
Appendix A:

Modeling Report

Lake Poinsett

and

St. Johns River above Puzzle Lake

WBIDs: 2893K & 2893I

Nutrients and Dissolved Oxygen

September 30, 2009



Table of Contents

1. WATERSHED DESCRIPTION	1
2. TMDL TARGETS	2
3. MODELING APPROACH	2
3.1. METEOROLOGICAL.....	2
3.1.1. <i>Flow</i>	3
3.1.2. <i>BOD and Nutrient Loadings</i>	3
3.2. LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE WATER QUALITY MODEL.....	3
3.2.1. <i>WASP Model</i>	4
4. LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE WATERSHED NATURAL CONDITION ANALYSIS	7
4.1. TMDL REDUCTION.....	8

Table of Figures

FIGURE 1 LAKE POINSETT WBID AND WATER QUALITY STATION LOCATION	1
FIGURE 2 RAINFALL FOR LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE AND WATERSHED	2
FIGURE 3 WASP CALIBRATION FOR TOTAL NITROGEN IN LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE	5
FIGURE 4 WASP CALIBRATION FOR TOTAL PHOSPHORUS IN LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE	5
FIGURE 6 WASP CALIBRATION FOR DISSOLVED OXYGEN IN LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE	6
FIGURE 7 WASP CALIBRATION FOR TOTAL NITROGEN IN LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE	6

Table of Tables

TABLE 1 ANNUAL RAINFALL.....	3
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TABLE 2 LAKE POINSETT AND ST. JOHNS RIVER ABOVE PUZZLE LAKE & NUTRIENT LOADS (2002-2008) 3

TABLE 3 WASP KINETIC RATES 4

TABLE 4 MODEL CALIBRATION SUMMARY 4

TABLE 5 EXISTING CONDITION ANNUAL AVERAGE MODEL PREDICTIONS 7

TABLE 6 NATURAL CONDITION ANNUAL AVERAGE NUTRIENT LOADS 7

TABLE 7 NATURAL CONDITION ANNUAL AVERAGE MODEL PREDICTIONS 7

TABLE 8 TMDL PERCENT REDUCTION 8

1. Watershed Description

Lake Poinsett lies in southern Brevard County just west of the city of Melbourne. It is an element of the upper St. Johns River, being located about a mile upstream of where US Highway 192 crosses the river. Lake Poinsett and its smaller companion Little Lake Poinsett to the south are bracketed by Lake Hell'n Blazes farther upstream and substantially larger Lake Washington (drinking water supply for the Melbourne area) to the north. Sawgrass, Little Sawgrass, and Hell'n Blazes Lakes are located within SJRWMD's Three Forks Marsh Conservation Area.

Although the land in the immediate vicinity of the 412-acre lake is mostly unaltered, beyond the floodplain there is a very large amount of agricultural and pasture land which is drained by canals leading into the river. The original floodplain is highly impacted by these hydrologic modifications.

WBID 2893K & 2893I were listed as not attaining its designated uses on Florida's 1998 303(d) list for Nutrients and Dissolved Oxygen. Figure 1 provides the location of Lake Poinsett and St. Johns River above Puzzle Lake.

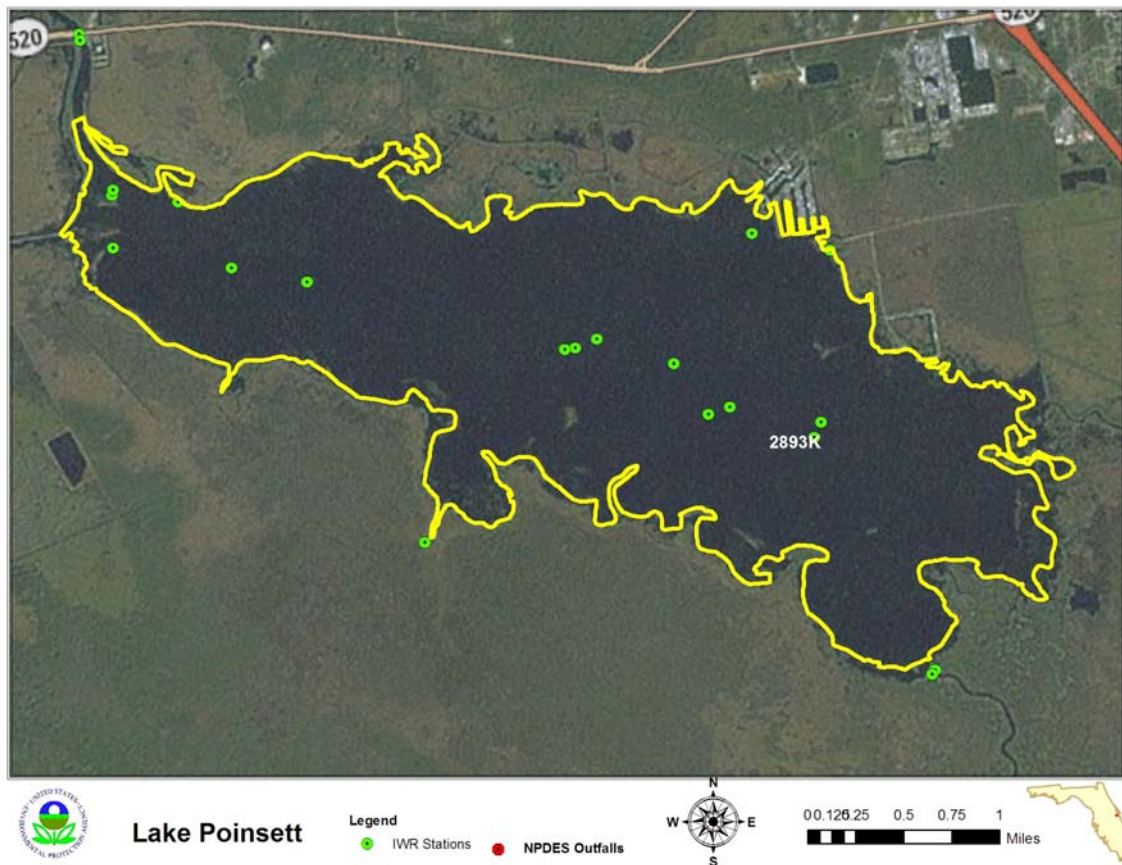


Figure 1 Lake Poinsett WBID and Water Quality Station Location

2. TMDL Targets

The TMDL target to be evaluated in this modeling report is to meet the Lake Poinsett and St. Johns River above Puzzle Lake dissolved oxygen standard of 5 mg/l.

3. Modeling Approach

A water quality modeling framework was used to simulate biological oxygen demand (BOD), nutrients (total nitrogen and total phosphorus), and chlorophyll a (Chla) and dissolved oxygen dissolved oxygen for the time period of 2002 through 2008. The receiving waterbody model was Water Quality Analysis Simulation Program (WASP 7.3) (USEPA, 2007). The WASP model integrates the USGS measured flows and the measured water quality concentrations to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. WASP will be calibrated to current conditions, and then a natural condition scenario will be developed to remove all anthropogenic sources from the watershed to determine natural condition. The WASP model will be used to determine the percent reduction in loadings that would be needed to meet water quality standards.

3.1. Meteorological

Pertinent meteorological data was obtained from the National Weather Service (NWS) WBAN station number 12838: Melbourne International Airport near Melbourne, Florida.

Figure 2 provides a time series plot of daily rainfall for the simulation period.

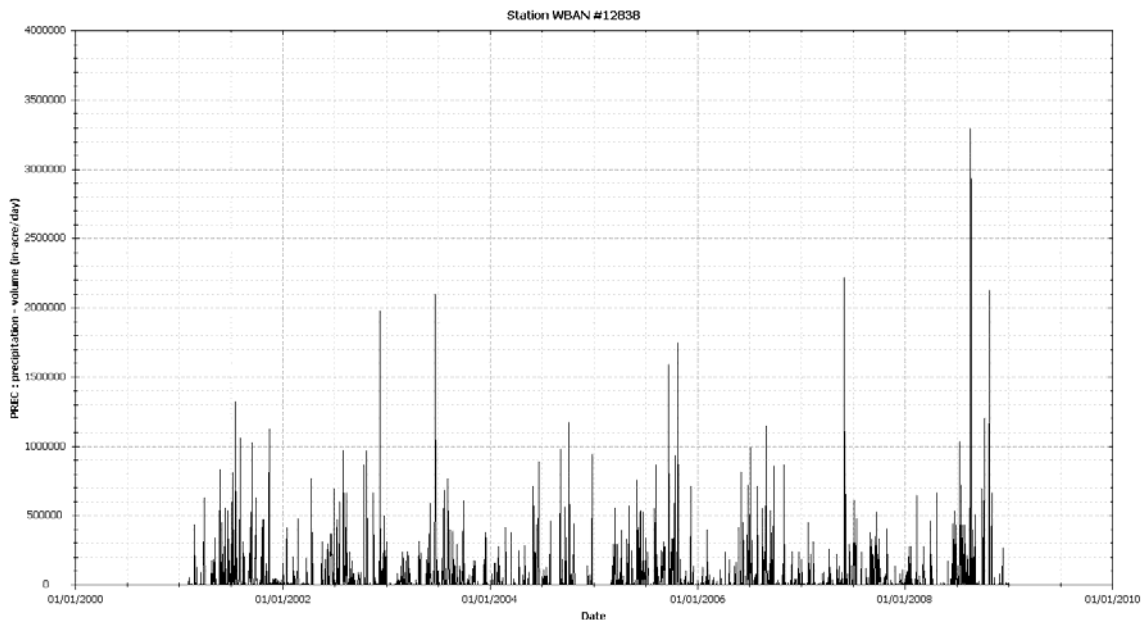


Figure 2 Rainfall for Lake Poinsett and St. Johns River above Puzzle Lake and Watershed

Table 1 shows the annual average rainfall for each of the years simulated.

Table 1 Annual Rainfall

Year	Rainfall (Inches)
2002	42
2002	51
2003	43
2004	34
2005	55
2006	40
2007	38
2008	70

3.1.1. Flow

Flows were directly taken from LAKE POINSETT USGS gage (USGS 02232400) and used directly by the model.

3.1.2. BOD and Nutrient Loadings

The water quality input concentrations were taken directly from 21FLSJRWMLPI Station. The nutrient loads in Table 2 were calculated by taking the average concentration times the USGS flow.

Table 2 Lake Poinsett and St. Johns River above Puzzle Lake & Nutrient Loads (2002-2008)

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Watershed above Lake Poinsett and St. Johns River above Puzzle Lake	1,958,836	123,185	2,019,418

3.2. Lake Poinsett and St. Johns River above Puzzle Lake Water Quality Model

The Lake Poinsett and St. Johns River above Puzzle Lake WASP water quality model integrates the measured flows and concentrations from the collected data to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. A 4 segment WASP water quality model was set up to model the Lake

3.2.1. WASP Model

The WASP water quality model uses the kinematic wave equation to simulate flow and velocity and the basic eutrophication module to predict dissolved oxygen and Chlorophyll a responses to the BOD, total nitrogen and total phosphorus loadings. Table 3 provides the basic kinetic rates used in the model.

Table 3 WASP Kinetic Rates

WASP Kinetic Parameters	Value
Global Reaeration Rate Constant @ 20 °C (per day)	0.25
Sediment Oxygen Demand (g/m ² /day)	2.5 for Lake segments
Phytoplankton Maximum Growth Rate Constant @20 °C (per day)	1.75
Phytoplankton Carbon to Chlorophyll Ratio	75
BOD (1) Decay Rate Constant @20 °C (per day)	0.06
Ammonia, nitrate, phosphorus rates @20 °C (per day)	0.05 to 0.1

The Lake Poinsett and St. Johns River above Puzzle Lake WASP model DO and Chl a predictions were compared to Lake Poinsett water quality data station 21FLSJRWMLPI.

Table 4 provides the annual average calibration summary of the comparison between the WASP Lake Poinsett and St. Johns River above Puzzle Lake segment and the Lake Poinsett and St. Johns River above Puzzle Lake Station for total nitrogen, total phosphorus, chlorophyll a and dissolved oxygen. Figure 3 to Figure 6 illustrates the comparisons of model results and data at the same location.

Table 4 Model Calibration Summary

Lake Poinsett and St. Johns River above Puzzle Lake 21FLSJRWMLPI	2002–2008 Data Average	2002-2008 Model Average
Total Nitrogen (mg/l)	1.94	1.94
Total Phosphorus (mg/l)	0.12	0.12
Average DO (mg/l)	4.7	4.9
Chla (ug/l)	10.3	11.2
Flow (cms)	32	32

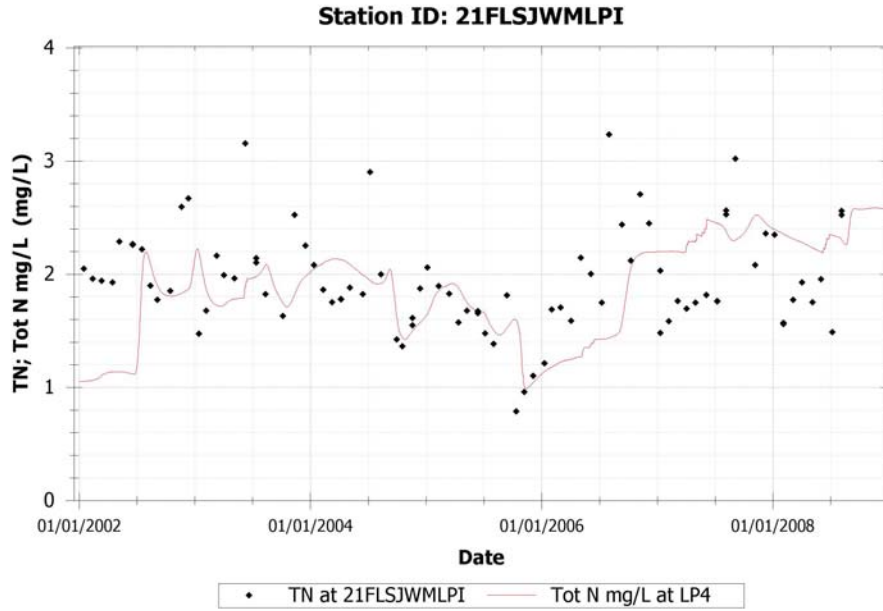


Figure 3 WASP Calibration for Total Nitrogen in Lake Poinsett and St. Johns River above Puzzle Lake

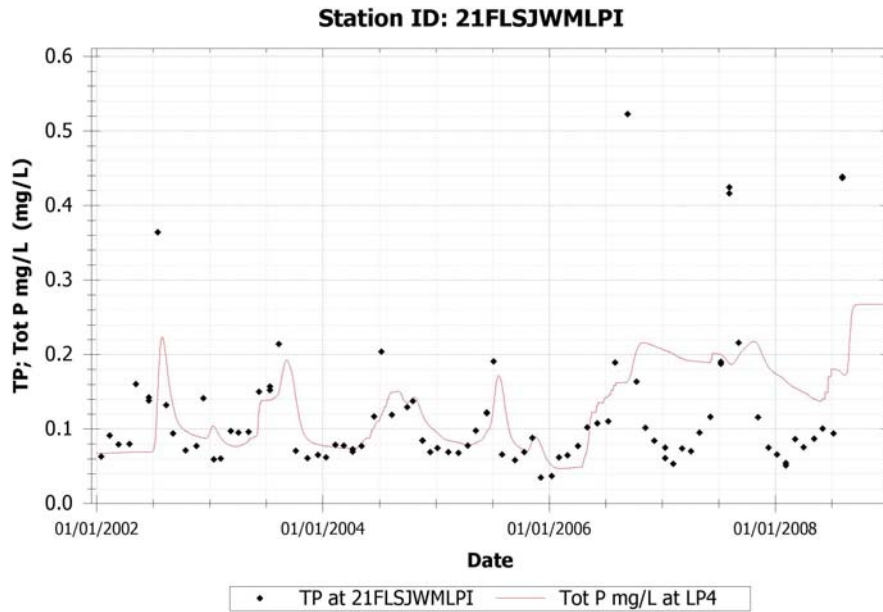


Figure 4 WASP Calibration for Total Phosphorus in Lake Poinsett and St. Johns River above Puzzle Lake

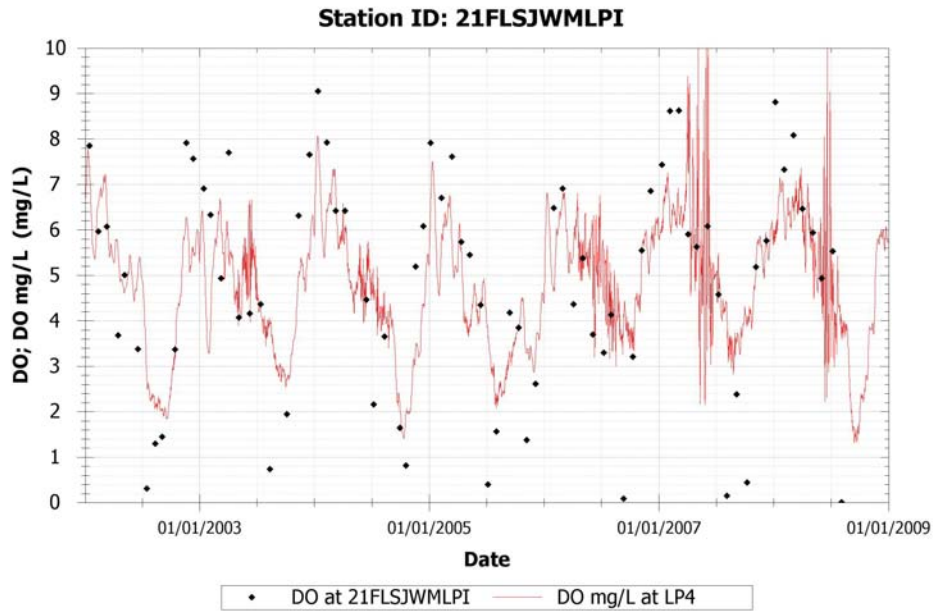


Figure 5 WASP Calibration for Dissolved Oxygen in Lake Pointsett and St. Johns River above Puzzle Lake

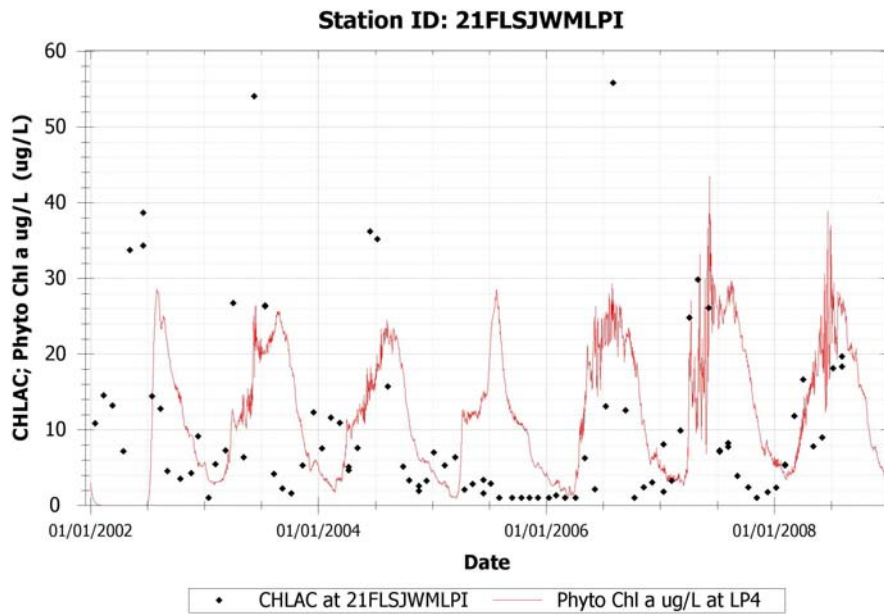


Figure 6 WASP Calibration for Total Nitrogen in Lake Pointsett and St. Johns River above Puzzle Lake

Table 5 presents the annual average predictions for BOD, total nitrogen, total phosphorus and dissolved oxygen.

Table 5 Existing Condition Annual Average Model Predictions

Lake Poinsett and St. Johns River above Puzzle Lake @ 21FLSJWMJGS	2002-2008 Model Prediction Annual Average
BOD (mg/l)	3
Total Nitrogen (mg/l)	1.94
Total Phosphorus (mg/l)	0.122
DO avg (mg/l)	4.7
DO min (mg/l)	1.5
<i>Chla</i> (ug/l)	11.2
<i>TSI</i>	61

4. Lake Poinsett and St. Johns River above Puzzle Lake Watershed Natural Condition Analysis

Lake Poinsett nutrient loads were calculated from estimated natural BOD, TN and TP concentrations. Table 6 provides the natural loads and Table 7 provides the natural annual average model predictions for total nitrogen, total phosphorus, chlorophyll a, dissolved oxygen.

Table 6 Natural Condition Annual Average Nutrient Loads

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Lake Poinsett and St. Johns River above Puzzle Lake Watershed	807,767	35,340	1,211,651

Table 7 presents the predicted annual average concentrations under natural conditions. Without the impacts of anthropogenic sources the dissolved oxygen concentration in the Lake Poinsett and St. Johns River above Puzzle Lake and would not achieve the dissolved oxygen standard of 5 mg/l.

Table 7 Natural Condition Annual Average Model Predictions

Lake Poinsett and St. Johns River above Puzzle Lake	2002-2008 Model Prediction Annual Average
BOD (mg/l)	1.2
Total Nitrogen (mg/l)	0.8
Total Phosphorus (mg/l)	0.035
DO avg (mg/l)	7.2
DO minimum (mg/l)	4.6

<i>Chla</i> (ug/l)	10
TSI	50

4.1. TMDL Reduction

The TMDL load reduction was set to the natural conditions scenario. Because the waterbodies can not meet the dissolved oxygen standard under natural conditions, there is no assimilative capacity for oxygen demanding materials. The percent reduction in Table 8 prescribed by the TMDL is calculated by reducing the existing loadings to natural conditions.

Table 8 TMDL Percent Reduction

Lake Poinsett and St. Johns River above Puzzle Lake Watershed	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Existing	1,958,836	123,185	2,019,418
Natural	807,767	35,340	1,211,651
Percent Reduction	59%	71%	40%