rates and Constants for 1999 Calibration
- Initial Calibration to Intensive 1999 Data Set
- Model Sensitivity Testing and Refinement

The following describes in detail the work to be performed under each component of Task SEGDO1.

3.1 Literature and Historic Data Review to Identify Critical Biogeochemical Processes to be Considered

Under this task the basic processes that will be considered within the water quality component (BFWASP) of the WQMAP system will be identified. Utilizing existing data, as well as past studies performed within the Lower Savannah River Estuary and the upper Savannah Basin, the important processes affecting dissolved oxygen within the Lower Savannah River, will be identified and reviewed through a Technical Review Group of the SEG.

The processes identified within this task will then be compared with the present kinetics implemented in the BFWASP component of the WQMAP system. Figure SEGDO1-2

presents a diagram of the present kinetic processes within the BFWASP component of WQMAP. Where BFWASP existing kinetics are insufficient to meet the needs identified under this task, an implementation plan, with appropriate kinetic modifications will be prepared and submitted to the Technical Review Group for approval.

Once the list of kinetic modifications have been identified and approved under the SEG review process, the BFWASP model code will be modified in order to include the identified changes. Simplified tests, that evaluate the accuracy of the revised processes in the BFWASP model, will be performed. The results from these simplified tests will be presented to the SEG Technical Review Group for approval upon completion. This will be additional work not presently identified within the Scope of Services and costs for Task SEGDO1.

3.2 Preliminary Model Set-up, Refinement and Testing Using Existing Data

Utilizing the BFWASP model component as modified under Section 3.1, preliminary model tests will be conducted utilizing the data set collected under the Tier I EIS. The goal of this task is to provide a preliminary evaluation of the model performance under the complex kinetics defined in Section 3.1, and to test the model against actual data from the Lower Savannah River Estuary.

The preliminary testing will identify any significant deficiencies in the model, and allow timely correction of these problems prior to the 1999 intensive data set being made available. Performing this task in parallel with the data collection will expedite the final calibration process by allowing the calibration to concentrate upon the determination of appropriate model coefficients and inputs rather than on modifications to the BFWASP model code and model refinements.

In addition, preliminary simulations of temperature will be conducted against the data collected in the summer of 1999. These preliminary simulations will be in preparation for the calibration of the thermal component of the hydrodynamic model described under Section 3.4.

In addition, the data post-processing algorithms for statistical and graphical model to data comparisons will be refined under this process. Once again performing this task in parallel with the data collection will expedite the final calibration process.

3.3 Analysis of 1999 Data to Verify Critical Biogeochemical Processes and Quantify Measured Kinetic Rates and Constants

An extensive data set is being collected under Task SEGP312 for use in the dissolved oxygen model calibration. Under this sub-task the data set will be analyzed to verify that the biogeochemical processes within the BFWASP model (refined under Section 3.1) are sufficient to represent the system as measured in the summer of 1999. In addition the data will be analyzed in order to define measured kinetic rates and constants from the 1999 data set for use in the model calibration. The determination of the types of data analyses required will be based on the data characteristics, and these analyses will be presented before the Technical Review Group of the SEG for discussion.

3.4 Calibration of Thermal Component of Hydrodynamic Model

Based upon input from agency personnel, it will be necessary to modify the hydrodynamic component of the WQMAP model in order to simulate the spatial and temporal nature of the temperature within the Lower Savannah River. Although in the model calibration discussed in Section 3.7 the spatial and temporal temperatures will be input based upon the data collected, for model critical condition simulations it will be necessary to project the temperature conditions for water quality simulations.

Under this sub-task the hydrodynamic model will be refined and calibrated to project the temperatures measured in the 1999 intensive data collection. The model inputs for solar radiation, etc will be derived from the meteorological data collected under Task SEGP312.

3.5 Determination of Model Input Conditions for 1999 Calibration

For the 1999 model calibration, the baseline hydrodynamics will come from the verification of the salinity model identified under Task SEGDO2. The following input conditions will need to be identified based upon the intensive data collection described under Task SEGP312 for the dissolved oxygen model.

- Offshore inflow concentrations of all simulated water quality parameters
- Inflow concentrations of all simulated water quality parameters at internal boundaries
- Inflow concentrations of all simulated water quality parameters across marsh interaction boundaries
- Flux of all simulated water quality parameters between benthic layer and upper water column
- Flux of all simulated water quality parameters across air/water interface
- Temporal and spatial varying temperature in the system

At present it is envisioned that the temperature will be utilized as an input condition rather than as a simulated parameter for the model calibration. This is based upon the intensive nature of the 1999 sampling program and the ability to project a more accurate spatial and temporal temperature field from data than from model projections. For critical condition impact simulations, the temperatures will be determined using the calibrated thermal component of the model described under Section 3.4.

The model input conditions will be prepared based upon the data collected under Task SEGP312. The inputs to be used will be presented to the SEG Technical Review Group for approval prior to commencement of model calibration.

3.6 Determination of Model Kinetic Rates and Constants for 1999 Calibration

Utilizing the site-specific kinetic rate and chemistry data collected under Task SEGP312, a list identifying the temporal and spatial nature of all the kinetic rates and constants will be prepared. This list will be based upon the processes defined under Section 3.1 and the analyses of the data described under Section 3.2. The list will include all rates and constants to be used within the model. Where site specific data are not available, reasonable and appropriate literature values will be determined and listed along with allowable ranges of variation for systems such as the Lower Savannah River. For all

literature and site-specific defined rates and constants, a table will be prepare that outlines the initial values and the allowable ranges for use in the model calibration. Where literature values are used rather than site-specific data, these values will be identified as such.

The rates and constants list will be presented to the SEG Technical Review Group for approval as the baseline conditions for the model calibration. Although these values may change during model calibration as (described under Section 3.6), all changes, along with technical documentation for the changes, will be presented to the SEG Technical Review Group for approval.

The one data set that may delay the determination of the full list of kinetic rates and constants will be the long-term BOD measurements. As these are ongoing tests, and results are available as the tests progress, these data will be made available prior to completion of the tests to allow model calibration work to move forward. This will need to be implemented under Task SEGP312.

3.7 Initial Calibration to Intensive 1999 Data Set

Utilizing the model input conditions determined under Section 3.5 and the model kinetic rates and constants defined under Section 3.6, the dissolved oxygen model will be calibrated to the intensive data set collected in the summer of 1999. The calibration will consist of model comparison to at least 30 days of data collected in the summer of 1999. Under the calibration process the hydrodynamic model as validated under Task SEGPDO2 will be utilized to drive the dissolved oxygen model. The spatially and temporally varying temperature field for the model calibration will come from analysis of the data collected under Tasks SEGP311, SEGP312, and SEGP313. The data collected under these tasks is sufficient to provide a highly accurate representation of the time varying temperature field.

The initial model calibration runs will be performed with the model kinetic rates and constants defined under Section 3.6. Comparisons of the simulated dissolved oxygen concentrations with the measured values will be made under the initial kinetic rates and constants and presented to the SEG Technical Review Group. Differences between the simulations and data will be identified along with potential reasons or processes affecting the solutions. Modification of site-specific measured rates and constants, outside of the allowable ranges defined under Section 3.6, will not be done to more accurately simulate dissolved oxygen concentrations unless technically justifiable. In addition, kinetic rates and constants determined from literature values will not be modified outside of acceptable literature ranges for the water body unless shown to be technically justifiable.

Model to data comparisons will include but not be limited to the following:

- Graphical
- RMS errors
- Percentile frequency of occurrence
- Least Squares Regression

Figures SEGDO1-3 through SEGDO1-5 present the locations of data collected for model comparison. These figures present the following:

- Locations for the comparison of continuous dissolved oxygen and the discrete chemistry sampling (SEGDO1-3).
- Locations for the comparison of the long-term biochemical oxygen demand (SEGDO1-4).
- Locations for the comparison of the synoptic in-situ monitoring for determination of the longitudinal structure of dissolved oxygen (SEGDO1-5).

The initial model calibration will be presented the SEG Technical Review Group for review upon completion.

3.8 Model Sensitivity Testing and Refinement

Sensitivity testing of the model will be made by adjusting the various model kinetic rates and constants within the range of values defined under Section 3.6. The results of the sensitivity testing will be presented relative to the impacts of the coefficient variations upon the dissolved oxygen concentrations within the system. The model sensitivity testing will follow the presentation of the initial model calibration to the SEG Technical Review Group and be under their guidance. Under this task the model will be refined and where necessary recalibrated based upon the SEG Technical Review Group input. Upon completion of this sub-task the model will be fully calibrated and tested and ready for use in impact evaluations.

5.0 Deliverables

The deliverable for this task will be a report that summarizes the work performed under Sections 3.1 through 3.8. The report will include all assumptions, methodologies, and equations used in the analyses and results of model simulations including all data comparisons. In addition, the report will summarize the findings and conclusions from this work task.

5.0 Schedule

The following schedule is recommended for this project task.

- Approval of task scope: July 6, 1999
- Literature and Historic Data Review: July 6 to September 1, 1999
- Preliminary Model Set-up, Refinement, and Testing: July 6 to Nov 1, 1999
- Analysis of 1999 Data: Nov 1 to Dec 1, 1999
- Calibration of Thermal Component of Hydrodynamic Model: Oct 1, 1999 to Dec 1, 1999
- Determination of Model Input Conditions for 1999 Calibration: Nov 1, 1999 to Dec 1, 1999
- Determination of Baseline and Allowable Ranges of Model Kinetic Rates and Constants for 1999 Calibration: Nov 1, 1999 to Dec 1, 1999
- Calibration to Intensive 1999 Data Set: Dec 1, 2000 to May 1, 2000
- Present Draft Report to SEG Technical Review Group including work to date: May 1, 2000
- Model Sensitivity Testing and Refinement of Model Calibration: May 1, 2000 to Aug 1, 2000
- Final Report Submittal: Sep 1, 2000

6.0 Related Issues

Upon completion of the deepening evaluation, the dissolved oxygen model will be provided to the United States Army Corps of Engineers (USACOE) under their Dissolved Oxygen Study, for use in evaluating ecosystem restoration alternatives. In addition, the model will be used to quantify the Total Maximum Daily Load (TMDL) for the estuarine portion of the Lower Savannah River.

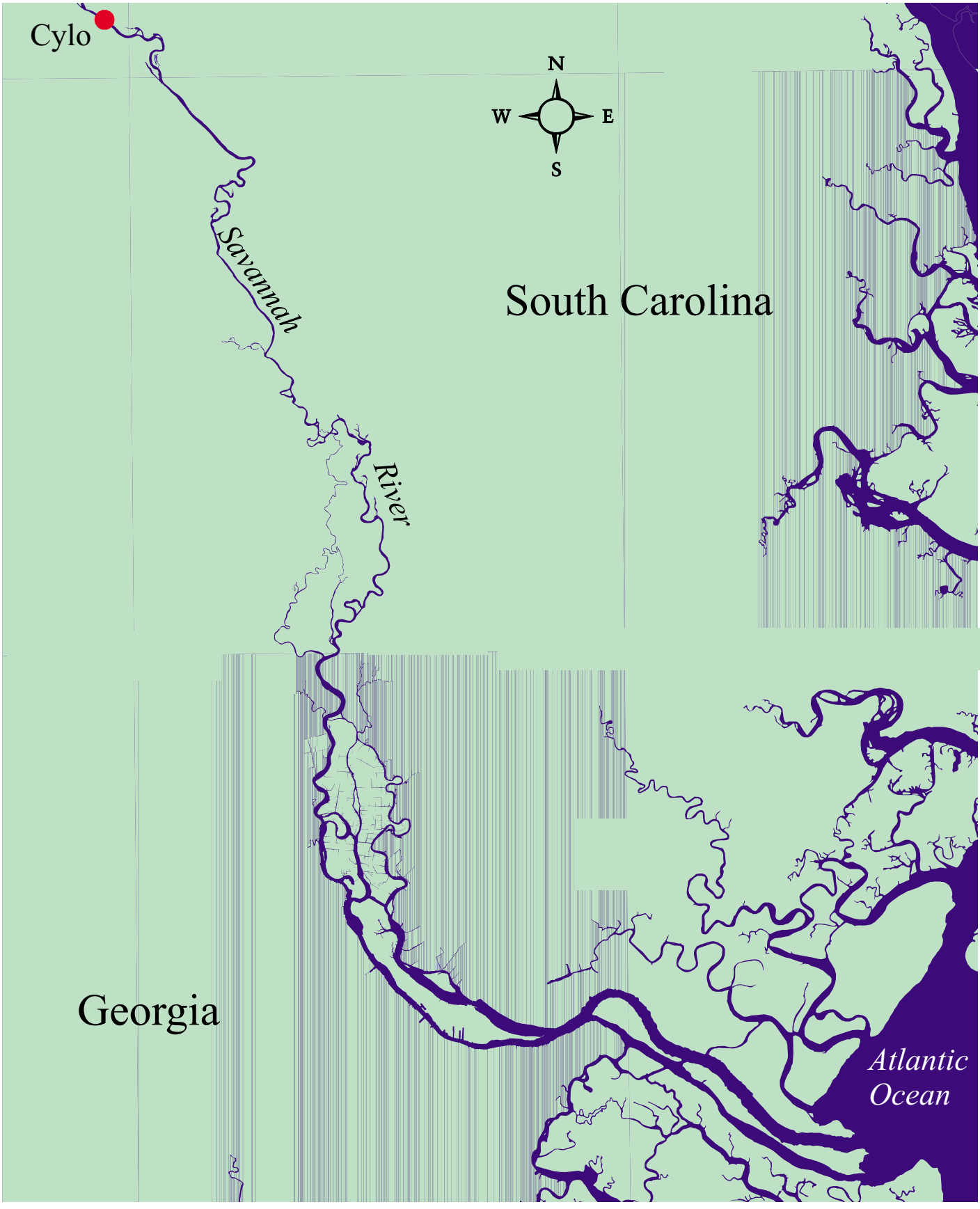

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Figure SEGDO1-1
Extent of Water Quality Model

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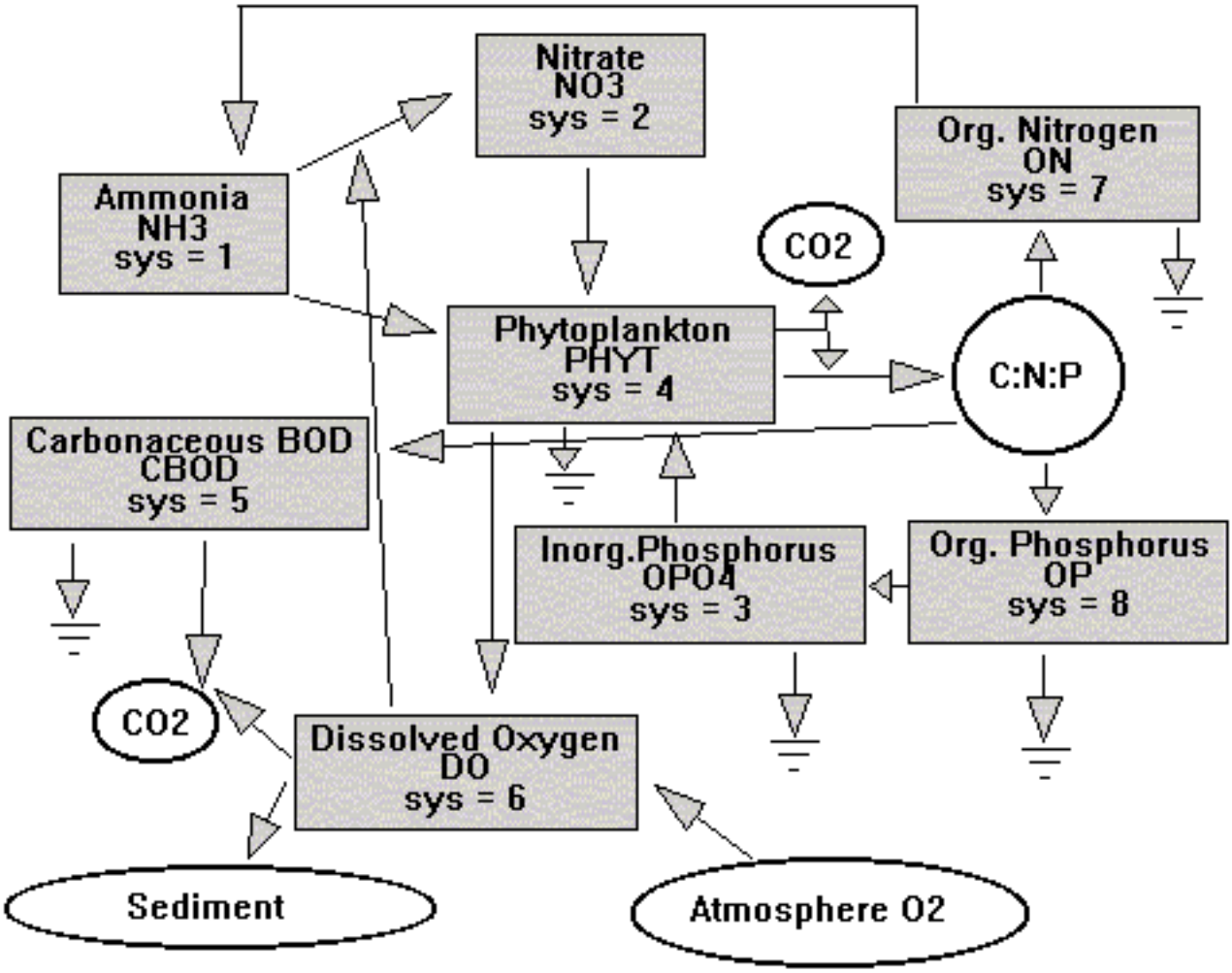

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Figure SEGDO1-2
WASP Kinetics Schematic Diagram

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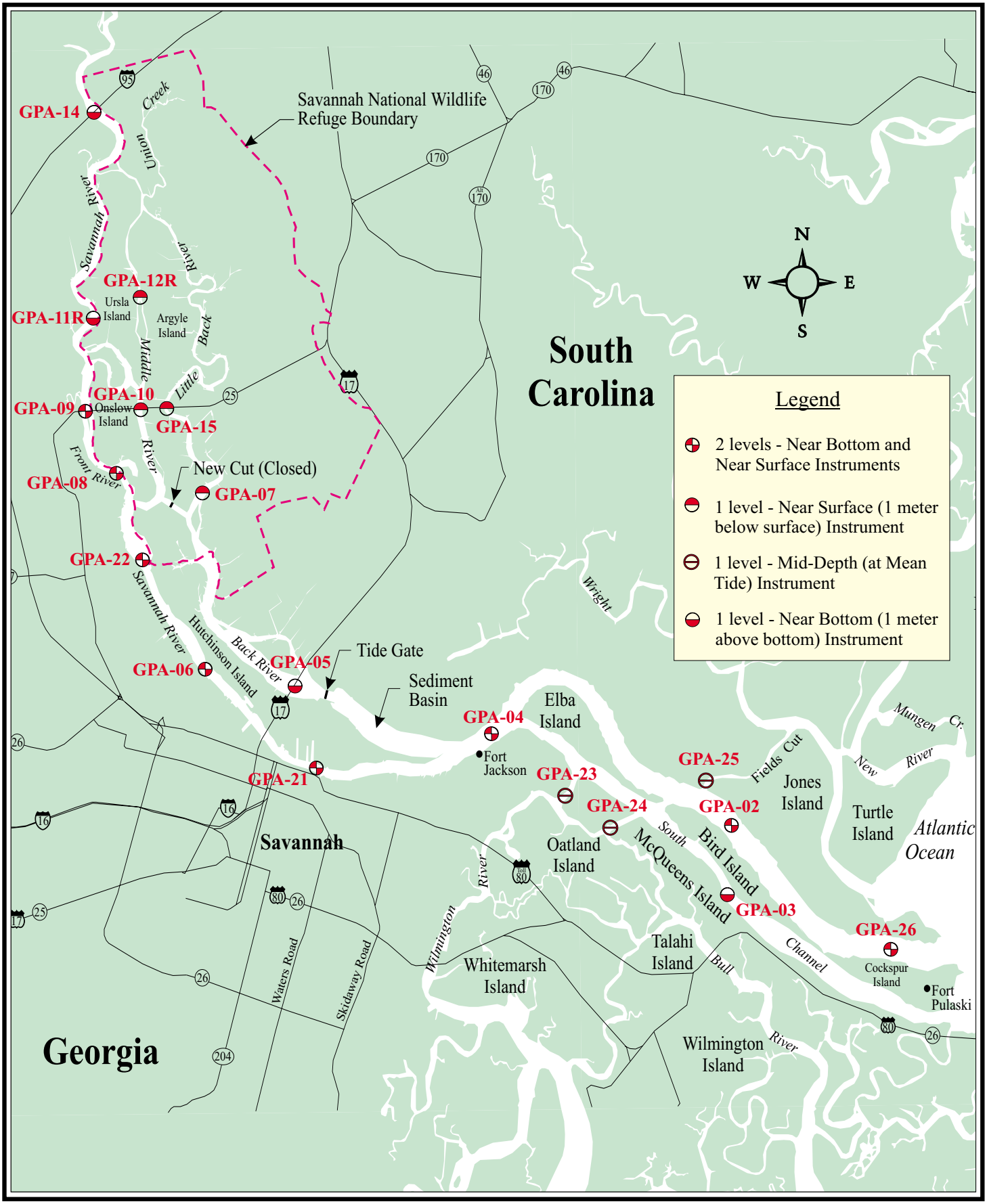

Figure SEGDO1-3A
Stations for Comparison of Continuous Dissolved Oxygen and Water Chemistry Measurements Below the I-95 Bridge

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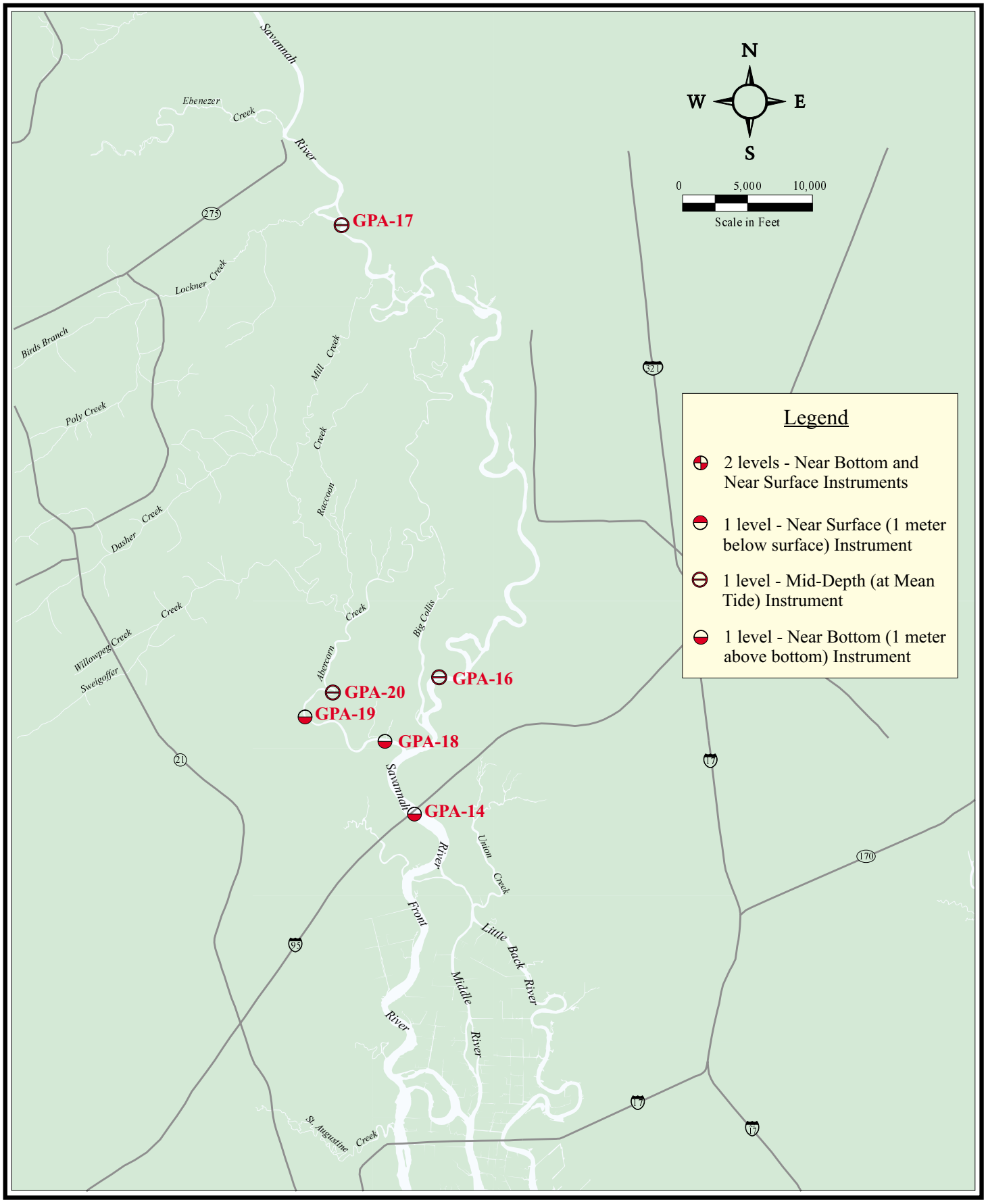

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Figure SEGDO1-3B
Stations for Comparison of Continuous Dissolved Oxygen and Water Chemistry Measurements Above the I-95 Bridge

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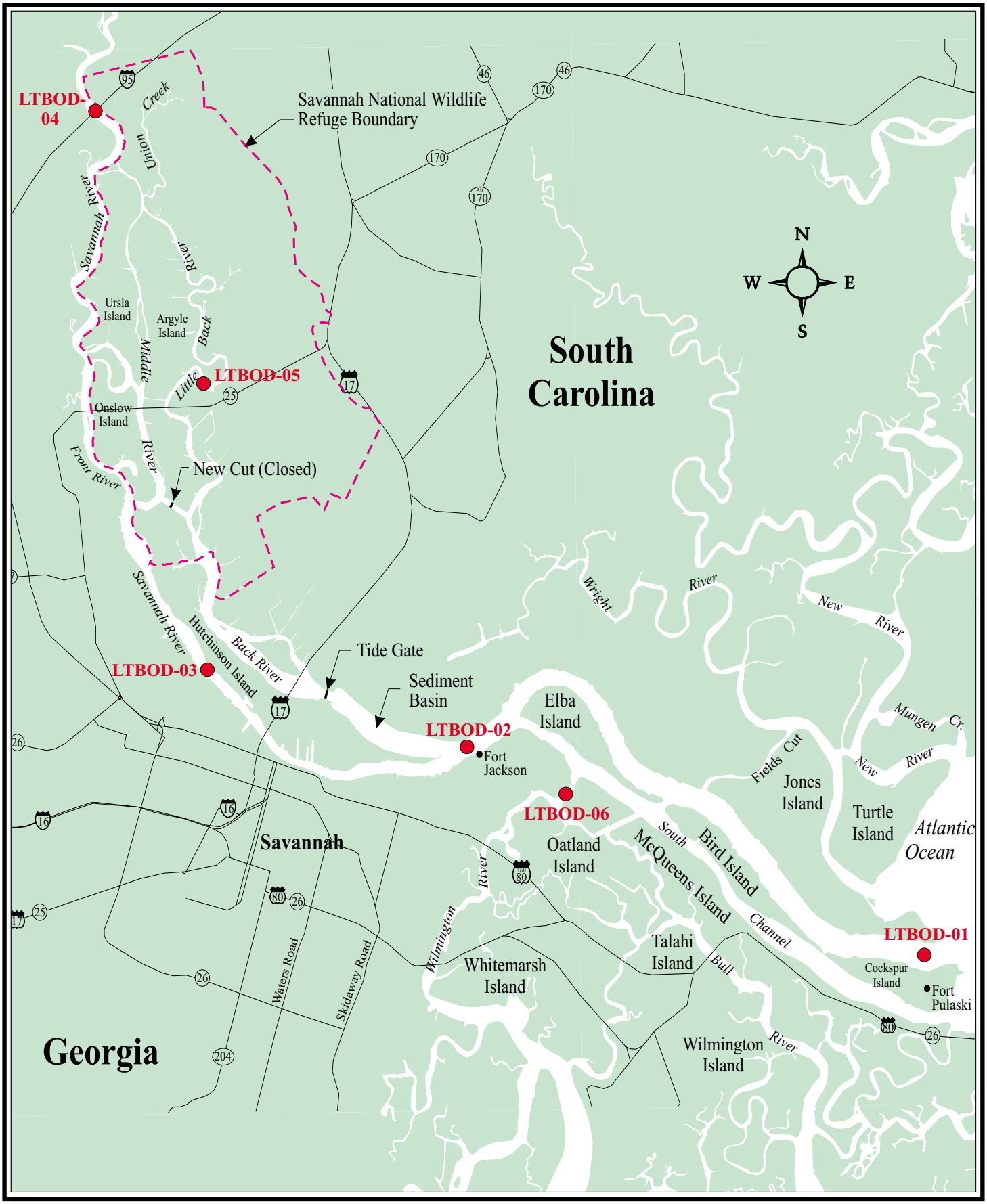

Figure SEGDO1-4
Stations for Comparison of LTBOD Concentrations

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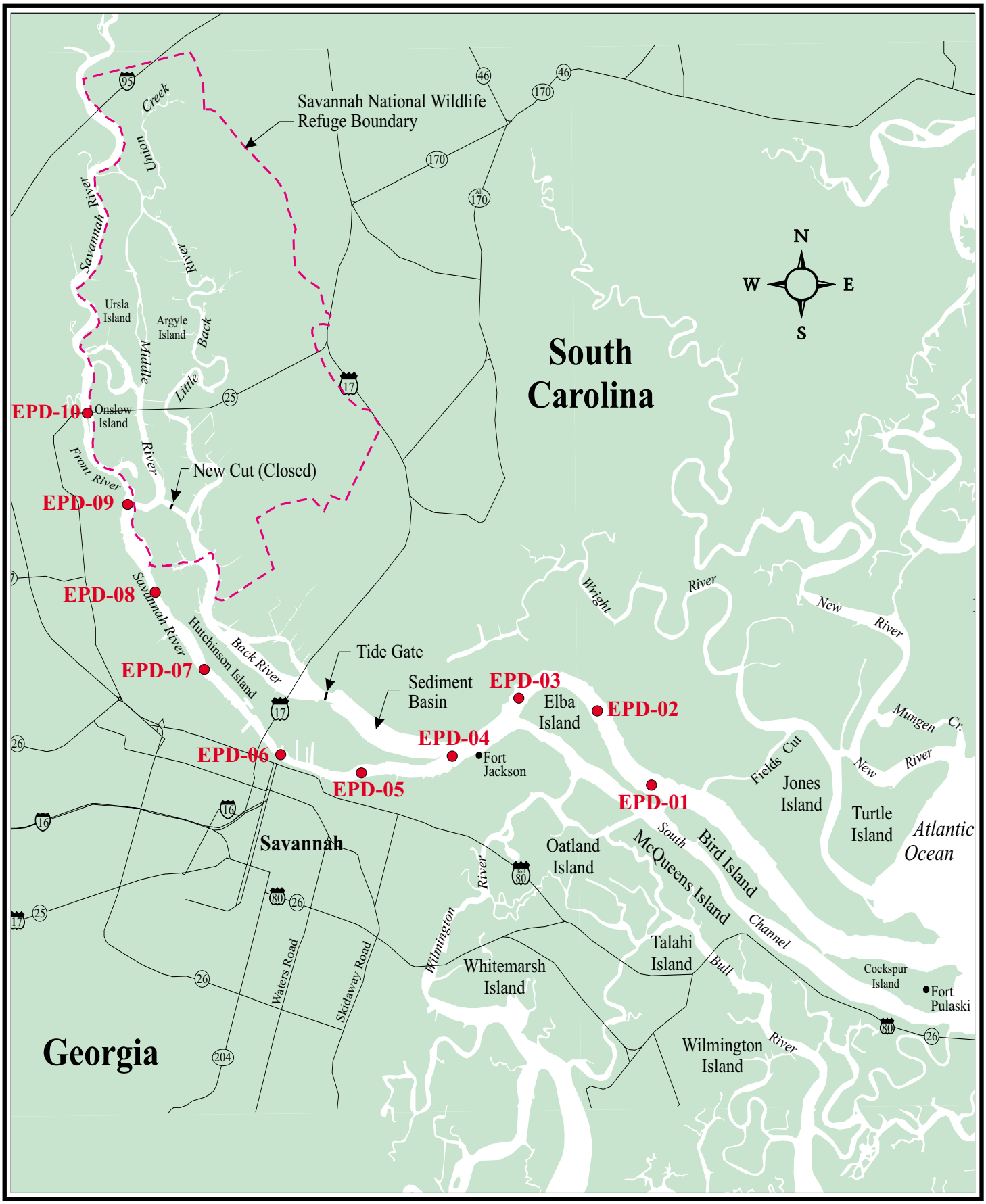

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Figure SEGDO1-5
Stations for Comparison of Longitudinal Dissolved Oxygen Structure

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