TECHNICAL MEMORANDUM

TO:	RUSSEL FRYDENBORG, FDEP NIJOLE K. WELLENDORF, FDEP	DATE:	JUNE 9, 2010
CC:	CHET THOMPSON, BUCKEYE FLORIDA, LP	RE:	APALACHEE BAY NUTRIENT CRITERIA SUPPORT ANALYSIS
FROM:	THOMAS W. GALLAGHER CRISTHIAN MANCILLA	FILE:	BUCC.009.000

1.0 INTRODUCTION

This document summarizes the analysis performed to support and assist the development of Total Nitrogen (TN) and Total Phosphorus (TP) criteria for several streams located in the Apalachee Bay area. While this analysis is not intended to define specific nutrient criteria values, it is the objective to present an approach and its corresponding results as guidance for other possible methodologies. Existing TN, TP and flow data has been analyzed and, considering flow to be an explanatory variable, long term nutrient concentrations have been estimated.

2.0 TN AND TP DATA ANALYSIS

Nutrient data was obtained for the following rivers: Econfina, Aucilla, St. Marks and Steinhatchee. TN and TP data was retrieved from the Suwannee River Water Management District (SRWMD) website, the Florida Department of Environmental Protection (FDEP) STORET online database, and the EPA STORET online database. Daily flow records were obtained from the USGS online data retrieval interface for several flow stations located along these rivers. The most downstream flow stations were isolated and if long term flow measurements were not available or tidal influence was noticed, the next upstream flow station that met both criteria was then selected. Table 1 presents the selected USGS flow stations for each river. As tabulated in this table, the selected Aucilla River flow station contains flow records for the 1976 to 1997 time period only. Because for the purposes of this analysis a long term flow record was needed (1950-2009), an approach was developed to estimate the daily flows for the required time period. A relationship was developed between the Econfina River and Aucilla River daily flows for the 1976-1997 period. Figure 1 presents the results of this analysis. This relationship was then employed to obtain an estimate of the Aucilla River daily flows for the 1950-2009 time period.

Table 1. Selected USGS Flow Stations

River	ID	Name	Drainage Area (mi)	Time Period
Econfina	02326000	Econfina River near Perry	198	1950-2009
Aucilla	02326512	Aucilla River near Scanlon	805	1976-1997
St. Marks	02326900	St. Marks River near Newport	535	1950-2009
Steinhatchee	02324000	Steinhatchee River near Cross City	350	1950-2009

Several water quality stations were identified in the vicinity of the selected USGS flow stations. The selected water quality stations are listed in Table 2. During the development of the analysis presented in this document several other water quality stations were also included. In later stages of the analysis, some of the selected water quality stations were discarded due to data inconsistencies observed between stations. In general, the discarded water quality stations provided data before 1999 only and were retrieved from the EPA LEGACY STORET online database. Temporal plots of TN and TP data for the selected stations are presented in Figures 2 to 9. These figures also present daily flow records for the time periods when the nutrient data was collected.

Table 2. Selected Water Quality Stations

River	ID	Name	Time Period	Source
Econfina	ECN010C1 6976	Econfina R. nr Perry Econfina R. at Cabbage Cove	1989-1992, 1999-2009 1999-2009	SRWMD FDEP STORET
Aucilla	AUC050C1	Aucilla R. at US 27 or at Lamont	2000-2009	SRWMD
St. Marks	3528	St. Marks R. at HWY 98 Newport	1998-2009	FDEP STORET
Steinhatchee	STN030C1 6978	Steinhatchee R. nr Cross City Steinhatchee R. nr Tennile	1999-2009 1999-2009	SRWMD FDEP STORET

Assuming flow to be an explanatory variable for the TN and TP concentrations, relationships between measured daily flows and nutrient concentrations were developed. Figures 10 to 13 depict the developed flow-concentration relationships for TN and similarly Figures 14 to 17 depict the equivalent relationships for TP. These relationships allowed the calculation of long term daily nutrient concentrations (1950-2009) as defined by the long term daily flows. Figures 18 to 21 and Figures 22 to 25 (upper two panels) present the long term measured flows and computed long term nutrient concentrations for TN and TP, respectively. Because EPA's proposed numeric nutrient water quality criteria for flowing waters within the State of Florida, specifically the proposed In-stream Protection Values (IPVs), are based on annual geometric means, Figures 18 to 25 (bottom panel) present a summary of the annual geometric means corresponding to the computed long term nutrient concentrations for TN and TP. EPA has proposed TN and TP IPVs of 0.824 mg/L and 0.043 mg/L, respectively, for the Panhandle region of Florida. These IPVs are indicated by the red dotted lines on Figures 18 to 25 (bottom panel). Because EPA could consider judging compliance with these TN and TP IPV concentrations as defined by a maximum number of exceedances in a specific time period (years), a sample 5-year moving average of the annual geometric means is also included in these figures (bottom panel). Figures 26 to 33, in a similar manner as Figures 18 to 25, present the analysis results for nutrient loadings as opposed to nutrient concentrations. The inclusion of the flow variability when dealing with nutrient loads is an important factor to consider when judging compliance as seen on these figures. Figures 34 to 37 and Figures 38 to 41 show log probability plots of 60 years of computed annual geometric means for TN and TP, respectively (both loads and concentrations). These type of figures are very useful when deciding, for example, a never to exceed value (concentration or load). Expressing nutrient criteria as a never to exceed value allows the regulatory agencies to establish compliance with the criteria each year rather that waiting many years to establish a long term average and a specific number of years to determine if there is more than one exceedance of the long term average.

Figures 42 to 45 show log probability plots of nutrient annual geometric mean concentrations computed (via flow-nutrient concentration relationships) for the years for which available data was employed and also for the data itself. This allowed a confirmation of the developed flow-concentration relationships performance. A key factor to consider is that, in general, the computed values reproduce the actual data variability. It should be considered that for the purposes of selecting a never to exceed value as a criteria, it is more important to capture the upper percentiles of the nutrient distributions as opposed to the lower values.

There are important factors to consider in the analysis presented in this document. The computed nutrient concentrations and loads were developed at the flow station's locations. It is possible to appropriately scale the loads to reflect drainage areas not included by the selected USGS flow stations. This would assume uniformity in the drainage areas with respect to loading characteristics. In the case of the St. Marks River, the selected flow and water quality stations are located upstream of the confluence with the Wakulla River. Enough nutrient data was not available for the Wakulla River but from a brief analysis of the measured flow at the Wakulla River near Crawfordville, the flow contribution of the Wakulla River is quite comparable with the St. Marks River flow. Also, similar analysis was intended to be performed for the Spring Warrior Creek but neither flow nor water quality data was readily available.

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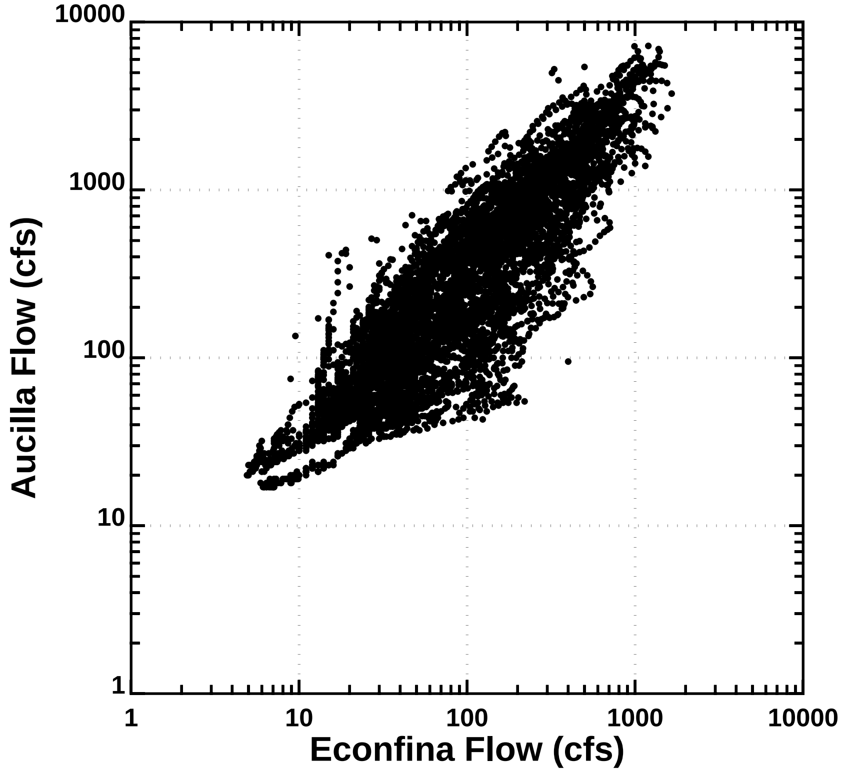

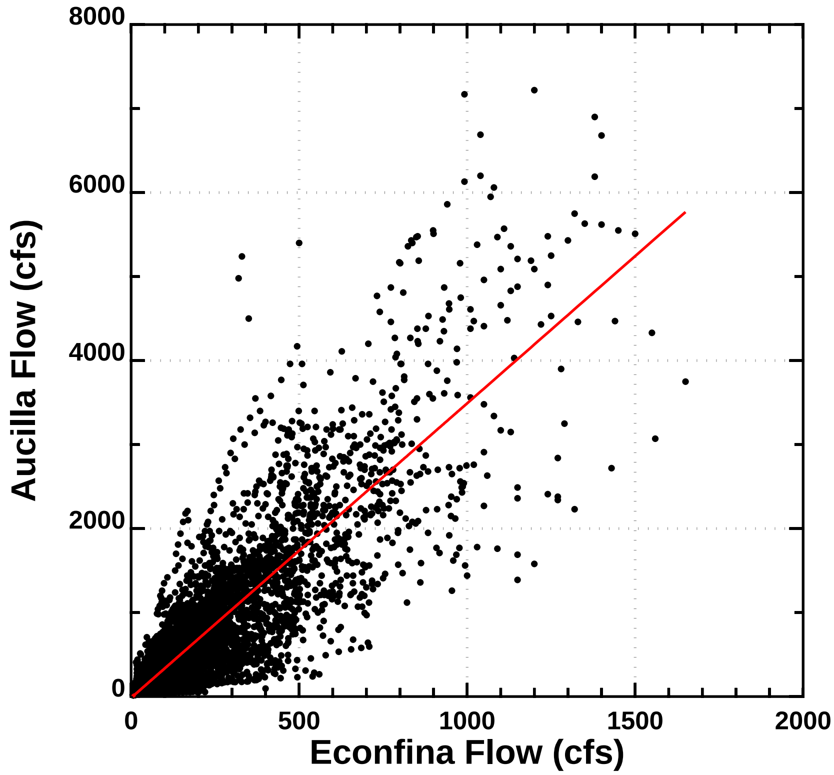

Figure 1. Econfina River - Aucilla River Daily Flows Relationship
USGS Flow stations: 02326000 (Econfina River near Perry)
02326512 (Aucilla River near Scanlon)

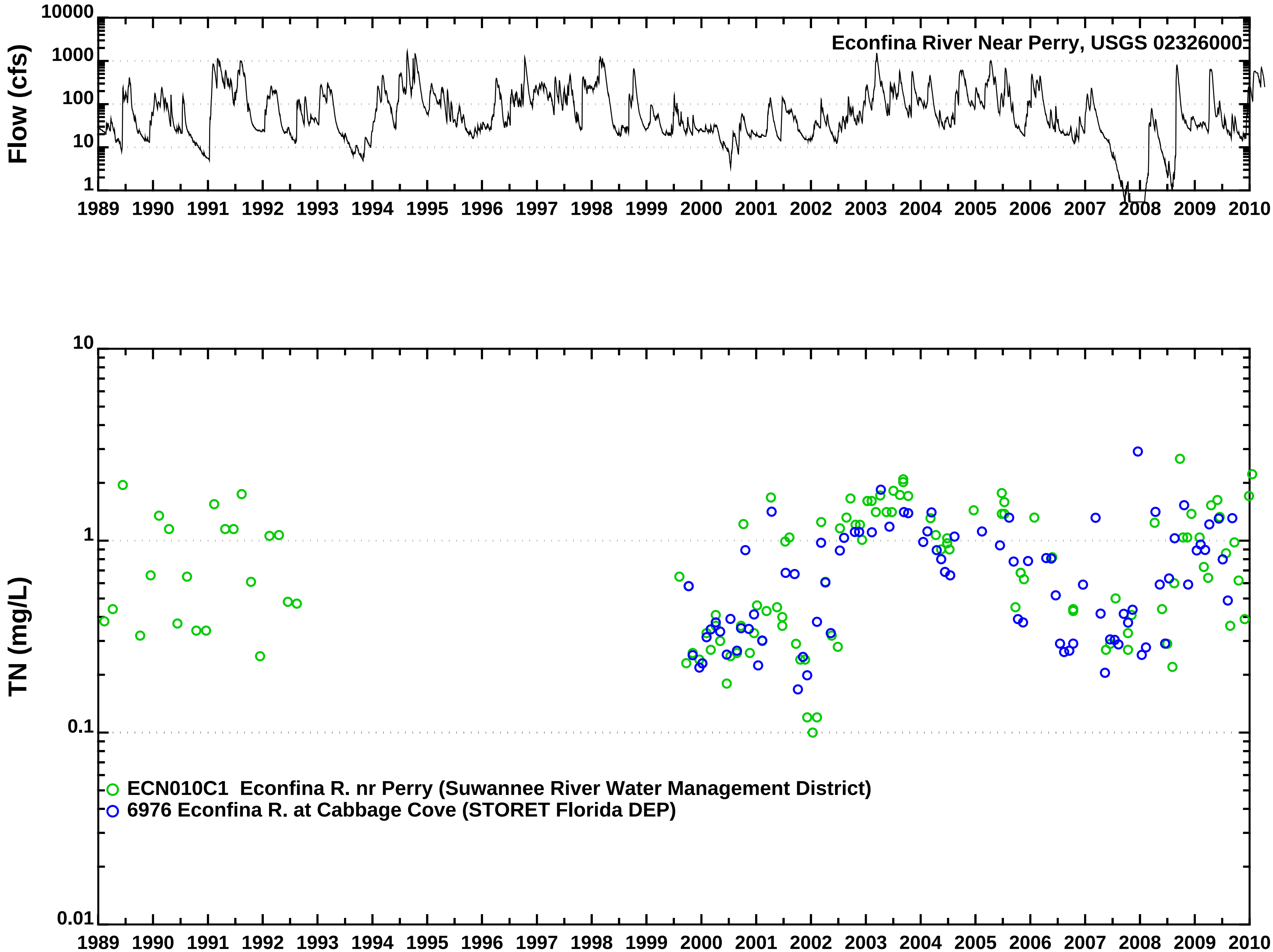

Figure 2. Total Nitrogen at Econfina River (1989-2010)

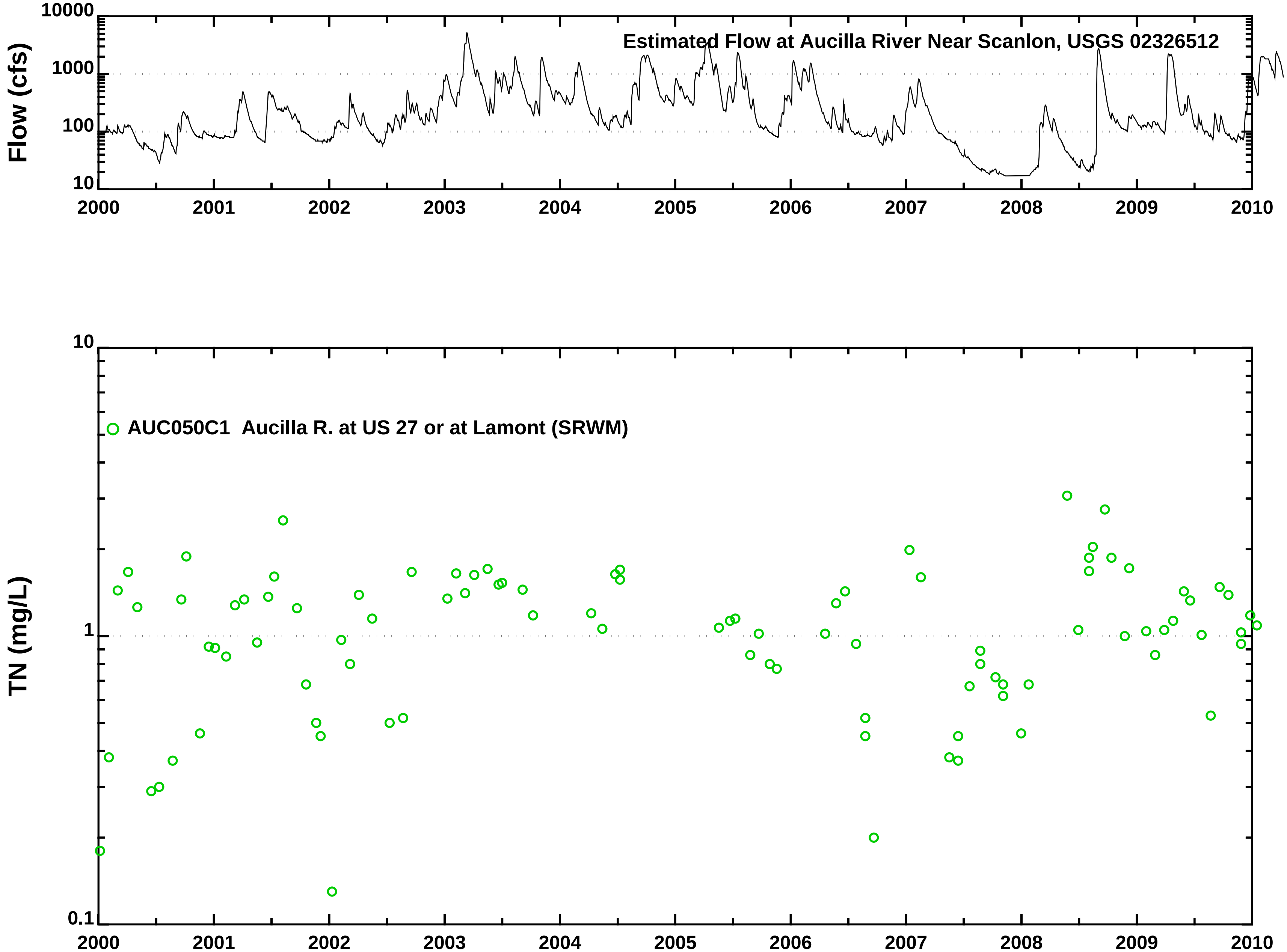

Figure 3. Total Nitrogen at Aucilla River (2000-2010)

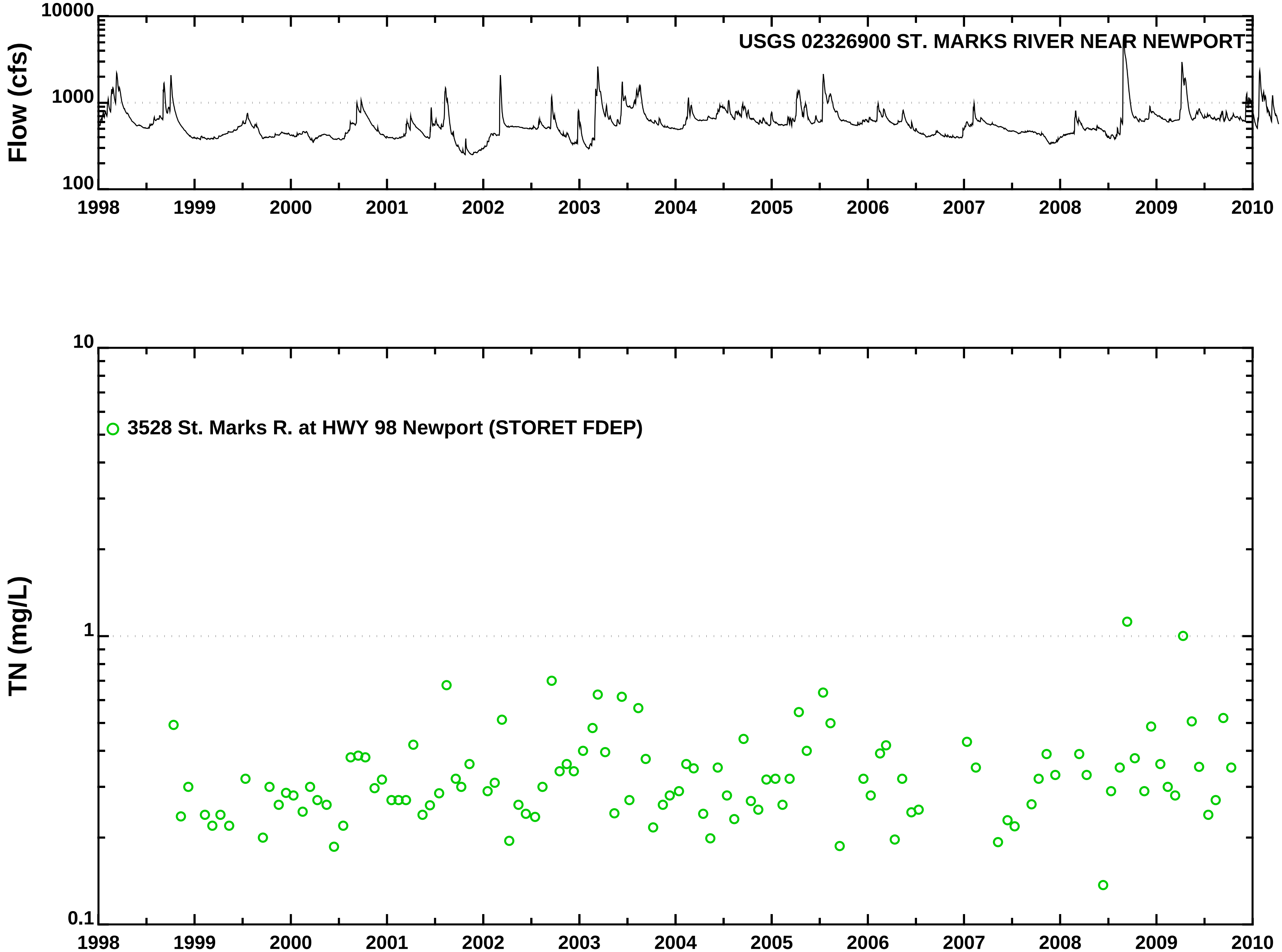

Figure 4. Total Nitrogen at St. Marks River (1998-2010)

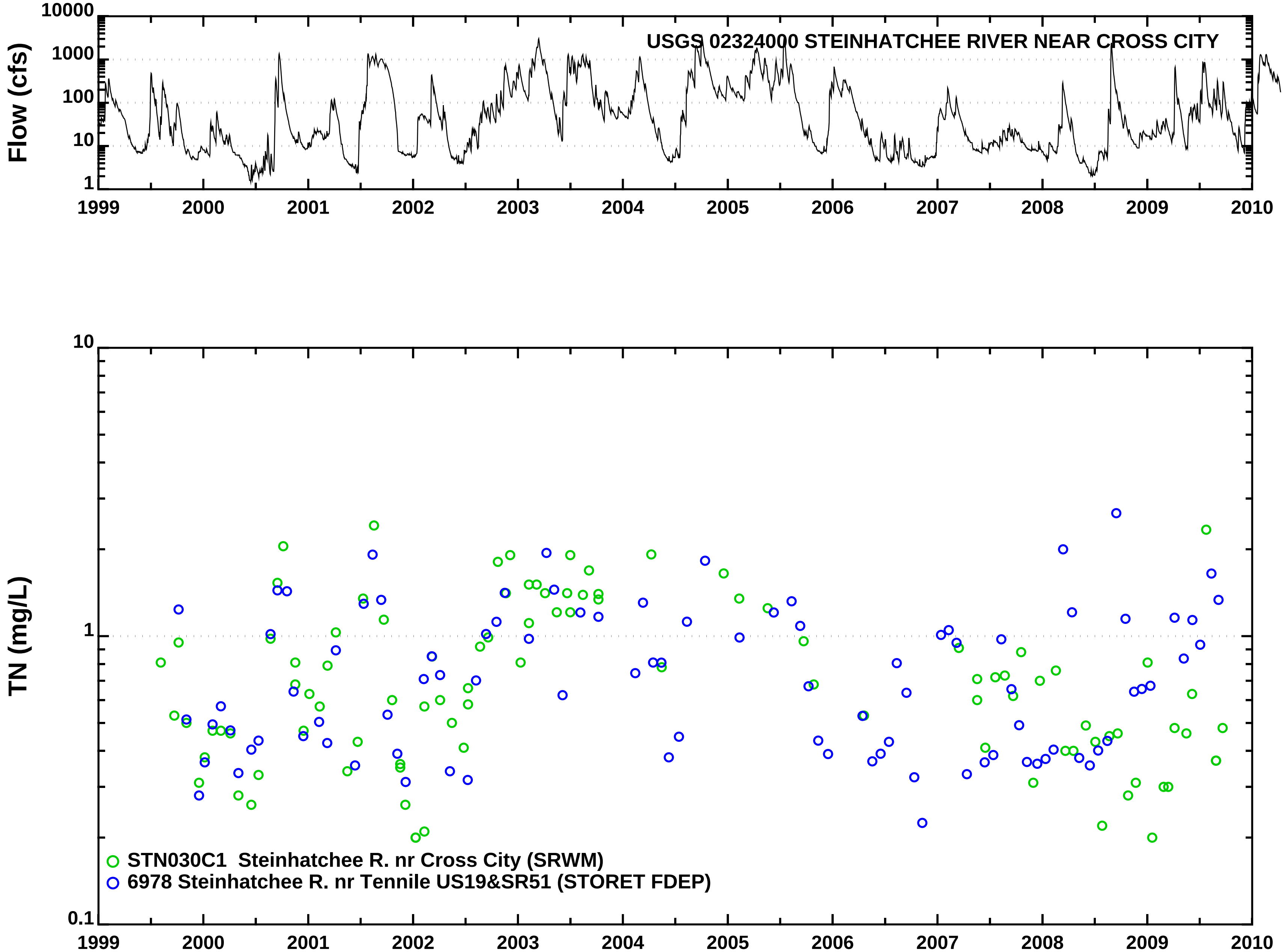

Figure 5. Total Nitrogen at Steinhatchee River (1999-2010)

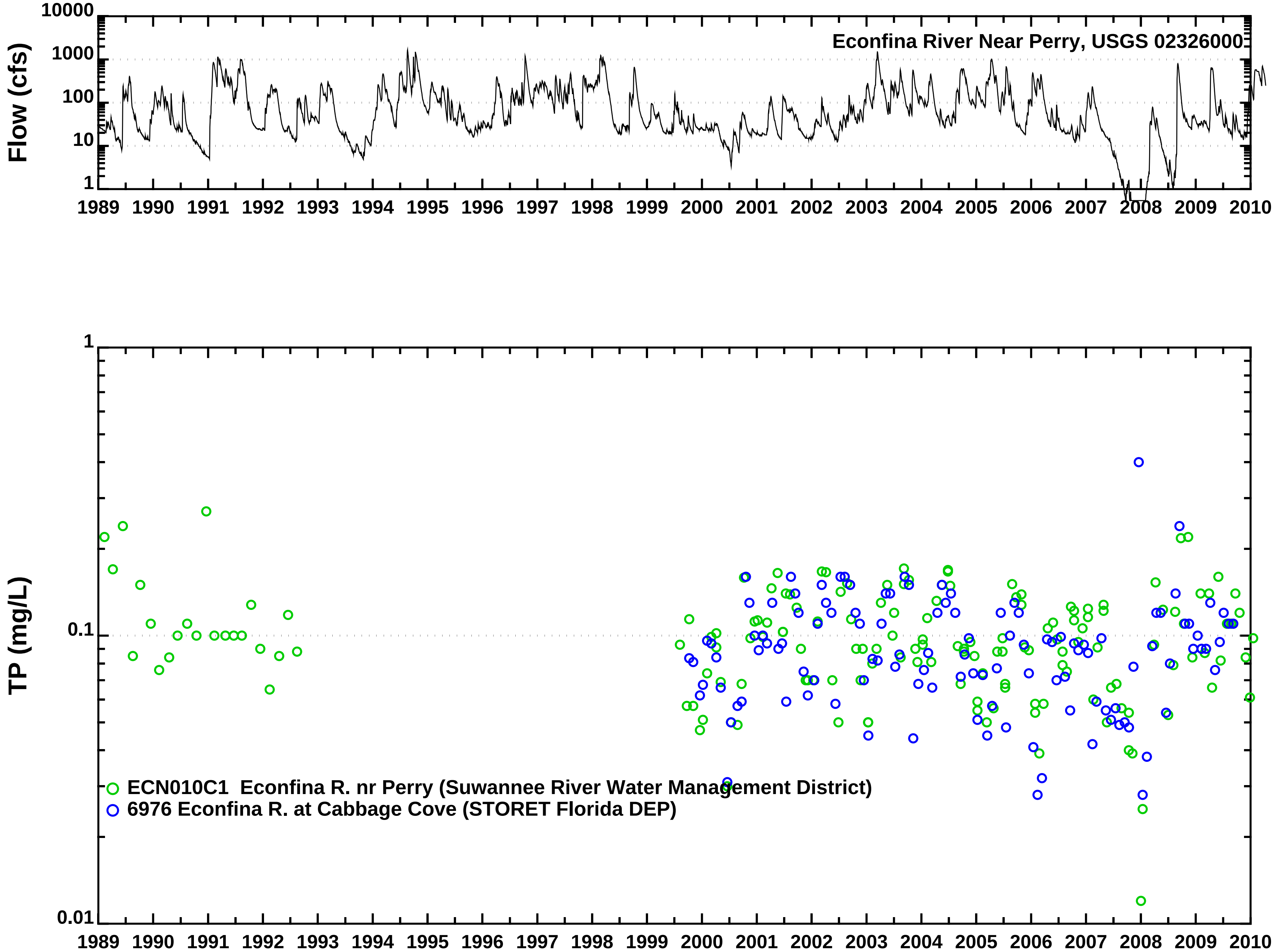

Figure 6. Total Phosphorus at Econfina River (1989-2010)

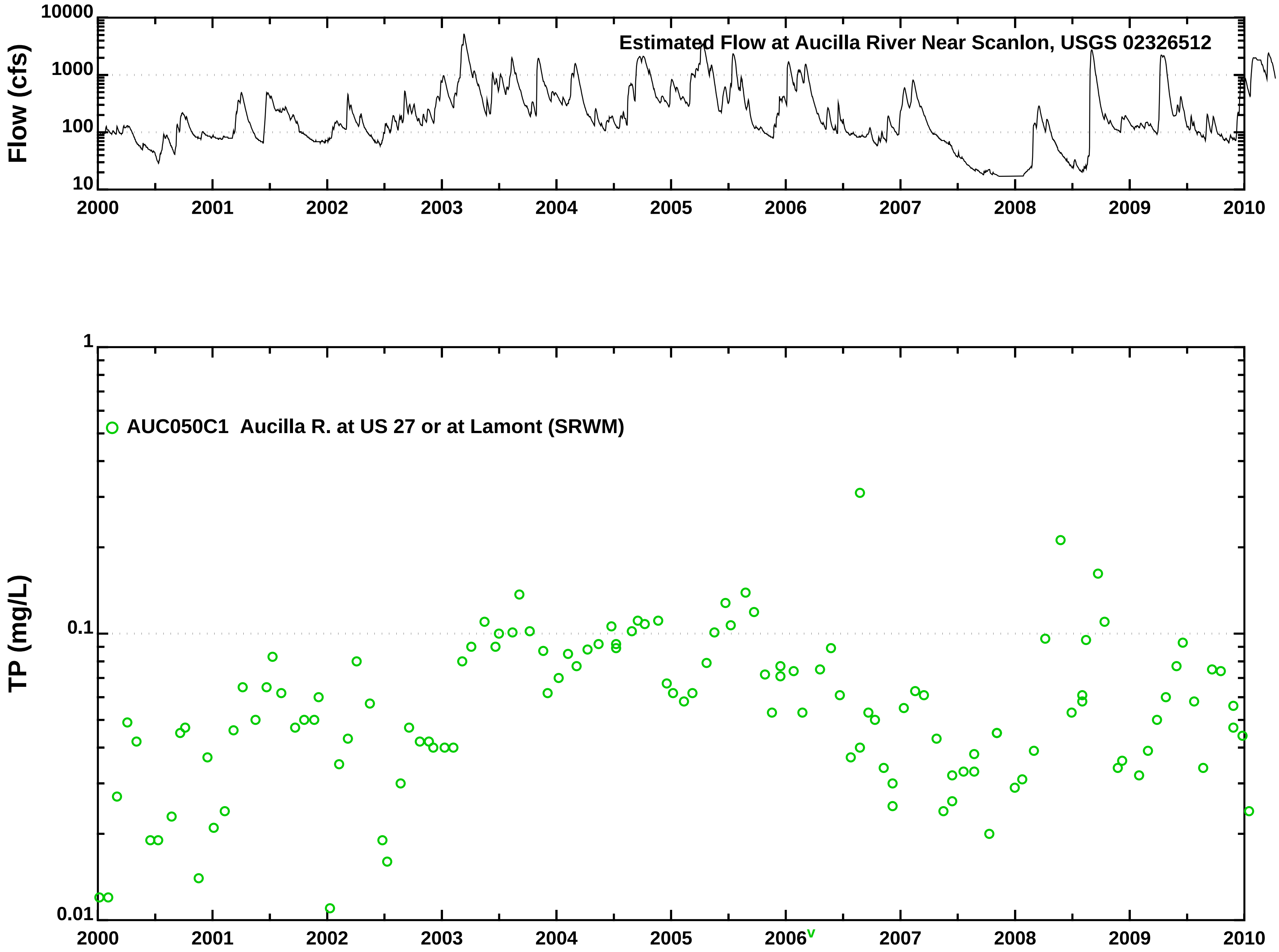

Figure 7. Total Phosphorus at Aucilla River (2000-2010)

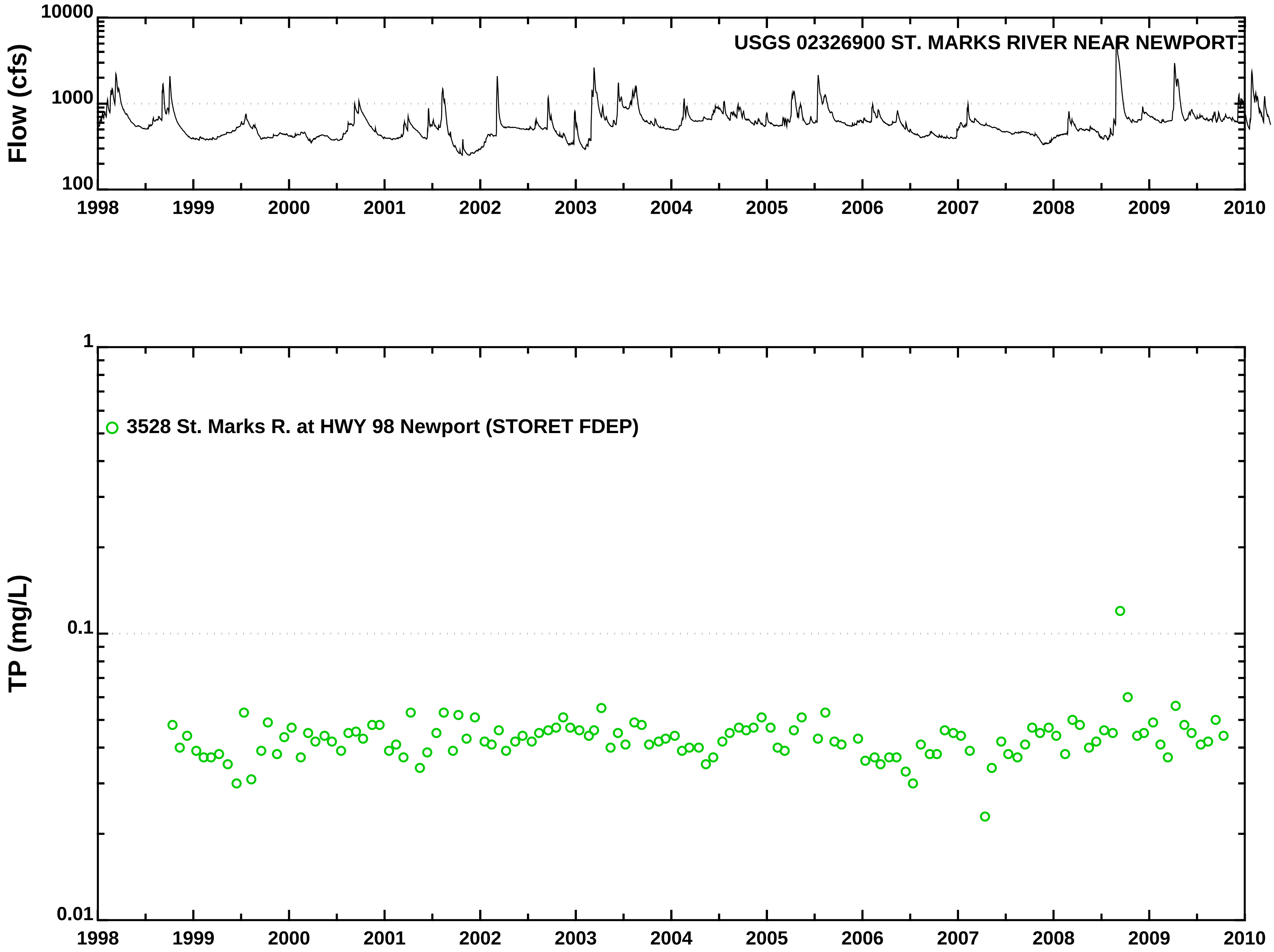

Figure 8. Total Phosphorus at St. Marks River (1998-2010)

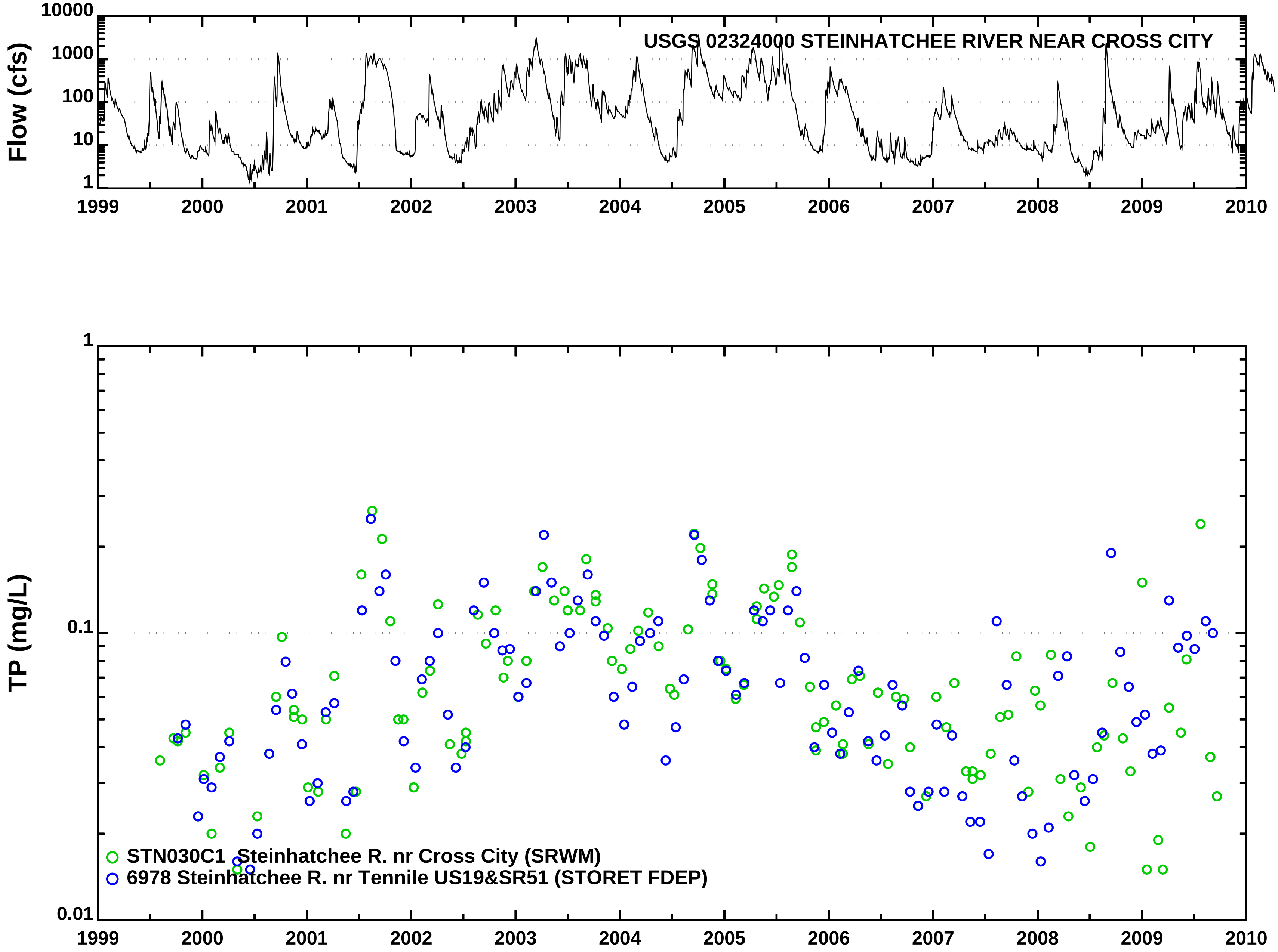

Figure 9. Total Phosphorus at Steinhatchee River (1999-2010)

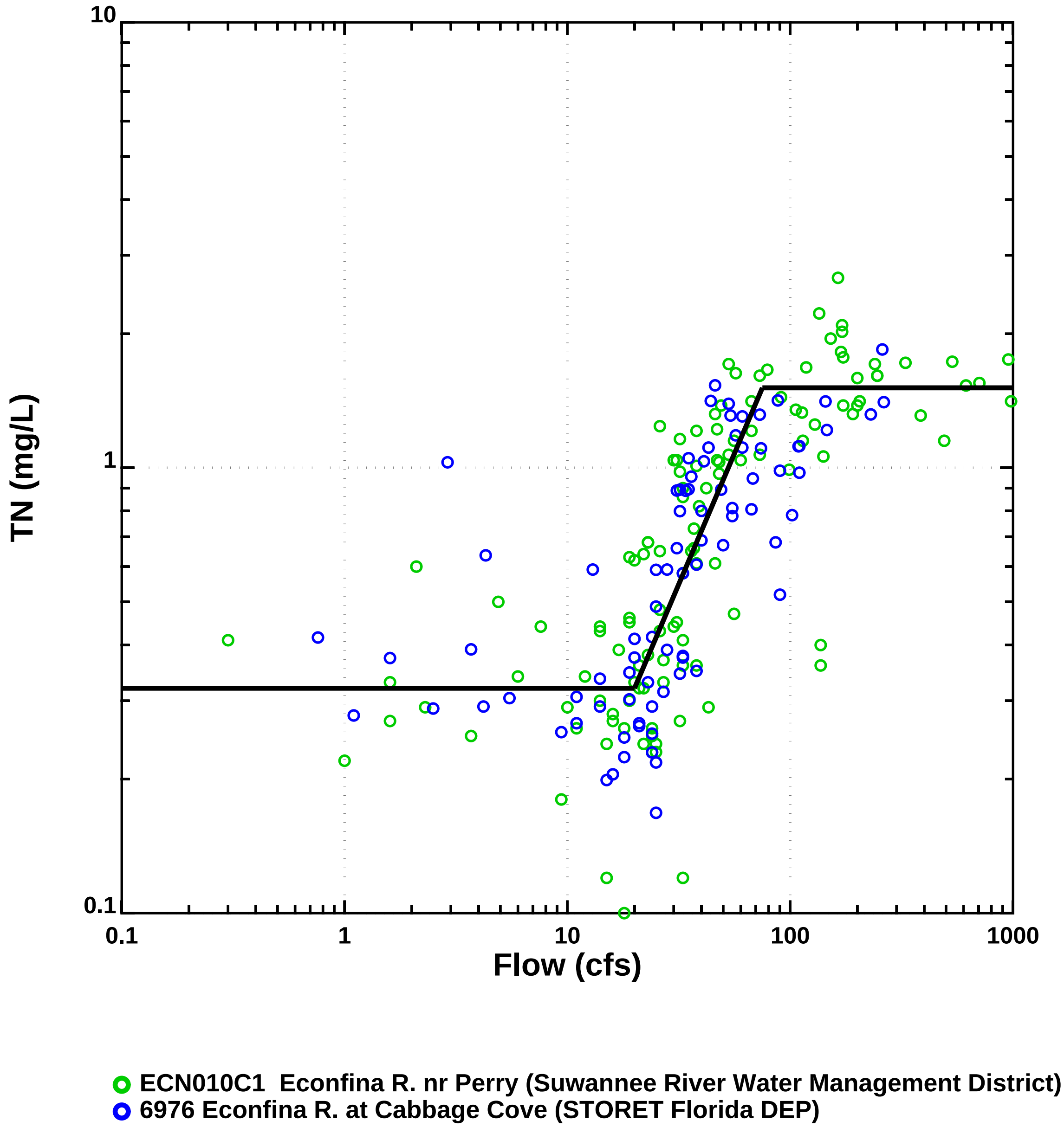

Figure 10. Total Nitrogen at Econfina River (1989-2010)

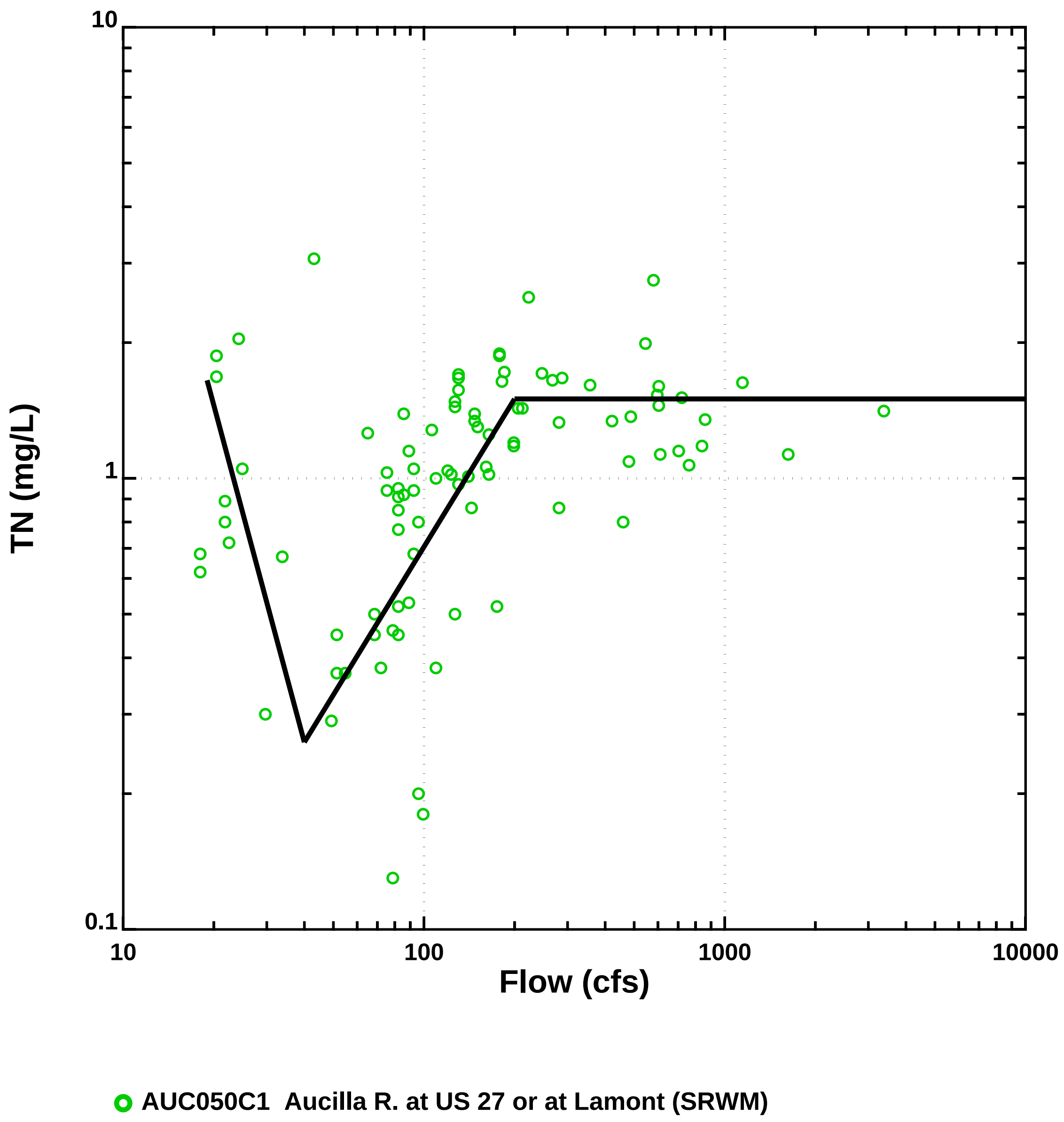

Figure 11. Total Nitrogen at Aucilla River (2000-2010)

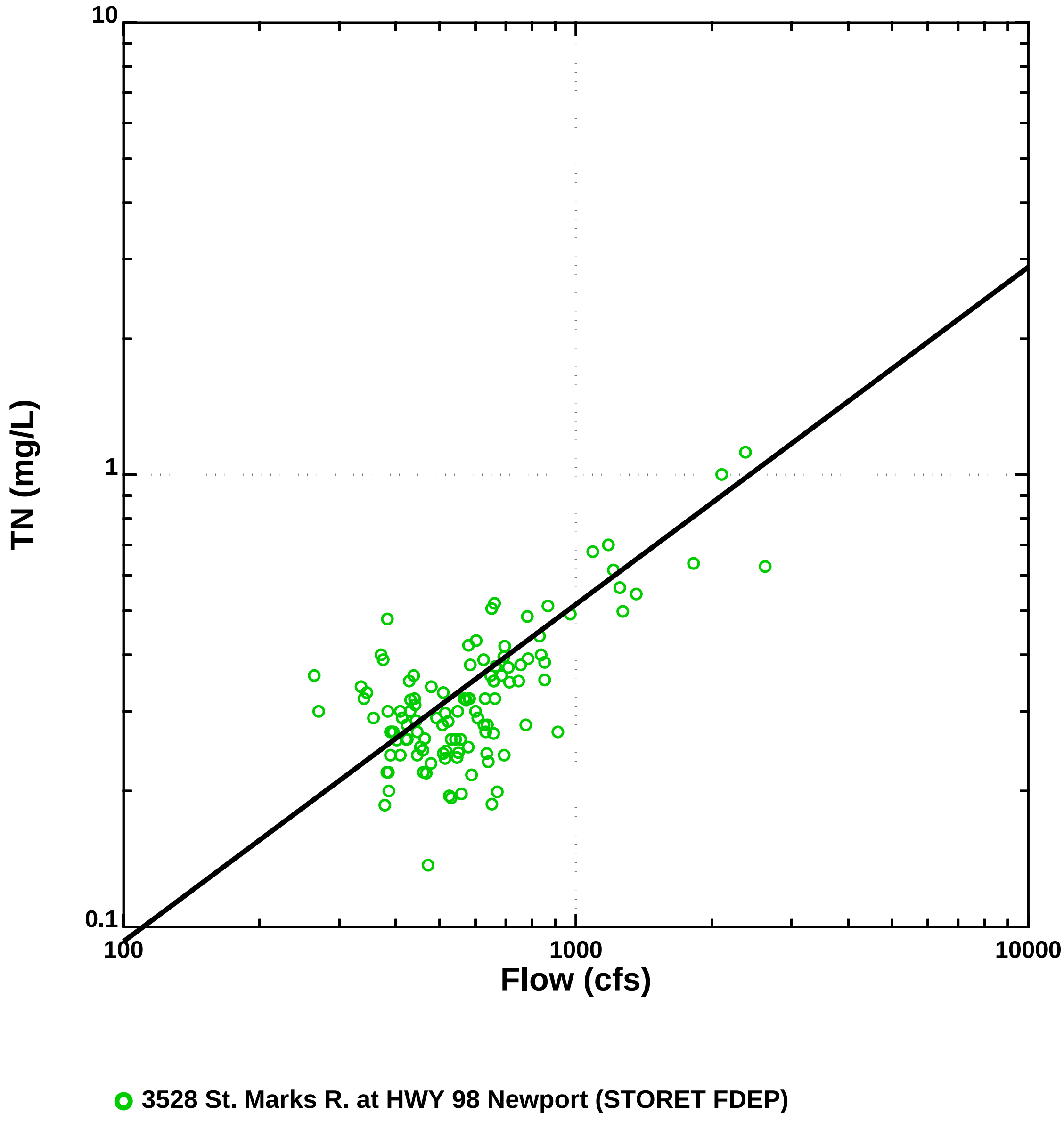

Figure 12. Total Nitrogen at St. Marks River (1998-2010)

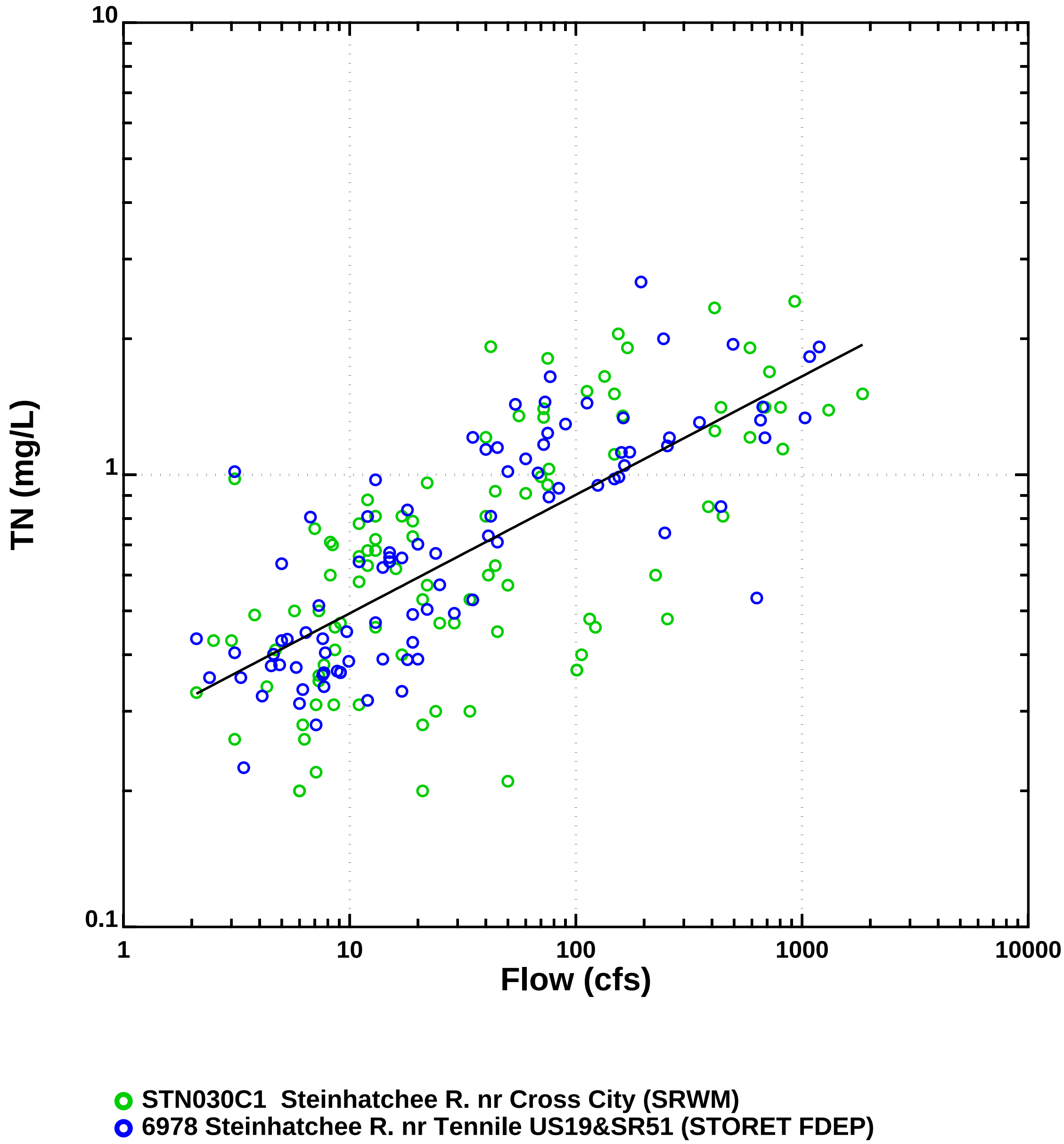

Figure 13. Total Nitrogen at Steinhatchee River (1999-2010)

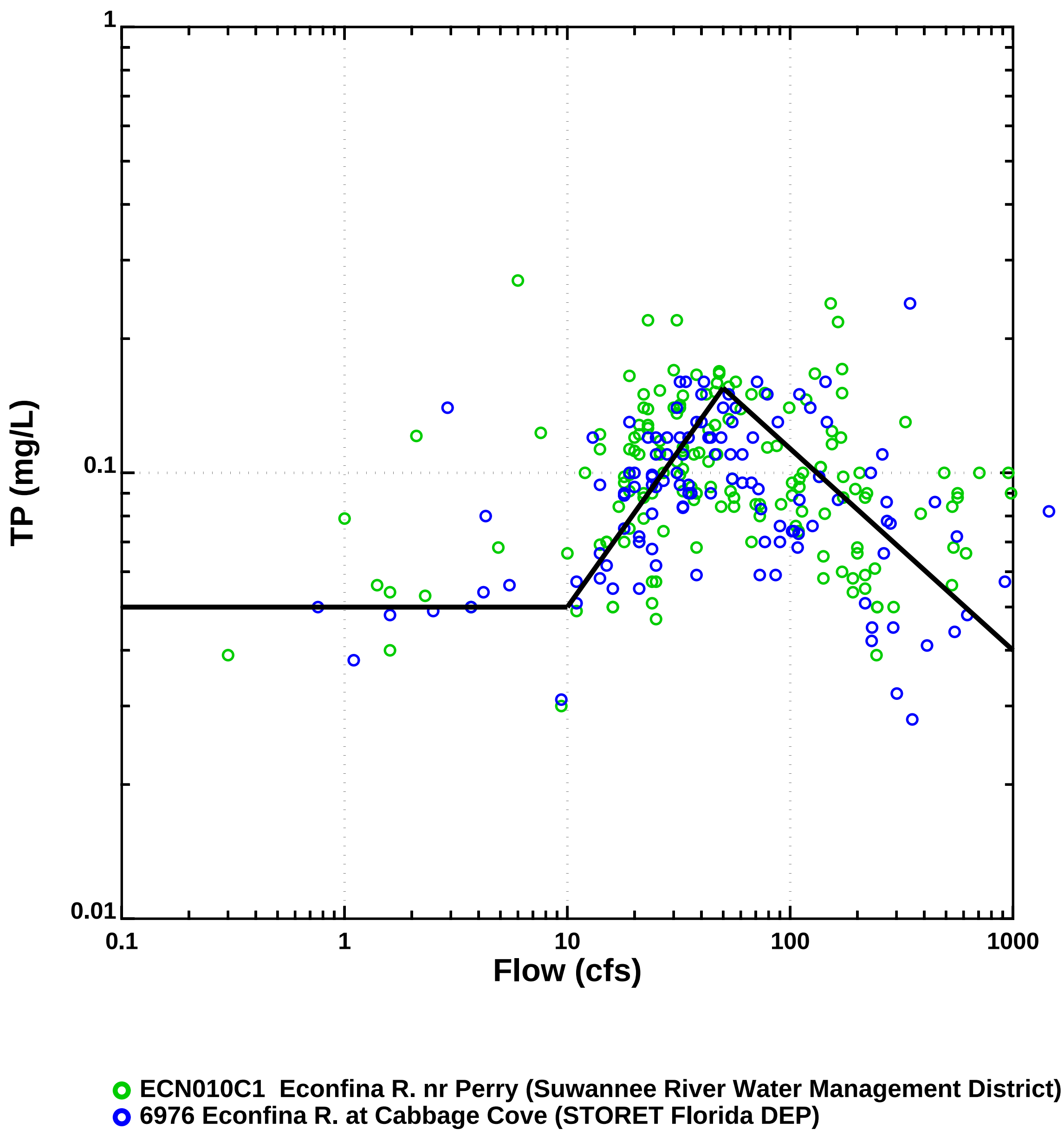

Figure 14. Total Phosphorus at Econfina River (1989-2010)

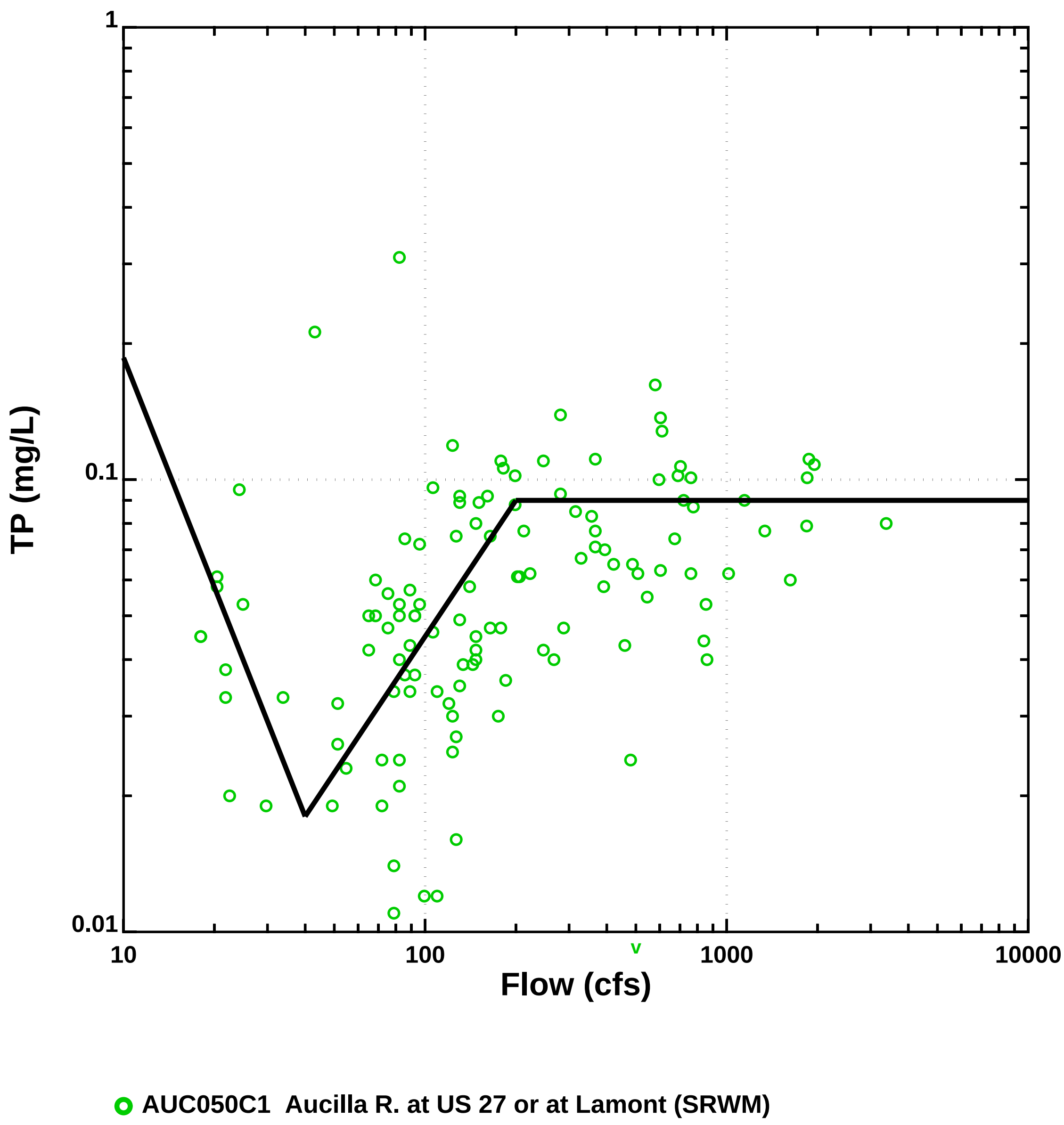

Figure 15. Total Phosphorus at Aucilla River (2000-2010)

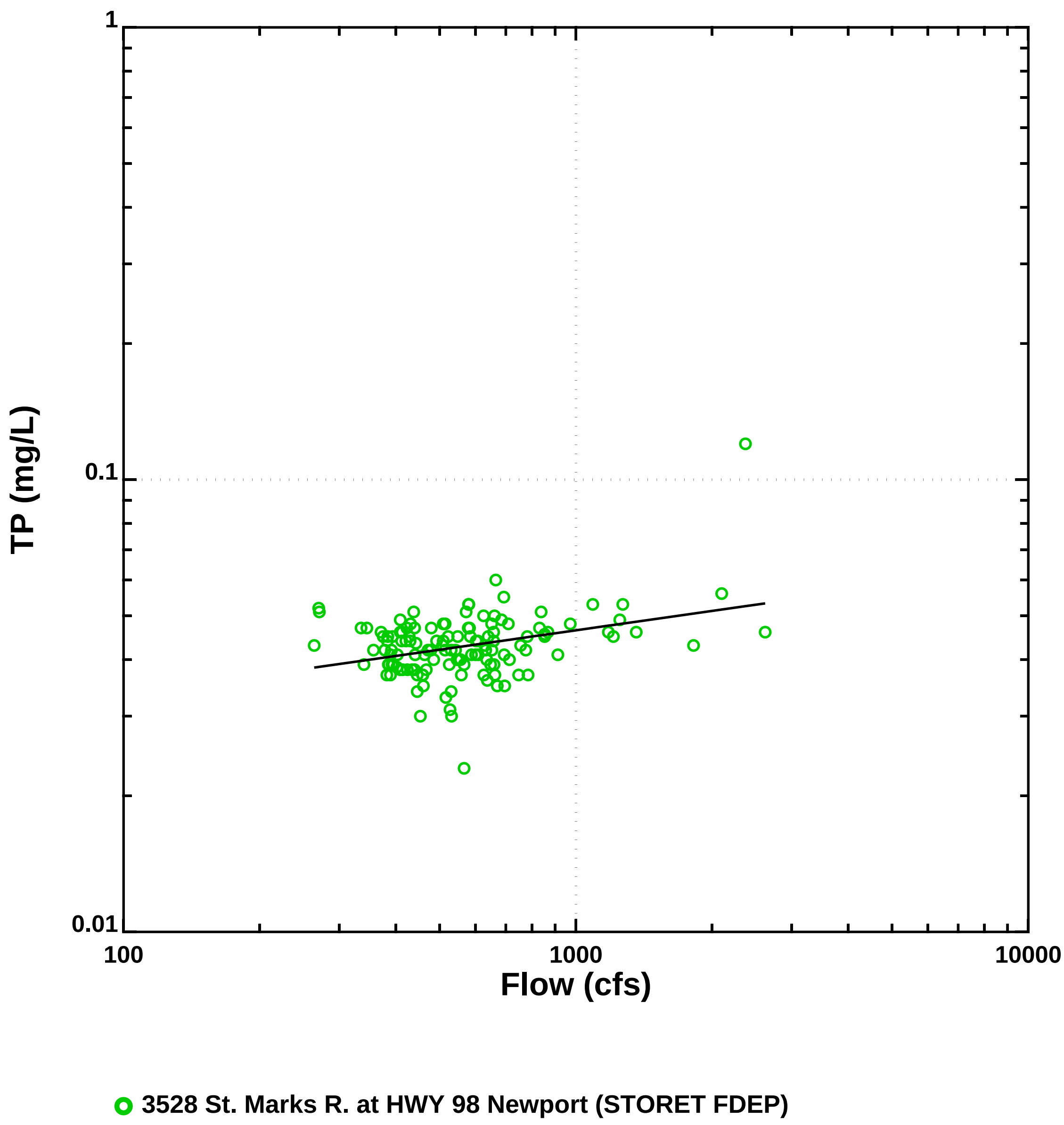

Figure 16. Total Phosphorus at St. Marks River (1998-2010)

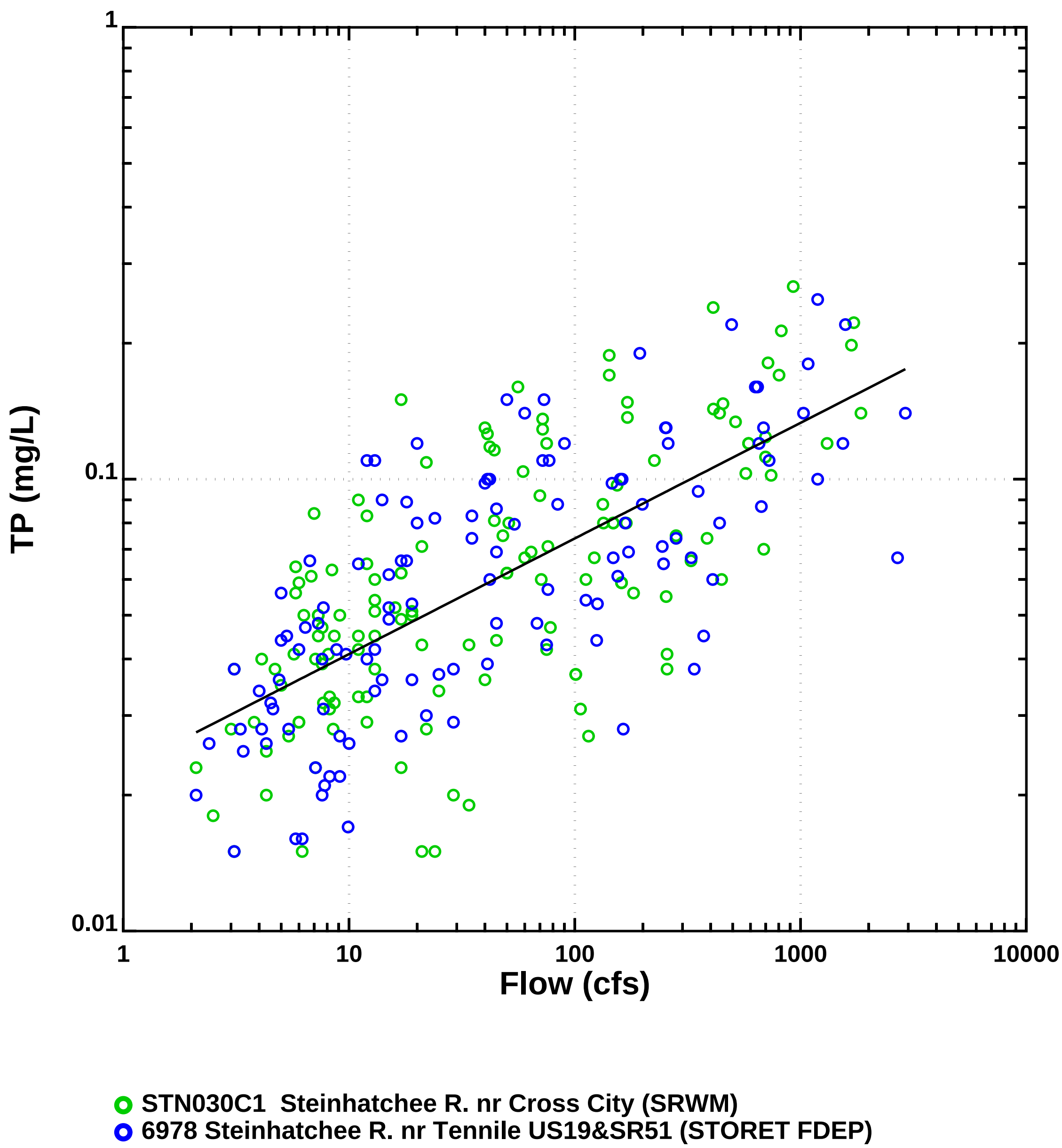

Figure 17. Total Phosphorus at Steinhatchee River (1999-2010)

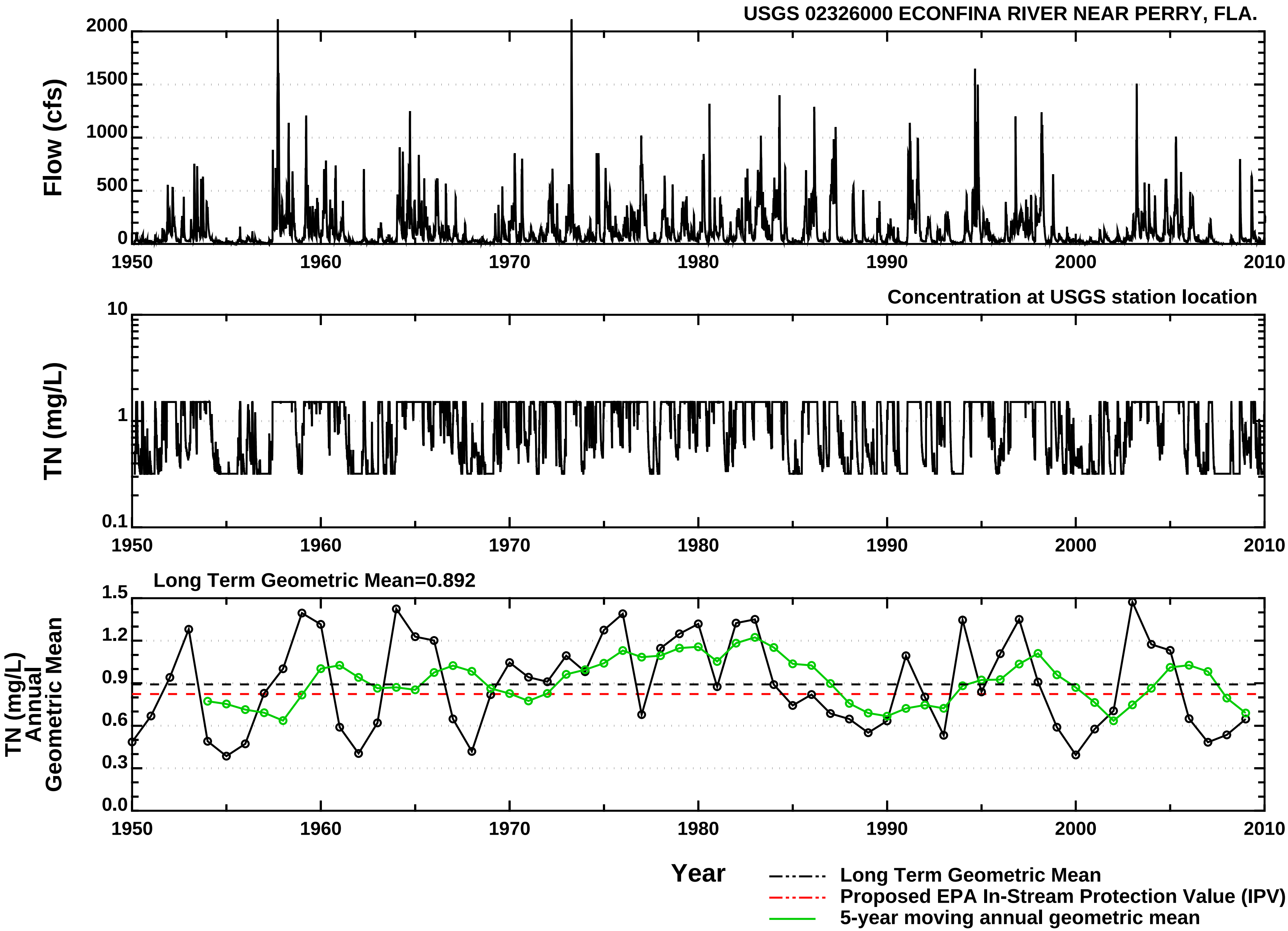

Figure 18. Econfina River Computed Total Nitrogen Concentrations (1950-2009)

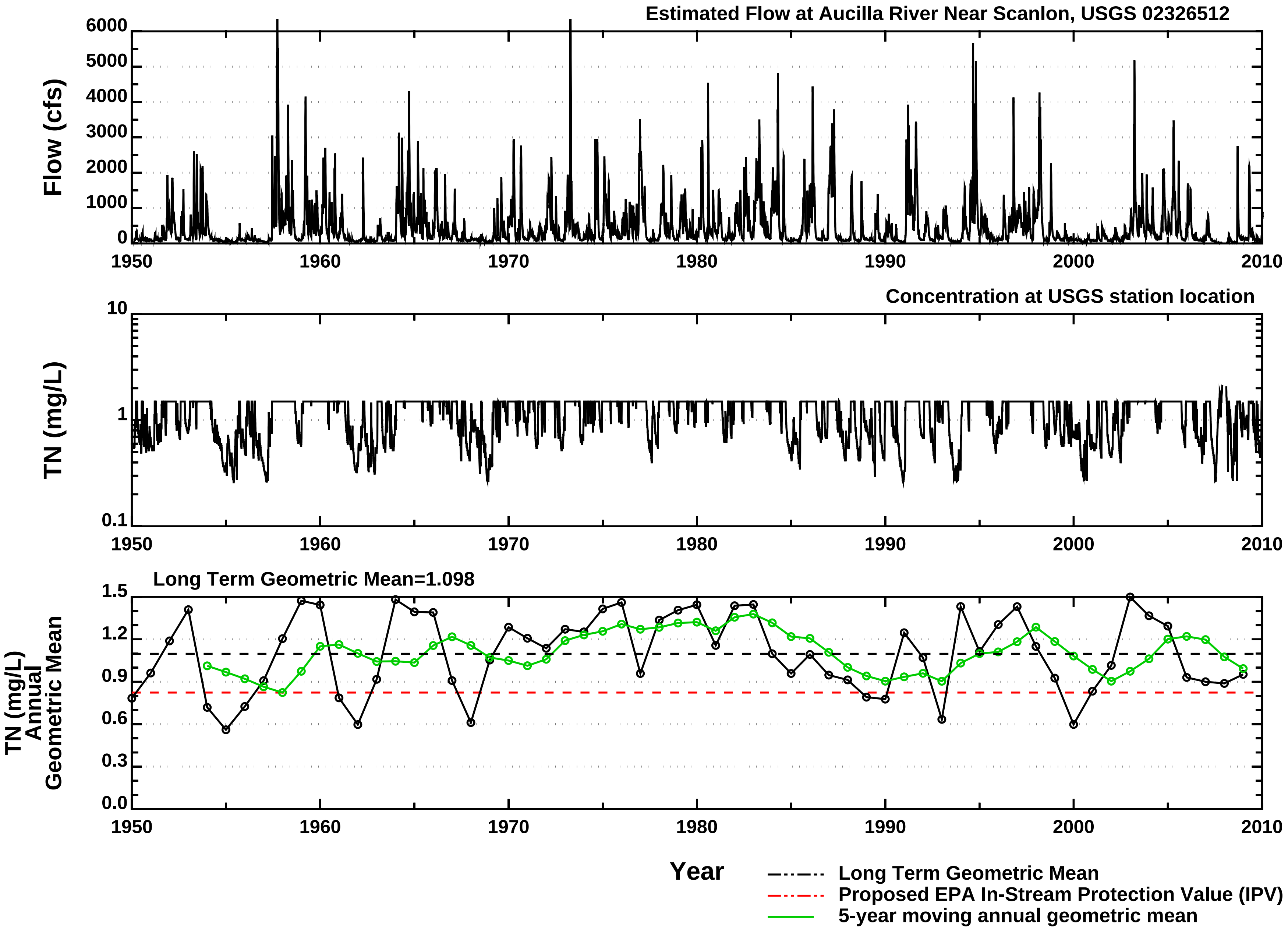

Figure 19. Aucilla River Computed Total Nitrogen Concentrations (1950-2009)

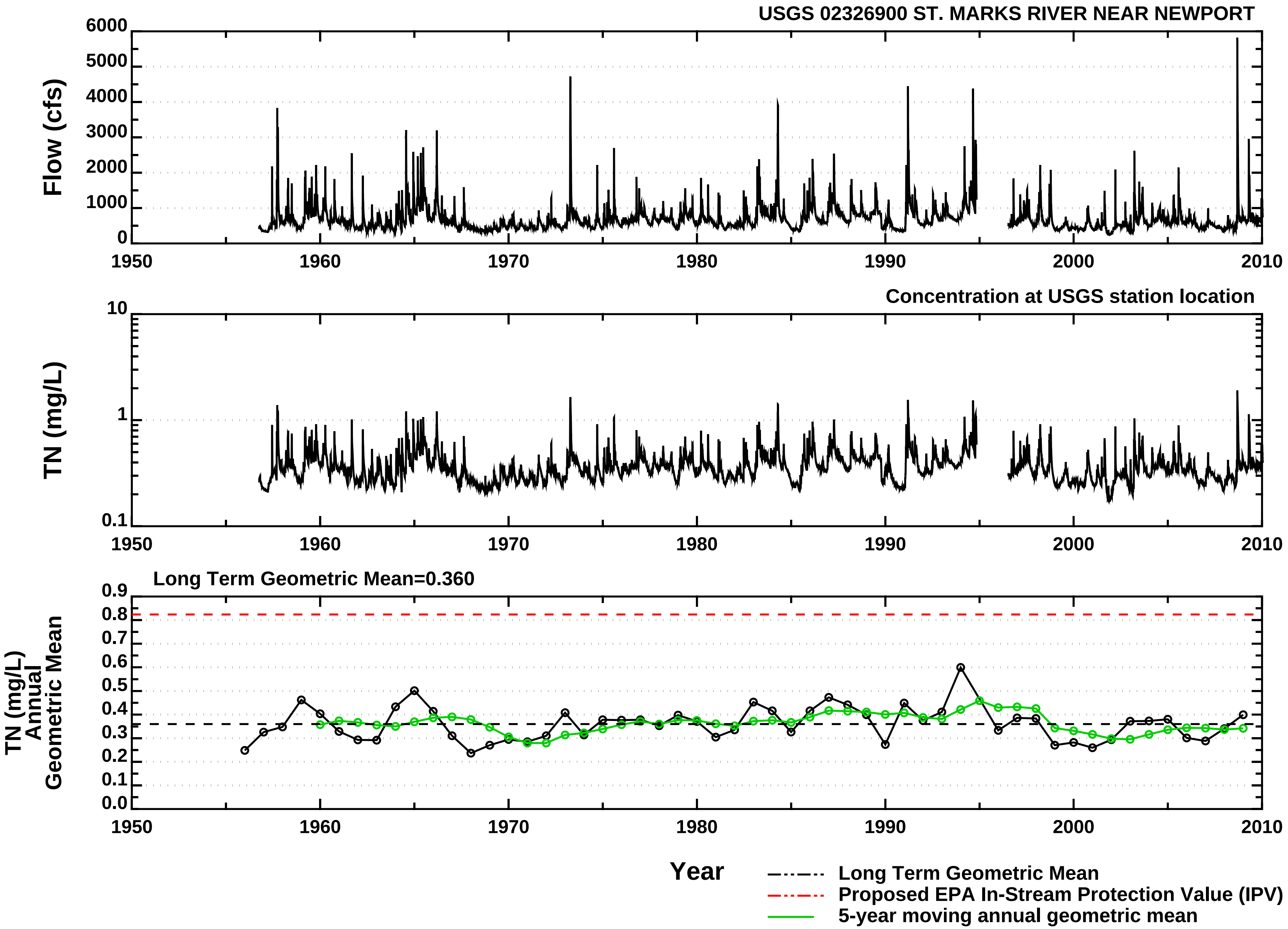

Figure 20. St. Marks River Computed Total Nitrogen Concentrations (1950-2009)

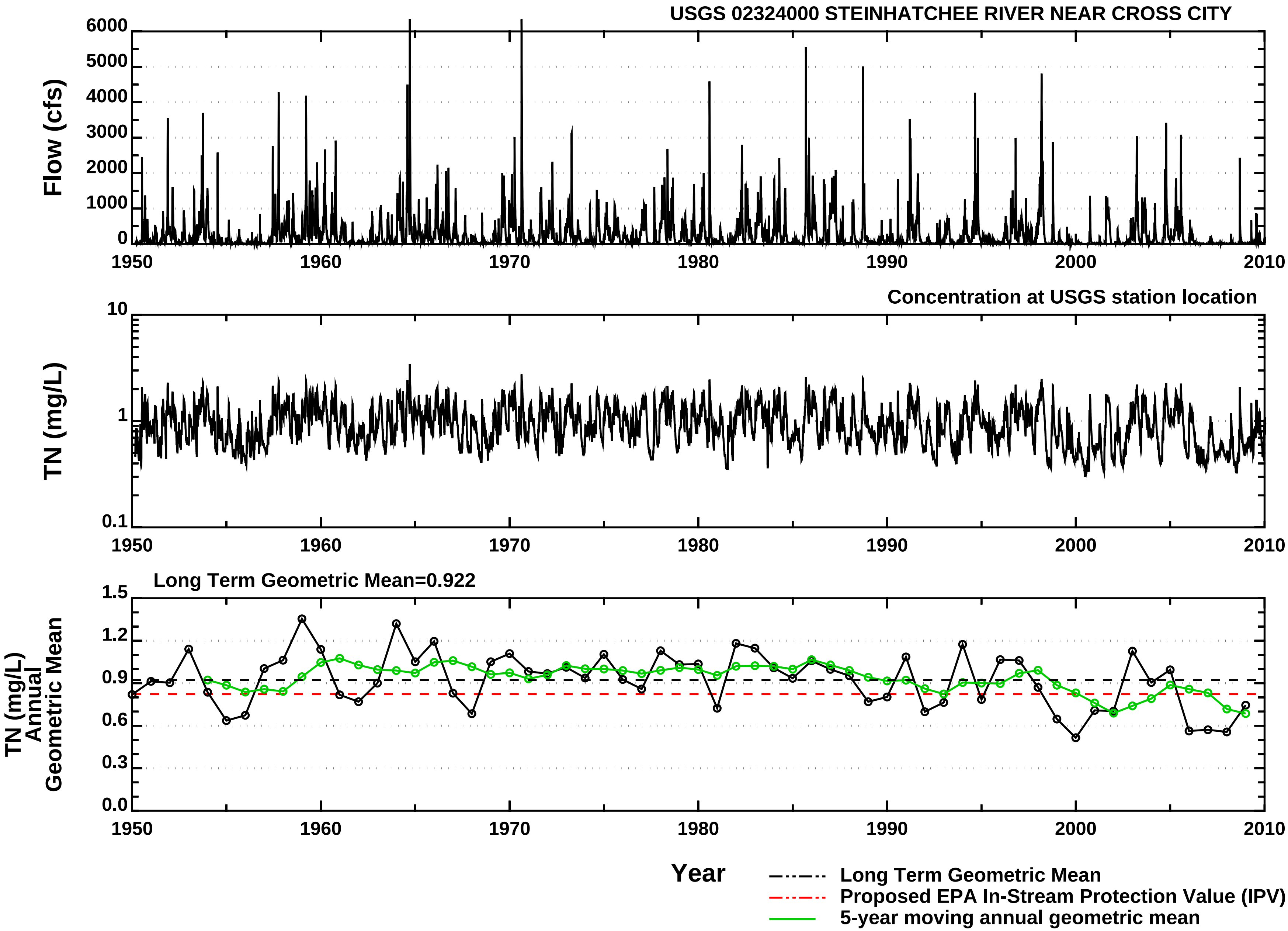

Figure 21. Steinhatchee River Computed Total Nitrogen Concentrations (1950-2009)

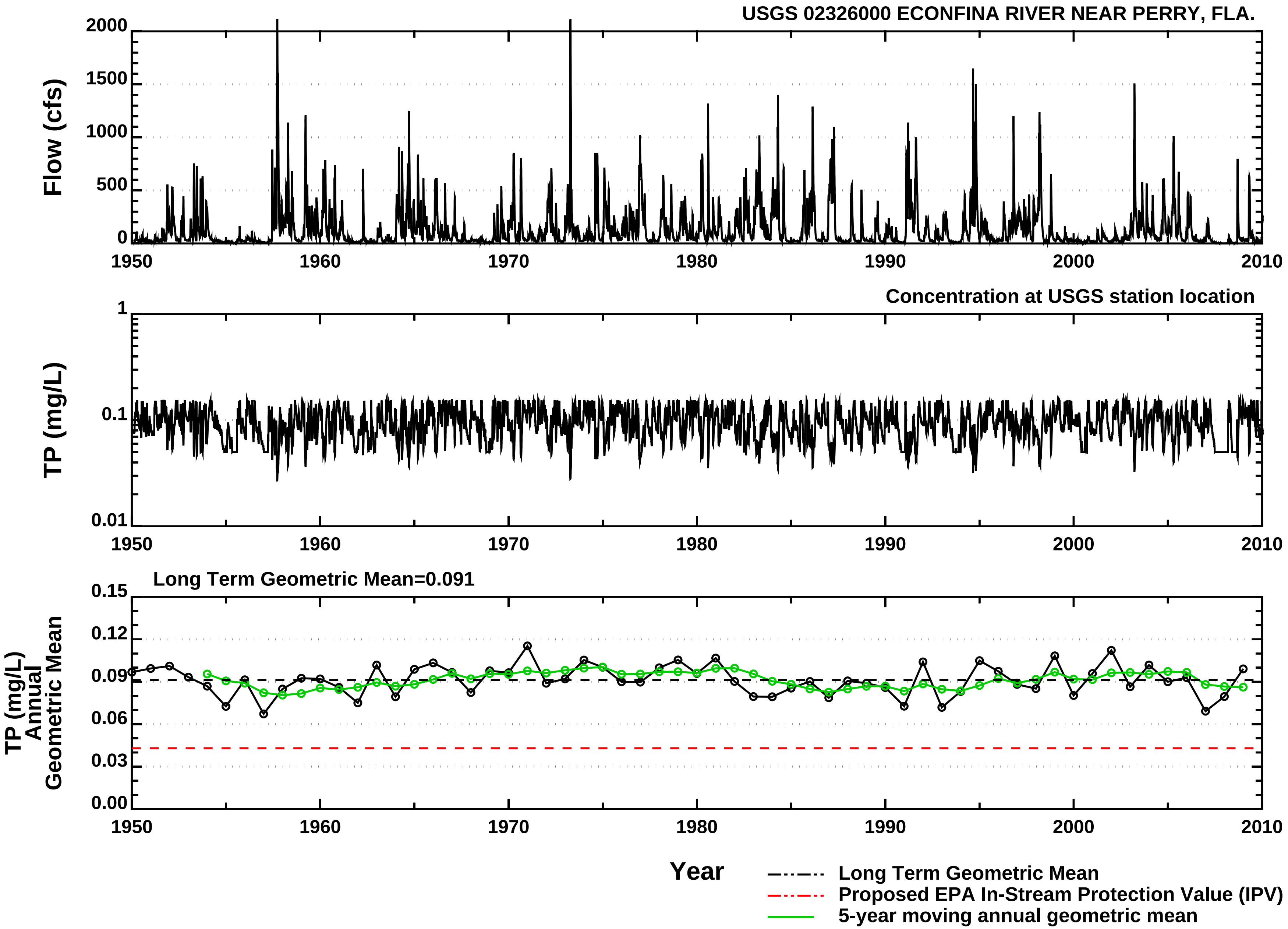

Figure 22. Econfina River Computed Total Phosphorus Concentrations (1950-2009)

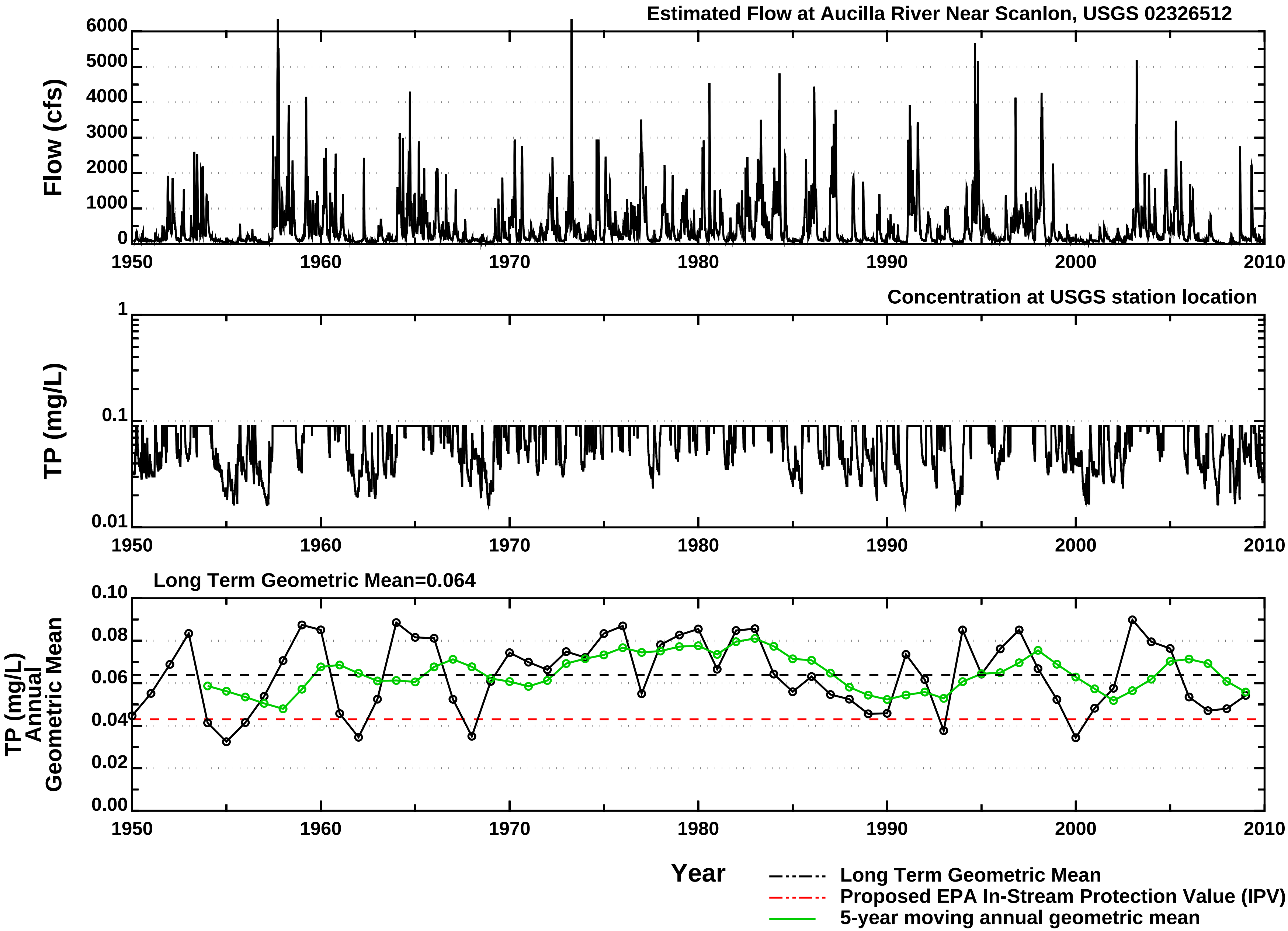

Figure 23. Aucilla River Computed Total Phosphorus Concentrations (1950-2009)

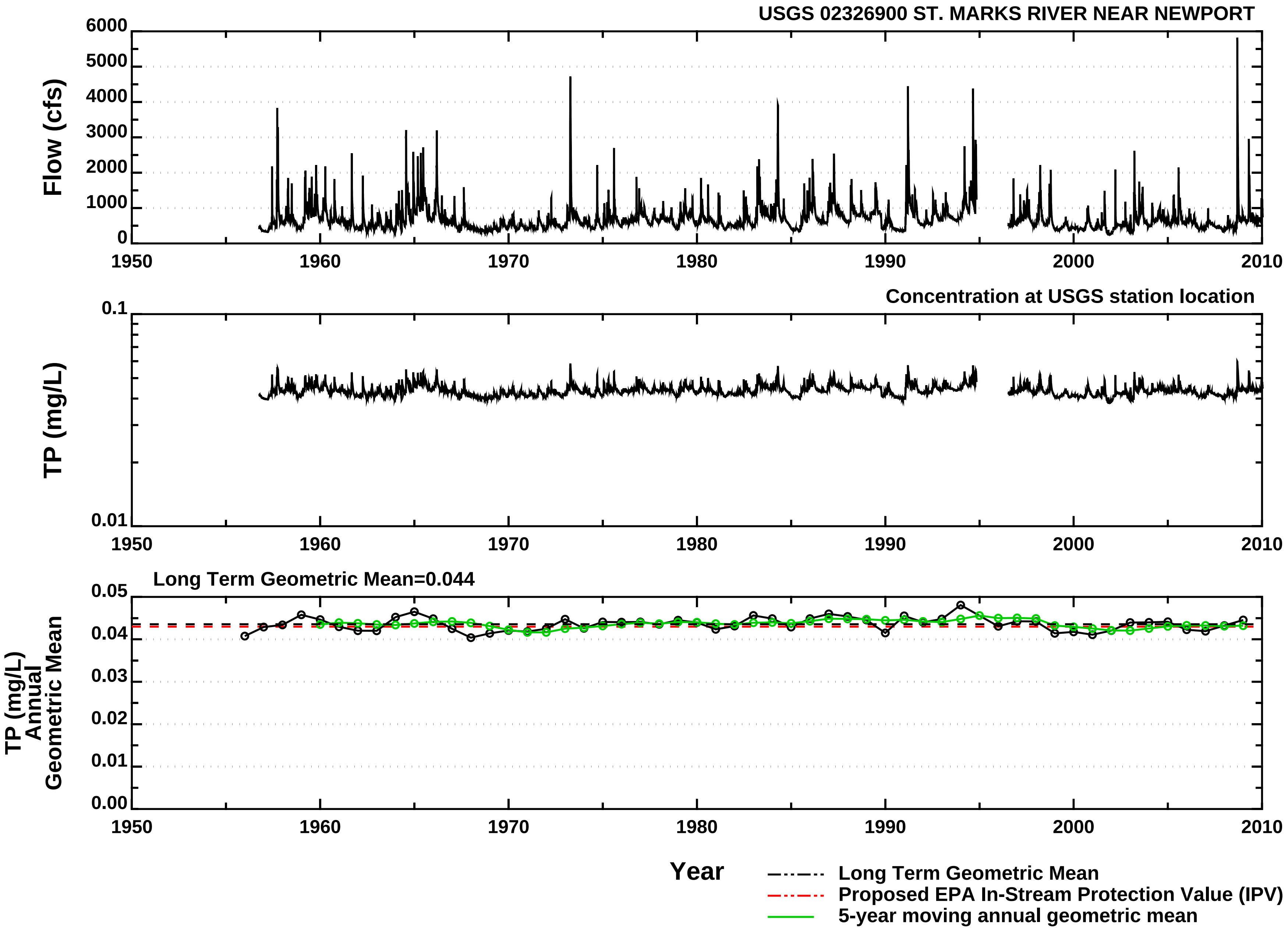

Figure 24. St. Marks River Computed Total Phosphorus Concentrations (1950-2009)

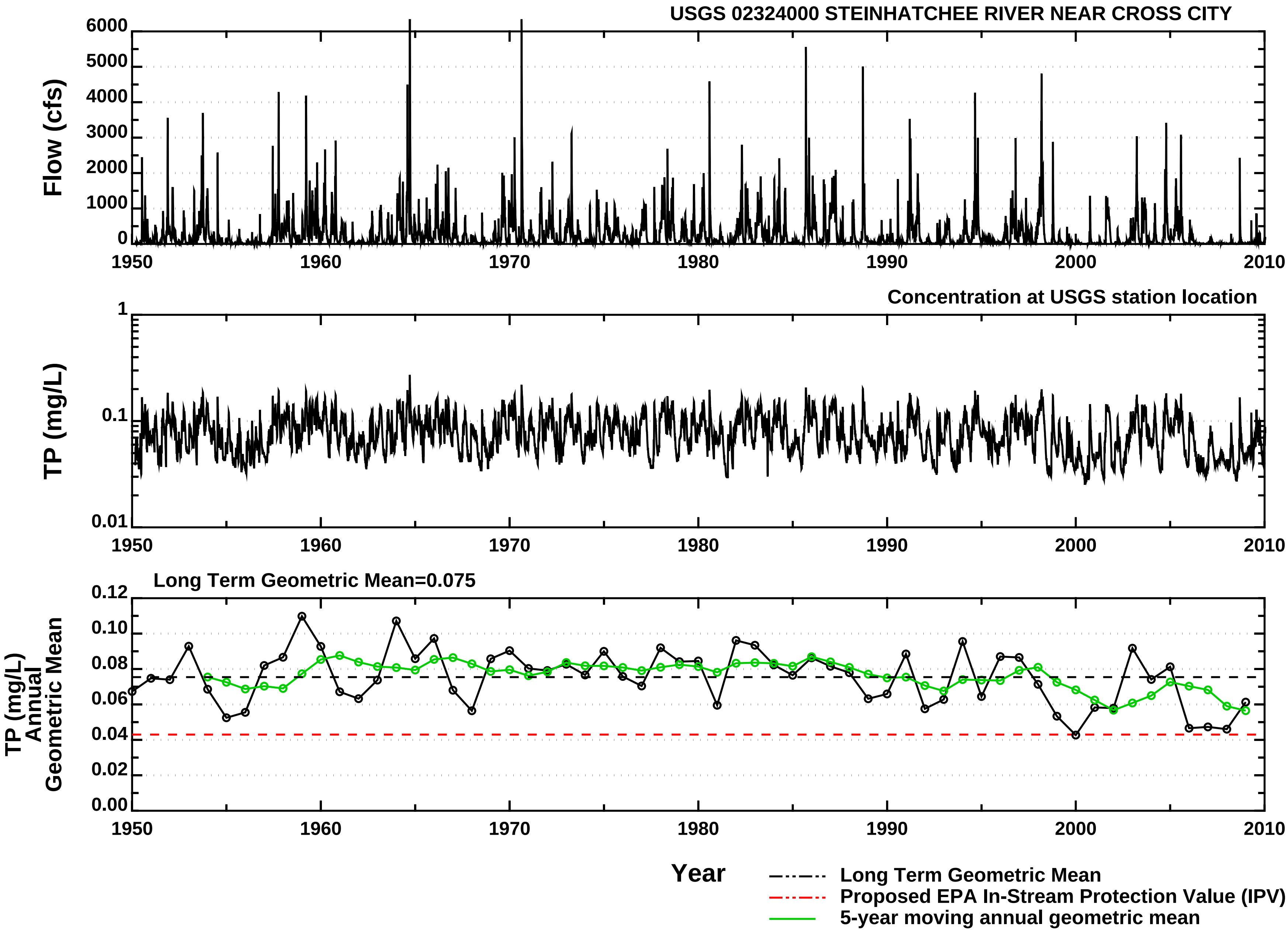

Figure 25. Steinhatchee River Computed Total Phosphorus Concentrations (1950-2009)

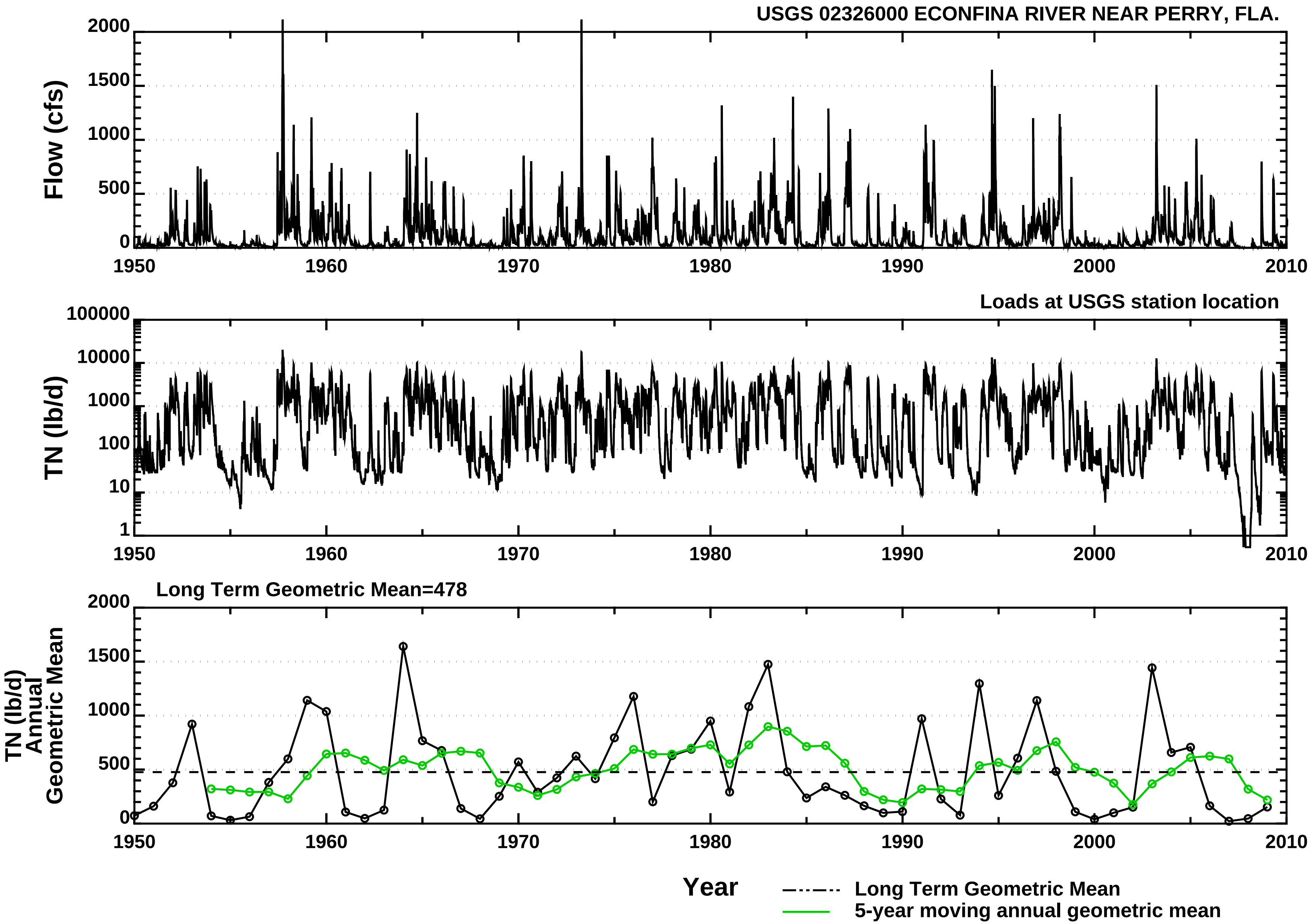

Figure 26. Econfina River Computed Total Nitrogen Loads (1950-2009)

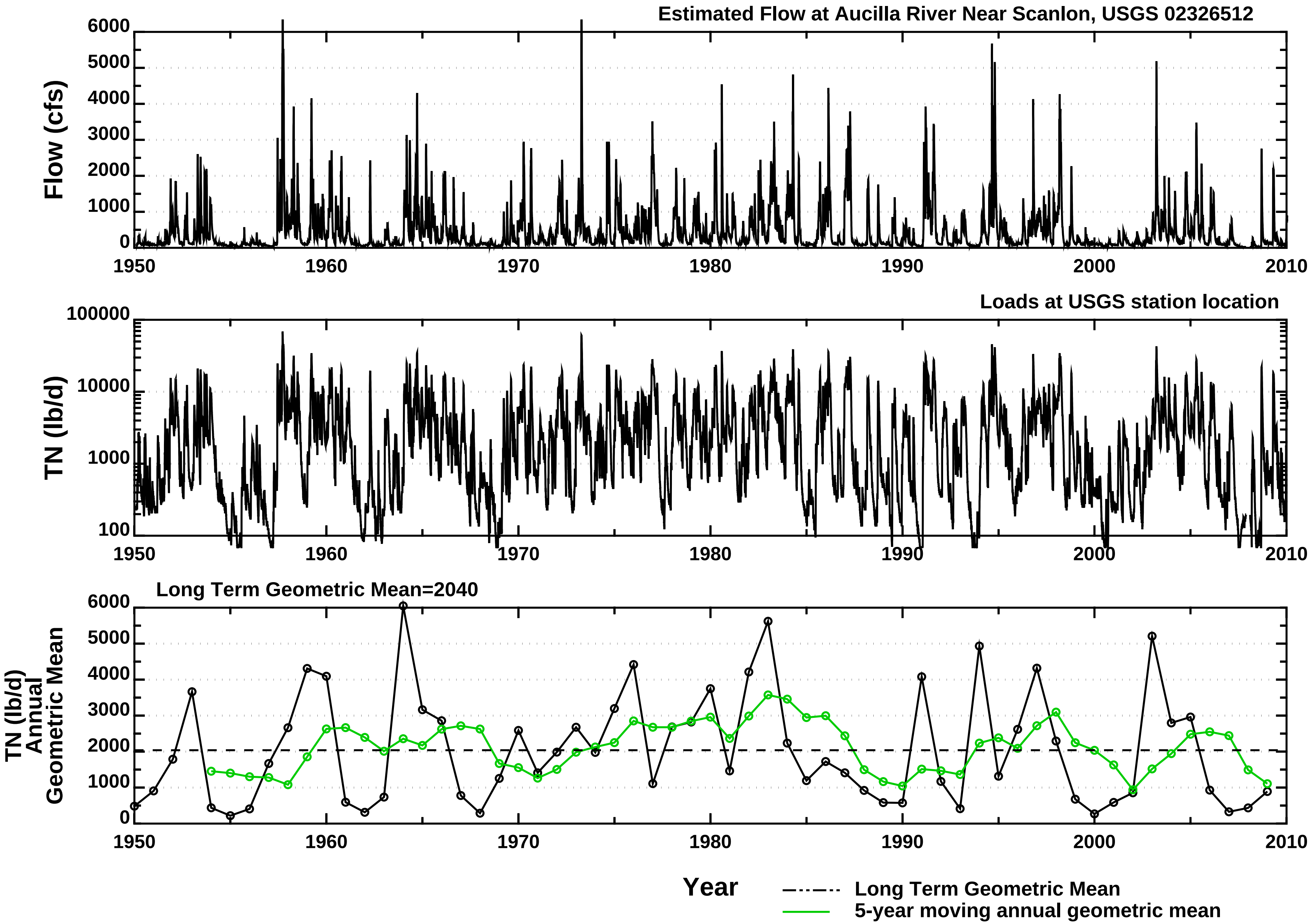

Figure 27. Aucilla River Computed Total Nitrogen Loads (1950-2009)

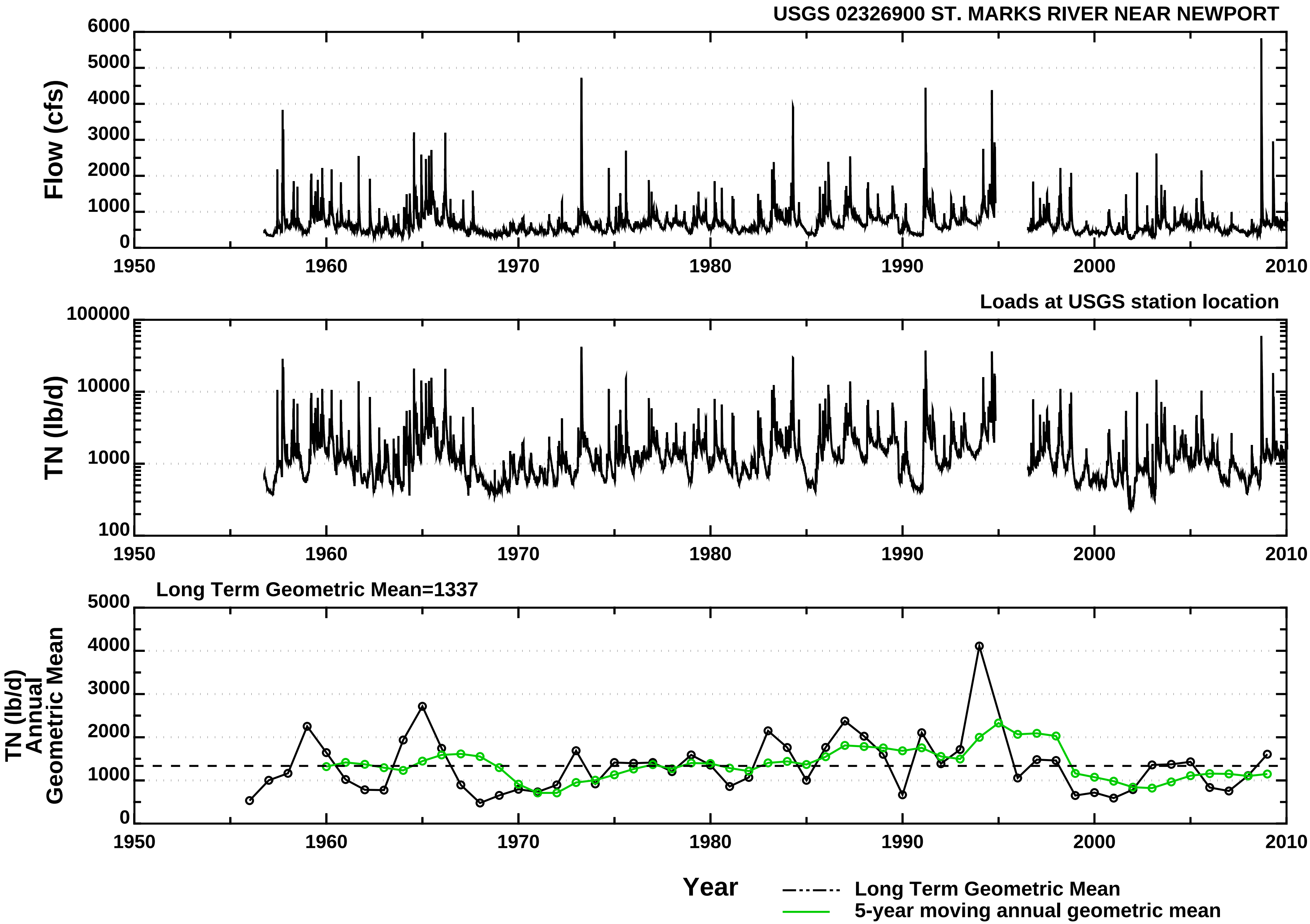

Figure 28. St. Marks River Computed Total Nitrogen Loads (1950-2009)

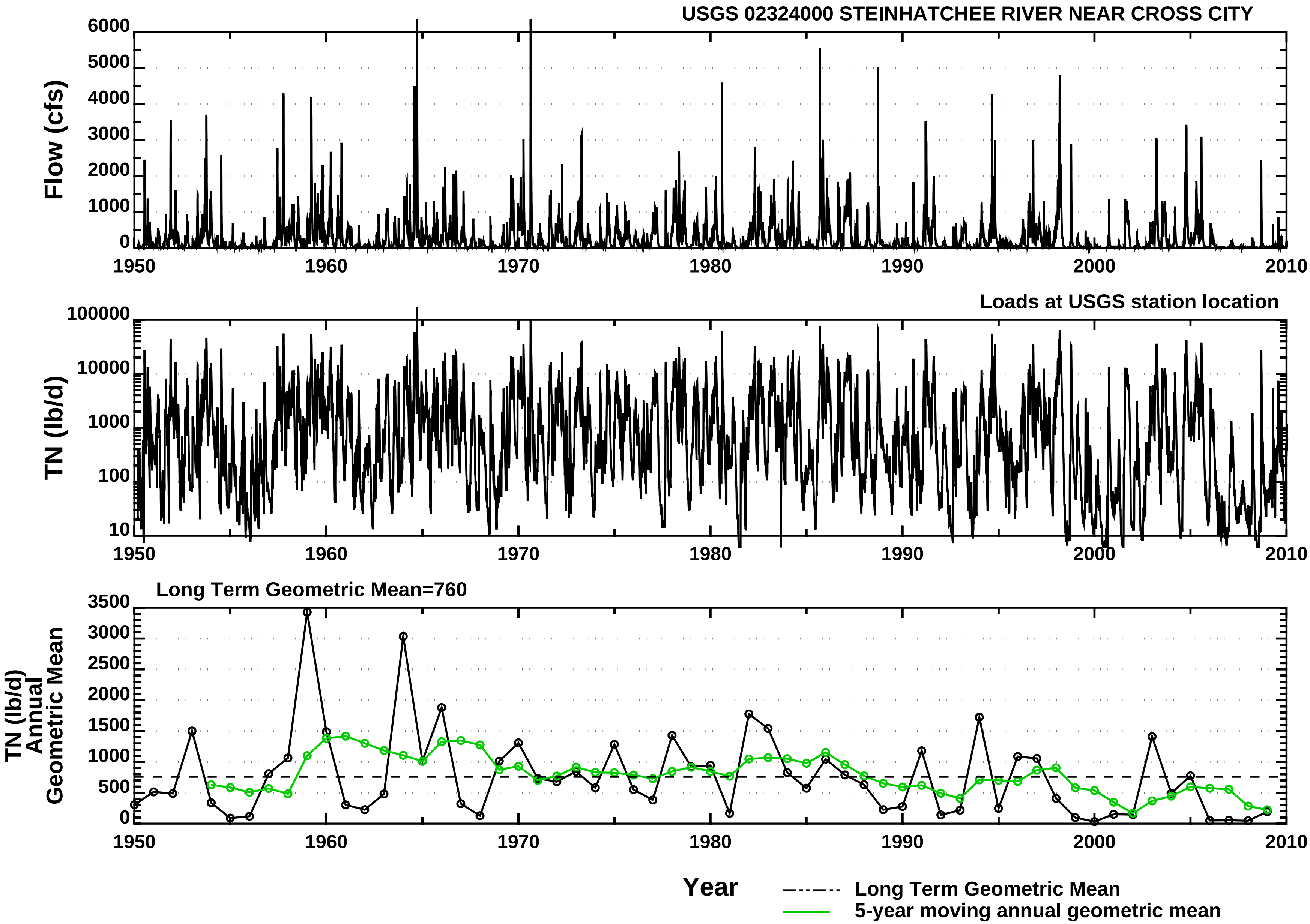

Figure 29. Steinhatchee River Computed Total Nitrogen Loads (1950-2009)

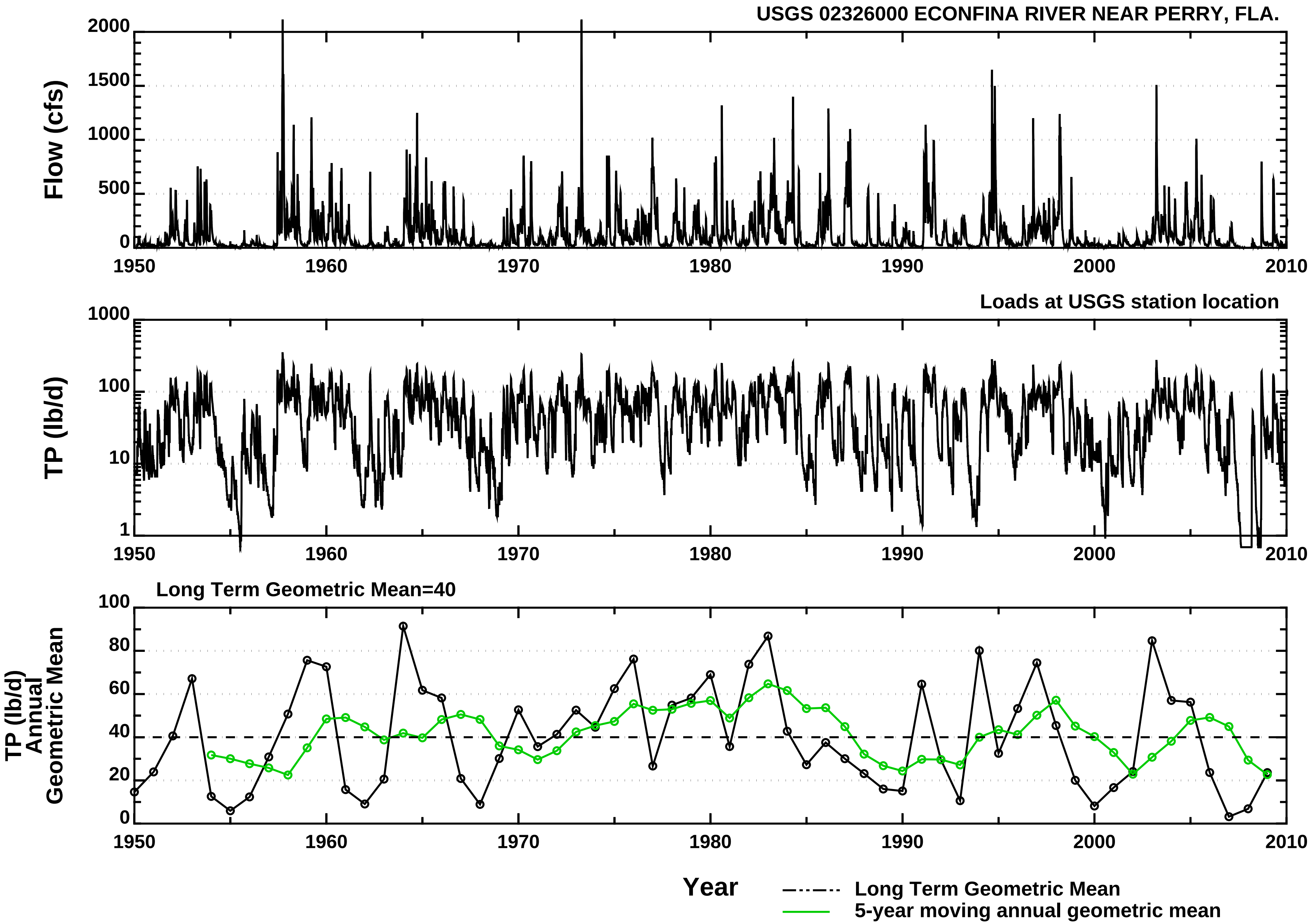

Figure 30. Econfina River Computed Total Phosphorus Loads (1950-2009)

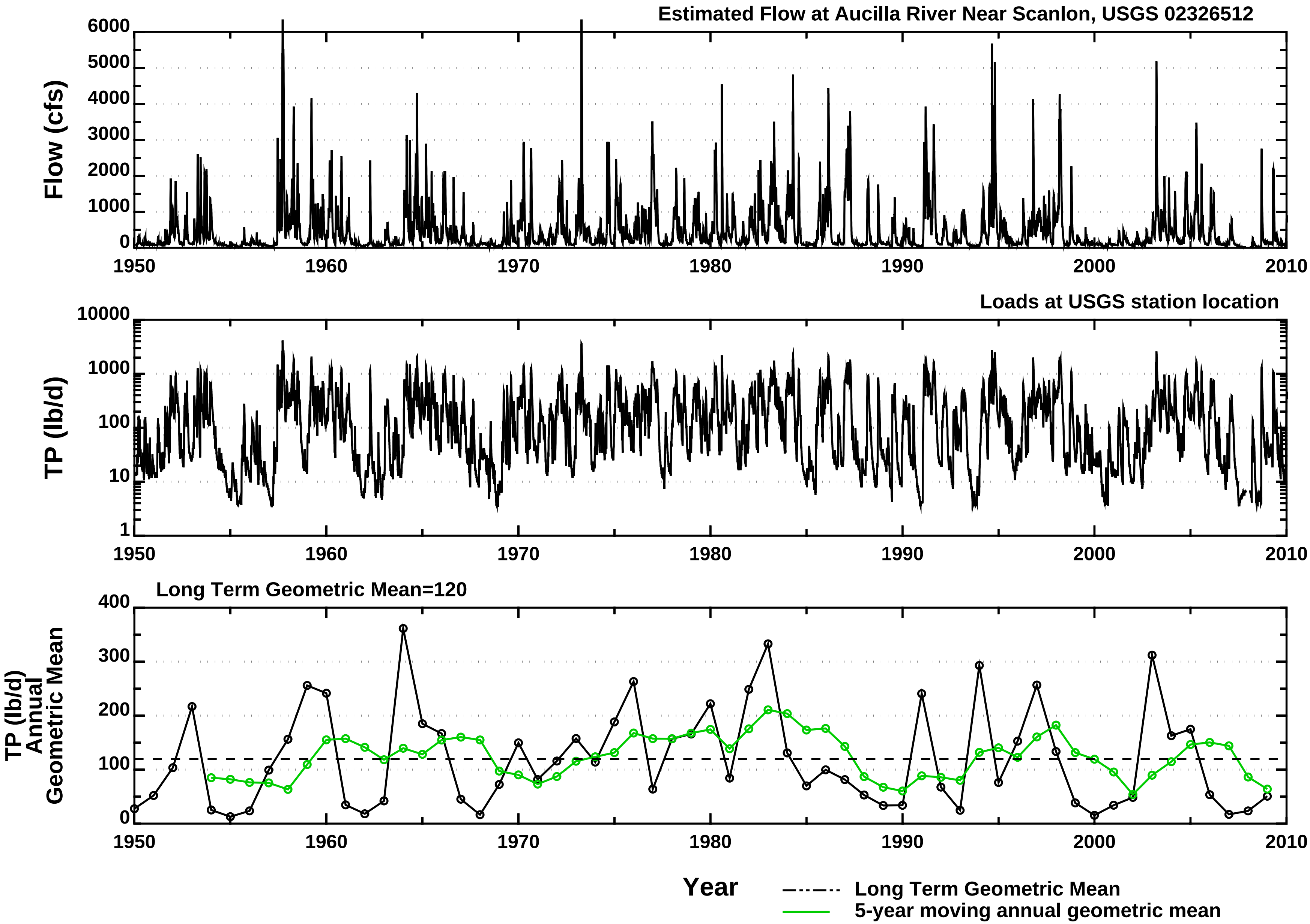

Figure 31. Aucilla River Computed Total Phosphorus Loads (1950-2009)

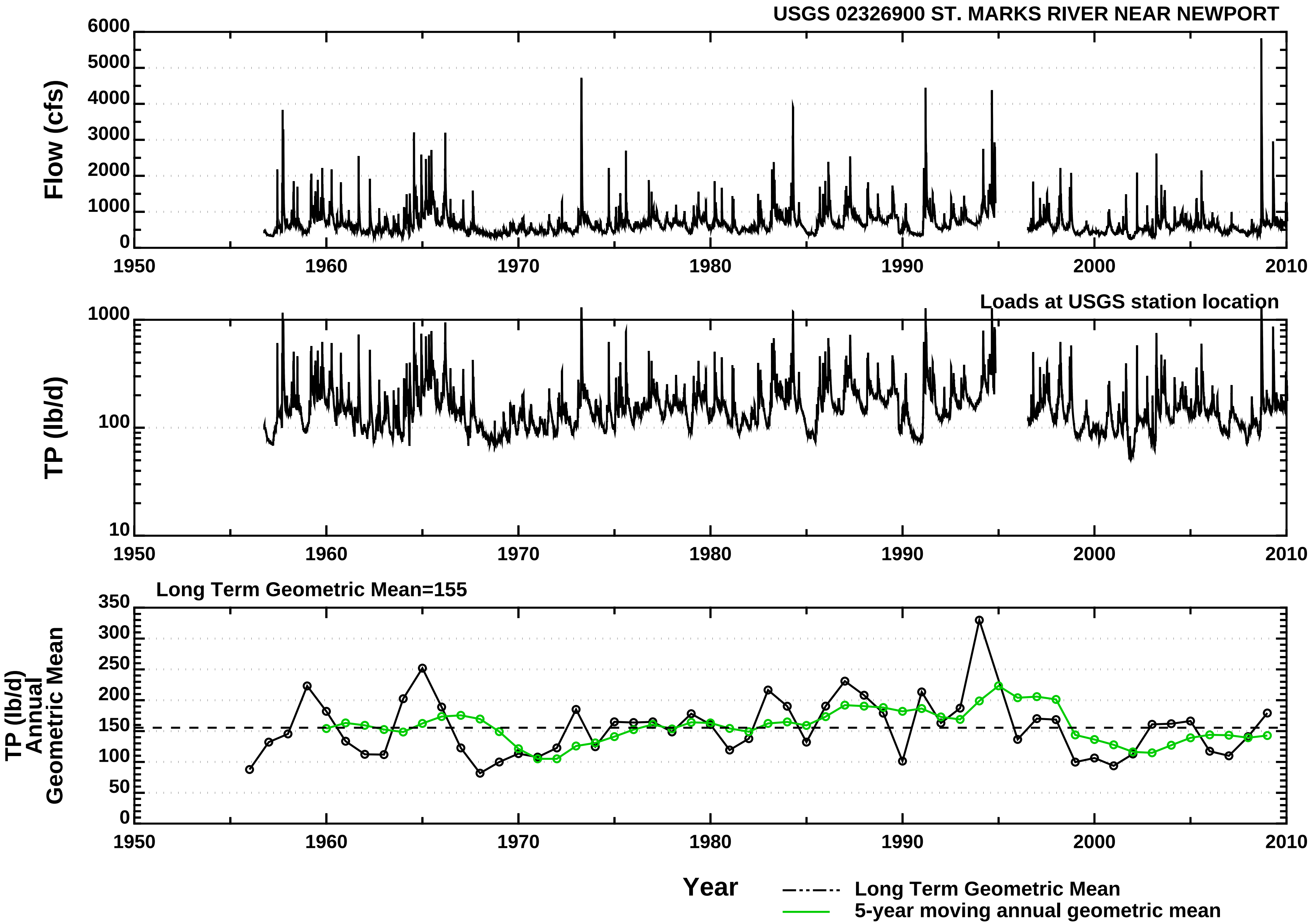

Figure 32. St. Marks River Computed Total Phosphorus Loads (1950-2009)

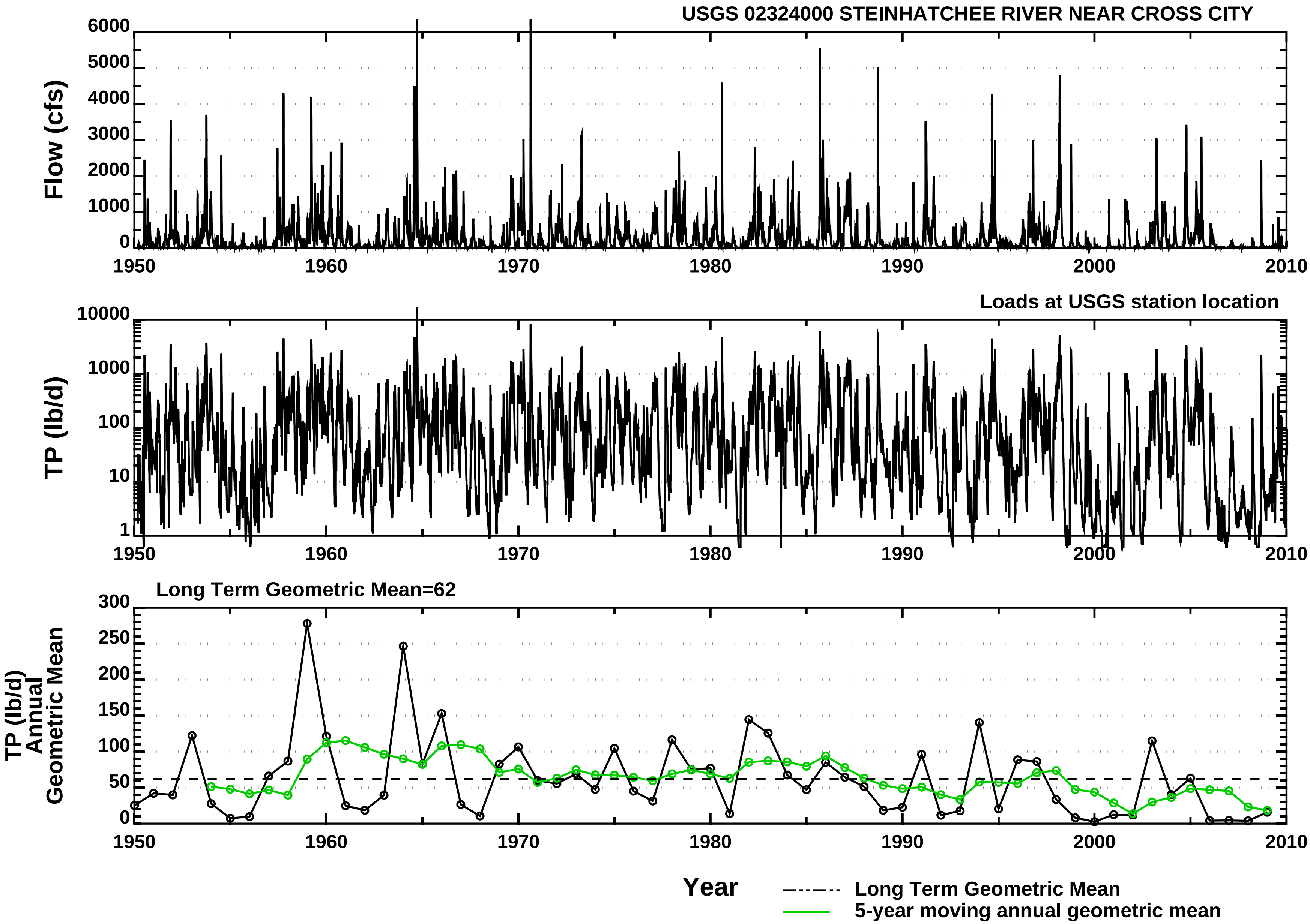

Figure 33. Steinhatchee River Computed Total Phosphorus Loads (1950-2009)

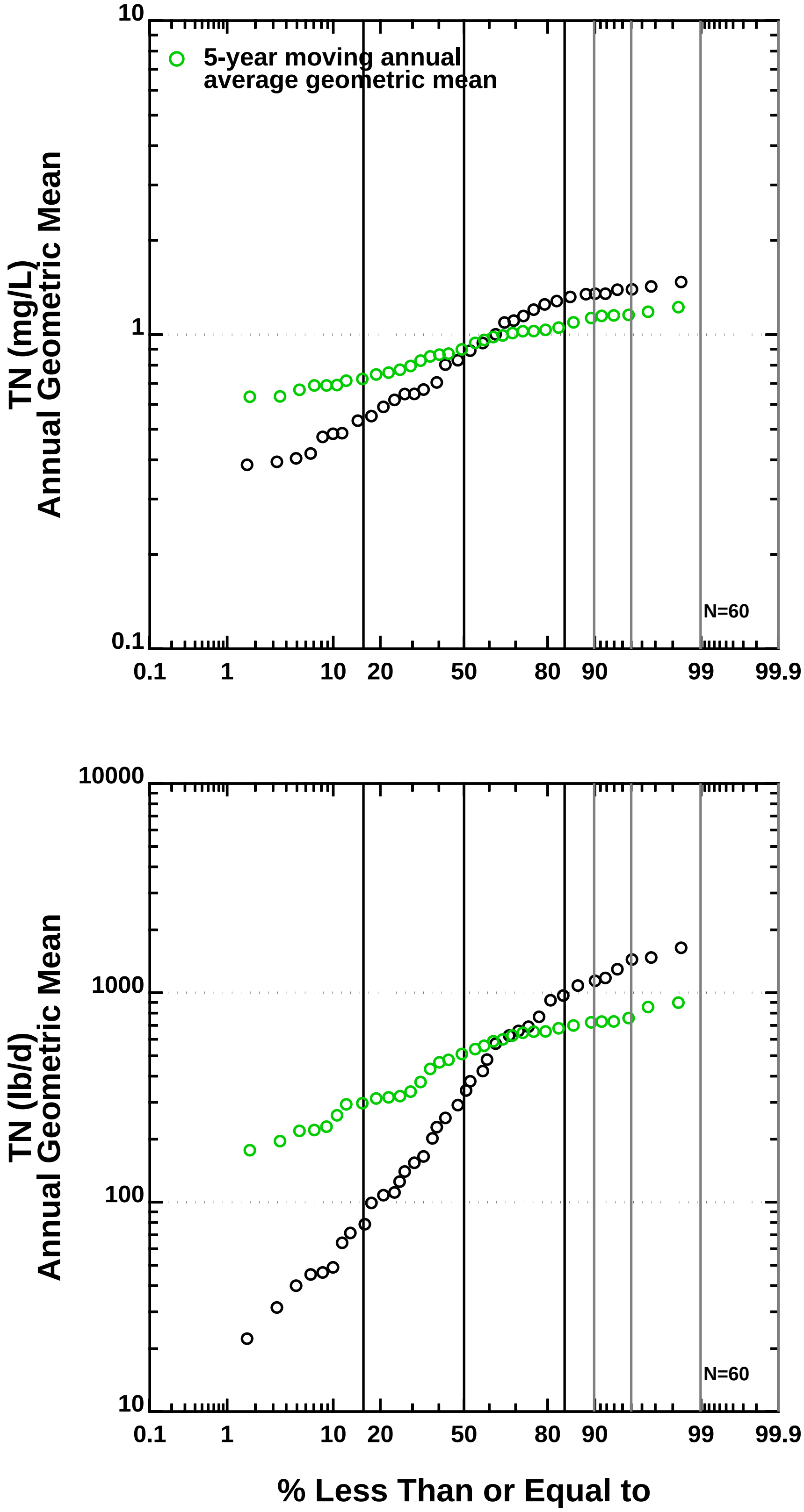

Figure 34. Econfina River Computed Total Nitrogen Concentrations and Loads (1950-2009)

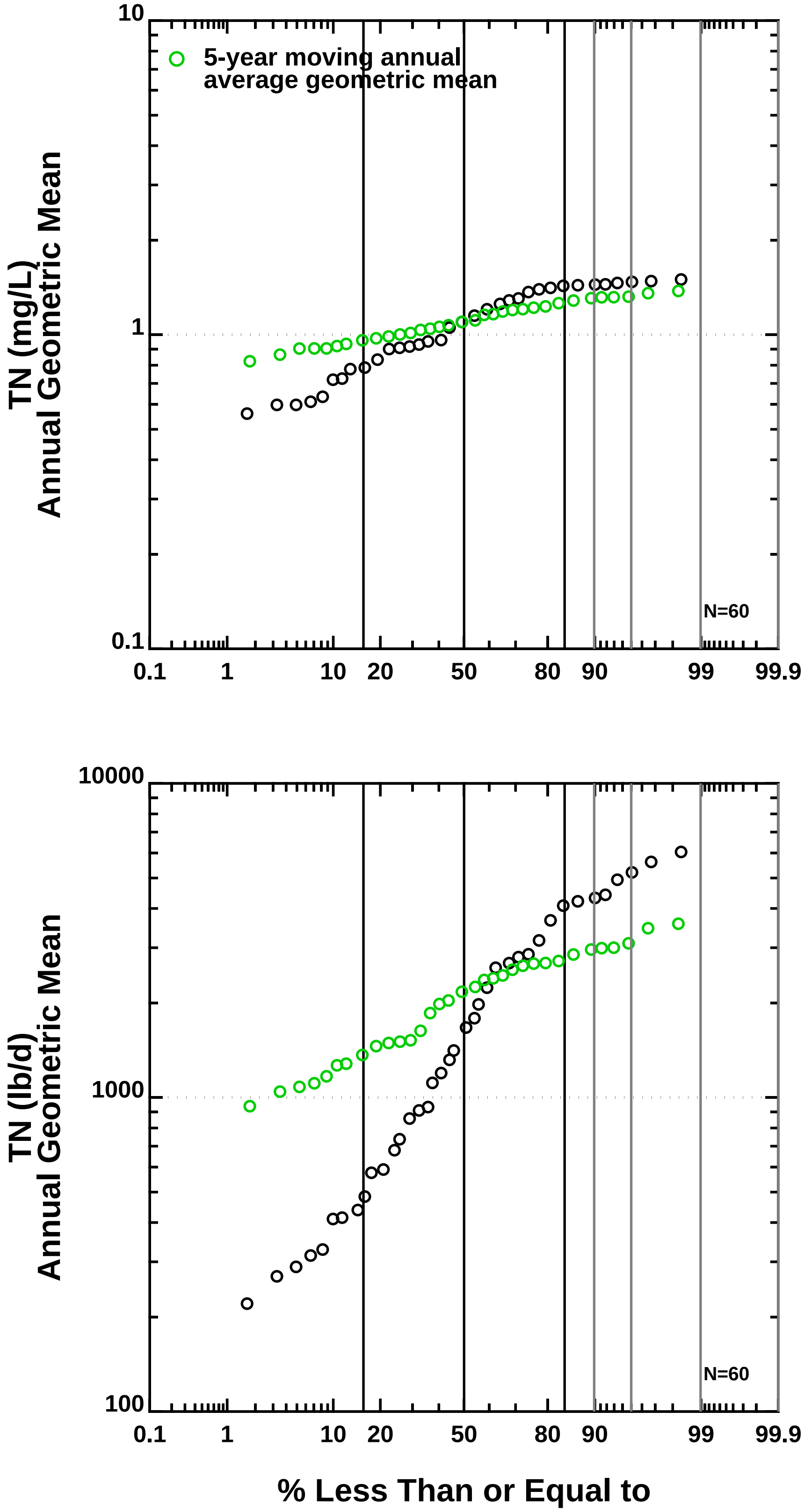

Figure 35. Aucilla River Computed Total Nitrogen Concentrations and Loads (1950-2009)

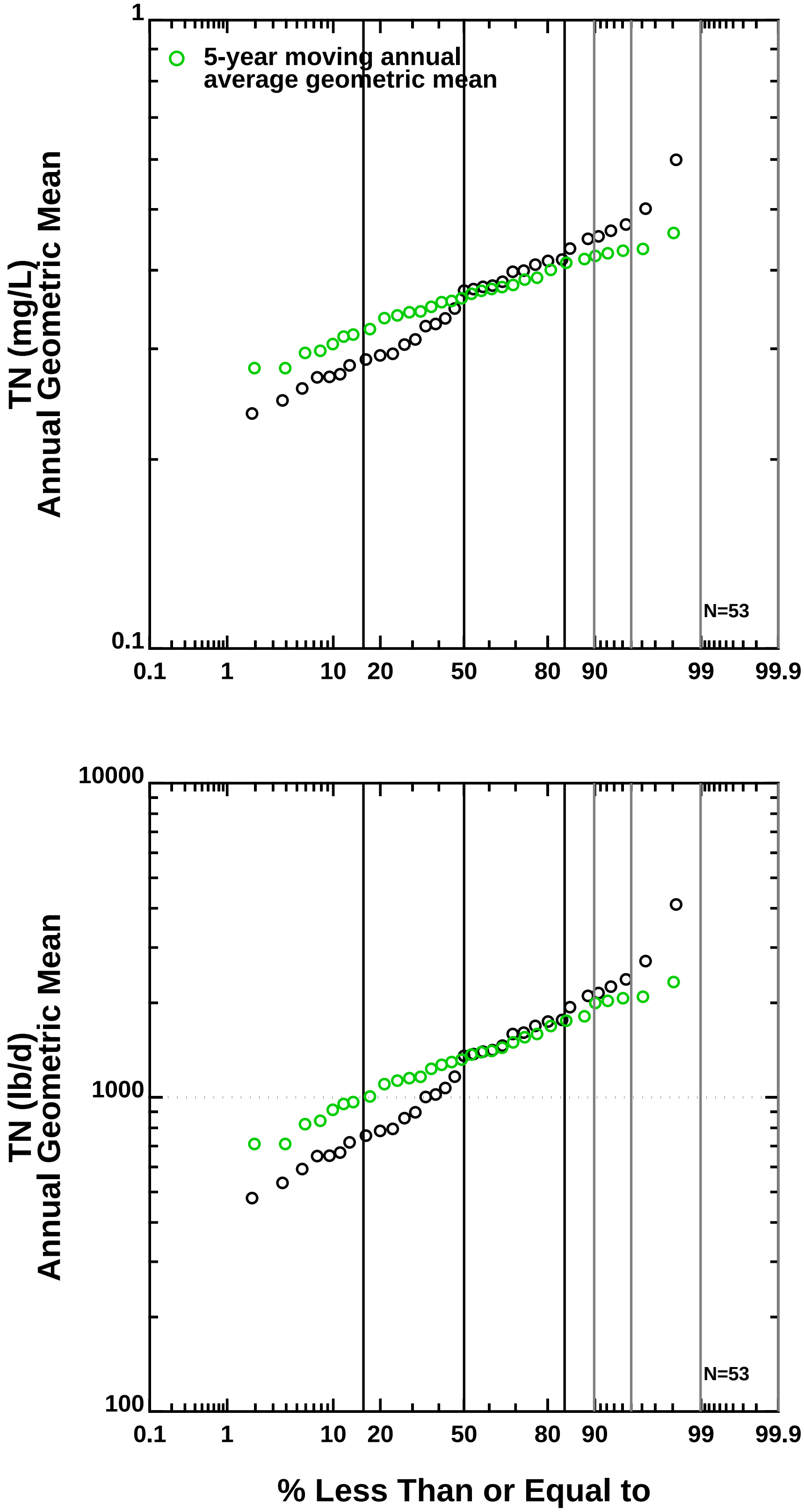

Figure 36. St. Marks River Computed Total Nitrogen Concentrations and Loads (1950-2009)

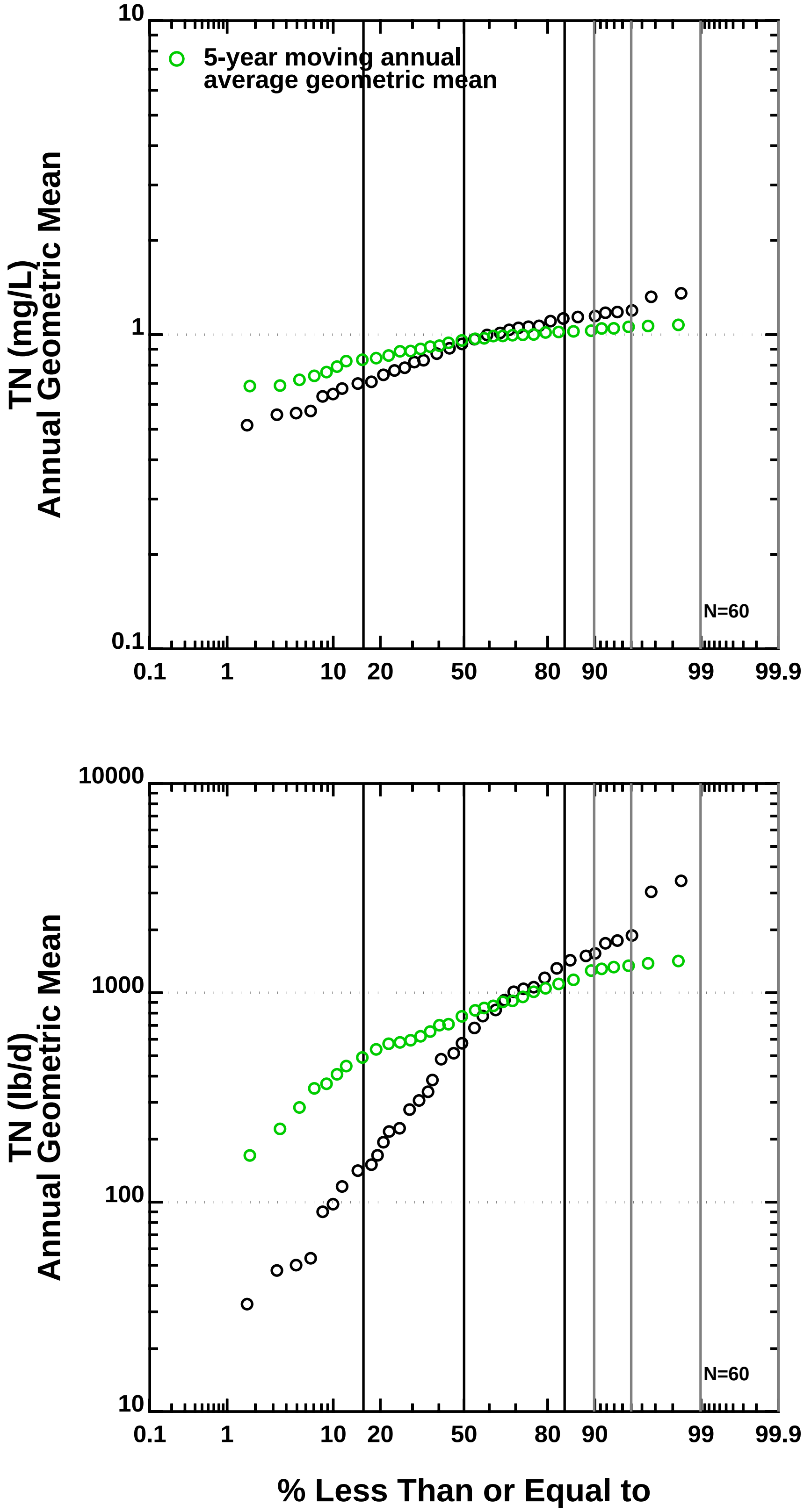

Figure 37. Steinhatchee River Computed Total Nitrogen Concentrations and Loads (1950-2009)

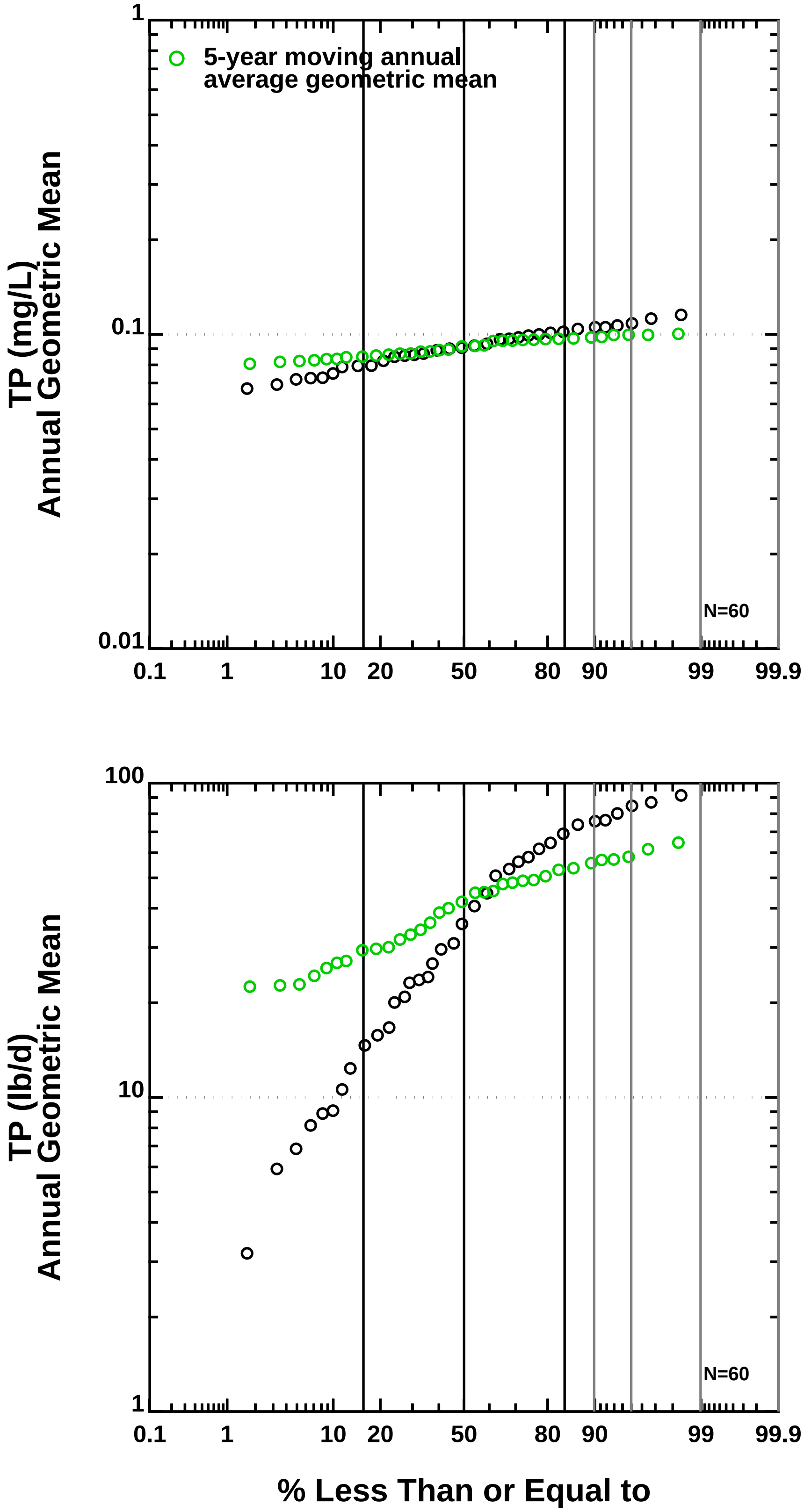

Figure 38. Econfina River Computed Total Phosphorus Concentrations and Loads (1950-2009)

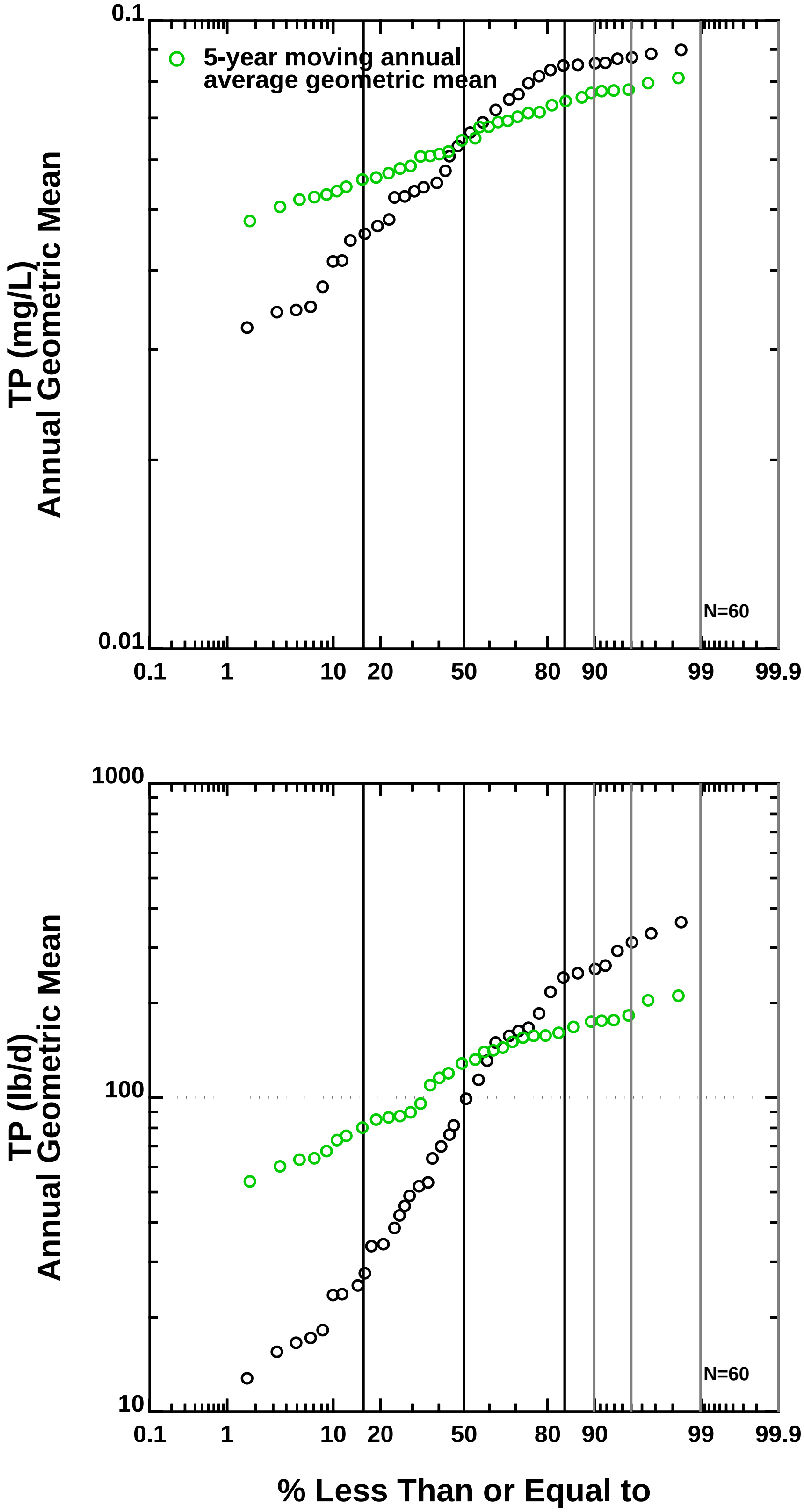

Figure 39. Aucilla River Computed Total Phosphorus Concentrations and Loads (1950-2009)

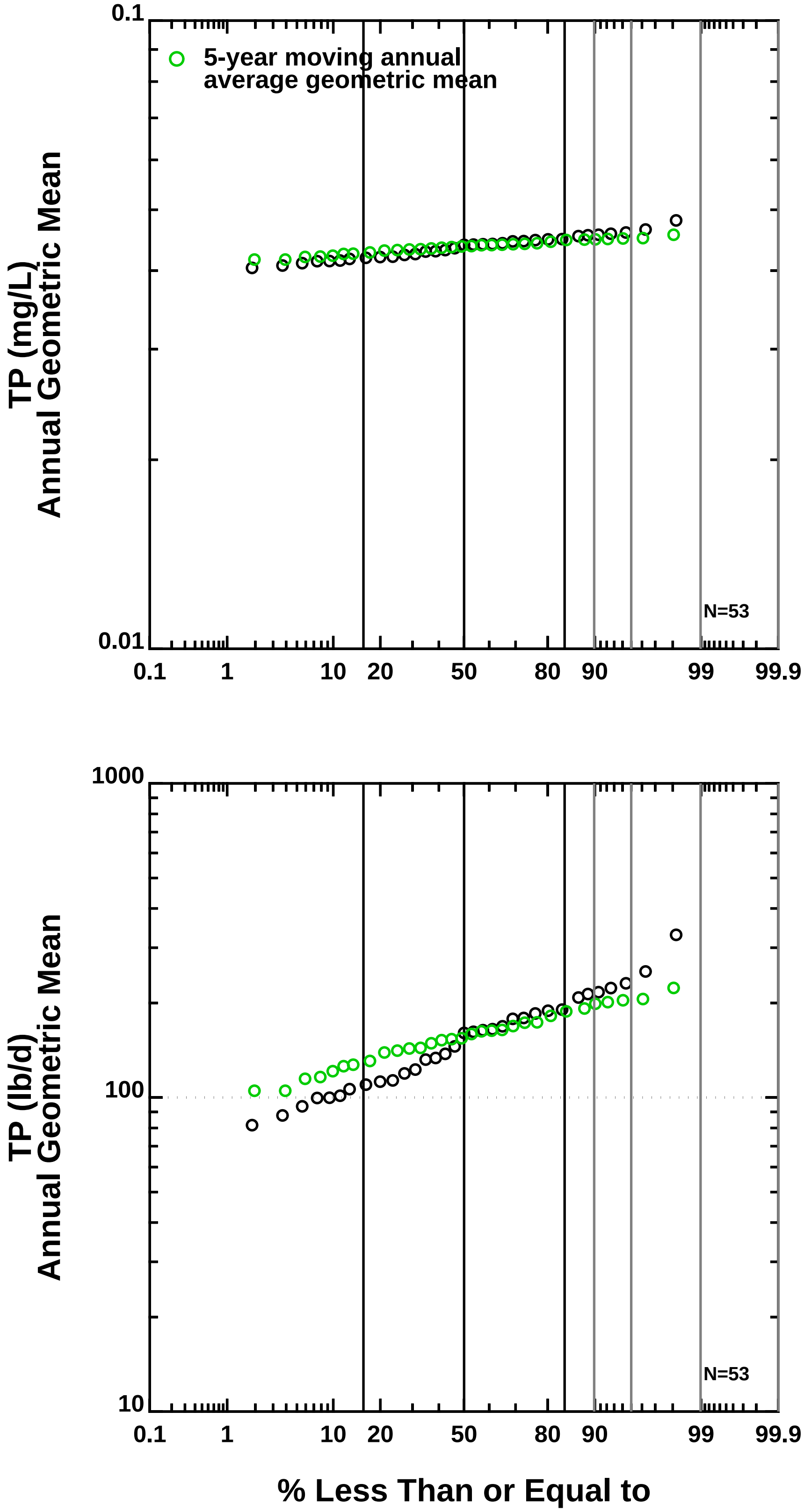

Figure 40. St. Marks River Computed Total Phosphorus Concentrations and Loads (1950-2009)

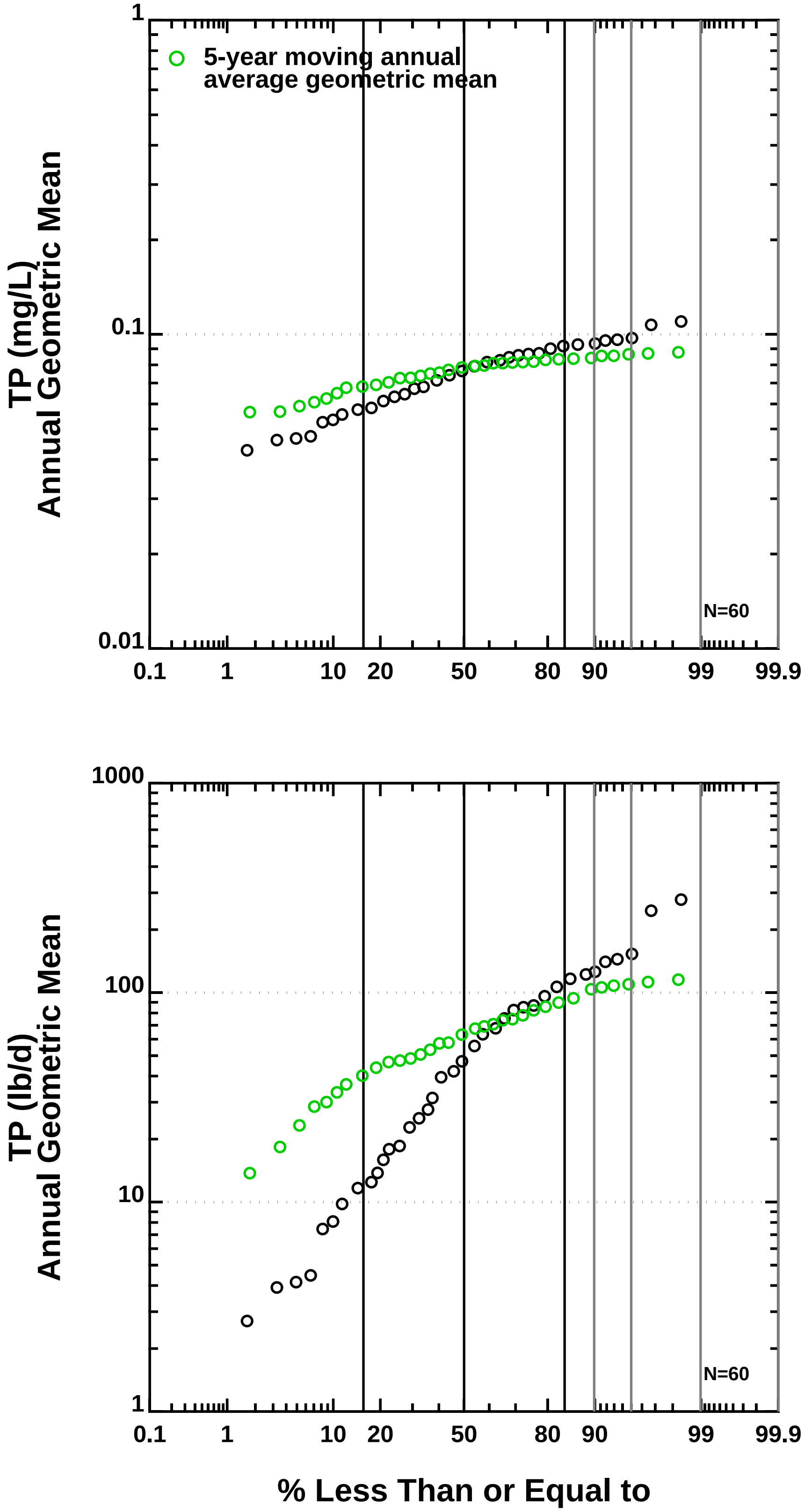

Figure 41. Steinhatchee River Computed Total Phosphorus Concentrations and Loads (1950-2009)

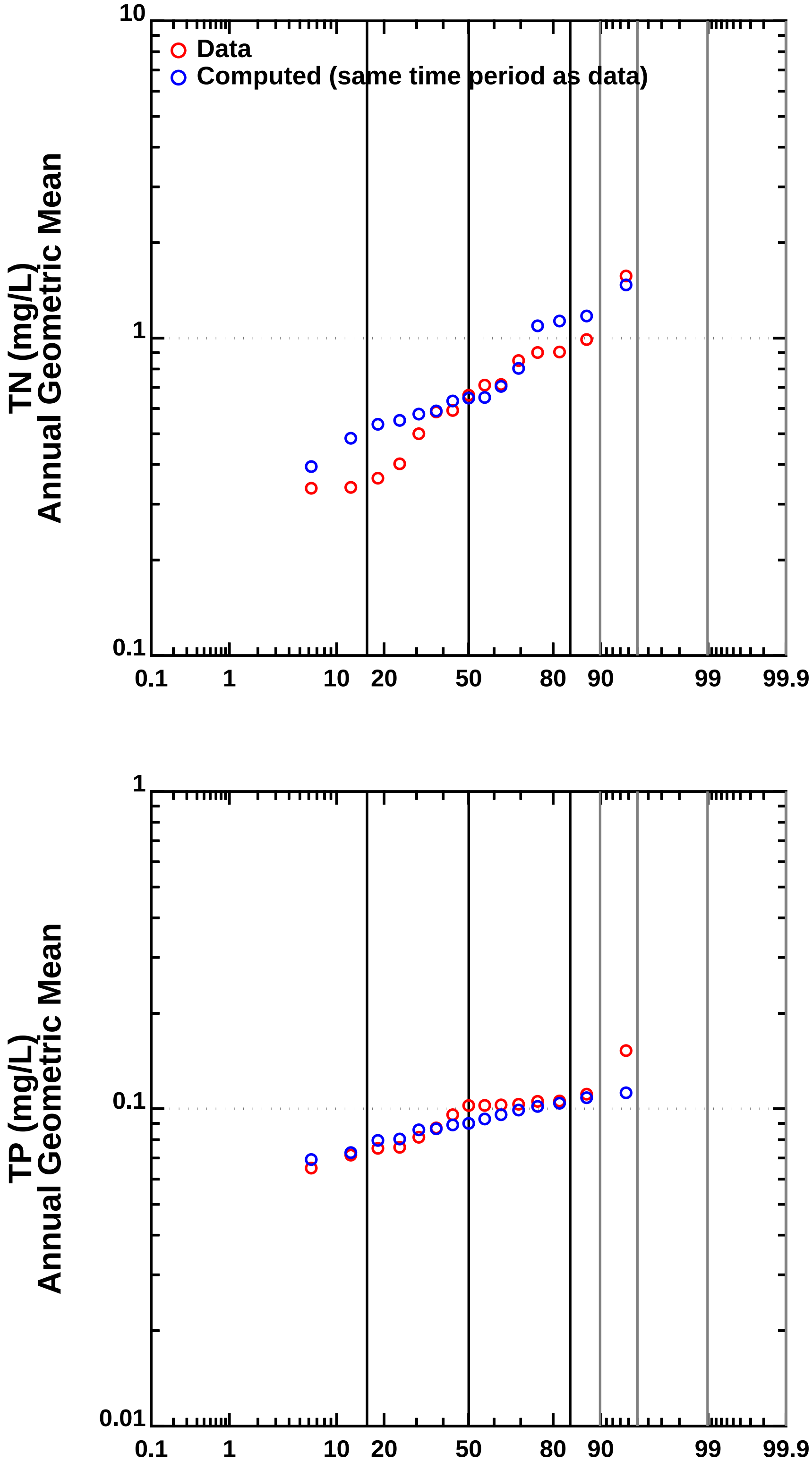

Figure 42. Econfina River Measured and Computed TN and TP

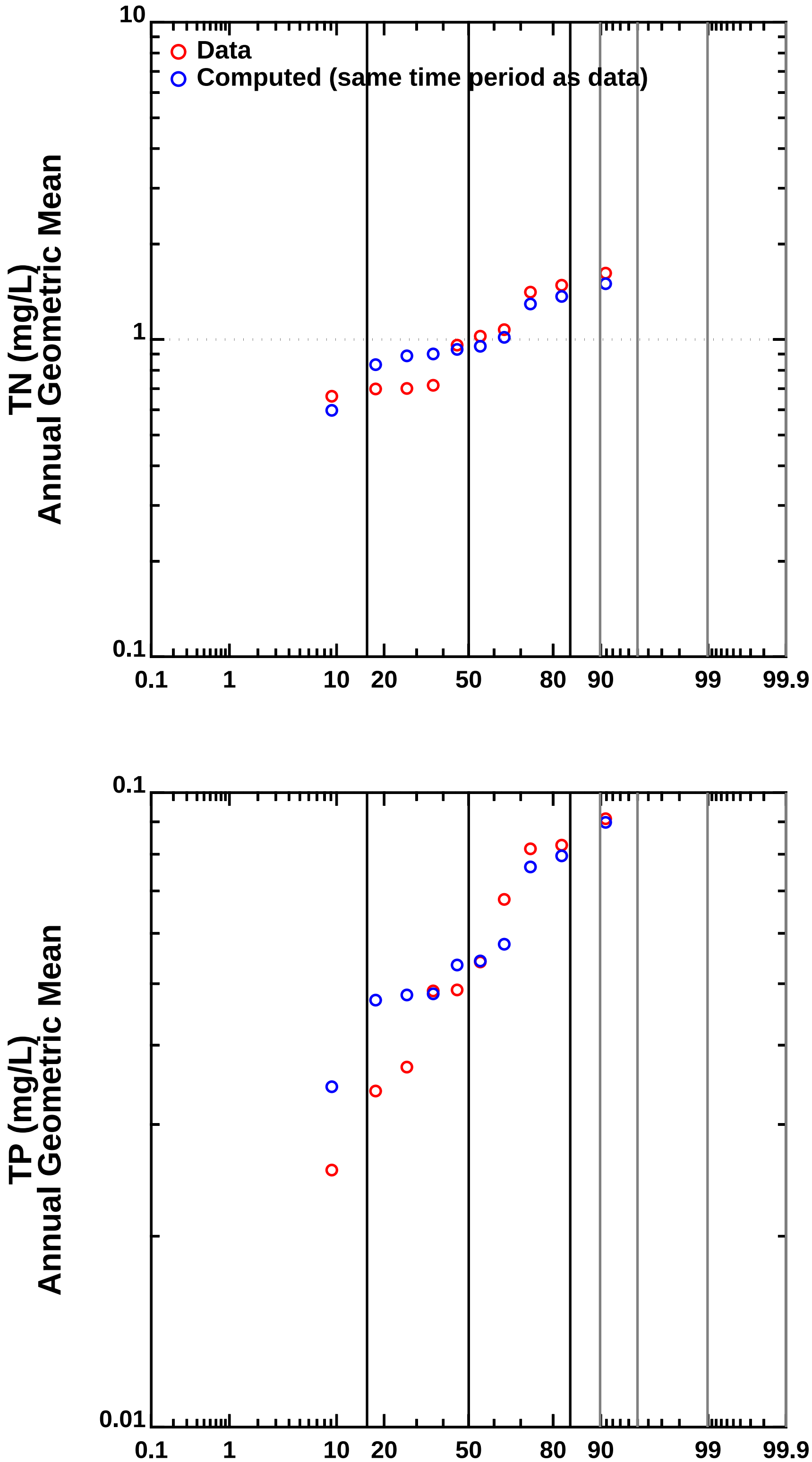

Figure 43. Aucilla River Measured and Computed TN and TP

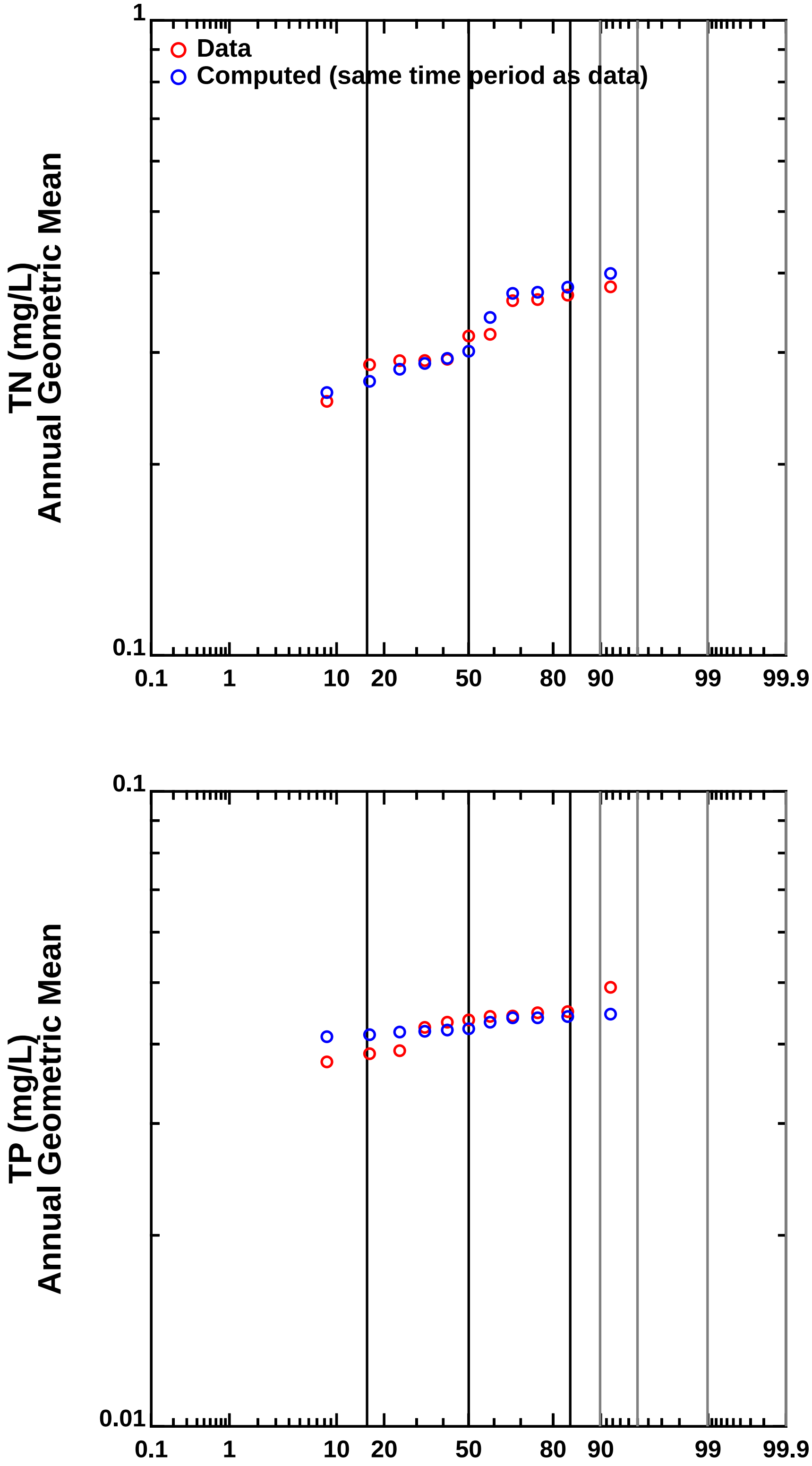

Figure 44. St. Marks River Measured and Computed TN and TP

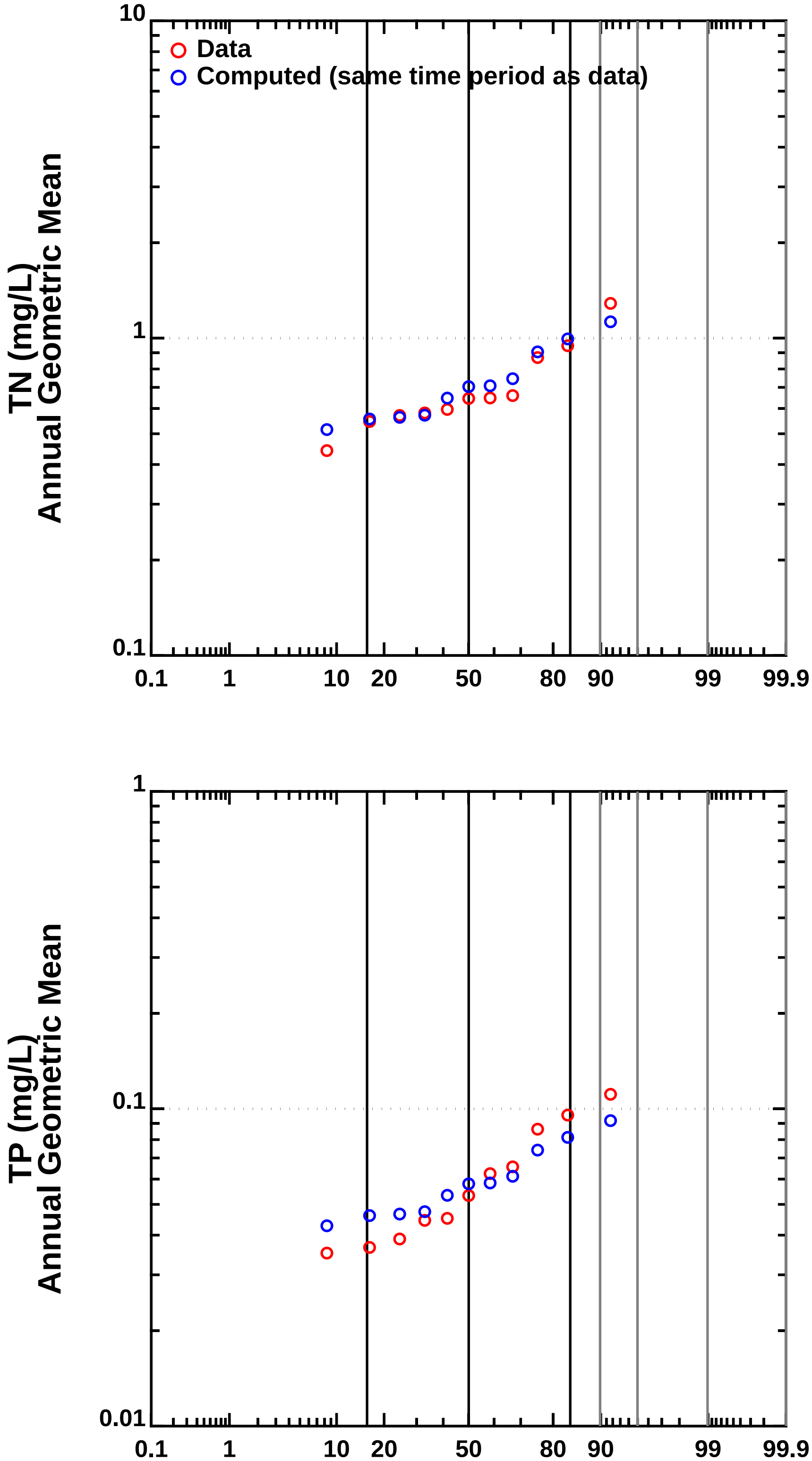

Figure 45. Steinhatchee River Measured and Computed TN and TP