MODEL-BASED ESTIMATES OF TOTAL NITROGEN LOADING TO TAMPA BAY: CURRENT CONDITIONS AND UPDATED 2010 CONDITIONS

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FOREWORD

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1. INTRODUCTION

One of the primary goals established in the Tampa Bay National Estuary Program (TBNEP) Comprehensive Conservation and Management Plan (CCMP) (TBNEP, 1996) is to restore seagrass extent in the bay to levels similar to those observed in the 1950s. Seagrass extent and condition can be impacted by many factors, including water quality.

To attain the seagrass restoration goal, the TBNEP developed the Nitrogen Management Strategy. The Strategy seeks to prevent future impacts due to excessive nitrogen loadings to Tampa Bay. To provide quantifiable goals for the Strategy, a paradigm that relates nitrogen loading to water quality and restorable seagrass acreage was utilized, as shown in Figure 1-1.

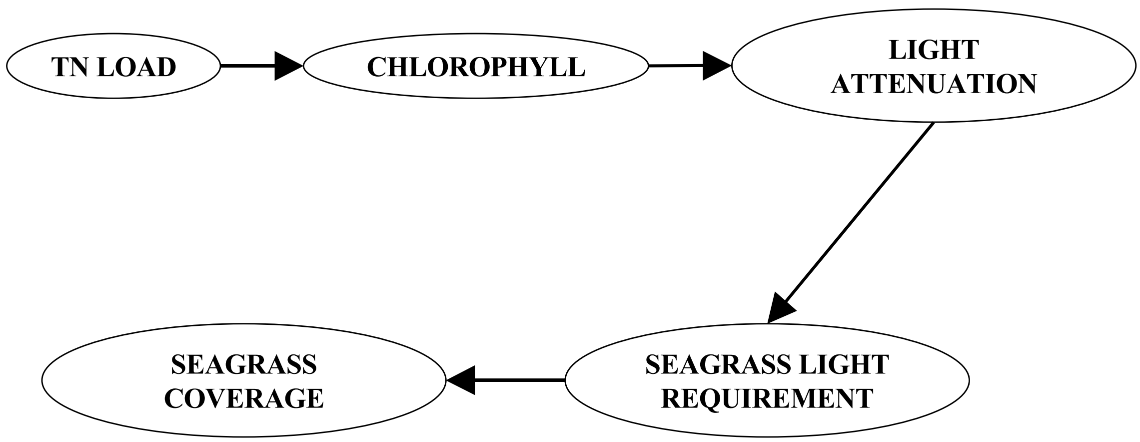

Figure 1-1. TBNEP Nitrogen Management Paradigm.

To quantify the relationships represented in the paradigm, empirical relationships between external total nitrogen (TN) loads and chlorophyll *a* concentrations, between chlorophyll *a* concentrations and light attenuation, and between light availability and restorable seagrass area were developed and presented in Janicki and Wade (1996). These relationships were developed for the Old Tampa Bay (OTB), Hillsborough Bay (HB), and Middle Tampa Bay (MTB) segments.

Using these relationships, predictions of the responses in chlorophyll *a* concentrations, light attenuation, and the extent of seagrass restoration to changes in external TN loading were derived.

The model predictions suggested that seagrass restoration goals could be met by meeting chlorophyll *a* concentration and light attenuation targets for the four mainstem bay segments. Two sets of chlorophyll *a* targets were considered, as follows:

- the chlorophyll *a* concentrations which would be expected to result in restoration of 95% of the seagrass goals for the segments; and

- the mean chlorophyll *a* concentrations observed during the 1992-94 period, i.e., current conditions at the time.

The latter set was considered since all evidence suggested that seagrass areal coverage had been increasing since 1988. It was concluded that the more prudent targets would be the lower of these two sets for each bay segment. Light attenuation targets were set based on the segment-specific depths necessary to allow for attainment of 95% of the seagrass goals.

The estimated 1992-1994 mean annual TN loads represent those loads identified by the TBNEP expected to result in light availability sufficient to meet the seagrass restoration goals. The empirical model relating total nitrogen loads to seagrass restoration goals (Janicki and Wade, 1996) suggested that light availability necessary for obtaining seagrass restoration goals could be met by establishing a "hold the line" strategy for nitrogen loads. This strategy would hold nitrogen loads to each segment of the bay to the average levels of 1992-1994. The Tampa Bay Nitrogen Management Consortium adopted this strategy in 1996.

To implement this strategy, local government partners agreed to preclude increases in future nitrogen loadings to the bay. The ca. 2010 total nitrogen loading estimates presented in Zarbock et al. (1996a) were developed to quantify expected TN loading increases, and were used for the TBNEP Allocation Workshops.

1.1 Objectives

The Tampa Bay Estuary Program (TBEP) is currently performing an update of the estimated TN loadings for the ca. 2010 period. This update incorporates the best available information as of 2000 for estimating ca. 2010 TN loads. ***The objective of this report is to update the expected future nitrogen loading from external sources to each bay segment for the year 2010.*** The annual average loading estimates for 2010 are derived from estimated future monthly loading estimates, using methods similar to those used previously (Zarbock et al., 1996a). In additional, this update contains the modeled TN loading estimates for current conditions.

Loading estimates were developed for each of the seven segments of Tampa Bay (Figure 1-2). The loading sources examined include:

- atmospheric deposition,
- domestic and industrial point sources,
- groundwater and springs,
- material losses from fertilizer handling facilities, and
- nonpoint sources.

The following sections present descriptions of the data and methods used for the estimated current and 2010 TN loadings from each loading source in the Tampa Bay watershed (Figure 1-3). Then a summary of the estimated TN loadings by bay segment, and the estimated loadings by bay segment and jurisdiction, for 2000 and 2010 is provided, followed by the conclusions.

Jurisdictional loads were estimated for Hillsborough, Pinellas, and Manatee counties, and the cities of Tampa, St. Petersburg, Clearwater, and Bradenton. Estimated loadings originating in Polk, Pasco, and Sarasota counties were incorporated into the bay segment TN loadings, but were not incorporated into the jurisdictional loadings. Only land-based sources of TN were accounted for in the jurisdictional loadings. Atmospheric deposition, springs, and groundwater loadings were not apportioned to any county or municipality.

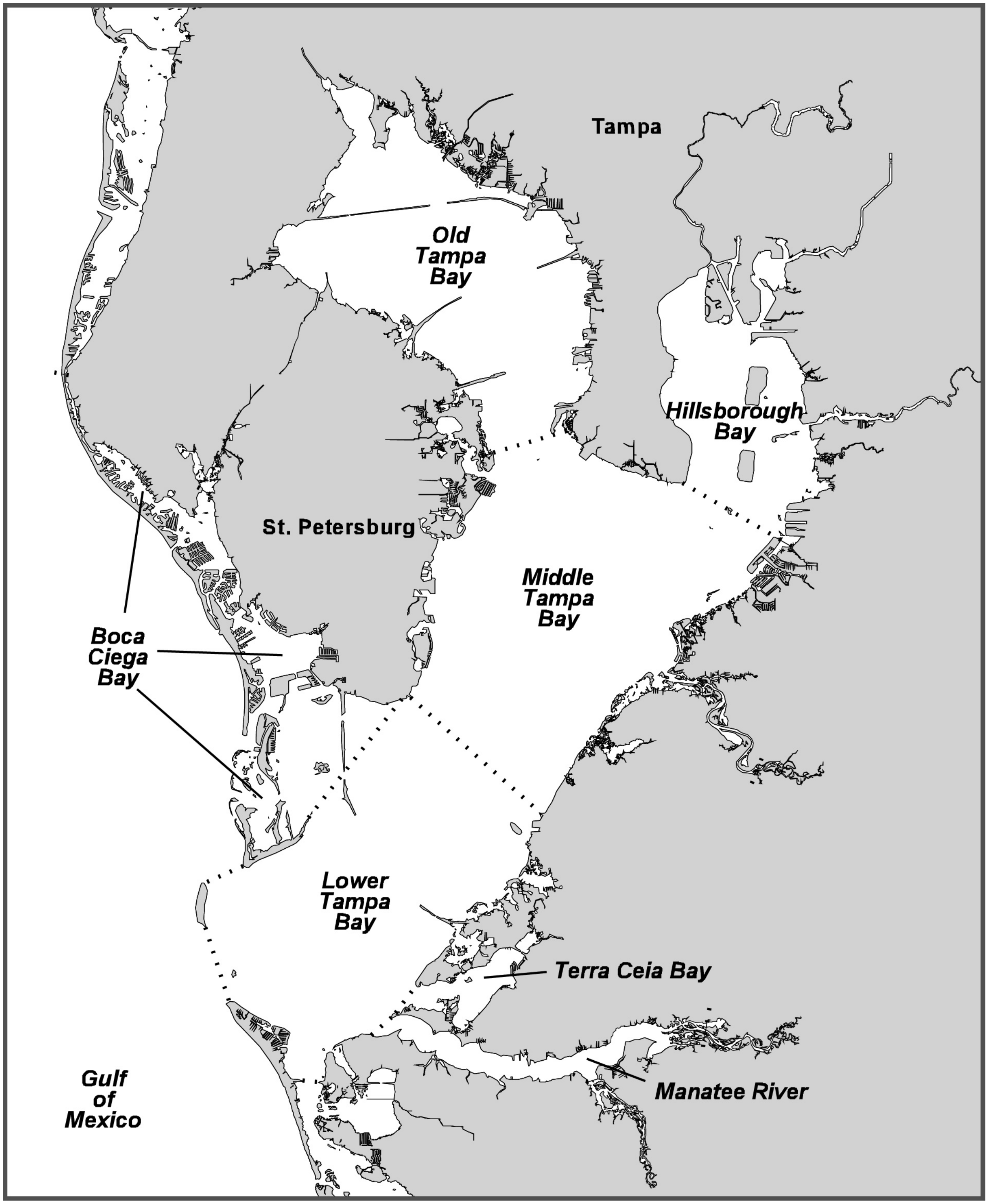

Figure 1-2. Bay segments of Tampa Bay.

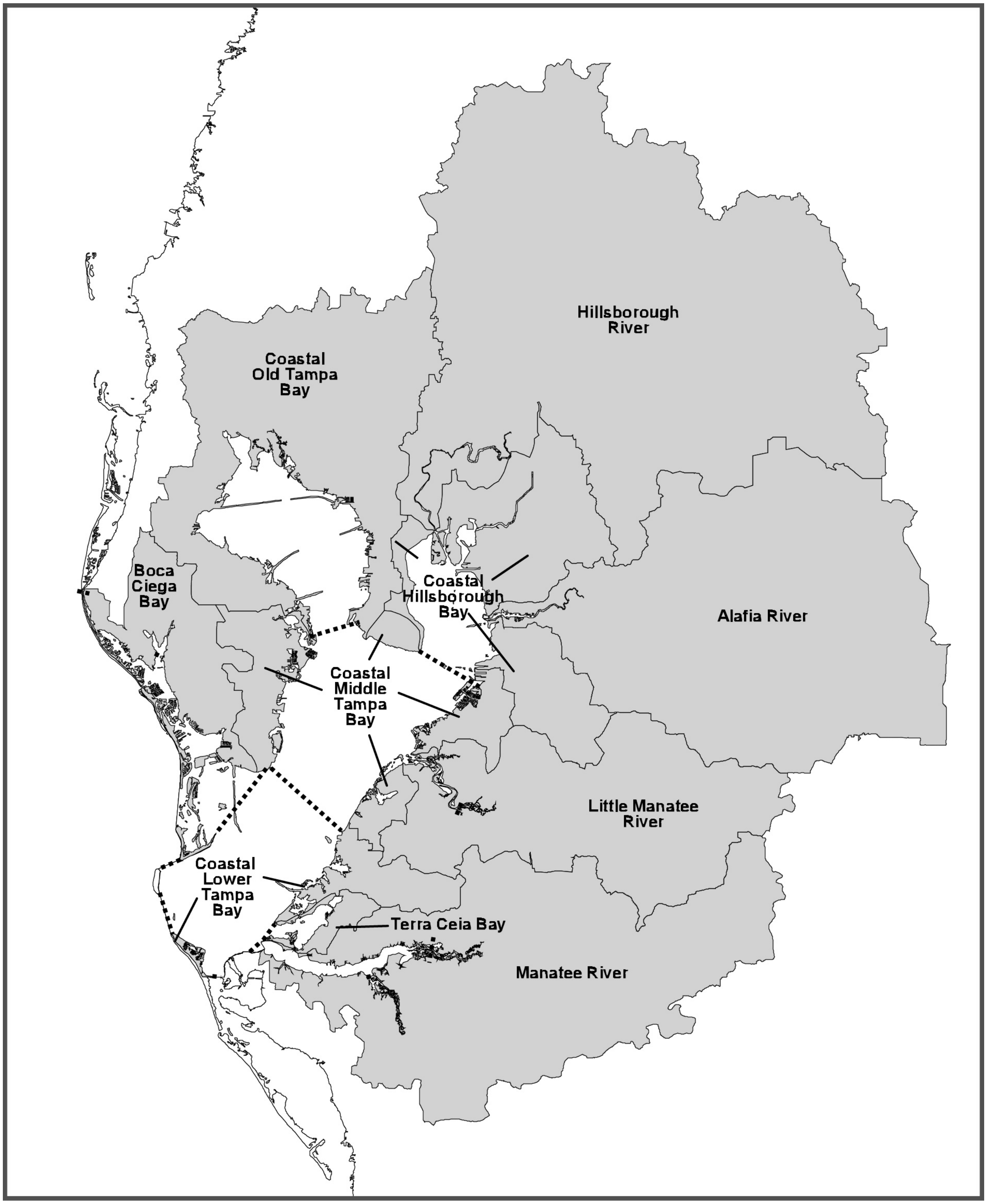

Figure 1-3. Major basins of the Tampa Bay watershed.

2. ATMOSPHERIC DEPOSITION

2.1 Current Conditions Atmospheric Deposition Loading Estimates

Atmospheric deposition is defined as the pollutant load delivered to the surface of the bay from the fallout of airborne pollutants, including both rainfall (wet) and airborne (dry) pollutants. Only nutrients delivered to the open water estuary were accounted for as atmospheric input.

2.1.1 Data Sources

The methods used for estimation of the current TN loading were the same as those used previously, with the exception of the precipitation nitrogen concentration data and the ratio of dry to wet nitrogen deposition. Descriptions of the methods used in both the previous current condition estimate (Zarbock et al., 1996a) and the updated current conditions estimate are provided below.

The previous current loading estimate utilized the best available data for developing the TN loading from atmospheric deposition. Estimates of atmospheric deposition loads were derived from the 1992-1994 NWS rainfall records and precipitation concentration data from the NADP Verna Wellfield site. The ratio of dry:wet deposition was 2.04:1, as in the estimate of 1992-1994 loadings (Zarbock et al., 1996b).

This updated loading estimate for current conditions differed from the previous estimate by utilizing more site-specific information for precipitation concentration and dry deposition. In August 1996, the TBEP initiated monitoring as part of the Tampa Bay Atmospheric Deposition Study (TBADS). This program includes sampling elements for both wet and dry deposition at an intensive monitoring site located on the Gandy Bridge Causeway. The data available from TBADS that can be used to estimate atmospheric deposition to Tampa Bay include nitrogen concentration data, wet and dry deposition rates, and an estimate of the ratio of dry:wet deposition. These data, together with the 1992-1994 hydrologic load from rainfall, were used to update the estimate of current conditions atmospheric deposition TN loading.

2.1.2 Methods

Precipitation volume (rainfall depth times the open water area of the bay) and pollutant concentration data were used to estimate pollutant loadings delivered directly to the estuary via atmospheric deposition. Wet deposition loadings were calculated on a monthly basis for each bay segment by multiplying the precipitation volume (expressed as volume per unit time) by the pollutant concentration (expressed as mg/L). The monthly mean precipitation-weighted TN concentration in rainfall was derived from the TBADS data for the period August 1996 through December 1998, and multiplied by the monthly mean 1992-1994 hydrologic load due to rainfall to derive the wet TN loading estimate for the current condition.

Pollutants are also delivered to the bay via dry deposition. Monitoring at the TBADS site also provided data concerning atmospheric concentrations of nitrogen. Utilizing these data, meteorological data, and a deposition model, dry fluxes of nitrogen to the surface of the bay were estimated (Pribble et al., 2001). Seasonal-specific ratios of dry:wet deposition were then estimated. These ratios were used to estimate monthly atmospheric deposition from both wet and dry deposition.

2.2 2010 Conditions Atmospheric Deposition Loading Estimates

The same NWS precipitation data that were used for 1992-1994 atmospheric deposition loading estimates were used for future condition loading estimates. These data were used to develop average monthly rainfall, so that only the rainfall chemistry concentrations and the dry:wet deposition ratio were different for this future condition update.

2.2.1 Data Sources

The predicted change in nitrogen emissions used in the development of the previous 2010 loading estimate was an increase of 10% between 1994 and 2010 (Zarbock et al., 1996a). The estimate utilized wet precipitation chemistry from the NADP Verna Wellfield site, estimated rainfall volumes based on a rainfall surface developed from data collected at 22 NWS sites, and a ratio of dry:wet deposition of 2.04, as suggested by the FADS study (ES&E, 1987).

The updated 2010 TN loading estimate utilized more recent projections of a decline in atmospheric nitrogen emissions. The decline is based on changes in emissions expected to occur from the Tampa Electric Company (TECO) Big Bend and F.J. Gannon facilities. In 1997, these two facilities accounted for approximately 80% of the stationary point source nitrogen emissions from Hillsborough and Pinellas counties. As a result of a federal agreement, a reduction in NO_x emissions from the two facilities by approximately 90% will occur between 1997 and 2010 (TECO, 2000). These reductions constitute a 46% reduction in NO_x emissions from Hillsborough and Pinellas counties compared to 1997 levels.

NO_x emissions from mobile on-road sources are not expected to change significantly by 2010 (FDEP, 2000). Projected increases in the numbers of automobiles are expected to be offset by implementation of EPA emissions standards taking effect in 2004, yielding no net change in NO_x emissions from mobile on-road sources.

The monthly average precipitation-weighted TN concentrations for the 2010 period were derived from the TBADS data for August 1996 through December 1998. These data were used with the 1992-1994 rainfall data to derive an updated future condition atmospheric loading estimate.

2.2.2 Methods

For the purposes of the updated 2010 atmospheric deposition, the simplest method of relating changes in atmospheric nitrogen concentration to changes in emissions was used, as in the previous estimate. A reduction in atmospheric nitrogen concentrations was considered to be linearly related to a reduction in atmospheric emissions. For these purposes, it was assumed that atmospheric emissions remained unchanged in 2010 from the emissions for 1997 from sources other than stationary point sources. The reduction in emissions resulting from the scheduled modifications to the TECO facilities, and the projected no net change in on-road mobile sources emissions, correspond to a reduction in atmospheric emissions of 46% by 2010. For this estimate, the 46% reduction in atmospheric emissions by 2010 corresponds to a 46% reduction in atmospheric nitrogen concentrations from the 1995-1998 period to 2010.

This relationship was used to provide the primary estimate of deposition, along with the most site-specific data available for precipitation chemistry from the TBADS site, and the dry:wet deposition ratio as derived from the TBADS site. These data were also used in the estimation of the 1995-1998 atmospheric deposition loadings to the bay (Pribble et al., 2001). The updated 2010 estimate based on this method is provided in the tabular presentation of predicted loadings later in this document.

The actual effects of the planned emission reductions with respect to changes in deposition are unknown, however. To provide some boundaries to the predicted 2010 deposition, two additional methods were used to provide alternative estimates. The first method uses a previously derived relationship between emission reductions and reductions in deposition that estimated a 1 ton reduction in deposition in response to a reduction in emissions of 400 tons (TBEP, 1999). The second method assumed no changes in atmospheric nitrogen concentrations from 1998 levels. A comparison of the results of these methods are shown in the results section below.

3. DOMESTIC AND INDUSTRIAL POINT SOURCES

3.1 Current Conditions Point Source Loading Estimates

Existing domestic and industrial point sources were identified in Pribble et al. (2001), and included direct surface discharges and land application discharges within the watershed with a permitted average daily flow (ADF) of 0.1 million gallons per day (MGD) or greater. Through interviews with local government utility planners and facility operators, projected flows and planned future facilities were identified for this analysis.

3.1.1 Data Sources

Point sources were identified by reviewing FDEP point source discharge locations in relation to the Tampa Bay watershed. The locations of all point sources in Florida were obtained from the PCS database provided by FDEP. These locations were used to create a GIS coverage, and then mapped for FDEP Tampa office staff review. The domestic point sources in the Tampa Bay watershed with ADF of 0.1 MGD or greater were identified by FDEP Tampa office staff.

Sources used to estimate point source discharges and concentrations data to Tampa Bay for the current period, based on 1998 data, were as follows:

- MORs and DMRs obtained from the EPCHC and the Tampa office of the FDEP; and
- MOR and DMR data obtained directly from the domestic wastewater treatment facilities for those data not obtained from the EPCHC and FDEP.

The database was subjected to quality control measures to ensure that the most accurate flows and concentrations obtainable were used in the loading estimates. The entries were scanned for incongruous data points. Obvious outliers (such as flows of two or three orders of magnitude higher than the design capacity of the facility) were removed from the record. Complete records existed for most domestic wastewater treatment plants, with facilities reporting flow rate and TN concentrations on a monthly basis. Attempts were made to locate sources of valid data to replace missing or invalid values, often by contacting facility personnel directly.

For those data gaps that could not be filled with actual recorded data, two methods were used to complete the record, depending upon the amount of data missing, as follows.

- If 1-3 months' of data were missing consecutively, discharge and/or pollutant concentrations were set to those of the last month's for which values existed.

- If more than 3 months' of data were missing consecutively, discharge and/or pollutant concentrations were set to the monthly averages of the 1995-1998 record.

In some cases, a form of nutrient other than total nitrogen was reported. For example, if both total nitrogen and nitrate nitrogen were recorded for some months at a facility, but only nitrate nitrogen was recorded for most months, the average ratio of nitrate to total nitrogen was calculated for those months with both values. The resulting ratio was applied to the other months, resulting in an estimate of total nitrogen for those months. If only nitrate nitrogen data existed, then total nitrogen concentration was set to the reported concentration of nitrate nitrogen.

If no data for a certain parameter were available for a facility and it was known or suspected that loadings of that chemical did occur, then other similar facilities were examined. Typical or averaged data from these facilities were used to fill data gaps if no other source of information was available. This method was chosen as an alternative to showing missing data for loads from major point sources.

3.1.2 Methods

Current condition point source loading estimates were developed as monthly loads for 1998. All facilities were assumed to discharge independently except the St. Petersburg facilities. Effluent from St. Petersburg's four facilities enters a common distribution system, and commingles prior to discharge as land application reuse.

Direct surface water discharges were calculated by multiplying the flow (expressed as volume per unit time, such as MGD, by the reported TN concentration (mg/L). With appropriate conversion factors, this calculation yields a mass per unit time, such as tons per year. All of the effluent released via surface discharge was assumed to reach the Tampa Bay system.

Land application of treated effluent is discharged most commonly by either spray irrigation or in percolation ponds. The applied effluent either evaporates, is taken up by vegetation, becomes surface runoff (generally a very small component of the total volume), or infiltrates to the water table. Therefore, pollutant loadings that reach the bay generally do so via groundwater. Land application loadings were estimated using recorded effluent quality data from specific facilities, with attenuation rates (Zarbock et al., 1996b) applied to flows and nitrogen loads once the effluent enters the environment.

These attenuation rates are the same as those used previously for loading estimations for the 1985-1994 period (Zarbock et al., 1994; 1996b), and account for attenuation of pollutants in the environment prior to the effluent flow reaching the receiving water of Tampa Bay. Pollutant loading reductions applied to loads discharged to land were as follows:

TN (spray irrigation)	: 95% reduction for City of St. Petersburg facilities,
	: 90% reduction for all other facilities, and
TN (percolation pond)	: 70% reduction.

These rates were the same as those used previously (Zarbock et al., 1994; 1996a; 1996b).

TN load reductions were based on literature values for nutrient behavior in the subsurface environment and local WWTP monitor well data. General assumptions used to estimate land application loads include:

- Recorded monthly values for domestic effluent for facilities with land application were used as the "influent" value.

- Initial concentration reductions result from above-ground and root zone processes, followed by downward migration through the unsaturated zone, to the water table.

- Some additional removal of TN may occur during waste stream movement towards the receiving water (surface water), through the surficial aquifer. However, this additional removal is thought to be relatively small, so there was no accounting for varying distances of effluent travel among individual sources.

- Removal rates for nitrogen in effluent are higher for spray irrigation than for percolation ponds because of enhanced volatilization and plant uptake that occurs with spray facilities. The City of St. Petersburg plants operate to maximize the ammonia proportion of nitrogen in the effluent. This enhances plant uptake and volatilization of nitrogen, and supports the estimated 95% removal rate calculated using monitor well data (St. Petersburg, 1993).

3.2 2010 Conditions Point Source Loading Estimates

Future condition point source loads were obtained by revising existing conditions loads base on projected changes in demand, treatment methods, or effluent disposal method. Data sources and methods are described below.

3.2.1 Data Sources

Information on the quality and quantity of future discharges from domestic and industrial point sources was obtained via telephone interviews and visits with representatives of each of the governmental entities responsible for the specific sources. A complete list of the persons contacted and a summary of the interviews is presented in Appendix 1. For each interview, the contacted party was supplied with the information provided during the development of the previous future condition estimates, and asked if there were any significant changes in these plans. Through these interviews, it was determined which facilities are proposed to remain in service or close, what changes in treatment levels or discharge methods are expected, and to what extent flows may be expected to rise or fall during the next decade.

Any new information provided for future condition point source estimates was used to develop updated 2010 loading estimates. For those facilities for which no revisions of 2010 loadings were necessary, the estimated future loadings remained the same as for the previous estimate. For those facilities that came online following the 1992-1994 period, the 1998 estimated loadings were used as a baseline.

3.2.2 Methods

The methods used to estimate projected future loads were the same as those used to estimate point source loads for the current period, using revised flows or concentrations based on the interviews. Monthly flows were multiplied by the TN concentrations to yield monthly loads, using the following assumptions:

- all loads from surface discharges reach the bay;
- 90% of the TN load from spray irrigation land application did not reach the bay, but was attenuated through process following application (except for St. Petersburg facilities, which had 95% TN attenuation because of the high level of volatile ammonia in the effluent); and
- 70% of the TN loads from percolation pond land application did not reach the bay, but were attenuated through processes following application.

4. SPRINGS AND GROUNDWATER

4.1 Current Conditions Springs and Groundwater Loading Estimates

Springs are a significant source of nitrogen loading to the bay. Estimates of spring loads were developed using existing measured data, and were developed independently of groundwater loads. Groundwater provides another source of nutrient loading to the bay. The surficial (water table), intermediate, and Floridan aquifers all contribute loadings to the bay.

4.1.1 Data Sources

Recorded flows and water quality data were used to estimate freshwater inflow rates and pollutant loadings from springs for the current condition. Previous loading estimates have been developed for Sulphur Springs, Lithia Springs, and Crystal Springs, which were identified as significant discharges in the Tampa Bay watershed (Zarbock et al., 1994; 1996b). Smaller springs do exist in the watershed, but have relatively small discharges and were not considered in this loading analysis or the previous estimates. Lithia Springs and Sulphur Springs are not in gaged portions of the Tampa Bay watershed, but are themselves gaged. Crystal Springs is located in a gaged basin within the Hillsborough River watershed and its flow was accounted for by the downstream gage, so that pollutant loadings from Crystal Springs are incorporated into the nonpoint source loading estimate, as done previously (Zarbock et al., 1994; 1996b).

Estimates of wet and dry season groundwater inflow to Tampa Bay were completed using the methods of Hutchinson (1983) and Brooks et al. (1993). Flow estimates were calculated using a flow net analysis and Darcy's equation (Freeze and Cherry, 1979), a well-recognized analytical method for estimating groundwater flow. TN concentration data for the surficial, intermediate, and Floridan aquifers were obtained from the SWFWMD Ambient Ground Water Monitoring Program (AGWMP) (DeHaven, personal communications). Only groundwater inflow that entered the bay directly from the shoreline or bay bottom was considered. Groundwater inflow to streams was accounted for in the nonpoint source empirical model. Septic tank loadings to the bay in groundwater were not explicitly accounted for in this analysis. Current condition groundwater loadings were set equal to those of 1998, as previously derived (Pribble et al., 2001).

4.1.2 Methods

The methods used to calculate current pollutant loadings from springs and groundwater follow those used in previous loading estimates (Zarbock et al., 1996b; Pribble et al., 2001). For both sources, average monthly TN concentrations for

1998 were multiplied by monthly flows to yield monthly TN loadings. Springs and groundwater loading estimates for the current period were set to those of 1998 (Pribble et al., 2001).

4.2 2010 Conditions Springs and Groundwater Loading Estimates

Loadings from springs and groundwater for future conditions were also estimated. Loadings from Lithia Springs and Sulphur Springs were estimated, as were the combined loadings from the surficial, intermediate, and Floridan aquifers.

4.2.1 Data Sources and Methods

Future condition spring loadings were estimated using 1998 data from the USGS and SWFWMD, as described for current conditions. No defensible means of quantifying trends in spring flows or spring nutrient concentrations is available. Therefore, the 1998 data were used to estimate future conditions spring loadings. Similarly, groundwater loading estimates for 1998 were assumed to be representative of future conditions.

5. MATERIAL LOSSES

5.1 Current Conditions Material Losses Loading Estimates

Fertilizer losses from loading docks at port facilities constitute a source of nutrient loading classified as material losses. In particular, bulk phosphate fertilizer is subject to product losses during its transfer from land carrier to storage facility, and onto vessels for shipping. Product is lost both through spilled product washing into the bay with stormwater runoff, and via fugitive dust. Material losses occur at facilities at the Port of Tampa, in the Coastal Hillsborough Bay basin, and at Port Manatee, in the Coastal Lower Tampa Bay basin.

5.1.1 Data Sources

Estimates of current total nitrogen loadings due to material losses were developed from data provided by the facilities for 1998. For the 1995-1998 estimates, all facilities provided spreadsheets containing loss estimates due to handling losses and airborne (fugitive) losses on an annual basis for the 1995-1998 period. These estimates were requested and obtained through the assistance of Mr. Craig Kovach, CF Industries, and provided to the TBEP in electronic format.

5.1.2 Methods

The loss estimates for the 1995-1998 period were much less than those from the 1992-1994 period (Zarbock et al., 1996). For the 1992-1994 estimates, facility personnel provided rock and chemical masses shipped. The shipped products were then converted to losses using conversion factors based on methods developed by Morrison and Eckenrod (1994). These methods suggested an overall loss rate of approximately 0.02% of product shipped, so that the total masses of nitrogen and phosphorus in the shipped product were multiplied by 0.0002 to derive the pollutant loadings from the phosphate handling facilities. The estimates for the 1995-1998 period, however, represent the best estimates by facility personnel of actual losses. These estimates reflect both actual reductions in nutrient losses from improved handling practices implemented by most facilities, and improved loss estimation techniques for both ship loading losses and air borne losses.

5.2 2010 Conditions Material Losses Loading Estimates

5.2.1 Data Sources and Methods

Material losses for future conditions were estimated by changing existing condition loadings by 1% per year from 1998 through 2010. This information was obtained from Mr. Craig Kovach, CF Industries, and Mr. Bruce DeGrove, Florida Phosphate Council, as representative of industry growth through 2010.

6. NONPOINT SOURCES

6.1 Current Conditions Nonpoint Sources Loading Estimates

Nonpoint sources include stormwater runoff and baseflow as streamflow. All nonpoint source loading estimates for existing conditions were model-based, and used no measured water quality or flow data. This approach was used so that an equitable comparison of existing condition to future condition loads (all model-based) could be made.

6.1.1 Data Sources

Data used to estimate nonpoint source loads include rainfall, land use, soils, subbasin boundaries, and land use-specific runoff coefficients and stormwater quality concentrations. These data were all used to develop modeled estimates of TN loads to Tampa Bay.

<u>Drainage Basin Boundaries</u>

Drainage basin boundaries were incorporated into all geographically-based data used for this project (e.g., land use data, precipitation data, drainage areas, point source locations). The drainage area boundaries were based on a geographic information system (GIS) coverage obtained from the Southwest Florida Water Management District (SWFWMD, 1992).

The Tampa Bay watershed includes a total of 425 subbasins covering approximately 2,276 sq. mi. (5,895 sq. km.), as delineated by USGS (Foose, 1993). Internally drained lands, which include 22 subbasins, encompass 125 sq. mi., or slightly more than 5% of the watershed area. These areas may be expected to retain initial rainfall volumes, and provide surface discharge only after internal storage areas are filled. For nonpoint source load modeling, these noncontributing subbasins were removed from the land area that generated stormwater runoff.

<u>Rainfall Records</u>

The precipitation data used for modeling surface water hydrology were obtained from the NWS for the 1992-1994 period. Total monthly precipitation records for 22 long-term stations within or near the Tampa Bay watershed were obtained for the period January 1992 through December 1994. The names and locations of these stations are presented in Zarbock et al. (1994). Total monthly precipitation values were estimated for each subbasin, month, and year of the existing period. Subbasin estimates were interpolated from a precipitation response surface that was fit to the entire watershed for each month and year of the existing period. The response surface was fit to account for regional patterns, but to give more emphasis to local conditions.

Land Use/Land Cover Data

Land use/land cover GIS data for 1995 were obtained from the SWFWMD and incorporated into the surface water hydrology model. These data represent an update of the land use data from that used for the previous estimate (Zarbock et al., 1996a), which were for 1990. The land use data were recorded following the Florida Land Use Cover Classification System (FLUCCS) level 3 developed by the Florida Department of Transportation Thematic Mapping Section (FDOT, 1985).

For the purpose of assigning land use-specific runoff and pollutant loading factors, the FLUCCS land uses were aggregated into 21 classes, as presented in Appendix 2. The aggregated land use classification system was developed by examining the source literature for the FLUCCS land uses, and combining hydrologically-similar land uses based on stormwater runoff coefficients and land use specific pollutant loading factors. Land use-specific stormwater runoff coefficients and pollutant concentrations were determined from a review of field investigations from central and south Florida, as described below.

Soils Data

The soils coverage includes discrete polygons of individual soil series (types) as identified and delineated by the USDA Natural Resources Conservation Service (NRCS) in the Hillsborough, Pinellas, Manatee, Polk, and Pasco county soil surveys. The GIS coverage of these data was obtained from the SWFWMD. The discrete soils polygons represented a soil series, and were aggregated by hydrologic soil groups (A - D). The NRCS has assigned a hydrologic group identification to each soil series to indicate runoff generating characteristics. "A" soils, in general, generate the least, and "D" soils the most amount of runoff for a given rainfall. The soils coverage was intersected with the land use coverage to provide the GIS layer used to estimate runoff coefficients. Each unique combination of land use type, soil series, and season has been assigned an associated runoff coefficient value.

Land Use-Specific Runoff Coefficients and Stormwater Quality Concentrations

Land use-specific runoff coefficients were obtained from published literature, including references for the west-central and south Florida geographic area. A range of runoff coefficient values for each land use was developed to account for seasonal changes in rainfall/runoff relationships, and for local soils conditions, as described in Zarbock et al. (1994) and used for the previously modeled current and future conditions (Zarbock et al., 1996a). These coefficients are presented in Appendix 3.

An extensive list of regional water quality concentration data for nonpoint source total nitrogen was compiled for this modeling effort, and is summarized in Appendix 4 and further described in Zarbock et al. (1994) and Pribble et al. (2001). The values are from a number of stormwater sampling programs and represent averaged values from multiple samples from each program.

Because base flow is a component of water sampled in channels during periods of runoff, base flow characteristics were assumed to be represented in these storm samples. Therefore, base flows were not estimated separately.

6.1.2 Methods

All nonpoint source loads for existing conditions were estimated using a model-based approach, so that an equitable comparison to modeled future loads could be made. An empirical hydrologic model was developed to provide estimates of nonpoint source surface water inflows (Zarbock et al., 1996a). Model construction and methods for estimating nonpoint source loads are summarized below.

Empirical data analyses indicated that the preferred model for predicting runoff in the Tampa Bay watershed was based on a log-linear relationship with rainfall and land use categories as independent variables. Rainfall for two previous months was included in the model in addition to rainfall for the present month. The land use composition of each basin was included through an adjustment factor (*a*). The model used was:

$$\text{FLOW} = \exp[\, a + (b_0 * \text{RAIN}_0 + b_1 * \text{RAIN}_1 + b_2 * \text{RAIN}_2)] \quad \text{(Equation 1)}$$

and,

$$a = (c_1 * L_1) + (c_2 * L_2) + (c_3 * L_3) + (c_4 * L_4)$$

where

FLOW = nonpoint source flow (meters per month) for a given basin, year, and month,

RAIN_0 = rainfall (meters per month) in the month,

RAIN_1 = rainfall (meters per month) in the month before the present month,

RAIN_2 = rainfall (meters per month) two months before the present month,

L_1 = the fraction of the basin in the URBAN land use category,

L_2 = the fraction of the basin in the AGRICULTURAL land use category,

L_3 = the fraction of the basin in the WETLANDS land use category,

L_4 = the fraction of the basin in the FORESTS land use category, and

c_1, c_2, c_3, c_4, b_0, b_1, and b_2 are parameters to be estimated.

The parameters associated with rainfall (b_0, b_1, and b_2) act as weighting factors when averaging rainfall over three months. Their absolute magnitude also affects the slope of the relationship between rainfall and runoff. The parameters associated with land use categories (c_1, c_2, c_3, and c_4) define an aggregate adjustment factor (a) that affects both the slope and the intercept of the relationship between rainfall and runoff.

The units of flow and rainfall listed above, meters per month (m/mo), were chosen for computational purposes. For flow, m/mo represents the total flow from a land area over the time period (month), expressed as a volume of water with an area equal to the land area, and the depth in meters. Although the unit is listed as depth, the volume is implicitly accounted for in the land area. For rainfall, m/mo represents the depth of rainfall over the land area during the time period (month).

A least squares regression with no intercept was used to estimate the seven parameters in Equation (1) after taking the natural logarithm of both sides of the equation:

$$\log(\mathrm{FLOW}) = (c_1 * L_1) + (c_2 * L_2) + (c_3 * L_3) + (c_4 * L_4) + (b_0 * \mathrm{RAIN}_0 + b_1 * \mathrm{RAIN}_1 + b_2 * \mathrm{RAIN}_2) \qquad \text{(Equation 2)}$$

Model development resulted in the definition of four separate rainfall/runoff relationships, varying with season and basin land use characteristics. "More urban" basins were defined as having greater than 19% urban land use, and "less urban" basins had less than 19% urban land use. The selection of the 19% level was based on an investigation of the distribution of urban land cover and the goodness of fit of the rainfall/runoff relationships. Months were classified into two categories based on rainfall: dry season (November through June) or wet season (July through October). The model was run for each combination of these categories, resulting in four complete sets of parameter estimates for the following conditions:

19% urban, dry season
19% urban, wet season
> 19% urban, dry season
> 19% urban, wet season

Total monthly flow for each subbasin was estimated using Equation (1) with the appropriate parameter estimates. The next step of estimating pollutant loads was to estimate the fraction of the total subbasin flow that originated from each land use. The total subbasin flow was apportioned among the constituent land use categories within each subbasin as follows:

$$FLOW_i = \frac{FLOW * A_i * R_i}{\sum_i A_i * R_i} \qquad \text{(Equation 3)}$$

where

$FLOW_i$ = the total nonpoint source flow (m/mo) from land use category *i*,

FLOW = the total nonpoint source flow (m/mo) from a subbasin,

A_i = area (acres) in land use category *i*, and

R_i = the runoff coefficient (fraction of rainfall that runs off) for land use category *i*.

The above calculation resulted in the disaggregation of the total nonpoint source flow for a subbasin into flows generated by individual land use types.

Subbasin pollutant loads were then estimated by land use using land use/soil-specific runoff coefficients and land use-specific pollutant concentrations. Nonpoint source runoff generated by an individual land use type within a basin was calculated by prorating the total flow using land use-specific runoff coefficients and the area of that land use type within the basin (Equation 3). Nonpoint source pollutant loads for specific land uses were then estimated for the desired time period according to the following equation:

$$\text{Pollutant loading for land use } i = Flow_{LUi} * PC_{Lui} \qquad \text{(Equation 4)}$$

where:

PC_{LUi} = Average pollutant concentration for land use *i* and

$Flow_{LUi}$ = Total flow from land use *i*.

The land use-specific pollutant loads were then summed to yield a total load for the subbasin. Subbasins within a larger area (jurisdictional area or bay segment major basin) were then summed as appropriate to obtain the loading estimates at their desired spatial scale.

6.2 2010 Conditions Nonpoint Sources Loading Estimates

All nonpoint source loads for projected future conditions were model-based. Projected future condition loads were estimated on a monthly basis for twelve calendar months and then summed to yield a representative annual load for the year 2010.

6.2.1 Data Sources

Average monthly rainfall was calculated using the same NWS data that were used for the 1992-94 conditions load estimates. The monthly rainfall amounts were used to drive the empirical model. All future condition loading estimates were model-based, and were calculated in the same manner as existing condition loadings. The future and existing loadings were calculated by changing only the land use, and by applying pollutant loading attenuation factors to the new urban land uses to account for surface water permit treatment requirements.

A previous study by the TBNEP (Zarbock et al., 1996a) developed projections of 2010 land use conditions to estimate future nonpoint source pollutant loadings. For that work, 1990 land use data obtained from SWFWMD was used as a base, and was changed to future conditions (2010) after consultation with local planning agencies. The methods used to estimate future land use coverage within the watershed (by basin) were based on 1990 land use coverage, population projections for 2010 developed by the U.S. Census Bureau, and population and employment information obtained from local planning agencies.

Changes in projected 2010 land uses may be the result of changes between the District's 1990 GIS land use coverage and the newer "current conditions" (1995) land use coverage. Changes also may result from revised population and housing projections developed by local planning agencies or from changes in mapping boundaries.

Local government planners were interviewed, and provided with the estimates of 2010 land use previously derived (Zarbock et al., 1996a) and with the 1995 land use. In addition to the interviews, local planning department documents, maps, and population projections were evaluated. Individuals from Hillsborough, Pinellas, Manatee, Pasco, and Polk counties were interviewed to obtain local expertise with respect to projected spatial and temporal growth trends for incorporated and unincorporated jurisdictions within the watershed. Some local governments used U.S. Census Bureau information or trends in land use changes to project where future growth would occur. Other jurisdictions used transportation-based analyses for their land use trend analysis. Information sources, individuals interviewed from each local government, and assumptions used to make the land use projections are discussed below.

<u>Pinellas County and Incorporated Jurisdictions</u>
Population and employment projections for Pinellas County, Clearwater, St. Petersburg, and other incorporated jurisdictions within the county were obtained from the Pinellas County Planning Department (1998). Revised projections had been developed by the department in 1998, and were enumerated by the 12 Planning Sectors in the county (Beardslee, pers. comm.).

The 1995 GIS land use coverage had some significant differences compared to the 1990 coverage. Medium density residential in St. Petersburg (Middle Tampa Bay and Boca Ciega Bay basins) declined 60%, according to the GIS coverage. This is likely either an artifact of the methods used to develop the two coverages or a result of reclassification of existing residential areas within the city, and may not reflect actual changes in land cover. However, this did result in changes to the future land use estimates.

Projected changes in population within each Planning Sector between 1995 and 2010 were determined. For drainage basins that encompassed more than one Planning Sector, a composite population change for the basin was estimated by weighting the contributions of each Planning Sector, based on area. Assumptions used for the Pinellas County projections include:

- Because 1997 population was the earliest reported by the county and the land use base used for update was based on 1995 aerial photography, the projected 1997-2010 population changes were increased by 8% to account for the two year difference in time period.

- Within each planning unit, all residential and commercial land uses were assumed to change at a rate sufficient to accommodate projected population changes.

- Industrial and institutional land uses were assumed to change on a site-specific basis.

- Agricultural, forested, and open lands were assumed to decrease corresponding to the urban land increase.

- Open water and wetlands were assumed to not change.

Hillsborough County and Incorporated Jurisdictions

Revised population, housing, and employment projections for Hillsborough County, Tampa, and other incorporated jurisdictions within the county (Plant City, Temple Terrace) were obtained from the Hillsborough County City County Planning Commission (1999a, 1999b). Projections had been developed by the agency using U.S. Census Bureau data, land use change trends, occupancy change rates, and other sources (Cullen, pers. comm.). Data for 1995 and 2010 were obtained by census tract and Planning Area.

The population estimates for the north-central portion of the County and "New Tampa" were revised upwards from the earlier estimates. Higher growth rates in the Cypress Creek and upper Hillsborough River Basins resulted in revisions to the future land use estimates.

Projected changes in population within each Planning Area between 1995 and 2010 were determined. For drainage basins that encompassed more than one Planning Area, a composite population change for the basin was estimated by weighting the contributions of each Planning Area, based on area. Assumptions used for the Hillsborough County projections include:

- Within each planning unit, all residential and commercial land uses were assumed to change at a rate sufficient to accommodate projected population changes.

- Industrial and institutional land uses were assumed to change on a site-specific basis.

- Agricultural, forested, and open lands were assumed to decrease corresponding to the urban land increase.

- Open water and wetlands were assumed to not change.

Manatee County and Bradenton

Revised population and employment projections for Manatee County and Bradenton were obtained from the Manatee County Planning Department (1999). Projections had been developed by the department using U.S. Census Bureau data, land use change trends, occupancy change rates, and other sources (Kotecki, pers. comm.). Population estimates and projections for 1995 and 2010 were obtained by Planning Sub-Areas.

It should be noted that the latest population and building projections are substantially higher than the projections used for the original future land use estimates (Kotecki, pers. comm.). Residential land use estimates for 2010 rose 28% using the new revised population projections. Also, there were significant differences in the baseline land use coverage for Manatee River basin. The 1995 land use coverage showed a 34% increase in medium density residential land uses over the 1990 coverage, which likely are the result of both actual land use changes, and differences in photo-interpretation. Both these factors contributed to the revised estimates of urban land use in the Manatee River basin increasing substantially.

Projected changes in population within each Sub-Area between 1995 and 2010 were determined. For drainage basins that encompassed more than one Sub-Area, a composite population change for the basin was estimated by weighting the contributions of each Sub-Area, based on land area. Assumptions used for the Manatee County projections include:

- Within each planning unit, all residential and commercial land uses were assumed to change at a rate sufficient to accommodate projected population changes.

- Industrial and institutional land uses were assumed to change on a site-specific basis.

- Agricultural, forested, and open lands were assumed to decrease corresponding to the urban land increase.

- Open water and wetlands were assumed to not change.

<u>Pasco County and Incorporated Areas</u>

Population and industrial, commercial, and service employment projections for Pasco County and incorporated jurisdictions within the county were obtained from the County Planning Department (1999). Projections had been developed by the department using U. S. Census Bureau data, land use change trends, occupancy change rates, and other sources (Burbridge, pers. comm.). Data for 1995 and 2010 projected populations were obtained by census tract and Planning Division. Projected changes in population within each Planning Division between 1995 and 2020 were determined. All Planning Divisions fell within a single basin, so no weighting of land use change rates was required. Assumptions used for the Pasco County projections include:

- Within each planning unit, all residential and commercial land uses were assumed to change at a rate sufficient to accommodate projected population changes.

- Industrial and institutional land uses were assumed to change on a site-specific basis.

- Agricultural, forested, and open lands were assumed to decrease corresponding to the urban land increase.

- Open water and wetlands were assumed to not change.

Polk County

No population projections other than at a county-wide scale were available from Polk County (Hommel, pers. comm.). Because of the lack of spatially- appropriate data, land use changes in the area of the Tampa Bay Watershed encompassed by Polk County were assumed to change at the same rate as lands in Pasco and Hillsborough counties within the same basin (upper Hillsborough River).

The updated 2010 land use estimates are presented in Appendix 5. The most common land use type projected for the year 2010 is pasture, at 14% of the total watershed area. All types of agriculture combined encompass 29% of the total area. Residential land uses account for over 18% of the total area. All urban land uses combined (except mining at 7%) make up 26% of the total area. It should be noted that the watershed acreage includes Tampa Bay itself, and not only the watershed. The bay comprises 13% of the total area.

A comparison of the 1990 and 1995 land use coverages, and of the original (1996) and revised (2000) 2010 land use projections, are included in Appendix 5. As stated above, changes between coverages of land use acreages in various categories account for some of the differences in the original and new 2010 land use projections. As can be seen, on a watershed–wide scale, the 1990 and 1995 coverages do not differ greatly, generally under 10% for most major urban and agricultural land use types. One exception to this is row crops, which covers 58% more land in the 1995 coverage than in the 1990 coverage. Additionally, several wetland types are very different. Differences are more pronounced on a major basin or basin level.

Reasons for the differences could include changes in methodologies for mapping and photo-interpretation, real land use changes, or changes in the boundary of the mapping. Boundary changes are most evident for open salt water and tidal flats, which were not included in the 1990 coverage but were in the 1995 coverage.

A comparison of the original (1996) and revised (2000) 2010 land use projections reveals a fairly good agreement in most urban and agricultural categories. On a watershed scale, urban land uses differed by under 15%. Row crops differed by 53%, but this can be accounted for by the differences in baseline coverages.

The assumptions used in making the projections were the same in both cases, so differences in upland land uses are the result of changes in the baseline coverage, and in the updated population, employment, and building projections made by the local planning agencies. Differences in wetland and water land covers are thought to be attributable mainly to changes in mapping methodologies and photo-interpretation, real land use changes, or changes in the boundary of the mapping.

There are two areas of the watershed where future land use projections changed the most: in the north-central Hillsborough County/New Tampa/south-central Pasco County area, and in western and central Manatee County. Both these areas have experienced accelerated growth during the past five years, necessitating substantial revisions to population and land use projections. For example, the revised residential projections for 2010 in the Manatee River basin increased by 28% over the original projections, with corollary reductions in range and pasture land uses. These increases reflect current conditions and were verified by discussions with County planners.

A comparison of the acreages of aggregated land use types in the watershed of each bay segment from the 1990 and 1995 land use coverages, and the previously developed and updated 2010 land use, is provided in Table 6-1. In the watershed of each bay segment, the updated 2010 land use shows more urban area than from the previous 2010 effort. Additionally, the updated 2010 land use shows greater areas of agricultural land use in the Hillsborough Bay, Middle Tampa Bay, Terra Ceia Bay, and Manatee River watersheds. Concomitantly, within the watersheds of almost all bay segments, pasture and rangeland and forested areas are less in the updated 2010 estimate than in that developed previously.

6.2.2 Methods

Future condition nonpoint source loads for the entire watershed were estimated using the same empirical hydrologic model that was used to estimate flows and loads for current. Model inputs included monthly rainfall, land use, soils, land use-specific runoff coefficients and water quality concentrations, and subbasin delineation. Monthly nonpoint source loads for 2010 were estimated using the same NWS data, those for 1992-1994, which were used for existing conditions. Therefore, for the future conditions loadings, only the land use was different from the existing conditions. The resultant twelve monthly loads were summed to yield a representative annual load for 2010.

After the future land use-based loads were estimated, the future loads were subtracted from current (1992-94) loads. The difference between the existing and future loads represented new urban land. The loads associated with the new urban land were then attenuated to account for water quality treatments that will be required for new development through surface water permit requirements. Attenuation rates were 35% for TN loads, and were based on values of typical treatment efficiencies for stormwater best management practices (BMPs) obtained from a literature review (Coastal Environmental, 1995).

Table 6-1. Comparison of land use proportions (% of segment watershed) for 1990, 1995, previous 2010 estimate, and updated 2010 estimate, by bay segment.

Old Tampa Bay				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	51.8	52.2	54.1	56.4
Agricultural	1.9	2.0	1.7	1.7
Pasture & Rangeland	19.1	16.9	16.9	14.0
Mining	0.3	0.3	0.3	0.3
Forest & Barren	7.7	7.1	7.1	6.1
Freshwater & Wetlands	20.3	21.6	20.3	21.5

Hillsborough Bay				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	21.2	22.5	24.2	26.8
Agricultural	5.4	6.6	1.7	6.2
Pasture & Rangeland	32.0	29.7	30.8	26.2
Mining	11.9	12.3	12.1	12.3
Forest & Barren	10.3	9.8	9.7	9.4
Freshwater & Wetlands	19.3	19.1	17.6	19.1

Middle Tampa Bay				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	17.7	18.3	19.2	20.1
Agricultural	15.0	20.5	14.7	19.4
Pasture & Rangeland	39.9	33.6	39.1	30.9
Mining	2.0	2.9	2.0	5.4
Forest & Barren	9.2	9.0	8.7	8.4
Freshwater & Wetlands	16.3	15.7	16.3	15.9

Lower Tampa Bay				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	21.0	22.8	24.7	29.1
Agricultural	24.8	23.1	24.6	22.9
Pasture & Rangeland	27.0	27.0	23.6	21.1
Mining	2.4	2.4	2.4	2.6
Forest & Barren	3.8	4.2	3.6	3.5
Freshwater & Wetlands	21.1	20.5	21.0	20.7

Boca Ciega Bay				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	84.2	84.3	83.8	87.4
Agricultural	0.2	0.3	1.3	0.2
Pasture & Rangeland	9.0	8.2	7.7	5.5
Mining	0.0	0.0	0.0	0.0
Forest & Barren	3.1	2.6	3.3	2.2
Freshwater & Wetlands	3.5	4.6	3.9	4.7

Terra Ceia Bay				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	43.3	45.4	50.0	57.1
Agricultural	8.7	10.0	8.7	9.2
Pasture & Rangeland	29.9	27.7	24.0	17.7
Mining	0.0	0.0	0.0	0.0
Forest & Barren	7.0	7.8	6.3	7.1
Freshwater & Wetlands	11.1	9.0	11.1	9.0

Manatee River				
Land Use Type	Land Use Type			
	1990	1995	Previous 2010	Updated 2010
Urban	11.2	12.6	15.6	20.2
Agricultural	13.2	18.5	12.8	16.7
Pasture & Rangeland	43.7	40.8	40.3	35.6
Mining	1.2	1.3	1.2	1.4
Forest & Barren	15.7	11.7	15.0	11.0
Freshwater & Wetlands	15.1	15.1	15.1	15.1

7. RESULTS OF LOADING ANALYSIS

Current and projected future TN loadings to Tampa Bay were estimated for bay segments by source and by local government jurisdiction, as discussed in the following section. These model-based loading estimates have been developed to assist the TBEP in setting living resource targets and in working with local governments to reexamine allocation of pollutant load reductions set previously.

In the following discussion, bay segment loadings by source included major external sources of TN inputs (atmospheric deposition, nonpoint sources, domestic and industrial point sources, material losses of fertilizer product, groundwater, and springs). Loadings by jurisdiction included only land-based, manageable loadings (nonpoint sources, point sources, and material losses). Because groundwater, springs, and atmospheric deposition loadings cannot be accurately apportioned among jurisdictions, they were not accounted for in the jurisdictional loading tables.

7.1 Current Conditions

Current Conditions Bay Segment Loadings by Source

For the current period, an annual load of approximately 3,666 tons of TN reached the bay. Current condition TN loading estimates are presented by source and bay segment in Table 7-1. For comparison purposes, the previously estimated 1994 conditions loadings using the 1990 landuse (Zarbock et al., 1996a) are shown in Table 7-2. Note that rounding to whole number tons and percentages may cause summation discrepancies. From the updated estimate of current conditions, nonpoint sources had the highest contribution with 1,427 tons/year (39% of the total external load). Atmospheric deposition had the second highest contribution with 1,142 tons/year (31%). Domestic and industrial point sources contributed approximately 436 (12%) and 382 tons/year (10%), respectively. Material losses of fertilizer products totaled 32 tons/year (1%). Groundwater and spring loadings totaled 247 tons/year (7%), with the great majority of that (approximately 245 tons/year) originating from springs.

Of the seven major bay segments, Hillsborough Bay (HB) received the highest TN loadings from the watershed, approximately 1,369 tons/year (37% of the total bay-wide loading). The sources with the highest contributions to Hillsborough Bay included nonpoint source (487 tons/year, or 36%), domestic point sources (281 tons/year, or 21%), and groundwater and springs (246 tons/year, or 18%). Industrial point sources (202 tons/year, or 15%), material losses (32 tons/year, or 2%), and atmospheric deposition (121 tons/year, or 9%) made up the balance of the TN load to Hillsborough Bay.

Middle Tampa Bay (MTB) received the next highest TN loading for existing conditions (approximately 695 tons/year). The largest contributors included atmospheric deposition (322 tons/year, or 47%), nonpoint source (290 tons/year, or 42%), and industrial point sources (60 tons/year, or 9%). No other source contributed more that 3% to this bay segment. Atmospheric deposition loading was the largest external TN source for this segment because of the large open water area of that segment with respect to the contributing watershed-based inputs.

Old Tampa Bay (OTB) received the next highest TN loading for existing conditions (516 tons/year). The highest source-specific load was atmospheric deposition (258 tons/year, or 50%). Atmospheric deposition loading was a significant external source for Old Tampa Bay because of the relatively large open water area of that segment with respect to the size of the watershed. The second highest contributor was nonpoint source (167 tons/year, or 32%). Domestic point source (87 tons/year, or 17%) was the only other significant TN source to Old Tampa Bay.

The Manatee River (MR) segment received approximately 464 tons TN/year for the current period. Nonpoint source loads were most significant (379 tons/year, or 82% of the total). Industrial and domestic point source contributed 12 tons/year (3%) and 27 tons/year (6%), respectively. Atmospheric deposition contributed 47 tons/year (10%). These loadings reflect the Manatee River's large tributary basin with respect to other inputs.

Lower Tampa Bay (LTB) received 400 tons/year for the current period, with 277 tons/year (69%) of that total from atmospheric deposition. Again, the large surface area of water with respect to watershed area, and the lack of other significant sources, makes atmospheric deposition by far the most important external source for this bay segment.

Boca Ciega Bay received a total TN load of 193 tons/year, with 99 tons/year (51%) originating from atmospheric deposition and 79 tons/year (41%) from nonpoint sources. Domestic point sources contributed approximately 14 tons/year (7%).

Terra Ceia Bay had the smallest TN loading of the bay segments, with only 28 tons/year. Of that amount, approximately 19 tons/year (68%) originated as atmospheric deposition, 6 tons/year (21%) was from nonpoint sources, and 4 tons/year (14%) resulted from domestic point sources.

Differences between the updated current conditions loadings and those previously derived in Zarbock et al. (1996a) for 1994 total about 204 tons, with the updated loadings higher than those estimated previously. This difference results from both the increased point source and springs loading estimates for the updated current conditions loadings, and the large decline in material losses. The loads from these sources are representative of those of the most recent year for which data exist, 1998, as described in Pribble et al. (2001). This time period included the high rainfall period of the winter of 1997-1998 associated with the El Niño event. The elevated loadings for the updated current conditions are at least partially related to this event.

Table 7-1. Updated current conditions annual TN loading by source and bay segment (all sources).

SOURCE		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Atmospheric Deposition	tons	258	121	322	277	99	19	47	1142
	%	50	9	47	69	51	68	10	31
Domestic Point Source	tons	87	281	23	1	14	4	27	436
	%	17	21	3	<1	7	14	6	12
Industrial Point Source	tons	4	202	60	103	0	0	12	382
	%	1	15	9	26	0	0	3	10
Material Losses	tons	0	32	0	<1	0	0	0	32
	%	0	2	0	<1	0	0	0	1
Nonpoint Source	tons	167	487	290	19	79	6	379	1427
	%	32	36	42	5	41	21	82	39
Groundwater+Springs	tons	<1	246	<1	<1	<1	<1	<1	247
	%	<1	18	<1	<1	<1	<1	<1	7
TOTAL	tons	516	1369	695	400	193	28	464	3666
	%	14	37	19	11	5	1	13	100

Table 7-2. Previous 1994 conditions annual TN loading by source and bay segment (all sources) (Zarbock et al., 1996a).

SOURCE		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Atmospheric Deposition	tons	227	115	306	288	93	20	54	1102
	%	50	8	48	86	51	67	12	30
Domestic Point Source	tons	85	220	20	1	15	4	16	362
	%	19	16	3	<1	8	15	4	10
Industrial Point Source	tons	0	82	58	<1	0	0	11	151
	%	0	6	9	<1	0	0	2	4
Material Losses	tons	0	233	0	24	0	0	0	257
	%	0	17	0	7	0	0	0	7
Nonpoint Source	tons	145	534	254	20	74	5	360	1392
	%	32	39	40	6	41	18	82	40
Groundwater+Springs	tons	<1	196	<1	<1	<1	<1	<1	197
	%	<1	14	<1	<1	<1	<1	<1	6
TOTAL	tons	457	1381	638	334	182	30	440	3462
	%	13	40	18	10	5	1	13	100

Current Conditions Bay Segment Loadings by Jurisdiction

The updated current conditions land-based TN loadings are presented by bay segment for each jurisdiction in Table 7-3. For comparison purposes, the previously estimated 1994 conditions loadings using the 1990 landuse (Zarbock et al., 1996a) are shown in Table 7-4. Atmospheric deposition and groundwater+springs were not included because it is not feasible to apportion those loads to a jurisdiction. It should be noted that Pasco, Polk, and Sarasota counties are included in Tables 7-3 and 7-4. Although these jurisdictions have not been active in the TBEP allocation process, their contributions are shown for reference and for accounting purposes. Land-based loads combined for approximately 2,277 tons/year for the updated current conditions.

For allocating all land-based, manageable loads to local governments, it was necessary to apportion all nonpoint source, point source, and material loss loadings to a jurisdiction. For example, although MacDill Air Force Base is owned by the Federal government, loadings from the base's wastewater treatment plant were assigned to the City of Tampa. Local jurisdictions were also assigned industrial point source loadings for facilities discharging within the governmental boundaries. One exception is material loss loadings to Hillsborough Bay, which were assigned to Hillsborough County. This was done because of the active role that the county plays in regulating the phosphate industry and this source of nutrient loads.

Of the participating jurisdictions (Pinellas, Hillsborough, and Manatee counties and the cities of Tampa, St. Petersburg, Clearwater, and Bradenton), Hillsborough County had the highest contribution at 804 tons/year (35% of the bay-wide total). Of this load, 436 tons/year entered Hillsborough Bay, 275 tons/year entered Middle Tampa Bay, and 93 tons/year entered Old Tampa Bay.

Manatee County had the second highest contribution, with 543 tons/year (24% of the bay-wide total). Manatee County's loads were dispersed to four bay segments, including Manatee River (366 tons/year), Lower Tampa Bay (123 tons/year), Middle Tampa Bay (44 tons/year), and Terra Ceia Bay (10 tons/year). The City of Tampa generated approximately 14% of the bay-wide load, contributing 303 tons/year to Hillsborough Bay and 25 tons/year to Old Tampa Bay. The City of St. Petersburg contributed approximately 122 tons/year (5%) of the total existing conditions TN load, distributed between Middle Tampa Bay (55 tons/year), Boca Ciega Bay (47 tons/year), and Old Tampa Bay (20 tons/year). Pinellas County contributed 119 tons/year (5% of the total TN load), distributed between Old Tampa Bay (73 tons/year) and Boca Ciega Bay (46 tons/year). The City of Clearwater contributed approximately 2% of the total TN load, all 44 tons/year going to Old Tampa Bay. The City of Bradenton contributed approximately 2% of the total TN load, with all 47 tons/year going to the Manatee River.

Differences between the updated current conditions loadings by jurisdiction and those previously derived in Zarbock et al. (1996a) for 1994 total about 114 tons, with the updated loadings higher than those estimated previously. This difference is largely due to the increased point source loading estimates for the updated existing conditions loadings. The loads from these sources are representative of those of the most recent year for which data exist, 1998, as described in Pribble et al. (2001). This time period included the high rainfall period of the winter of 1997-1998 associated with the El Niño event. The elevated loadings for the updated current conditions are at least partially related to this event.

Table 7-3. Updated current conditions annual TN loading by bay segment and jurisdiction (land-based sources).

JURISDICTION		**BAY SEGMENT**							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Hillsborough County	tons	93	436	275	0	0	0	0	804
	%	36	44	73	0	0	0	0	35
Pinellas County	tons	73	0	0	<1	46	0	0	119
	%	28	0	0	<1	49	0	0	5
Manatee County	tons	0	0	44	123	0	10	366	543
	%	0	0	12	100	0	100	87	24
Tampa	tons	25	303	0	0	0	0	0	329
	%	10	30	0	0	0	0	0	14
St. Petersburg	tons	20	0	55	0	47	0	0	122
	%	8	0	15	0	51	0	0	5
Clearwater	tons	44	0	0	0	0	0	0	44
	%	17	0	0	0	0	0	0	2
Bradenton	tons	0	0	0	0	0	0	47	47
	%	0	0	0	0	0	0	11	2
Polk County	tons	0	231	0	0	0	0	0	231
	%	0	23	0	0	0	0	0	10
Pasco County	tons	1	31	0	0	0	0	0	33
	%	1	3	0	0	0	0	0	1
Sarasota County	tons	0	0	0	0	0	0	5	5
	%	0	0	0	0	0	0	1	<1
Total	tons	258	1002	374	123	93	10	418	2277
	%	11	44	16	5	4	<1	18	100

Table 7-4. Previous existing conditions (1994) annual TN loading by bay segment and jurisdiction (land-based sources) (Zarbock et al., 1996a).

JURISDICTION		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Hillsborough County	tons	85	540	238	0	0	0	0	862
	%	37	51	72	0	0	0	0	40
Pinellas County	tons	63	0	0	0	40	0	0	103
	%	27	0	0	0	45	0	0	5
Manatee County	tons	0	0	41	46	0	10	351	447
	%	0	0	12	100	0	100	91	21
Tampa	tons	24	283	1	0	0	0	0	307
	%	10	26	<1	0	0	0	0	14
St. Petersburg	tons	15	0	53	0	49	0	0	118
	%	7	0	16	0	55	0	0	5
Clearwater	tons	41	0	0	0	0	0	0	41
	%	18	0	0	0	0	0	0	2
Bradenton	tons	0	0	0	0	0	0	31	31
	%	0	0	0	0	0	0	8	1
Polk County	tons	0	216	0	0	0	0	0	216
	%	0	20	0	0	0	0	0	10
Pasco County	tons	2	31	0	0	0	0	0	33
	%	1	3	0	0	0	0	0	2
Sarasota County	tons	0	0	0	0	0	0	5	5
	%	0	0	0	0	0	0	1	<1
Total	tons	230	1070	332	46	89	10	387	2163
	%	11	50	15	2	4	<1	18	100

7.2 2010 Conditions

Future Conditions Bay Segment Loadings by Source

For the period ca. 2010, an estimated average annual load of 3,132 tons/year of TN is projected to reach the bay. Projected future condition TN loadings are presented by source and bay segment in Table 7-5. For comparison purposes, the previously estimated future conditions loadings (Zarbock et al., 1996a) are shown in Table 7-6. From the updated future estimate, nonpoint sources were projected to have the highest contribution with approximately 1,432 tons/year (49%), and atmospheric deposition was projected to have the second highest contribution with 578 tons/year (20% of the total external load). Domestic and industrial point sources were estimated to contribute approximately 453 (15%) and 204 tons/year (7%), respectively. Material losses of fertilizer products were estimated to total 36 tons/year (1%). Groundwater and springs loadings were estimated to total 247 tons/year (8%), with much of that (about 246 tons/year) originating from springs.

Of the bay segments, Hillsborough Bay was expected to receive the highest future TN loading, estimated at 1,257 tons/year. The sources with the highest expected future contributions to Hillsborough Bay included nonpoint source (502 tons/year, or 40% of the total), domestic point sources (283 tons/year, or 23% of the total), and industrial point sources (130 tons/year, 10% of the total). Springs and groundwater were projected to contribute 246 tons/year (20%), atmospheric deposition 60 tons/year (5%), and material losses 36 tons/year (3%).

Middle Tampa Bay was projected to have the second highest future condition TN loading (515 tons/year). Nonpoint sources were estimated to be the most significant TN loading source (265 tons/year, or 51% of the total). Atmospheric deposition was estimated to be another significant source, contributing 159 tons/year, or 31% of the total. Industrial and domestic point sources combined for 89 tons/year, or 17% of the total load.

The Manatee River segment was projected to receive the next highest loading for future conditions, approximately 438 tons/year. Nonpoint source loads were expected to be most significant (366 tons/year, or 84% of the segment total). Industrial and domestic point sources were expected to contribute 11 tons/year (3%) and 31 tons/year (7%), respectively, and atmospheric deposition approximately 29 tons/year (7% of the total to that segment).

Old Tampa Bay was expected to receive the next highest TN loading for future conditions (388 tons/year). The highest source-specific load was projected to be from nonpoint sources (183 tons/year, or 47%). Atmospheric deposition loads were estimated to be 117 tons year (30% of the total). Atmospheric deposition will continue to be a significant external TN source for Old Tampa Bay because of the relatively large open water area of that segment, and because of the small contributions of other sources (small tributary drainage area and few point sources). Domestic point sources (84 tons/year, or 22%) and industrial point sources (4 tons/year, or 1%) were the only other significant TN sources to Old Tampa Bay.

Lower Tampa Bay was expected to receive an average of approximately 176 tons/year for ca. 2010, with 153 tons/year (87%) of that total from atmospheric deposition. Again, the large surface area of water and the lack of other significant sources made atmospheric deposition by far the most important external source for this bay segment. Of the remainder, 21 tons/year (10%) is expected to be from nonpoint sources, with 2 tons/year (1%) from domestic point sources. Less than 1 ton/year is expected from the material losses at Port Manatee.

Boca Ciega Bay was projected to receive a total TN load of 150 tons/year, with 88 tons/year (59%) from nonpoint sources and 48 tons/year (32%) originating from atmospheric deposition. Domestic point sources were expected to contribute about 14 tons/year (9%). Terra Ceia Bay had the smallest projected future TN loading of the bay segments, with almost 26 tons/year. Of that amount, approximately 11 tons/year (42%) was expected to originate as atmospheric deposition and 7 tons/year (27%) from nonpoint sources.

The updated future loading estimate is approximately 720 tons less than those from the previous estimate. This difference is largely due to the decreases in atmospheric deposition loading predicted for the period. The decreased nitrogen emissions resulting from the TECO facilities are expected to decrease atmospheric nitrogen concentrations. As discussed previously, for the updated future loading estimate, a decrease in concentrations of 46% is assumed. This reduction leads to predicted atmospheric deposition loads of approximately half of those from the previous prediction. Further differences between the updated and previous future loading estimates result from the decrease in the predicted material losses loading. This decrease results from the improved handling operations and refined loss estimates compared to those used previously. The lower loss rate was applied after discussions with phosphate industry representatives (Pribble et al., 2001).

As discussed previously, three methods of estimating 2010 atmospheric deposition were utilized to provide some bounds on expected changes in deposition due to emission reductions. The results of the method using a 46% reduction in atmospheric nitrogen concentration, proportional to the 46% reduction in emissions, are shown in Table 7-5 below. The second method used estimated a 1-ton reduction in deposition for a 400-ton reduction in emissions. The third method assumed no changes in atmospheric nitrogen concentrations from 1998 levels. A comparison of the results of these methods are shown below:

Method	Deposition
Percentage reduction:	578 tons/yr
400:1 ratio:	898 tons/yr
No change in deposition:	1142 tons/yr

Table 7-5. Updated future conditions annual TN loading by source and bay segment (all sources).

SOURCE		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Atmospheric Deposition	tons	117	60	159	153	48	11	29	578
	%	30	5	31	87	32	42	7	20
Domestic Point Source	tons	84	283	32	2	14	7	31	453
	%	22	23	6	1	9	27	7	15
Industrial Point Source	tons	4	130	58	0	0	0	11	204
	%	1	10	11	<1	0	0	3	7
Material Losses	tons	0	36	0	<1	0	0	0	36
	%	0	3	0	<1	0	0	0	1
Nonpoint Source	tons	183	502	265	21	88	8	366	1432
	%	47	40	51	12	59	31	84	49
Groundwater+Springs	tons	<1	246	<1	<1	<1	<1	<1	247
	%	<1	20	<1	<1	<1	<1	<1	8
TOTAL	tons	388	1257	515	176	150	26	438	2950
	%	13	43	17	6	5	1	15	100

Table 7-6. Previous future conditions annual TN loading by source and bay segment (all sources) (Zarbock et al., 1996a).

SOURCE		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Atmospheric Deposition	tons	249	126	336	317	102	23	59	1213
	%	54	9	50	86	53	77	12	33
Domestic Point Source	tons	47	283	20	3	15	0	21	390
	%	10	19	3	1	7	0	5	11
Industrial Point Source	tons	0	77	58	<1	0	0	11	147
	%	0	5	9	<1	0	0	2	4
Material Losses	tons	0	247	0	26	0	0	0	273
	%	0	17	0	7	0	0	0	7
Nonpoint Source	tons	165	540	256	23	78	7	381	1451
	%	36	37	38	6	40	23	81	40
Groundwater+Springs	tons	<1	196	<1	<1	<1	<1	<1	197
	%	<1	13	<1	<1	<1	<1	<1	5
TOTAL	tons	463	1470	670	369	195	29	473	3670
	%	13	40	18	10	5	1	13	100

Future Conditions Bay Segment Loadings by Jurisdiction

The updated future conditions TN land-based loadings by bay segment and jurisdiction are presented in Table 7-7. For comparison purposes, the previously estimated future conditions loadings using the 1990 landuse (Zarbock et al., 1996a) are shown in Table 7-8. As with existing conditions, atmospheric deposition and groundwater+springs are not included because it is not feasible to apportion those loads to a jurisdiction. It should be noted that Pasco, Polk, and Sarasota counties are included in Tables 7-7 and 7-8. Although these jurisdictions have not been active in the TBEP process, their contributions to Tampa Bay loadings are shown for reference and for accounting purposes.

Of the participating jurisdictions (Pinellas, Hillsborough, and Manatee counties and the cities of Tampa, St. Petersburg, Clearwater, and Bradenton), Hillsborough County had the highest contribution, at 741 tons/year (35% of the total load to the bay). Of this load, 378 tons/year were expected to go to Hillsborough Bay, 267 tons/year to Middle Tampa Bay, and 97 tons/year to Old Tampa Bay. The large proportion of projected future loadings from Hillsborough County resulted from a large contributing land area, and significant point source inflows.

Manatee County had the second highest expected contribution, with 434 tons/year (20%). Manatee County's loads were dispersed to four bay segments, including Manatee River (365 tons/year), Middle Tampa Bay (31 tons/year), Lower Tampa Bay (23 tons/year), and Terra Ceia Bay (15 tons/year).

The City of Tampa was expected to generate approximately 16% (331 tons/year) of the total bay-wide load, with 303 tons/year going to Hillsborough Bay and 28 tons/year going to Old Tampa Bay. The City of St. Petersburg was expected to contribute 6% (128 tons/year) of the future TN load, distributed between Middle Tampa Bay (57 tons/year), Boca Ciega Bay (51 tons/year), and Old Tampa Bay (21 tons/year). Pinellas County was expected to contribute 5% (110 tons/year) of the future TN load, distributed between Old Tampa Bay (59 tons/year), and Boca Ciega Bay (51 tons/year).

The City of Bradenton was projected to contribute approximately 2% of the total future TN load, with all 39 tons/year going to the Manatee River. The City of Clearwater was projected to contribute approximately 3% of the total TN load, all 65 tons/year going to Old Tampa Bay. Polk, Pasco, and Sarasota counties combined for an additional 275 tons/year, or approximately 12% of the total future bay loading.

Differences between the updated future conditions loadings by jurisdiction and those previously derived in Zarbock et al. (1996a) total about 135 tons, with the updated loadings higher than those estimated previously. This difference is largely due to the increased point source loading estimates for the updated future conditions loadings. As described in Pribble et al. (2001), six industrial sources were identified for inclusion in the updated future loading estimate that were not included in the previous estimate, including five in the Hillsborough Bay watershed and one in the Old Tampa Bay watershed. Additionally, revisions to planned increases in domestic point source loadings, resulting from the interviews described in Appendix 1, led to increased loadings. Both industrial and domestic point source contributions were higher in the updated future estimate than previously.

Table 7-7. Updated future conditions annual TN loading by bay segment and jurisdiction (land-based sources).

JURISDICTION		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Hillsborough County	tons	97	378	267	0	0	0	0	741
	%	36	40	75	0	0	0	0	35
Pinellas County	tons	59	0	0	<1	51	0	0	110
	%	22	0	0	<1	50	0	0	5
Manatee County	tons	0	0	31	23	0	15	365	434
	%	0	0	9	100	0	100	89	20
Tampa	tons	28	303	0	0	0	0	0	331
	%	10	32	0	0	0	0	0	16
St. Petersburg	tons	21	0	57	0	51	0	0	128
	%	8	0	16	0	50	0	0	6
Clearwater	tons	65	0	0	0	0	0	0	65
	%	24	0	0	0	0	0	0	3
Bradenton	tons	0	0	0	0	0	0	39	39
	%	0	0	0	0	0	0	10	2
Polk County	tons	0	219	0	0	0	0	0	219
	%	0	23	0	0	0	0	0	10
Pasco County	tons	1	41	0	0	0	0	0	52
	%	<1	4	0	0	0	0	0	2
Sarasota County	tons	0	0	0	0	0	0	4	4
	%	0	0	0	0	0	0	1	<1
Total	tons	271	951	355	23	102	15	409	2125
	%	13	45	17	1	5	<1	19	100

Table 7-8. Previous future conditions annual TN loading by bay segment and jurisdiction (land-based sources) (Zarbock et al., 1996a).

JURISDICTION		BAY SEGMENT							
		OTB	HB	MTB	LTB	BCB	TCB	MR	TOTAL
Hillsborough County	tons	87	530	237	0	0	0	0	855
	%	41	40	71	0	0	0	0	38
Pinellas County	tons	44	0	0	0	40	0	0	83
	%	27	0	0	0	43	0	0	4
Manatee County	tons	0	0	40	53	0	7	372	472
	%	0	0	12	100	0	100	90	21
Tampa	tons	24	365	1	0	0	0	0	390
	%	11	32	<1	0	0	0	0	17
St. Petersburg	tons	16	0	56	0	53	0	0	125
	%	8	0	17	0	57	0	0	5
Clearwater	tons	40	0	0	0	0	0	0	40
	%	13	0	0	0	0	0	0	2
Bradenton	tons	0	0	0	0	0	0	36	36
	%	0	0	0	0	0	0	9	2
Polk County	tons	0	222	0	0	0	0	0	222
	%	0	19	0	0	0	0	0	10
Pasco County	tons	2	30	0	0	0	0	0	32
	%	1	3	0	0	0	0	0	1
Sarasota County	tons	0	0	0	0	0	0	6	6
	%	0	0	0	0	0	0	1	<1
Total	tons	213	1148	334	53	92	7	414	2260
	%	9	51	15	2	4	<1	18	100

8. CONCLUSIONS

To attain its seagrass restoration goal, the TBNEP developed the Nitrogen Management Strategy. The Strategy seeks to prevent future impacts due to excessive nitrogen loadings to Tampa Bay. To provide quantifiable goals for the Strategy, a suite of models were developed relating total nitrogen loading to chlorophyll concentrations in the bay and chlorophyll concentrations to light attenuation. These models suggested that light availability necessary for obtaining seagrass restoration goals could be met by establishing a "hold the line" strategy for nitrogen loads. The Tampa Bay Nitrogen Management Consortium adopted this strategy in 1996.

To implement this strategy, local government partners agreed to preclude increases in future nitrogen loadings to the bay. The ca. 2010 total nitrogen loading estimates presented in Zarbock et al. (1996a) were developed to quantify expected TN loading increases, and were used for the TBNEP Allocation Workshops. This report presents the results of an update of the ca. 2010 total nitrogen loadings for use in reviewing the previous allocations for load preclusion.

The following provides the conclusions from this update.

- The greatest difference in predicted future loadings from any source is for atmospheric deposition. As a result of planned decreases in nitrogen emissions from TECO facilities, the updated load is approximately half of the previously predicted load. A more conservative method of deposition reduction estimation (400:1 ratio) still results in a reduction of 25% from that predicted previously.

- The updated future loading predictions from domestic and industrial point sources are higher than previously. Revised estimates for domestic facilities include recent modifications to planned future operations. Revised estimates for industrial facilities include six additional facilities that were not included in the previous estimate.

- The updated future loading predictions from material losses are less than those predicted previously. This is largely the result of improved operations at several facilities, resulting in lower material losses, and improved loss estimation methods.

- The updated future nonpoint source loadings did not change appreciably from the previous prediction, despite an update of the future land use showing a larger proportion of urban land use than previously predicted. This is likely due to the load attenuation from any new development incorporated into the estimate.

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APPENDIX 1

INDIVIDUALS CONTACTED FOR FUTURE CONDITIONS POINT SOURCE INFORMATION AND SUMMARY OF INTERVIEWS

Domestic Point Sources Projected Plans for 2010

City of St. Petersburg Southwest
City of St. Petersburg Albert Whitted
City of St. Petersburg Northeast
City of St. Petersburg Northwest

In 2000 spoke to Mr. Bill Johnson of the City of St. Petersburg and he stated that the predictions from previous interview with Mr. Dave Schulmister (1995) are still the same.

City of Largo

Spoke to Brian Dean of the City of Largo Plant. Said that Plant capacity did increase to 18 MGD (i1997). Reclaimed water (reuse) is hoped to be at 70% reuse by 2005 and 90% reuse by 2010. Do not foresee any changes in nutrient loading and have no plans to expand the plant.

City of Clearwater Northeast
City of Clearwater East

Spoke to Mr. Joe Reckenwald in 2000. He stated that the NE plant 2010 predictions will remain the same from his previous interview in 1996. Says that East plant is currently at 50% reclaimed and anticipates that number increasing to 75% by 2010.

City of Lakeland

Mr. Don Schulender, Planning Engineer for Wastewater Division of the City of Lakeland, was contacted in 2000. He stated that out of 10 MGD, 25%-33% will goto Reuse. There is a possiblity that the city is expanding their power plant and will take all of the effluent, so 100% reuse. Mr. Schulender still anticipates no modifications in effluent quality from the plant.

Bradenton

Mr. John W. Cumming, Director of Public Works, was contacted in August of 2000. Mr. Cumming related that the City plan to expand the system, with SWFMD assistance, is a multi-year plan reaching about four years (2004) into the future. That plan calls for addition of transmission piping, storage and pumping facilities. The original plan calls for system extensions to agricultural lands to the southeast and to a manmade wetland discharging to the Braden River downstream of the City's drinking water reservoir. Recent events and additional demands for reclaimed water have, however, brought about some change to the plan and may result in more changes.

A major change has been the inclusion of Tropicana Products as a major user of reclaimed water. A project now under construction will provide Tropicana with approximately 1.2 MGD of the City's reclaimed water. Other industrial users have begun discussion with the City regarding use of 2.0 to 4.0 MGD of reclaimed water. That need may occur by early 2004. Should such be the case, the manmade wetland may be replaced by a user or users that would otherwise require ground or surface water supplies. The Florida Power and Light orimulsion conversion mention in the last report, did not come to pass so there is no proposed use at that location.

The following information was received from Mr. Cumming in August 2000.

Year	Population	Functional Population	Estimated ADF (MGD)
2000	50,500	57,065	6.13
2005	53,000	59,880	6.43
2010	55,500	62,715	6.74

Manatee County Southeast
North County Regional (Manatee)

Mr. Leon Kotecki, Planning, was contacted in August 2000. Mr. Kotecki related that the Manatee County SE area has had lot of development since 1995, such as Lakewood Ranch and six other developments. He also states that there are no changes in discharge methods or treatment methods.

Below is a information provided by Mr. Kotecki:

Facility	Year	Population	Population plus Snowbirds
SE	2010	98,332	114,884
N	2010	40,082	52,707

Usage Rate: 105 GPD
Figure Snowbirds are around for 6 months/year.

City of Oldsmar

Mr. Jerry Wein was contacted in September 2000, who said there were no changes anticipated from the previous estimate.

City of Mulberry

Mr. Troy Cassidy was contacted in August 2000 and stated that there were no changes from what was last reported. The discharge from the plant would be approximately 0.415 MGD by 2016. No changes in effluent quality were expected.

Plant City

Spoke to Steve Saffels, said they have a new permit as of January 1997, going to have an annual of 2.68MGD by 2010. All discharge should be to reuse. The plant is allowed an emergency pop-off of 30% of its annual total flow to the East Side Canal. Reuse will be for industrial purposed, with approximately 2 MGD to CF Industries. Projected flows for 2012 were 5.0 MGD. Effluent quality would remain the same for the future.

City of Palmetto

Mr. Don Patterson, Interm Public Works Director, said they are permitted for 2.4 MGD but currently averages 1.2 MGD over the year. Currently they discharge 50% to Bay (2000) hopes by year 2004 have 100% reuse. Predicts flow of plant to be 2.36MGD by 2010

Dale Mabry
Van Dyke
Northwest Regional Water Reclamation Facility
River Oaks
Falkenburg
Valrico
South County
Summerfield
Eagles

Ms. Carole Awad, Senior Engineer, Water/Reclaimed Water Planning Team, Mr. Nick Leprici, Engineer II, Wastewater Planning, and Ms. Anita Wang, Engineer II, Wastewater Planning, of Hillsborough County, were contacted in August 2000 for information relating to the plants of the county.

Ms. Awad stated that no changes in water quality would occur, as most of the plants were already AWT, with the exceptions of Summerfield and Van Dyke, both of which were secondary plants. The Van Dyke plant, with all effluent used for spray irrigation, and the Eagles plant, with all discharge to a percolation pond, were on-line in 1995. Van Dyke was previously a private plant, with 1.5 MGD capacity and approximately 0.6 MGD flow. According to Mr. Garrett, the Eagles plant in 1995 had flow of only 0.02 MGD. Ms. Awad related that the Summerfield plant is scheduled to go off-line in 1998, with its flow diverted to the Falkenburg and Valrico plants. Ms. Awad also stated that the Southern Regional facility scheduled to come on-line in 2005 was longer planned.

Information on the changes in discharge and the modifications in effluent reuse percentages were calculated from graphs and tables obtained in a visit with the above-mentioned contacts. The county's goal is to have 100% reuse by 2015.

The following information was obtained from the graphs and tables provided by Ms. Awad and Mr. Leprici.

Hillsborough County Domestic Facilities

Dale Mabry

	1995	2000	2005	2010	2015	2020
Plant Capacity (MGD)	6	6	6	6	6	6
Plant ADF	3.86	4.35	4.48	4.72	4.96	5.19
Total Reuse ADF	3.43	*	*	*	*	*
Non-Reuse ADF	0.43	*	*	*	*	*

Van Dyke

	1995	2000	2005	2010	2015	2020
Plant Capacity (all MGD)	1.5	1.5	1.5	1.5	1.5	1.5
Plant ADF	0.62	0.7	0.9	1.1	1.3	1.5
Total Reuse ADF	0.62	*	*	*	*	*
Non-Reuse ADF	0	*	*	*	*	*

Northwest Regional Water Reclamation Facility
River Oaks

NW & River Oaks	1995	2000	2005	2010	2015	2020
NW Plant Capacity (MGD)	5	5	5	5	5	5
NW Plant ADF	2.49	3.5	3.76	4.02	4.28	4.54
RO Plant Capacity	10	10	10	10	10	10
RO Plant ADF	8.14	6.33	7.08	7.41	7.74	8.07
NW/RO Total Reuse ADF	1.69	*	*	*	*	*
NW/RO Non-Reuse ADF	8.94	*	*	*	*	*

Combined Total Northwest

Plant ADF	15.11	14.88	16.22	17.25	18.28	
Reuse ADF	5.74	6.53	11.47	13.12	14.09	14.61
Non-Reuse ADF	9.37	8.35	4.75	4.13	4.19	4.69

* In 2000, the Northwest WWTP reuse systems were interconnected and flows were transferred throughout reuse systems. Reuse & Non-Reuse ADF shown is for entire Northwest area

Falkenburg
Valrico

Falkenburg & Valrico	1995	2000	2005	2010	2015	2020
F Plant Capacity (all MGD)	6	6	9	9	9	12
F Plant ADF	3.8	4.87	6.34	6.56	8.45	10.35
V Plant Capacity	3	4	6	12	12	12
V Plant ADF	2.7	3.72	4.76	6.94	8.38	9.55
TOT Total Reuse ADF	3.58	*	*	*	*	*
TOT Non-Reuse ADF	2.92	*	*	*	*	*

* Combined Valrico and Falkenburg
Val/Falk Plant Flow 6.5 8.59 11.1 13.5 16.83 19.9
Val/Falk Reuse ADF 3.58 6.51 * * * 22.6
Val/Falk Non-Reuse ADF 2.92 4.97 * * * 1.6
*In 1998, the Valrico and Falkenburg reuse systems were interconnected.

149A,B - South County
South County 1995 2000 2005 2010 2015 2020
Plant Capacity (all MGD) 4.5 4.5 4.5 4.5 4.5 4.5
Plant Flow ADF 2.7 2.88 3.89 4.5 4.5 4.5
Plant Reuse ADF 2.4 2.42 * * * *
Plant Non-Reuse ADF 0.3 0.46 * * * *

* Combined Central and South Reuse Systems
S-C Plant ADF 9.2 11.47 14.99 18 21.33 24.4
S-C Reuse 5.98 8.93 14.12 17.68 20.12 22.72
S-C Non-Reuse ADF 3.22 2.54 0.87 0.32 1.21 1.68
* In 2002, WWTP's in the South/Central area are anticipated to be interconnected. Reuse & Non-Reuse ADF shown is for entire South/Central area

Summerfield - Offline in 1998
Eagles

Summerfield	1995	2000	2005	2010	2015	2020
Plant Capacity	0.75	0.75				
Demand	0.12	0.22				

Eagles	1995	2000	2005	2010	2015	2020
Plant Capacity	0.15	0.3	0.3	0.3	0.3	0.3
Demand	0.01	0.12	0.17	0.22	0.24	0.24

Eastlake Woodlands
Pine Ridge
Tarpon Woods
Tarpon Lake Village

No changes to current discharge rate. 100% reclaimed.
By 2010, Tarpon Lake & Tarpon Woods are to be diverted to the NW Facility.

MacDill

Mr. Mike Harr, Water Program Manager was contacted in 2000. He stated that the plant capacity will remain the same, and effluent quantity will as well. Currently at 100% reuse.

Howard Curren

Spoke to Mr. Bill Schafer, Head of Planning, said in the next 10 years the plant will remain the same.

The following information on projected growth demand (MGD) was obtained from the Tampa Comprehensive Plan:

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
ADF	0.54	0.75	0.96	1.07	1.13	1.19	1.25	1.31	1.37	1.43

Extrapolations to 2010 were as follows:

Year	2005	2006	2007	2008	2009	2010
ADF	1.49	1.55	1.61	1.67	1.73	1.79

Industrial Point Sources Projected Plans for 2010

IMC AGRICO - Kingsford
IMC AGRICO - Four Corners
IMC AGRICO - Port Sutton
IMC AGRICO - Lonesome

Received no information regarding any changes from Mr. Greg Williams, Environmental Superintendent.

CF Industries - Plant City

Corresponded with Mr. Tom Edwards, Superintendent, who stated that the Plant City facility does plan on increasing production and does expect an increase in the volume of nutrients produced. He also stated that they do not anticipate any extra runoff due to the closing of a gypsum stack by 2004. They expect to be very dynamic over the next 10 years which will keep the quality and quantity of nitrogen from their facility to be the same.

Pakhoed Dry Bulk Terminals -

Spoke to Mr. Chris Tolbert, Manager of Environmental Safety and Health and he anticipates no increase in quality or quantity nitrogen from their facility.

Farmland Hydro - Green Bay Plant

Mr. Chuck Jenkins, Manager of Environment and Safety Services, stated that they have decreased nitrogen output over the past four years and he anticipates no increase in quality or quantity of nitrogen from their facility.

Tropicana

Contacted Mr. Doug Foster, Environmental Affairs Manager, who said that they plan to be 100% deep well injection by end of 2000. They anticipate no other changes.

AGRIFOS – Nichols Mine

Spoke to Mr. Tom Abel, Environmental Engineer, who said the facility was closed on 6 August 2000 and there is no anticipated reopening date at the time. He also stated that if the facility did reopen that they expect no changes that would affect nitrogen loadings.

CARGILL – East Tampa

Ms. Melody Foley was contacted in September 2000, and anticipates no increase in the quality or quantity of nitrogen from their facility.

TECO - Gannon Station
TECO - Big Bend Station

Contacted Mr. Stan Maloy who anticipates no increase in quality or quantity of nitrogen from their facility.

Bridgeway Acres Class I Landfill

Spoke with Ms. Kelsy Oswald, Solid Waste Specialist, who stated that the landfill is currently changing intake structures to decrease turbidity which should then decrease metals in their runoff. She stated that their runoff is rainfall driven so it is difficult to predict completely runoff amounts. Ms. Oswald also stated that they are starting new plans to have 0% of wastewater to go offsite. This should all take place before 2010.

DEP Stock Enhancement Program

Corresponded with Frank Courtney, Assistant Research Scientist, who said that any changes to the Stock Enhancement Research facility are funding dependent. If increase funding, plan to increase stock production. Along with that there would be an increase to the wastewater treatment systems. They do plan to implement better treatment methods if this expansion does happen.

Florida Juice

Was being sold as of August 1999 and was unable to reach anyone other than the receptionist who had no comment.

Mulberry Phosphates

Spoke with Mr. Paul Moore who anticipates no increase in quality or quantity of nitrogen from their facility.

Nitram Chemical

Mr. Dan Ross was contacted, and anticipates no increase in quality or quantity of nitrogen from their facility.

Coronet Industries

Spoke with Mr. Viet Ta, Environmental Manager, who anticipates no increase in quality or quantity of nitrogen from their facility.

APPENDIX 2

AGGREGATED FLORIDA LAND USE AND COVER CLASSIFICATION SYSTEM CATEGORIES

URBAN LAND USE CATEGORIES

Coastal Land Use Code	FLUCCS Code
1 - Low Density Residential	1100
2 - Medium Density Residential	1200
3 - High Density Residential	1300
4 - Commercial	1400
5 - Industrial	1500
7 - Institutional, Transportation, Utilities	1700 8100 8200 8300

AGRICULTURAL LAND USE CATEGORIES

Coastal Land Use Code	FLUCCS Code
6 - Mining	1600
11 - Groves	2200 2210 2220 2230
12 - Feedlots	2300
13 - Nursery	2400
14 - Row and Field Crops	2100 2140 2150 2440

UPLAND FORESTED LAND USE CATEGORIES

Coastal Land Use Categories	FLUCCS Code
8 - Range Lands	1480 1800 1900 2420 2600 3100 3200 3300
9 - Barren Lands	7100 7200 7300 7400
10 - Pasture	2110 2120 2130
15 - Upland Forests	4100 4110 4120 4200 4300 4340 4400

WATER AND WETLANDS LAND USE CATEGORIES

Coastal Land Use Categories	FLUCCS Code
16 - Freshwater	2500 2540 2550 5100 5200 5210 5220 5230 5240 5300 5310 5320 5330 5340 5500 5600 6440 6450
17 - Saltwater	5400 9113 9116 9121
18 - Forested Freshwater Wetlands	6100 6110 6150 6200 6210 6240 6300
19 - Saltwater Wetlands	6120 6420
20 - Non-forested Freshwater Wetlands	6400, 6410, 6411, 6430 6530
21 - Tidal Flats	6500, 6510 6520

APPENDIX 3

LAND USE-SPECIFIC SEASONAL RUNOFF COEFFICIENTS

Seasonal Land Use-Specific Runoff Coefficients			
Coastal Land Use Classification and Land Use Type	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
1) Single Family Residential	A	0.15	0.25
	B	0.18	0.28
	C	0.21	0.31
	D	0.24	0.34
2) Medium Density Residential	A	0.25	0.35
	B	0.30	0.40
	C	0.35	0.45
	D	0.40	0.50
3) Multifamily Residential	A	0.35	0.50
	B	0.42	0.57
	C	0.50	0.65
	D	0.58	0.75
4) Commercial	A	0.70	0.79
	B	0.74	0.83
	C	0.78	0.97
	D	0.82	0.91
5) Industrial	A	0.65	0.75
	B	0.70	0.80
	C	0.75	0.85
	D	0.80	0.90
6) Mining	A	0.20	0.20
	B	0.30	0.30
	C	0.40	0.40
	D	0.50	0.50

Seasonal Land Use-Specific Runoff Coefficients			
Coastal Land Use Classification and Land Use Type	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
7) Institutional, Transportation Utils.	A	0.40	0.50
	B	0.45	0.55
	C	0.50	0.60
	D	0.55	0.65
8) Range Lands	A	0.10	0.18
	B	0.14	0.22
	C	0.18	0.26
	D	0.22	0.30
9) Barren Lands	A	0.45	0.55
	B	0.50	0.60
	C	0.55	0.65
	D	0.60	0.70
10) Agricultural - Pasture	A	0.10	0.18
	B	0.14	0.22
	C	0.18	0.26
	D	0.22	0.30
11) Agricultural - Groves	A	0.20	0.26
	B	0.23	0.29
	C	0.26	0.32
	D	0.29	0.33
12) Agricultural - Feedlots	A	0.35	0.45
	B	0.40	0.50
	C	0.45	0.55
	D	0.50	0.60

Seasonal Land Use-Specific Runoff Coefficients			
Coastal Land Use Classification and Land Use Type	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
13) Agricultural - Nursery	A	0.20	0.30
	B	0.25	0.35
	C	0.30	0.40
	D	0.35	0.45
14) Agricultural - Row and Field Crops	A	0.20	0.30
	B	0.25	0.35
	C	0.30	0.40
	D	0.35	0.45
15) Upland Forested	A	0.10	0.15
	B	0.13	0.18
	C	0.16	0.21
	D	0.19	0.24
16) Freshwater - Open Water	A	0.80	0.90
	B	0.80	0.90
	C	0.80	0.90
	D	0.80	0.90
17) Saltwater - Open Water	A	1.0	1.0
	B	1.0	1.0
	C	1.0	1.0
	D	1.0	1.0
18) Forested Freshwater Wetlands	A	0.50	.60
	B	0.55	0.65
	C	0.60	0.70
	D	0.65	0.75

Seasonal Land Use-Specific Runoff Coefficients			
Coastal Land Use Classification and Land Use Type	Hydrologic Soil Group	Dry Season Runoff Coefficient	Wet Season Runoff Coefficient
19) Saltwater Wetlands	A	0.95	0.95
	B	0.95	0.95
	C	0.95	0.95
	D	0.95	0.95
20) Non-forested Freshwater Wetlands	A	0.45	0.55
	B	0.50	0.60
	C	0.55	0.65
	D	0.60	0.70
21) Tidal Flats	A	1.0	1.0
	B	1.0	1.0
	C	1.0	1.0
	D	1.0	1.0

APPENDIX 4

LAND USE-SPECIFIC RUNOFF WATER QUALITY CONCENTRATIONS

Land Use-Specific Nonpoint Source Water Quality Concentrations

URBAN LAND USES						
Land Use Classification			Land Use-Specific Water Quality Concentrations			
Coastal Land Use Classification	Land Use Description	Reference	TN (mg/L)	TP (mg/L)	TSS (mg/L)	BOD (mg/L)
1 (LDR)	Low Density Single Family Residential (SFR)	(1)	2.31	0.40	33.0	-
		(1)	2.14	0.32	28.0	-
		(1)	0.605	0.073	7.2	-
		(1)	1.18	0.307	3.5	-
		(1)	3.0	0.45	-	-
		(1)	2.2	0.25	-	-
		(4)	1.87	0.39	-	-
		(8)	1.46	0.401	19.0	-
		(9)	1.56	0.27	20.8	-
		(10)	2.04	0.593	49.7	-
		(11)	2.88	0.72	56.8	-
		(13)	-	-	-	4.4
		min	0.605	0.073	3.5	-
		mean	1.93	0.380	27.3	4.4
		max	2.88	0.598	56.8	-
2 (MDR)	Medium Density (See notes)	mean	2.04	0.44	33.5	- 7.4 -
3 (HDR)	Multifamily Residential	(1)	1.61	0.33	53.0	-
		(1)	2.57	0.45	36.8	-
		(1)	4.68	0.72	95.6	-
		(1)	1.91	0.73	-	-
		(1)	1.02	0.033	67.6	-
		(1)	1.91	0.51	14.3	-
		(4)	1.65	0.33	-	-
		(8)	2.05	1.34	29.0	-
		(9)	2.04	0.282	10.7	-
		(10)	2.05	0.150	8.3	-
		(11)	2.00	0.56	41	-
		(13)	-	-	-	11.0
		min	1.02	0.033	8.3	-
		mean	2.14	0.49	39.6	11.0
		max	4.68	1.34	95.6	-

Coastal Land Use Classification	Land Use Description	Reference	TN (mg/L)	TP (mg/L)	TSS (mg/L)	BOD (mg/L)
4	Low Intensity Commercial	(1)	1.19	0.15	22.0	-
		(1)	1.10	0.10	45.0	-
	High Intensity Commercial	(1)	2.81	0.31	94.3	-
		(1)	3.53	0.82	-	-
		(1)	2.15	0.15	-	-
	Commercial (Office)	(8)	2.38	0.305	36.5	-
		(9)	1.08	0.495	50.6	-
		(10)	1.40	0.113	6.2	-
		(11)	1.05	0.145	13.8	-
	Commercial (Retail)	(8)	1.69	0.253	9.3	-
		(10)	1.28	0.177	14.5	-
		(11)	2.12	0.22	36.3	-
	Combined Commercial	min	1.05	0.100	6.2	-
		mean	1.82	0.270	32.9	17.2
		max	3.53	0.495	94.3	-
5	Industrial	(1)	1.42	0.19	71.8	-
		(1)	1.42	0.31	102.0	-
		(4)	1.18	0.15	-	-
		(8)	2.28	0.332	18.2	-
		(9)	1.77	0.465	28.3	-
		(10)	1.92	0.490	84.3	-
		(11)	3.00	0.503	70.0	-
		(13)	-	-	-	9.6
6	Mining	(4)	1.18	0.15	35 (e)	-
		(13)	-	-	-	9.6
7	Institutional	(4)	1.18	0.15	35 (e)	-
		(13)	-	-	-	8.2

AGRICULTURAL LAND USES						
Land Use Classification			Land Use-Specific Water Quality Concentrations			
Coastal Land Use Classification	Land Use Description	Reference	TN (mg/L)	TP (mg/L)	TSS (mg/L)	BOD (mg/L)
10	Pasture	(1)	2.37	0.697	-	-
		(1)	2.48	0.27	8.6	-
		(2)	2.0	0.3	-	-
		(3)	3.0	0.25	-	-
		(4)	1.02	0.16	-	-
		(5)	5.1	3.2	-	-
		(13)	-	-	-	5.1
11	Grove	(7)	2.31	0.10	-	-
		(13)	-	-	-	2.55
11,13	Grove, Nursery	(4)	0.92	0.41	-	-
		(13)	-	-	-	2.55
12	Feed Lot	(3)	29.3	5.1	-	-
		(3)	3.74	1.13	-	-
		(5)	26.0	5.1	-	-
		(13)	-	-	-	5.1
14	Field Crop	(2)	2.5	0.25	-	-
		(3)	2.5	2.5	-	-
		(4)	3.75	1.13	-	-
		(13)	-	-	-	5.1
Mixed Agricultural						
10,11	Citrus + Pasture	(1)	1.57	0.09	-	-
		(1)	1.33	0.09	4.6	-
		(1)	2.58	0.046	180	-
		(1)	2.68	0.562	-	-
		(1)	3.26	0.24	28.0	-
11,14	Citrus + Row Crops	(6)	1.78	0.3	5.6	-

(See following page for summarized agricultural water quality concentrations.)

SUMMARIZED AGRICULTURAL LAND USE DATA						
Land Use Classification			Land Use-Specific Water Quality Concentrations			
Coastal Land Use Classification	Land Use Description	Reference	TN (mg/L)	TP (mg/L)	TSS (mg/L)	BOD (mg/L)
8	Range	min mean max	0.90 1.24 1.47	0.02 0.01 0.21	4.8 11.0 17.3	- 1.45 -
10	Pasture	min mean max	1.0 2.66 5.1	0.16 0.81 3.2	8.6 8.6 8.6	- 5.1 -
11	Grove	min mean max	0.92 1.67 2.31	0.10 0.27 0.41	5.0 5.3 5.6	- 2.55 -
12	Feed Lot	min mean max	3.74 19.7 29.3	1.13 3.8 5.1	50(e)	- 5.1 -
13	Nursery (See notes)	mean	1.67(e)	0.27(e)	5.3(e)	2.55
14	Row Crop (See notes)	mean	2.91	0.54	10	5.1

WATER/WETLAND AND FOREST/UNDEVELOPED LAND USES						
Land Use Classification			Land Use-Specific Water Quality Concentrations			
Coastal Land Use Classification	Land Use Description	Reference	TN (mg/L)	TP (mg/L)	TSS (mg/L)	BOD (mg/L)
8	Open Space/ Non-forested	(1)	1.38	0.07	17.3	-
		(1)	0.90	0.02	4.8	-
		(1)	1.47	0.07	-	-
		(4)	1.02	0.16	-	-
		(13)	-	-	-	1.45
15	Upland Forest	(2)	0.1	0.007	-	-
		(3)	0.2	0.007	-	-
		(4)	1.02	0.16	-	-
		(13)	-	-	-	1.45
16,17	Open Water	(1)	0.79	0.17	-	-
		(1)	0.73	0.04	0.00	-
		(1)	2.22	-	6.2	-
		(13)	-	-	-	0.00
18,20	Freshwater Wetland	(1)	2.26	0.09	13.4	-
		(1)	1.02	0.16	-	-
		(1)	1.24	0.018	4.6	-
		(1)	1.88	0.33	12.7	-
		(4)	0.79	0.17	-	-
		(13)	-	-	-	4.63
17	Saltwater		NA	NA	NA	NA
19	Saltwater Wetlands		NA	NA	NA	NA
21	Tidal Flats		NA	NA	NA	NA

Notes:

- Concentrations for CLUCCS code 2 (MDR) are an average of CLUCCS codes 1 (LDR) and 3 (HDR).
- Concentrations for CLUCCS code 4 (Commercial) are an average of reported values for "low intensity" and "high intensity" commercial.
- Estimated (e) agricultural values were based on similar land uses data when no land use specific data were identified.
- Row crop data were often reported with other agricultural uses.
- Saltwater and saltwater wetlands were assigned zero loads.

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APPENDIX 5

EXISTING AND PROJECTED FUTURE LAND USE ACREAGES, FROM PREVIOUS STUDY (ZARBOCK ET AL., 1996A) AND UPDATED

Previous Analysis - Tampa Bay Watershed, 1990 Land Use (Acres) by Segment and Basin

Bay Segment Basin	Single Family Res.	Medium Density Res.	High Density Res.	Comm.	Indust.	Mining	Inst. Trans. Utility	Range	Barren Land	Pasture	Grove	Feedlot	Nursery	Row Crops	Upland Forest	Fresh Water	Forest Fresh Wetl.	Salt Wetl.	Non-forest. Fresh Wetl.	Total
OTB																				
02306647	730	1647	3205	850	617	194	454	1282	11	79	249	0	37	0	340	1523	738	0	254	12210
02307000	2050	2989	5007	392	156	34	885	4682	60	2680	512	0	120	24	929	2744	4809	0	706	28779
02307359	1844	2031	269	15	0	55	203	3248	5	3094	1273	0	108	0	2961	1958	5451	0	722	23237
206-1	2665	4492	21584	6855	3685	143	9834	9729	157	2205	316	0	165	0	6459	2779	5840	4933	1000	82841
LTARPON	862	989	2766	357	1	5	405	1752	26	441	26	0	12	0	862	414	2005	0	140	11063
HB																				
02300700	409	230	151	104	19	78	379	2425	0	5801	1158	5	97	2934	2122	516	1480	0	509	18417
02301000	4541	5840	457	617	798	29171	1871	4755	47	16220	8202	2470	126	447	5194	3547	4762	1802	1532	92399
02301300	157	0	0	0	4	15591	101	2142	0	5734	3202	0	0	0	2615	469	5437	0	618	36070
02301500	3953	1472	44	235	237	41306	619	3460	357	16479	5577	235	279	1537	6620	1430	9468	0	1857	95165
02301695	467	1400	557	113	0	0	140	581	3	291	96	0	6	0	225	157	257	0	173	4466
02301750	411	1863	987	1073	20	710	1638	48	829	221	221	38	7	0	560	362	121	0	214	9323
02303000	10246	9260	3686	1971	1512	2703	2426	21138	336	46164	4351	756	376	724	15196	2905	24222	2	6711	154685
02303330	11892	4802	2068	1506	661	627	1355	14902	523	31261	4801	189	984	3148	9671	2975	3154	0	6156	100675
02304500	6877	8178	5227	2785	669	290	4374	25552	608	28662	3846	121	214	608	17975	5276	31985	0	10003	153250
204-2	1905	6161	467	413	6	2383	595	3973	94	12374	652	299	105	62	10640	1109	4590	83	1140	47051
205-2	100	496	10588	3318	152	27	1589	918	2	0	20	0	3	0	374	373	43	0	56	18059
206-2	2086	1948	7799	4252	2036	1560	6062	6203	1213	6520	133	133	115	112	4174	1855	682	1127	780	48790
TBYPASS	2255	1629	1426	1616	587	174	1231	2275	154	1810	530	123	64	0	1006	742	999	0	471	17092
MTB																				
02300500	816	274	85	112	0	2293	185	14411	46	35459	9443	34	123	5586	9428	4311	10104	0	3210	95920
02300530	0	38	941	155	0	0	167	1047	0	482	0	0	5	412	360	321	611	0	224	4763
203-3	1876	1342	934	352	113	130	963	5606	37	8119	3371	36	198	4899	4766	1055	4614	742	1605	40758
206-3C	0	6	14	3	0	0	2677	52	2	0	0	0	0	0	514	68	151	724	10	4221
206-3E	118	117	864	219	126	1238	924	2183	5	4756	767	6	118	2624	936	555	1688	3169	136	20549
206-3W	82	1256	12966	2347	637	0	2009	1835	6	0	0	0	44	0	836	857	510	747	97	24229
LTB																				
206-4	809	794	493	166	67	448	1528	2326	21	2625	3724	10	170	647	669	635	2915	1919	317	20283
BCB																				
206-5	29	308	1251	90	0	0	566	947	1	0	0	0	0	0	171	101	42	535	0	4041
207-5	987	2191	24933	4954	2136	16	3569	3417	53	18	433	0	162	27	1411	855	844	960	96	47062
TCB																				
206-6	600	379	1073	288	39	0	301	756	0	1094	409	0	106	27	432	130	516	603	37	6790
MR																				
02299950	0	0	0	0	0	1120	127	16106	0	9790	2731	0	0	529	6702	16	1171	0	3552	41844
202-7	4815	2909	8213	2095	882	213	2584	11675	91	22644	5156	739	502	9984	11018	1718	11329	1672	3706	101945
EVERSRES	479	221	1198	30	0	1245	548	6426	19	8194	322	0	17	3057	7351	1104	2843	12	2001	35067
LMANATEE	205	0	0	0	0	0	132	10156	52	10081	2553	8	0	3045	8854	1446	1739	0	2256	40527
TOTAL	64266	65262	119253	37283	15160	101754	50441	186008	4758	283298	64074	5202	4263	40433	141371	44306	145120	19030	50289	1441571

Previous Analysis - Tampa Bay Watershed Future Conditions (circa 2010), Land Use (Acres) by Major Basin

Bay Segment Basin	Single Family Res.	Medium Density Res.	High Density Res.	Comm	Indust.	Mining	Inst. Trans. Utility	Range	Barren Land	Pasture	Grove	Feedlot	Nursery	Row Crops	Upland Forest	Fresh Water	Forest Fresh Wetl.	Salt Wetl.	Non-forest. Fresh. Wetl.	Total
OTB																				
02306647	621	1812	3686	935	630	194	454	769	10	75	199	0	37	0	273	1523	738	0	254	12210
02307000	1845	3577	6008	431	164	34	972	4236	60	2268	409	0	120	20	836	2744	4349	0	706	28779
02307359	2213	2416	331	15	0	55	213	2932	5	2784	1252	0	95	0	2795	1958	5451	0	722	23237
206-1	2721	4752	22460	6994	3697	143	9936	9002	157	2007	316	0	165	0	6001	2779	5840	4933	938	82841
LTARPON	905	1137	3181	375	1	5	409	1409	26	331	23	0	12	0	690	414	2005	0	140	11063
HB																				
02300700	818	460	219	156	19	78	379	1940	0	5801	1089	5	97	2729	2122	516	1480	0	509	18417
02301000	4768	6424	594	679	838	30040	1871	4256	47	16230	6935	2470	126	424	5077	3524	4762	1802	1532	92399
02301300	157	0	0	0	4	15591	101	2142	0	5734	3202	0	0	0	2615	469	5437	0	618	36070
02301500	4623	1829	88	419	284	41306	647	3291	357	15989	5361	235	279	1383	6319	1430	9468	0	1857	95165
02301695	490	1540	624	119	0	0	140	465	3	235	77	0	6	0	180	157	257	0	173	4466
02301750	411	1863	987	1073	20	710	1638	48	828	221	221	38	7	0	560	362	121	0	214	9322
02303000	12927	11277	4637	2562	1663	2703	2547	18157	336	44317	3959	756	376	652	13976	2905	24222	2	6711	154685
02303330	14268	5956	2689	1807	694	627	1355	14902	523	28135	4105	189	984	2883	9273	2975	3154	0	6156	100675
02304500	8547	10854	5996	3117	669	290	4374	22784	608	26647	3547	121	214	781	17436	5276	31985	0	10003	153249
204-2	2267	7393	701	496	6	2383	625	3655	94	11319	619	299	105	59	10108	1109	4590	83	1140	47051
205-2	100	496	10588	3318	152	27	1589	918	2	0	20	0	3	0	374	373	43	0	56	18059
206-2	2141	2031	8072	4262	2049	1560	6062	6069	1212	6333	133	133	115	106	4098	1855	682	1127	750	48790
TBYPASS	2255	1710	1521	1648	593	174	1231	2207	154	1756	488	123	64	0	956	742	999	0	471	17092
MTB																				
02300500	1624	411	128	182	0	2293	370	13739	46	35702	9443	34	123	5339	8861	4311	10104	0	3210	95920
02300530	0	38	941	155	0	0	167	1047	0	482	0	0	5	412	360	321	611	0	224	4763
203-3	2183	1543	1046	370	115	130	963	5494	37	7808	3371	36	198	4807	4641	1055	4614	742	1605	40758
206-3C	0	6	14	3	0	0	2677	52	2	0	0	0	0	0	514	68	151	724	10	4221
206-3E	142	152	1123	263	132	1237	933	2074	5	4613	767	6	118	2546	889	555	1688	3169	136	20548
206-3W	80	1231	13422	2370	637	0	2009	1431	5	0	0	0	44	0	794	857	505	747	97	24229
LTB																				
206-4	1052	1112	592	199	69	448	1528	1946	21	2360	3707	10	170	634	649	635	2915	1919	317	20283
BCB																				
206-5	29	317	1289	91	0	0	566	900	1	0	0	0	0	0	170	101	42	535	0	4041
207-5	960	2191	25422	5009	2136	16	3569	2910	53	18	433	0	162	27	1411	855	834	960	96	47062
TCB																				
206-6	780	493	1188	294	39	0	301	605	0	875	409	0	106	24	390	130	516	603	37	6790
MR																				
02299950	0	0	0	0	0	1120	127	16106	0	9790	2731	0	0	529	6702	16	1171	0	3552	41844
202-7	7223	4364	11498	2514	926	213	2636	9924	91	18794	5156	739	503	9097	9916	1718	11329	1672	3632	101945
EVERSRES	958	442	2396	36	0	1245	548	5783	19	7365	322	0	17	2967	7010	1104	2842	12	2001	35067
LMANATEE	226	0	0	0	0	0	132	9953	52	9984	2808	8	0	3069	8854	1446	1739	0	2256	40527
TOTAL	77334	77827	131441	39892	15537	102622	51069	171146	4754	267973	61102	5202	4251	38488	134850	44283	144644	19030	50123	1441568

Updated Analysis - Tampa Bay Watershed Future Conditions (circa 2010), Land Use (Acres) by Major Basin

Bay Segment Basin	Single Family Res.	Med. Density Res.	High Density Res.	Comm.	Indust.	Mining	Inst. Trans. Utility	Range	Barren Land	Pasture	Grove	Feedlot	Nursery	Row Crop	Upland Forest	Fresh Water	Open Saltwater	Forest Fresh Wetl.	Salt Wetl.	Non-forest. Fresh. Wetl.	Tidal Flat	Total
OTB																						
02306647	672	2083	3600	976	711	104	587	639	0	45	109	0	16	0	300	1492	0	734	0	142	0	12209
02307000	1937	3861	6064	470	101	12	1198	3590	0	2021	694	0	99	0	664	2916	0	4453	0	726	0	28804
02307359	2322	2663	374	19	0	77	225	2278	0	3093	1219	0	122	0	2773	2066	0	5278	0	726	0	23235
206-1	2735	4906	23247	7722	3975	217	10723	7281	46	1825	291	0	109	0	5198	2992	46512	5631	5179	1221	8270	138082
LTARPON	924	1683	3267	443	2	0	563	1010	0	85	20	0	7	0	567	2982	0	1960	0	198	0	13712
HB																						
02300700	656	427	288	163	35	141	427	1915	12	3427	1243	5	173	4769	2124	623	0	1438	0	561	0	18426
02301000	5871	7581	590	1188	1017	29301	2102	4249	170	11011	3585	17	116	1877	6551	2305	0	6961	0	1935	0	86429
02301300	315	31	0	13	0	18862	83	838	0	5112	2810	7	32	148	1989	613	0	4776	0	445	0	36074
02301500	5183	2047	175	436	288	41494	669	3255	237	14691	6134	178	94	2569	5629	2155	0	8503	0	1480	0	95215
02301695	510	1800	903	130	0	0	161	178	0	84	79	0	10	0	176	148	0	220	0	79	0	4478
02301750	439	2115	1638	1383	27	0	906	825	7	442	125	0	10	0	398	420	0	109	0	269	0	9113
02303000	12851	10787	5260	2681	1824	2737	3167	18300	20	42550	5117	912	343	998	14268	2963	0	23289	0	6645	0	154712
02303330	14792	6301	2576	2103	766	672	1708	10314	175	23811	4518	154	779	2787	8798	3249	0	15510	0	5911	0	104926
02304500	10641	13618	7829	4238	848	557	5872	14797	146	24231	5360	73	255	615	17890	5985	0	30868	42	9919	0	153782
204-2	2467	7127	1155	503	9	2296	697	2673	10	11281	667	285	309	1105	9777	1342	511	4324	89	1151	2	47780
205-2	119	505	11138	3609	161	10	1581	272	0	0	22	0	2	0	124	650	5	62	0	44	5	18310
206-2	2405	2058	9027	4512	2327	1181	6266	4677	678	6059	287	121	58	171	4338	2343	19850	810	1329	897	4216	73608
TBYPASS	2421	1750	1622	1790	633	170	1307	1875	9	1688	456	67	56	13	949	1151	0	1043	0	492	0	17492
MTB																						
02300500	1368	448	130	185	36	8169	320	10005	62	29180	10143	35	282	10906	8119	4505	0	9360	0	2708	17	95979
02300530	43	52	1131	182	0	0	174	891	0	521	0	0	2	287	276	346	0	642	0	215	0	4762
203-3	2291	1536	1193	364	125	200	1435	3673	12	5775	3465	40	200	5836	4657	1151	1391	4522	798	1544	49	40259
206-3C	0	0	27	5	0	0	2666	86	15	0	0	0	0	0	494	84	60483	143	813	20	4097	68933
206-3E	264	339	1119	261	166	1549	1217	1350	0	3749	816	5	117	3197	901	620	1184	1446	3647	247	1085	23279
206-3W	73	189	14583	2445	668	0	1999	1536	2	0	0	0	44	0	664	912	2219	524	793	79	519	27250
LTB																						
206-4	1199	451	1351	184	140	450	1993	1583	17	2392	3667	10	188	420	685	709	59996	2664	2271	415	877	81661
BCB																						
206-5	38	33	1642	97	0	0	594	892	22	0	0	0	0	0	174	99	11431	32	638	0	368	16059
207-5	858	1321	27801	5255	2287	7	3564	1865	30	15	45	0	54	0	838	1670	9123	408	660	104	309	56213
TCB																						
206-6	732	526	1445	371	46	0	371	340	10	737	443	0	109	8	420	138	3855	361	786	49	47	10793
MR																						
02299950	0	0	0	0	0	1337	275	15570	0	7453	3862	0	0	2058	6452	151	0	2577	0	2115	0	41849
202-7	8502	5776	14551	3443	1192	220	3540	6203	59	16414	5278	361	341	11218	7099	1811	7616	10383	1712	3917	217	109853
EVERSRES	921	1552	2752	178	0	1500	976	5682	35	7381	383	0	5	3245	6202	1423	0	2782	12	2417	0	37446
LMANATEE	589	19	0	50	0	0	211	9694	0	10141	3419	0	20	6637	4247	1631	0	2380	0	1492	0	40530
TOTAL	84138	83584	146477	45399	17383	111264	57576	138336	1775	235214	64256	2268	3951	58865	123742	51646	157296	154193	18770	48163	7586	1636472

Updated Analysis - Tampa Bay Watershed, 1995 Land Use (Acres) by Segment and Basin

Bay Segment Basin	Single Family Res.	Med Density Res.	High Density Res.	Comm	Indust.	Mining	Inst. Trans. Utility	Range	Barren Land	Pasture	Grove	Feedlot	Nursery	Row Crops	Upland Forest	Fresh Water	Open Saltwater	Forest Fresh Wetl.	Salt Wetl.	Non-forest. Fresh. Wetl.	Tidal Flat	Total
OTB																						
02306647	746	1984	3000	929	697	104	534	1040	0	64	156	0	27	0	334	1658	0	734	0	203	0	12209
02307000	2152	3677	5053	447	91	12	1198	4025	0	2377	771	0	124	0	781	2916	0	4453	0	726	0	28804
02307359	2019	2048	250	12	0	77	161	2590	0	3437	1354	0	136	0	3081	2066	0	5278	0	726	0	23235
206-1	2604	4460	22140	7020	3786	217	10213	9022	91	2147	324	0	136	0	6116	2992	46512	5631	5179	1221	8270	138082
LTARPON	840	1530	2970	403	2	0	469	1500	0	121	20	0	7	0	709	2982	0	1960	0	198	0	13712
HB																						
02300700	418	272	262	109	22	94	356	2128	12	3707	1243	5	173	4769	2236	623	0	1438	0	561	0	18426
02301000	5592	7220	536	1132	969	29301	2002	4473	170	11478	3585	17	116	2086	6551	2305	0	6961	0	1935	0	86428
02301300	178	17	0	7	0	19054	47	838	0	5112	2810	7	32	148	1989	613	0	4776	0	445	0	36074
02301500	4712	1861	175	363	240	42341	608	3356	237	14996	5841	178	94	2446	5629	2155	0	8503	0	1480	0	95215
02301695	425	1500	704	109	0	0	161	445	0	279	99	0	10	0	220	148	0	220	0	158	0	4477
02301750	366	1922	1092	1317	25	0	697	1324	7	736	250	0	10	0	568	420	0	109	0	269	0	9113
02303000	10709	8989	4384	2234	1520	2281	2639	20334	20	46250	5117	912	343	998	15085	2963	0	23289	0	6645	0	154712
02303330	11834	5041	2061	1683	613	672	1366	11460	175	25609	5315	193	974	3484	9775	3249	0	15510	0	5911	0	104926
02304500	7094	9078	5592	3027	707	507	4517	19121	183	32308	5955	121	255	615	17890	5985	0	30868	42	9919	0	153783
204-2	2056	6197	1050	457	7	2296	581	2970	10	11972	702	356	309	1105	10292	1342	511	4324	89	1151	2	47779
205-2	111	472	10606	3373	151	10	1581	907	0	0	22	0	2	0	309	650	5	62	0	44	5	18310
206-2	2291	1871	8206	4297	2115	1181	5967	5772	848	6326	319	151	64	190	4566	2343	19850	810	1329	897	4216	73609
TBYPASS	2305	1591	1544	1705	603	170	1189	2083	17	1875	507	133	62	15	1006	1151	0	1043	0	492	0	17492
MTB																						
02300500	912	299	86	124	22	4085	200	11117	62	30883	10143	35	282	12118	9022	4505	0	9360	0	2708	17	95979
02300530	27	49	1028	166	0	0	158	954	0	549	0	0	2	319	306	346	0	642	0	215	0	4762
203-3	2083	1396	1085	331	114	200	944	4591	12	6417	3850	40	200	6484	5174	1151	1391	4522	798	1544	49	42378
206-3C	0	0	27	5	0	0	2666	86	15	0	0	0	0	0	494	84	60483	143	813	20	4097	68933
206-3E	200	257	848	198	126	1174	922	1544	0	4411	907	5	146	3366	949	620	1184	1446	3647	247	1085	23279
206-3W	72	185	14297	2397	655	0	1999	1853	2	0	0	0	44	0	699	912	2219	524	793	79	519	27250
LTB																						
206-4	951	358	1072	146	111	450	1581	2006	17	2990	3667	10	188	420	761	709	59996	2664	2271	415	877	81662
BCB																						
206-5	37	32	1594	94	0	0	571	959	22	0	0	0	0	0	183	99	11431	32	638	0	368	16059
207-5	825	1270	26731	5053	2199	7	3511	3109	30	15	64	0	77	0	1048	1670	9123	408	660	104	309	56213
TCB																						
206-6	581	418	1147	294	42	0	294	561	10	1134	492	0	109	10	467	138	3855	361	786	49	47	10793
MR																						
02299950	0	0	0	0	0	1337	136	15708	0	7453	3862	0	0	2058	6452	151	0	2577	0	2115	0	41849
202-7	5001	3398	8560	2296	917	220	2950	8270	84	23610	6598	722	487	13198	7887	1811	7616	10383	1712	3917	217	109853
EVERSRES	576	776	1720	99	0	1364	813	6343	35	8201	383	0	5	3605	6892	1423	0	2782	12	2417	0	37446
LMANATEE	393	12	0	42	0	0	141	9891	0	10311	3109	0	20	6637	4470	1631	0	2380	0	1492	0	40529
Total	68111	68182	127820	39867	15733	107152	51172	160380	2061	264770	67463	2884	4433	64071	131942	51812	224174	154193	18770	48303	20079	1693371