FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

Total Maximum Daily Load for Iron for Hatchet Creek, Alachua County, Florida

WBID 2688

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1. INTRODUCTION

1.1 Purpose

This report presents a Total Maximum Daily Load (TMDL) for Total Iron for Hatchet Creek. Using the methodology to identify and verify water quality impairments described in Chapter 62-303, Florida Administrative Code, (Identification of Impaired Surface Waters, which is commonly referred to as the Impaired Waters Rule, or IWR), the creek was verified as impaired by iron, and was included on the verified list of impaired waters for the Ocklawaha Basin that was adopted by Secretarial Order on August 28, 2002. The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions.

1.2 Identification of Waterbody

Hatchet Creek is located northeast of the City of Gainesville in the Orange Creek planning unit (Figure 1) of the Ocklawaha River Basin. It is the headwater to Newnans Lake and is considered a blackwater stream (low pH and high color). It is approximately 10.75 miles long and has a contributing watershed of approximately 41,285 acres.

Hatchet Creek is in the Rodman catchment landuse area. The predominant landuses in this area are tree plantations and mixed wetland forests. The next most significant landuses are low density residential housing, cropland/pastureland, and transportation (airport). Permitted discharges in the area include a 1.5 mgd discharge from the Florida Department of Transportation's Fairbanks ground water remediation facility that treats contaminated ground water via air stripping. Historically, Hatchet Creek was used as a disposal site for batteries from railroad crossing signals of the Sea Coast Railroad Company near the City of Waldo. There are no permitted domestic wastewater facilities in the Hatchet Creek drainage area.

The geologic formation underlying the Ocklawaha Basin is a thick sequence of primarily carbonate rocks capped by thin layers of clay, silt, and sand sediment (Scott, 1992). Fluctuations in sea level and subsequent subareal exposure contributed significantly to deposition of sediments. Contained within the carbonate rock are three aquifer systems: the Floridan, Intermediate, and Surficial Aquifers (Southeastern Geological Society, 1986).

In many parts of the basin, an intermediate confining unit separates the Florida Aquifer from the Surficial Aquifer. This unit is composed of fine-grained phosphoric sediments of the Hawthorne Formation that retard the exchange of water between the Surficial and Florida Aquifer. The Hawthorne Formation is largely absent in western Marion County and west of Gainesville. Where thick beds of permeable material are present, the Hawthorn Formation can contain an intermediate aquifer system. The Surficial Aquifer is highly variable in thickness and consists of undifferentiated deposits of silt, clay, and sand (pride et al., 1966). Karst landscape is well developed in parts of the basin, especially western Alachua County and western Marion County, with numerous faults, fractures, sinkholes, and caverns in the limestone of the Upper Florida Aquifer (Puri and Vernon, 1964). These sinkholes and fractures provide additional routes for water to move from land surface to the aquifer.

For assessment purposes, the watersheds within the Ocklawaha Basin have been broken out into smaller watersheds, with a unique **w**ater**b**ody **id**entification (WBID) number for each. Hatchet Creek has been assigned WBID 2688 (Figure 1).

2. STATEMENT OF PROBLEM

Hatchet Creek (WBID 2688) was verified as impaired for iron based on the methodology in Chapter 62-303, Florida Administrative Code, (Identification of Impaired Surface Waters, which is commonly referred to as the Impaired Waters Rule, or IWR). Available data (Table 1) indicate that more than 34% of the samples exceeded the Class III total iron criteria during the verification period (Jan. 1995-June 2002). The creek was included on the verified list for the Ocklawaha Basin, which was adopted by Secretarial Order on August 26, 2002 and submitted to EPA as part of the 2002 update to Florida's 303(d) list.

During the verification period, 13 of the 38 iron samples exceeded the criterion. There was slight seasonal variability in the iron values, with higher averages in the fall (average concentration of 1.46 mg/L), followed by summer (1.16 mg/L), winter (1.06 mg/L), and spring (0.74 mg/L). However, there was no clear relationship between iron concentrations and area rainfall. Precipitation measured from January 1995 through June 2002 at the Gainesville Regional Airport was highest in the summer (averaging 19.14 inches), followed by the spring (11.41 inches), fall (10.73 inches) and winter (9.66 inches).

Table 1. Iron Data for WBID 2688

Station	Year	Month	Day	Time	Iron mg/L
21FLSJWMHAT26	1993	5	24	1045	1.13
21FLSJWMHAT26	1993	6	21	917	0.797
21FLSJWMHAT26	1993	7	26	1000	1.09
21FLSJWMHAT26	1993	8	25	1250	0.32
21FLSJWM02240800	1995	6	6	1300	0.59
21FLSJWM02240800	1995	8	28	1215	1.75
21FLSJWM02240800	1995	10	3	1030	0.917
21FLSJWM02240800	1996	2	12	1100	1.2
21FLSJWM02240800	1996	4	10	1200	1.09
21FLSJWM02240800	1996	6	11	915	0.352
21FLSJWM02240800	1996	8	6	1230	1.81
21FLSJWM02240800	1996	10	8	1345	0.577
21FLSJWM02240800	1996	12	19	1235	0.439
21FLSJWM02240800	1997	2	18	1300	0.492
21FLSJWM02240800	1997	4	29	1030	0.517
21FLSJWM02240800	1997	6	16	1200	0.923
21FLSJWM02240800	1997	8	12	1145	1.52
21FLSJWM02240800	1997	9	10	1230	1.76
21FLSJWM02240800	1997	10	1	1245	0.66
21FLSJWM02240800	1997	11	24	1045	1.19
21FLSJWM02240800	1998	1	7	1100	0.641
21FLSJWM02240800	1998	2	23	1115	0.338
21FLSJWM02240800	1998	4	8	1130	0.844

21FLSJWM02240800	1998	6	3	1015	0.359
21FLSJWM02240800	1998	11	20	700	0.624
21FLSJWM 02240800	1999	1	29	800	0.535
21FLSJWM 02240800	1999	3	23	1330	0.4912
21FLSJWM 02240800	1999	5	24	1130	0.987
21FLSJWM 02240800	1999	7	22	1110	1.287
21FLSJWM 02240800	1999	9	16	1200	0.626
21FLSJWM 02240800	1999	11	10	1215	0.535
21FLSJWM 02240800	2000	1	18	1230	0.592
21FLSJWM 02240800	2000	3	22	1200	0.4318
21FLSJWM 02240800	2000	5	4	1030	0.446
21FLSJWM 02240800	2000	7	10	1010	0.605824
21FLSJWM 02240800	2000	11	9	950	3.964712
21FLSJWM 02240800	2001	1	9	1145	2.827751
21FLSJWM 02240800	2001	3	13	1045	3.069259
21FLSJWM 02240800	2001	5	18	915	0.850896
21FLSJWM 02240800	2001	7	3	835	0.554395
21FLSJWM 02240800	2001	9	13	1130	1.383413
21FLSJWM 02240800	2001	11	6	941	2.959289
21FLSJWM 02240800	2001	11	6	940	2.734985

3. DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGET

Hatchet Creek, WBID 2688, is a Class III waterbody with designated uses of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III criterion for iron states that in no case shall iron concentrations exceed 1.0 milligram/L.

4. ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of the pollutant of concern in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either “point sources” or “nonpoint sources.” Historically, the term point sources has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term “nonpoint sources” was used to describe intermittent, rainfall driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, runoff from agriculture, runoff from silviculture, runoff from mining, discharges from failing septic systems, and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under EPA’s National Pollutant Discharge Elimination Program (NPDES). These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and from a wide variety of industries (see Appendix A for background information about the State and Federal Stormwater Programs).

To be consistent with Clean Water Act definitions, the term “point source” will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) AND stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see Section 6). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Land Uses and Nonpoint Sources

Forest/Rural open areas (64%) dominate land use in the Hatchet Creek watershed. Other significant land uses include water and wetlands (22%), low density residential (5%) and agricultural (5%). Urban and built up land uses represented less than 8% of the watershed acreage.

The most common nonpoint source of iron in the watershed is groundwater, which is typically naturally elevated in iron due to the weathering of iron bearing minerals and rocks. However, industrial effluent, acid – mine drainage, sewage and landfill leachate may also contribute iron to local groundwater.

4.3 Point Sources in the Watershed

There is one permitted wastewater facility that discharges directly into Hatchet Creek. Florida Department of Transportation's Fairbanks facility, NPDES# FL0169871, located at 29°43' 36" latitude, 82°15' 55" longitude, is a ground water remediation facility that is permitted for a 1.5 MGD discharge. The facility has two discharge locations: outfall 0001-1 and 01A-1. Outfall 0001-1 has a monthly average discharge of 0.17 MGD and outfall 01A-1 a monthly average discharge of 0.28 MGD. The facility has been operational since March of 1997. According to the permit application, iron was not present in the effluent discharged from the facility and therefore, no monitoring is required for iron.

Alachua County's NE Landfill lies just south of Hatchet Creek and north of Little Hatchet Creek in WBID 2695 (as seen in Figure 1). Monitoring well data provided by Alachua County Public Works for the 1995 to 2003 period indicate iron levels in the area ranged from 0.15 to 22.0 mg/L with 60 of 75 values above 1 mg/L in the downgradient wells.

4.4 Flow Data

A USGS flow gauge is located on Hatchet Creek (Figure 1), but was only operational from June 1995 to September 1998. Over this time period, the flow averaged 36 cubic feet per second (CFS), with 90 percent of the daily flows greater than 28 CFS. Annual rainfall during this period recorded at Gainesville Regional Airport averaged 47.63 inches, 3 inches below the annual average for the area, and long-term flows for the creek are likely higher than indicated by the flow record.

Creek flows include a groundwater baseflow component (Growth Management Dept. Alachua County), but there are insufficient data to estimate the volume of ground water flow. Groundwater flow in the basin is generally from the Eastern part of the County toward the

Northwest, and most discharge from the aquifer occurs beyond the boundaries of Alachua County. Local pumpage from wells, sinkholes, fractures in the limestone, rainfall and other factors may influence the flow regime.

5. DETERMINATION OF THE LOADING CAPACITY

This TMDL was developed using a methodology developed by the State of Kansas. This method, often called "The Kansas Approach ", uses load duration curves to estimate the percent reduction in loading needed to meet the applicable water quality criterion. While most commonly used for coliform TMDLs, the method can be applied to a variety of parameters for the development of TMDLs. For this TMDL, a load duration curve was developed using techniques very similar to those of the state of Kansas as well as slight modifications approved by EPA Region 4.

Due to lack of adequate flow data for Hatchet Creek, flows for the sampling dates were estimated from the flow record at Hogtown Creek (USGS gauge 02240950) using the drainage area ratios for both creeks (1.56). The estimated flows for Hatchet Creek were used to develop a flow duration curve as per the "Kansas Approach." Using the flows from this curve, a load duration curve for iron (Figure 3) was calculated using the following equation:

(Observed flow) x (conversion factor) x (state criteria) = (kg iron/day or daily load) **(1)**

The above equation yields the load duration curve or allowable load curve (Figure 3, blue line). Total Iron observations were then plotted, noting where the samples are in relation to the allowable load curve (above or below the curve). Those above the curve (Figure 3, in red) are noted as exceedances of the state criterion. Using equation 1 (above), a table was calculated (Table 2), substituting the observed data for the state criteria value.

A trendline of best-fit was applied through the exceedances (Figure 3, in red). The best-fitting trend line was determined by evaluating different functions until the highest R-squared value was found. In this case, a linear function was determined to be the best fit, and took the following form:

$$y = -0.3901x + 55.224 \qquad \textbf{(2)}$$

This linear function (equation 2) was used to determine the predicted loads by substituting different percentile numbers (70 - 95, incremented by 5: Table 2) for x. These percentile increments were chosen due to the fact that there were no exceedances found below the 70th percentile, and extreme drought conditions were excluded. The results yield a range of predicted loads within each 5th percentile (Table 2).

Finally, the percent reduction in loading needed for the creek to meet the iron criterion was calculated. This calculation involved both the predicted and allowable loads previously computed (Table 2). Using percentile increments of 5, (ranging from 70 - 95; Table 2), the needed reduction of daily load was computed using:

$$\frac{\text{(predicted load) - (allowable load)}}{\text{(predicted load)}} \times 100 \qquad \textbf{(3)}$$

As Table 2 indicates, percent reductions were calculated within each 5^{th} percentile. The reduction percents were then averaged to obtain a daily average load reduction expression as a percent, needed for the waterbody to satisfy the state criterion.

According to EPA (personal communication, June 2003), values on load duration curves can be interpreted to have three key areas that indicate the source(s) of exceedances. Exceedances can be attributed to point sources or low flow conditions when they fall into the 90^{th} - 100^{th} percentile flows, while those falling into the 10^{th} - 90^{th} percentile can typically be attributed to non-point sources, and those in the 1^{st} - 10^{th} percentile potentially exceed feasible management practices (Figure 3). Of the 13 exceedances represented on the curve, the majority (9) fell in the area associated with nonpoint sources.

6. DETERMINATION OF THE TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

As mentioned in Section 4.1, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$TMDL \cong \sum WLAs_{wastewater} + \sum WLAs_{NPDES\ Stormwater} + \sum LAs + MOS$$

It should be noted that the various components of the TMDL equation may not sum up to the value of the TMDL because a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is accounted for within the LA, and b) TMDL components can be expressed in different terms [for example, the WLA for stormwater is typically expressed as a percent reduction and the WLA for wastewater is typically expressed as a mass per day].

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges is also different than the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of Best Management Practices.

This approach is consistent with federal regulations [40 CFR § 130.2(I)], which state that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. The TMDL for Hatchet Creek (Table 3) is expressed in terms of pounds per year for the point sources and in terms of the percent reduction for nonpoint sources.

Table 3. TMDL Components

WBID	Parameter	WLA		LA (Lbs/day)	MOS	TMDL[1] (lbs/day)	Percent Reduction [2]
		Wastewater (lbs/day)	NPDES Stormwater				
2688	Iron	5.6	N/A	30.31	Implicit	35.91	30.8%

1. TMDL represents the average allowable load between 70th and 95th percent recurrence interval.
2. Overall reduction to achieve an in-stream water quality criterion of 1.0 mg/L.

6.1 Load Allocations (LAs)

Based on a loading duration curve approach similar to that developed by the state of Kansas (Stiles, 2002) and New Jersey (Al-Ebus and Jacobson, 2002), a total iron reduction of 30.8% is needed from nonpoint sources, which results in a total load (TMDL) of 35.91 lbs/day. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the Water Management Districts that are not part of the NPDES Stormwater Program (see Appendix A).

6.2 Wasteload Allocations (WLAs)

<u>NPDES Wastewater Discharges</u>

The DOT Fairbanks facility is the only wastewater facility with an NPDES permit authorizing a discharge to Hatchet Creek. An effluent concentration limit equal to the Class III criterion (1 mg/L) will ensure that the facility does not cause or contribute to exceedances of the criterion, and the allowable load for the facility is 5.6 lbs./day, based on the permitted flow for the facility.

<u>NPDES Stormwater Discharges</u>

As noted previously in this section and in Section 4, load from stormwater discharges permitted under the NPDES Stormwater Program is placed in the WLA, rather than the LA. This includes loads from municipal separate storm sewer systems (MS4). However, based on the information provided by EPA, no MS4 area was found overlapping the Hatchet Creek watershed and no stormwater loads were assigned to the WLA.

6.3 Margin of Safety (MOS)

An implicit margin of safety was used for this TMDL. The science of prediction (i.e. model predictions, statistical evaluations, etc.) always incorporates some level of assumptions. When making these conjectures, error becomes incorporated into the process. When the explicit numerical error threshold is not known, the error is expressed implicitly. Implicit margins of safety are an inherent consequence of an analytical or statistical evaluation of some processes. Such was the case here, where assumptions made during the analysis undoubtedly led to some degree of error, but the exact threshold or number of this error was unknown.

The assumptions made during the load duration curve analysis included the use of a linear regression equation used to calculate the predicted loads, the use of derived flows using watershed size ratios, and the assumption that the observational water quality data was error free.

7. CRITICAL CONDITIONS

The critical condition for iron loadings from nonpoint sources is a product of groundwater baseflow component. Unconfined background wells in Alachua County historically indicate iron levels up to 24 mg/L. In fact, many surface water systems in central Florida are closely interconnected with the underlying groundwater system through springs and sinkholes (Alachua County Comprehensive Plan 2001-2020). In accordance with hydrologic conditions, these natural interconnections may augment flow, reduce flow, or perform both functions intermittently. Because the region manifests annual wet and dry seasons with significant variations in precipitation frequency and intensity, the contribution of surface runoff and groundwater baseflow to stream varies. This cyclic pattern of changing baseflow conditions results in variable surface water quantity and quality.

8. SEASONAL VARIATION

An analysis of iron concentrations versus season or rainfall did not indicate a seasonal pattern. Observed exceedances of the iron criterion indicated that exceedances occurred in the 70 - 90th percentile of flow.

9. NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

Following adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, which will be a component of the Basin Management Action Plan for the Ocklawaha Basin. This document will be developed in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished.

The Basin Management Action Plan (B-MAP) will include:

- Appropriate allocations among the affected parties.
- A description of the load reduction activities to be undertaken.
- Timetables for project implementation and completion.
- Funding mechanisms that may be utilized.
- Any applicable signed agreements.
- Local ordinances defining actions to be taken or prohibited.
- Local water quality standards, permits, or load limitation agreements.
- Monitoring and follow-up measures.

It should be noted that TMDL development and implementation is an iterative process, and this TMDL will be re-evaluated during the BMAP development process and subsequent Watershed Management cycles. The Department acknowledges the uncertainty associated with TMDL development and allocation, particularly in estimates of nonpoint source loads and allocations for NPDES stormwater discharges, and fully expects that it may be further refined or revised over time. If any changes in the estimate of the assimilative capacity AND/OR allocation between point and nonpoint sources are required, the rule adopting this TMDL will be revised, thereby providing a point of entry for interested parties.

References

Florida Administrative Code, Chapter 62-302, Surface Water Quality Standards.

Florida Administrative Code, Chapter 62-303, Identification of Impaired Surface Waters.

Florida Department of Environmental Protection, Bureau of Watershed Management, Division of Water Resource Management, Ocklawaha Basin Assessment Report. August 2003.

Growth Management Department Alachua County, Natural Resources Water, Comprehensive Plan 2001-2020 Data and Analysis.

The Kansas Method "**http://www.kdhe.state.ks.us/tmdl/Data.htm**"

Figure 1: Hatchet Creek WBID 2688

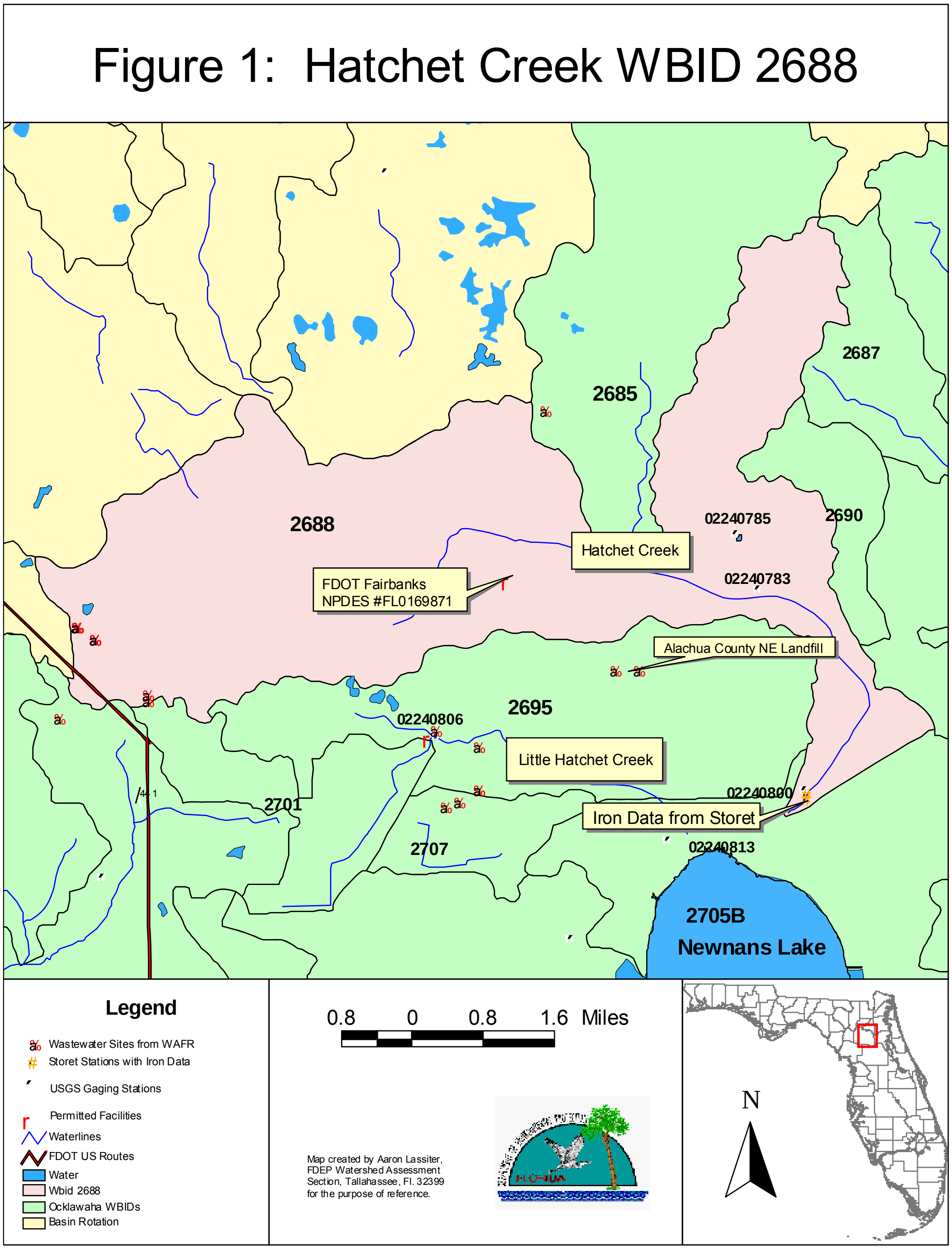

Figure 2: Hatchet Creek Land Use

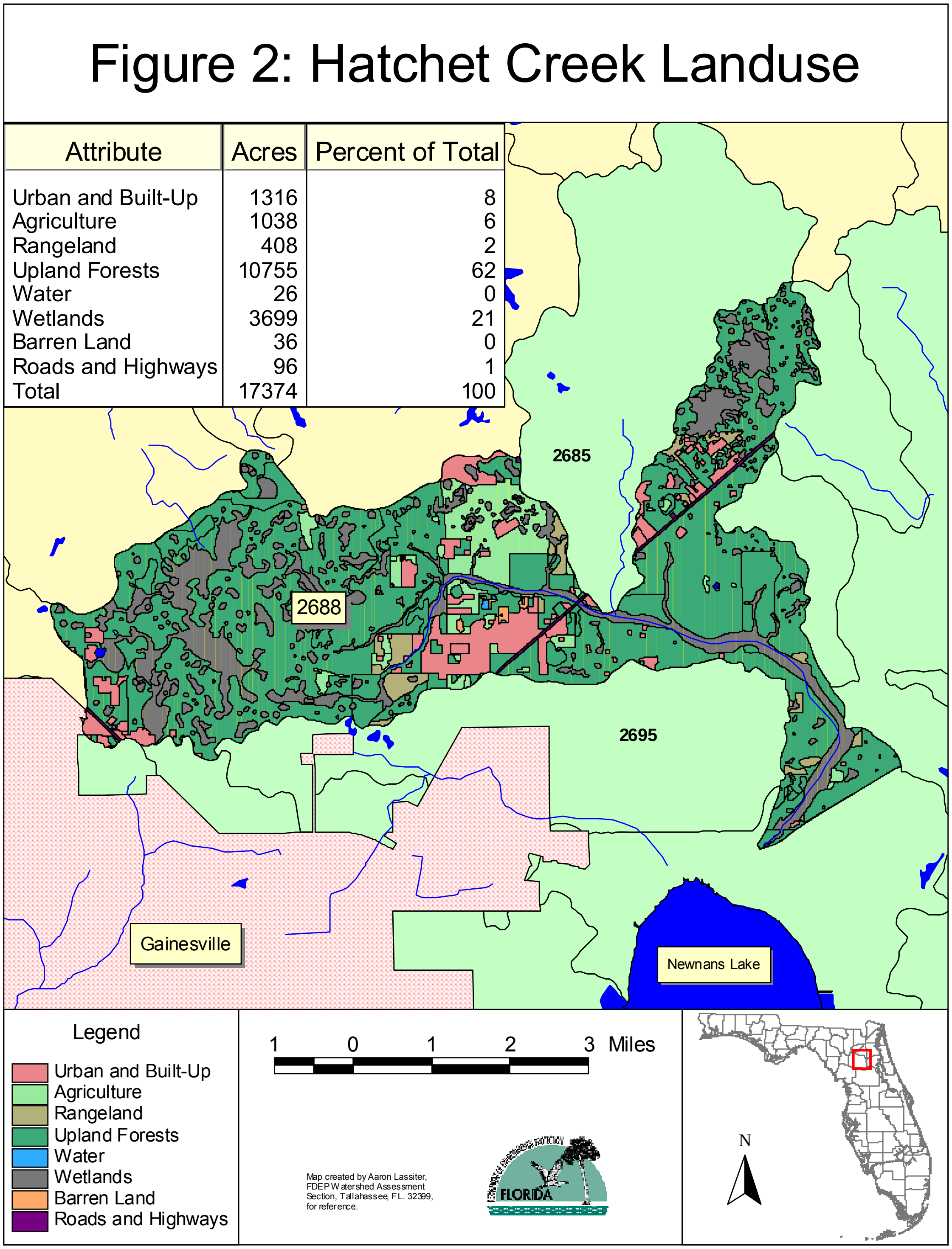

Figure 3: Allowable Load Curve, Existing Daily Loads, and Violated Daily Loads for Hatchet Creek Iron TMDL

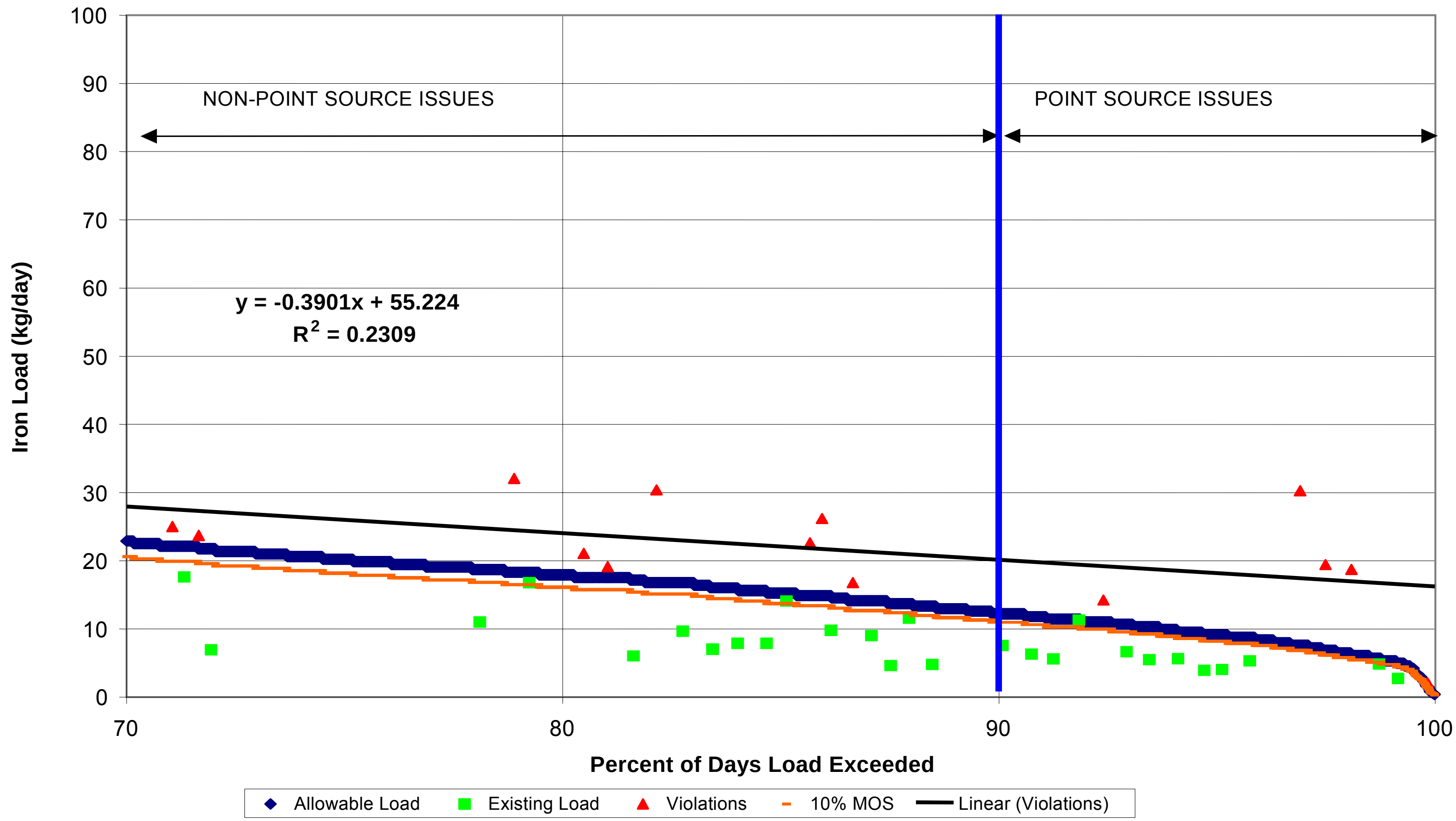

Table 2: Loading and Needed Percent Reduction Table

Percentile Interval	Allowable Load (kg/day)	Predicted Load (kg/day)	Load Reduction Necessary (%)
95	9.160998912	18.1645	49.56646804
90	12.21466522	20.115	39.27583785
85	15.26833152	22.0655	30.80450695
80	17.94028954	24.016	25.29859454
75	20.23053926	25.9665	22.08984937
70	22.90249728	27.917	17.96218333
			30.8
			Average Percent Reduction Needed for Compliance