Appendix A:

Modeling Report

Econlockhatchee

and

Little Econlockhatchee Rivers

WBIDs: 2991A & 3001

Nutrients and Dissolved Oxygen

September 30, 2009

Region 4 serving the southeast

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1. Watershed Description

The Econlockhatchee and the Little Econlockhatchee River is located in the north-central part of Orange County and in southern Seminole County. The Little Econlockhatchee River is a major tributary of the Econlockhatchee River. It originates in the relatively high lands of central Orange County, on the eastern edge of the Orlando metropolitan area. It flows primarily in a north direction in Orange County and in a northeasterly direction in Seminole County into the Econlockhatchee River. Unlike the largely unaltered Econlockhatchee River proper, the Little Econlockhatchee River is hydrologically altered extensively, with substantial portions of the river channel canalized and interrupted by control structures. A number of canals draining various parts of the Orlando area flow into the Little Econlockhatchee River. The watershed of the Little Econlockhatchee River is highly urbanized by residential land use.

WBID 2991A and 3001 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 Econlockhatchee and Little Econlockhatchee Rivers.

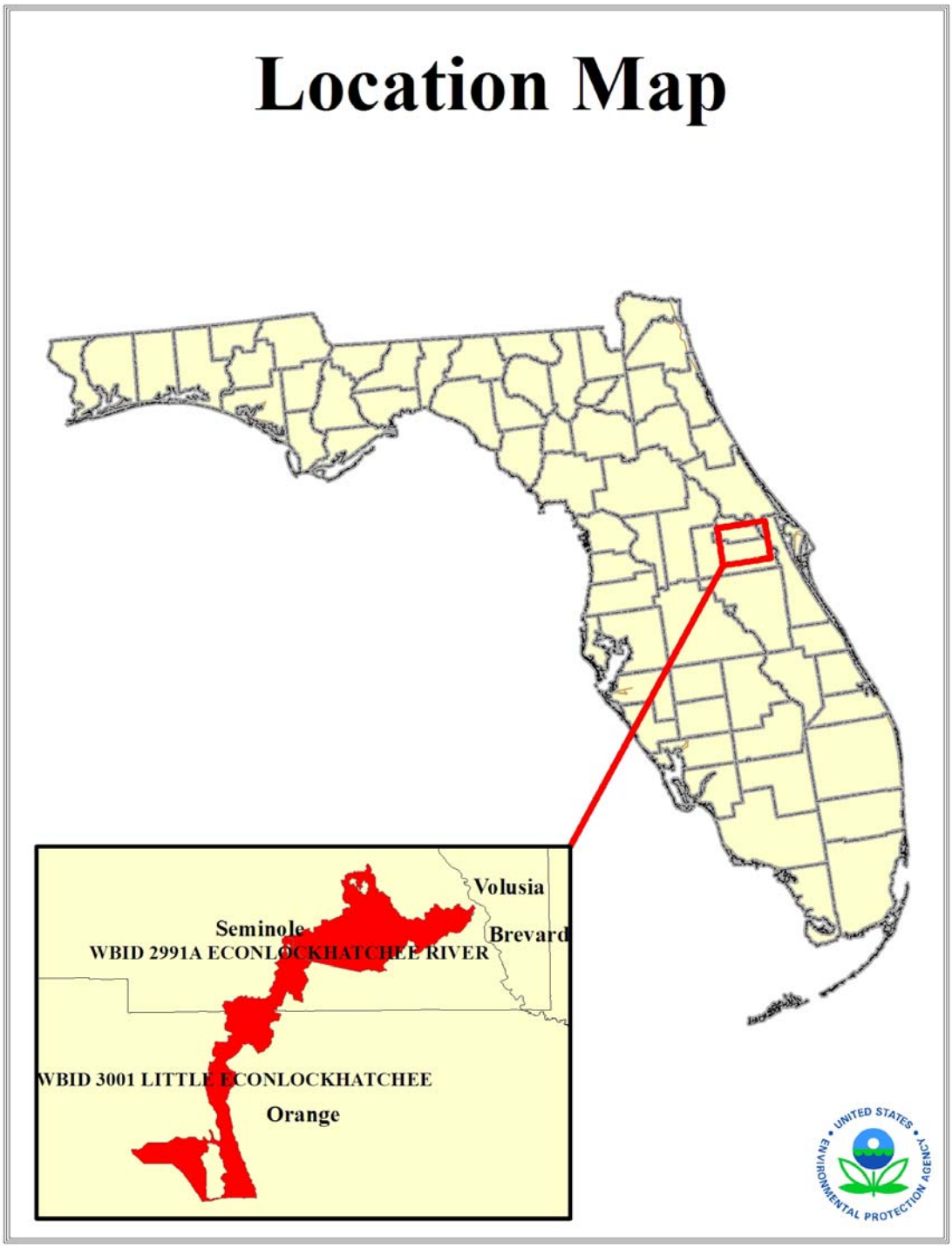

Figure 1 TMDL, Nutrients, Dissolved Oxygen, Florida Consent Decree, Little Manatee River, WBID 1790, Modeling Report

The landuse distribution for the Econlockhatchee and Little Econlockhatchee Rivers is presented in Table 1.

Table 1 Landuse Distribution in Econlockhatchee and Little Econlockhatchee Rivers Watershed

Land Use Name	Area (ac)	Portion of Watershed (%)
AGRICULTURE	27,693	16%
BARREN LAND	468	0%
RANGELAND	17,690	10%
TRANSPORTATION, COMMUNICATION AND UTILITIES	7,566	4%
UPLAND FORESTS	23,464	13%
URBAN AND BUILT-UP	50,669	29%
WATER	7,534	4%
WETLANDS	41,464	23%
Totals	176,548	100%

2. TMDL Targets

The TMDL target to be evaluated in this modeling report is to meet the Econlockhatchee and Little Econlockhatchee Rivers dissolved oxygen standard of 5 mg/l.

3. Modeling Approach

A coupled watershed and 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 watershed model provides daily runoff, nutrient and BOD loadings from the Watersheds. The predicted results from the LSPC model are transferred forward to the receiving waterbody model Water Quality Analysis Simulation Program (WASP 7.3) (USEPA, 2007). The WASP model integrates the predicted flows and loads from the LSPC model to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. Both LSPC and WASP will be calibrated to current conditions, a 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. Econlockhatchee and Little Econlockhatchee Rivers Watershed Model

The goal of this watershed modeling effort is to estimate runoff (flow), nutrient (total nitrogen & total phosphorus) and BOD loads and concentrations from the upstream watersheds flowing into Econlockhatchee and Little Econlockhatchee Rivers. The Loading Simulation Program C++ (LSPC) as the watershed model.

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality on land as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by EPA Region 3 (under contract with Tetra

Tech) and has been widely used for TMDLs. In 2003, the U.S. Environmental Protection Agency (EPA) Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the EPA TMDL Modeling Toolbox.

3.1.1. Econlockhatchee and Little Econlockhatchee Rivers Watershed Delineation and Landuse

The surrounding watershed that drains directly to the Econlockhatchee and Little Econlockhatchee Rivers are presented in Figure 2 and Figure 3. This WBID was delineated into 13 LSPC sub basins to simulate the runoff and pollutant loads.

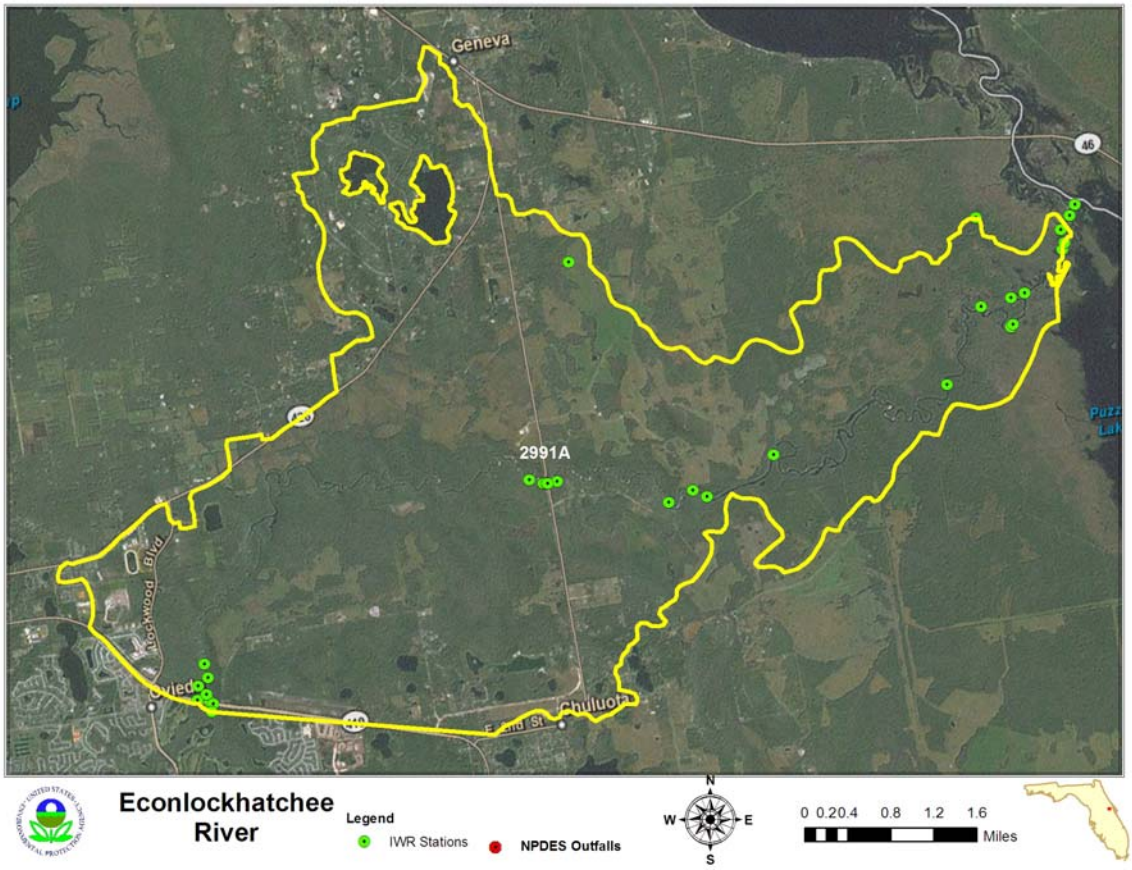

Figure 2 Econlockhatchee River Watershed

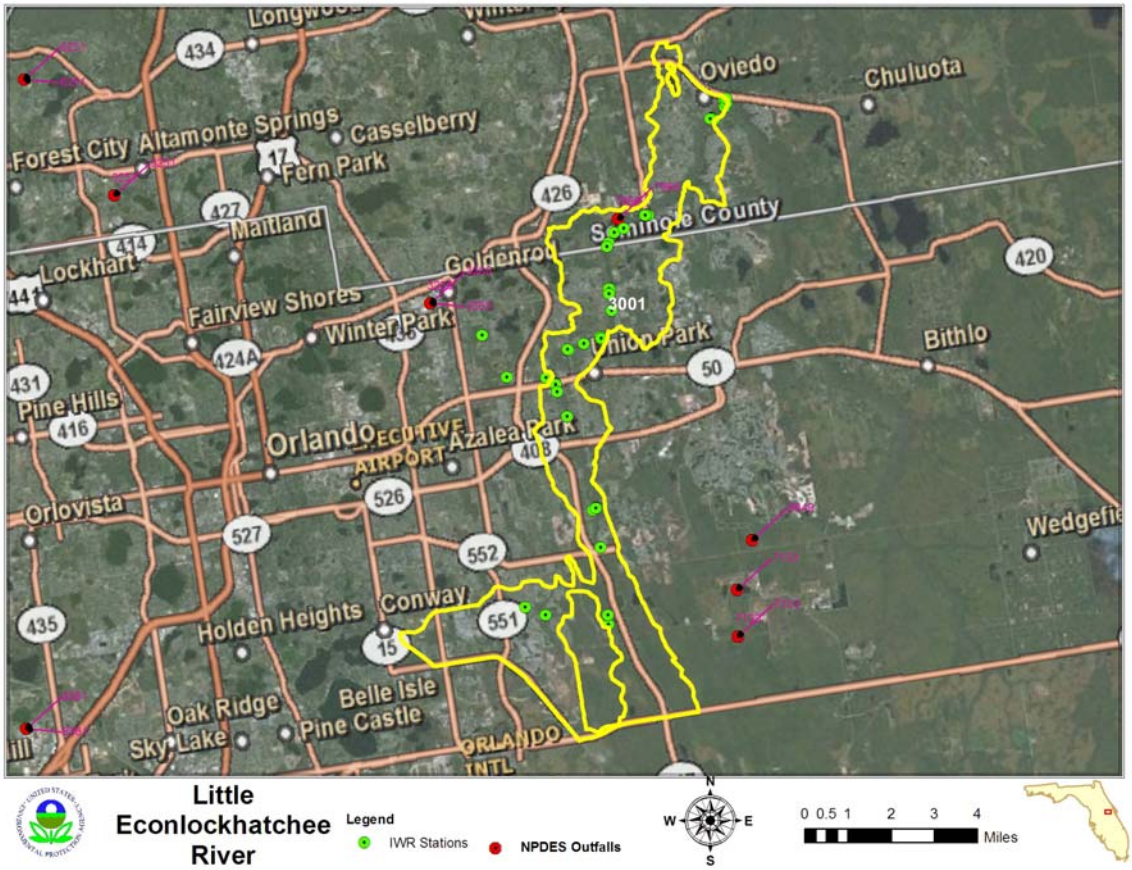

Figure 3 Little Econlockhatchee Watershed

Figure 4 illustrates the Florida Landuse Classification (Level-1) for the Econlockhatchee and Little Econlockhatchee Rivers surrounding watershed.

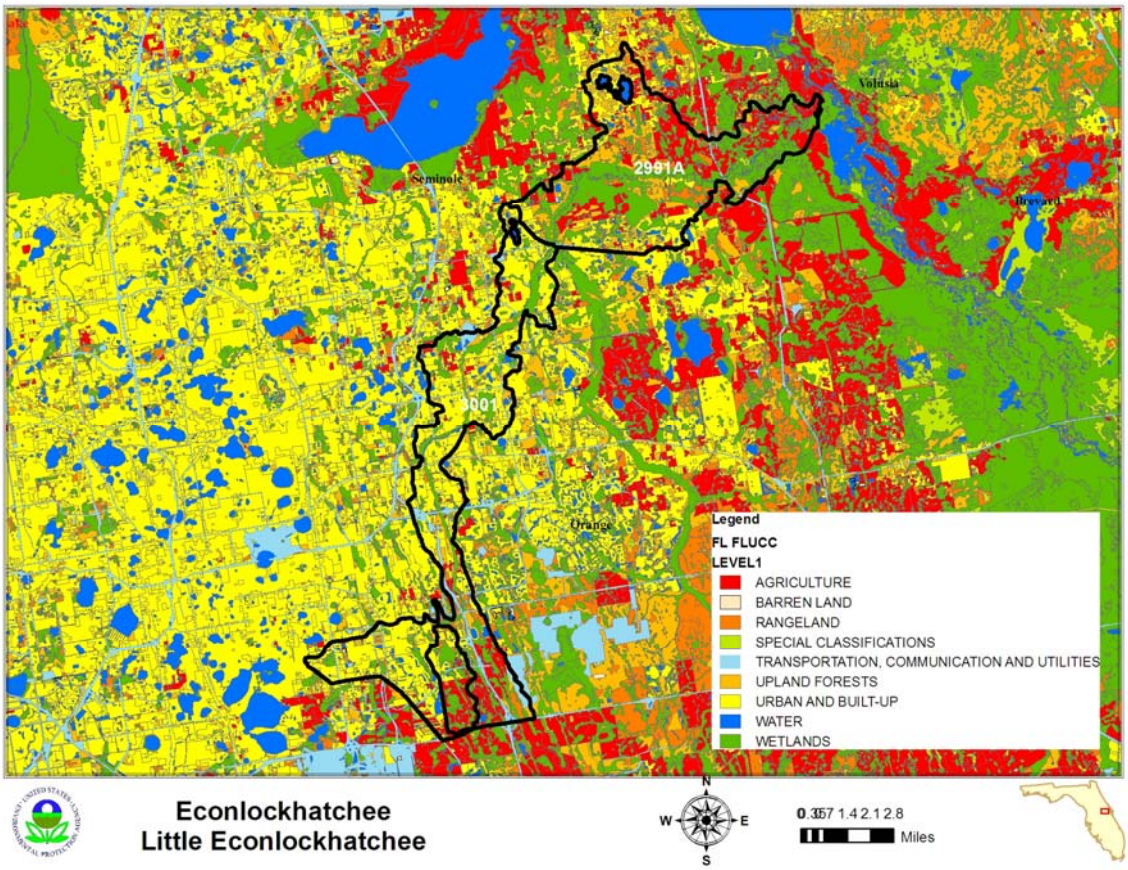

Figure 4 Econlockhatchee and Little Econlockhatchee Rivers Watershed Landuse Distribution

3.2. Econlockhatchee and Little Econlockhatchee Rivers Watershed Runoff

The LSPC watershed model was developed to simulate hydrologic runoff and pollutant loadings in response to recorded precipitation events.

3.2.1. Meteorological

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

Figure 5 provides a time series plot of daily rainfall for the simulation period.

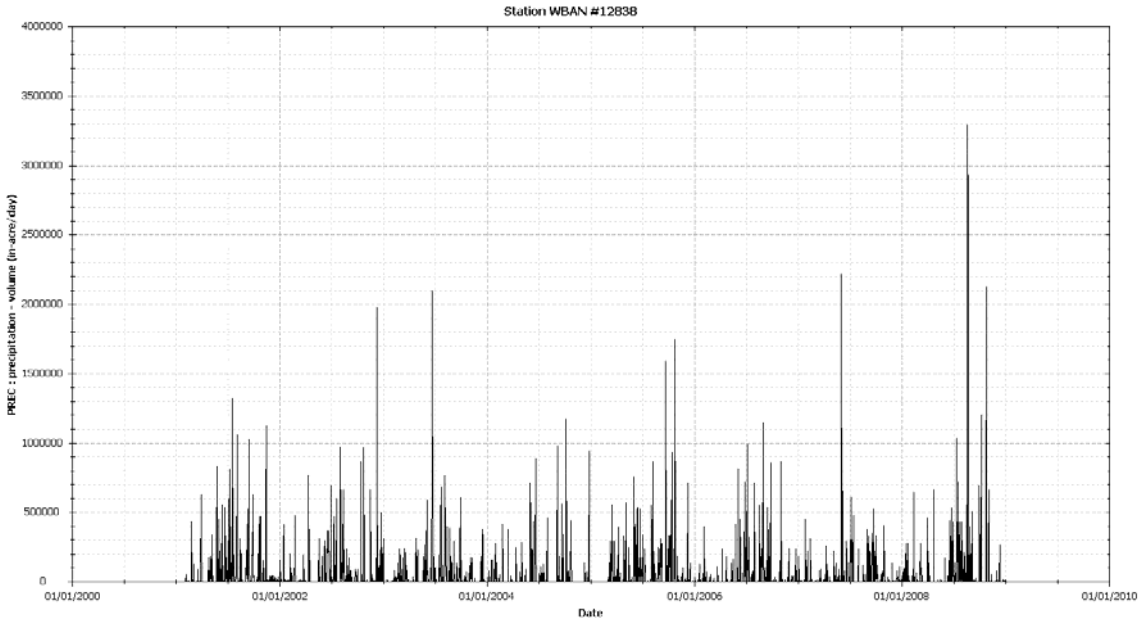

Figure 5 Rainfall for Econlockhatchee and Little Econlockhatchee Rivers and Watershed

Table 2 shows the annual average rainfall for each of the years simulated.

Table 2 Annual Rainfall

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

3.2.2. Flow

Flows were simulated for the Econlockhatchee and Little Econlockhatchee Rivers watershed using the watershed model and compared to the ECONLOCKHATCHEE USGS gage (USGS 02233500). Flows in the Econlockhatchee and Little Econlockhatchee Rivers watersheds were determined by the hydrology component of the LSPC watershed model. The hydrological values used to parameterize LSPC were taken from a previous application of the Hydrologic Simulation Program (FORTRAN) (HSPF) that was previously applied and calibrated for Sarasota County.

3.2.3. BOD and Nutrient Loadings

The pollutagraph was generated using event mean concentrations for total nitrogen, total phosphorus and BOD (Table 3). The initial EMC values were derived for each landuse type from Harpers Report (Harper, 1994) and Sarasota County modeling report (JEA 2005). Baseflow concentrations were derived from the USJR HSPF report (CDM 2007) and review of the Econlockhatchee and Little Econlockhatchee Rivers data.

Table 3 Event Mean Concentration for Landuse Classifications

Landuse	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	BOD (mg/l)
Agriculture	4	1.1	8
WTF Wetlands	5	1	5
Rangeland	2.2	0.34	8
Special Classification	2.2	0.3	10
Transporation	2.2	0.3	10
Upland Forest	1.02	0.16	3
Urban Area	1.9	0.4	10
Water	1.02	0.1	3
Wetlands	1.02	0.1	3

BOD and nutrient watershed runoff were determined using EMCs for surface water runoff and interflow runoff and baseflow concentrations for groundwater flow. Note Barren Land which was modeled as wastewater treatment wetlands and land application of the 19 mgd of wastewater was simulated by this mechanism. Table 4 provides the annual average total nitrogen, total phosphorus and BOD loads for the period of record 2002 thru 2008.

Table 4 Econlockhatchee and Little Econlockhatchee Rivers Nutrient Loads (2002-2008)

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Wastewater Land Application (19 mgd)	78,870	26,290	131,450
Econlockhatchee and Little Econlockhatchee Rivers Watershed	337,454	53,772	1,836,572
Total for the Econlockhatchee and Little Econlockhatchee Rivers Watershed	416,324	80,062	1,968,022

3.3. Econlockhatchee and Little Econlockhatchee Rivers Water Quality Model

The Econlockhatchee and Little Econlockhatchee Rivers WASP water quality model integrates the predicted flows and loads from the LSPC model to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. A 20 segment WASP water quality model was setup to include the Econlockhatchee and Little Econlockhatchee Rivers sub basins.

3.3.1. 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 5 provides the basic kinetic rates used in the model.

Table 5 WASP Kinetic Rates

WASP Kinetic Parameters	Value
Global Reaeration Rate Constant @ 20 °C (per day)	0.2
Sediment Oxygen Demand (g/m2/day)	0.5 to 1.5 for stream segments and 2.5 for Lake segments
Phytoplankton Maximum Growth Rate Constant @20 °C (per day)	2
Phytoplankton Carbon to Chlorophyll Ratio	80
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 Econlockhatchee and Little Econlockhatchee Rivers WASP model predictions were compared to Econlockhatchee and Little Econlockhatchee Rivers water quality data stations 21FLSJWMJGS and 21FLSJWMUSJ055.

Table 6 provides the annual average calibration summary of the comparison between the WASP Econlockhatchee and Little Econlockhatchee Rivers segment and the Econlockhatchee and Little Econlockhatchee Rivers Station for total nitrogen, total phosphorus, chlorophyll a and dissolved oxygen. Figure 6 to Figure 11 illustrates the comparisons of model results and data at the same location.

Table 6 Model Calibration Summary

Econlockhatchee and Little Econlockhatchee Rivers 21FLSJWMECH	**2002–2008 Data Average**	**2002-2008 Model Average**
Total Nitrogen (mg/l)	0.86	0.89
Total Phosphorus (mg/l)	0.10	0.10
DO (mg/l)	6.6	6.8

Flow (cms)	10.6	10.7
21FLSJWMLER-LBB	**2002–2005 Data Average**	**2002-2008 Model Average**
Total Nitrogen (mg/l)	0.85	0.73
Total Phosphorus (mg/l)	0.11	0.11
DO (mg/l)	6.5	6.3

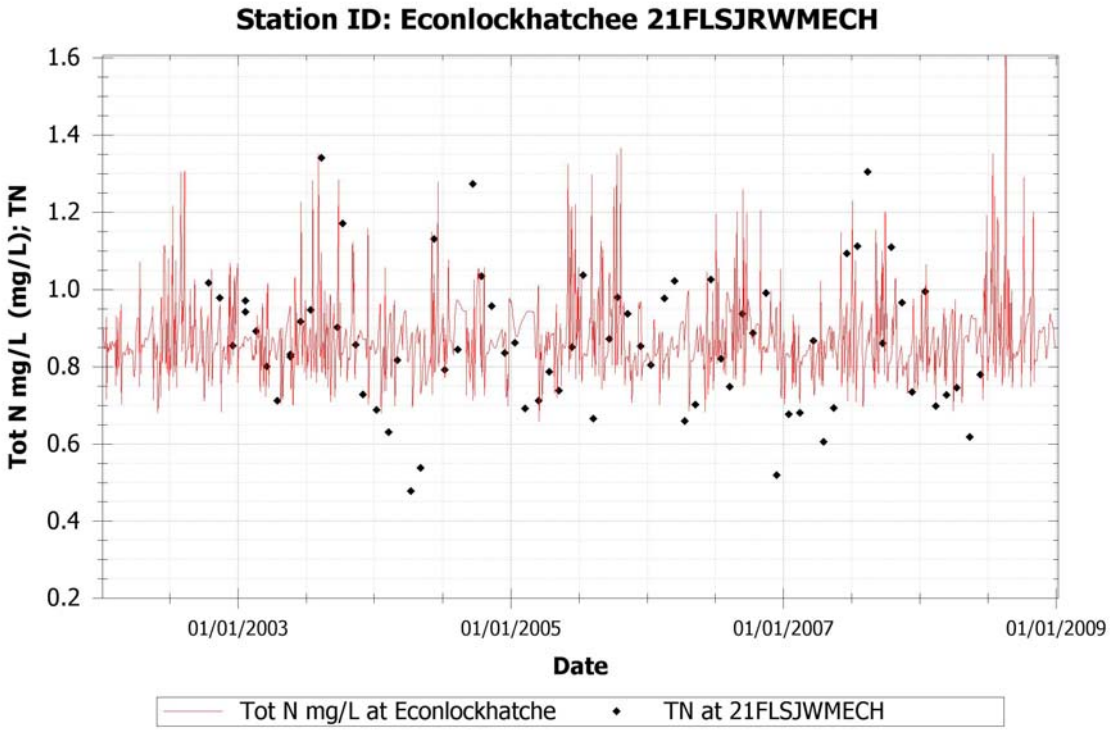

Figure 6 WASP Calibration for Total Nitrogen in Econlockhatchee River

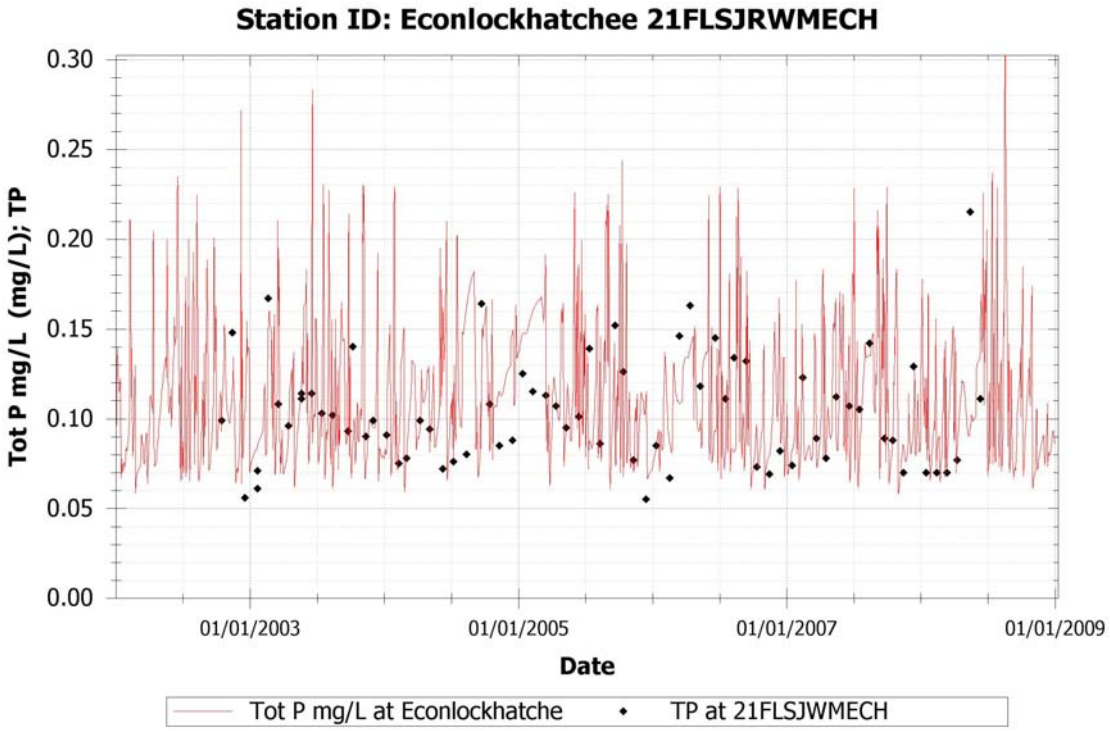

Figure 7 WASP Calibration for Total Phosphorus in Econlockhatchee River

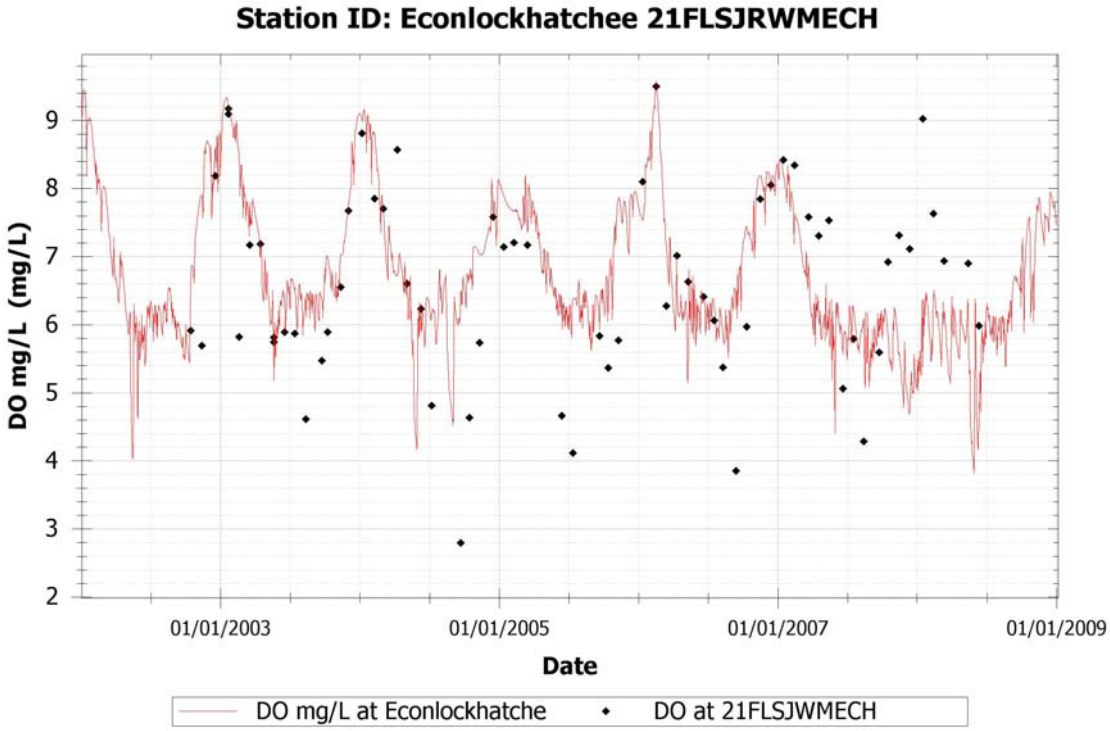

Figure 8 WASP Calibration for Dissolved Oxygen in Econlockhatchee River

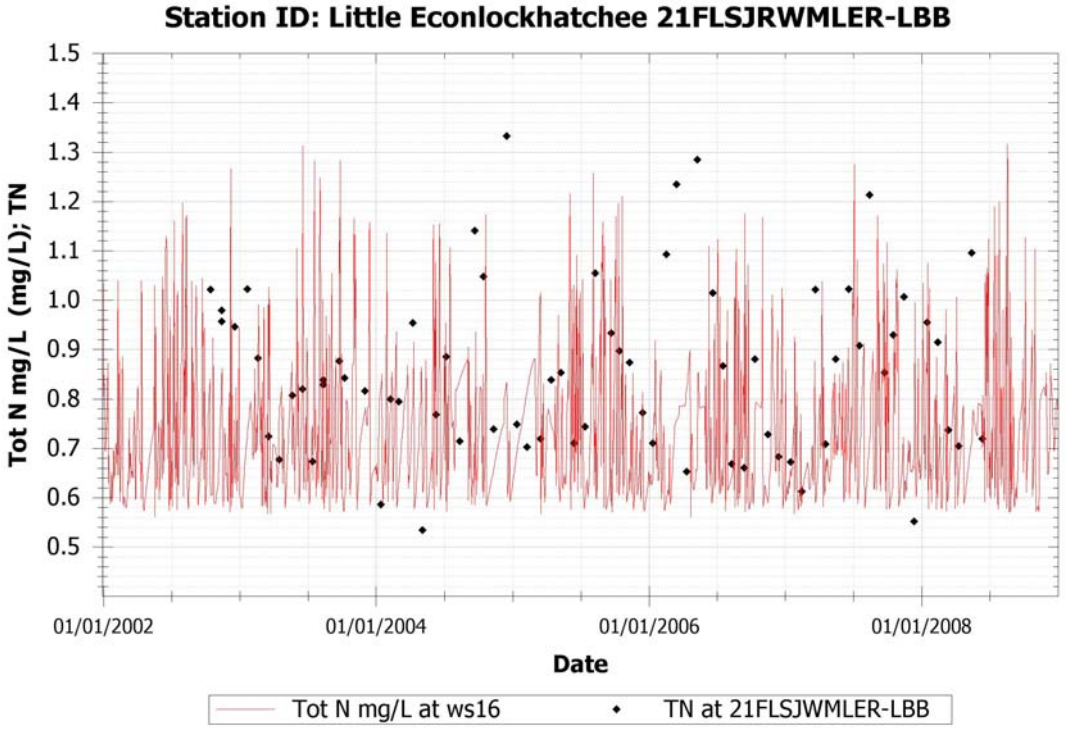

Figure 9 WASP Calibration for Total Nitrogen in Little Econlockhatchee River

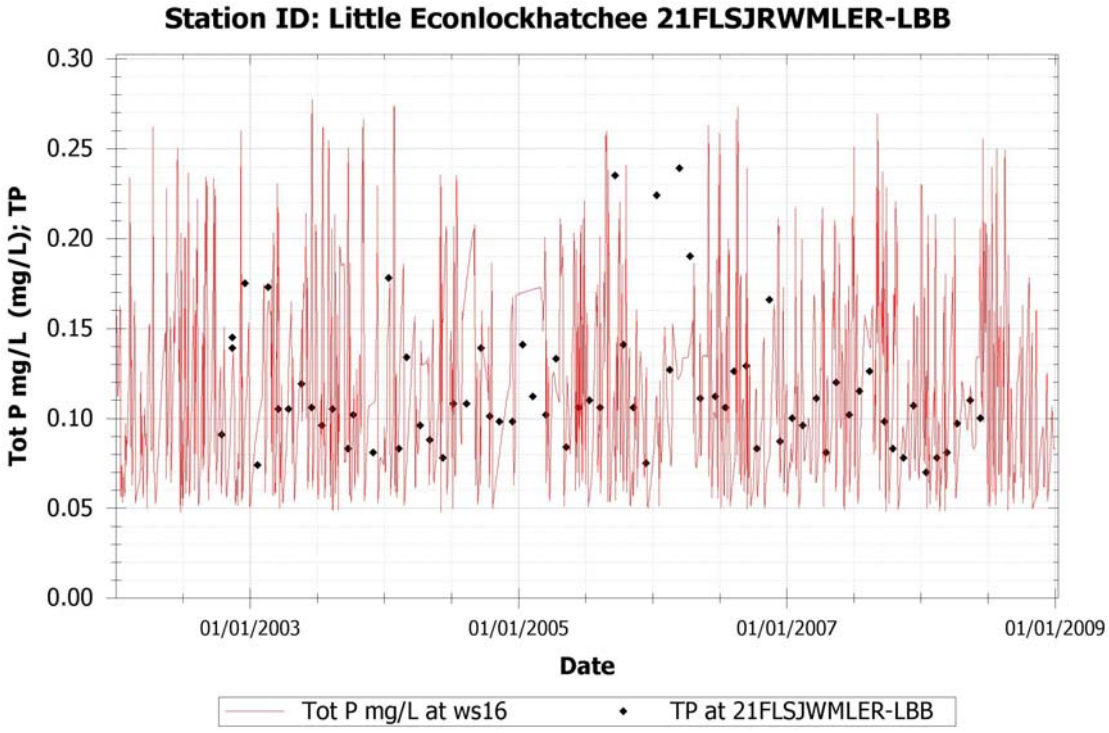

Figure 10 WASP Calibration for Total Phosphorus in Little Econlockhatchee River

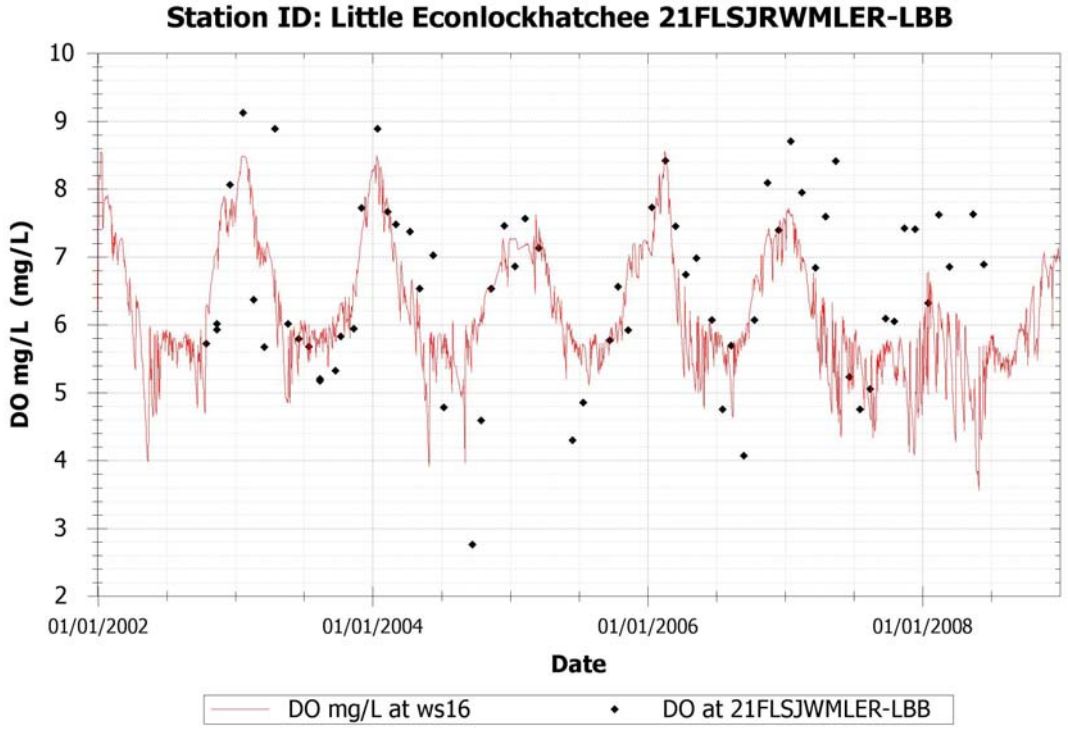

Figure 11 WASP Calibration for Dissolved Oxygen in Little Econlockhatchee River

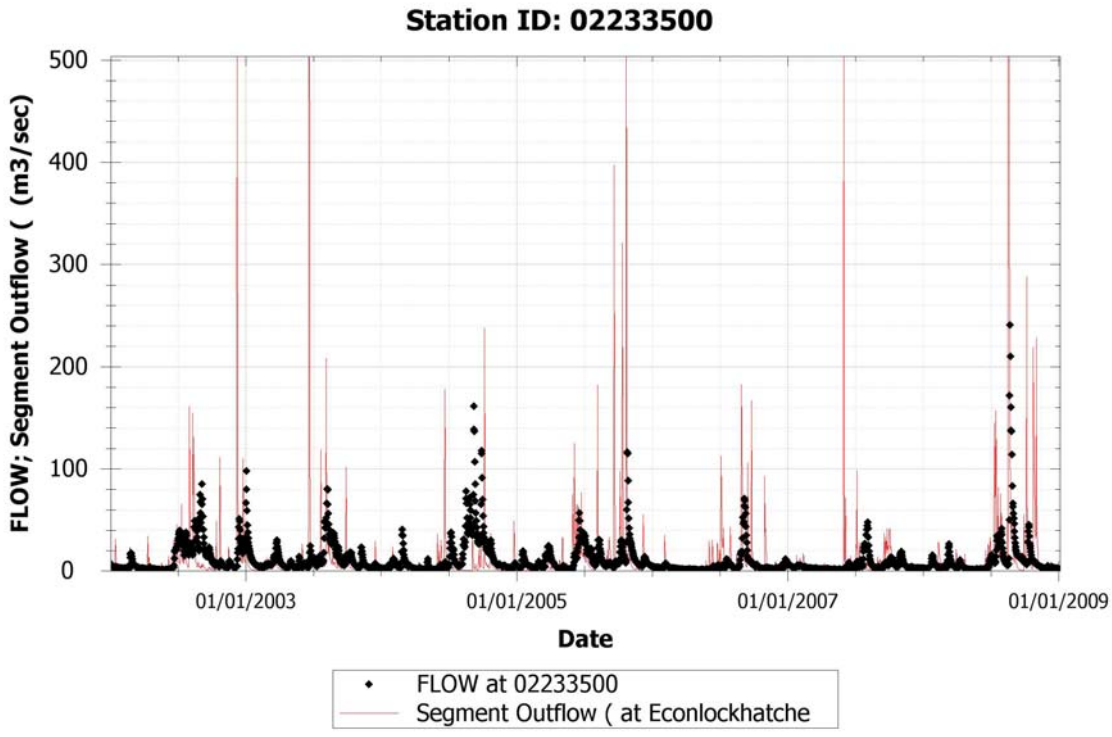

Figure 12 Flow Calibration @ USGS 02233500

Table 7 presents the annual average predictions for BOD, total nitrogen, total phosphorus and dissolved oxygen.

Table 7 Existing Condition Annual Average Model Predictions

Econlockhatchee and Little Econlockhatchee Rivers	2002-2008 Model Prediction Annual Average
BOD (mg/l)	2.8
Total Nitrogen (mg/l)	0.8
Total Phosphorus (mg/l)	0.09
DO avg (mg/l)	6.7
DO min (mg/l)	4.0

4. Modeling Scenarios

Two modeling scenarios were completed to evaluate potential nutrient reduction options. Model years 2002 thru 2008 were used, 2001 was used as model ramp up period. An initial natural condition analysis was completed to predict what Econlockhatchee and Little Econlockhatchee Rivers chlorophyll a and dissolved oxygen levels would be if all impacted upstream lands were converted back to upland forest and wetlands. The second analysis examined the impacts of a 25 percent reduction of BOD, total nitrogen and total phosphorus TMDL scenario.

4.1. Econlockhatchee and Little Econlockhatchee Rivers Watershed Natural Condition Analysis

Econlockhatchee and Little Econlockhatchee Rivers sub basins landuses were changed from impacted lands to upland forest and wetlands landuses. LSPC was then used to simulate the natural condition nutrient loads (Table 8) were inputted in to WASP model. Other than the nutrient load reductions the SOD rate was reduced to reflect the reduced loadings. Table 8 provides the annual average model predictions for total nitrogen, total phosphorus, chlorophyll a, dissolved oxygen.

Table 8 Natural Condition Annual Average Nutrient Loads

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Econlockhatchee and Little Econlockhatchee Rivers Watershed	212,935	18,617	571,895

Table 9 presents the predicted annual average concentrations under natural conditions.

Table 9 Natural Condition Annual Average Model Predictions

Econlockhatchee and Little Econlockhatchee Rivers	2002-2008 Model Prediction Annual Average
BOD (mg/l)	1.1
Total Nitrogen (mg/l)	0.52
Total Phosphorus (mg/l)	0.033
DO avg (mg/l)	7.7
DO minimum (mg/l)	5.8

4.2. 25 Percent Reduction Scenario

A twenty five percent reduction of BOD, total nitrogen and total phosphorus and corresponding reduction in sediment oxygen demand (SOD) (Table 10). Table 11 list the resultant predictions for total nitrogen, total phosphorus and dissolved oxygen.

Table 10 25% Reduction Annual Average Nutrient Loads

Subbasin	total nitrogen Load (kg/yr)	TP Load (kg/yr)	BOD Load (kg/yr)
Wastewater Land Application (19 mgd)	78,870	26,290	131,450
Econlockhatchee and Little Econlockhatchee Rivers Watershed	233,373	33,756	1,344,567
Total for the Econlockhatchee and Little Econlockhatchee Rivers Watershed	312243	60046.37	1476016

Table 11 25% Predicted Water Quality Concentrations from 25% Reduction

Econlockhatchee and Little Econlockhatchee Rivers	2002-2008 Model Prediction Annual Average
BOD (mg/l)	2.3
Total Nitrogen (mg/l)	0.72
Total Phosphorus (mg/l)	0.076
DO avg (mg/l)	7.2
DO minimum (mg/l)	5.0

4.3. TMDL Reduction

The TMDL load reduction was set to the 25 percent reduction scenario. Table 12 provides a summary of the reduction loadings.

Table 12 TMDL Load Analysis and Allocation

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Existing WLA	78,870	26,290	131,450
Existing LA	337,454	53,772	1,836,572
Existing Load	416,324	80,062	1,968,022
TMDL WLA	78,870	26,290	131,450
TMDL LA	233,373	33,756	1,344,567
TMDL	312243	60046.37	1476016
Percent Reduction TMDL	25%	25%	25%