EVALUATION OF PERFORMANCE EFFICIENCIES OF CASSELBERRY GROSS POLLUTANT SEPARATORS

Final Report – Revised December 2014

Prepared For:

City of Casselberry Public Works Department

Prepared By:

Environmental Research and Design, Inc.
Harvey H. Harper, III, Ph.D., P.E.
David Baker, P.E.

TABLE OF CONTENTS

TABLE OF CONTENTS -- CONTINUED

TABLE OF CONTENTS -- CONTINUED

TABLE OF CONTENTS -- CONTINUED

LIST OF FIGURES

LIST OF FIGURES -- CONTINUED

LIST OF FIGURES -- CONTINUED

LIST OF FIGURES -- CONTINUED

LIST OF FIGURES -- CONTINUED

Figure Number/Description **Page**

LIST OF FIGURES -- CONTINUED

LIST OF TABLES

LIST OF TABLES -- CONTINUED

LIST OF TABLES -- CONTINUED

SECTION 1

INTRODUCTION

1.1 Introduction

This document provides a summary of work efforts conducted by Environmental Research & Design, Inc. (ERD) for the City of Casselberry (City) to evaluate the pollution reduction efficiencies of five recently-installed gross pollutant separators (GPS) and three inlet basket inserts within the Gee Creek and Howell Creek drainage basin. Each of these drainage basins ultimately discharges to Lake Jesup which is a designated Impaired Water with an adopted TMDL and BMAP. A general location map for the City of Casselberry study area is given on Figure 1-1. The City of Casselberry is located in Seminole County in Central Florida, north of Orlando and south of the City of Sanford.

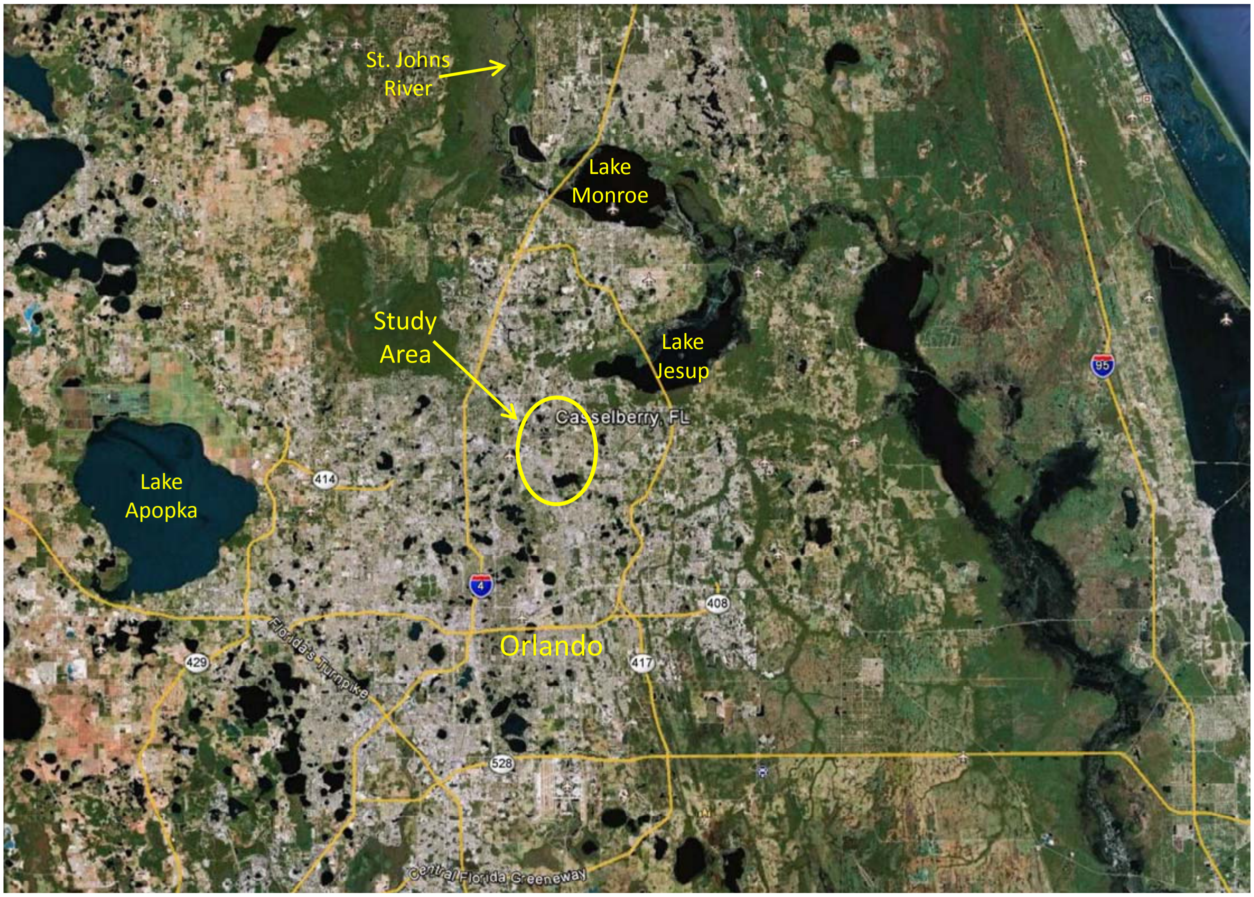


Figure 1-1. Location Map for the City of Casselberry Study Area.

The City of Casselberry is a highly urbanized area consisting of a combination of residential, commercial, and roadway land uses. Many of the existing residential areas within the City were constructed prior to implementation of requirements for stormwater management systems and discharge largely untreated stormwater runoff into Lake Howell, a 399-acre waterbody in the Howell Creek basin, and Gee Creek. The GPS units evaluated as part of this project are designed to capture sediments, nutrients, and debris from the residential areas prior to discharge into the adjacent receiving waterbodies.

General locations of the monitored GPS sites are indicated on Figure 1-2. Each of the devices provides treatment for watershed areas which discharge either into Gee Creek or Howell Creek, both of which ultimately discharge to Lake Jesup. A summary of GPS equipment installed at each of the monitoring sites is given on Table 1-1. At the Lake Hodge (a small lake which ultimately discharges into Gee Creek) and Gee Creek baffle box sites, the installed baffle boxes were manufactured by EcoSense and are equipped with Vault-Ox® inserts. The baffle box constructed at the San Pablo site consists of an EcoSense baffle box without a Vault-Ox® insert. The EcoSense systems contain a media filter on the downstream side of the baffle box, a process which is not present in most other second generation baffle boxes. The other San Pablo site contains a previously-installed Contech CDS unit. The Lake Concord monitoring site consists of a Suntree 2nd Generation Nutrient Separating Baffle Box. The three inlet basket inserts (manufactured by Suntree) are located in the general vicinity of the San Pablo CDS and baffle box units. Additional information concerning construction and removal processes for each of the monitored GPS systems is given in Section 2.

The specific objectives of this research project are to:

1. Quantify the field monitored removal efficiencies for nutrients and heavy metals for each of the evaluated units;

2. Estimate annual load reductions and pollutant removal costs for each BMP type; and

3. Compare effectiveness of 4 current GPS technologies

The monitoring program discussed in this document is designed to compare the relative pollutant removal effectiveness of four evaluated GPS technologies. In addition to more common GPS technologies such as a CDS unit or the Suntree 2nd Generation Nutrient Separating Baffle Box, monitoring was also conducted on an EcoSense baffle box which contained a downstream media filter, a technology which is relatively new within Florida. The results of this project will be used to identify technologies which produce the largest pollutant load reductions at the lowest pollutant removal cost for future BMP projects.

The evaluated GPS technologies were installed in two drainage basins, the Howell Creek basin and Gee Creek basin, both of which are part of the larger Lake Jesup watershed. The Howell Creek basin covers approximately 55 square miles (approximately 2 square miles in City), extending from Orange County into Seminole County, eventually flowing into Lake Jesup, a tributary of the St. Johns River. The Gee Creek basin covers approximately 11 square miles, with 5 square miles in the City limits. The constructed GPS units are part of the recently-adopted Lake Jesup Basin Management Action Plan (BMAP) and will support the ongoing TMDL goals for this impaired waterbody.

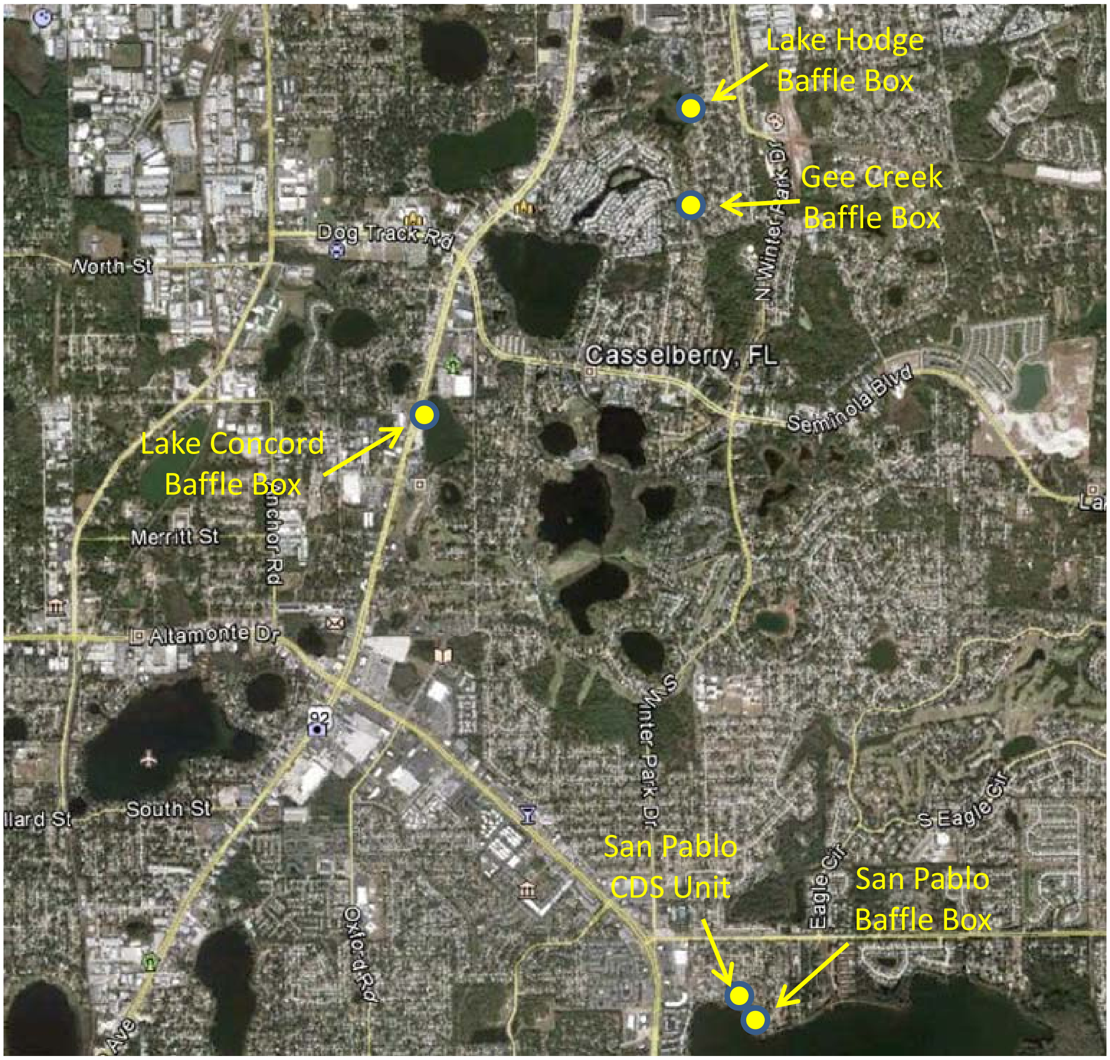


Figure 1-2.

Locations of the GPS Monitoring Sites.

TABLE 1-1

SUMMARY OF GPS EQUIPMENT INSTALLED AT EACH OF THE MONITORING SITES

SITE NAME	MANUFACTURER	UNIT MODEL / TYPE
Lake Hodge	EcoSense International	EcoSense Baffle Box with Vault-Ox® Insert
Gee Creek	EcoSense International	EcoSense Baffle Box with Vault-Ox® Insert
San Pablo	EcoSense International	EcoSense Baffle Box
San Pablo	Contech	CDS Unit
Lake Concord	Suntree Technologies	Suntree 2nd Generation Nutrient Separating Baffle Box
668 San Pablo	Suntree Technologies	High-capacity Curb Inlet Basket
669 San Pablo	Suntree Technologies	High-capacity Curb Inlet Basket
680 San Pablo	Suntree Technologies	High-capacity Curb Inlet Basket

Partial funding for this project was provided through a TMDL Water Quality Grant issued through the Florida Department of Environmental Protection (FDEP). The TMDL Grant included construction of five baffle boxes and other miscellaneous tasks, but only three of the five baffle boxes are included in this evaluation. According to the TMDL Water Quality Grant application, the constructed GPS units are expected to remove 2,810 kg/yr of TSS, 23.5 kg/yr of total phosphorus, and 57.6 kg/yr of total nitrogen.

This project will provide a reduction in the quantity of nonpoint source pollutants in the Lake Jesup watershed. The baffle boxes proposed in this project are included in the recently-adopted Lake Jesup Basin Management Action Plan (BMAP). The baffle boxes are also called for in the City of Casselberry's Stormwater, Lakes Management, and Water Quality Master Plan. The baffle boxes and inlet filter baskets are expected to provide significant removal of hydrocarbons, leaf litter, and other gross pollutants. In addition, the baffle boxes will provide removal of TSS, sediment, total phosphorus, and total nitrogen. In concert with the structural projects, the City implemented enhanced education, training, and technical assistance programs intended to encourage source control through responsible fertilizer use (or disuse), runoff control, stormwater harvesting, proper shoreline revegetation and maintenance, Florida-friendly landscaping, proper septic system maintenance (and use of sewer when available), responsible construction activities BMPs, and other related BMPs. The project will provide localized improvement to the overall health (TSI) of Lake Hodge, Lake Howell, and Gee Creek; and it will provide load reductions for Lake Jesup consistent with the TMDL and BMAP for this impaired waterbody.

1.2 Work Efforts Performed by ERD

A Quality Assurance Project Plan (QAPP) was developed by ERD during June 2012 which provided details concerning the proposed field monitoring and laboratory activities. Monitoring equipment was installed at each of the GPS monitoring sites by ERD during May and June 2013. Field monitoring was initiated on June 15, 2013 and was conducted over a period of approximately 7 months until January 15, 2014. Flow monitoring equipment and automatic sequential stormwater samplers were installed at the 5 automated monitoring sites to measure volumetric inflows and to collect samples in a flow-proportioned mode. At the completion of the field monitoring program, the collected field and laboratory data were used to estimate annual load reductions and performance efficiencies for each of the evaluated systems.

This report has been divided into 5 separate sections which provide a discussion of work efforts conducted by ERD and the results of the field and laboratory analyses. Section 1 contains an introduction to the report and a brief summary of work efforts performed by ERD. Section 2 provides a discussion of each of the evaluated GPS technologies. Section 3 provides a discussion of the individual monitoring sites and general methodology used for field and laboratory evaluations. Section 4 provides a discussion of the hydrologic and water quality results, and a summary is provided in Section 5. Appendices are attached which contain additional supplemental information referenced within the report.

1.3 Project Costs and Funding

Funding for the Casselberry GPS projects was provided largely by the City of Casselberry and FDEP, with limited in-kind match participation from Seminole County and the Florida Fish and Wildlife Commission (FWC). Project cost information for those components of the Casselberry GPS projects specifically studied under this evaluation is provided in Section 4.5 of this report. For details on overall project costs, please see the "Project Cost and Funding" section in the City's main report for this project.

In addition to the Casselberry GPS projects constructed as part of the FDEP TMDL Grant (Agreement S0497), two additional GPS devices were also evaluated as part of the monitoring project which were constructed as part of previous Casselberry Public Works projects. These sites include the San Pablo CDS Unit and the Lake Concord Suntree baffle box unit. Estimated construction and O&M costs for these units are provided in a subsequent section.

SECTION 2

DESCRIPTION OF INSTALLED GPS TECHNOLOGIES

This section provides a description of the GPS technologies that were evaluated as part of this project, along with specific details for each of the monitored installations.

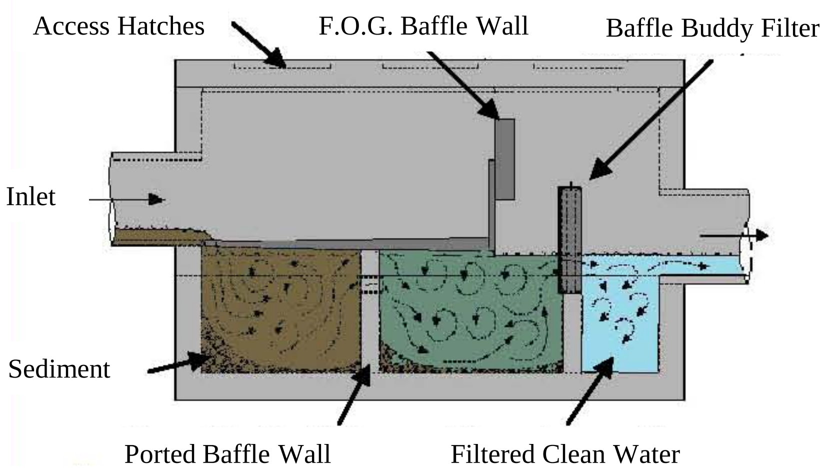
2.1 GPS Technology Overview

The GPS technologies evaluated for this project include systems manufactured by Contech Industries, EcoSense International, and Suntree Technologies. A discussion of the configuration, theory of operation, and operational characteristics for each of the evaluated technologies is given in the following sections.

2.1.1 EcoVault® Baffle Box

As indicated on Figure 1-2 and in Table 1-1, EcoVault® baffle boxes were installed at the Lake Hodge, Gee Creek, and San Pablo baffle box sites. The EcoVault® baffle box is manufactured by EcoSense International (ESI), which is located in Rockledge, Florida. The EcoVault® is a pre-cast concrete baffle box system which, according to ESI, is designed to remove sediments, trash, organics, nutrients, metals, and oils/grease.

Photographs of the ESI EcoVault® baffle box system are given on Figure 2-1. As indicated on Figure 2-1a, the EcoVault® contains three separate internal chambers separated by concrete walls. As water enters the EcoVault® unit, the flow spreads out over a series of hinged screen aluminum hatches. The runoff passes downward through the screens (illustrated on Figure 2-1b) which filter out larger debris, leaves, and vegetation, while allowing smaller particles (such as sand and grit) to settle into the internal chambers. The elevation of the screens is designed to be higher than the outflow invert elevation so that the collected solid material is stored out of the water between storm events. Storage of the collected vegetation and debris under dry conditions minimizes leaching of nutrients from the vegetation which is substantially accelerated when the vegetation is maintained in a saturated environment. The EcoVault® baffle box is cleaned by first vacuuming the solids from the top of the screens. The screens then open up (as illustrated on Figure 2-1c) to allow access to the lower chambers to remove accumulated solids.



a. Schematic flow patterns in the EcoVault® unit

b. Bottom solids screens

c. Bottom screens opened for cleaning

d. “Baffle Buddy” Outlet filter

Figure 2-1. Overview of the ESI EcoVault® Baffle Box.

One of the unique features of the ESI EcoVault® baffle box is the inclusion of an outlet filter system located on the downstream side of the baffle box unit. Water which exits the baffle box must first pass through the outlet filter system (illustrated on Figure 2-1d). ESI refers to the filter as the "Baffle Buddy filter" which contains a patented surfactant-modified alumino silicate which, according to ESI, absorbs cations and anions such as phosphates, ammonia, dissolved heavy metals, hydrocarbons, fecal bacteria, and a variety of organic compounds. Product literature for the EcoVault® baffle box system is included in Appendix A.1.

In addition to the outflow filter system, the Lake Hodge and Gee Creek EcoVault® baffle boxes also contained Vault-Ox® inserts, which are also manufactured by ESI. Photographs of the ESI Vault-Ox® inserts are given on Figure 2-2. The Vault-Ox® insert consists of water-permeable mesh which contains a proprietary blend of two active ingredients, one of which is calcium peroxide. As the calcium peroxide dissolves, hydrogen peroxide is produced which is a strong oxidizer designed to maintain oxidized conditions within the baffle box between storm events. According to ESI, the addition of a Vault-Ox® cartridge to a baffle box is intended to improve dissolved oxygen, immobilize phosphorus, elevate and buffer pH, absorb nitrogen, enhance aerobic activity, promote oxidation of organics, lower COD/BOD, and absorb heavy metals.

a. Vault-Ox® insert

b. Vault-Ox® insert holder

Figure 2-2.

Photos of the ESI Vault-Ox® Inserts.

The Vault-Ox® insert is placed into a protective holder (Figure 2-2b) which provides protection for the mesh insert. ESI refers to Vault-Ox® as "static stormwater remediation chemistry", since it is designed primarily to maintain oxidized conditions within baffle boxes between storm events. Product literature information for Vault-Ox® is given in Appendix A.2. The Vault-Ox® inserts are stand-alone products which can be used in many types of baffle boxes and small detention devices.

2.1.2 Contech CDS Unit

As indicated on Figure 1-2 and Table 1-1, field monitoring was also conducted in a previously-installed CDS unit for comparison with the other baffle box type technologies. The CDS unit was manufactured by Contech Engineered Solutions, an international corporation with North American headquarters located in West Chester, Ohio. The CDS (Continuous Deflective Separation) system is a swirl concentrator hybrid technology that provides a combination of swirl concentration and indirect screening. According to Contech, CDS units effectively screen, separate, and trap debris, sediment, and oil from stormwater runoff and are ideal systems to meet trash TMDLs.

Under operational conditions, the inflow is directed into a curved conduit which creates a swirling action on the inside of the unit in the separation cylinder. The swirling action inside the cylinder creates centrifugal forces on larger solids, causing them to pass through the internal screen and settle into the bottom sump area. In addition, the swirling action within the separation chamber acts to continually shear debris off the screen to keep it clean. Floating debris and trash is collected and stored in the center portion of the unit, with larger particles of sand and grit accumulating into the bottom of the sump. Cleaning operations consist of vacuum removal of the accumulated material within the central sump portions of the unit and sump.

A schematic of a typical Contech CDS unit is given on Figure 2-3, and product literature for Contech CDS units is given in Appendix A.3. According to Contech, the design of the CDS unit provides virtually full retention for captured pollutants, even during extremely high flow conditions through the unit. However, due to the vertical construction of the CDS unit, installation of CDS units typically requires deeper excavations than would be required for a typical baffle box unit.

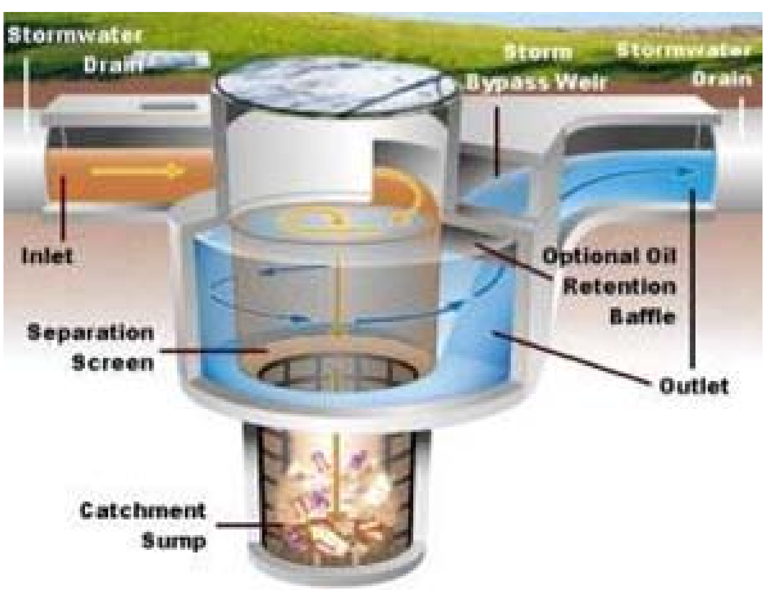


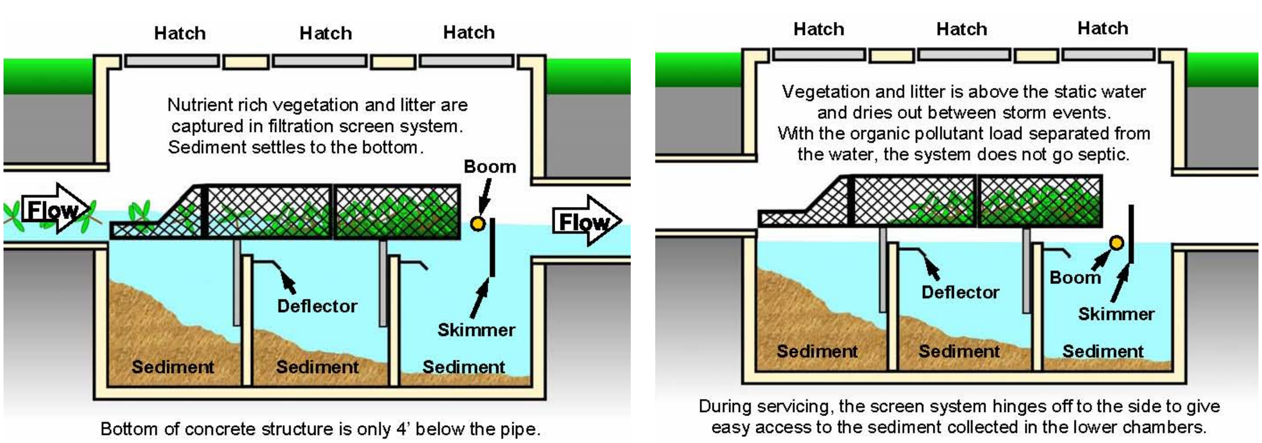
Figure 2-3.

Schematic of the Contech CDS Unit.

2.1.3 Suntree 2nd Generation Nutrient Separating Baffle Box

As indicated on Figure 1-2 and in Table 1-1, a Suntree 2nd Generation Nutrient Separating Baffle Box was installed at the Lake Concord monitoring site. The nutrient separating baffle box was manufactured by Suntree Technologies, Inc., located in Cocoa, Florida. The basic structural configuration of the Suntree baffle box unit consists of a standard 3-chamber 1st generation baffle box system. However, the 2nd generation system is designed to separate and store nutrient-rich vegetation and litter on a filtration screen system, with larger sediment particles settling into the bottom chambers. The outflow invert for the system is designed to be slightly lower than the inflow invert, which causes the filtration screen system to remain above the water level between storm events, theoretically separating the nutrient-rich vegetation and litter from the roadway dirt and solids. Numerous studies have indicated that significant release of nutrients occurs from vegetation, leaves, and litter if these materials are stored in submerged conditions for extended periods of time.

A somewhat unique feature of the Suntree 2nd generation baffle box is the deflector shields provided on the internal walls of the basic baffle box structure. These deflectors minimize opportunity for development of turbulent and circular flow regimes adjacent to the baffle wall which could potentially mobilize collected sediments. The latest version of the nutrient separating baffle box contains deflector shields on both sides of the internal chambers. The Suntree system also contains a floating boom, referred to as the Storm Boom, designed to collect and adsorb hydrocarbons floating on the water surface in front of the outflow skimmer. The Suntree nutrient separating baffle box structures are available in a variety of sizes to accommodate pipe diameters ranging from 4-72 inches. A schematic of the Suntree unit is given on Figure 2-4, and product literature for the Suntree 2nd Generation Nutrient Separating Baffle Box System is given in Appendix A.4.



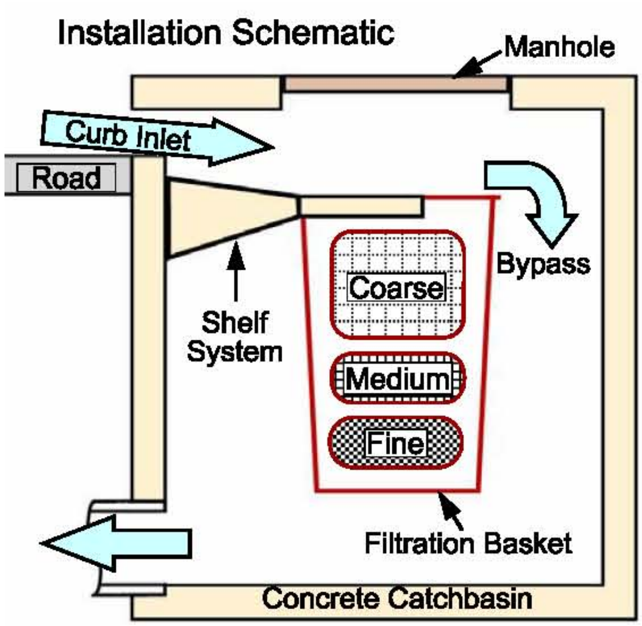
a. During storm event conditions

b. Following storm event conditions

Figure 2-4. Schematic of the Suntree 2nd Generation Nutrient Separating Baffle Box.

2.1.4 Suntree High-Capacity Curb Inlet Basket

In addition to the baffle box and CDS structures, monitoring was also conducted at three curb inlet basket sites which were located in the general vicinity of the San Pablo CDS and baffle box units. The installed high-capacity curb inlet baskets were manufactured by Suntree Technologies in Cocoa, Florida. A schematic of the Suntree high-capacity curb inlet basket is given on Figure 2-5. The unit consists of a wire mesh basket which is suspended near the center of a storm inlet using a shelf support system (Figure 2-5a). The shelf support also serves to direct the runoff inflow into the filtration basket where the water passes through the mesh openings, trapping suspended solids, vegetation, litter, and debris inside the basket. Inflows which exceed the intake capacity of the filtration basket bypass the unit and travel downstream through the stormsewer system. A photograph of a filtration basket filled with collected solids is given on Figure 2-5b. Product information concerning the Suntree high-capacity curb inlet basket is given in Appendix A.5.



a. Schematic of the Suntree high-capacity curb inlet basket

b. Basket filled with collected solids

Figure 2-5. Schematic of the Suntree High-Capacity Curb Inlet Basket.

2.2 Description of Installed Systems

A discussion of the general characteristics, watershed areas, and installation details for each of the evaluated GPS systems is given in the following sections.

2.2.1 Osceola Trail Sites

2.2.1.1 General Description

The monitoring sites referred to on Figure 1-2 and in Table 1-1 as the Lake Hodge baffle box and the Gee Creek baffle box are each located along Osceola Trail, and are collectively referred to as the Osceola Trail sites. Locations of the Lake Hodge and Gee Creek monitoring sites are illustrated on Figure 2-6. Each of these sites contained an EcoSense EcoVault® baffle box with Vault-Ox® inserts.

Figure 2-6. Locations of the EcoVault® Baffle Boxes at the Osceola Trail Sites.

Contributing watershed areas for the Lake Hodge and Gee Creek baffle box systems are illustrated on Figure 2-7. The Lake Hodge baffle box receives inflow from the sub-basin designated as G-1 which consists of approximately 20.98 acres of single-family residential homes. The Gee Creek baffle box unit receives inflows from the sub-basin identified as G-2 which consists of approximately 29.98 acres of single-family residential homes.

Figure 2-7.

Contributing Watersheds for the Osceola Trail Sites.

A summary of hydrologic characteristics of the G-1 and G-2 sub-basins is given on Table 2-1. Each of the sub-basin areas is approximately 40% impervious. Sub-basin G-1 is estimated to be approximately 30% DCIA due to the curb and gutter system used in portions of the sub-basin. However, Sub-basin G-2 has a DCIA percentage near zero due to the extensive shallow roadside swale system. Each of the two sub-basins is located in areas dominated by well drained soils in HSG A. Selected construction plans for the Osceola Trail baffle box sites are included in Appendix B.1.

TABLE 2-1

HYDROLOGIC CHARACTERISTICS OF THE G-1 AND G-2 SUB-BASINS

SUB-BASIN ID	AREA (acres)	IMPERVIOUS AREA (%)	DCIA AREA (%)	HSG SOIL GROUP	TREATMENT DEVICE
G-1	20.98	41	30	A	EcoVault® baffle box with Vault-Ox® insert
G-2	29.98	43	0	A	EcoVault® baffle box with Vault-Ox® insert
TOTAL:	**50.96**				

2.2.1.2 Lake Hodge Baffle Box

An overview of drainage patterns in the vicinity of the Lake Hodge baffle box site is given on Figure 2-8. In general, drainage within the sub-basin travels by a combination of roadside swales and curb and gutter systems before converging into the combined inflow for the EcoVault® unit.

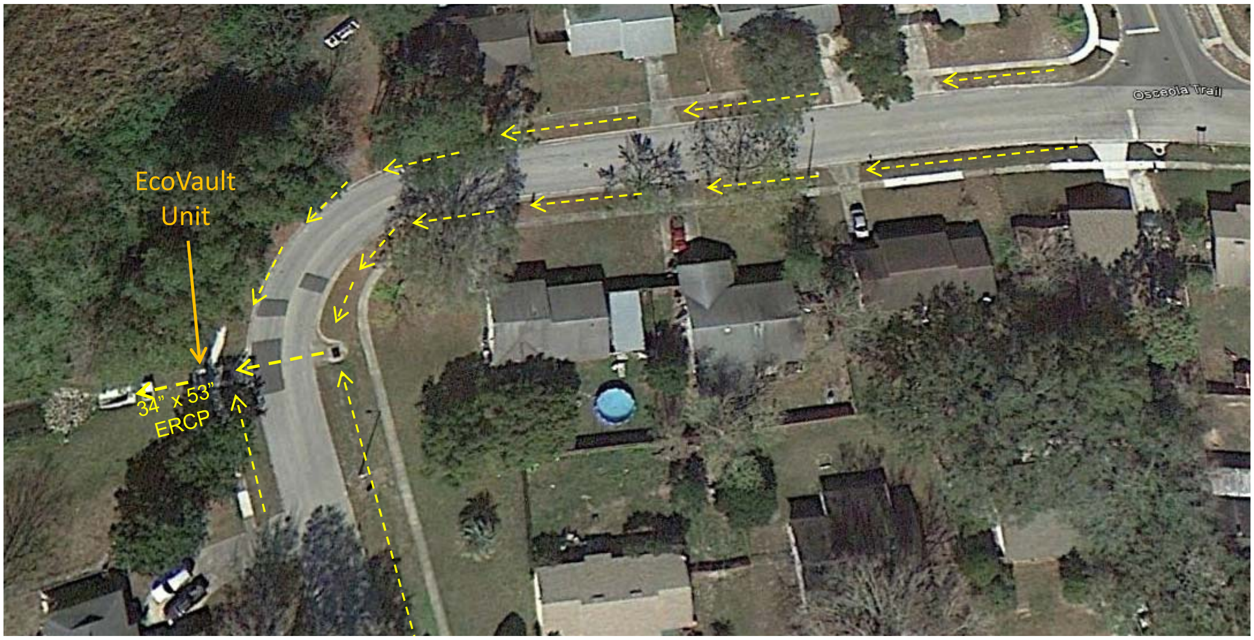


Figure 2-8. Drainage Patterns in the Vicinity of the Lake Hodge Baffle Box Site.

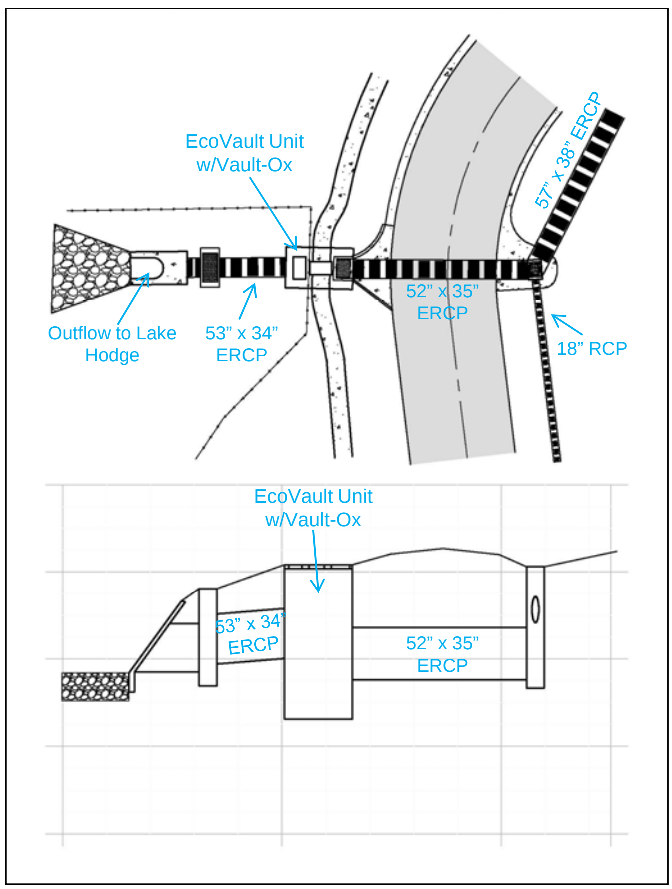
Photographs of the Lake Hodge baffle box inflow are given on Figure 2-9. Runoff is collected on the east side of the roadway in a grate inlet and conveyed beneath Osceola Trail through a 52-inch x 36-inch ERCP. This RCP combines with surface inflows from the west and north sides of Osceola Trail to form the inflow into the EcoVault® unit.

Figure 2-9. Photographs of the Lake Hodge Baffle Box Inflow.

Plan and cross-section views of the Lake Hodge EcoVault® baffle box are illustrated on Figure 2-10. The inflow into the baffle box consists of a 52-inch x 36-inch ERCP, with the discharge from the structure consisting of a 34-inch x 53-inch ERCP. The EcoVault® unit installed at this site is similar to the model illustrated on Figure 2-1 which incorporates the outlet filter. In addition, a Vault-Ox® insert was also installed at this site. Construction drawings for the Lake Hodge EcoVault® site are included in Appendix B.1.

Figure 2-10.

Plan and Cross-Section Views of the Lake Hodge EcoVault® Baffle Box.



2.2.1.3 Gee Creek Baffle Box

Drainage patterns in the vicinity of the Gee Creek baffle box site are illustrated on Figure 2-11. The drainage system within the watershed discharging to the baffle box site consists almost exclusively of shallow vegetated roadside swales which lead to periodic grate inlets within the swales. Due to the highly permeable soils within the basin, a large portion of the generated runoff infiltrates into the onsite soils and swales, resulting in a relatively low runoff potential for this sub-basin area.

Figure 2-11. Drainage Patterns in the Vicinity of the Gee Creek Baffle Box Site.

A photograph of the Gee Creek baffle box site is given on Figure 2-12. A 42-inch RCP and a 15-inch RCP converge into a manhole located in the roadside swale area. The combined flows are then introduced into the EcoVault® baffle box through a 42-inch RCP. After treatment within the EcoVault® system, water discharges from the unit through a 42-inch CMP into Gee Creek. Plan and cross-section views of the Gee Creek EcoVault® baffle box are illustrated on Figure 2-13. The EcoVault® unit installed at this site is similar to the model illustrated on Figure 2-1 which incorporates the outlet filter. In addition, a Vault-Ox® insert was also installed at this site. Construction drawings for the Gee Creek EcoVault® system are included in Appendix B.1.

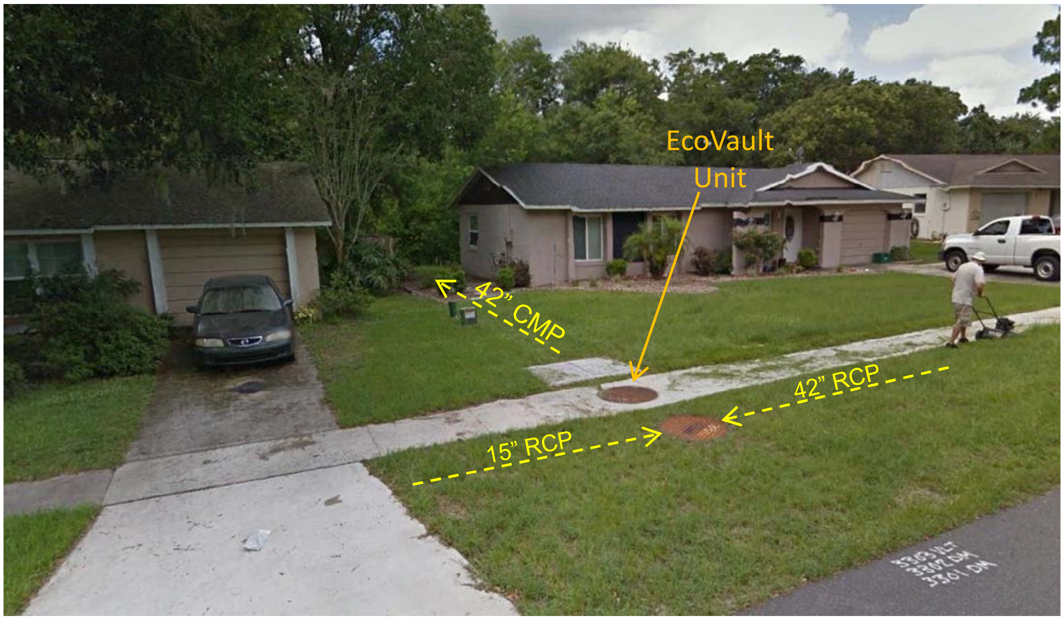


Figure 2-12. Photograph of the Exterior of the Gee Creek EcoVault® Unit.

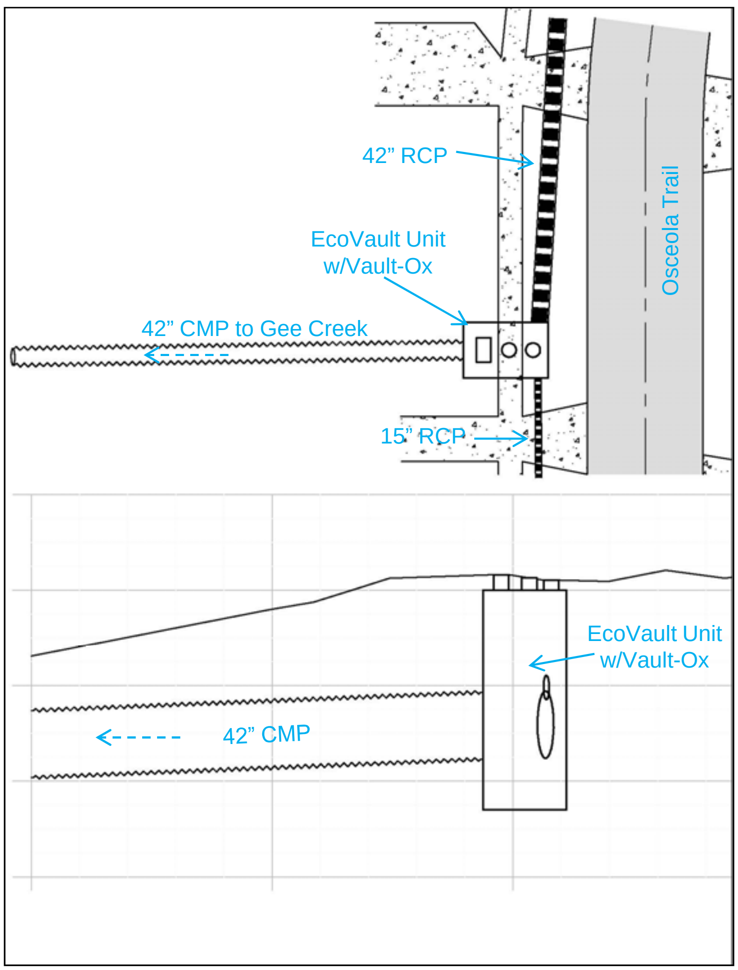


Figure 2-13.

Plan and Cross-Section Views of the Gee Creek EcoVault® Baffle Box.

2.2.2 San Pablo Avenue Sites

2.2.2.1 General Description

The monitoring sites referred to on Figure 1-2 and in Table 1-1 as the San Pablo CDS unit, San Pablo baffle box, and San Pablo inlet filter baskets are each located along San Pablo Avenue on the north shore of Lake Howell and are collectively referred to as the San Pablo Avenue sites. Locations of the San Pablo Avenue GPS units are illustrated on Figure 2-14. The site designated as San Pablo CDS unit consists of a Contech CDS unit which was constructed as part of a previous project not associated with the TMDL Grant. The site referred to as San Pablo baffle box contains an EcoVault® baffle box without a Vault-Ox® insert. The San Pablo inlet filter basket sites each contain Suntree high-capacity curb inlet baskets, as described in Section 2.1.4.

Figure 2-14. Location of the San Pablo Avenue GPS Units.

Contributing watershed areas for the San Pablo Avenue GPS units are illustrated on Figure 2-15. The San Pablo EcoVault® site receives runoff from the sub-basin designated as H-3 which consists of approximately 21.37 acres of single-family residential homes. Approximately 19.37 acres of sub-basin H-3 discharge to the EcoVault® unit, with 2.0 acres discharging to the 680 San Pablo inlet filter basket. The 668/669 San Pablo Suntree curb inlet baskets receive inflow from the sub-basin designated as H-4 which consists of approximately 2.71 acres of single-family residential homes. The Contech CDS unit receives runoff from the sub-basin designated as H-5 which consists of approximately 4.90 acres of single-family residential homes.

Figure 2-15.

Contributing Watershed Areas for the San Pablo Avenue GPS Units.

A summary of hydrologic characteristics of the H-3, H-4, and H-5 sub-basins is given on Table 2-2. Each of the sub-basin areas contains a large amount of impervious area. Each of the sub-basins is also estimated to contain approximately 25-30% DCIA due to the curb and gutter system used throughout each of the sub-basins. The overall basin area is dominated by well drained soils in HSG A. Selected construction plans for the San Pablo Avenue GPS units are included in Appendix B.2.

TABLE 2-2

HYDROLOGIC CHARACTERISTICS OF THE H-3, H-4, AND H-5 SUB-BASINS

SUB-BASIN ID	AREA (acres)	IMPERVIOUS AREA (%)	DCIA AREA (%)	HSG SOIL GROUP	TREATMENT DEVICE
H-3	21.37	45	25	A	EcoVault® Baffle Box
H-4	2.71	58	30	A	Suntree Inlet Baskets
H-5	4.90	67	50	A	CDS Unit
TOTAL:	**28.98**				

2.2.2.2 EcoVault® Baffle Box and Suntree Inlet Filter (Sub-basin H-3)

An overview of drainage patterns in the vicinity of the sub-basin H-3 EcoVault® baffle box site is given on Figure 2-16. In general, drainage within the sub-basin travels by a combination of curb and gutter systems and underground stormsewers which conveys the runoff into the EcoVault® unit. Approximately 19.37 acres of sub-basin H-3 discharge to the EcoVault® unit. The remaining 2 acres is treated by the inlet filter basket at 680 San Pablo and discharges into the downstream side of the EcoVault® unit through the 15-inch RCP.

Figure 2-16.

Drainage Patterns at the San Pablo Baffle Box Site.

A photograph of the exterior of the San Pablo EcoVault® site is given on Figure 2-17. The unit was constructed entirely within the existing right-of-way. Access into the unit is obtained through one of three manholes located in the grassed portion of the right-of-way.

Figure 2-17. Photograph of the San Pablo Baffle Box Site.

Plan and cross-section views of the San Pablo EcoVault® baffle box are illustrated on Figure 2-18. Inflow into the baffle box originates from a 36-inch RCP as well as local street runoff which discharges into the curb inlet structure and combines with the 36-inch RCP inflow. The combined flows pass through the EcoVault® unit, discharges into a manhole, and combines with the 15-inch CP treated by the Suntree inlet filter. The combined flows then discharge through a 36-inch RCP to Lake Howell. As part of this project, a bleeder orifice was installed in a pre-existing outfall sump to control the static water table elevation. This orifice was prone to clogging and is responsible for surcharged conditions frequently observed in the EcoVault® unit. The EcoVault® unit installed at this site is similar to the EcoVault® units installed at the Lake Hodge and Gee Creek sites with the exception that the San Pablo EcoVault® did not contain a Vault-Ox® insert. Construction drawings for the San Pablo EcoVault® site are provided in Appendix B.2.

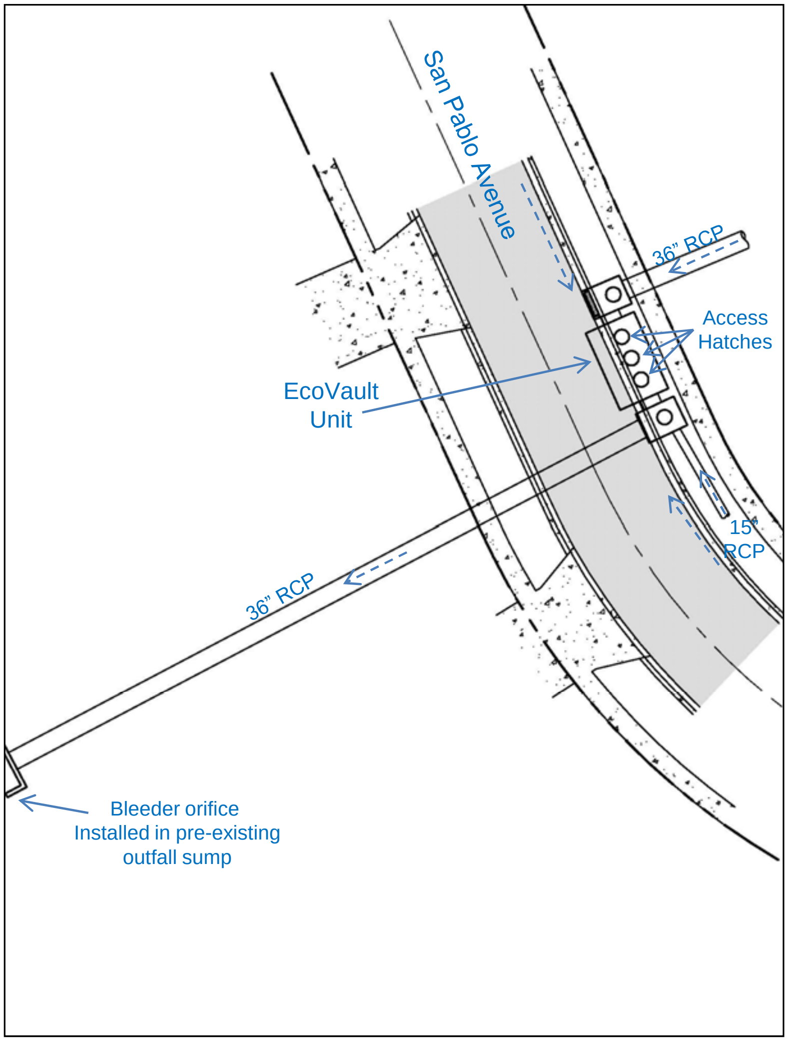


Figure 2-18.

Plan View of the San Pablo EcoVault® Baffle Box

2.2.2.3 <u>San Pablo CDS Unit (Sub-basin H-5)</u>

Drainage patterns in the vicinity of the San Pablo CDS unit are illustrated on Figure 2-19. The drainage system within sub-basin H-5 consists almost exclusively of roadside curb and gutters with underground stormsewer systems. Runoff is collected within sub-basin H-5 and conveyed to the location of the CDS unit on San Pablo Avenue. Due to the highly permeable soils within the sub-basin, a large portion of the generated runoff infiltrates into the onsite soils, resulting on a relatively low runoff potential for the sub-basin area.

A photograph of the San Pablo CDS site is given on Figure 2-20. Runoff enters the CDS unit through an 18-inch RCP which conveys drainage from northern portions of sub-basin H-5. The discharge from the CDS unit to Lake Howell also consists of an 18-inch RCP. Access into the CDS unit is obtained through two separate manhole covers which are removed for clean-out operations. Plan and cross-section views of the San Pablo CDS unit are given on Figure 2-21. Construction drawings for the San Pablo CDS site are included in Appendix B.3.

Figure 2-19. Drainage Patterns at the San Pablo CDS Unit Site.

Figure 2-20.

Photographs of the San Pablo CDS Unit Site.

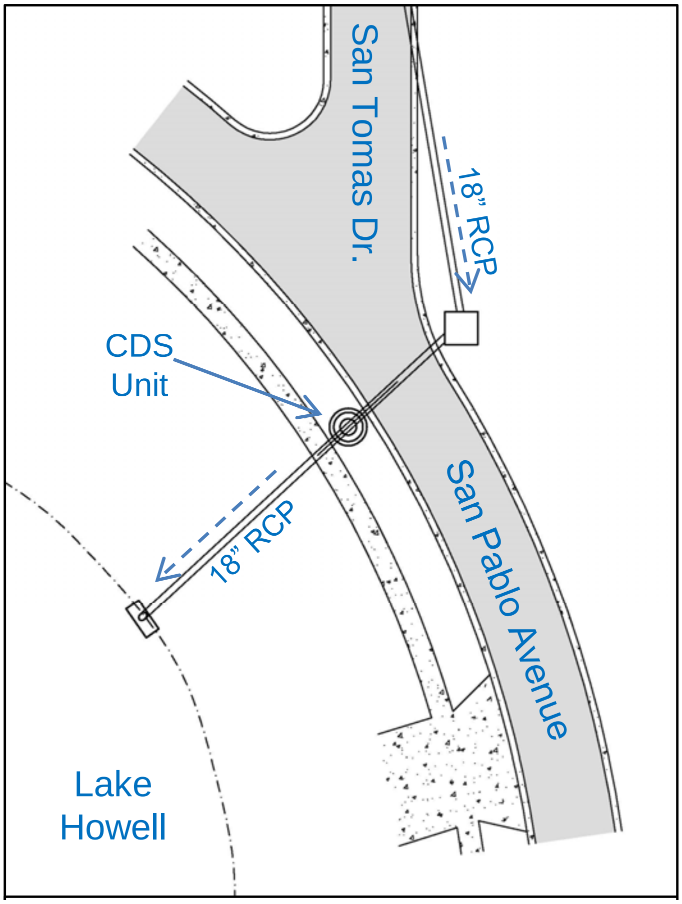
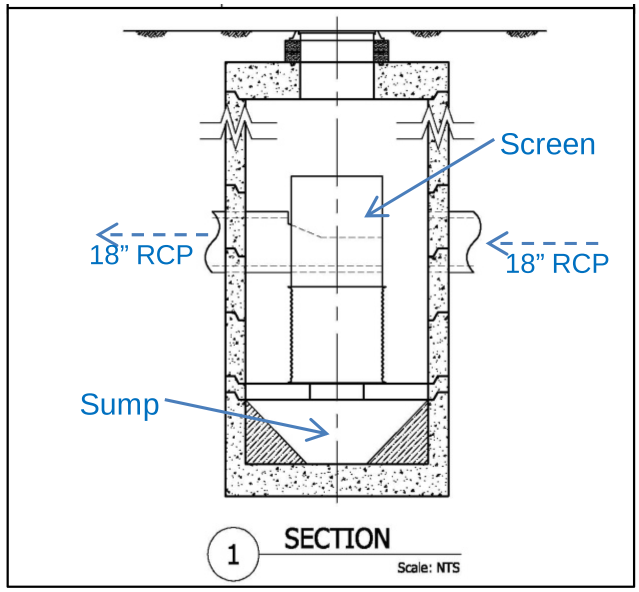


Figure 2-21.

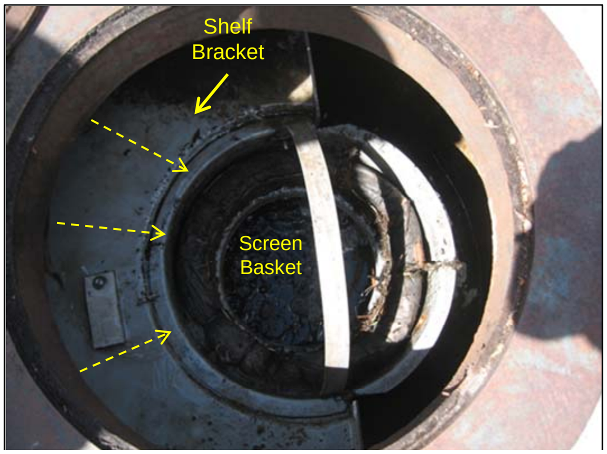
Plan and Cross-section Views of the San Pablo CDS Unit.



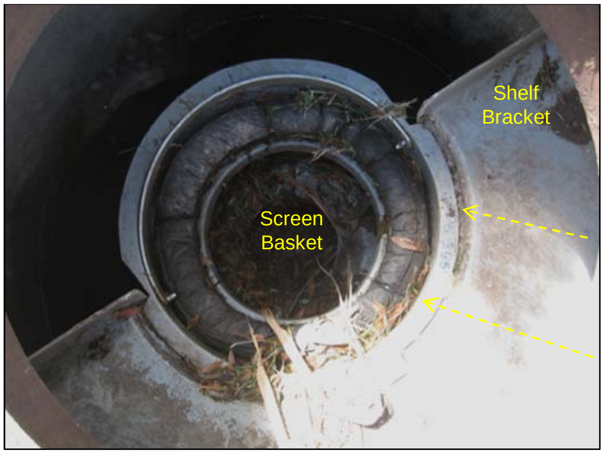
2.2.2.4 <u>Suntree Inlet Baskets</u>

Three Suntree inlet baskets were installed along San Pablo Avenue, with two installed in sub-basin H-4 and one installed in sub-basin H-3 (see Section 2.2.2.2). An overview of drainage patterns in the vicinity of the San Pablo Suntree inlet basket sites in sub-basin H-4 is given on Figure 2-22. Runoff is conveyed to each of the inlet basket inserts by overland flow through the existing curb and gutter system. The runoff is collected in curb inlets located on the north and south sides of San Pablo Avenue, with separate inlet baskets located in each of the two structures. Photographs of the inlet basket units are given on Figure 2-23. Construction drawings for the Suntree inlet baskets are given in Appendix B.2.

Figure 2-22. Photograph of the San Pablo Suntree Inlet Basket Site.



a. Interior of the 668 San Pablo inlet basket



b. Interior of the 669 San Pablo inlet basket

Figure 2-23. Photographs of the San Pablo Inlet Basket Units.

2.2.3 Lake Concord Suntree Baffle Box Site

2.2.3.1 General Description

The monitoring site referred to on Figure 1-2 and in Table 1-1 as the Lake Concord baffle box site is located on the west side of Lake Concord. The location of the Lake Concord baffle box is indicated on Figure 2-24. The system installed at this site consists of a Suntree 2nd Generation Nutrient Separating Baffle Box system.

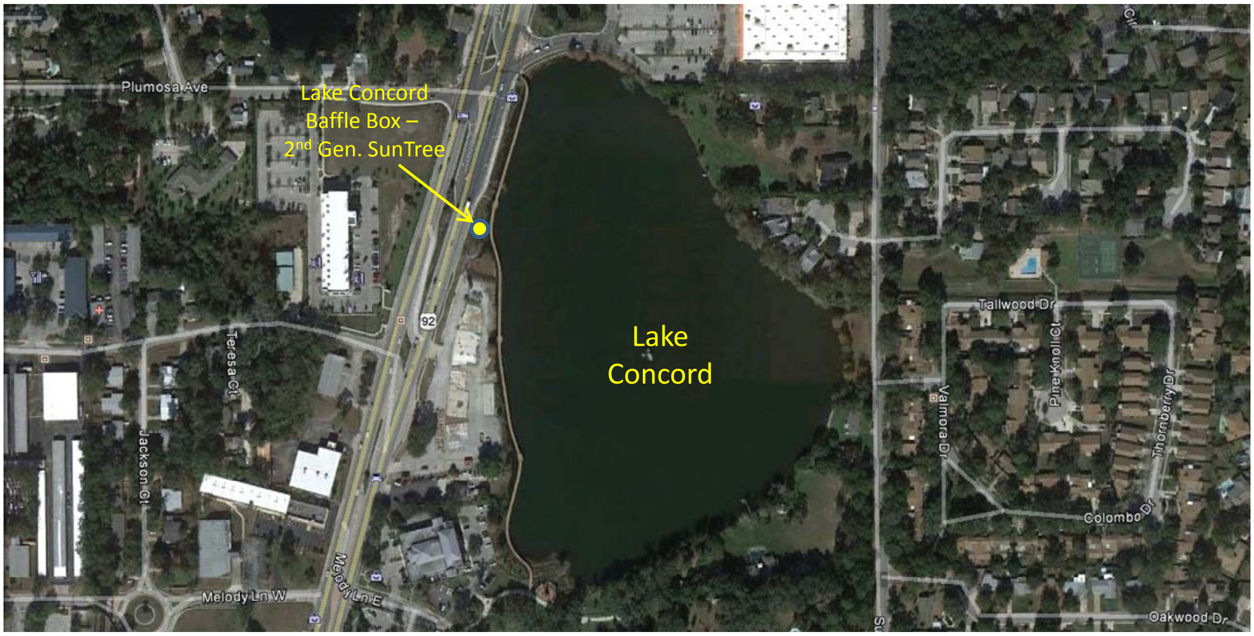


Figure 2-24. Location of the Lake Concord Baffle Box Site.

The contributing watershed area for the Lake Concord baffle box is illustrated on Figure 2-25. The watershed area is referred to as sub-basin G-3 and consists of 5.64 acres of single-family residential, commercial, and roadway land uses on the west side of US 17-92. Soils within the sub-basin are well drained and classified in HSG A which implies a relatively low runoff potential for pervious areas within the basin.

A photograph of the Suntree baffle box unit is given on Figure 2-26. The unit contains three separate manhole covers which can be removed to provide access into interior portions of the baffle box unit during cleaning operations. Construction drawings for the Lake Concord baffle box unit are provided in Appendix B.4.

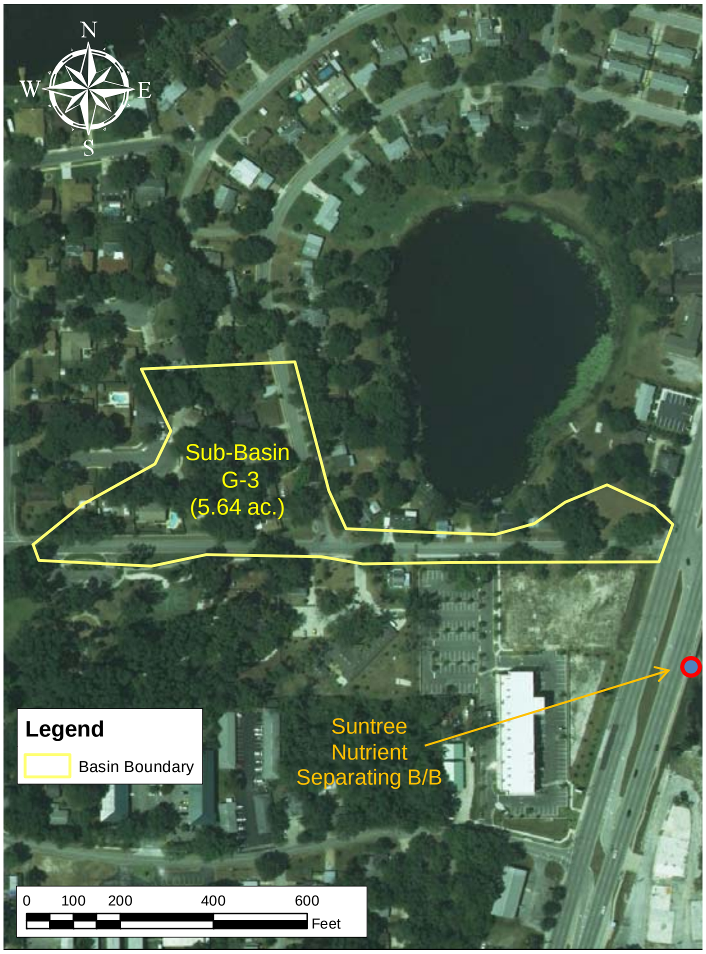


Figure 2-25.

Contributing Watershed Area for the Lake Concord Baffle Box Units.

Figure 2-26.

Photograph of the Outside of the Lake Concord Baffle Box Site.

SECTION 3

FIELD AND LABORATORY ACTIVITIES

Field and laboratory activities were conducted by ERD from June 2013-January 2014 to evaluate the effectiveness of GPS-based stormwater treatment technologies installed within the City of Casselberry. These facilities were constructed by the City to reduce pollutant loadings discharging from adjacent watershed areas into Howell Creek and Gee Creek, both of which are tributaries to Lake Jesup.

Flow monitoring and sample collection equipment was installed at five separate locations by ERD, and field monitoring was conducted over a period of seven months to evaluate the efficiencies of the individual GPS units. The accumulated sediments within each of the evaluated units were removed approximately midway through the monitoring program and at the end of the program to document mass and nutrient loadings removed by each of the units. Specific details of monitoring efforts conducted at each of the monitoring sites are given in the following sections. All field and laboratory work efforts complied with the quality assurance requirements addressed in Chapter 62-160 FAC as well as the document titled "Requirements for Field and Analytical Work Performed for the Department of Environmental Protection Under Contract" (DEP-QA-002/02), dated February 2002.

3.1 Field Monitoring and Instrumentation

A discussion of field monitoring techniques and instrumentation installed at each of the field monitoring sites is given in the following sections.

3.1.1 Osceola Trail Monitoring Sites

Locations of the Osceola Trail monitoring sites are illustrated on Figure 3-1. Field monitoring was conducted at two separate sites containing EcoVault® baffle boxes with Vault-Ox® inserts. Instrumentation was installed at each of the two sites to provide a continuous measurement of discharges through each of the two EcoVault® units under storm event conditions, as well as to collect flow-weighted samples during a wide range of flow conditions. The sampling equipment at each site was installed by ERD during May-June 2013. Formal monitoring was initiated at each of the two sites on June 15, 2013 and continued for a period of 214 days until January 15, 2014.

Figure 3-1. Locations of the Osceola Trail Monitoring Sites.

3.1.1.1 <u>Lake Hodge EcoVault® Site</u>

Monitoring at the Lake Hodge EcoVault® site was conducted at both the inflow and outflow for the baffle box using automatic sequential stormwater samplers with integral flowmeters (ISCO Model 7612). However, since volumetric inflows and outflows for the treatment system are identical, flow monitoring was conducted only at one location. The 34-inch x 53-inch ERCP discharge pipe from the unit was selected as the point of flow measurement since it provided the longest undisturbed reach in the piping system associated with the unit. Discharge monitoring was conducted using an ISCO Model 720 submerged depth probe which provided continuous measurements of water depth within the pipe which are used to calculate discharge rates. The integral flow meter unit was programmed to provide a continuous record of discharges through the EcoVault® unit, with measurements stored into internal memory at 10-minute intervals. The discharge data generated by the flow module provided a continuous hydrograph record of discharges through the EcoVault® unit as well as input to the autosampler to collect composite samples of storm event discharges in a flow-weighted manner.

Each of the automatic samplers was housed inside a single insulated aluminum equipment shelter which was installed on the top of the downstream grate of the installation. Sensor cables and sample tubing were run through the open grate beneath the equipment shelter and extended through the stormsewer system to the point of flow measurement or sample collection. An overview of sampling equipment installed at the Lake Hodge site is given on Figure 3-2.

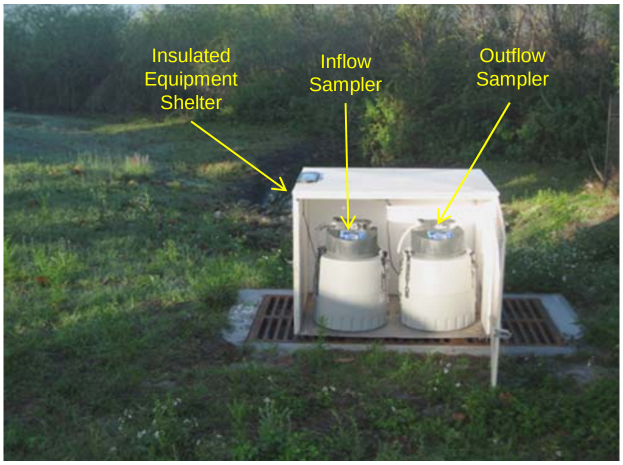


Figure 3-2. Overview of Sampling Equipment Installed at the Lake Hodge Site.

Flow measurements at the Lake Hodge monitoring site were performed using a sensitive pressure transducer sensor which transforms measurements of water depth into discharge rates using the Manning Equation and pipe geometry. The Manning Equation is expressed as:

$$\boldsymbol{Q = \frac{1.486}{n} \times A \times R^{2/3} \times S^{1/2}} \quad \textbf{(Eq. 1)}$$

where:

where:	Q	=	discharge rate (cfs)
	n	=	Manning coefficient
	A	=	cross-sectional area of flow (ft^2)
	R	=	hydraulic radius (ft)
	S	=	pipe slope (ft/ft)

Each of the two automatic samplers contained single 5-gallon polyethylene bottles and were programmed to collect samples in a flow-weighted mode during storm events. The autosampler which contained the attached flow module was linked by cable to the other sampler so that a sampling event at the discharge monitoring site would trigger a simultaneous event at the inflow monitoring site. This process ensured that the inflow and outflow samples are related to runoff characteristics at the time each sample was collected. Each of the automatic samplers was operated on a gel cell battery connected to a solar panel.

3.1.1.2 Gee Creek EcoVault® Unit Site

Monitoring at the Gee Creek EcoVault® site was conducted at both the inflow and outflow for the baffle box using automatic sequential stormwater samplers with integral flowmeters (ISCO Model 7612). Since volumetric inflows and outflows for the treatment system are identical, flow monitoring was conducted at only one location inside the 42-inch CMP which extends from the discharge of the EcoVault® unit to Gee Creek. Discharge monitoring was conducted using an ISCO Model 720 submerged depth probe which provided continuous measurements of water depth within the pipe which are used to calculate discharge rates using the Manning Equation (Equation 1). The integral flowmeter unit was programmed to provide a continuous record of discharges through the EcoVault® unit, with measurements stored into internal memory at 10-minute intervals.

Each of the automatic samplers were installed inside the access riser for the EcoVault® unit and supported on a wooden shelf constructed by ERD. The autosamplers were well above the hydraulic flow line within the unit and did not interfere with flow characteristics. Sensor cables and sample tubing were extended from the autosamplers to the points of flow measurement and sample collection. An overview of sampling equipment installed at the Gee Creek site is given on Figure 3-3.

Figure 3-3. Overview of Sampling Equipment Installed at the Gee Creek Site.

Each of the two automatic samplers contained single 5-gallon polyethylene bottles and were programmed to collect samples in a flow-weighted mode during storm events. The autosampler which contained the attached flow module was linked by cable to the other sampler so that a sampling event at the discharge monitoring site would trigger a simultaneous event at the inflow monitoring site. This process ensured that the inflow and outflow samples are related to inflow characteristics at the time each sample was collected. Each of the automatic samplers was operated on a gel cell battery which was replaced during each site visit.

3.1.2 San Pablo Avenue Monitoring Sites

Locations of the San Pablo Avenue monitoring sites are illustrated on Figure 3-4. Automated field monitoring was conducted at two separate sites, with one site containing an EcoVault® baffle box (without Vault-Ox® insert) and a previously-installed CDS unit. Instrumentation was installed at each of the two sites to provide a continuous measurement of discharges through each of the two units under storm event conditions, as well as to collect flow-weighted samples during a wide variety of flow conditions. The sampling equipment at each site was installed by ERD during May-June 2013. Formal monitoring was initiated at each of the two sites on June 15, 2013 and continued for a period of 214 days until January 15, 2014.

Figure 3-4. Locations of the San Pablo Avenue Monitoring Sites.

3.1.2.1 San Pablo EcoVault® Site

Flow monitoring at the San Pablo EcoVault® site was conducted at both the inflow and outflow for the baffle box using automatic sequential stormwater samplers with integral flowmeters (ISCO Model 7612). However, since volumetric inflows and outflows for the treatment system are identical, flow monitoring was conducted at only one location. Discharge monitoring was conducted at the 36-inch inflow into the baffle box which included the combined flows from 36-inch RCP input from northern portions of the watershed, as well as inputs into the curb inlet which also discharges into the junction manhole (see Figure 2-17). Discharge monitoring at this location was conducted using an ISCO Model 750 area velocity flow module which provided continuous measurements of water depth within the pipe and flow velocities which are then used to calculate discharge rates. The integral flowmeter unit was programmed to provide a continuous record of discharges through the EcoVault® unit, with measurements stored into internal memory at 10-minute intervals.

Flow measurements at the San Pablo EcoVault® site were conducted using an area-velocity sensor which transforms measurements of water depth and velocity into a discharge rate using the Continuity Equation and pipe geometry. The Continuity Equation is expressed as:

$$\mathbf{Q = V \ x \ A} \qquad \textbf{(Eq. 2)}$$

where:

where:	Q	=	discharge rate (cfs)
	V	=	flow velocity (fps)
	A	=	cross-sectional area of flow (ft^2)

Each of the two automatic samplers contained single 5-gallon polyethylene bottles and was programmed to collect samples in a flow-weighted mode during storm events. The autosampler which contained the attached flow module was linked by cable to the other sampler so that a sampling event at the discharge monitoring site would trigger a simultaneous monitoring event at the inflow monitoring site. This process ensured that the inflow and outflow samples are related to runoff characteristics at the time each sample was collected. Each of the automatic samplers was operated on a gel cell battery connected to a solar panel. A photograph of sampling equipment used at the San Pablo Avenue EcoVault® site is given on Figure 3-5.

Figure 3-5. Photograph of Sampling Equipment Used at the San Pablo Avenue EcoVault® Site.

3.1.2.2 San Pablo CDS Unit Site

Field monitoring at the San Pablo CDS unit was conducted only at the discharge for the unit. An ISCO Model 7612 automatic sequential stormwater sampler, with integral flowmeter, was installed at the end of the 36-inch RCP which discharges from the CDS unit. The 36-inch RCP extends approximately 100 ft from the unit and discharges into a sump area used for solids settling before discharging into an earthen channel which conveys the runoff approximately 30 ft into Lake Howell. The sump area was constructed with a horizontal downstream weir which was submerged during flow conditions. The elevation of the weir was raised by ERD by pouring a concrete cap over the original weir to provide a control section for a measurement of discharges through the CDS unit. Flow monitoring was conducted using an ISCO Model 720 submerged depth probe which provided continuous measurements of water depth above the weir crest which was used to calculate discharge rates. The integral flowmeter unit was programmed to provide a continuous record of discharges through the CDS unit, with measurements stored into internal memory at 10-minute intervals.

Flow measurements at the San Pablo CDS site were conducted using a sensitive water depth sensor which transforms measurements of water depth above the horizontal weir into a discharge rate using the following standard horizontal weir equation:

$$\mathbf{Q = C \times L \times H^{1.5}} \qquad \textbf{(Eq. 3)}$$

where: Q = discharge (cfs)

C = weir constant = 2.7 for broad-crested rectangular weir

L = weir length (ft)

H = head over weir crest (ft)

The automatic sampler installed at the CDS site contained a single 5-gallon polyethylene bottle and was programmed to collect samples in a flow-weighted mode during storm events. The automatic sampler was operated on a gel cell battery connected to a solar panel. A photograph of the sampling equipment used at the San Pablo CDS unit site is given on Figure 3-6.

Figure 3-6. Photographs of the Sampling Equipment Used at the San Pablo CDS Unit Site.

3.1.2.3 <u>San Pablo Inlet Baskets</u>

The objective of the monitoring conducted at the San Pablo inlet basket sites was to quantify the mass of solids and nutrients collected in the inlet basket structures. Therefore, automated field equipment was not used at these sites. Estimates of the mass of solids and nutrients removed were obtained by measuring the volume of material captured in each of the three units approximately mid-way through the monitoring program and at the end of the monitoring program, with sub-samples of the collected solids returned to the ERD Laboratory for analysis of physical characteristics and nutrient content.

3.1.3 Lake Concord Suntree Baffle Box Site

The location of the Lake Concord Suntree baffle box monitoring site is illustrated on Figure 3-7. This site contains a Suntree 2nd Generation Baffle Box which was monitored at the outfall only, similar to monitoring conducted for the previously-installed CDS unit. An automatic sequential stormwater sampler (ISCO Model 7612) with integral flowmeter was installed at the discharge from the baffle box system to provide a continuous measurement of discharges through the system. A horizontal sharp-crested rectangular weir was constructed at the end of the 18-inch RCP discharge pipe to provide a primary device for flow measurement of discharges through the system. Discharge monitoring at this site was conducted using an ISCO Model 720 submerged probe module which provided continuous measurements of water depth above the crest of the rectangular sharp-crested weir which is then used to calculate discharge rates. The integral flowmeter unit was programmed to provide a continuous record of discharges through the Suntree baffle box unit, with measurements stored into internal memory at 10-minute intervals.

Figure 3-7. Location of the Lake Concord Monitoring Site.

Flow measurements at the Lake Concord Suntree baffle box site were conducted using a submerged sensor probe which transforms measurements of water depth above the weir crest into a discharge rate using the standard rectangular weir equation summarized in Equation 3, and a weir constant (C value) of 3.2. The length of the weir at the crest elevation was approximately 15 inches.

The autosampler installed at the baffle box site contained a single 5-gallon polyethylene bottle and was programmed to collect samples in a flow-weighted mode during storm events. The automatic sampler was operated on a gel cell battery which was replaced during each visit to the site. A photograph of sampling equipment used at the Lake Concord Suntree baffle box unit site is given on Figure 3-8.

Figure 3-8. Photographs of Sampling Equipment Used at the Lake Concord Suntree Baffle Box Site.

3.1.4 Monitoring Philosophy

3.1.4.1 CDS and Suntree Baffle Box Units

As mentioned previously, field monitoring was conducted only at the outfall from the CDS and Suntree baffle box unit. This is a departure from typical performance efficiency evaluations conducted for GPS units which generally include monitoring at both the inflow and outflows to the units. This new monitoring protocol is based upon the assumption that the total mass of solids and nutrients discharging to the unit is equal to the pollutant loadings measured in the discharge from the unit plus the total mass collected by the system. Captured sediments and debris were removed from the CDS and Suntree baffle box unit on two occasions, and were quantified and analyzed for total nitrogen, total phosphorus, and gross solids. The total input to the CDS unit is then calculated by adding the mass of collected solids and nutrients removed from the unit to the mass discharges from the units. Mass removal efficiencies are then calculated based upon the difference between the inflow and outflow mass loadings.

The specific equations used for estimation of input and output loadings, as well as overall removal efficiency, are summarized below:

The total mass of solids entering the unit is calculated as:

$$\textit{Input Mass} = \textit{Discharge Mass} + \textit{Mass of Sump Solids}$$

The performance efficiency of the unit is calculated by:

$$Efficiency = \frac{Mass\ of\ Sump\ Solids}{Input\ Mass} \times 100$$

It is anticipated that this new methodology outlined above will be substantially more accurate in identifying mass inputs and mass losses from simple GPS units. It is often difficult to quantitatively monitor input concentrations for inflows containing concentrated solid matter for several reasons. First, material such as leaves and debris are too large to be collected by autosamplers and this material is excluded from the inflow monitoring. In addition, much of the sand and grit is transported as a bed loading along the bottom of the stormsewer pipe where the sample intake strainers are typically located. Since the sample strainers are in an area of concentrated solids flow, TSS measurements at the inflow may exaggerate actual solids inflow concentrations. Monitoring only at the outfall location eliminates much of this concern since the heavier materials which tend to travel along the bottom of the stormsewer pipe will be removed within the GPS units, and the discharge will contain primarily small particle sizes which can be sampled in a more representative manner.

This modified protocol is most appropriate for GPS units, such as CDS devices, which do not have significant changes in dissolved constituents during passage through the unit so that the overall removal is a function of solids removal only. However, the EcoVault® units also monitored during this study have media filters on the outflow which are designed to remove dissolved constituents, as well as particulate matter, so monitoring at these sites is conducted at both inflow and outflow locations. A summary of monitoring protocol for each of the GPS sites is given in Table 3-1.

TABLE 3-1

MONITORING PROTOCOL FOR THE CASSELBERRY GPS PERFORMANCE EVALUATION STUDY

SITE NAME	UNIT TYPE	PROPOSED MONITORING
San Pablo	CDS	Outflow Only
San Pablo	Baffle Box (EcoVault®)	Inflow/Outflow
Lake Hodge	Baffle Box (EcoVault® with Vault-Ox®)	Inflow/Outflow
Gee Creek	Baffle Box (EcoVault® with Vault-Ox®)	Inflow/Outflow
Lake Concord	Baffle Box (Suntree 2nd Generation)	Outflow Only

However, based on the previous discussion, the inflow loads into the EcoVault® units may be underestimated if inputs of leaves and debris or solids are significant in the inflow. Due to the residential character of the watershed areas and the well defined curb and gutter drainage system, underestimation of input loadings may occur at the Lake Hodge and San Pablo EcoVault® sites. Underestimation is much less likely at the Gee Creek site since much of the solid matter would be removed in the vegetated swale drainage system. The analyses in Section 4 attempt to address this potential underestimation by adding the collected sump solids and nutrients to the measured inflow loadings.

3.1.4.2 EcoVault® Units

In addition to solids retention on the internal screens and in the sump area, the EcoVault® units also contain a "Baffle Buddy" outlet filter system (see Figure 2-1d) which contains a patented surfactant-modified aluminosilcate which absorbs cations and anions, such as phosphates, ammonia, dissolved metals, hydrocarbons, fecal bacteria, and a variety of organic compounds. Because of this additional removal process, the total mass of solids entering the EcoVault® units cannot simply be calculated as the discharge mass plus the mass of sump solids as was used for the CDS and Suntree baffle box units. Mass removal in the outlet filter system must also be considered. Therefore, the equation used for estimation of input and output mass loadings are summarized below:

$$\text{Input Mass} = \text{Discharge Mass} + \text{Mass of Sump Solids} + \text{Mass Retained in Outlet Filter}$$

The performance efficiency of the EcoVault® units are then calculated by:

$$\textit{Efficiency} = \frac{\textit{Mass of Sump Solids} + \textit{Mass Retained in Inlet Filter}}{\textit{Input Mass}} \times 100$$

As discussed in Section 3.1.1, field monitoring at the EcoVault® units was conducted at both the inflow and outflow for the unit. The measurements conducted at the inflow allow estimation of the mass of dissolved constituents retained in the outlet filter as well as a check on the overall mass balance since the inflow mass loading should equal the sum of the discharge mass, sump solids mass, and filter retained mass.

3.1.5 Rainfall Monitoring Sites

Continuously recording rain gauges were installed in the vicinity of the Osceola Trail, San Pablo Avenue, and Lake Concord monitoring sites to provide a continuous record of rainfall events which occurred during the field monitoring program. Each of the rain gauge units was manufactured by Texas Electronics (Model 1014) and consisted of a tipping bucket system with a resolution of 0.01 inches. The information is used to identify storm-induced runoff events and for evaluating rainfall/runoff relations for each site.

Photographs of rain gauges installed at the San Pablo Avenue and Lake Concord sites are given on Figure 3-9. The rain gauge at the San Pablo site was installed at a neighborhood park on Sausalito Blvd. The rain gauge at the Lake Concord site was installed adjacent to the baffle box unit. Rainfall at the Osceola Trail monitoring sites was monitored using a rain gauge installed at the Lake Hodge EcoVault® site. Each of the rain gauges provided a complete record of rain events which occurred in the vicinity of each of the monitored GPS units during the field monitoring program from June 2013-January 2014.

a. Rain gauge at the San Pablo site

b. Rain gauge at the Lake Concord site

Figure 3-9. Photographs of Rain Gauges Installed at the San Pablo and Lake Concord Sites.

3.1.6 <u>Field Monitoring Activities</u>

During the seven-month field monitoring program, ERD field personnel visited each of the eight automated monitoring sites within approximately 24 hours following significant rain events, or in the absence of rain events, a minimum of once each week to retrieve collected samples, stored hydrologic data from the autosamplers and rain gauges, and perform any necessary equipment maintenance. The internal compartment of the bottom portion of the autosamplers which houses the collection bottles was filled with ice during each site visit so that the collected samples would be stored under chilled conditions until collected. All activities performed at each site were recorded on field notes, and operation of all onsite equipment was evaluated during each visit. All collected inflow/outflow samples were returned to the ERD Laboratory for analyses.

In addition to the continuous monitoring conducted by the automated stormwater samplers, fecal coliform samples were also collected as grab samples on a periodic basis at each of the eight inflow/outflow monitoring sites. Samples for fecal coliform analyses were only collected when flowing water was present at the monitoring sites during visits by ERD field personnel. During these events, fecal coliform samples were collected in sterile Whirl-pak containers and placed in ice. The collected fecal coliform samples were returned to the ERD Laboratory for analysis.

3.2 GPS Clean-Out Operations

3.2.1 Clean-Out Operations

Immediately prior to initiation of the field monitoring program, each of the five monitored GPS units and two inlet basket inserts were cleaned by the City of Casselberry so that the monitoring would be initiated with clean units containing no residual from previous storm events. The material removed from each of the units was disposed of by the City and was not quantified, either in terms of quantity or chemical characteristics, since the solids were collected prior to initiation of the field monitoring program.

After the start-up of the field monitoring program, each of the five monitored GPS units, along with the two inlet basket inserts on San Pablo Avenue, were cleaned and maintained on two occasions during the field monitoring program. The initial clean-out operations for each of the units occurred during September 2013, approximately mid-way through the field monitoring program. The final clean-out event occurred during January 2014 at the completion of the field monitoring efforts.

3.2.1.1 Lake Hodge EcoVault® Unit

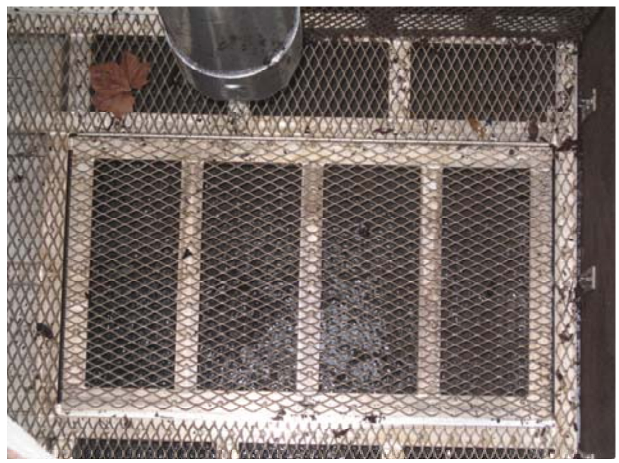
Photographs of clean-out operations for the Lake Hodge EcoVault® unit are illustrated on Figure 3-10. At the time of each of the clean-out events, the screen platform contained a large amount of leaves, vegetation, and other debris. This material was removed from the top of the unit using the vactor truck. Next, standing water was pumped from the sump area using a hydraulic pump. The hinged screens were then opened, allowing access to the lower sump areas for solids removal using the vactor truck. At the completion of the cleaning, virtually all of the solids had been removed from the screen platform and the lower sump area.

The Lake Hodge EcoVault® unit contained multiple Vault-Ox® inserts which were also replaced during each clean-out operation. The inserts were replaced by opening the top of the PVC holder, removing the sock-type cartridge from the unit, and replacing with a new Vault-Ox® insert. Photographs of an exhausted Vault-Ox® insert removed from a canister at the Lake Hodge EcoVault® site is shown on Figure 3-11a, along with a new Vault-Ox® insert illustrated on Figure 3-11b.

a. Captured vegetation on the screen

b. Water pumped from sump area

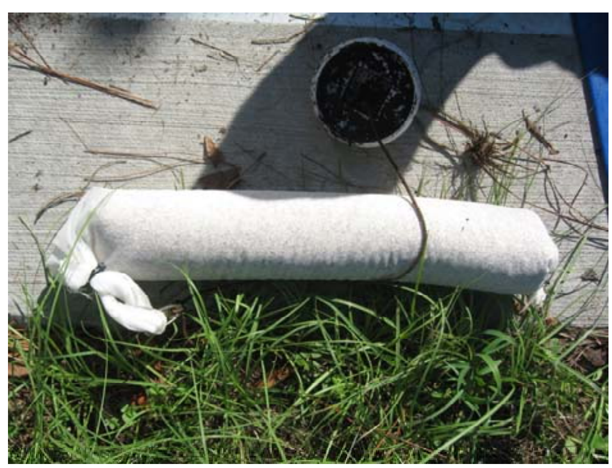
c. Solids removed using vactor truck



d. Screen following cleaning

Figure 3-10. Clean-out Operations for the Lake Hodge EcoVault® Unit.

a. Exhausted Vault-Ox® insert removed from canister



b. New Vault-Ox® insert

Figure 3-11. Photographs of Exhausted and New Vault-Ox® Inserts.

3.2.1.2 Gee Creek EcoVault® Unit

Photographs of clean-out operations at the Gee Creek EcoVault® site are given on Figure 3-12. In general, clean-out operations at the Gee Creek EcoVault® site were similar to those conducted at the Lake Hodge EcoVault® site. As indicated on Figure 3-12a, a large amount of accumulated vegetation was found on the top of the bottom screens. This material was removed using the vactor truck, and the screens were opened to expose the lower sump area. The standing water was pumped from the sump area, and the solids were removed using a vactor truck. A photograph of the Gee Creek screening system following cleaning is illustrated on Figure 3-12d. The Gee Creek unit also contained multiple Vault-Ox® inserts which were replaced at the time of each clean-out operation.

a. Accumulated vegetation on the screens

b. Standing water is pumped from the sump area

c. Solids removed from screen using vactor truck

d. Screening following cleaning

Figure 3-12. Clean-Out Operations for the Gee Creek EcoVault® Site.

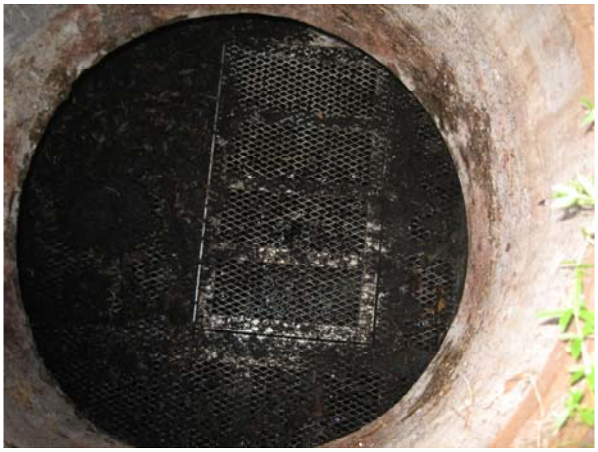
3.2.1.3 San Pablo EcoVault® Unit

Photographs of clean-out operations for the San Pablo EcoVault® baffle box site are illustrated on Figure 3-13. Access to this system was obtained through a series of manhole covers rather than the larger hatches associated with the Lake Hodge and Gee Creek Vault-Ox® units. Standing water was pumped from the bottom chambers, and solids were vacuumed from the bottom screen and sump areas. A photograph of the screen structure following cleaning is given on Figure 3-13d.

a. Clean-out operations

b. Standing water pumped from bottom chambers

c. Solids vacuumed from chambers



d. Screens following cleaning

Figure 3-13. Clean-out Operations for the San Pablo EcoVault® Unit.

3.2.1.4 <u>San Pablo CDS Unit</u>

Photographs of clean-out operations for the San Pablo CDS unit are illustrated on Figure 3-14. Access into the CDS unit for cleaning is obtained through a circular manhole cover located in the grassed median. Excess water is pumped from the CDS unit, and the central sump area is cleaned using the vactor truck. A photograph of the sump area of the CDS unit following the cleaning process is given on Figure 3-14d.

a. Interior of CDS unit prior to cleaning

b. Standing water is pumped from the unit

c. Sump area cleaned using vactor truck

d. Sump area of CDS unit following cleaning

Figure 3-14. Clean-Out Operations for San Pablo CDS Unit.

3.2.1.5 Lake Concord Baffle Box

Photographs of clean-out operations for the Lake Concord baffle box unit are given on Figure 3-15. This unit was cleaned in a manner similar to the EcoVault® units discussed previously. Trapped leaves were first vacuumed from the screen structures, and the screens were opened to expose the bottom sump areas which were also cleaned using the vactor truck.

a. Accumulated solids and debris

b. Vegetation screen prior to cleaning

c. Solids removed from screen using vactor truck

d. Baffle box unit following cleaning

Figure 3-15. Clean-Out Operations for the Lake Concord Baffle Box Unit.

3.2.2 Solids Disposal and Monitoring

Cleaning operations for each of the units were conducted individually such that the vactor truck contained only the solids removed from a specific unit. The material was then transported to a City-owned yard where the contents of the vactor truck were emptied onto the ground. Photographs of solids removed from the Lake Hodge baffle box, Gee Creek baffle box, San Pablo baffle box, and Lake Concord baffle box units are illustrated on Figure 3-16. Material removed from the units appears to consist primarily of vegetation and fine sand. A photograph of material removed from the San Pablo CDS unit is given on Figure 3-17 and appears to be visually similar to debris removed from the other units.

a. Material removed from the Lake Hodge baffle box

b. Material removed from the Gee Creek baffle box

c. Material removed from the San Pablo baffle box

d. Material removed from the Lake Concord baffle box

Figure 3-16. Photographs of Solids Removed from the Baffle Box Units.

Figure 3-17. Photograph of Solids Removed from the CDS Unit.

After the contents of the vactor truck were deposited in the yard, a period of approximately one hour was allowed for the free water to drain from the solids. The solid material was then formed into a rectangular shape so that the dimensions could be measured relatively accurately and the volume of material removed could be calculated. This process was repeated for clean-out operations conducted during September 2013 as well as January 2014 to provide estimates of the total volume of material removed from each of the units during the field monitoring program.

3.3 Laboratory Analyses

A summary of laboratory methods and MDLs for analyses conducted on water samples collected during this project is given in Table 3-2. All laboratory analyses were conducted in the ERD Laboratory. The ERD Laboratory is NELAC-certified (No. 1031026). In addition, a Quality Assurance Project Plan (QAPP), outlining the specific field and laboratory procedures to be conducted for this project, was submitted to and approved by FDEP prior to initiation of any field and laboratory activities.

A summary of laboratory methods and MDLs for analyses conducted on sediment/solid samples collected during this project is given in Table 3-3. All laboratory analyses on solids materials were conducted in the ERD Laboratory.

TABLE 3-2

ANALYTICAL METHODS AND DETECTION LIMITS FOR LABORATORY ANALYSES

PARAMETER	METHOD OF ANALYSIS[1]	METHOD DETECTION LIMITS (MDLs)[2]
pH	SM-21, Sec. 4500-H^+ B	N/A
Conductivity	SM-21, Sec. 2510 B	0.3 μmho/cm
Alkalinity	SM-21, Sec. 2320 B	0.6 mg/l
Ammonia	SM-21, Sec. 4500-NH_3 G	0.003 mg/l
NO_x	SM-21, Sec. 4500-NO_3 F	0.005 mg/l
Total Nitrogen	SM-21, Sec. 4500-N C	0.02 mg/l
Ortho-P (SRP)	SM-21, Sec. 4500-P F	0.003 mg/l
Total Phosphorus	SM-21, Sec. 4500-P F (analysis) and Sec. 4500-P B.5	0.001 mg/l
Turbidity	SM-21, Sec. 2130 B	0.4 NTU
Color	SM-21, Sec. 2120 C	1 Pt-Co Unit
TSS	SM-21, Sec. 2540 D	0.7 mg/l
Copper	SM-21, Sec. 3111 B	2.4 μg/l
Iron	SM-21, Sec. 3111 B	2.2 μg/l
Zinc	SM-21, Sec. 3111 B	1.1 μg/l
Fecal Coliform	SM-21, Sec. 9221 E	N/A

1. Standard Methods for the Examination of Water and Wastewater, 21st Ed., 2005.
2. MDLs are calculated based on the EPA method of determining detection limits

TABLE 3-3

ANALYTICAL METHODS AND DETECTION LIMITS FOR SEDIMENT / SOLIDS ANALYSES

PARAMETER	METHOD OF ANALYSIS	METHOD DETECTION LIMITS (MDLs)[1]
pH	EPA 9045	N/A
Organic Content	EPA/CE-81[2] (pp. 3-54 and 3-59 to 3-60	0.1%
Total Nitrogen	EPA/CE-81 (pp. 3-201 and 3-201 to 3-204	0.01 mg/kg
Total Phosphorus	EPA/CE-81 (pp. 3-323); EPA 365.4	0.005 mg/kg
Density	EPA/CE-81 (pp. 3-61 to 3-62)	N/A

1. MDLs are calculated based on the EPA method of determining detection limits
2. Procedures for Handling and Chemical Analysis of Sediments and Water Samples, EPA/Corps of Engineers, EPA/CE-81-1, 1981.

SECTION 4

RESULTS

Field monitoring, sample collection, and laboratory analyses were conducted by ERD from June 2013-January 2014 to evaluate the pollutant removal efficiencies of five GPS units and two curb inlet inserts installed within the City of Casselberry. A discussion of the results of these efforts is given in the following sections.

4.1 Monitoring Site Hydrology

4.1.1 Rainfall Characteristics

Continuous records of rain event characteristics were collected at rainfall recording sites for the Osceola Trail, San Pablo Avenue, and Lake Concord monitoring sites from June 15, 2013-January 15, 2014 using a tipping bucket rainfall collector with a resolution of 0.01 inch, equipped with a digital data logging recorder. Characteristics of individual rain events measured at each of the rainfall recording sites from June 15, 2013-January 15, 2014 are given in Table 4-1 for the Osceola Trail site, Table 4-2 for the San Pablo Avenue site, and in Table 4-3 for the Lake Concord site. Information is provided on the event start time, event end time, rainfall depth, event duration, antecedent dry period, and average intensity for each individual rain event measured at the three monitoring sites. For purposes of this analysis, average rainfall intensity is calculated as the total rainfall divided by the total event duration.

A total of 32.82 inches of rainfall fell in the vicinity of the Osceola Trail monitoring sites over the 214-day monitoring period from a total of 96 separate storm events. A total rainfall of 27.38 inches was measured at the San Pablo Avenue monitoring site from a total of 97 separate storm events. At the Lake Concord monitoring site, a total of 89 individual storm events were monitored, generating a total of 31.09 inches of rain.

A summary of rain event characteristics measured at each of the three rainfall recording sites from June 15, 2013-January 15, 2014 is given in Table 4-4. In general, minimum recorded values for event rainfall, event duration, average intensity, and antecedent dry period were relatively similar between each of the three rainfall recording sites. However, a substantially higher degree of variability is apparent for the maximum recorded rain event characteristics at the three sites. Overall mean rain event characteristics for each of the three sites appear to be relatively similar. Mean rain event characteristics for the Osceola Trail and Lake Concord monitoring sites are virtually identical for each of the four listed parameters. The San Pablo Avenue site had a slightly lower mean event rainfall depth as well as event duration but was characterized by a somewhat higher average intensity for rainfall.

TABLE 4-1

SUMMARY OF MEASURED RAINFALL EVENTS AT THE OSCEOLA TRAIL RECORDING SITE FROM JUNE 15, 2013-JANUARY 15, 2014

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
Date	Time	Date	Time				
6/16/2013	20:10	6/16/2013	21:00	0.95	0.82	---	1.16
6/17/2013	7:08	6/17/2013	10:18	2.22	3.16	0.4	0.70
6/18/2013	3:37	6/18/2013	7:29	0.15	3.87	0.7	0.04
6/19/2013	13:19	6/19/2013	13:19	0.03	0.00	1.2	---
6/20/2013	18:55	6/20/2013	20:49	0.24	1.89	1.2	0.13
6/21/2013	16:08	6/21/2013	20:19	2.23	4.19	0.8	0.53
6/22/2013	2:31	6/22/2013	2:31	0.01	---	0.3	---
6/28/2013	17:21	6/28/2013	18:32	0.07	1.18	6.6	0.06
6/29/2013	12:14	6/29/2013	14:20	0.02	2.11	0.7	0.01
6/30/2013	14:01	6/30/2013	18:37	0.25	4.60	1.0	0.05
7/1/2013	15:10	7/2/2013	15:45	0.39	24.59	0.9	0.02
7/3/2013	12:04	7/3/2013	21:36	0.31	9.53	0.8	0.03
7/4/2013	19:17	7/4/2013	19:48	0.32	0.53	0.9	0.60
7/5/2013	11:33	7/5/2013	12:29	0.07	0.94	0.7	0.07
7/10/2013	14:04	7/10/2013	14:25	0.20	0.36	5.1	0.56
7/11/2013	13:40	7/11/2013	13:40	0.01	---	1.0	---
7/12/2013	13:12	7/12/2013	13:17	0.03	0.09	1.0	0.32
7/13/2013	15:13	7/13/2013	15:33	0.31	0.33	1.1	0.93
7/14/2013	14:42	7/14/2013	16:59	0.32	2.28	1.0	0.14
7/16/2013	17:02	7/16/2013	19:01	0.89	1.99	2.0	0.45
7/17/2013	17:43	7/17/2013	23:04	0.31	5.35	0.9	0.06
7/18/2013	12:55	7/18/2013	22:28	0.27	9.55	0.6	0.03
7/19/2013	5:47	7/19/2013	5:47	0.01	---	0.3	---
7/19/2013	17:09	7/19/2013	17:09	0.01	---	0.5	---
7/19/2013	23:26	7/20/2013	10:34	1.32	11.13	0.3	0.12
7/21/2013	3:00	7/21/2013	3:00	0.01	---	0.7	---
7/22/2013	11:30	7/22/2013	18:42	0.33	7.21	1.4	0.05
7/23/2013	11:45	7/23/2013	12:11	0.22	0.44	0.7	0.50
7/24/2013	11:06	7/24/2013	14:15	0.51	3.15	1.0	0.16
7/25/2013	6:48	7/25/2013	6:48	0.02	---	0.7	---
7/26/2013	0:13	7/26/2013	0:13	0.01	---	0.7	---
7/27/2013	16:43	7/27/2013	17:14	0.14	0.50	1.7	0.28
7/28/2013	14:56	7/28/2013	17:45	1.85	2.81	0.9	0.66
7/29/2013	0:50	7/29/2013	0:50	0.01	---	0.3	---
7/29/2013	17:33	7/29/2013	17:36	0.02	0.05	0.7	0.36
8/1/2013	17:14	8/1/2013	18:48	0.21	1.56	3.0	0.13
8/2/2013	4:03	8/2/2013	4:03	0.01	---	0.4	---
8/3/2013	15:05	8/3/2013	19:19	0.36	4.24	1.5	0.09
8/4/2013	12:54	8/4/2013	12:54	0.02	0.00	0.7	---
8/5/2013	13:58	8/5/2013	20:01	0.07	6.06	1.0	0.01
8/7/2013	17:59	8/7/2013	18:01	0.04	0.04	1.9	1.01
8/8/2013	14:18	8/8/2013	14:56	0.06	0.62	0.8	0.10
8/10/2013	14:33	8/10/2013	14:40	0.04	0.11	2.0	0.37
8/13/2013	9:21	8/13/2013	9:21	0.01	---	2.8	---
8/14/2013	16:36	8/14/2013	19:28	0.03	2.87	1.3	0.01
8/15/2013	21:21	8/15/2013	22:56	0.51	1.58	1.1	0.32
8/16/2013	17:19	8/16/2013	17:54	0.02	0.57	0.8	0.04
8/17/2013	0:24	8/17/2013	1:37	0.04	1.22	0.3	0.03
8/19/2013	12:14	8/19/2013	16:15	0.15	4.02	2.4	0.04
8/21/2013	13:46	8/21/2013	16:27	1.02	2.69	1.9	0.38
8/22/2013	11:46	8/22/2013	16:47	1.51	5.02	0.8	0.30
8/23/2013	13:17	8/23/2013	18:46	2.10	5.48	0.9	0.38
8/24/2013	14:31	8/24/2013	14:31	0.01	---	0.8	---
8/24/2013	21:57	8/24/2013	21:57	0.02	---	0.3	---
8/31/2013	19:26	8/31/2013	22:42	1.37	3.28	6.9	0.42

TABLE 4-1 -- CONTINUED

SUMMARY OF MEASURED RAINFALL EVENTS AT THE OSCEOLA TRAIL RECORDING SITE FROM JUNE 15, 2013-JANUARY 15, 2014

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
Date	Time	Date	Time				
9/1/2013	20:36	9/1/2013	23:02	0.09	2.44	0.9	0.04
9/4/2013	16:30	9/4/2013	18:31	1.02	2.01	2.7	0.51
9/5/2013	8:45	9/5/2013	8:45	0.01	---	0.6	---
9/6/2013	14:29	9/6/2013	20:36	1.04	6.13	1.2	0.17
9/12/2013	19:44	9/12/2013	19:44	0.01	---	6.0	---
9/17/2013	16:08	9/17/2013	16:35	0.07	0.46	4.8	0.15
9/18/2013	7:27	9/18/2013	8:23	0.03	0.93	0.6	0.03
9/22/2013	16:02	9/22/2013	16:55	0.64	0.88	4.3	0.73
9/23/2013	14:04	9/24/2013	1:46	1.10	11.71	0.9	0.09
9/24/2013	17:07	9/24/2013	21:12	0.34	4.08	0.6	0.08
9/25/2013	5:55	9/25/2013	5:55	0.01	---	0.4	---
9/27/2013	8:57	9/27/2013	19:02	0.07	10.09	2.1	0.01
9/28/2013	12:26	9/28/2013	13:34	0.05	1.14	0.7	0.04
9/30/2013	8:47	9/30/2013	8:47	0.01	---	1.8	---
10/1/2013	8:32	10/1/2013	8:32	0.02	0.00	1.0	---
10/6/2013	15:47	10/6/2013	18:40	0.85	2.89	5.3	0.29
10/7/2013	6:30	10/7/2013	6:30	0.02	0.00	0.5	---
10/7/2013	13:04	10/7/2013	19:13	0.56	6.15	0.3	0.09
10/8/2013	8:56	10/8/2013	8:56	0.02	---	0.6	---
10/21/2013	13:38	10/21/2013	13:38	0.01	---	13.2	---
11/2/2013	9:51	11/2/2013	13:10	0.63	3.32	11.8	0.19
11/5/2013	5:48	11/5/2013	8:01	0.07	2.22	2.7	0.03
11/5/2013	19:33	11/6/2013	0:37	0.30	5.06	0.5	0.06
11/15/2013	19:04	11/16/2013	3:53	0.14	8.81	9.8	0.02
11/16/2013	16:46	11/16/2013	17:29	0.02	0.72	0.5	0.03
11/20/2013	10:49	11/20/2013	10:49	0.01	---	3.7	---
11/20/2013	22:00	11/20/2013	23:27	0.05	1.46	0.5	0.03
11/21/2013	18:32	11/21/2013	20:15	0.03	1.73	0.8	0.02
11/26/2013	8:24	11/26/2013	9:25	0.18	1.01	4.5	0.18
11/27/2013	1:13	11/27/2013	9:20	0.51	8.13	0.7	0.06
12/15/2013	7:11	12/15/2013	7:35	0.26	0.40	17.9	0.65
12/24/2013	5:18	12/24/2013	9:23	0.15	4.08	8.9	0.04
12/28/2013	5:06	12/28/2013	15:01	0.31	9.92	3.8	0.03
12/29/2013	10:12	12/29/2013	20:59	0.41	10.80	0.8	0.04
1/1/2014	5:44	1/1/2014	14:50	0.06	9.10	2.4	0.01
1/2/2014	3:12	1/2/2014	4:26	0.11	1.24	0.5	0.09
1/2/2014	15:21	1/3/2014	0:20	0.55	8.97	0.5	0.06
1/9/2014	17:28	1/9/2014	20:42	0.07	3.23	6.7	0.02
1/11/2014	20:27	1/11/2014	23:32	1.29	3.09	2.0	0.42
1/14/2014	8:22	1/14/2014	8:38	0.04	0.26	2.4	0.15
			TOTAL:	**32.82**	---	---	---
Event Statistics			**Minimum:**	**0.01**	**0.00**	**0.26**	**0.01**
			Maximum:	**2.23**	**24.59**	**17.91**	**1.16**
			Mean:	**0.35**	**3.61**	**2.13**	**0.22**
			Median:	**0.11**	**2.36**	**0.93**	**0.09**
			Geometric Mean:	**0.11**	**1.28**	**1.22**	**0.10**

TABLE 4-2

SUMMARY OF MEASURED RAINFALL EVENTS AT THE SAN PABLO AVENUE RECORDING SITE FROM JUNE 15, 2013-JANUARY 15, 2014

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
Date	Time	Date	Time				
6/16/2013	19:40	6/16/2013	20:30	0.35	0.82	---	0.43
6/17/2013	6:38	6/17/2013	9:48	0.70	3.16	0.4	0.22
6/18/2013	3:07	6/18/2013	6:59	1.31	3.87	0.7	0.34
6/18/2013	22:40	6/18/2013	22:42	0.02	0.04	0.7	0.55
6/19/2013	14:16	6/19/2013	14:16	0.02	0.01	0.6	---
6/19/2013	20:46	6/19/2013	21:09	0.26	0.39	0.3	0.67
6/20/2013	19:01	6/21/2013	2:32	0.40	7.51	0.9	0.05
6/21/2013	22:25	6/22/2013	1:39	0.94	3.23	0.8	0.29
6/26/2013	15:40	6/26/2013	15:40	0.02	0.00	4.6	---
6/28/2013	20:39	6/28/2013	20:39	0.01	---	2.2	---
6/29/2013	19:42	6/29/2013	19:50	0.20	0.14	1.0	1.47
6/30/2013	18:31	7/1/2013	0:15	1.25	5.74	0.9	0.22
7/1/2013	21:09	7/2/2013	6:34	0.27	9.41	0.9	0.03
7/2/2013	18:33	7/2/2013	22:16	0.22	3.72	0.5	0.06
7/3/2013	18:50	7/4/2013	3:05	0.42	8.26	0.9	0.05
7/5/2013	0:22	7/5/2013	1:11	0.59	0.82	0.9	0.72
7/5/2013	17:05	7/5/2013	17:57	0.21	0.87	0.7	0.24
7/10/2013	13:45	7/10/2013	13:46	0.02	0.01	4.8	---
7/16/2013	22:23	7/16/2013	23:06	0.15	0.70	6.4	0.21
7/19/2013	0:38	7/19/2013	0:46	0.11	0.13	2.1	0.83
7/19/2013	14:07	7/19/2013	14:12	0.02	0.08	0.6	0.26
7/19/2013	22:56	7/20/2013	4:15	1.22	5.32	0.4	0.23
7/20/2013	21:50	7/21/2013	7:12	0.03	9.37	0.7	0.00
7/22/2013	20:52	7/23/2013	0:03	0.11	3.19	1.6	0.03
7/23/2013	17:18	7/23/2013	17:25	0.07	0.11	0.7	0.63
7/24/2013	17:15	7/24/2013	19:04	0.05	1.82	1.0	0.03
7/26/2013	8:53	7/26/2013	13:28	0.04	4.58	1.6	0.01
7/27/2013	22:06	7/27/2013	22:16	0.27	0.16	1.4	1.68
7/28/2013	20:49	7/28/2013	23:25	2.05	2.60	0.9	0.79
7/31/2013	9:16	7/31/2013	9:16	0.01	---	2.4	---
8/1/2013	1:08	8/1/2013	1:08	0.01	---	0.7	---
8/1/2013	17:37	8/1/2013	19:11	0.35	1.57	0.7	0.22
8/3/2013	14:41	8/3/2013	19:25	0.96	4.73	1.8	0.20
8/5/2013	14:25	8/5/2013	20:16	0.46	5.85	1.8	0.08
8/8/2013	14:13	8/8/2013	14:17	0.08	0.08	2.7	1.07
8/14/2013	16:25	8/14/2013	19:20	0.25	2.93	6.1	0.09
8/15/2013	22:59	8/15/2013	22:59	0.01	---	1.2	---
8/16/2013	17:21	8/16/2013	17:21	0.01	---	0.8	---
8/16/2013	23:48	8/17/2013	1:35	0.09	1.78	0.3	0.05
8/19/2013	16:00	8/19/2013	16:08	0.04	0.12	2.6	0.33
8/21/2013	14:55	8/21/2013	16:31	0.79	1.59	1.9	0.50
8/22/2013	8:02	8/22/2013	13:17	0.74	5.25	0.6	0.14
8/23/2013	13:41	8/23/2013	18:12	1.51	4.52	1.0	0.33
8/24/2013	16:29	8/24/2013	21:36	0.07	5.11	0.9	0.01
8/25/2013	12:29	8/25/2013	14:17	0.14	1.80	0.6	0.08
8/26/2013	15:47	8/26/2013	15:49	0.04	0.03	1.1	1.52
8/29/2013	15:17	8/29/2013	15:17	0.01	---	3.0	---
8/31/2013	19:11	8/31/2013	22:35	1.58	3.40	2.2	0.46
9/1/2013	20:34	9/1/2013	20:45	0.03	0.19	0.9	0.16
9/5/2013	10:57	9/5/2013	10:57	0.01	---	3.6	---
9/6/2013	14:40	9/6/2013	19:55	1.33	5.25	1.2	0.25
9/7/2013	5:41	9/7/2013	5:41	0.01	---	0.4	---
9/12/2013	19:14	9/12/2013	20:18	0.34	1.06	5.6	0.32

TABLE 4-2 -- CONTINUED

SUMMARY OF MEASURED RAINFALL EVENTS AT THE SAN PABLO AVENUE RECORDING SITE FROM JUNE 15, 2013-JANUARY 15, 2014

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
Date	Time	Date	Time				
9/16/2013	17:55	9/16/2013	18:01	0.17	0.09	3.9	1.87
9/18/2013	7:24	9/18/2013	9:30	0.13	2.11	1.6	0.06
9/19/2013	9:43	9/19/2013	18:03	0.04	8.33	1.0	0.00
9/22/2013	16:05	9/22/2013	16:58	0.45	0.89	2.9	0.51
9/23/2013	14:20	9/23/2013	20:51	0.89	6.52	0.9	0.14
9/24/2013	16:45	9/24/2013	21:10	0.37	4.42	0.8	0.08
9/25/2013	6:09	9/25/2013	6:09	0.01	---	0.4	---
9/27/2013	9:25	9/27/2013	9:25	0.01	---	2.1	---
9/27/2013	19:21	9/27/2013	19:21	0.02	0.00	0.4	---
9/28/2013	13:56	9/28/2013	15:04	0.02	1.14	0.8	0.02
10/6/2013	17:17	10/6/2013	20:10	0.46	2.89	8.1	0.16
10/7/2013	14:34	10/7/2013	20:43	0.64	6.15	0.8	0.10
10/8/2013	10:26	10/8/2013	10:26	0.03	0.00	0.6	---
10/9/2013	12:34	10/9/2013	12:34	0.01	---	1.1	---
11/2/2013	11:21	11/2/2013	14:40	0.40	3.32	23.9	0.12
11/5/2013	7:18	11/5/2013	9:31	0.03	2.22	2.7	0.01
11/14/2013	17:04	11/14/2013	17:06	0.02	0.03	9.3	0.69
11/16/2013	3:16	11/16/2013	10:18	0.16	7.02	1.4	0.02
11/17/2013	0:52	11/17/2013	1:30	0.03	0.64	0.6	0.05
11/20/2013	19:46	11/20/2013	19:50	0.04	0.07	3.8	0.61
11/21/2013	6:50	11/21/2013	7:13	0.04	0.40	0.5	0.10
11/22/2013	3:38	11/22/2013	4:05	0.03	0.44	0.9	0.07
11/26/2013	16:21	11/26/2013	17:26	0.16	1.08	4.5	0.15
11/27/2013	9:16	11/27/2013	13:45	0.40	4.49	0.7	0.09
11/29/2013	20:38	11/29/2013	20:40	0.02	0.03	2.3	0.77
11/30/2013	17:31	11/30/2013	17:31	0.01	---	0.9	---
12/4/2013	18:32	12/4/2013	18:33	0.02	0.02	4.0	1.14
12/11/2013	19:23	12/11/2013	19:24	0.02	0.02	7.0	1.03
12/15/2013	15:21	12/15/2013	15:36	0.18	0.25	3.8	0.72
12/17/2013	21:19	12/17/2013	21:20	0.02	0.02	2.2	1.09
12/24/2013	13:25	12/24/2013	14:15	0.12	0.84	6.7	0.14
12/27/2013	17:44	12/27/2013	17:45	0.02	0.02	3.1	0.84
12/28/2013	13:04	12/29/2013	1:07	0.36	12.05	0.8	0.03
12/29/2013	18:14	12/29/2013	18:14	0.01	---	0.7	---
12/30/2013	0:17	12/30/2013	4:14	0.30	3.95	0.3	0.08
12/30/2013	21:54	12/30/2013	21:54	0.01	---	0.7	---
1/1/2014	14:11	1/1/2014	14:11	0.01	---	1.7	---
1/1/2014	21:18	1/1/2014	22:36	0.03	1.31	0.3	0.02
1/2/2014	11:04	1/2/2014	12:34	0.10	1.50	0.5	0.07
1/2/2014	23:36	1/3/2014	8:24	0.36	8.80	0.5	0.04
1/3/2014	20:38	1/3/2014	20:39	0.02	0.02	0.5	0.94
1/9/2014	19:45	1/9/2014	19:50	0.19	0.09	6.0	2.09
1/11/2014	20:53	1/12/2014	0:37	0.81	3.73	2.0	0.22
1/15/2014	10:33	1/15/2014	10:33	0.01	---	3.4	---
			TOTAL:	**27.38**	**---**	**---**	**---**
Event Statistics			**Minimum:**	**0.01**	**0.00**	**0.25**	**0.00**
			Maximum:	**2.05**	**12.05**	**23.95**	**2.09**
			Mean:	**0.28**	**2.55**	**2.13**	**0.39**
			Median:	**0.10**	**1.50**	**0.98**	**0.22**
			Geometric Mean:	**0.09**	**0.63**	**1.31**	**0.17**

TABLE 4-3

SUMMARY OF MEASURED RAINFALL EVENTS AT THE LAKE CONCORD RECORDING SITE FROM JUNE 15, 2013-JANUARY 15, 2014

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
Date	Time	Date	Time				
6/16/2013	20:10	6/16/2013	21:00	0.82	0.82	---	1.00
6/17/2013	7:08	6/17/2013	10:18	1.82	3.16	0.4	0.58
6/18/2013	3:37	6/18/2013	7:29	0.09	3.87	0.7	0.02
6/19/2013	21:16	6/19/2013	21:39	0.16	0.39	1.6	0.41
6/20/2013	15:58	6/20/2013	23:28	0.22	7.51	0.8	0.03
6/21/2013	19:21	6/21/2013	22:35	1.40	3.23	0.8	0.43
6/28/2013	18:05	6/28/2013	19:15	0.14	1.18	6.8	0.12
6/29/2013	19:03	6/29/2013	19:11	0.14	0.14	1.0	1.03
7/1/2013	20:30	7/2/2013	5:55	0.31	9.41	2.1	0.03
7/2/2013	17:54	7/2/2013	21:37	0.18	3.72	0.5	0.05
7/3/2013	17:05	7/4/2013	1:20	0.46	8.26	0.8	0.06
7/4/2013	22:37	7/4/2013	23:26	0.45	0.82	0.9	0.55
7/5/2013	17:05	7/5/2013	17:57	0.16	0.87	0.7	0.18
7/10/2013	15:34	7/10/2013	15:55	0.09	0.36	4.9	0.25
7/11/2013	15:10	7/11/2013	15:10	0.01	---	1.0	---
7/12/2013	14:42	7/12/2013	14:47	0.03	0.09	1.0	0.32
7/13/2013	16:43	7/13/2013	17:03	0.09	0.33	1.1	0.27
7/16/2013	18:32	7/16/2013	20:31	0.42	1.99	3.1	0.21
7/17/2013	17:42	7/17/2013	22:59	0.41	5.29	0.9	0.08
7/18/2013	9:20	7/18/2013	13:18	0.78	3.97	0.4	0.20
7/18/2013	19:21	7/18/2013	19:24	0.02	0.06	0.3	0.34
7/19/2013	17:33	7/19/2013	22:23	1.25	4.83	0.9	0.26
7/20/2013	16:41	7/20/2013	21:10	0.05	4.48	0.8	0.01
7/21/2013	17:26	7/21/2013	17:26	0.02	---	0.8	---
7/22/2013	10:26	7/22/2013	18:34	0.51	8.14	0.7	0.06
7/23/2013	11:41	7/23/2013	15:38	0.24	3.95	0.7	0.06
7/24/2013	11:47	7/24/2013	14:17	0.23	2.50	0.8	0.09
7/27/2013	18:16	7/27/2013	18:16	0.01	---	3.2	---
7/28/2013	14:55	7/28/2013	17:58	1.10	3.05	0.9	0.36
7/29/2013	17:33	7/29/2013	17:55	0.22	0.37	1.0	0.60
7/31/2013	12:29	7/31/2013	12:29	0.01	---	1.8	---
8/1/2013	1:14	8/1/2013	1:14	0.01	---	0.5	---
8/1/2013	17:34	8/1/2013	18:44	0.22	1.16	0.7	0.19
8/2/2013	2:12	8/2/2013	2:12	0.01	---	0.3	---
8/3/2013	14:46	8/3/2013	19:16	0.42	4.51	1.5	0.09
8/4/2013	11:24	8/4/2013	11:24	0.01	---	0.7	---
8/5/2013	14:18	8/5/2013	20:01	0.56	5.73	1.1	0.10
8/8/2013	14:18	8/8/2013	14:57	0.39	0.65	2.8	0.60
8/14/2013	19:17	8/14/2013	19:17	0.01	---	6.2	---
8/15/2013	22:15	8/16/2013	4:43	0.85	6.47	1.1	0.13
8/16/2013	17:17	8/16/2013	17:29	0.05	0.21	0.5	0.24
8/16/2013	23:54	8/17/2013	1:33	0.05	1.65	0.3	0.03
8/19/2013	16:11	8/19/2013	16:11	0.01	---	2.6	---
8/20/2013	15:11	8/20/2013	15:17	0.04	0.11	1.0	0.37
8/21/2013	13:49	8/21/2013	16:37	0.72	2.80	0.9	0.26
8/22/2013	11:28	8/22/2013	13:21	0.85	1.89	0.8	0.45
8/23/2013	10:57	8/23/2013	19:11	1.70	8.23	0.9	0.21
8/24/2013	21:03	8/24/2013	21:03	0.01	---	1.1	---
8/25/2013	16:06	8/25/2013	16:09	0.04	0.06	0.8	0.67
8/26/2013	13:34	8/26/2013	23:00	0.05	9.43	0.9	0.01
8/28/2013	8:21	8/28/2013	8:21	0.01	---	1.4	---
8/31/2013	19:24	8/31/2013	22:36	1.14	3.20	3.5	0.36

TABLE 4-3 -- CONTINUED

SUMMARY OF MEASURED RAINFALL EVENTS AT THE LAKE CONCORD RECORDING SITE FROM JUNE 15, 2013-JANUARY 15, 2014

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
Date	Time	Date	Time				
9/1/2013	20:33	9/1/2013	21:37	0.06	1.08	0.9	0.06
9/4/2013	16:25	9/4/2013	18:20	1.63	1.92	2.8	0.85
9/5/2013	7:28	9/5/2013	7:28	0.02	---	0.5	---
9/6/2013	14:26	9/6/2013	20:11	1.07	5.75	1.3	0.19
9/12/2013	18:32	9/12/2013	20:05	1.22	1.55	5.9	0.79
9/18/2013	11:02	9/18/2013	11:02	0.02	---	5.6	---
9/22/2013	16:05	9/22/2013	16:45	0.41	0.67	4.2	0.61
9/23/2013	7:23	9/23/2013	7:23	0.01	---	0.6	---
9/23/2013	14:10	9/23/2013	21:14	0.94	7.07	0.3	0.13
9/24/2013	9:52	9/24/2013	9:52	0.01	---	0.5	---
9/24/2013	16:33	9/24/2013	21:14	0.32	4.69	0.3	0.07
9/25/2013	5:58	9/25/2013	9:10	0.02	3.20	0.4	0.01
9/27/2013	10:06	9/27/2013	10:06	0.01	---	2.0	---
9/28/2013	13:25	9/28/2013	13:53	0.08	0.46	1.1	0.17
10/6/2013	15:38	10/6/2013	21:45	0.17	6.11	8.1	0.03
10/7/2013	12:59	10/7/2013	19:13	0.51	6.24	0.6	0.08
10/8/2013	12:55	10/8/2013	12:55	0.02	---	0.7	---
11/2/2013	9:47	11/2/2013	13:08	1.22	3.36	24.9	0.36
11/3/2013	3:35	11/3/2013	3:35	0.01	---	0.6	---
11/5/2013	5:50	11/5/2013	7:54	0.05	2.06	2.1	0.02
11/5/2013	19:38	11/6/2013	2:43	0.18	7.08	0.5	0.03
11/15/2013	19:09	11/16/2013	1:39	0.34	6.50	9.7	0.05
11/16/2013	16:53	11/16/2013	17:51	0.04	0.98	0.6	0.04
11/20/2013	11:42	11/20/2013	11:42	0.01	---	3.7	---
11/21/2013	18:11	11/21/2013	18:43	0.16	0.54	1.3	0.30
11/26/2013	8:17	11/26/2013	9:18	0.16	1.02	4.6	0.16
11/27/2013	1:00	11/27/2013	9:08	0.34	8.13	0.7	0.04
12/15/2013	7:15	12/15/2013	7:37	0.16	0.36	17.9	0.44
12/24/2013	5:17	12/24/2013	5:51	0.23	0.57	8.9	0.41
12/28/2013	5:29	12/28/2013	15:10	0.23	9.68	4.0	0.02
12/29/2013	10:22	12/29/2013	20:31	0.40	10.15	0.8	0.04
1/1/2014	6:01	1/1/2014	14:05	0.03	8.08	2.4	0.00
1/2/2014	3:13	1/2/2014	6:28	0.04	3.25	0.5	0.01
1/2/2014	15:19	1/2/2014	23:59	0.53	8.67	0.4	0.06
1/9/2014	17:26	1/9/2014	20:04	0.05	2.63	6.7	0.02
1/11/2014	20:27	1/12/2014	0:04	1.38	3.63	2.0	0.38
1/14/2014	8:26	1/14/2014	8:55	0.02	0.49	2.3	0.04
			TOTAL:	**31.09**	**---**	**---**	**---**
Event Statistics			**Minimum:**	**0.01**	**0.06**	**0.25**	**0.00**
			Maximum:	**1.82**	**10.15**	**24.87**	**1.03**
			Mean:	**0.35**	**3.50**	**2.29**	**0.24**
			Median:	**0.16**	**3.11**	**0.93**	**0.17**
			Geometric Mean:	**0.12**	**1.91**	**1.26**	**0.12**

TABLE 4-4

SUMMARY OF RAIN EVENT CHARACTERISTICS AT THE THREE RAINFALL RECORDING SITES FROM JUNE 15, 2013-JANUARY 15, 2014

PARAMETER	UNITS	MINIMUM VALUE			MAXIMUM VALUE			MEAN VALUE		
		Osceola Trail	San Pablo Avenue	Lake Concord	Osceola Trail	San Pablo Avenue	Lake Concord	Osceola Trail	San Pablo Avenue	Lake Concord
Event Rainfall	inches	0.01	0.01	0.01	2.23	2.05	1.82	0.35	0.28	0.35
Event Duration	hours	0.01	0.01	0.06	24.6	12.1	10.2	3.61	2.55	3.50
Average Intensity	in/hr	0.01	0.01	0.01	1.16	2.09	1.03	0.22	0.39	0.24
Antecedent Dry Period	days	0.26	0.25	0.25	17.9	24.0	24.9	2.13	2.13	2.29

A comparison of measured and typical "normal" rainfall in the vicinity of the Casselberry GPS units is given in Figure 4-1. Measured rainfall in this figure is based upon the field measured rain events at each of the three rainfall recording sites, summarized on a monthly basis. "Normal" rainfall conditions are based upon historical rainfall recorded at the Sanford Experimental Station (Site 087982) over the 30-year period from 1981-2010. Comparisons for rainfall during the months of June 2013 and January 2014 for both the measured and "normal" data sets reflect only partial months, with the values for June reflecting measured and typical rainfall characteristics from June 15-30, 2013 and the January values reflecting measured and "normal" rainfall characteristics over the period from January 1-15, 2014.

As seen in Figure 4-1, measured rainfall in the vicinity of the GPS monitoring sites was approximately normal only during the month of August. Slightly higher than "normal" rainfall was observed at the GPS monitoring sites during June and January, with lower than "normal" rainfall observed during the remaining months. Overall, "normal" rainfall in the general area during the field monitoring program is approximately 36.78 inches, compared with measured rainfall amounts of 31.09 inches at the Lake Concord site, 32.82 inches at the Osceola Trail sites, and 27.38 inches at the San Pablo Avenue monitoring sites. Overall, rainfall was somewhat less than "normal" at each of the monitoring sites during the field monitoring program.

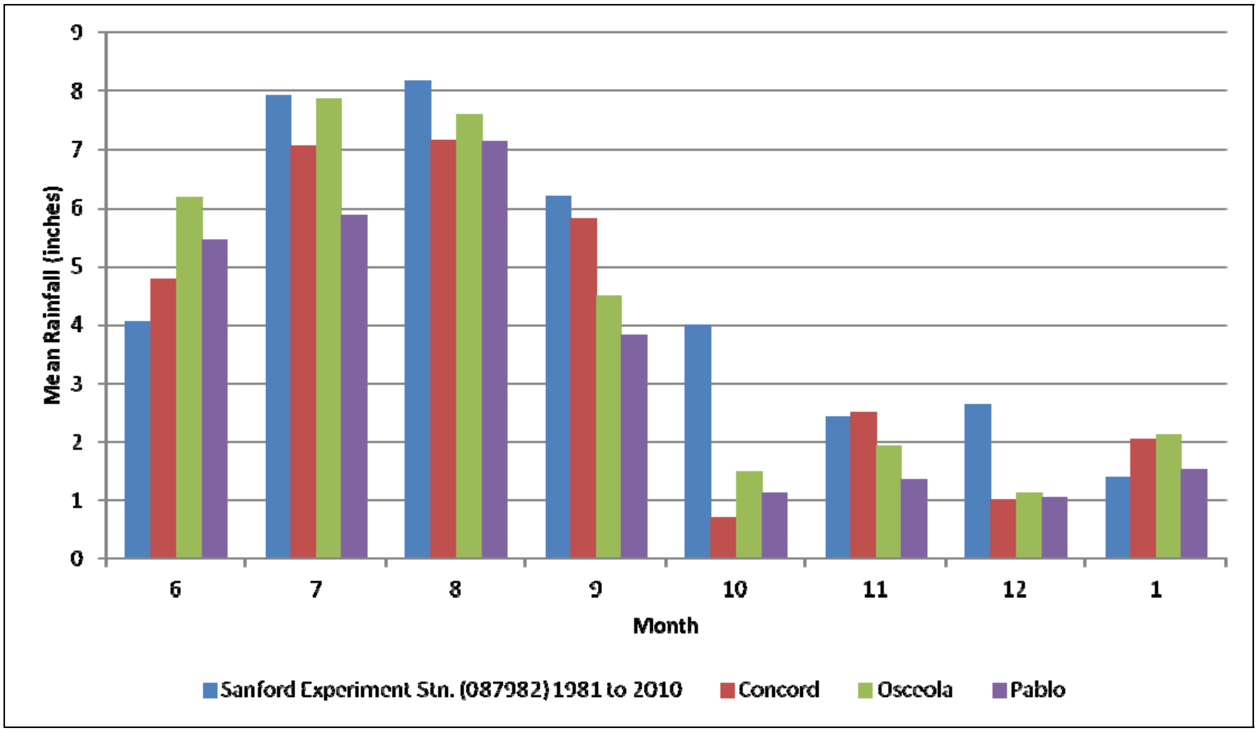


Figure 4-1. Comparison of "Average" and Measured Rainfall in the Vicinity of the GPS Monitoring Sites.

4.1.2 Hydrologic Inputs

Continuous records of hydrologic inputs/outputs for each of the five GPS monitoring sites were recorded at 15-minute intervals during the field monitoring program from June 15, 2013-January 15, 2014. A discussion of monitored hydrologic inputs/outputs at each of the monitoring sites is given in the following sections.

4.1.2.1 Lake Hodge EcoVault® Site

A graphical summary of measured runoff hydrographs at the Lake Hodge EcoVault® site from June 15, 2013-January 15, 2014 is given on Figure 4-2. Monitored rain events are also included for evaluation of relationships between rainfall and runoff. Measured discharge rates at the Lake Hodge site ranged from approximately 0-22 cfs, with the vast majority of monitored runoff rates less than approximately 10 cfs. The highest runoff inflow rates were observed from rain events in excess of 2 inches or from multiple significant rain events occurring on sequential days. In general, peak flows measured during storm events appear to be closely related to the depth of the rainfall event. Rainfall events of approximately 0.25 inches or less resulted in relatively insignificant runoff inflow rates.

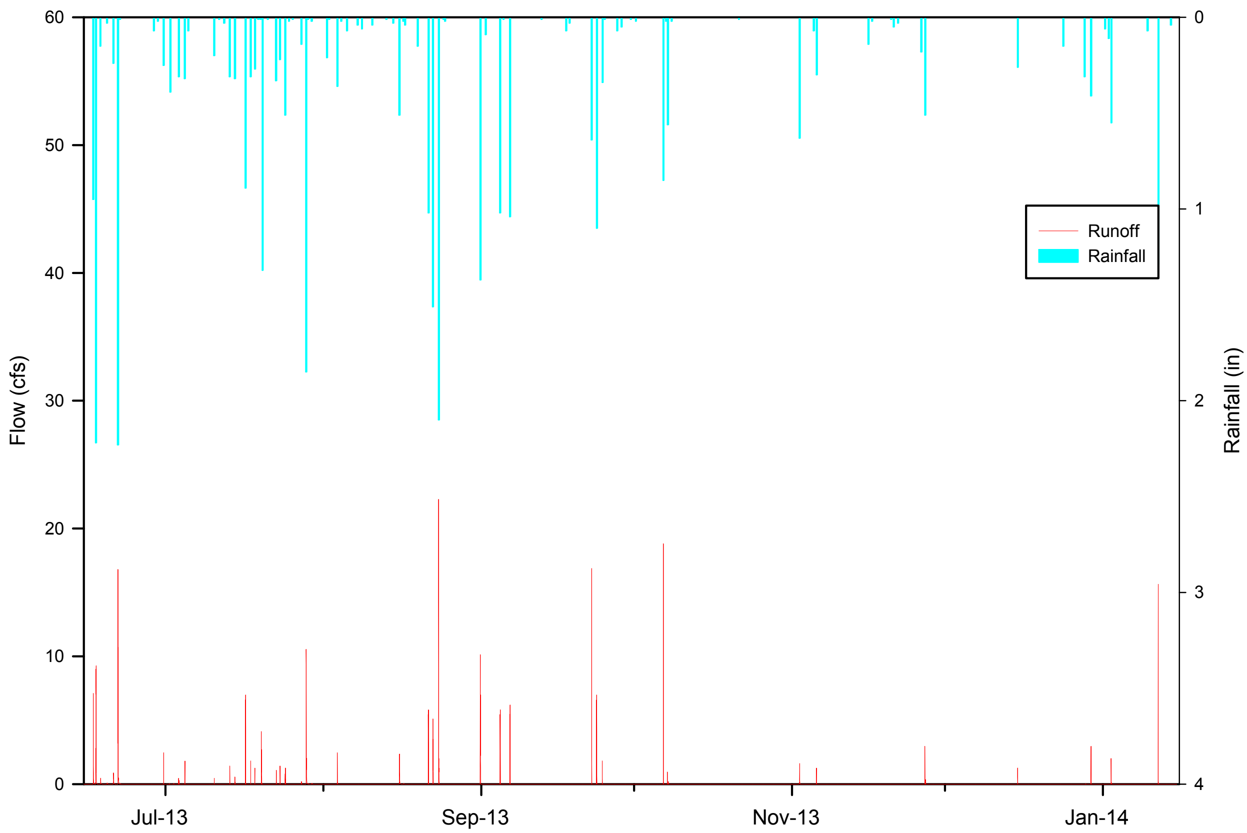


Figure 4-2. Measured Runoff Hydrographs at the Lake Hodge EcoVault® Site from June 15, 2013-January 15, 2014.

A summary of measured monthly runoff inputs to the Lake Hodge EcoVault® unit is given on Table 4-5. The information obtained in this table was generated by integrating the runoff hydrographs illustrated on Figure 4-2 over each monthly monitoring period. Runoff inputs for the months of June and January reflect only partial months, with the June runoff volume reflecting runoff inputs from June 15-30 and the January reflecting inputs from January 1-15.

Runoff inputs to the Lake Hodge EcoVault® unit ranged from a high of 3.13 ac-ft during August to a low of 0.11 ac-ft during December. Overall, approximately 10.84 ac-ft of runoff passed through the EcoVault® unit during the field monitoring program.

A summary of runoff coefficient calculations for the Lake Hodge site is given on Table 4-6. During the field monitoring program, approximately 31.51 inches of rainfall fell on the 20.98-acre basin area, generating a runoff volume of 10.84 ac-ft. The calculated runoff coefficient for this site is 0.197, indicating that approximately 19.7% of the basin rainfall became stormwater runoff.

TABLE 4-5

MEASURED MONTHLY RUNOFF INPUTS TO THE LAKE HODGE EcoVault® UNIT

MONTH	RUNOFF VOLUME (ac-ft)	MONTH	RUNOFF VOLUME (ac-ft)
June[1]	2.56	October	0.47
July	2.09	November	0.26
August	3.13	December	0.11
September	1.65	January[2]	0.57
		TOTAL:	**10.84**

1. Period from June 15-30
2. Period from January 1-15

TABLE 4-6

RUNOFF COEFFICIENT CALCULATIONS FOR THE LAKE HODGE EcoVault® SITE

PARAMETER	UNITS	VALUE
Site Rainfall	inches	31.51
Basin Area	acres	20.98
Rainfall Volume	ac-ft	55.09
Runoff Volume	ac-ft	10.84
C Value	--	0.197

4.1.2.2 Gee Creek EcoVault® Site

A graphical summary of measured runoff hydrographs at the Gee Creek EcoVault® site from June 15, 2013-January 15, 2014 is given on Figure 4-3. Rain events at the monitoring site are also included for evaluation of relationships between rainfall and runoff. Measured discharge rates at the Gee Creek EcoVault® site ranged from 0 cfs to approximately 23 cfs, although the vast majority of peak runoff values were less than 10 cfs. Runoff inflow rates in excess of 10 cfs were typically generated by rain events in excess of 2 inches or multiple smaller rain events occurring over consecutive days. Rain events less than approximately 0.25 inches resulted in relatively insignificant runoff inputs. Peak flows measured during storm events appear to be closely related to the depth of the rainfall event.

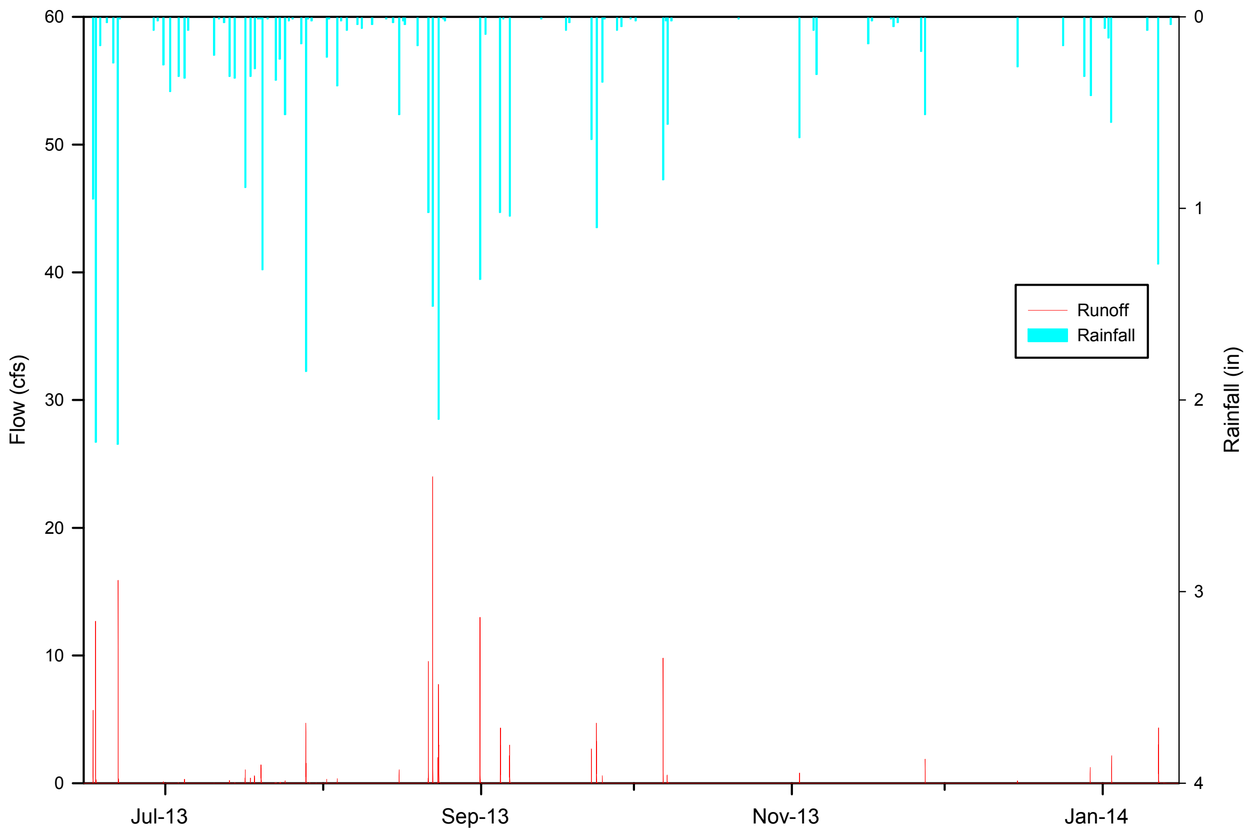


Figure 4-3. Measured Runoff Hydrographs at the Gee Creek EcoVault® Site from June 15, 2013-January 15, 2014.

A tabular summary of measured monthly runoff inputs to the Gee Creek EcoVault® unit is given in Table 4-7. The runoff inputs summarized in this table were generated by integrating the runoff hydrographs illustrated on Figure 4-3 for each monthly monitoring period. Measured runoff inputs ranged from a high of 2.65 ac-ft during August to a low of 0.06 ac-ft during December. Overall, approximately 6.56 ac-ft of runoff discharged through the Gee Creek EcoVault® unit during the field monitoring program.

A summary of runoff coefficient calculations for the Gee Creek monitoring site is given on Table 4-8. A total of approximately 31.51 inches of rainfall fell on the 29.98-acre watershed during the 7-month field monitoring program, generating a total of 6.56 ac-ft of runoff. The resulting runoff coefficient for the watershed is approximately 0.083 which is approximately half of the runoff coefficient measured at the Lake Hodge site. Both the Lake Hodge and Gee Creek drainage basins are characterized by highly permeable HSG A soils which have a low runoff potential. The primary difference between the two sub-basins is the lack of significant DCIA in the Gee Creek sub-basin since runoff is collected and conveyed in vegetated roadside swales where much of the runoff infiltrates into the soil before reaching the point of inflow into the stormsewer system. In contrast, the Lake Hodge sub-basin contains a mixture of curb and gutter and grassed roadside swales, resulting in a larger proportion of the rainfall becoming runoff and reaching the GPS device.

TABLE 4-7

MEASURED MONTHLY RUNOFF INPUTS TO THE GEE CREEK EcoVault® UNIT

MONTH	RUNOFF VOLUME (ac-ft)	MONTH	RUNOFF VOLUME (ac-ft)
June[1]	1.36	October	0.38
July	0.70	November	0.13
August	2.65	December	0.06
September	0.87	January[2]	0.41
		TOTAL:	**6.56**

1. Period from June 15-30
2. Period from January 1-15

TABLE 4-8

RUNOFF COEFFICIENT CALCULATIONS FOR THE GEE CREEK EcoVault® SITE

PARAMETER	UNITS	VALUE
Site Rainfall	inches	31.51
Basin Area	acres	29.98
Rainfall Volume	ac-ft	78.72
Runoff Volume	ac-ft	6.56
C Value	--	0.083

4.1.2.3 San Pablo EcoVault® Site

A graphical summary of measured runoff hydrographs at the San Pablo EcoVault® site from June 15, 2013-January 15, 2014 is given on Figure 4-4. Rainfall depths for measured rain events at the monitoring site are also included for evaluation of relationships between rainfall and runoff. Measured discharge rates at the EcoVault® monitoring site ranged from approximately 0-12 cfs, although the vast majority of measured peak discharge values were less than 5 cfs. Runoff peaks in excess of 5 cfs generally required rain events in excess of approximately 1-1.5 inches or a series of multiple significant rain events on consecutive days. Relatively insignificant runoff flow rates were generated from rain events of approximately 0.1 inch or less. In general, peak flow rates measured during storm events appear to be closely related to the depth of the rainfall event.

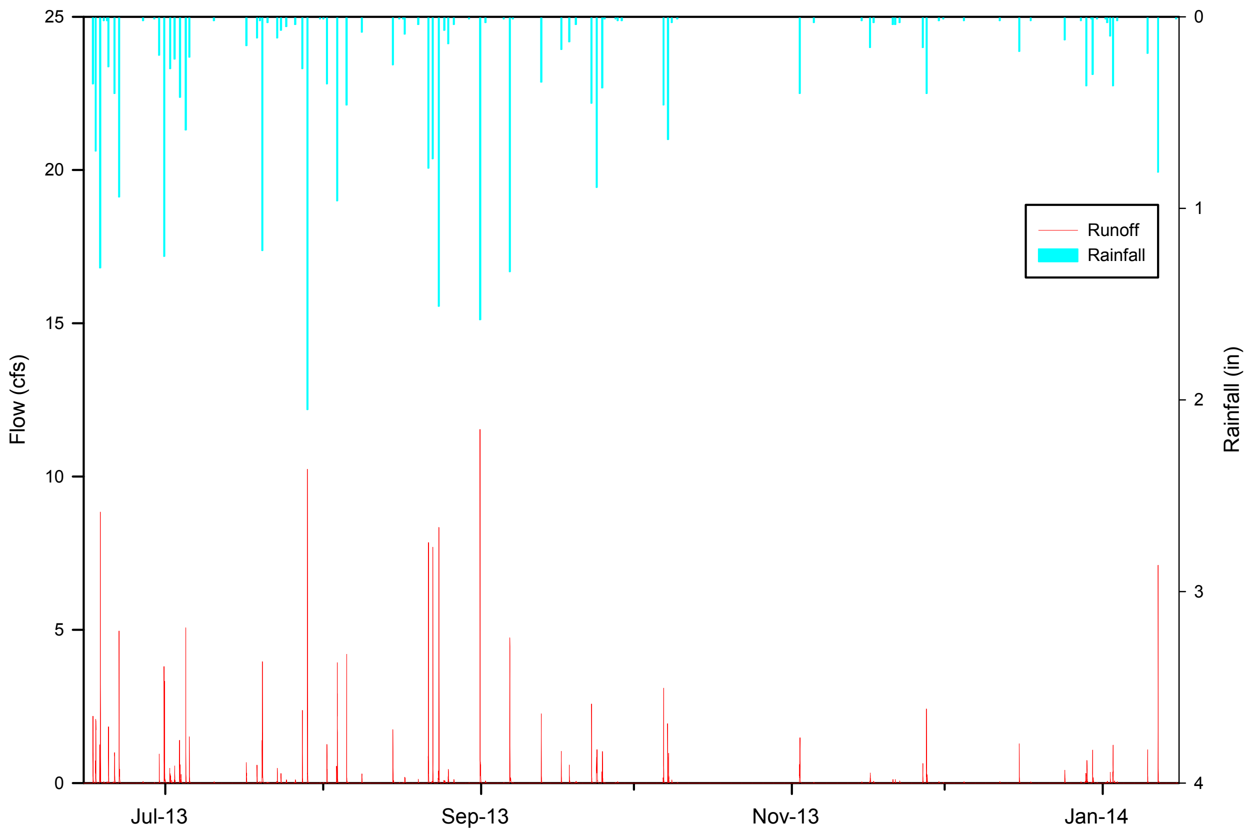


Figure 4-4. Measured Runoff Hydrographs at the San Pablo EcoVault® Site from June 15, 2013-January 15, 2014.

A tabular summary of measured monthly runoff inputs to the San Pablo EcoVault® unit is given on Table 4-9. Monthly inflows to the unit ranged from a high of 2.5 ac-ft during August to a low of 0.35 ac-ft during December. Overall, a total of approximately 9.31 ac-ft of runoff discharged through the EcoVault® unit during the 7-month monitoring program.

Runoff coefficient calculations for the San Pablo EcoVault® site are given in Table 4-10. During the field monitoring program, a total rainfall of 27.39 inches fell over the 21.37-acre sub-basin area, generating 9.31 ac-ft of runoff. This relationship corresponds to a runoff C value of approximately 0.191 which is typical of values commonly observed in urban residential areas with curb and gutter systems and permeable HSG A soils.

TABLE 4-9

MEASURED MONTHLY RUNOFF INPUTS TO THE SAN PABLO EcoVault® UNIT

MONTH	RUNOFF VOLUME (ac-ft)	MONTH	RUNOFF VOLUME (ac-ft)
June[1]	1.77	October	0.37
July	2.00	November	0.50
August	2.50	December	0.35
September	1.30	January[2]	0.52
		TOTAL:	**9.31**

1. Period from June 15-30
2. Period from January 1-15

TABLE 4-10

RUNOFF COEFFICIENT CALCULATIONS FOR THE SAN PABLO EcoVault® SITE

PARAMETER	UNITS	VALUE
Site Rainfall	inches	27.39
Basin Area	acres	21.37
Rainfall Volume	ac-ft	48.78
Runoff Volume	ac-ft	9.31
C Value	--	0.191

4.1.2.4 San Pablo CDS Unit

A graphical summary of measured runoff hydrographs at the San Pablo CDS site from June 15, 2013-January 15, 2014 is given on Figure 4-5. Rainfall depths for measured events at the monitoring site are also included for evaluation of relationships between rainfall and runoff. Measured discharge rates at the CDS unit monitoring site ranged from approximately 0-5 cfs, with the majority of peak runoff inflows less than approximately 2 cfs. Relatively insignificant runoff inflow rates were generated from rain events of approximately 0.1 inch or less. The observed peak flows measured during storm events appear to be closely related to the depth of the rainfall event.

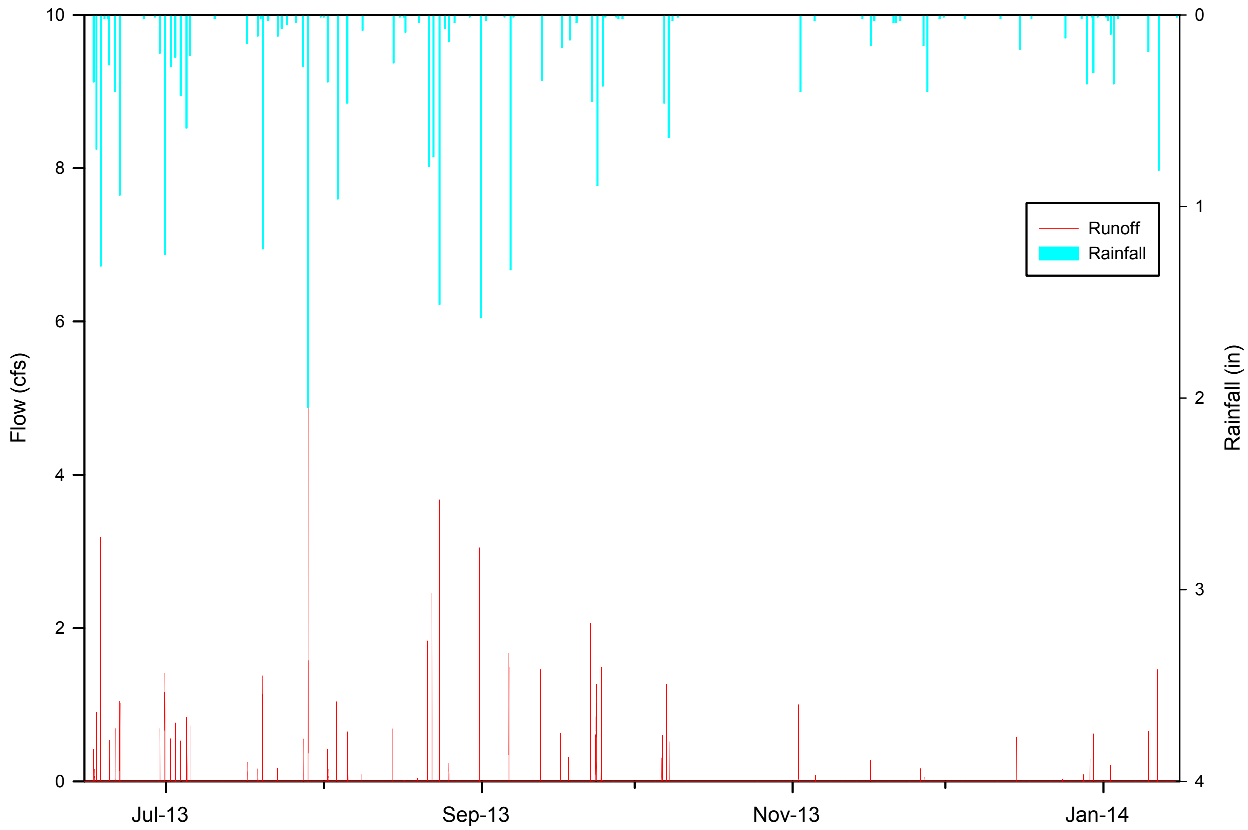


Figure 4-5. Measured Runoff Hydrographs at the San Pablo CDS Site from June 15, 2013-January 15, 2014.

A tabular summary of measured monthly runoff inputs to the San Pablo CDS unit during the field monitoring program is given on Table 4-11. Runoff inputs into the CDS unit ranged from a high of 0.55 ac-ft during September to a low of 0.08 ac-ft during October. Overall, approximately 2.22 ac-ft of runoff discharged through the CDS unit during the field monitoring program.

Runoff coefficient calculations for the San Pablo CDS site are given in Table 4-12. During the field monitoring program, approximately 27.38 inches of rainfall fell over the 4.90-acre sub-basin area, generating a runoff volume of 2.22 ac-ft. This rainfall runoff relationship corresponds to a runoff coefficient C value of 0.199. This value is typical of runoff coefficients commonly observed in urban residential areas with HSG A soils.

TABLE 4-11

MEASURED MONTHLY RUNOFF INPUTS TO THE SAN PABLO CDS UNIT

MONTH	RUNOFF VOLUME (ac-ft)	MONTH	RUNOFF VOLUME (ac-ft)
June[1]	0.41	October	0.08
July	0.44	November	0.11
August	0.49	December	0.04
September	0.55	January[2]	0.10
		TOTAL:	**2.22**

1. Period from June 15-30
2. Period from January 1-15

TABLE 4-12

RUNOFF COEFFICIENT CALCULATIONS FOR THE SAN PABLO CDS SITE

PARAMETER	UNITS	VALUE
Site Rainfall	inches	27.38
Basin Area	acres	4.90
Rainfall Volume	ac-ft	11.18
Runoff Volume	ac-ft	2.22
C Value	--	0.199

4.1.2.5 Lake Concord Suntree Baffle Box Site

A graphical summary of measured runoff hydrographs at the Lake Concord Suntree baffle box site from June 15, 2013-January 15, 2014 is given on Figure 4-6. Rainfall depths for measured rain events at the monitoring site are also included for evaluation of relationships between rainfall and runoff. Measured discharge rates at the Suntree baffle box monitoring site ranged from approximately 0-8 cfs, although the vast majority of measured peak runoff values were less than approximately 3 cfs. Relatively insignificant runoff inflow rates were generated from rain events of approximately 0.1 inch or less. The peak flows measured during storm events appear to be closely related to the depth of the rainfall event.

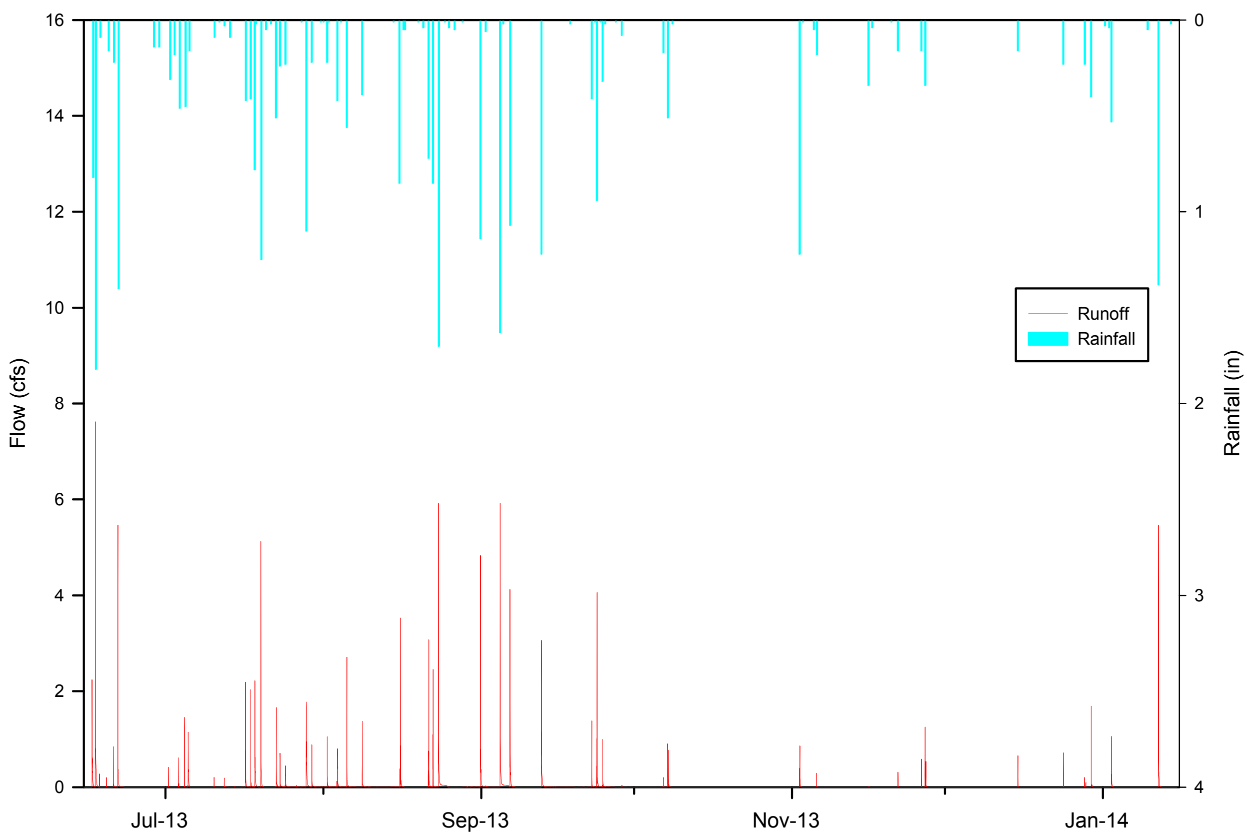


Figure 4-6. Measured Runoff Hydrographs at the Lake Concord Suntree Baffle Box Site from June 15, 2013-January 15, 2014.

A tabular summary of measured monthly runoff inputs to the Lake Concord Suntree baffle box is given in Table 4-13. Runoff inputs into the baffle box ranged from a high of 1.95 ac-ft during August to a low of 0.13 ac-ft during October.

A summary of runoff coefficient calculations for the Lake Concord Suntree baffle box site is given in Table 4-14. During the field monitoring program, a total of 31.09 inches of rainfall fell on the 5.64-acre watershed area, generating approximately 7.42 ac-ft of runoff. This rainfall-runoff relationship corresponds to a runoff coefficient C value of 0.508. This value is somewhat greater than observed at the residential monitoring sites and is likely related to the large amount of impervious area and DCIA contained within the Lake Concord sub-basin. The measured C value of 0.508 is slightly greater than would be expected for the given land uses, soil types, and sub-basin area, suggesting that the actual drainage area discharging to the baffle box site may be greater than the sub-basin area illustrated on Figure 2-22.

TABLE 4-13

MEASURED MONTHLY RUNOFF INPUTS TO THE LAKE CONCORD SUNTREE BAFFLE BOX UNIT

MONTH	RUNOFF VOLUME (ac-ft)	MONTH	RUNOFF VOLUME (ac-ft)
June[1]	1.23	October	0.13
July	1.66	November	0.24
August	1.95	December	0.15
September	1.65	January[2]	0.43
		TOTAL:	**7.42**

1. Period from June 15-30
2. Period from January 1-15

TABLE 4-14

RUNOFF COEFFICIENT CALCULATIONS FOR THE LAKE CONCORD SUNTREE BAFFLE BOX SITE

PARAMETER	UNITS	VALUE
Site Rainfall	inches	31.09
Basin Area	acres	5.64
Rainfall Volume	ac-fat	14.61
Runoff Volume	ac-ft	7.42
C Value	--	0.508

4.2 Chemical Characteristics of Collected Inflow/Outflow Samples

During the 7-month field monitoring program from June 15, 2013-January 15, 2014, ERD collected a total of 136 flow-weighted composite inflow and outflow samples at the five monitoring sites. A summary of the composite samples collected at each of the field monitoring sites is given on Table 4-15. The number of composite samples collected at the individual sites ranged from 14 sets of inflow/outflow samples at the San Pablo EcoVault® site to 20 sets of inflow/outflow samples at the Gee Creek EcoVault® site. Each of the inflow and outflow samples was collected as a flow-weighted composite during each collection period. A complete listing of the chemical characteristics of each of the inflow and outflow composite samples is given in Appendix C. The results of laboratory analyses of the inflow and outflow samples are presented in the following sections.

TABLE 4-15

SUMMARY OF COMPOSITE SAMPLES COLLECTED AT EACH OF THE FIELD MONITORING SITES

SITE	LOCATION	NUMBER OF COMPOSITE SAMPLES
Lake Hodge EcoVault® Site	Inflow Outflow	17 17
Gee Creek EcoVault® Site	Inflow Outflow	20 20
San Pablo EcoVault® Site	Inflow Outflow	14 14
San Pablo CDS Site	Outflow	16
Lake Concord Suntree Baffle Box	Outfall	18
	TOTAL:	**136**

In general, environmental data typically exhibit a log-normal distribution rather than a normal probability distribution, indicating that the log-normal mean value (also referred to as the geometric mean) is a more accurate indicator of central tendency for these data sets rather than a simple arithmetic mean value. Therefore, references to mean characteristics for the collected samples reflect geometric mean values unless noted otherwise.

4.2.1 Lake Hodge EcoVault® Site

4.2.1.1 General Parameters

A graphical comparison of measured inflow and outflow concentrations of pH, alkalinity, conductivity, turbidity, color, and TSS at the Lake Hodge EcoVault® site is given on Figure 4-7. Measured pH values of the inflow and outflow samples were highly variable, ranging from approximately 6.3-7.8. In general, inflow pH values were slightly lower than outflow values during many of the monitoring events.

Measured alkalinity values of the inflow and outflow samples were also highly variable, ranging from approximately 20-75 mg/l during the field monitoring program. With the exception of June 2013, when measured alkalinity values in the outflow samples were substantially higher than alkalinity values measured in the inflow, a relatively close agreement was observed between inflow and outflow alkalinity values during most monitoring events.

Measured conductivity values of the inflow and outflow samples ranged from approximately 30-360 μmho/cm during the field monitoring program. With the exception of inflow and outflow samples collected during July 2013, when conductivity values at the outflow were substantially greater than values measured at the inflow, a relatively close agreement was observed between measured inflow and outflow values for most monitored events.

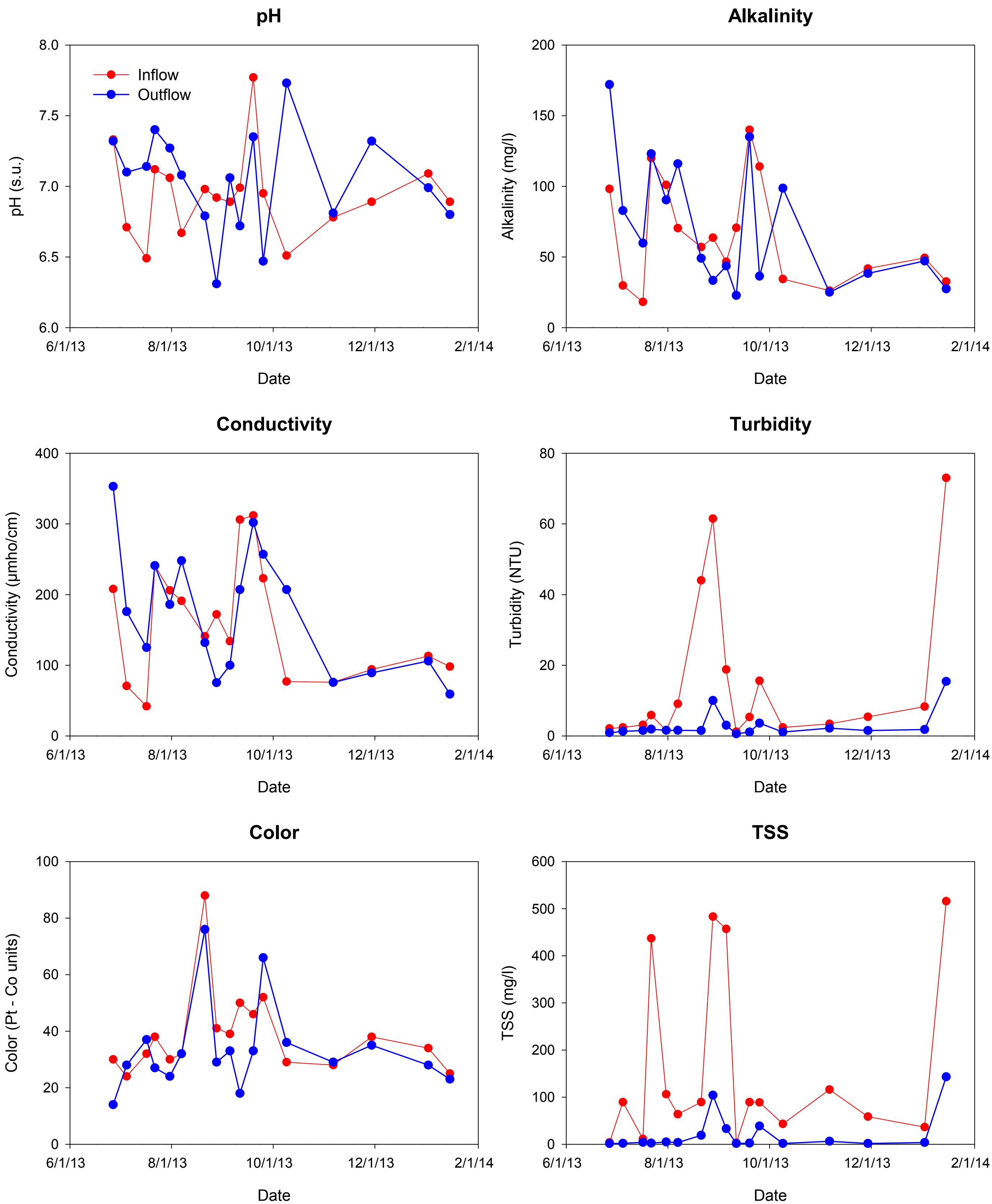


Figure 4-7. Comparison of Inflow and Outflow Concentrations of pH, Alkalinity, Conductivity, Turbidity, Color, and TSS at the Lake Hodge EcoVault® Site.

Unlike the previous trends observed for pH, alkalinity, and conductivity where inflow and outflow concentrations were relatively similar, measured turbidity levels were substantially lower in the outflow samples than the inflow samples during virtually all of the monitoring events. Measured turbidity values of inflows ranged from approximately 1-73 NTU, while turbidity measurements in discharge samples ranged from 0.6-15.4 NTU.

Measured color concentrations in the inflow samples ranged from approximately 24-88 Pt-Co units, with relatively similar concentrations between inflow and outflow samples. A light trend of slightly lower color concentrations in the outflow compared with the inflow may be present.

In general, the observed pattern for TSS concentrations is similar to the pattern previously discussed for turbidity. Measured TSS concentrations in the inflow ranged from 2.8-516 mg/l, with TSS concentrations in the discharge ranging from 1.4-143 mg/l. Measured TSS concentrations in discharges from the EcoVault® unit were substantially lower than inflow concentrations during virtually all monitoring events. These data indicate that a large amount of the incoming TSS loading was retained within the system.

A statistical comparison of inflow and outflow concentrations of pH, alkalinity, conductivity, and TSS at the Lake Hodge EcoVault® site is given in Figure 4-8 in the form of box and whisker plots, often referred to Tukey Box Plots. The bottom of the box portion of each plot represents the lower quartile, with 25% of the data points falling below this value. The upper line of the box represents the 75% upper quartile, with 25% of the data falling above this value. The **blue horizontal line** within the box represents the median value, with 50% of the data falling both above and below this value, while the **red horizontal line** represents the mean value. The vertical lines, also known as "whiskers", represent the 10 and 90 percentiles for the data sets. Individual values which fall outside of the 10-90 percentile range are indicated as **red dots**.

In general, measured pH values in the discharge samples for the EcoVault® unit appear to exhibit a higher degree of variability, along with a higher overall median pH value, than measurements conducted at the inflow. The observed variability in alkalinity concentrations between inflow and outflow samples appears to be relatively similar, although the outflow samples may be characterized by a slightly lower median alkalinity value. The observed variability in measured conductivity values is also similar between the inflow and outflow samples, although the outflow samples are characterized by a slightly greater median conductivity value. However, a large difference is apparent in the characteristics of measured TSS samples at the inflow and outflow locations. Measured TSS concentrations for inflow samples are highly variable and contain a number of substantially elevated TSS concentrations. In contrast, TSS concentrations in the outflow samples are primarily within a relatively narrow range of values with a substantially lower median concentration.

A statistical comparison of inflow and outflow concentrations of turbidity and color at the Lake Hodge EcoVault® site are given on Figure 4-9. The observed characteristics of inflow and outflow samples for turbidity are similar to the characteristics previously observed for TSS. Inflow turbidity concentrations are highly variable, with a larger number of elevated concentrations compared with outflow samples characterized by a relatively narrow range of values and a substantially lower median value. Measured color concentrations in the inflow samples appear to have a higher degree of variability, as well as a higher median value, than color concentrations observed in the discharge samples.

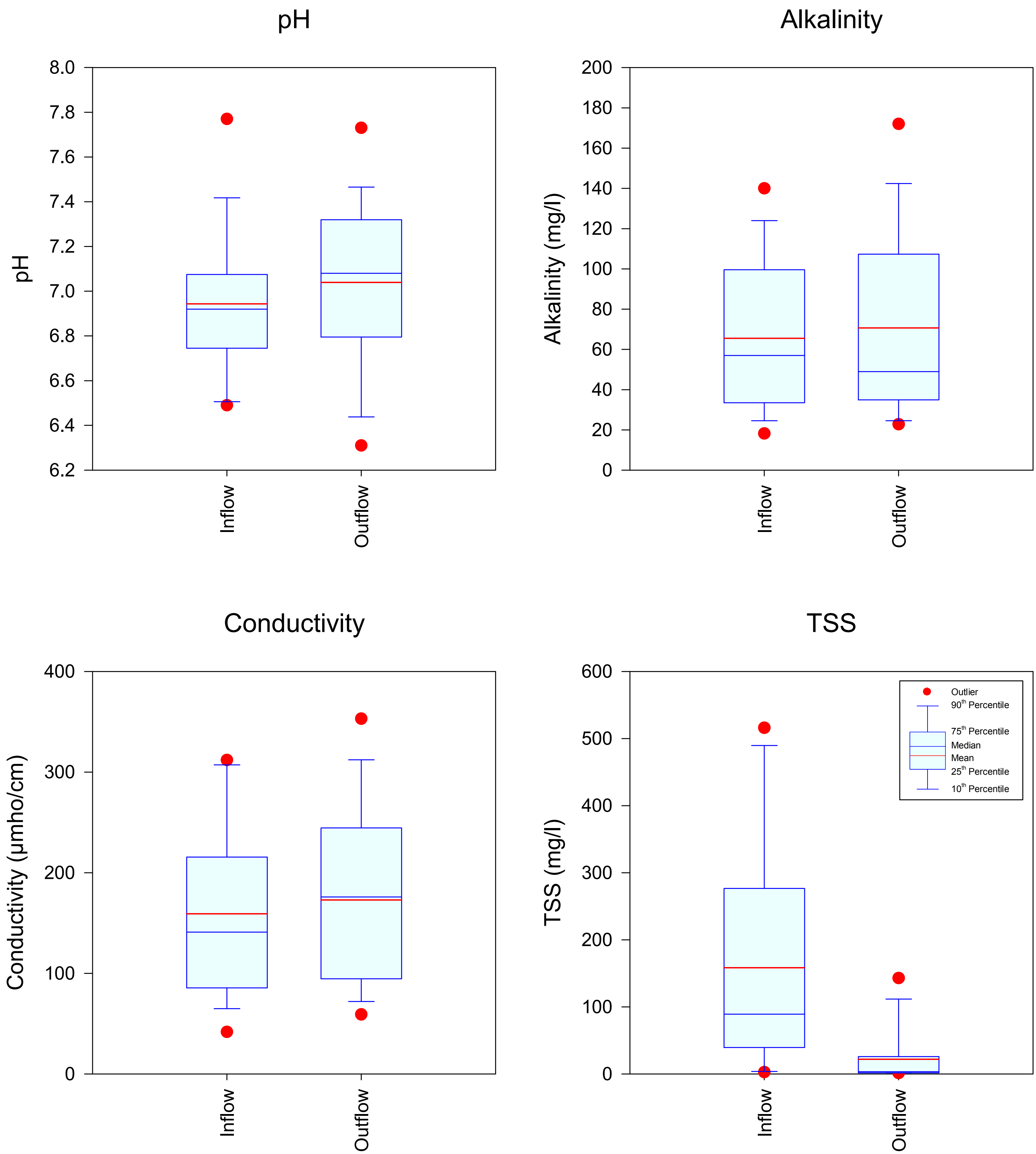


Figure 4-8. Statistical Comparison of Inflow and Outflow Concentrations of pH, Alkalinity, Conductivity, and TSS at the Lake Hodge EcoVault® Site.

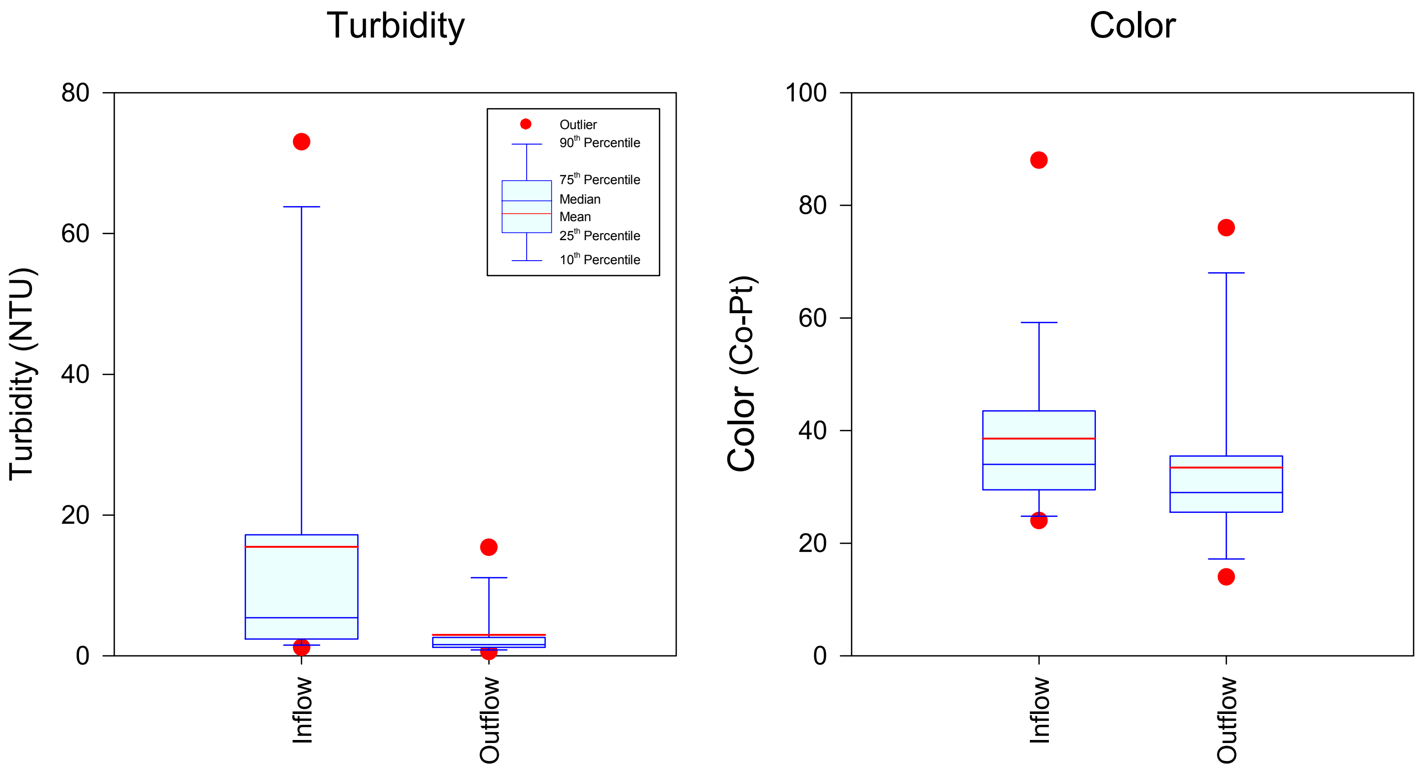


Figure 4-9. Statistical Comparison of Inflow and Outflow Concentrations of Turbidity and Color at the Lake Hodge EcoVault® Site.

4.2.1.2 <u>Nitrogen Species</u>

A graphical comparison of measured concentrations of nitrogen species at the Lake Hodge EcoVault® site is given on Figure 4-10. Ammonia concentrations in both the inflow and outflow samples were highly variable during the field monitoring event, with inflow concentrations ranging from 3-470 µg/l and outflow samples ranging from 3-265 µg/l. Although no consistent pattern or relationship appears to exist between measured inflow and outflow concentrations of ammonia, measured concentrations in the outflow samples appear to be somewhat higher in value during many of the monitoring events.

Measured concentrations of NO_x (nitrate + nitrite) exhibited a large degree of variability in both inflow and outflow characteristics, with NO_x inflow concentrations ranging from 3-1074 µg/l, and discharge samples ranging from 4-635 µg/l. In general, NO_x concentrations in the outflow appear to be somewhat higher in value than the inflow during a majority of the monitoring events.

Measured concentrations of dissolved organic nitrogen exhibited a wide range of values in both the inflow and outflow samples. Although the inflow and outflow concentrations appear to be closely related, there does not appear to be a clear pattern of either higher or lower concentrations for the inflow or outflow.

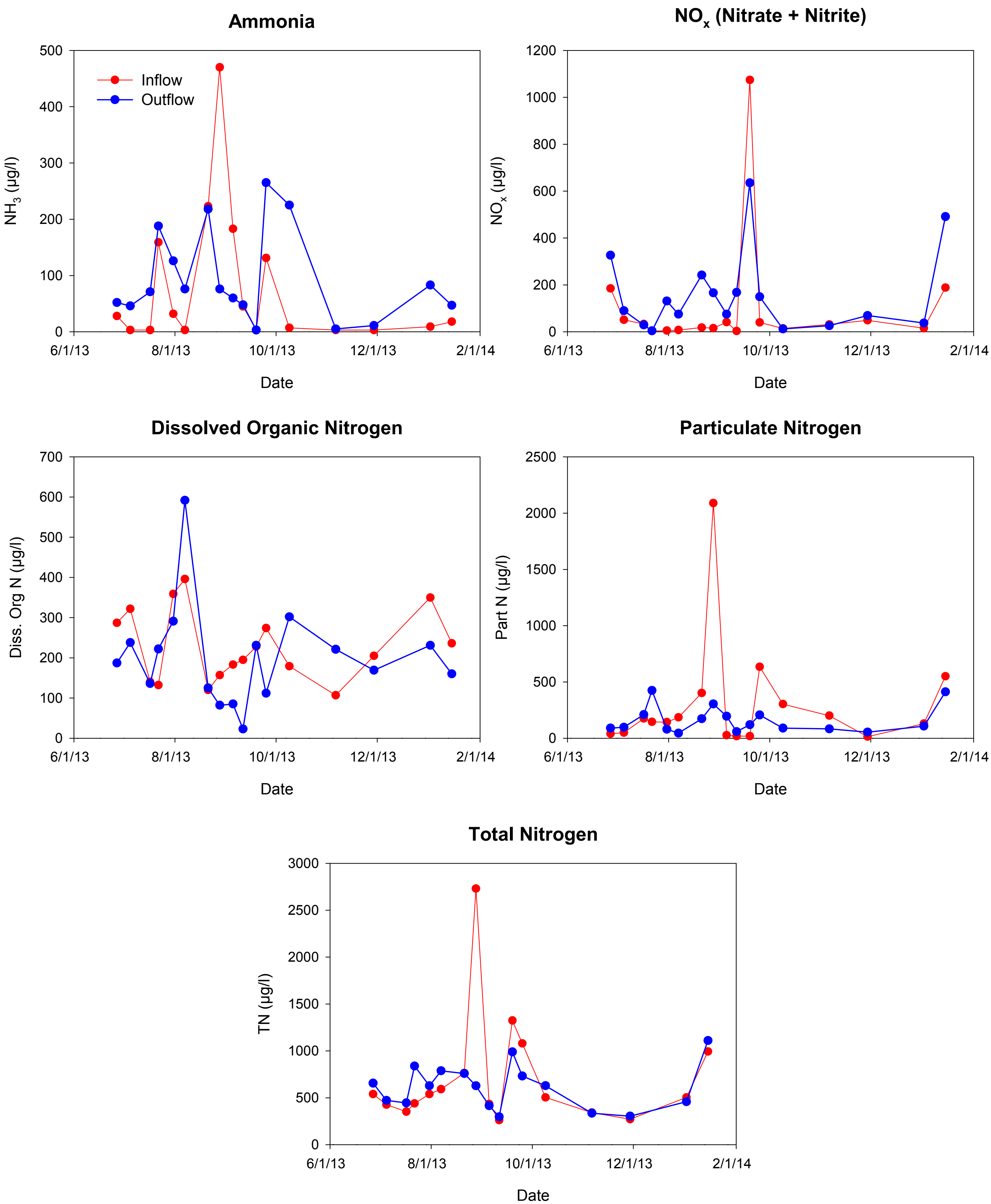


Figure 4-10. Comparison of Inflow and Outflow Concentrations of Nitrogen Species at the Lake Hodge EcoVault® Site.

Measured concentrations of particulate nitrogen were also highly variable, with inflow concentrations ranging from 14-2,088 µg/l and outflow concentrations ranging from 45-424 µg/l. Particulate nitrogen concentrations in the outflow were generally lower in value than inflow concentrations during a majority of the monitoring events.

Measured concentrations of total nitrogen in the inflow and outflow samples appear to be relatively similar during most monitoring events. A substantially elevated inflow total nitrogen concentration of 2,730 µg/l was observed during one of the monitoring events, with relatively similar inflow and outflow characteristics during the remaining events. The data suggests very little difference between inflow and outflow total nitrogen concentrations during virtually all of the monitoring events.

A statistical comparison of inflow and outflow concentrations of nitrogen species measured at the Lake Hodge EcoVault® site is given on Figure 4-11. Inflow samples for ammonia appear to be characterized by a higher degree of variability, as well as a lower median concentration, than ammonia concentrations observed in outflow samples. In contrast, inflow concentrations of NO_x were extremely low in value during most monitoring events, with higher concentrations and a higher degree of variability in measured NO_x concentrations in the discharge samples. Measured concentrations of particulate nitrogen in the inflow samples appear to exhibit a modest degree of variability, with a substantially lower degree of variability and lower median concentration observed in the outflow samples. Overall, total nitrogen concentrations in the inflow samples are characterized by a higher degree of variability than concentrations measured in the discharge samples. Median concentrations of total nitrogen between inflow and outflow samples appear to be relatively similar.

4.2.1.3 <u>Phosphorus Species</u>

A graphical comparison of inflow and outflow concentrations of phosphorus species at the Lake Hodge EcoVault® site is given on Figure 4-12. Measured concentrations of SRP were highly variable during the field monitoring program at both the inflow and outflow monitoring sites. A relatively close agreement appears to occur in SRP concentrations between inflow and outflow samples during most monitoring events, although a trend of slightly lower outflow SRP concentrations is apparent during portions of the study. A relatively close agreement was also observed between inflow and outflow concentrations for dissolved organic phosphorus which also exhibited a large degree of variability in concentrations. In general, measured dissolved organic phosphorus concentrations appear to be slightly greater in the outflow samples during many of the monitoring events.

Inflow concentrations of particulate phosphorus were characterized by a high degree of variability, with measured concentrations ranging from 34-733 µg/l. However, particulate phosphorus in the discharge samples were substantially lower in value, ranging from 6-245 µg/l. Overall, particulate phosphorus concentrations in the discharge were lower than inflow samples during virtually all of the monitoring events.

Measured concentrations of total phosphorus in the inflow and outflow samples were also highly variable. Total phosphorus concentrations in the discharge samples were lower in value than the inflow concentrations during virtually all of the monitoring events, suggesting that a large portion of the total phosphorus loadings was retained within the unit.

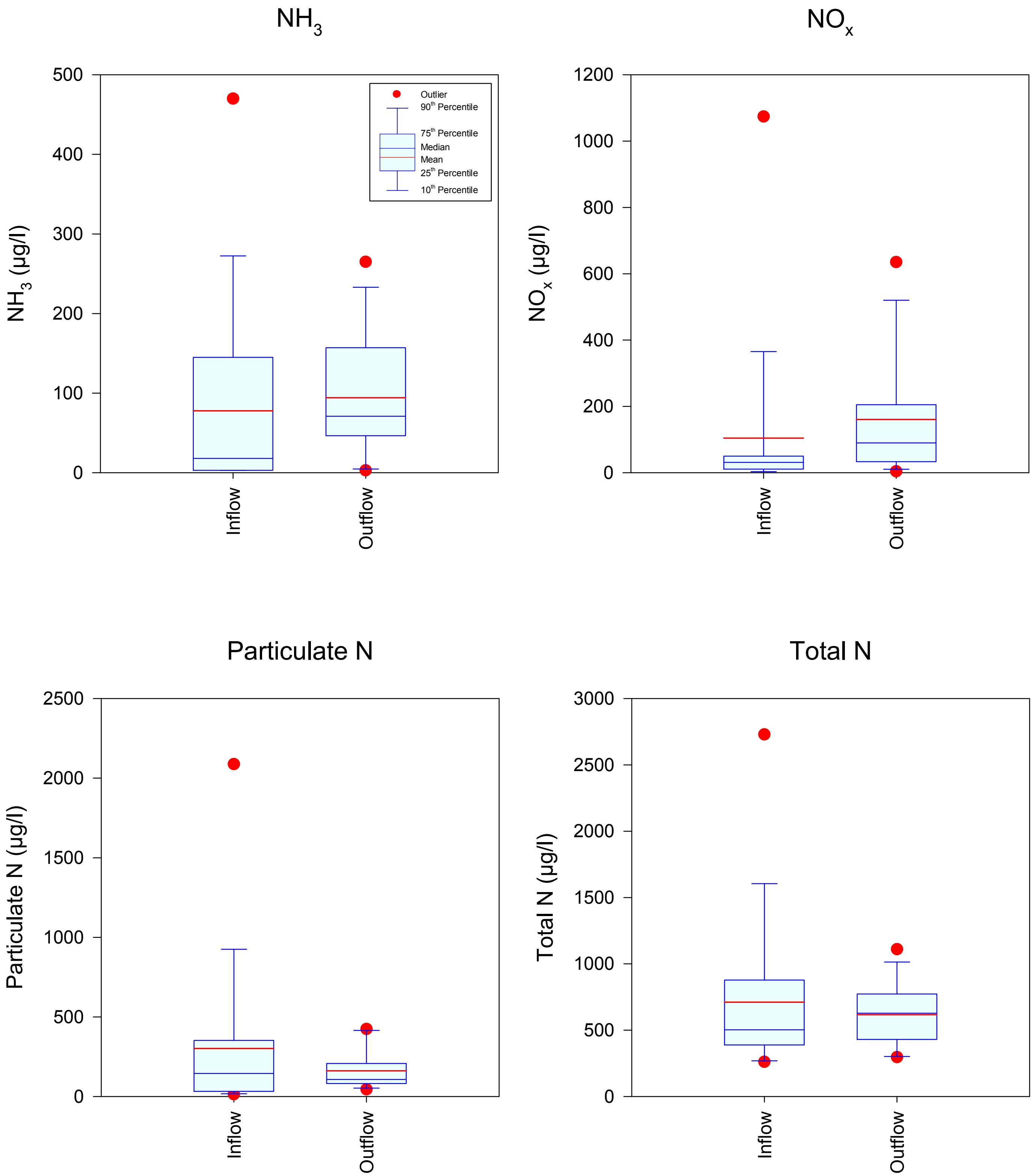


Figure 4-11. Statistical Comparison of Inflow and Outflow Concentrations of Nitrogen Species at the Lake Hodge EcoVault® Site.

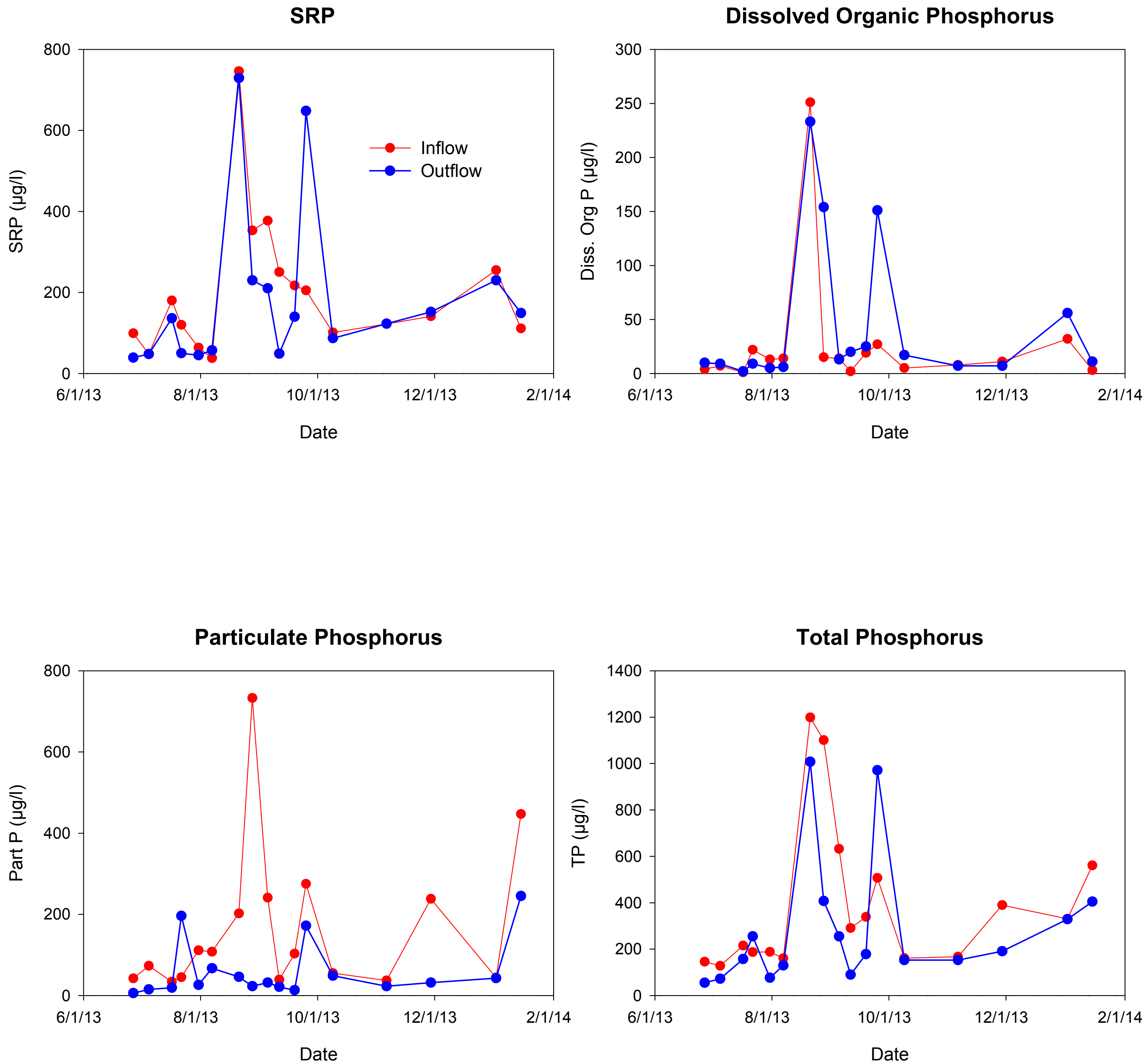


Figure 4-12. Comparison of Inflow and Outflow Concentrations of Phosphorus Species at the Lake Hodge EcoVault® Site.

A statistical comparison of inflow and outflow concentrations of phosphorus species at the Lake Hodge EcoVault® site is given on Figure 4-13. A relatively similar degree of variability was observed in measured inflow and outflow SRP concentrations although the outflow appears to have a slightly lower median value. In contrast, inflow concentrations of organic phosphorus exhibited a low degree of variability, with a somewhat higher degree of variability observed in the discharge samples. A high degree of variability was observed in particulate phosphorus concentrations at the inflow samples, with a substantially lower degree of variability, combined with a lower median concentration, observed at the outflow. A similar pattern is also apparent for total phosphorus, with a higher degree of variability observed for inflow samples and a lower degree of variability and lower median concentration observed for the outflow samples.

4.2.1.4 Metals

A graphical comparison of inflow and outflow concentrations of copper, iron, and zinc at the Lake Hodge EcoVault® site is given on Figure 4-14. Inflow concentrations of total copper were relatively consistent during the field monitoring program, with the vast majority of measured values ranging from approximately 2-49 μg/l. Outflow concentrations of copper were relatively consistent in value, ranging from 2-12 μg/l, with concentrations typically lower than observed in the inflow samples. The data suggests that a significant portion of the copper inputs are retained within the Lake Hodge EcoVault® system.

Measured concentrations of total iron at the inflow were generally less than approximately 1000 μg/l, although a more elevated total iron concentration of 4,830 μg/l was measured at the inflow on one occasion. In general, discharge samples from the unit exhibited lower concentrations for total iron during most monitoring events, with discharge concentrations ranging from 85-1,046 μg/l. In general, it appears that the unit retains a relatively small portion of the iron inputs within the unit.

Highly variable inflow concentrations of zinc were observed at this site, with raw concentrations ranging from 2-79 μg/l. In contrast, total zinc concentrations in the outflow were generally lower than inflow concentrations during virtually all monitoring events, with measured concentrations ranging from 2-39 μg/l. The data suggests that the EcoVault® retains a substantial portion of the total zinc inputs within the system.

A statistical comparison of inflow and outflow concentrations of copper, iron, and zinc at the Lake Hodge EcoVault® site is given on Figure 4-15. Inflow concentrations of copper exhibited a moderate degree of variability along with a relatively low input concentration. Measured concentrations of total copper in the outflow exhibited a lower median concentration as well as a lower degree of variability.

Variability in inflow and outflow concentrations of total iron were relatively similar, with similar median concentrations. The Lake Hodge EcoVault® site appears to have little significant impact on measured concentrations of total iron. In contrast, the Lake Hodge EcoVault® appears to have a significant impact on concentrations of total zinc. Inflow concentrations of total zinc were highly variable, with a moderately elevated median concentration. Outflow concentrations of total zinc exhibited a low degree of variability with an extremely low median concentration.

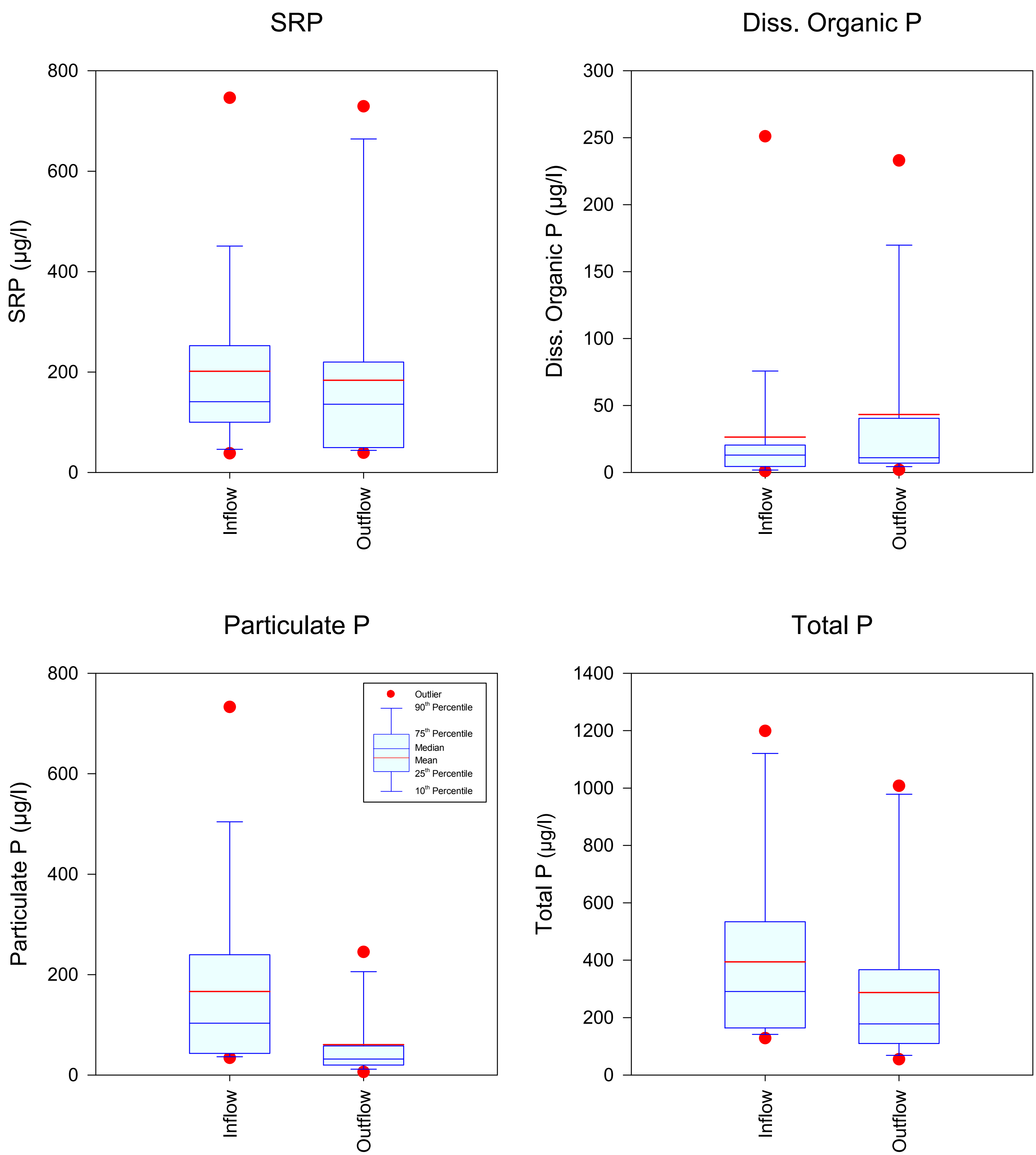
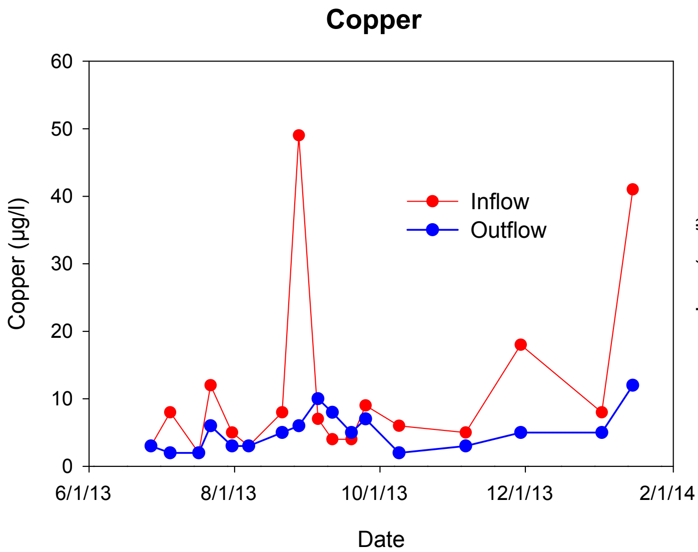
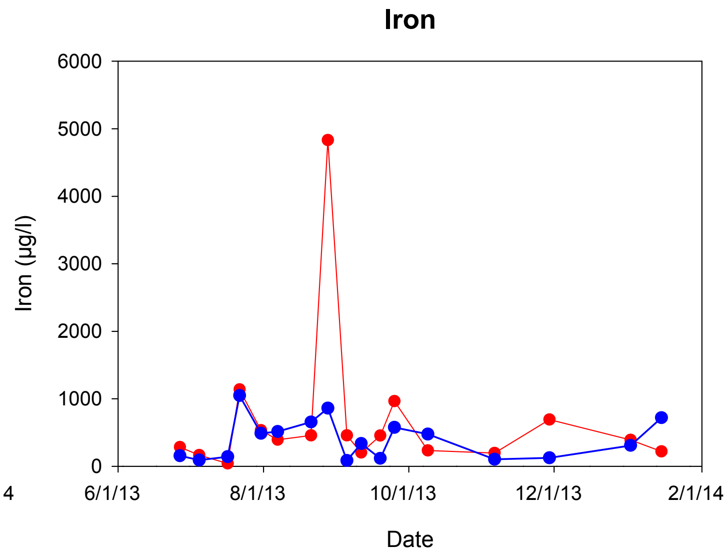


Figure 4-13. Statistical Comparison of Inflow and Outflow Concentrations of Phosphorus Species at the Lake Hodge EcoVault® Site.





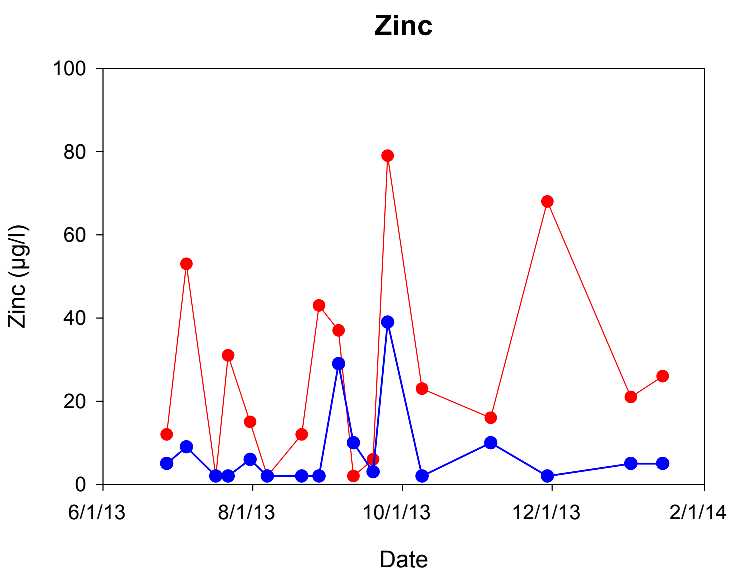


Figure 4-14. Comparison of Inflow Concentrations of Copper, Iron, and Zinc at the Lake Hodge EcoVault® Site.

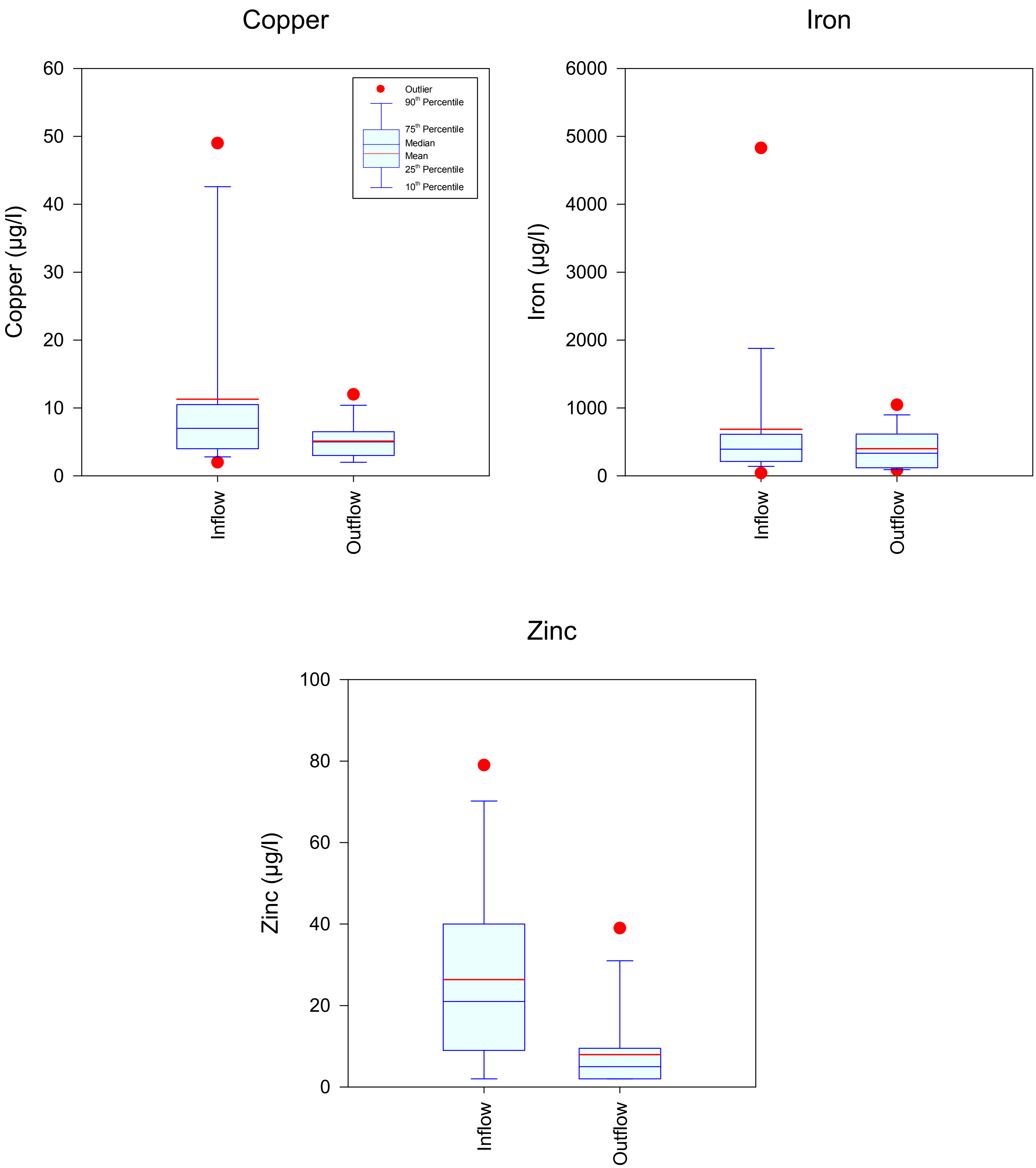


Figure 4-15. Statistical Comparison of Inflow and Outflow Concentrations of Copper, Iron, and Zinc at the Lake Hodge EcoVault® Site.

4.2.1.5 Comparison of Inflow and Outflow Characteristics

A comparison of inflow and outflow runoff characteristics at the Lake Hodge EcoVault® site is given on Table 4-16. The values summarized in this table reflect geometric mean values for each evaluated parameter. Slight increases in mean concentrations between inflow and outflow samples were observed for pH, alkalinity, conductivity, ammonia, NO_x, particulate nitrogen, and dissolved organic phosphorus. Reductions in concentrations were observed for dissolved organic nitrogen and total nitrogen which decreased by approximately 1% between the inflow and outflow samples.

TABLE 4-16

COMPARISON OF INFLOW AND OUTFLOW CHARACTERISTICS AT THE LAKE HODGE EcoVault® UNIT

PARAMETER	UNITS	MEAN INFLOW CONCENTRATION[1]	MEAN OUTFLOW CONCENTRATION[1]	PERCENT CHANGE (%)
pH	s.u.	6.94	7.03	1
Alkalinity	mg/l	56.0	58.4	4
Conductivity	μmho/cm	138	152	10
NH_3	μg/l	20	56	181
NO_x	μg/l	27	85	210
Diss. Organic N	μg/l	211	165	-22
Particulate N	μg/l	123	129	4
Total N	μg/l	577	573	-1
SRP	μg/l	153	122	-20
Diss. Organic P	μg/l	11	17	61
Particulate P	μg/l	104	36	-65
Total P	μg/l	306	202	-34
Turbidity	NTU	6.9	2.0	-72
Color	Pt-Co	37	31	-16
TSS	mg/l	70.8	6.2	-91
Fecal Coliform	cfu/100 ml	1,268	287	-77
Copper	μg/l	7.4	4.4	-40
Iron	μg/l	390	291	-26
Zinc	μg/l	16	5	-70

1. Reflect geometric mean values

Substantial reductions in concentrations were observed for measured phosphorus species, with a 20% reduction for SRP, 65% for particulate phosphorus, and 34% for total phosphorus. Turbidity concentrations were reduced by approximately 72% within the unit, with a 91% reduction in TSS and 16% reduction in color. Overall, a reduction of approximately 77% was observed for fecal coliform.

4.2.2 Gee Creek EcoVault® Site

4.2.2.1 General Parameters

A comparison of inflow and outflow concentrations of pH, alkalinity, conductivity, turbidity, color, and TSS at the Gee Creek EcoVault® site is given on Figure 4-16. Measured pH values in the inflow samples ranged from 6.86-7.82, reflecting approximately neutral characteristics. Measured inflow and outflow pH values were relatively similar during a majority of the monitored events, although somewhat lower inflow concentrations were observed during several events. Measured alkalinity values were highly variable in the inflow, with measured values ranging from 60.2-182 mg/l. A relatively close agreement was observed between inflow and outflow concentrations during most events, although a slight trend of lower alkalinity values in the outflow is apparent during multiple monitored events.

Highly variable conductivity values were observed at the Gee Creek EcoVault® site, particularly for the inflow samples. A somewhat lower degree of variability was observed for the discharge samples, particularly during the first half of the monitoring program. Overall, measured concentrations in the outflow appear to be lower than inflow concentrations during most monitored events.

Measured turbidity levels were highly variable at the inflow to the system, ranging from 3.7-49.0 NTU. Substantially lower concentrations were observed in the discharge, with measured values ranging from 3.3-12.3 NTU.

Measured color concentrations were relatively similar between the inflow and outflow samples during a majority of the monitoring events. Measured color concentrations in the inflow ranged from 41-81 Pt-Co units, with no significant trend of increasing or decreasing concentrations in the outflow compared with the inflow.

However, a substantial difference was observed between measured concentrations of TSS in the inflow and outflow samples. Inflow concentrations of TSS were highly variable, ranging from 2.7-166 mg/l, with outflow samples ranging from 2.1-25.8 mg/l. Monitored TSS concentrations in the outflow samples were lower than inflow concentrations during each monitoring event.

A statistical comparison of inflow and outflow concentrations of pH, alkalinity, conductivity, and TSS at the Gee Creek EcoVault® site are illustrated on Figure 4-17. Measured pH values of the inflow samples exhibited a relatively high range, with a fairly narrow range observed in the discharge samples, combined with a slightly higher median pH value. Measured inflow alkalinity concentrations exhibited a higher degree of variability as well as a higher median value than observed in the discharge samples.

Measured conductivity values appear to exhibit relatively similar degrees of variability in the inflow and outflow samples, with a slightly lower median conductivity observed in the outflow samples, suggesting removal of dissolved constituents within the system. In contrast, a very large degree of variability was observed in measured TSS concentrations compared with the outflow samples which exhibited a relatively low degree of variability as well as a substantially lower median value. These data indicate that a large amount of the incoming TSS loading was retained within the system.

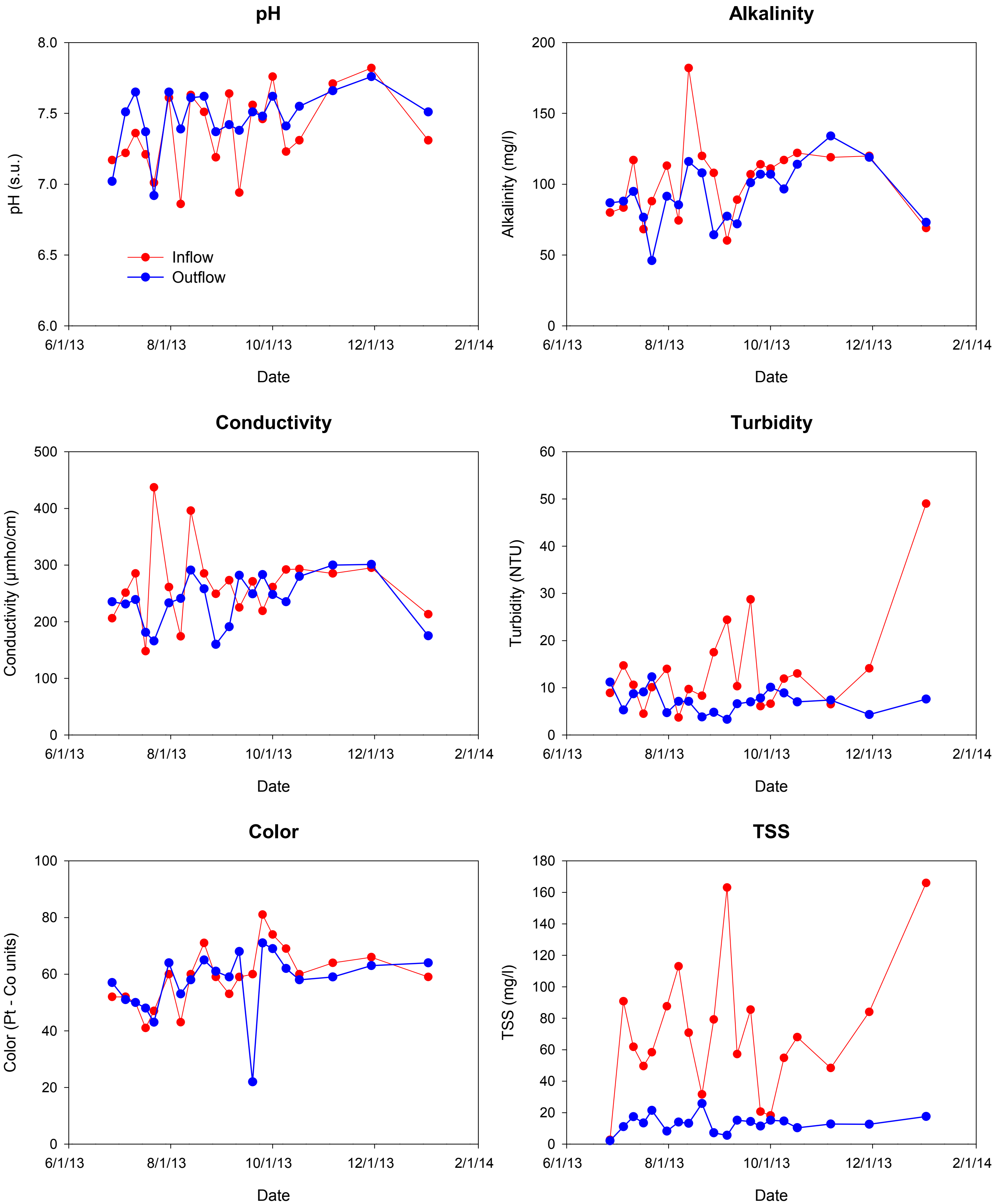


Figure 4-16. Comparison of Inflow and Outflow Concentrations of pH, Alkalinity, Conductivity, Turbidity, Color, and TSS at the Gee Creek EcoVault® Site.

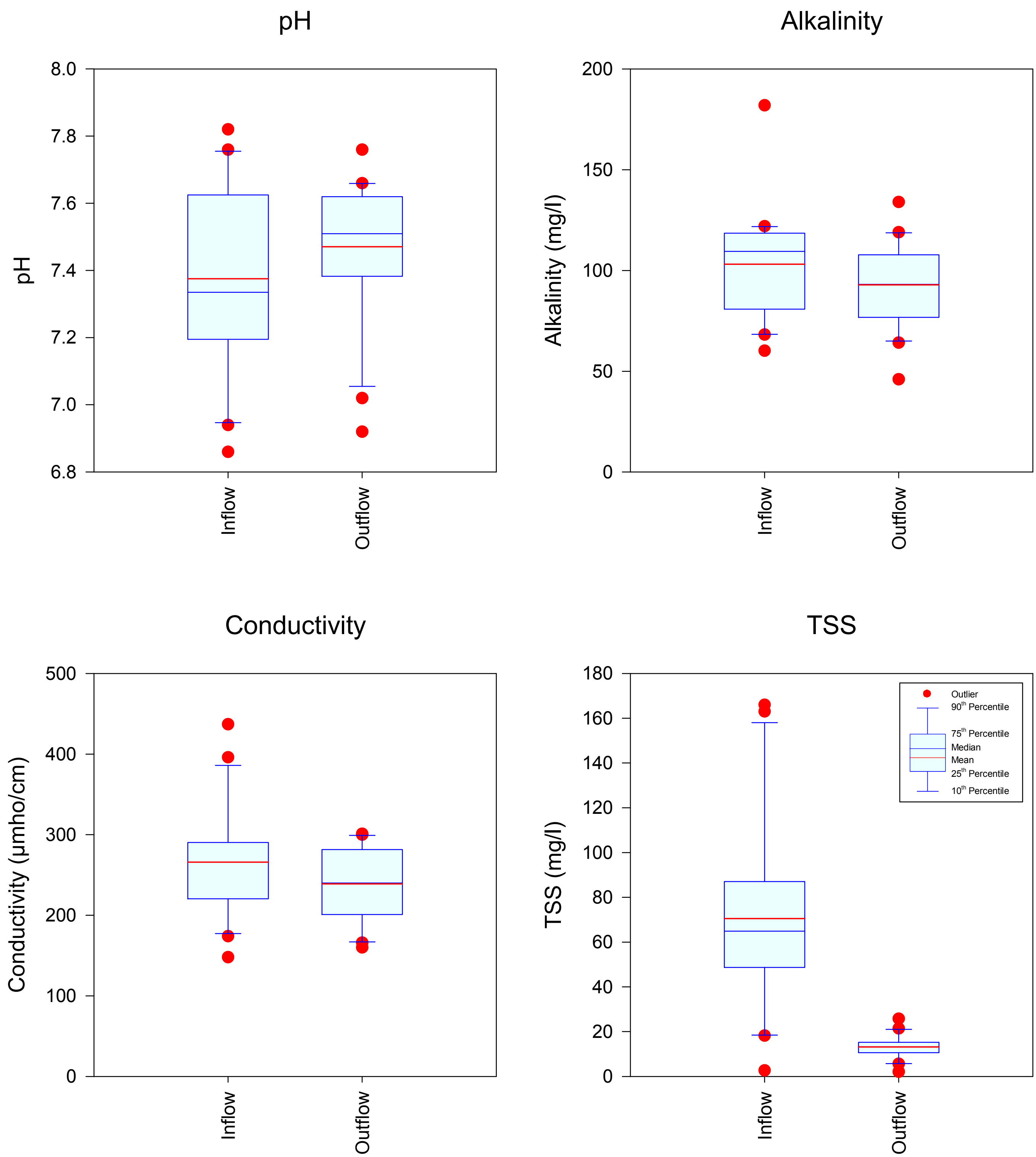


Figure 4-17. Statistical Comparison of Inflow and Outflow Concentrations of pH, Alkalinity, Conductivity, and TSS at the Gee Creek EcoVault® Site.

A statistical comparison of inflow and outflow concentrations for turbidity and color at the Gee Creek EcoVault® Site are given on Figure 4-18. Measured turbidity values at the inflow exhibited a relatively high degree of variability compared with the outflow samples which also exhibited a substantially lower median concentration. However, in contrast, little change appears to occur within the Gee Creek EcoVault® unit for color, with virtually identical statistical profiles for the inflow and outflow samples.

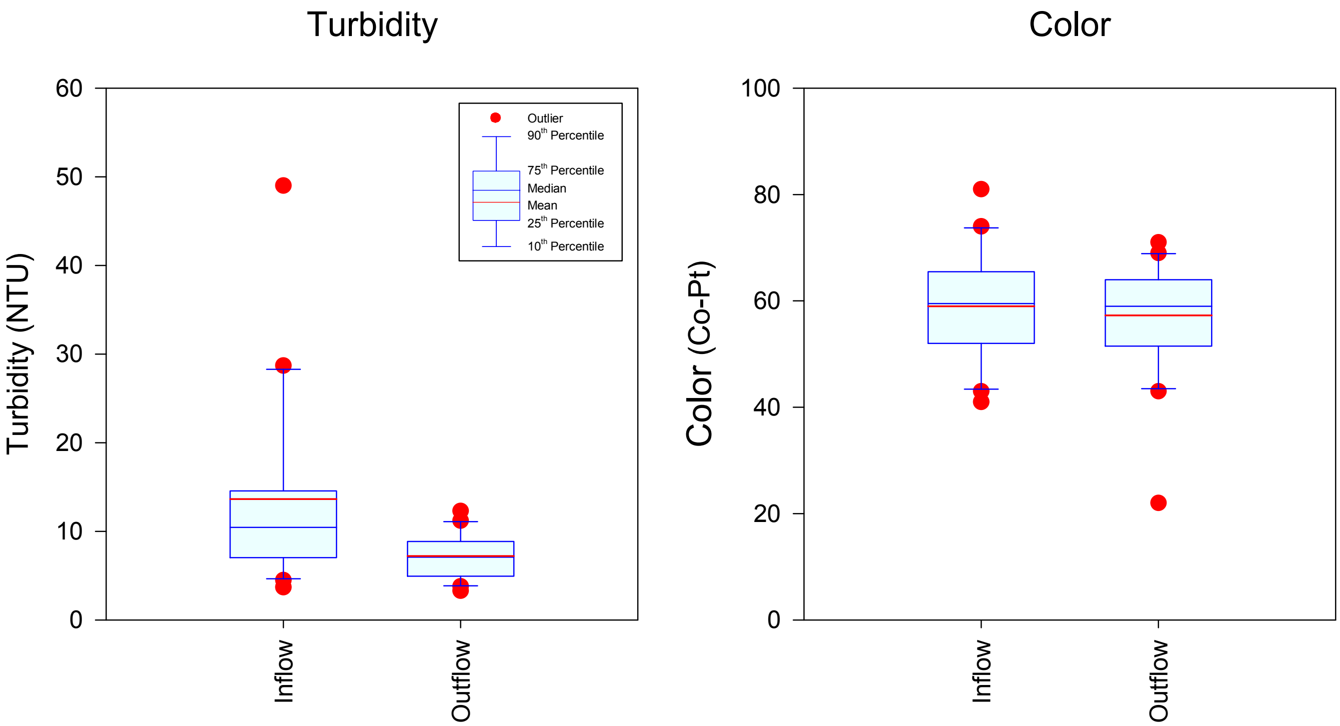


Figure 4-18. Statistical Comparison of Inflow and Outflow Concentrations of Turbidity and Color at the Gee Creek EcoVault® Site.

4.2.2.2 Nitrogen Species

A graphical comparison of measured inflow and outflow concentrations of nitrogen species at the Gee Creek EcoVault® Site is given on Figure 4-19. In general, measured concentrations of ammonia in the inflow samples exhibited a relatively high degree of variability, with a low degree of variability, combined with low measured concentrations, observed in the outflow. The only exception to this appears to be a spike in ammonia concentrations measured in the outflow samples during September 2013. However, overall, it appears that a slight reduction in ammonia concentrations occurred within the unit.

Measured NO_x concentrations in both the inflow and outflow samples exhibited an extremely high degree of variability throughout the field monitoring program, with inflow concentrations ranging from 209-890 µg/l. No defined pattern in inflow and outflow NO_x concentrations appears to exist during the first 2-3 months of the field monitoring program. However, beginning during September 2013, NO_x concentrations in the outfall samples were substantially lower during each monitoring even than observed in the inflow samples.

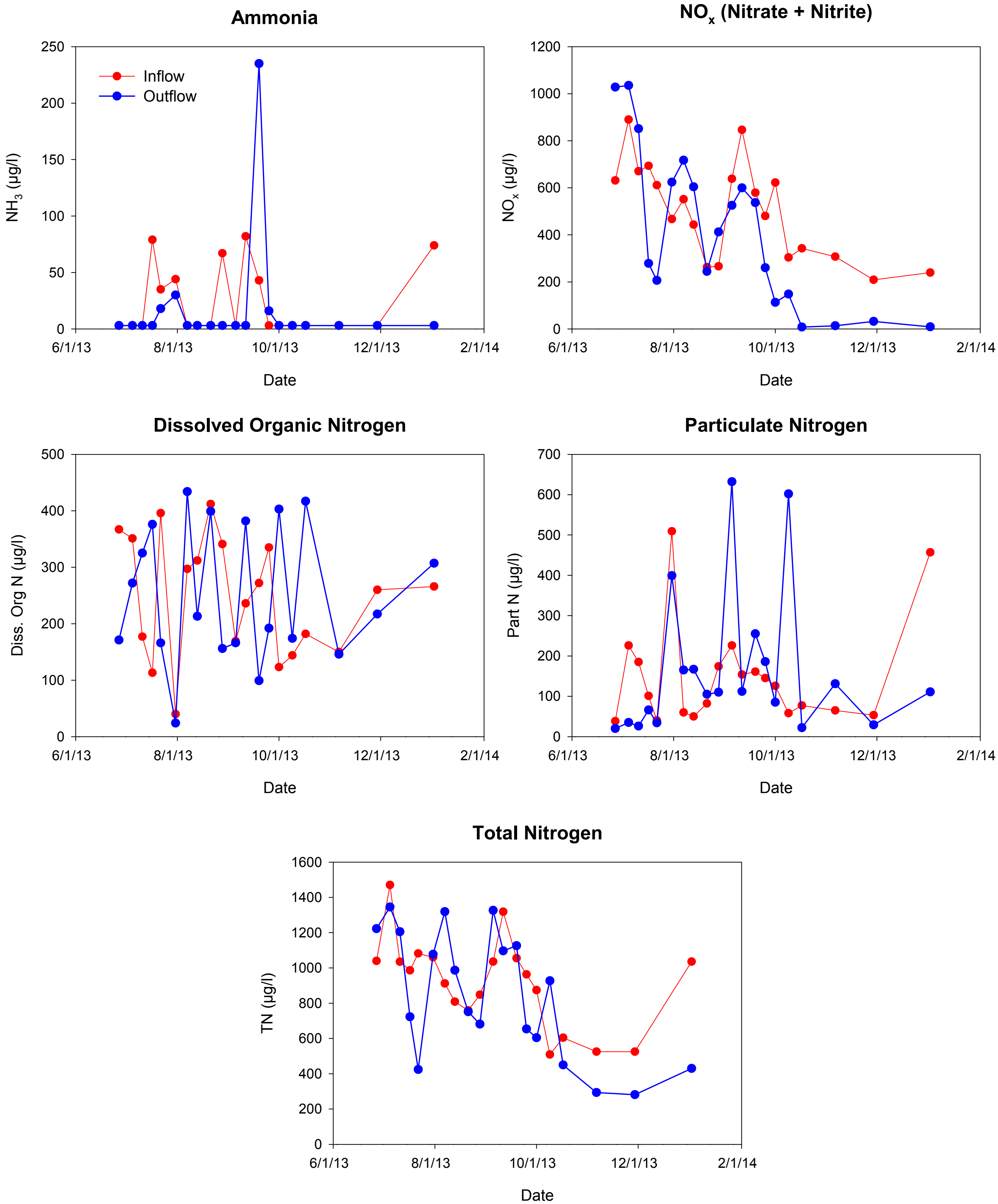


Figure 4-19. Comparison of Inflow and Outflow Concentrations of Nitrogen Species at the Gee Creek EcoVault® Site.

Measured concentrations of dissolved organic nitrogen were highly variable throughout the field monitoring program, with measured inflow values ranging from 40-412 μg/l. Overall, it appears that inflow and outflow concentrations of dissolved organic nitrogen are relatively similar during a majority of the monitoring events.

Measured concentrations of particulate nitrogen exhibited a high degree of variability in both the inflow and outflow samples, although the degree of variability appears to be slightly less at the inflow compared with the outflow. During some monitoring events, inflow concentrations exceeded outflow concentrations, with the reverse pattern observed during other events. Overall, it appears that the EcoVault® unit does not result in any predictable changes to particulate nitrogen concentrations.

Overall, measured concentrations of total nitrogen exhibited a relatively distinct relationship between the inflow and outflow during most monitoring events. A pattern of lower outflow concentrations compared with inflow concentrations is apparent beginning in approximately October 2013. The trends observed for total nitrogen are similar to the trend observed for NO_x which comprises a large portion of the total nitrogen.

A statistical comparison of inflow and outflow concentrations of nitrogen species at the Gee Creek EcoVault® Site is given on Figure 4-20. In general, measured concentrations of ammonia at the inflow exhibited a high degree of variability compared with the outflow samples which exhibited a substantially lower degree of variability as well as lower median concentration. In contrast, a higher degree of variability was observed in NO_x concentrations in the discharge compared with the runoff inflow, although a somewhat lower median concentration was measured in the outflow than in the inflow. A relatively similar degree of variability in concentrations, as well as median values, was observed at the inflow and outflow for particulate nitrogen. Overall, total nitrogen concentrations in the outflow appear to be slightly lower than concentrations observed at the runoff inflow, although a higher degree of variability was observed in outflow concentrations compared with inflow concentrations. The data suggest that a measurable, although likely small, change in total nitrogen concentration occurs within the EcoVault® unit.

4.2.2.3 <u>Phosphorus Species</u>

A comparison of inflow and outflow concentrations of phosphorus species at the Gee Creek EcoVault® Site is given on Figure 4-21. A high degree of variability was observed in both inflow and outflow concentrations for SRP, although it appears that SRP concentrations are somewhat lower in the outflow than in the inflow during a majority of the monitoring events.

Measured concentrations of dissolved organic phosphorus were also highly variable in both the inflow and outflow, although the range of measured inflow values extended only from 2-17 μg/l. During many events, it appears that outflow concentrations of dissolved organic phosphorus are lower than inflow, although substantially more elevated outflow concentrations were observed on multiple occasions.

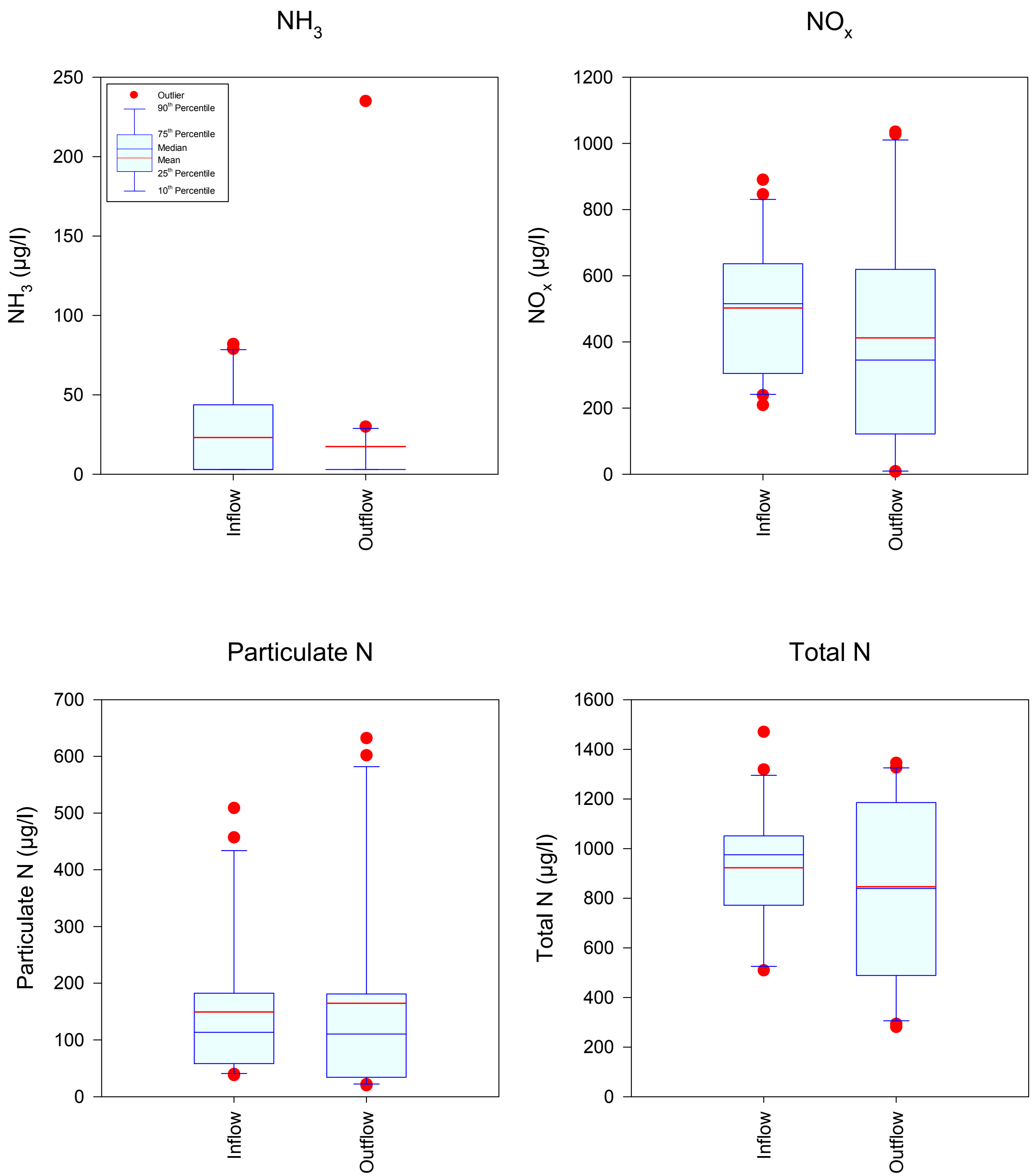


Figure 4-20. Statistical Comparison of Inflow and Outflow Concentrations of Nitrogen Species at the Gee Creek EcoVault® Site.

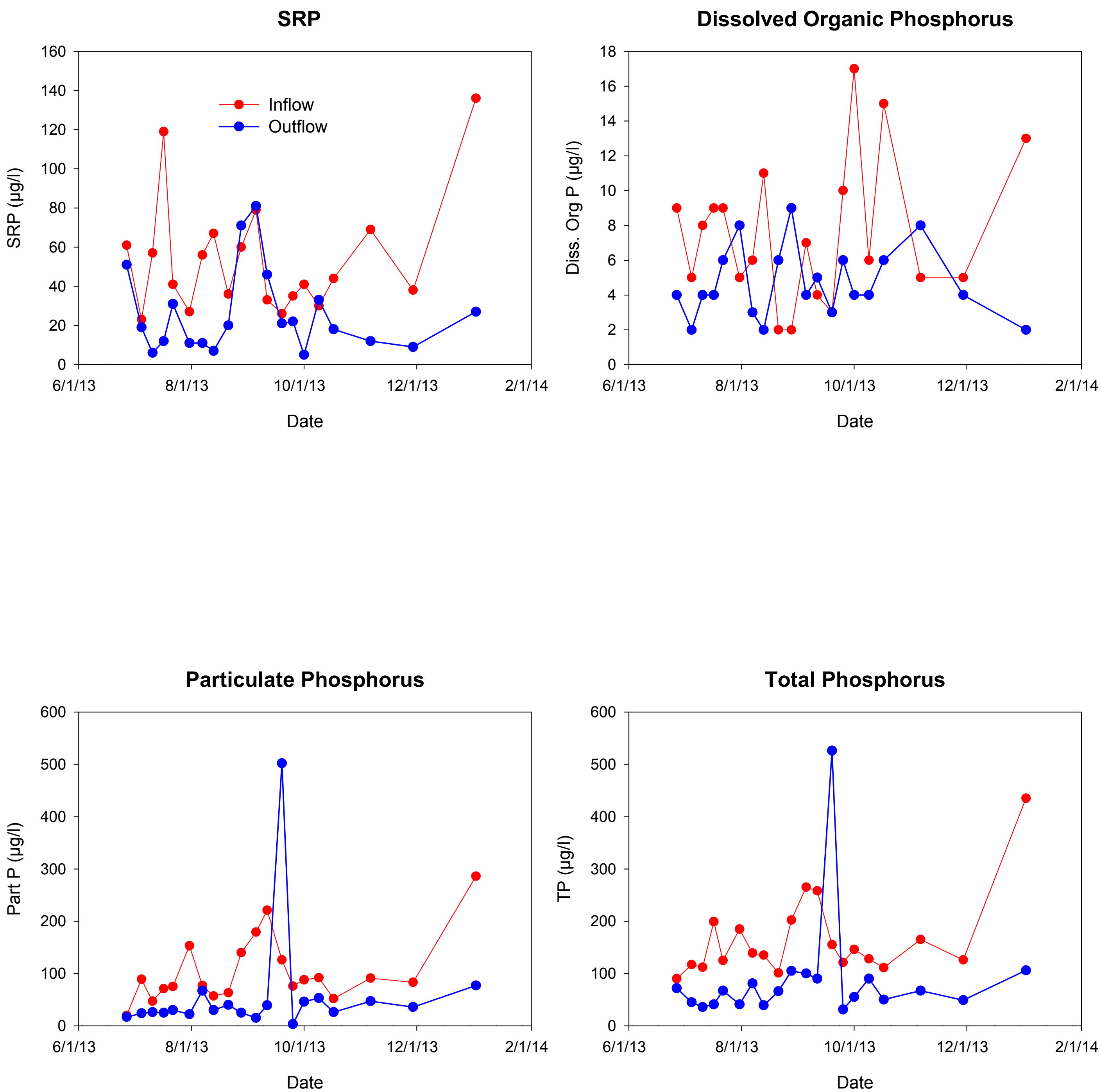


Figure 4-21. Comparison of Inflow and Outflow Concentrations of Phosphorus Species at the Gee Creek EcoVault® Site.

Measured concentrations of particulate phosphorus were highly variable in the inflow, with a substantially lower degree of variability and lower concentration observed in the outflow during most events. Overall, it appears that the Gee Creek EcoVault® system is retaining particulate phosphorus within the unit.

Overall, total phosphorus concentrations were more variable in the inflow than the outflow, with lower outflow concentrations compared with inflow concentrations during virtually all of the monitoring events. The only exception appears to be the elevated outfall total phosphorus concentration observed during September 2013 which also exhibited elevated concentrations for dissolved organic phosphorus and particulate phosphorus as well. Overall, it appears that the EcoVault® unit is successful in retaining total phosphorus within the unit.

A statistical comparison of inflow and outflow concentrations of phosphorus species at the Gee Creek EcoVault® site is given on Figure 4-22. Outflow concentrations of SRP appear to exhibit a higher degree of variability, although a lower median concentration, compared with samples collected at the inflow. In contrast, inflow concentrations of dissolved organic phosphorus were higher in both variability and median concentration than samples collected at the outflow. A similar pattern is also apparent for particulate phosphorus as well as total phosphorus, with inflow characteristics for each of these parameters both more variable and higher in concentration than samples collected at the outflow. The data suggest that a substantial amount of the incoming total phosphorus is retained within the EcoVault® system.

4.2.2.4 Metals

A comparison of inflow and outflow concentrations of copper, iron, and zinc at the Gee Creek EcoVault® site is given on Figure 4-23. In general, inflow concentrations of copper were highly variable at this site, ranging from 2-46 µg/l. With only a few exceptions, measured copper concentrations in outflow samples were lower in value than inflow concentrations, with outflow samples ranging from 2-10 µg/l. Overall, it appears that the Gee Creek EcoVault® unit is retaining a large portion of the copper inputs within the unit.

Inflow concentrations of total iron at the Gee Creek site were highly variable throughout the field monitoring program, with measured values ranging from 143-1997 µg/l. Outflow total iron concentrations were generally lower than inflow concentrations during a majority of the monitoring events, with discharge concentrations ranging from 168-1137 µg/l. Overall, it appears that the Gee Creek EcoVault® unit is retaining a substantial portion of the iron loadings within the unit.

Highly variable concentrations of total zinc were observed at the inflow for the EcoVault® site, with measured concentrations ranging from 4-63 µg/l. In contrast, outflow concentrations were generally low in value, ranging from 2-22 µg/l, with concentrations substantially less than inflow concentrations during virtually all events. Overall, it appears that the Gee Creek EcoVault® unit is retaining substantial portions of the zinc loadings within the unit.

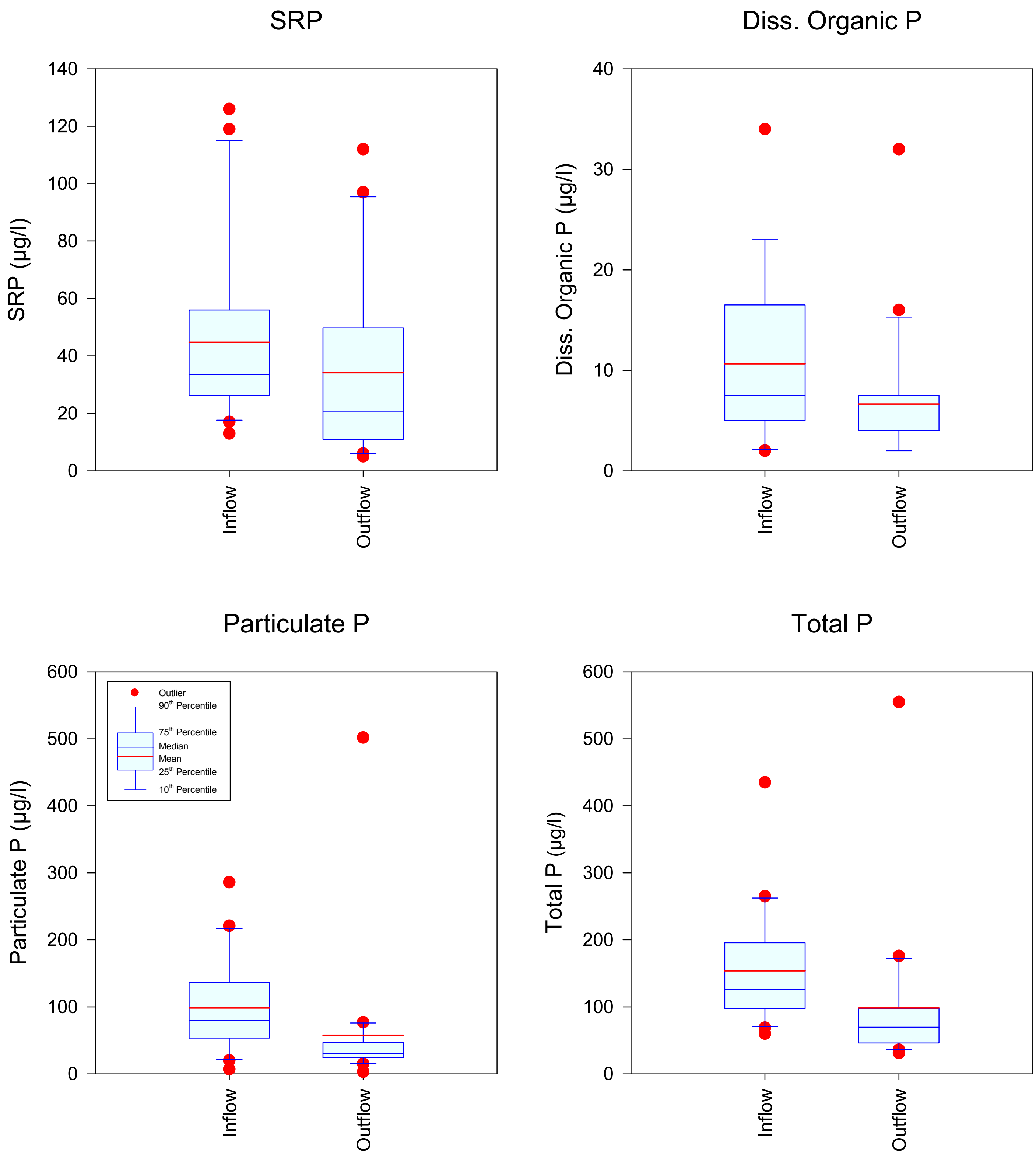


Figure 4-22. Statistical Comparison of Inflow and Outflow Concentrations of Phosphorus Species at the Gee Creek EcoVault® Site.

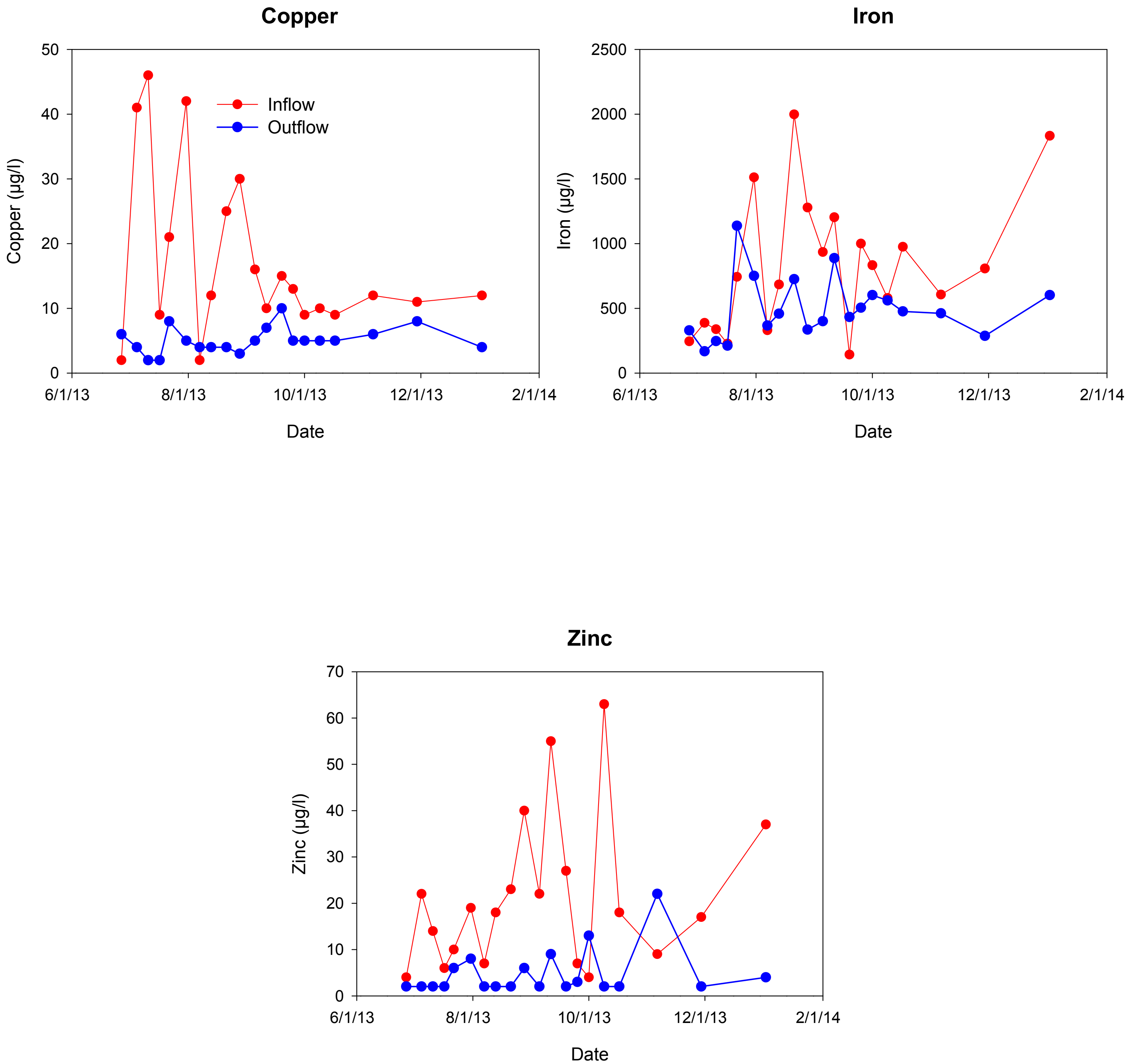


Figure 4-23. Comparison of Inflow Concentrations of Copper, Iron, and Zinc at the Gee Creek EcoVault® Site.

A statistical comparison of inflow and outflow concentrations of copper, iron, and zinc at the Gee Creek EcoVault® site is given on Figure 4-24. Measured inflow concentrations of total copper at the Gee Creek site exhibited a relatively high degree of variability in values. In contrast, outflow samples exhibited a low degree of variability and a substantially lower median concentration for total copper than observed at the inflow. A similar pattern is also apparent for iron. Measured iron concentrations in the inflow were highly variable, with a relatively elevated median concentration. In contrast, total iron concentrations in the discharge exhibited a substantially lower degree of variability as well as a lower median value. A similar pattern was also observed for zinc, with highly variable and elevated concentrations at the inflow compared with a low degree of variability and a lower median concentration observed at the outflow.

4.2.2.5 Comparison of Inflow and Outflow Characteristics

A tabular summary of chemical characteristics in the inflow and outflow samples for the Gee Creek EcoVault® site is given on Table 4-17. Treatment of runoff by the EcoVault® unit resulted in little measurable change in pH, dissolved organic nitrogen, or color. Slight reductions in outflow concentrations (+15%) were observed for alkalinity, conductivity, particulate nitrogen, and total nitrogen. However, relatively significant reductions in concentrations were observed for ammonia (although both inflow and outflow concentrations were extremely low in value), NO_x, SRP, dissolved organic phosphorus, particulate phosphorus, total phosphorus, turbidity, TSS, and fecal coliform bacteria.

TABLE 4-17

COMPARISON OF INFLOW AND OUTFLOW CHARACTERISTICS AT THE GEE CREEK EcoVault® UNIT

PARAMETER	UNITS	MEAN INFLOW CONCENTRATION[1]	MEAN OUTFLOW CONCENTRATION[1]	PERCENT CHANGE (%)
pH	s.u.	7.37	7.47	1
Alkalinity	mg/l	99.7	90.4	-9
Conductivity	μmho/cm	258	235	-9
NH_3	μg/l	8	5	-41
NO_x	μg/l	461	211	-54
Diss. Organic N	μg/l	219	215	-2
Particulate N	μg/l	112	99	-12
Total N	μg/l	887	760	-14
SRP	μg/l	37	23	-60
Diss. Organic P	μg/l	8	5	-34
Particulate P	μg/l	75	33	-63
Total P	μg/l	137	74	-56
Turbidity	NTU	11.2	6.8	-39
Color	Pt-Co	58	56	-4
TSS	mg/l	54.7	11.9	-78
Fecal Coliform	cfu/100 ml	314	82	-74
Copper	μg/l	13	4.7	-64
Iron	μg/l	669	447	-33
Zinc	μg/l	16	3	-79

1. Reflect geometric mean values

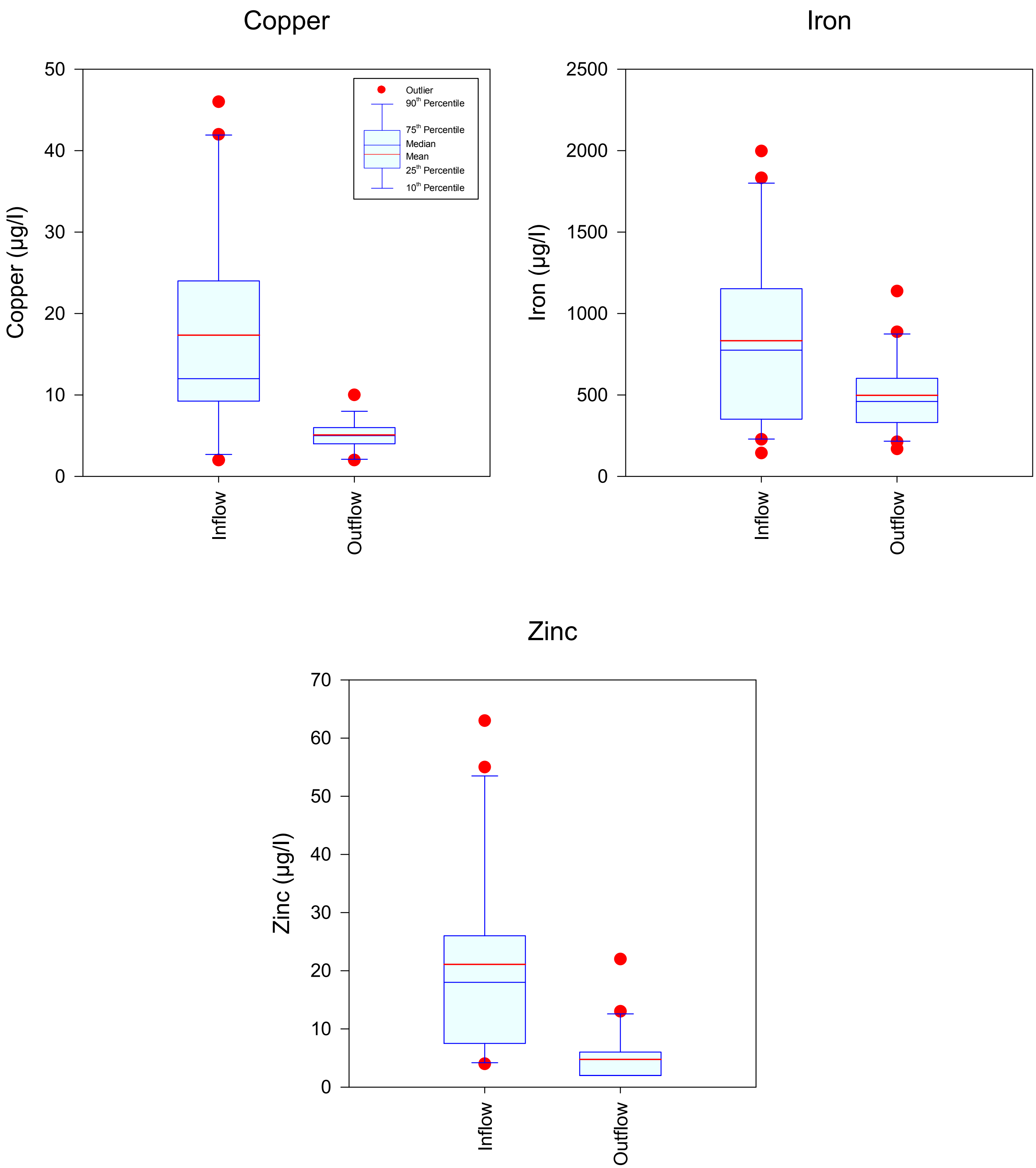


Figure 4-24. Statistical Comparison of Inflow and Outflow Concentrations of Copper, Iron, and Zinc at the Gee Creek EcoVault® Site.

4.2.3 San Pablo EcoVault® Site

4.2.3.1 General Parameters

A graphical comparison of inflow and outflow concentrations of pH, alkalinity, conductivity, turbidity, color, and TSS at the San Pablo EcoVault® Site is given on Figure 4-25. In general, both the inflow and outflow samples were approximately neutral in pH. A relatively close agreement was observed in measured inflow pH values at the inflow and outflow sites during most monitoring events, suggesting that no significant change in pH appears to occur during migration through the San Pablo EcoVault® unit.

Highly variable concentrations of alkalinity were measured at both the inflow and outflow monitoring locations, with measured inflow values ranging from 36.4-126 mg/l. Inflow and outflow alkalinity concentrations appear to track relatively closely during a majority of the monitoring events, with a slight trend of lower alkalinity values in the outflow compared with the inflow.

Measured conductivity values in the inflow and outflow samples also appear to track relatively closely with measured inflow values, ranging from 95-335 μmho/cm. In general, no significant change in conductivity appears to occur during movement through the San Pablo EcoVault® unit.

Measured turbidity values at the inflow to the EcoVault® were highly variable, ranging from 1.4-33.3 NTU, reflecting relatively low values. A much lower range of values, from 1.6-10.5 NTU, was measured in the outflow samples. In general, turbidity measurements in the discharge were lower than inflow concentrations during most monitoring events.

Measured color concentrations also appear to track closely between the inflow and outflow concentrations during a majority of the monitoring events. Measured color concentrations at the inflow ranged from 22-64 Pt-Co units. Migration through the San Pablo EcoVault® unit appears to have little impact on measured color concentrations within the samples.

Inflow concentrations of TSS exhibited a high degree of variability, ranging from 20.4-233 mg/l. In contrast, relatively low TSS concentrations were measured in the discharge which ranged from 2.0-44 mg/l. Overall, TSS concentrations in the outflow samples were lower than the inflow concentrations during a majority of the monitoring events.

A statistical comparison of inflow and outflow concentrations for pH, alkalinity, conductivity, and TSS is given on Figure 4-26. In general, the degree of variability in pH values appears to be similar between the inflow and ouflow samples, with a slightly higher median pH value observed in the discharge. For alkalinity, a higher degree of variability was observed at the outflow compared with the inflow. A similar pattern was observed for conductivity, although similar median values were observed in the inflow and outflow samples.

Measured TSS concentrations in the inflow exhibited a relatively high degree of variability as well as an elevated median concentration. In contrast, the outflow samples were characterized by a substantially lower median concentration and a lower degree of variability. These data suggest that significant amounts of TSS are retained within the EcoVault® unit.

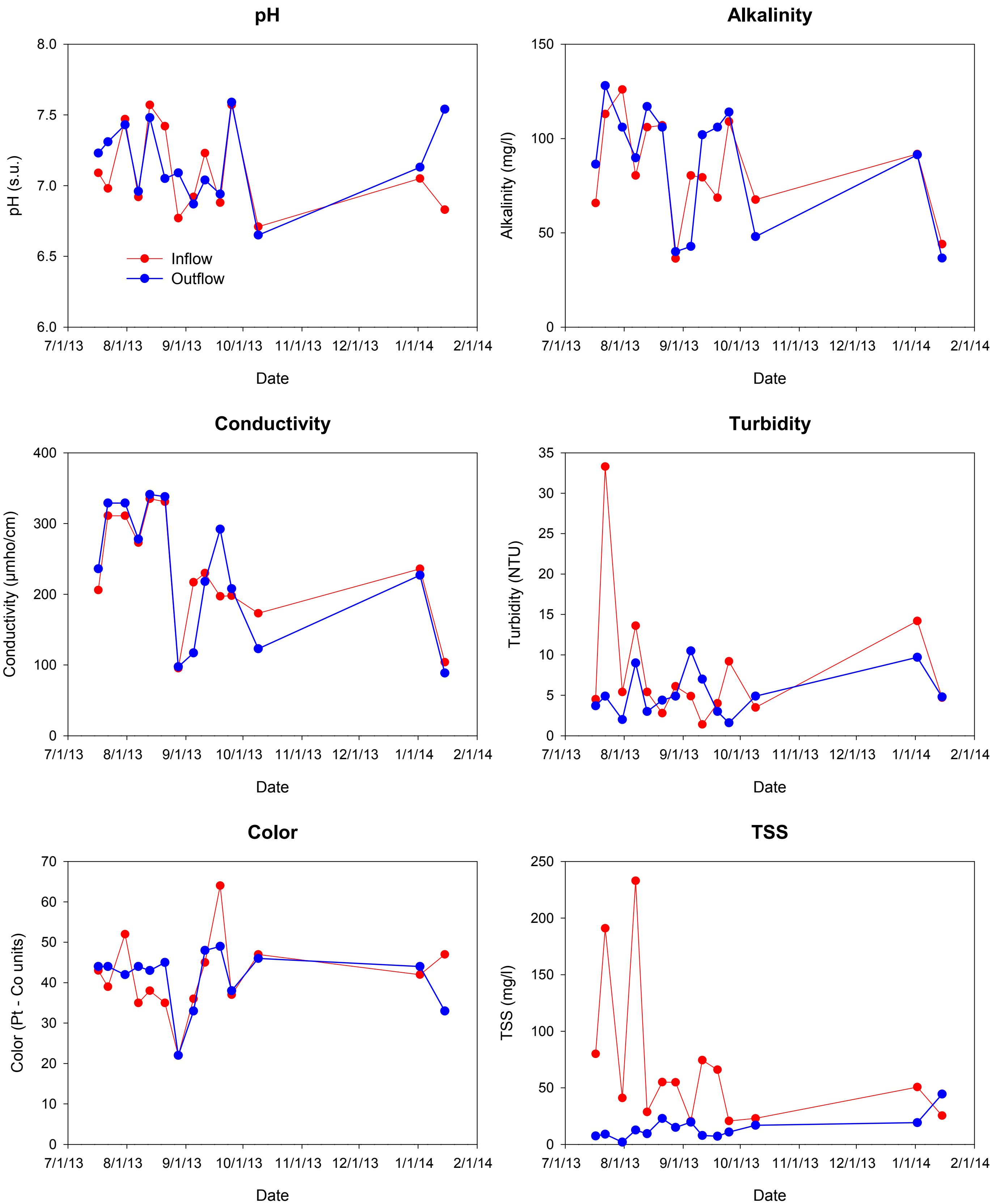


Figure 4-25. Comparison of Inflow and Outflow Concentrations of pH, Alkalinity, Conductivity, Turbidity, Color, and TSS at the San Pablo EcoVault® Site.

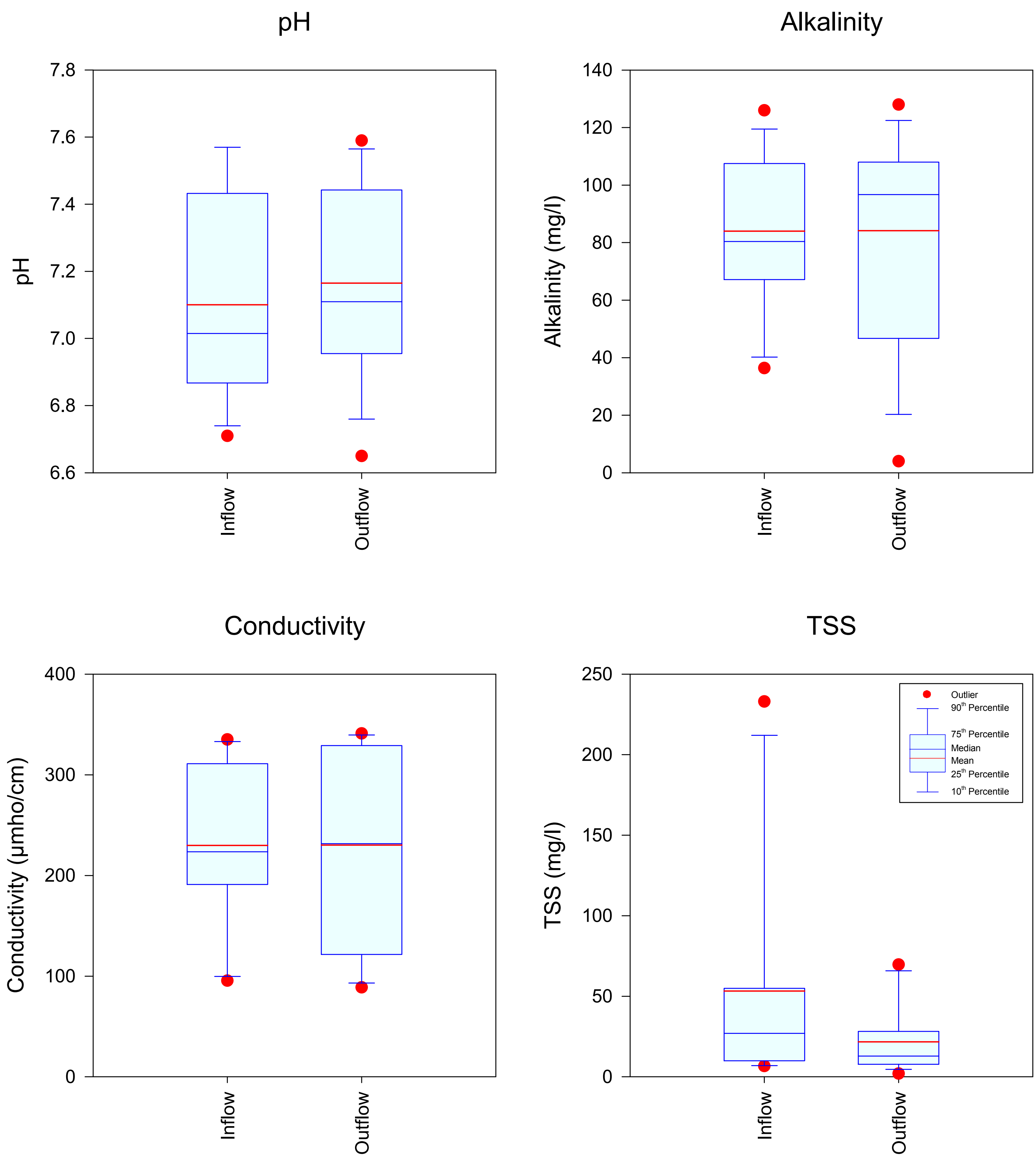


Figure 4-26. Statistical Comparison of Inflow and Outflow Concentrations of pH, Alkalinity, Conductivity, and TSS at the San Pablo EcoVault® Site.

A statistical comparison of inflow and outflow concentrations of turbidity and color at the San Pablo EcoVault® site is given on Figure 4-27. In general, measured turbidity concentrations in the outflow samples exhibited a lower degree of variability as well as a slightly lower median concentration compared with the inflow. A similar degree of variability was observed in measured color concentrations at the inflow and outflow monitoring sites, with no significant apparent differences in median concentrations.

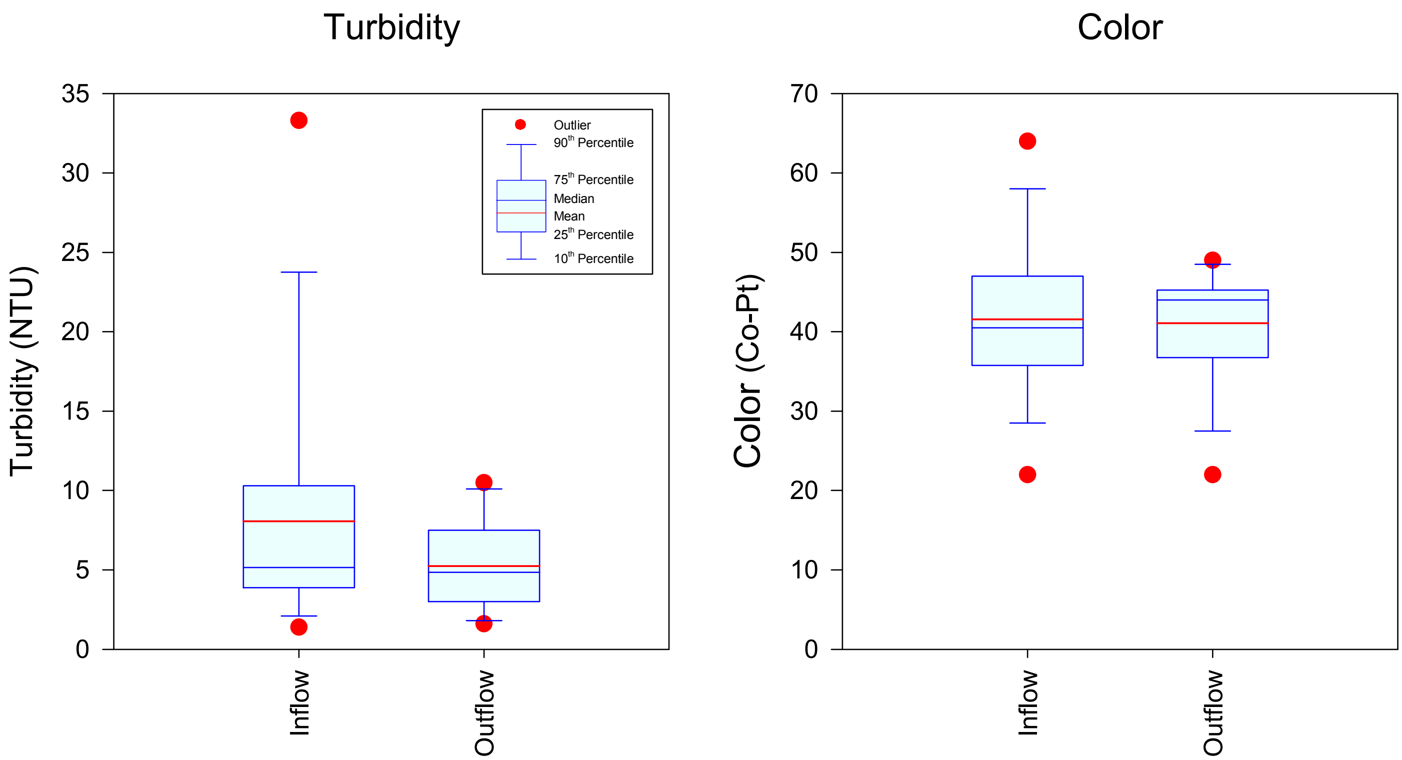


Figure 4-27. Statistical Comparison of Inflow and Outflow Concentrations of Turbidity and Color at the San Pablo EcoVault® Site.

4.2.3.2 Nitrogen Species

A graphical comparison of inflow and outflow concentrations of nitrogen species at the San Pablo EcoVault® site is given on Figure 4-28. Measured concentrations of ammonia were highly variable at both the inflow and outflow monitoring sites, with a slight tendency of more elevated concentrations of ammonia at the outfall location. Measured inflow concentrations of ammonia at the site ranged from 3-295 µg/l. A high degree of variability was also observed in measured concentrations for NO_x, particularly during the first two months of the field monitoring program. Measured concentrations of NO_x at the inflow and outflow sites tracked very closely during a majority of the monitoring events, with no apparent difference between inflow and outflow concentrations.

A high degree of variability was also observed in measured concentrations of dissolved organic nitrogen, with inflow values ranging from 62-580 µg/l. A trend of slightly lower concentrations in the outflow compared with the inflow is apparent during many of the monitoring events.

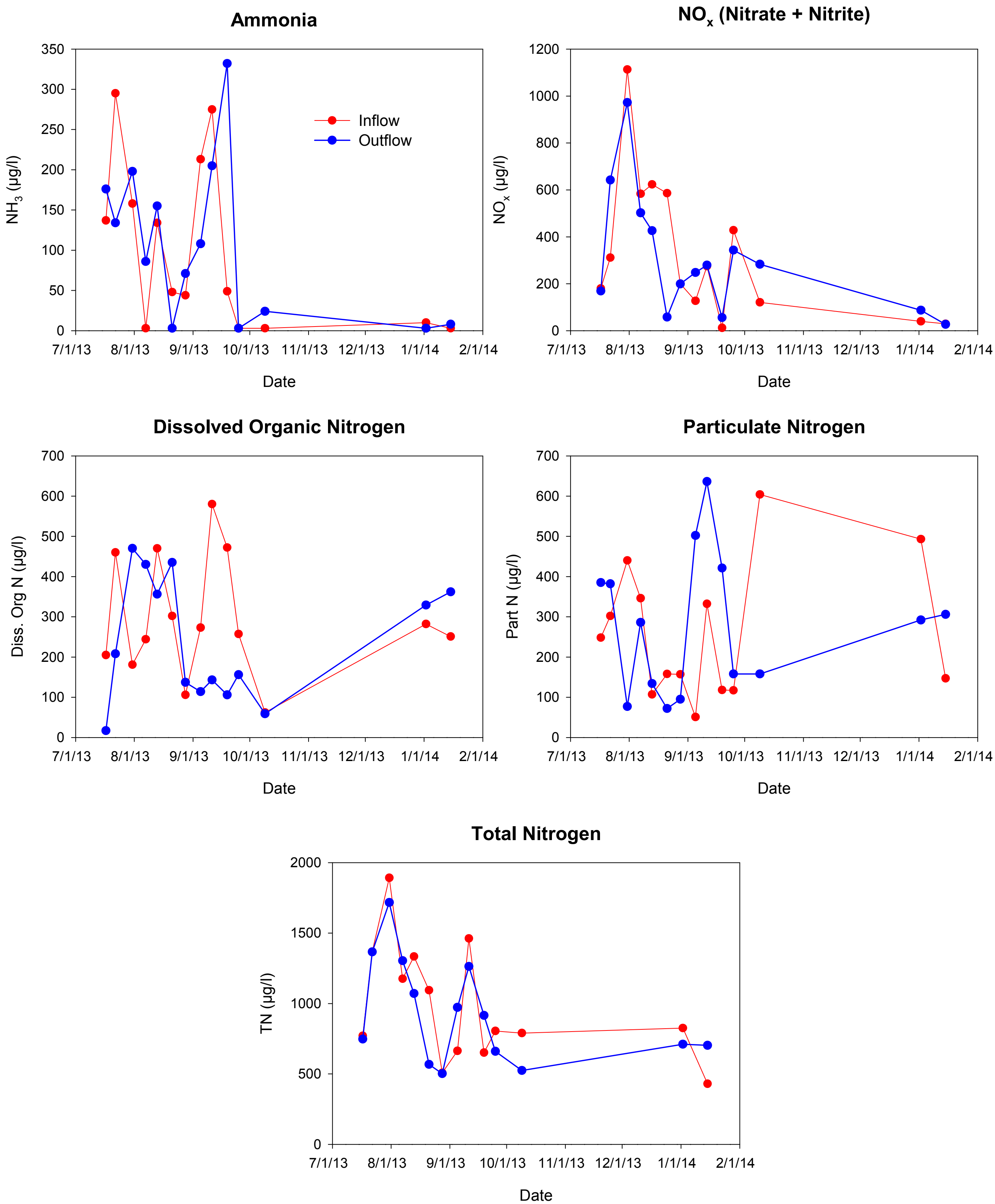


Figure 4-28. Comparison of Inflow and Outflow Concentrations of Nitrogen Species at the San Pablo EcoVault® Site.

Measured concentrations of particulate nitrogen were also highly variable, with inflow concentrations ranging from 51-604 μg/l. No trend is apparent between inflow and outflow characteristics for particulate nitrogen, suggesting that the unit has little affinity for removal of this parameter.

Overall, measured total nitrogen concentrations exhibited relatively close relationships between the inflow and outflow sites, with a slight trend of lower concentrations in the outflow samples compared with the inflow. The system appears to remove total nitrogen, although the removal appears to be relatively low in value.

A statistical comparison of inflow and outflow concentrations of nitrogen species at the San Pablo EcoVault® Site is given on Figure 4-29. A relatively similar degree of variability is apparent in measured ammonia concentrations at the inflow and outflow, with a slightly greater median concentration observed in the outflow. A similar pattern is also apparent for NO_x, with a slightly higher NO_x concentration observed in the outflow compared with the inflow, although the inflow is characterized by a higher degree of variability than the outflow.

Concentrations of dissolved organic nitrogen appear to exhibit a relatively similar degree of variability between the inflow and outflow monitoring sites. Dissolved organic nitrogen concentrations in the outflow samples appear to be slightly greater than measured in the inflow. Overall, total nitrogen concentrations exhibit a slightly lower degree of variability in the discharge, along with a slightly lower median concentration.

4.2.3.3 Phosphorus Species

A graphical comparison of inflow and outflow concentrations of phosphorus species at the San Pablo EcoVault® Site is given on Figure 4-30. In general, measured concentrations of SRP appear to be relatively similar at the inflow and outflow for this site, with no significant differences in inflow and outflow characteristics. Dissolved organic phosphorus concentrations were generally low in value, with inflow concentrations ranging from 2-13 μg/l, and the vast majority of monitoring events indicating higher concentrations of dissolved organic phosphorus in the discharge compared with the inflow.

Measured concentrations of particulate phosphorus were moderate in value, with inflow concentrations ranging from 19-288 μg/l. A trend of lower values is apparent at the outflow, compared with the inflow, during many of the monitoring events although the reverse condition occurs on multiple occasions.

Overall, total phosphorus concentrations in the discharge from the San Pablo EcoVault® unit exhibited a relatively high degree of variability in both the inflow and outflow, with measured inflow concentrations ranging from 103-385 μg/l. Total phosphorus concentrations in the discharge are lower than the inflow during approximately two-thirds of the monitoring events, with higher concentrations at the outflow during the remaining events. Overall, reduction in total phosphorus concentrations within the unit appears to be relatively low.

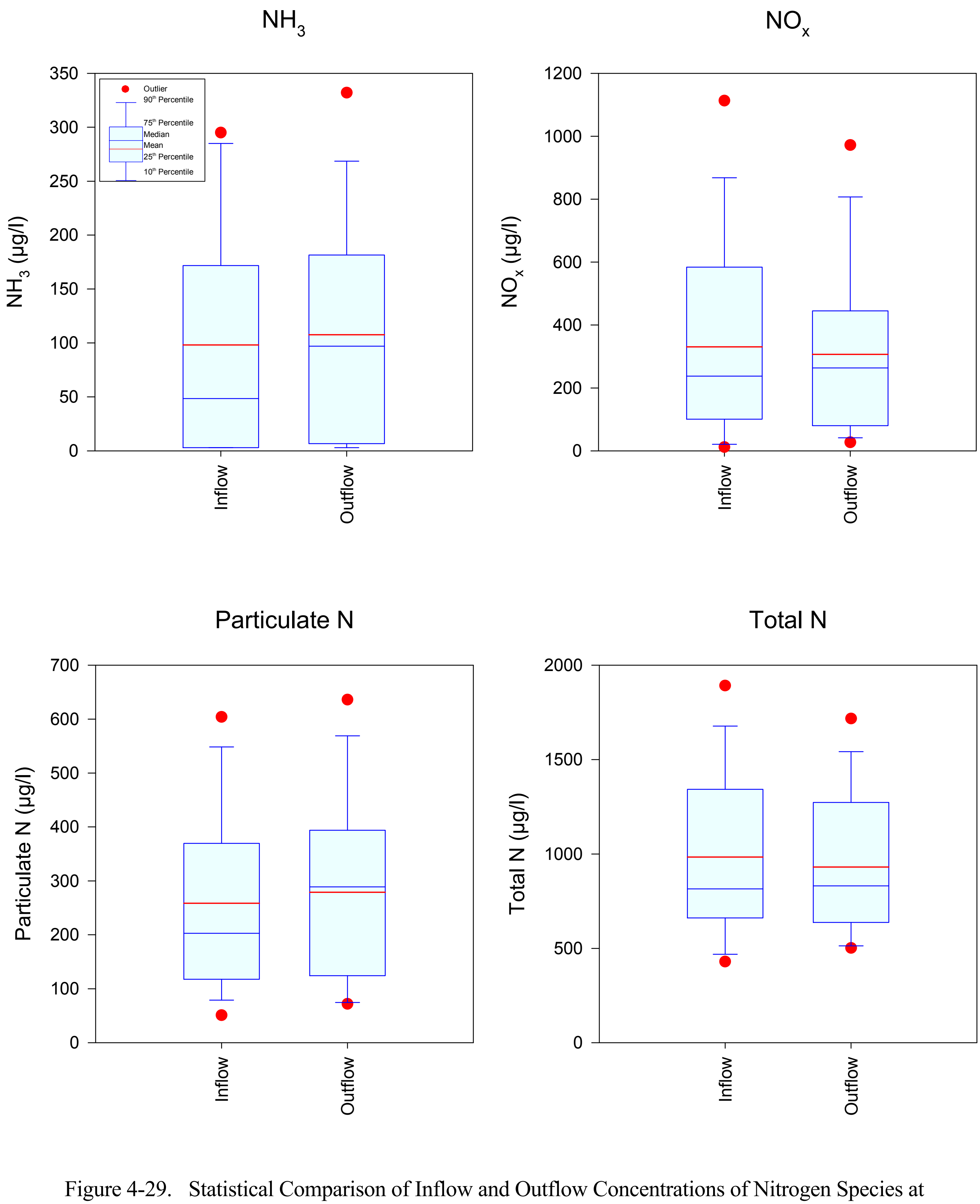


Figure 4-29. Statistical Comparison of Inflow and Outflow Concentrations of Nitrogen Species at the San Pablo EcoVault® Site.

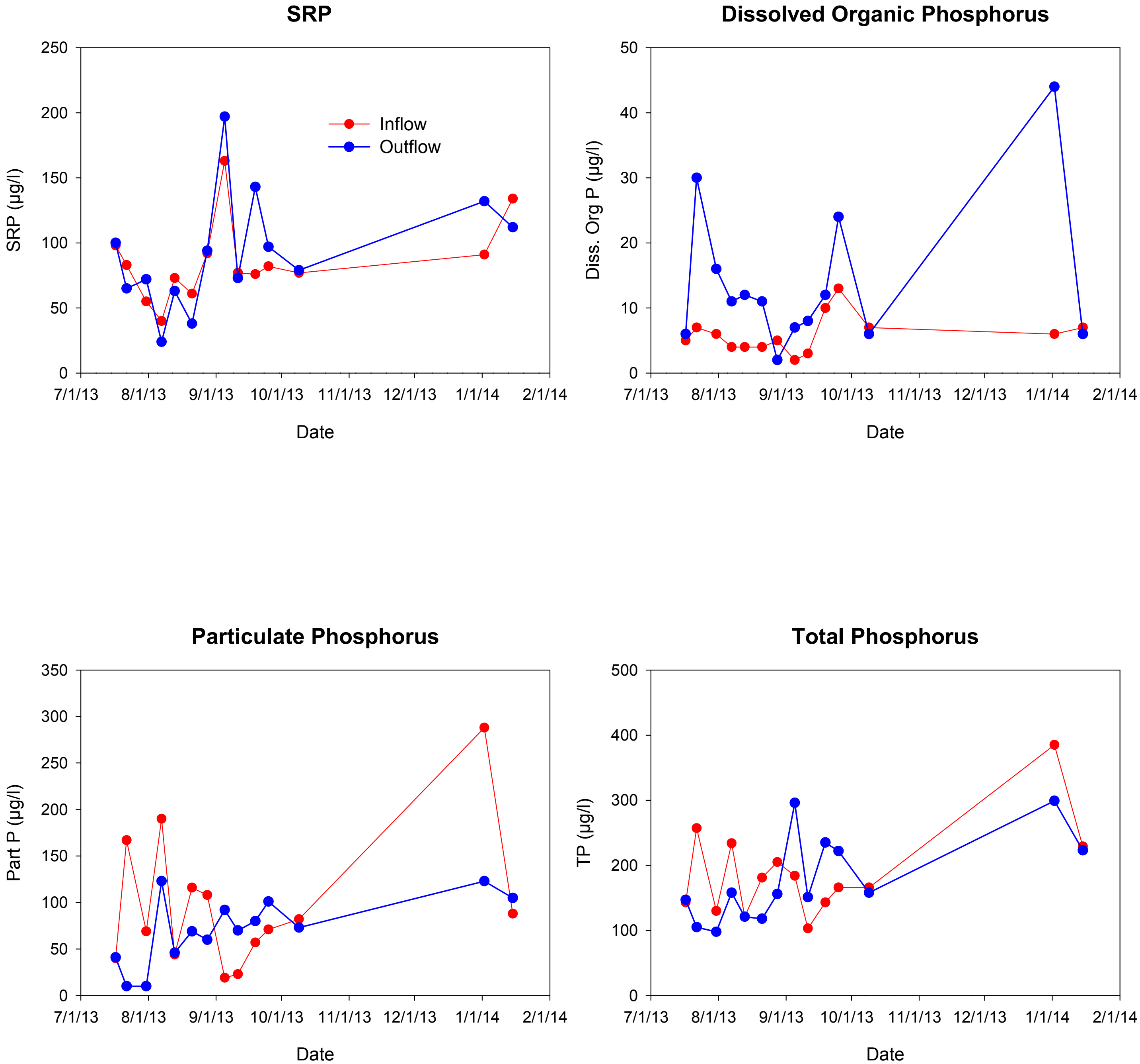


Figure 4-30. Comparison of Inflow and Outflow Concentrations of Phosphorus Species at the San Pablo EcoVault® Site.

A statistical comparison of inflow and outflow concentrations of phosphorus species at the San Pablo EcoVault® Site is given on Figure 4-31. Measured SRP concentrations in the outflow appear to exhibit a higher degree of variability than concentrations measured at the inflow, although the median values appear to be relatively similar. A higher degree of variability in the outflow samples was also observed for dissolved organic phosphorus, along with a higher median value compared with inflow characteristics. In contrast, inflow concentrations of particulate phosphorus exhibited both a higher degree of variability as well as a higher median concentration compared with the discharge samples. Overall, variability in total phosphorus concentrations appear to be relatively similar between the inflow and outflow samples. A slight reduction in total phosphorus concentrations appears to occur within the unit.

4.2.3.4 Metals

A graphical comparison of inflow and outflow concentrations of copper, iron, and zinc at the San Pablo EcoVault® is given on Figure 4-32. Highly variable concentrations of total copper were observed in both the inflow and outflow monitoring locations, although the measured values were relatively low in value. No distinct pattern of decreases or increases in total copper concentrations is apparent in the data.

Measured concentrations of total iron were highly variable at the monitoring site, with inflow concentrations ranging from 108-1299 mg/l. Relatively similar concentrations were also measured at the outflow which contained lower concentrations of total iron during approximately half of the monitoring events. Overall, it appears that no significant change occurred in iron concentrations within the EcoVault® unit.

Measured concentrations of total zinc were also highly variable at the San Pablo site, with inflow concentrations ranging from 3-48 mg/l. Measured outflow concentrations were also highly variable, exceeding inflow concentrations during approximately half of the monitoring events. Overall, the San Pablo EcoVault® site appears to have little affinity for reduction of zinc concentrations within the unit.

A statistical comparison of inflow and outflow concentrations of copper, iron, and zinc at the San Pablo EcoVault® site is given on Figure 4-33. Measured concentrations of total copper appear to exhibit a higher degree of variability in the outflow samples compared with the inflow. However, overall, the discharge copper concentration appears to be slightly lower than the inflow concentration.

In contrast, inflow concentrations of iron exhibited a higher degree of variability than outflow concentrations. Outflow concentrations for iron also appear to have a slightly lower median value than observed at the inflow.

A relatively high degree of variability was observed in measured zinc concentrations at the inflow to the San Pablo EcoVault®. Measured zinc concentrations in the outflow exhibited a lower degree of variability as well as a slightly lower median concentration than observed in the inflow samples.

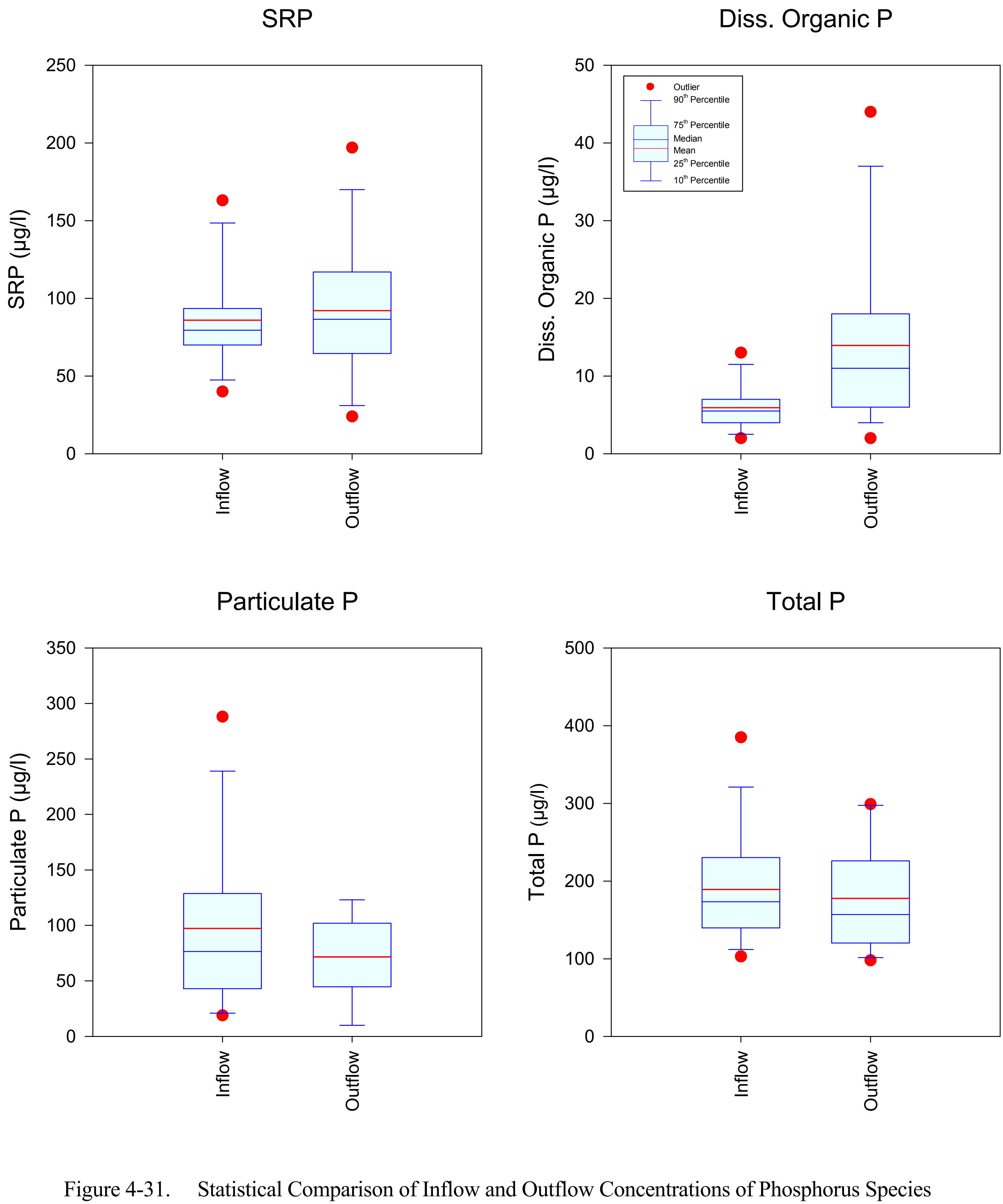


Figure 4-31. Statistical Comparison of Inflow and Outflow Concentrations of Phosphorus Species at the San Pablo EcoVault® Site.

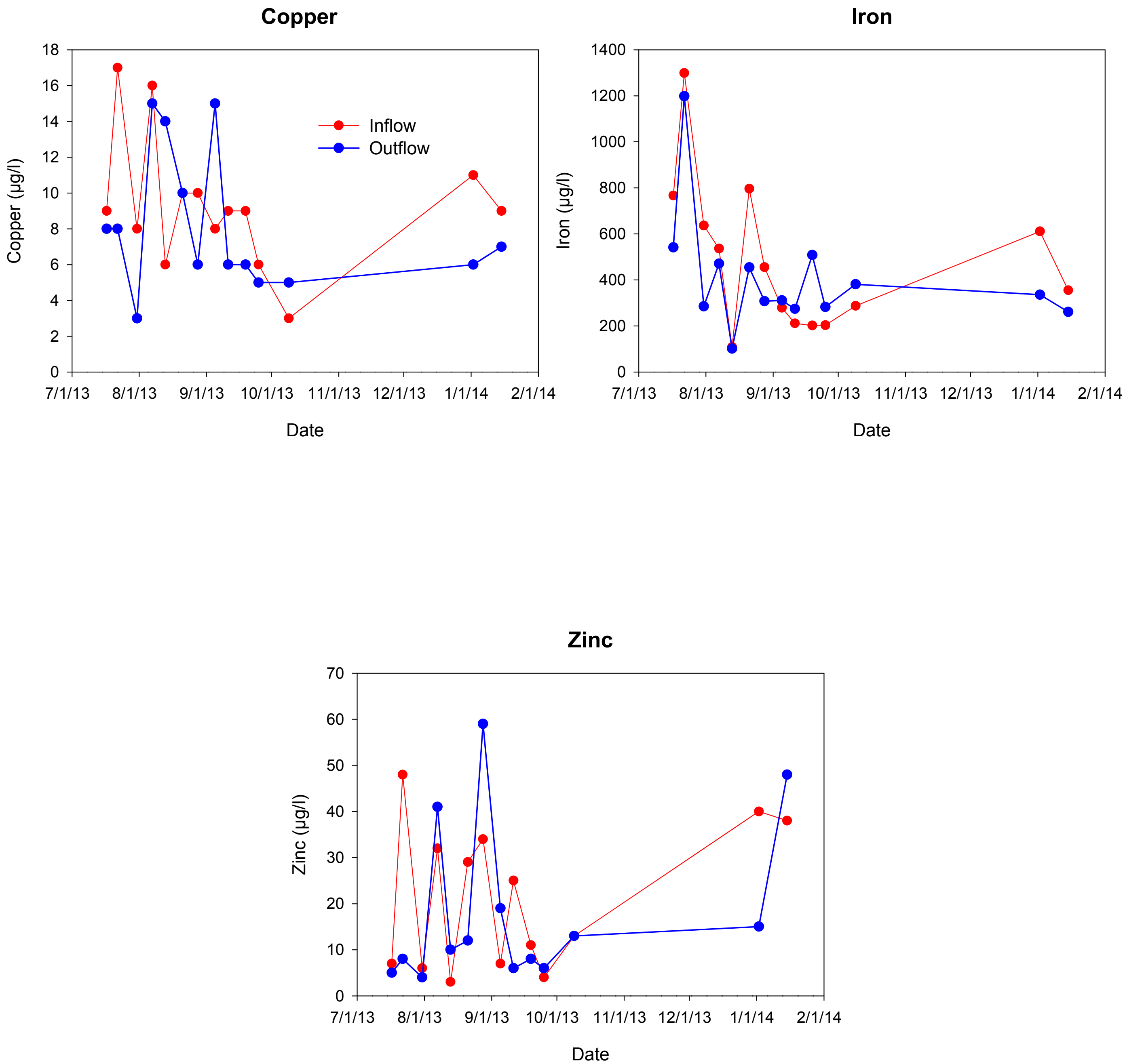


Figure 4-32. Comparison of Inflow Concentrations of Copper, Iron, and Zinc at the San Pablo EcoVault® Site.

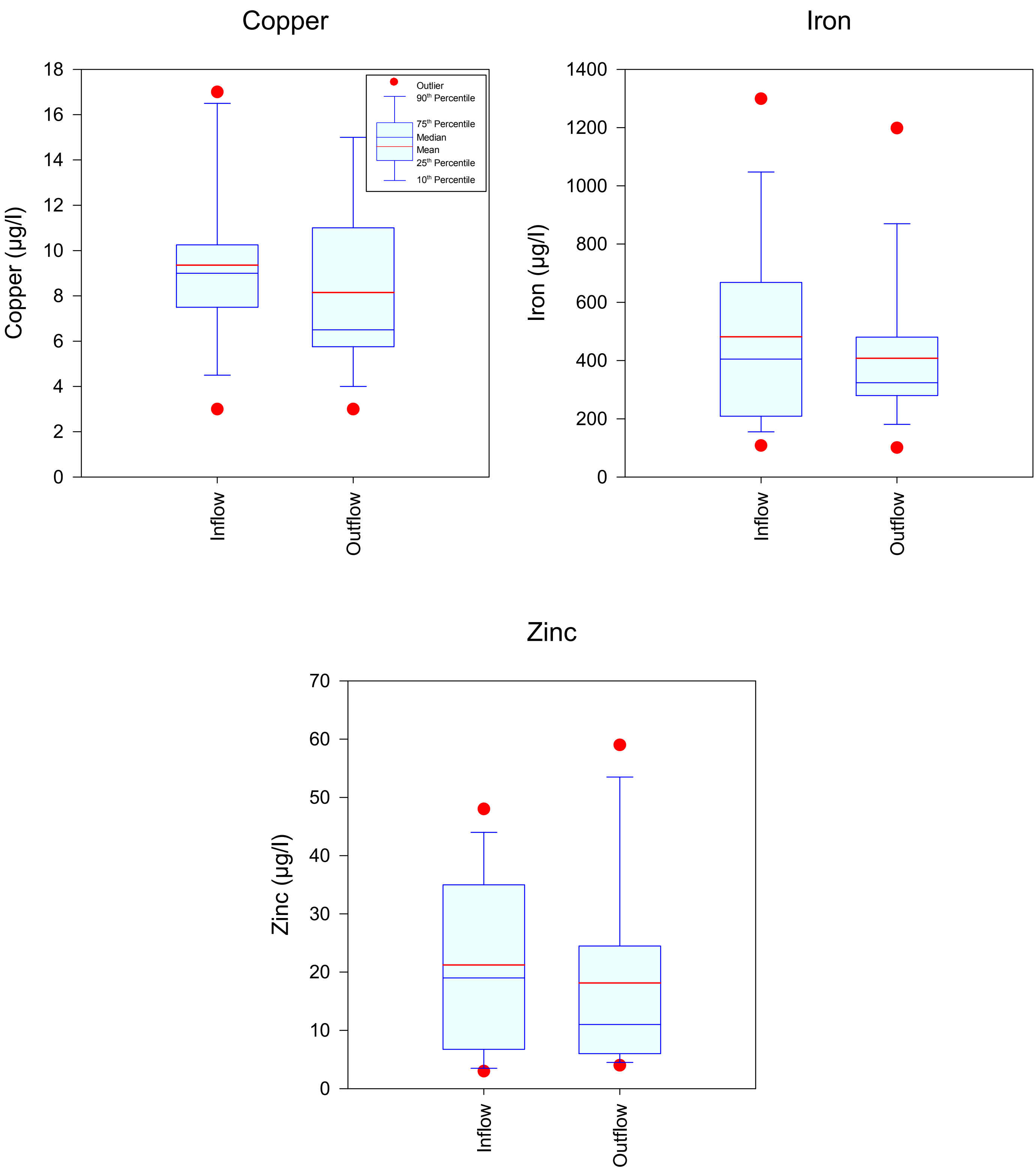


Figure 4-33. Statistical Comparison of Inflow and Outflow Concentrations of Copper, Iron, and Zinc at the Lake Hodge EcoVault® Site.

4.2.3.5 Inflow/Outflow Comparison

A comparison of mean inflow and outflow characteristics measured at the San Pablo EcoVault® unit is given on Table 4-18. Treatment in the EcoVault® unit have little impact on measured concentrations for pH, alkalinity, conductivity, NO_x, particulate nitrogen, total nitrogen, SRP, or color, with changes of 10% or less between inflow and outflow concentrations. Modest reductions in concentrations , ranging from 10-30%, were observed for dissolved organic nitrogen (-21%), particulate phosphorus (-23%), turbidity (-22%), and fecal coliform (-30%). Removal efficiencies in excess of 30% were obtained only for TSS (-77%). Substantial increases between inflow and outflow sites were observed for ammonia (+30%) and dissolved organic phosphorus (+98%). Relatively elevated fecal coliform bacteria were observed at the San Pablo site, with a reduction of 30% in the EcoVault® unit. Sources of fecal coliform in runoff are poorly understood.

TABLE 4-18

COMPARISON OF INFLOW AND OUTFLOW CHARACTERISTICS AT THE SAN PABLO EcoVault® UNIT

PARAMETER	UNITS	MEAN INFLOW CONCENTRATION[1]	MEAN OUTFLOW CONCENTRATION[1]	PERCENT CHANGE (%)
pH	s.u.	7.09	7.16	1
Alkalinity	mg/l	79.5	67.9	1
Conductivity	μmho/cm	216	209	-3
NH_3	μg/l	35	46	30
NO_x	μg/l	188	205	9
Diss. Organic N	μg/l	245	194	-21
Particulate N	μg/l	209	226	8
Total N	μg/l	905	867	-4
SRP	μg/l	81	82	1
Diss. Organic P	μg/l	5	11	98
Particulate P	μg/l	75	58	-23
Total P	μg/l	178	167	-6
Turbidity	NTU	5.9	4.6	-22
Color	Pt-Co	40	40	0
TSS	mg/l	28.4	14.4	-77
Fecal Coliform	cfu/100 ml	5,581	3,883	-30
Copper	μg/l	9	7	-15
Iron	μg/l	392	355	-9
Zinc	μg/l	15	13	-16

1. Reflect geometric mean values

4.2.4 San Pablo CDS Site

As discussed in Section 3.1.4, field monitoring was conducted only at the outflow for the San Pablo CDS unit. Therefore, the water quality discussions provided in the following sections pertain only to discharges from the CDS unit since inflows were not measured at this site.

4.2.4.1 General Parameters

A comparison of outflow characteristics of pH, alkalinity, conductivity, turbidity, color, and TSS at the San Pablo CDS site is given on Figure 4-34. Measured pH values in the discharge ranged from neutral to slightly alkaline, with measured values ranging from 6.65-7.93. Measured alkalinity values in the CDS discharge were highly variable during the field monitoring program, ranging from 26.2-142 mg/l. A similar degree of variability was also observed for measured conductivity concentrations which ranged from 76-348 μmho/cm.

Measured turbidity values in the CDS discharge were typically less than 10 NTU, with a single measurement extending to 31.1 NTU. Turbidity values in the discharge appeared to be relatively consistent with the exception of this peak value.

Measured color concentrations in the CDS discharge ranged from 19-54 Pt-Co units, reflecting low to moderate color concentrations. Measured TSS concentrations in the discharge were generally low in value, with the vast majority of measurements less than approximately 20 mg/l. However, peaks in concentrations were observed on multiple occasions, with one peak reaching a concentration of 77.2 mg/l.

A statistical comparison of outflow characteristics of pH, alkalinity, and conductivity at the San Pablo CDS site is given on Figure 4-35. A relatively high degree of variability was observed for each of these parameters, particularly for alkalinity and conductivity.

A statistical comparison of outflow concentrations of color, turbidity, and TSS at the San Pablo CDS site is given on Figure 4-36. In general, color concentrations were moderate in value. Discharge concentrations of both turbidity and TSS were confined within a relatively narrow range with the exception of several outlier values measured during the field monitoring program.

4.2.4.2 Nitrogen Species

A graphical summary of measured outflow concentrations of nitrogen species at the San Pablo CDS site is given on Figure 4-37. In general, measured concentrations for each of the evaluated nitrogen species were highly variable during the field monitoring program. Measured concentrations of ammonia in the discharge ranged from < 5-388 μg/l, reflecting low to moderate elevations. A wide range of NO_x concentrations was measured in the discharge, with values ranging from 8-887 μg/l, reflecting low to elevated values.

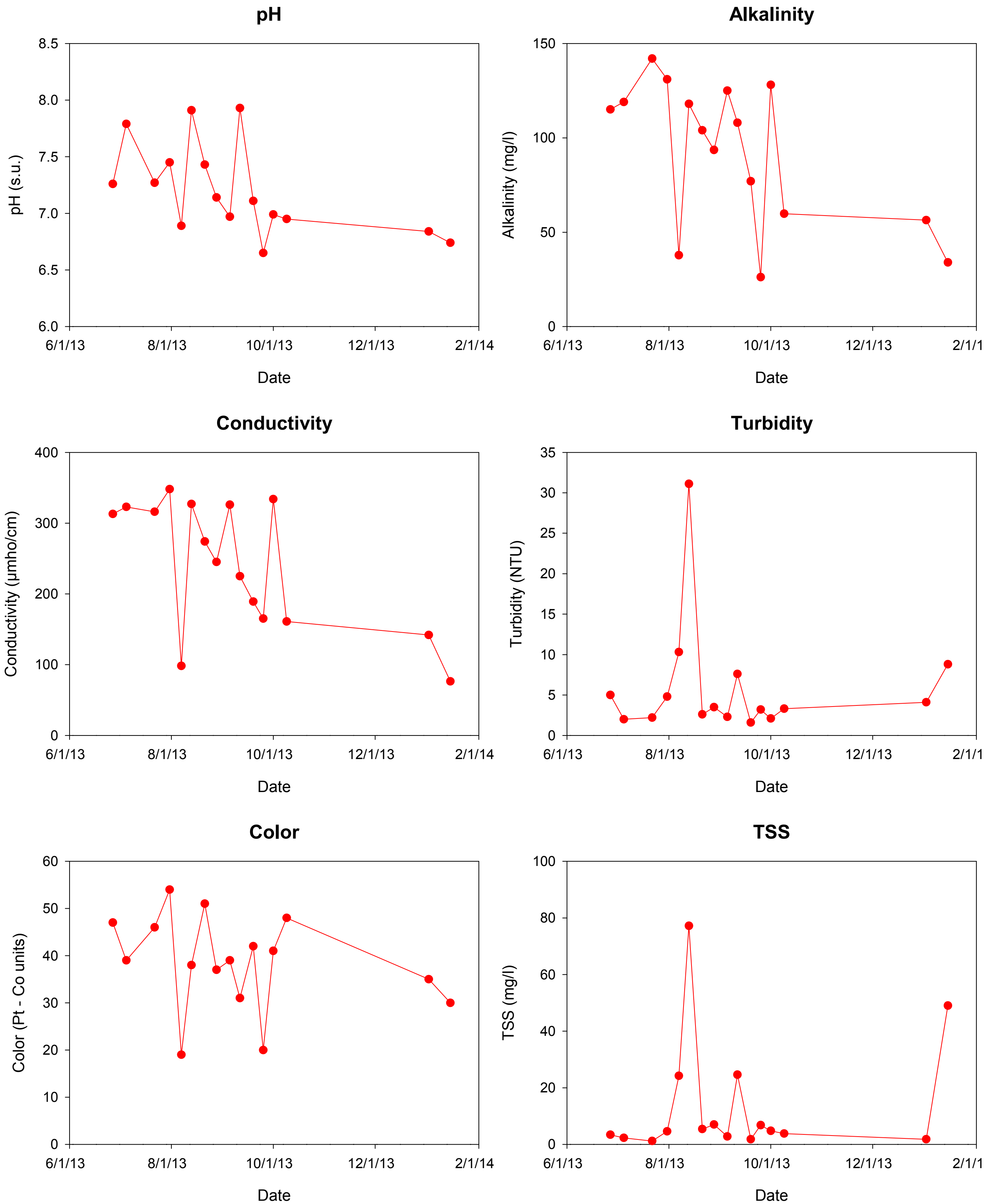


Figure 4-34. Characteristics of Outflow Concentrations of pH, Alkalinity, Conductivity, Turbidity, Color, and TSS at the San Pablo CDS Site.

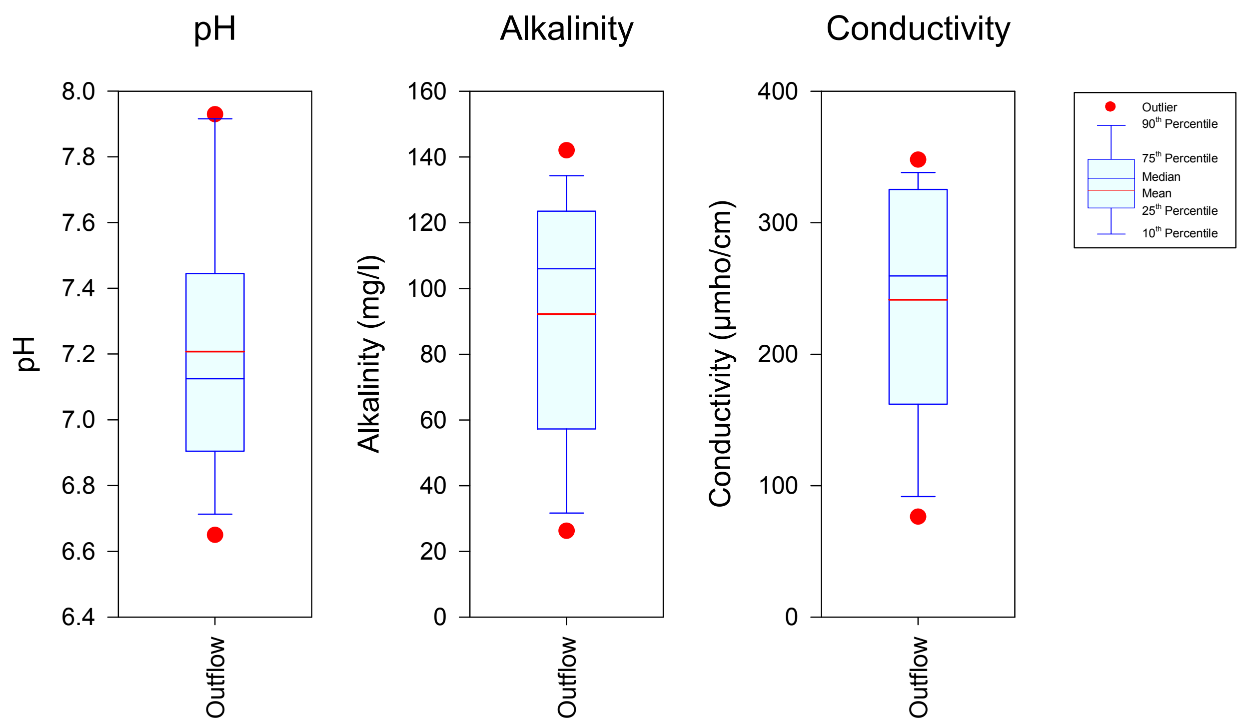


Figure 4-35. Statistical Summary of Outflow Concentrations of pH, Alkalinity, and Conductivity at the San Pablo CDS Site.

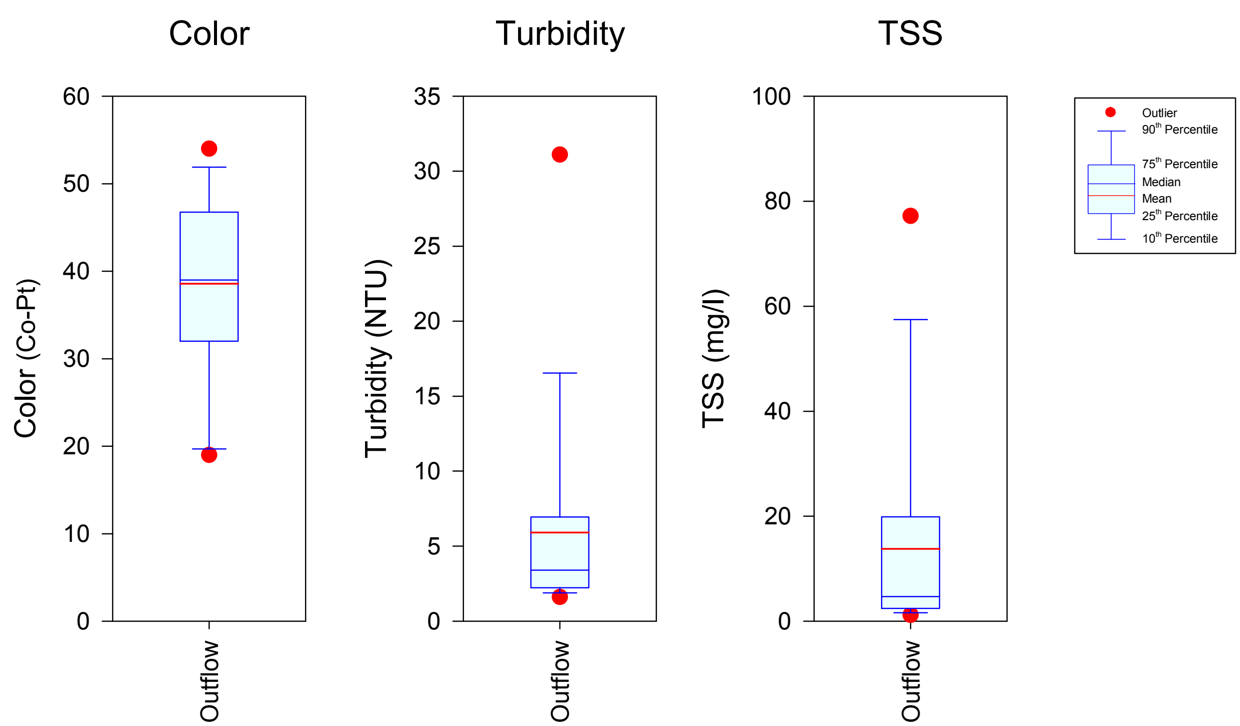


Figure 4-36. Statistical Summary of Outflow Concentrations of Color, Turbidity, and TSS at the San Pablo CDS Site.

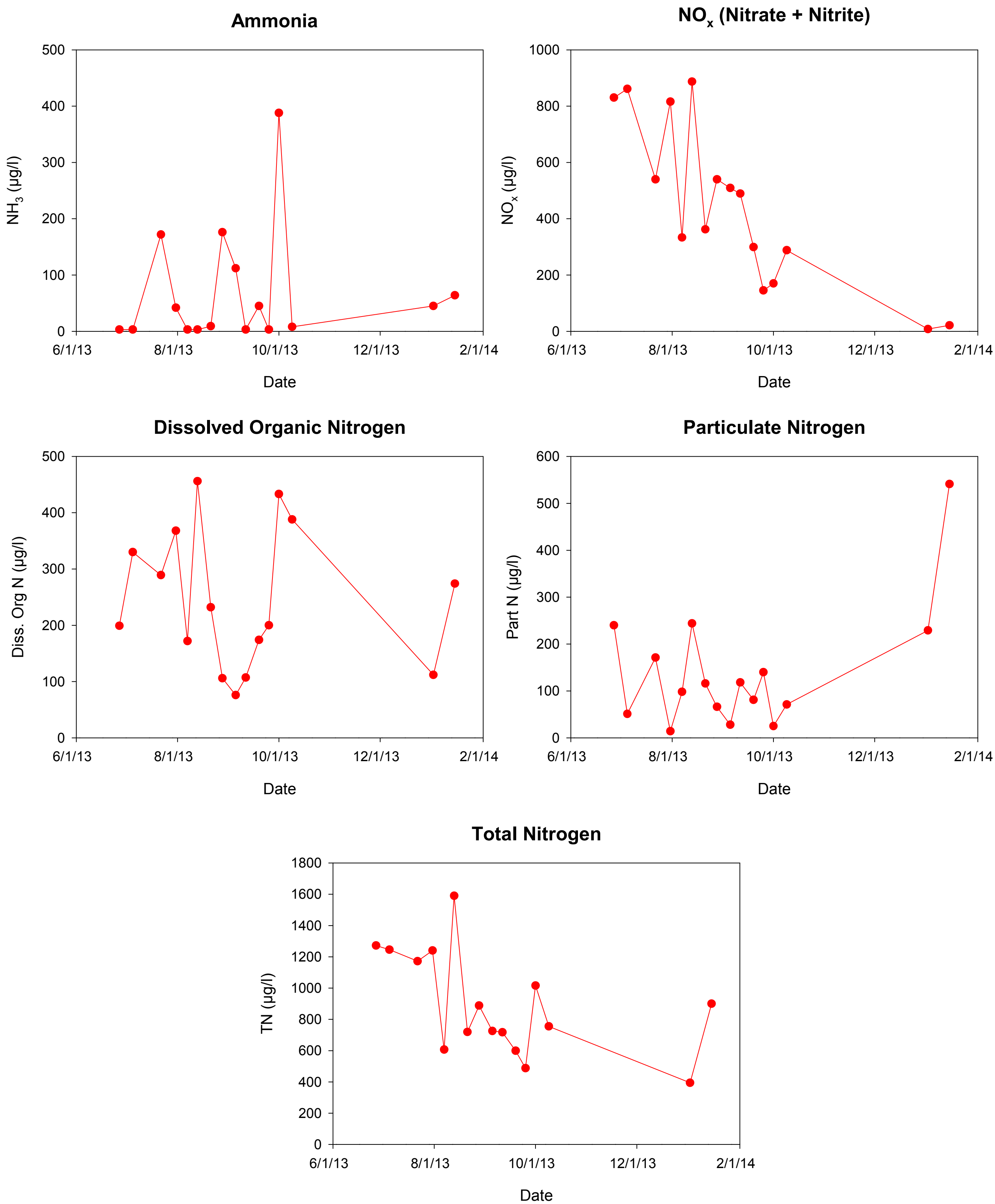


Figure 4-37. Characteristics of Outflow Concentrations of Nitrogen Species at the San Pablo CDS Site.

Measured concentrations of dissolved organic nitrogen in the discharge ranged from 76-456 µg/l, reflecting low to moderate concentrations. Measured concentrations of particulate nitrogen were generally less than 250 µg/l, with the exception of a single outlier value, reflecting moderate concentrations for this parameter.

Overall, measured total nitrogen concentrations in the CDS discharge ranged from 394-1,590 µg/l, although the vast majority of measured concentrations appear to be between 600-1,200 µg/l.

A statistical summary of outflow concentrations of nitrogen species is given on Figure 4-38. Relatively low levels of ammonia were observed in the majority of discharge samples collected at this site. However, moderate to elevated levels of NO_x were observed during the field monitoring program. Overall, total nitrogen concentrations in the unit discharge were lower than nitrogen concentrations commonly observed in urban runoff.

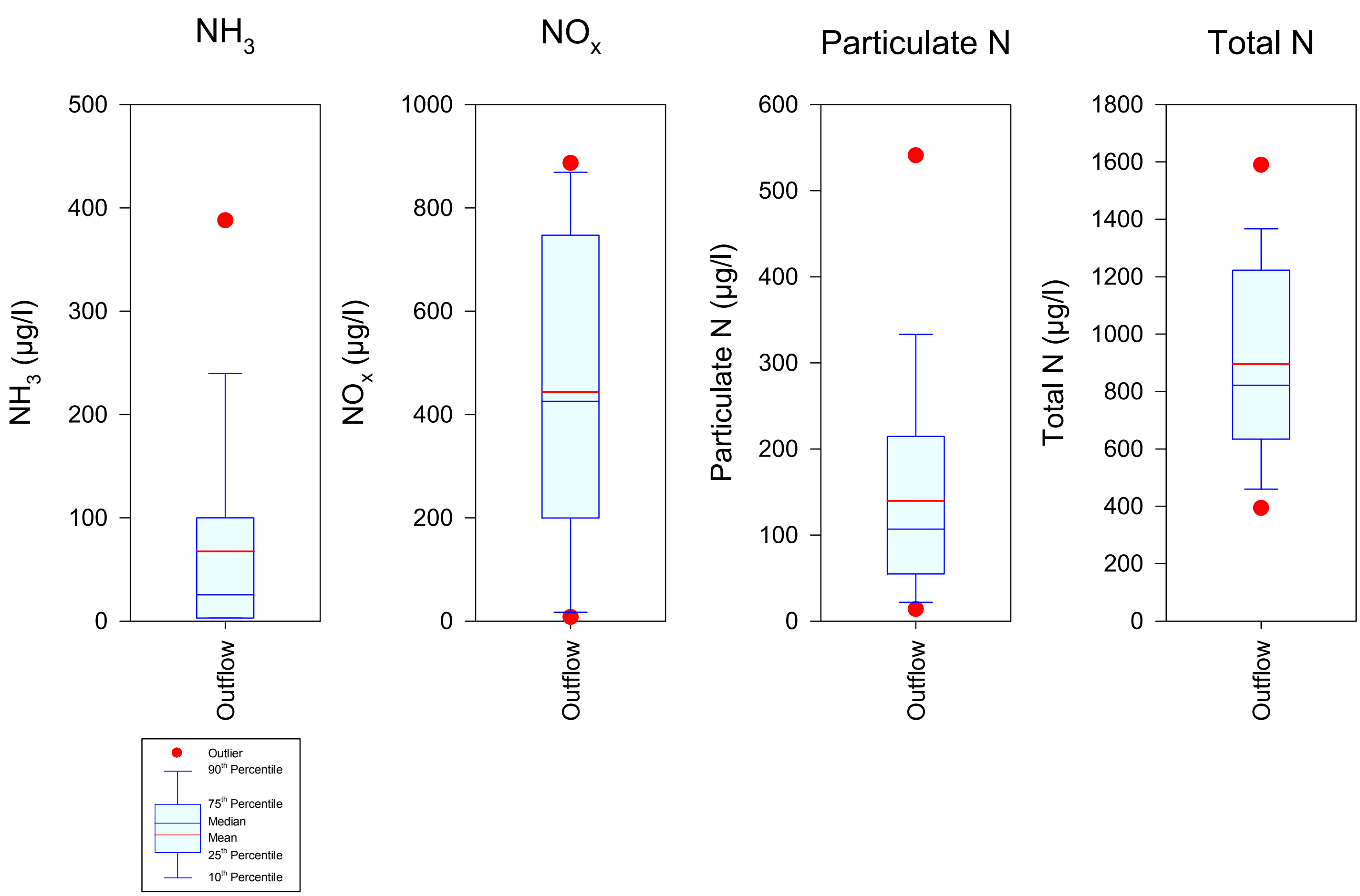


Figure 4-38. Statistical Summary of Outflow Concentrations of Nitrogen Species at the San Pablo CDS Site.

4.2.4.3 Phosphorus Species

A comparison of measured discharge concentrations of phosphorus species at the San Pablo CDS site is given on Figure 4-39. Measured discharge concentrations of SRP were highly variable, ranging from 41-111 μg/l, reflecting values commonly observed in urban runoff. Measured discharge concentrations of dissolved organic phosphorus were also highly variable, but low in value. Particulate phosphorus concentrations were highly variable in the discharge, ranging from 2-177 μg/l, reflecting low to slightly elevated values. Overall, total phosphorus concentrations in the discharge range from 50-290 μg/l, with overall observed values somewhat less than commonly observed in urban runoff.

A statistical summary of measured concentrations of phosphorus species at the San Pablo CDS unit site is given on Figure 4-40. In general, a majority of the measured SRP concentrations occur in the range of approximately 45-60 μg/l. Measured dissolved organic phosphorus concentrations were extremely low in value. Particulate phosphorus concentrations were typically low to moderate in value, with the majority of concentrations ranging from approximately 10-90 μg/l. Overall, the majority of discharge concentrations of phosphorus occurred in the range of approximately 70-150 μg/l, reflecting values somewhat lower than commonly observed in urban runoff.

4.2.4.4 Metals

A graphical summary of measured concentrations of copper, iron, and zinc in the San Pablo CDS discharge is given on Figure 4-41. Measured copper concentrations ranged from 2-15 μg/l, reflecting low to moderate concentrations. Measured concentrations of iron in the discharge ranged from 131-710 μg/l, reflecting low to somewhat elevated concentrations of iron. Measured concentrations of zinc in the outflow were highly variable, ranging from 2-35 μg/l.

A statistical summary of measured concentrations of copper, iron, and zinc in the San Pablo CDS unit discharge is given on Figure 4-42. In general, the majority of the measured concentrations for copper, iron, and zinc occurred within a relatively narrow range of values, with outliers both above and below the range of typical values.

4.2.4.5 Characteristics of Unit Discharges

A tabular summary of the characteristics of discharges from the San Pablo CDS unit is given on Table 4-19. Total nitrogen in discharges from the CDS unit were comprised primarily of NO_x, dissolved organic nitrogen, and particulate nitrogen, with a much smaller contribution from ammonia. Phosphorus discharges from the unit were comprised primarily of SRP and particulate phosphorus, with a relatively small component for dissolved organic phosphorus.

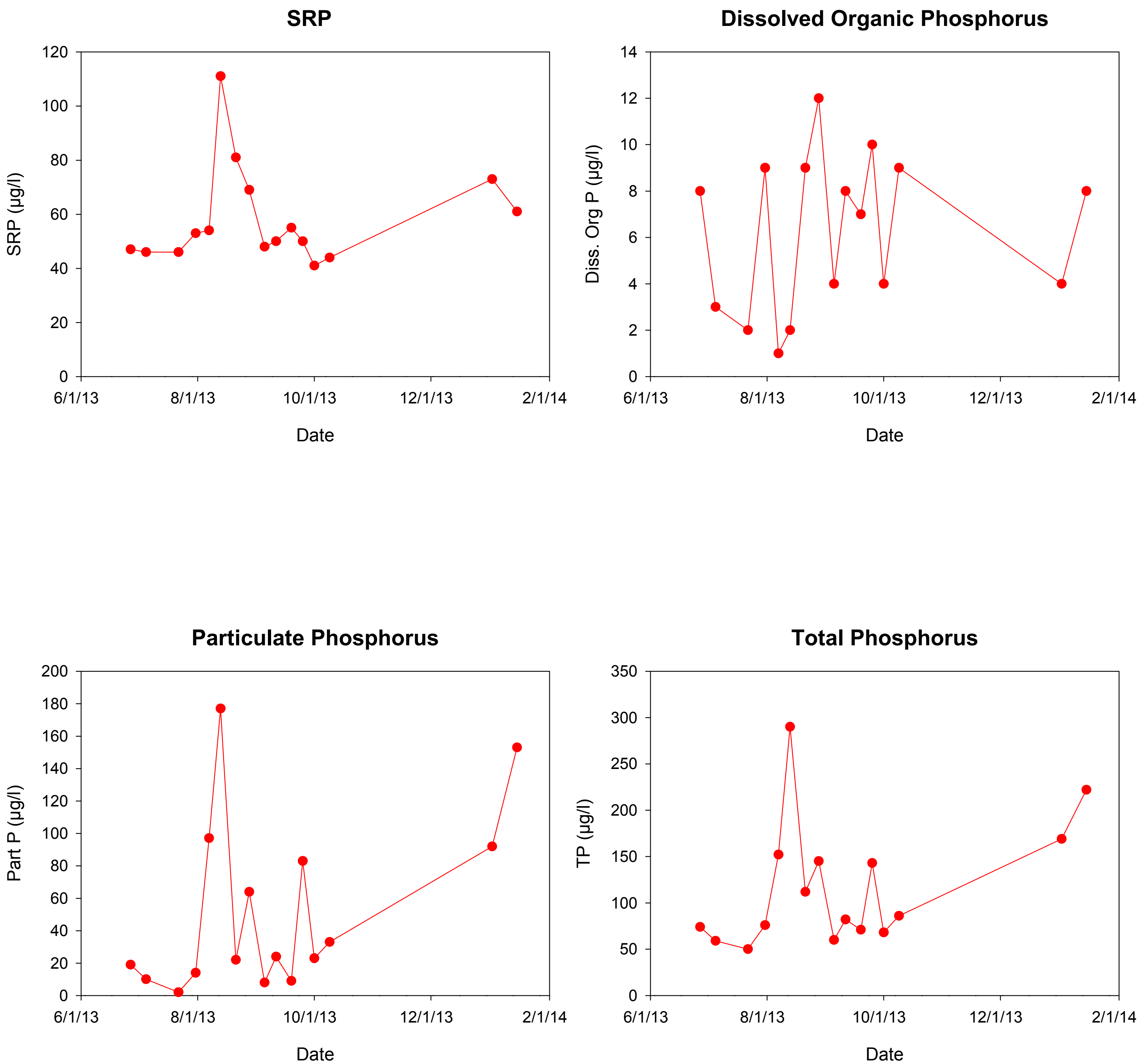


Figure 4-39. Characteristics of Outflow Concentrations of Phosphorus Species at the San Pablo CDS Site.

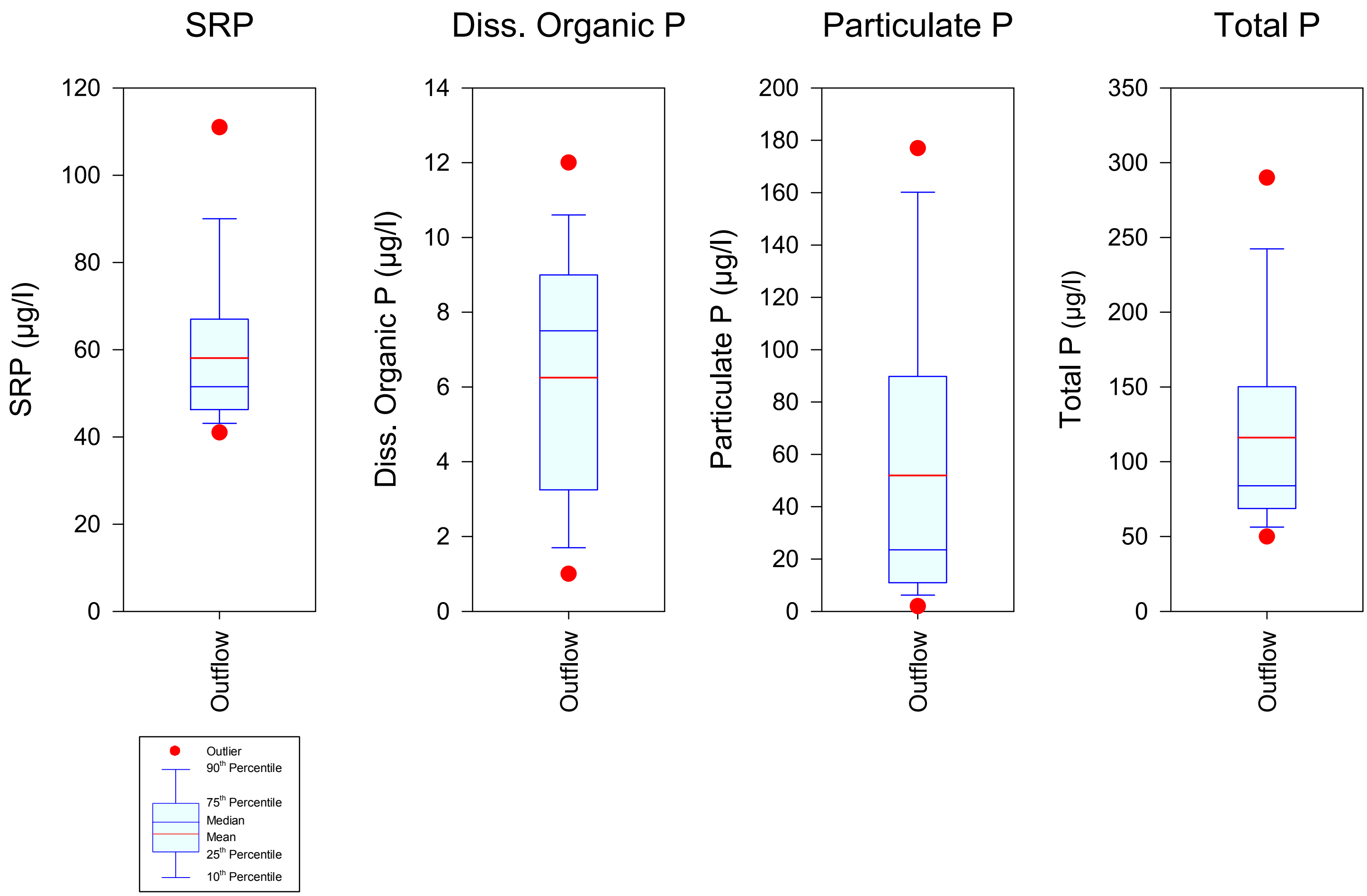


Figure 4-40. Statistical Summary of Outflow Concentrations of Phosphorus Species at the San Pablo CDS Site.

Discharges from the unit were characterized by low levels of turbidity and TSS, with a moderate degree of color. Discharge concentrations of fecal coliform ranged from 20-680 cfu/100 ml, with an overall geometric mean of 161 cfu/100 ml. Relatively low levels of copper, iron, and zinc were observed in discharge from the unit in spite of the somewhat high degree of variability observed in the measured values.

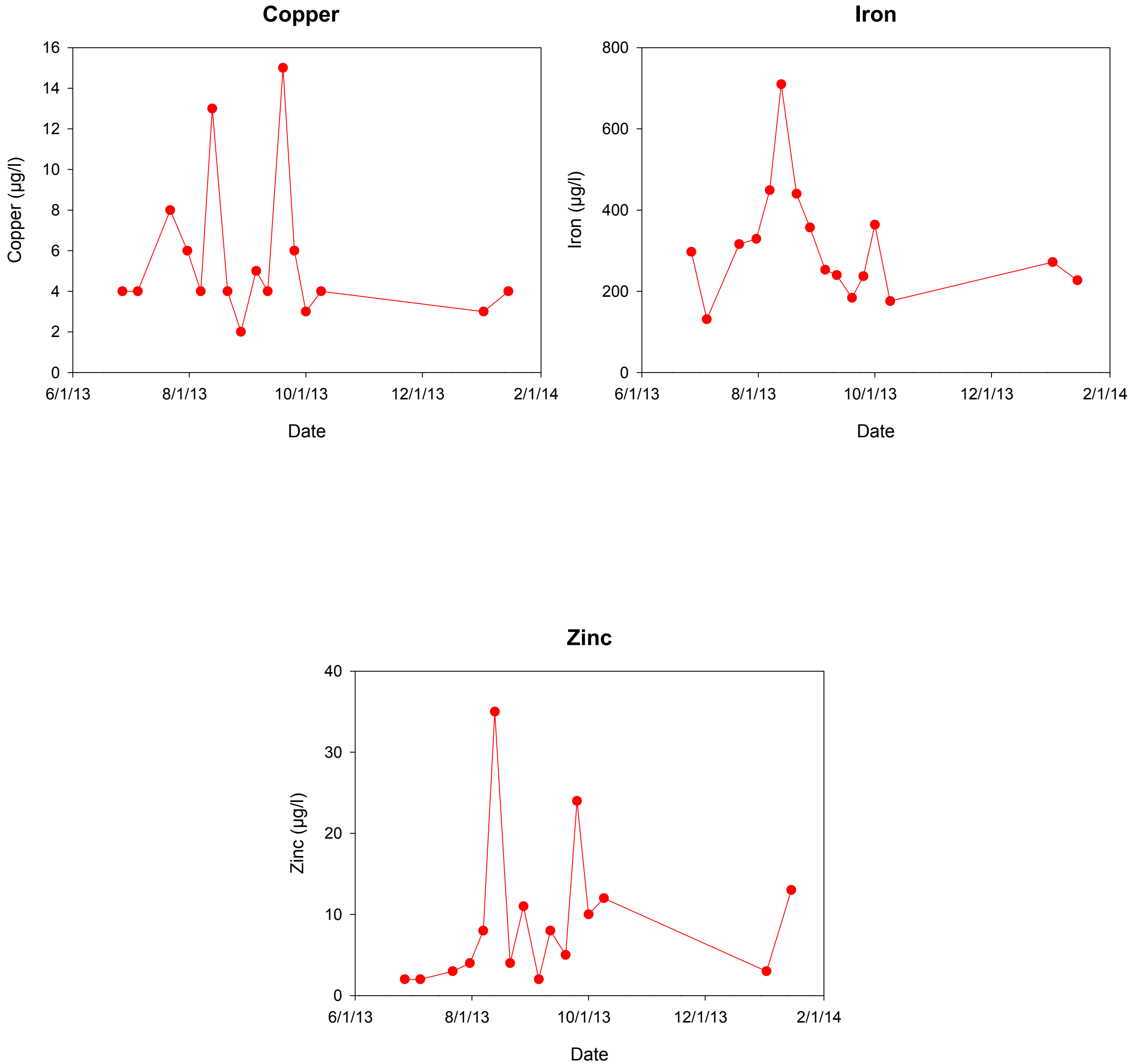


Figure 4-41. Characteristics of Outflow Concentrations of Copper, Iron, and Zinc at the San Pablo CDS Site.

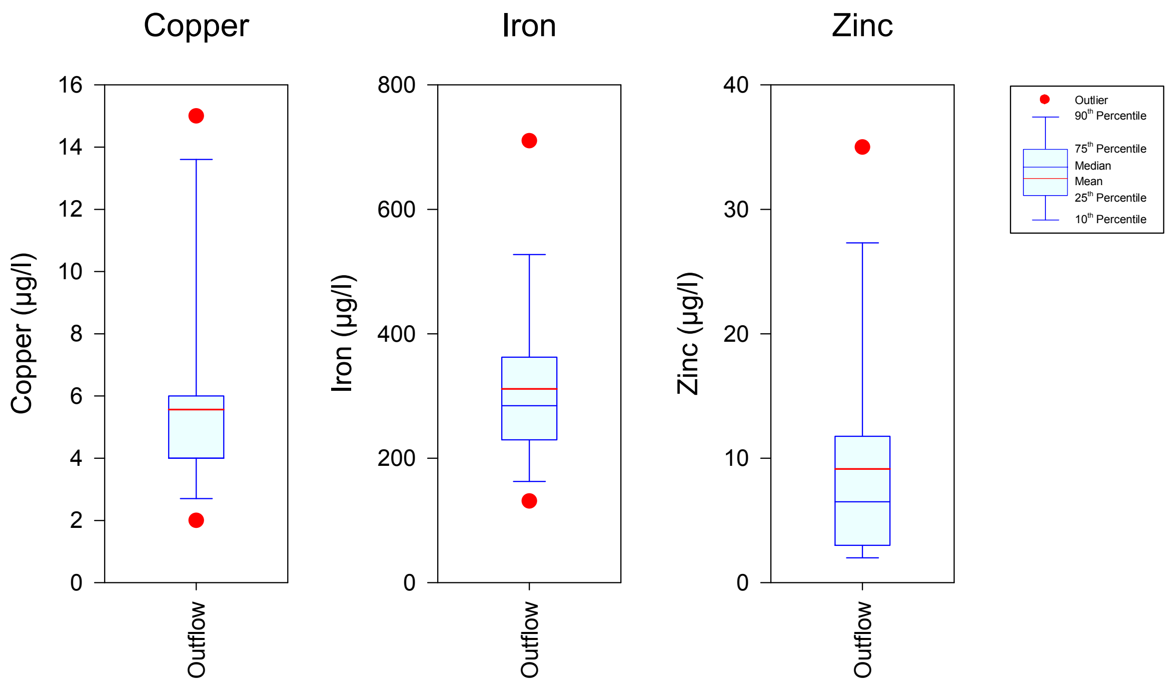


Figure 4-42. Statistical Summary of Outflow Concentrations of Copper, Iron, and Zinc at the San Pablo CDS Site.

TABLE 4-19

CHARACTERISTICS OF DISCHARGES FROM THE SAN PABLO CDS UNIT

PARAMETER	UNITS	MINIMUM VALUE	MAXIMUM VALUE	GEOMETRIC MEAN
pH	s.u.	6.65	7.93	7.20
Alkalinity	mg/l	26.2	142	82.3
Conductivity	µmho/cm	76	348	221
NH_3	µg/l	3	388	19
NO_x	µg/l	8	887	282
Diss. Organic N	µg/l	76	456	214
Particulate N	µg/l	14	541	95
Total N	µg/l	394	1,590	837
SRP	µg/l	41	111	56
Diss. Organic P	µg/l	1	12	5
Particulate P	µg/l	2	177	29
Total P	µg/l	50	290	102
Turbidity	NTU	1.6	31.1	4.1
Color	Pt-Co	19	54	37
TSS	mg/l	1.2	77.2	6.1
Fecal Coliform	cfu/100 ml	20	680	161
Copper	µg/l	2	15	4.8
Iron	µg/l	131	710	287
Zinc	µg/l	2	35	6.2

4.2.5 Lake Concord Suntree Baffle Box Site

As discussed in Section 3.1.4, field monitoring at the Suntree unit was conducted only at the discharge from the unit. Therefore, the discussion of water quality characteristics in subsequent sections refers only to the characteristics of discharges.

4.2.5.1 General Parameters

A graphical summary of measured discharge concentrations of pH, alkalinity, conductivity, turbidity, color, and TSS at the Lake Concord Suntree baffle box site is given on Figure 4-43. Measured pH concentrations in the discharge ranged from 6.97-8.18. Measured alkalinity values at the baffle box discharge were highly variable during the field monitoring program, ranging from 40.4-214 mg/l. Measured conductivity values were also highly variable, ranging from 112-548 μmho/cm. The temporal patterns exhibited by outflow concentrations for alkalinity, conductivity, and to a lesser extent pH, appear to be relatively similar.

Measured concentrations of turbidity in the baffle box discharge exhibited a moderate degree of variability, ranging in value from 0.3-18.6 NTU, with an overall trend of relatively low concentrations with a few elevated peaks. Measured color concentrations were also highly variable, although low to moderate in value, ranging from 12-45 Pt-Co units. In general, discharge TSS concentrations were typically less than approximately 20 mg/l, although significant peaks in concentrations, extending as high as 108 mg/l, were observed on multiple occasions.

A statistical summary of outflow concentrations of pH, alkalinity, and conductivity at the Suntree baffle box site are given on Figure 4-44. The probability plots for alkalinity and conductivity appear to be very similar, suggesting that values for these parameters are affected by similar processes.

A statistical summary of discharge concentrations of color, turbidity, and TSS at the Suntree baffle box site are given on Figure 4-45. In general, a relatively low degree of variability was observed in measured concentrations for each of these parameters, with a few isolated outliers both above and below the typical range of values.

4.2.5.2 Nitrogen Species

A graphical summary of measured outflow concentrations for nitrogen species at the Lake Concord Suntree baffle box site is given on Figure 4-46. Measured concentrations for ammonia were generally low in value, with the exception of several isolated peak values, with one extending as high as 224 μg/l. However, overall, measured concentrations of ammonia in the discharge were relatively low in value.

Measured concentrations of NO_x were also highly variable, ranging from 5-553 μg/l. The observed NO_x concentrations appear to loosely follow the same data patterns exhibited by alkalinity and conductivity.

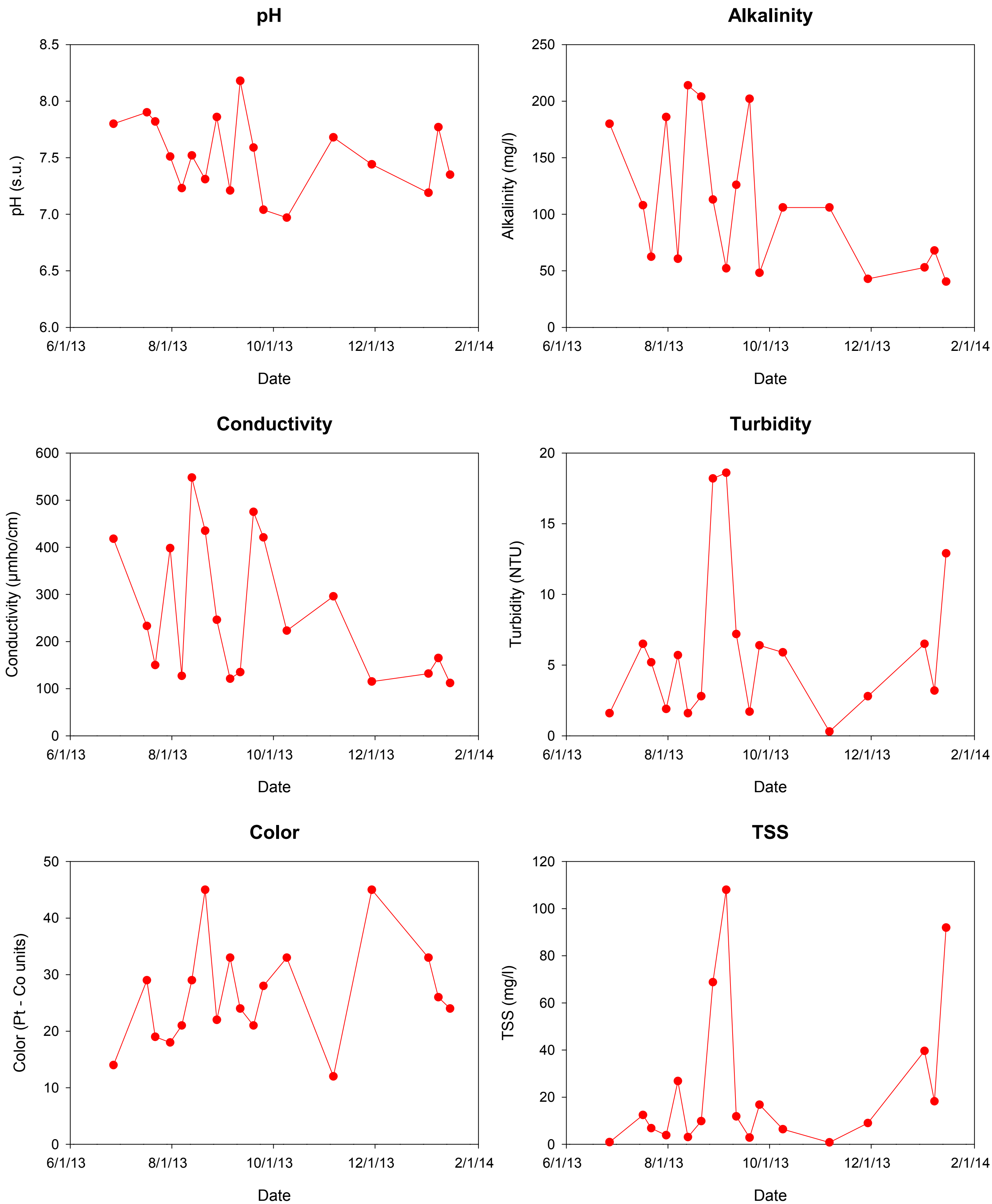


Figure 4-43. Characteristics of Outflow Concentrations of pH, Alkalinity, Conductivity, Turbidity, Color, and TSS at the Lake Concord Suntree Baffle Box Site.

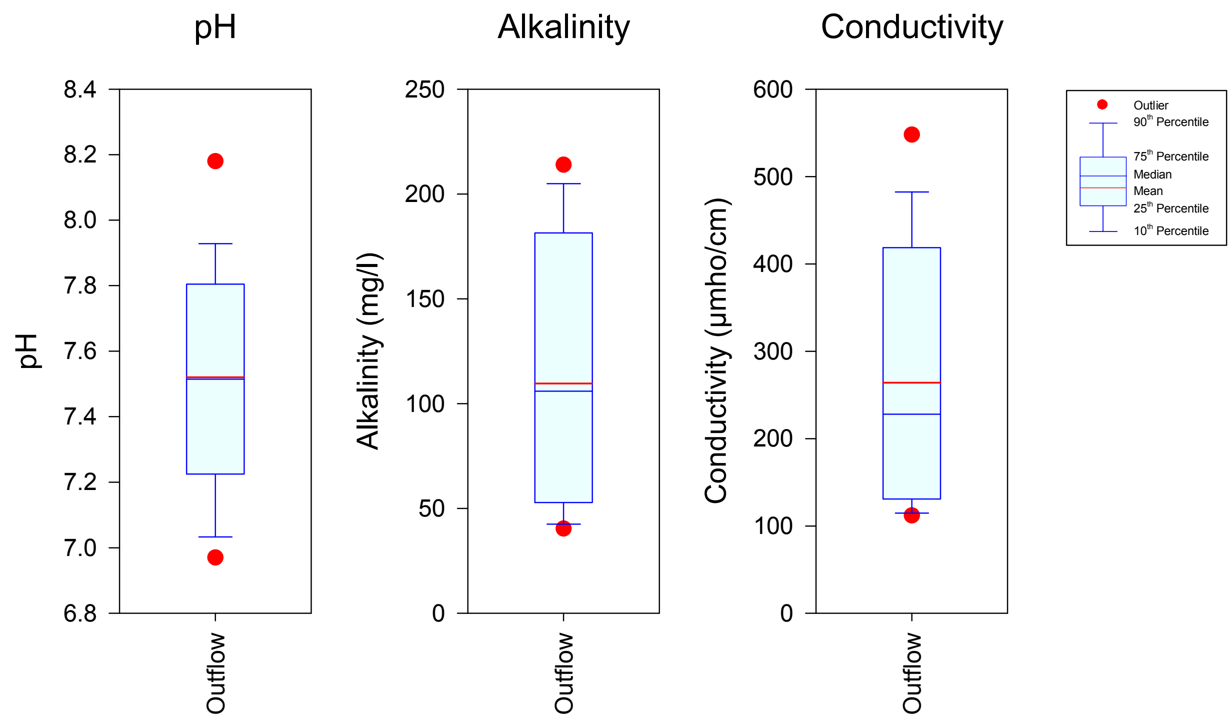


Figure 4-44. Statistical Summary of Outflow Concentrations of pH, Alkalinity, and Conductivity at the Lake Concord Suntree Baffle Box Site.

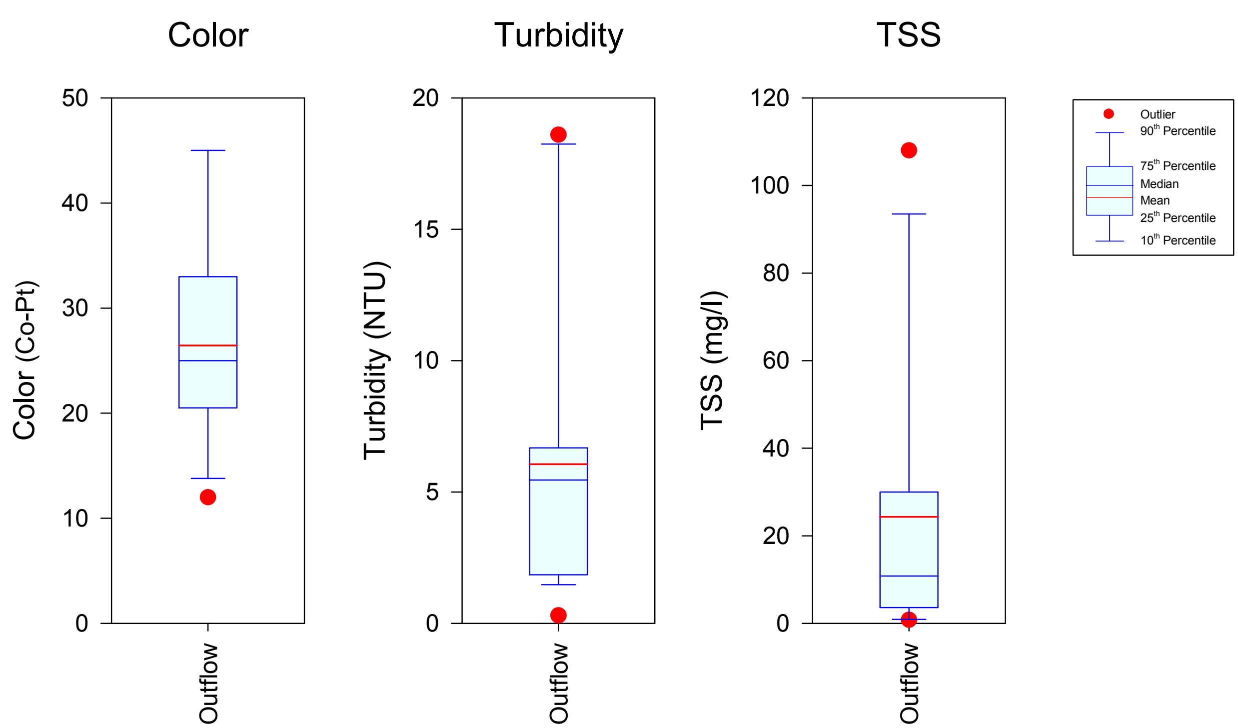


Figure 4-45. Statistical Summary of Outflow Concentrations of Color, Turbidity, and TSS at the Lake Concord Suntree Baffle Box Site.

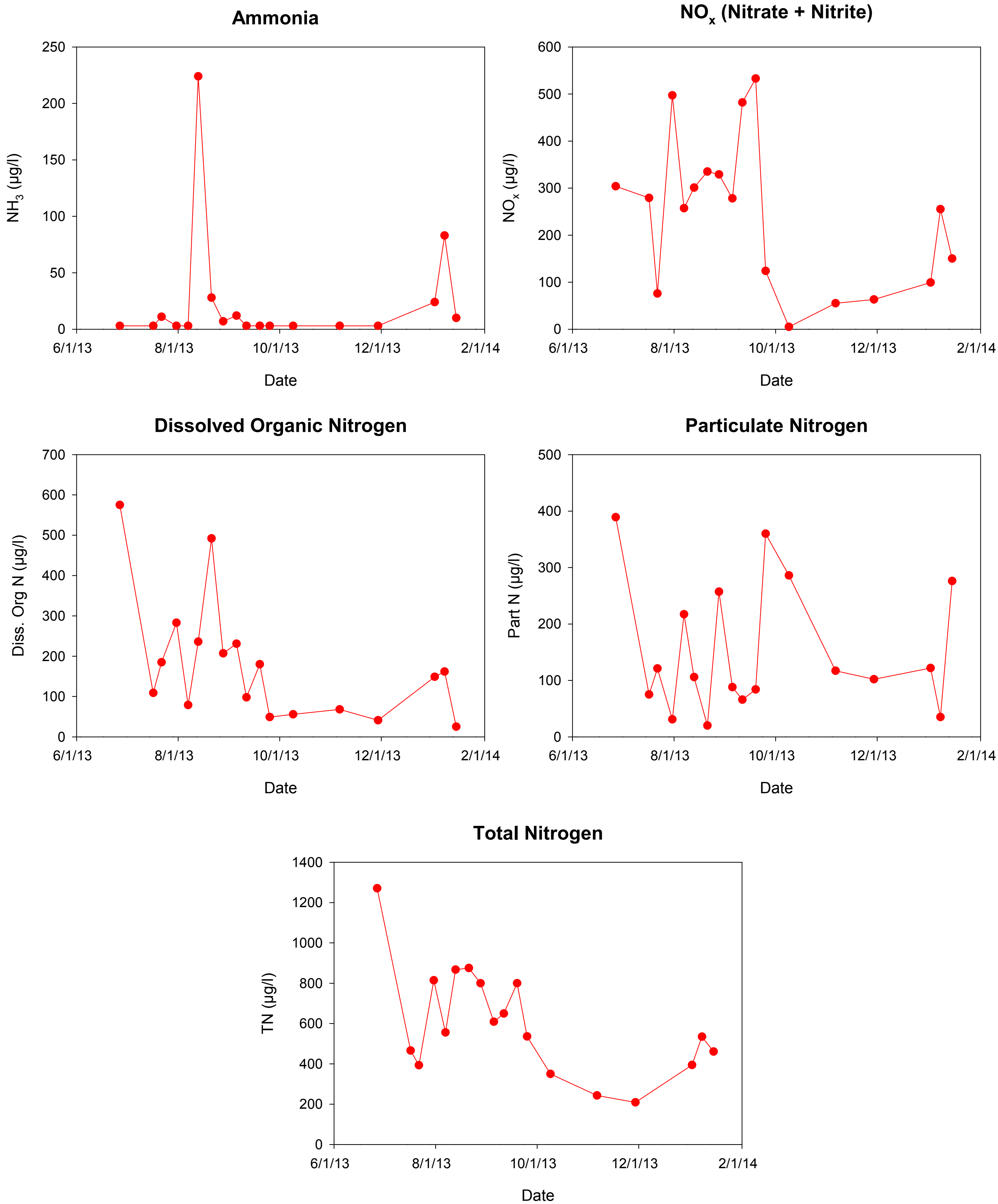


Figure 4-46. Characteristics of Outflow Concentrations of Nitrogen Species at the Lake Concord Suntree Baffle Box Site.

Measured concentrations of dissolved organic phosphorus in the baffle box discharge were also highly variable, ranging from 25-575 µg/l. The temporal pattern in dissolved organic nitrogen concentrations also resembles patterns exhibited by alkalinity, conductivity, and NO_x.

Highly variable discharge concentrations were also observed for particulate nitrogen, with values ranging from 20-389 µg/l. The observed concentrations in the discharge are similar to concentrations of particulate nitrogen commonly observed in urban runoff.

Overall, measured total nitrogen concentrations in discharges from the Suntree baffle box ranged from 209-1,271 µg/l. The observed temporal pattern for the data exhibited by total nitrogen loosely resembles the patterns for dissolved organic nitrogen, alkalinity, and conductivity.

A statistical summary of measured concentrations of nitrogen species in discharges from the Lake Concord Suntree baffle box site is given on Figure 4-47. The observed data distributions for concentrations of NOx and particulate nitrogen in the baffle box discharge appear to be relatively similar, with a smaller degree of variability exhibited for total nitrogen.

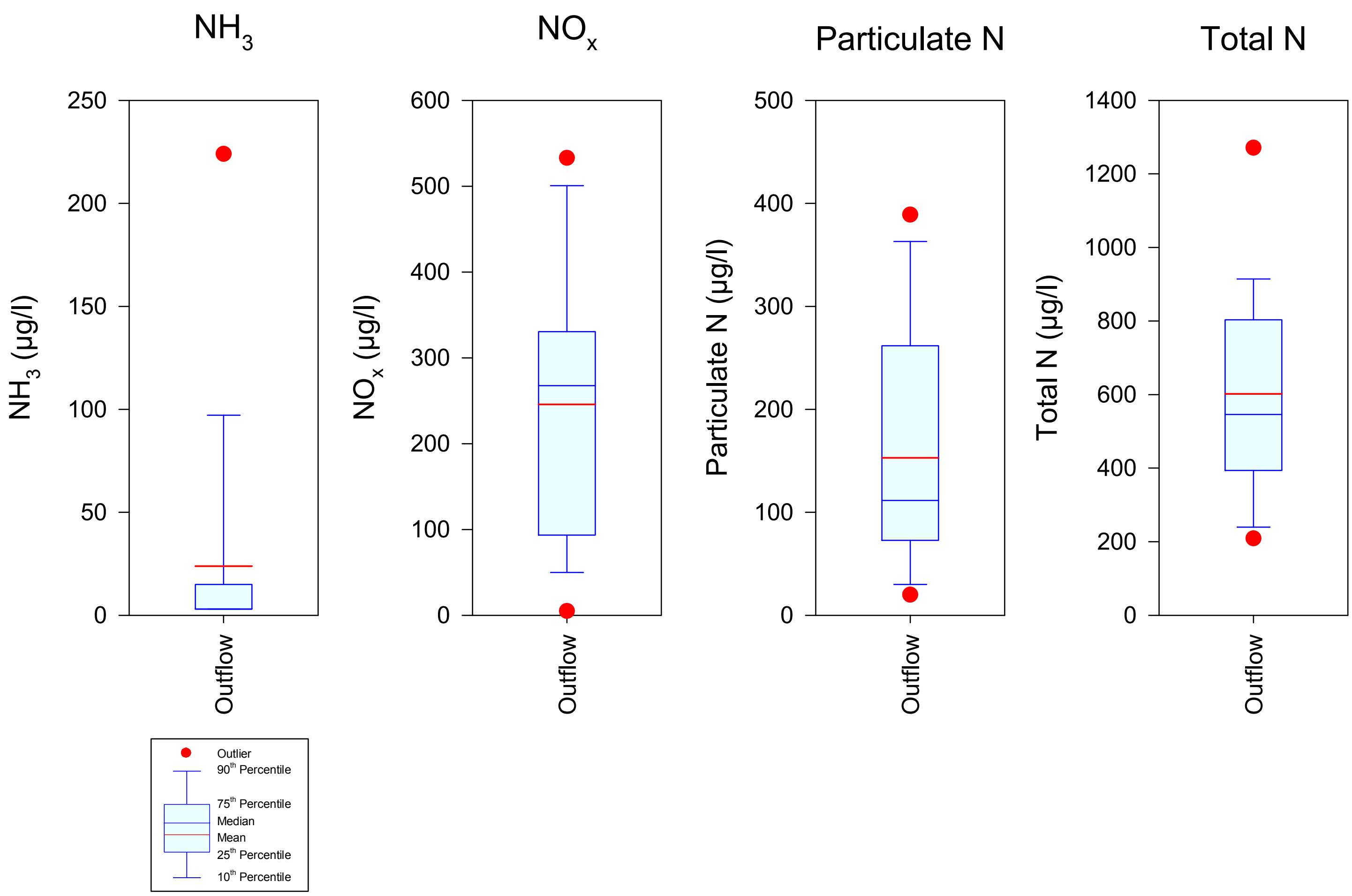


Figure 4-47. Statistical Summary of Outflow Concentrations of Nitrogen Species at the Lake Concord Suntree Baffle Box Site.

4.2.5.3 Phosphorus Species

A graphical summary of measured outflow concentrations of phosphorus species at the Lake Concord Suntree baffle box site is given on Figure 4-48. Measured concentrations of SRP in the baffle box outflow ranged between 2-169 µg/l, although the majority of outflow concentrations ranged from 30-60 µg/l. Isolated peaks in concentrations both above and below this range were observed on multiple occasions.

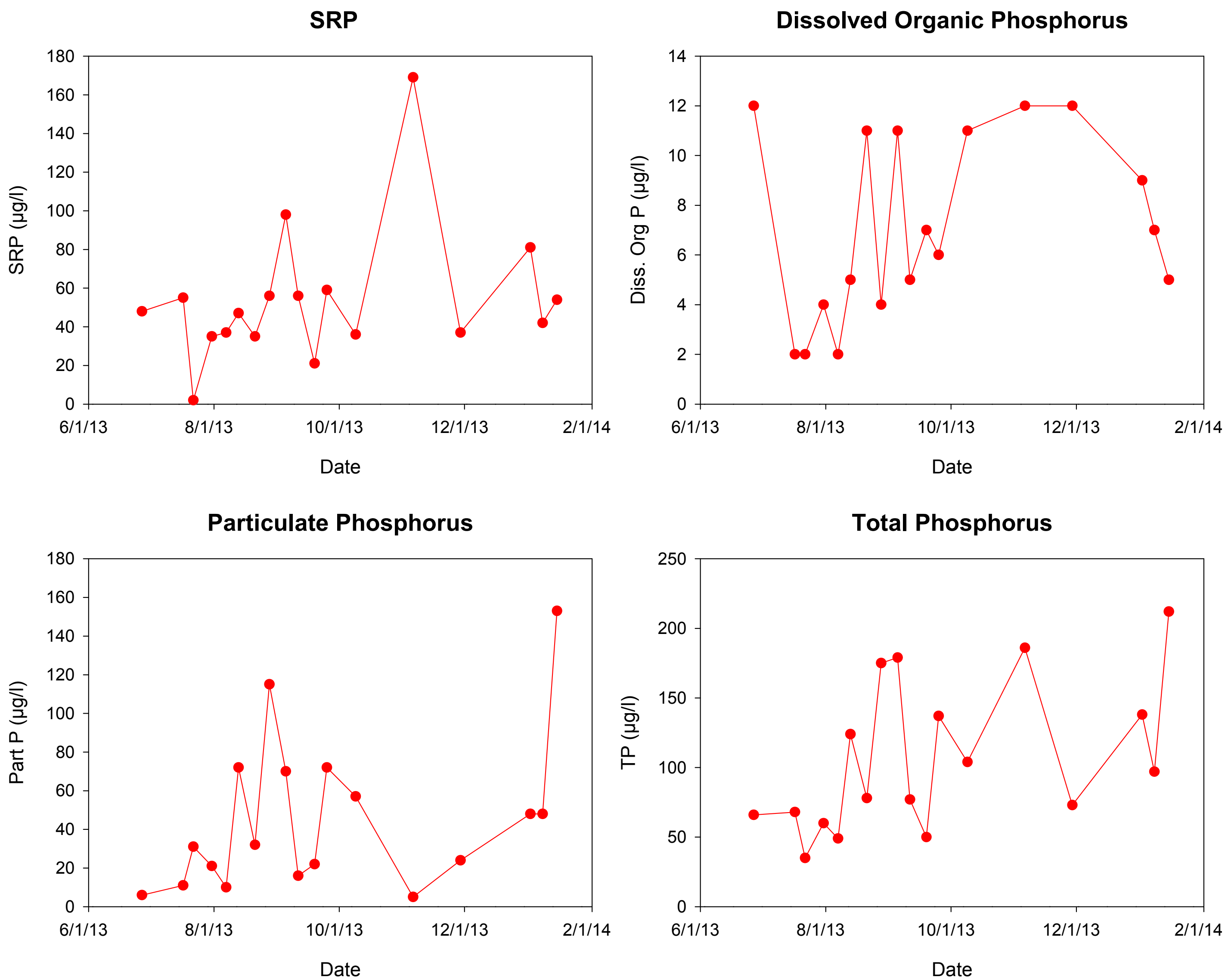


Figure 4-48. Characteristics of Outflow Concentrations of Phosphorus Species at the Lake Concord Suntree Baffle Box Site.

Measured concentrations of dissolved organic phosphorus in the discharge from the Suntree baffle box were extremely low in value. The observed irregular pattern should not be considered significant due to the extremely low measured values.

Highly variable concentrations of particulate phosphorus were measured in discharges from the Suntree baffle box, with measured concentrations ranging from 5-153 µg/l. The vast majority of discharge concentrations of particulate phosphorus were less than approximately 70 µg/l, with more elevated concentrations observed on several occasions.

Overall, measured total phosphorus concentrations were also highly variable in the baffle box discharge, with measured values ranging from 35-212 µg/l. The phosphorus data line suggests that a trend of increasing total phosphorus concentrations may have occurred over time, although it is likely that this is not a statistically significant trend. A statistical summary of measured concentrations for phosphorus species in discharges from the Suntree baffle box are given on Figure 4-49.

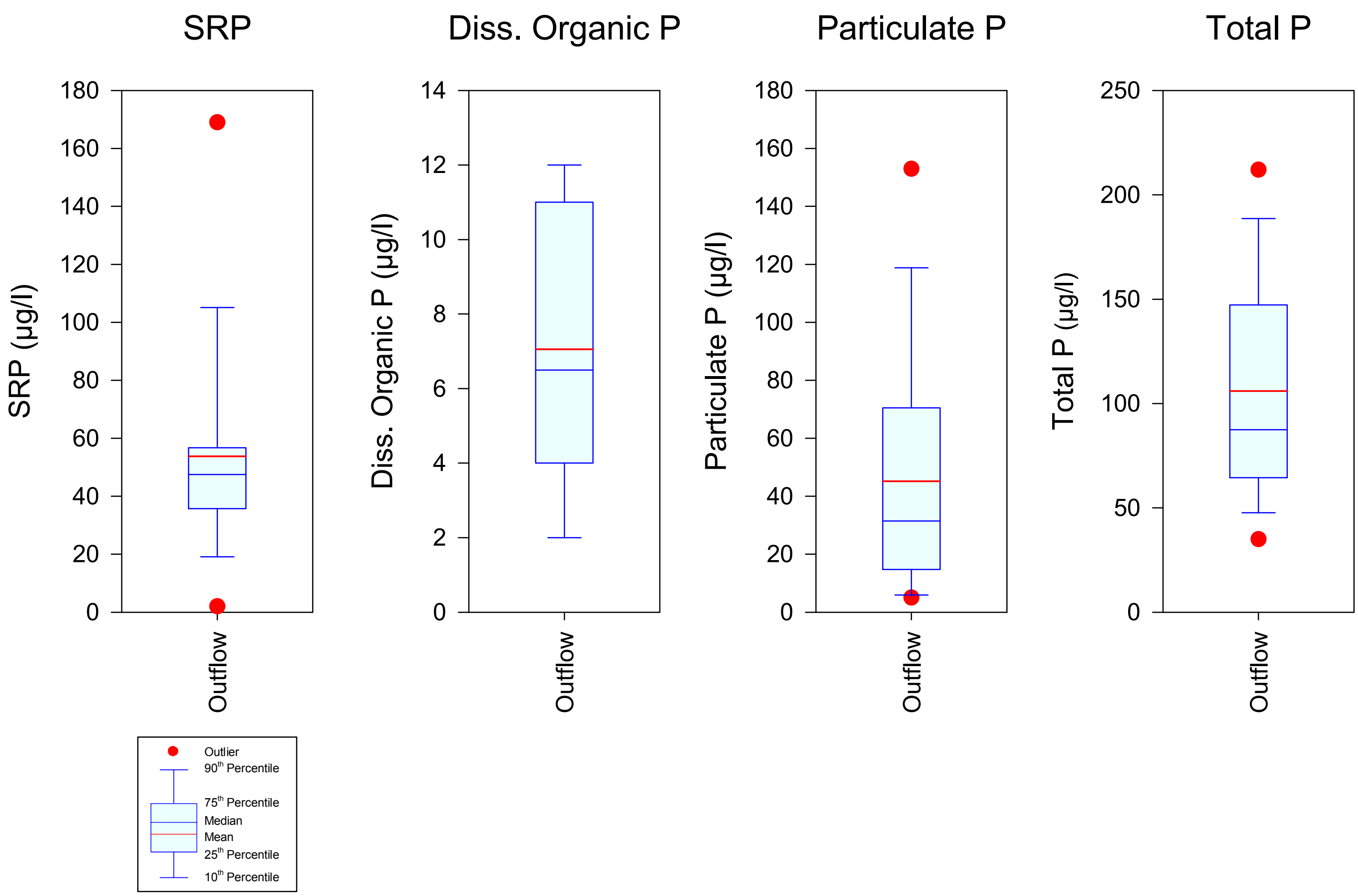


Figure 4-49. Statistical Summary of Outflow Concentrations of Phosphorus Species at the Lake Concord Suntree Baffle Box Site.

4.2.5.4 <u>Metals</u>

A graphical summary of measured concentrations of cooper, iron, and zinc in discharges from the Lake Concord Suntree baffle box unit is given on Figure 4-50. Measured concentrations for copper, iron, and zinc exhibited a high degree of variability during the field monitoring program. Measured copper concentrations in the discharges ranged from 2-16 µg/l, reflecting low to moderate values. Measured concentrations of iron in the discharge ranged from 89-582 µg/l, also reflecting low to moderate concentrations. Measured concentrations for zinc ranged from 2-55 µg/l, reflecting low to moderate concentrations. A statistical summary of measured concentrations for copper, iron, and zinc in the Suntree baffle box discharges is given on Figure 4-51.

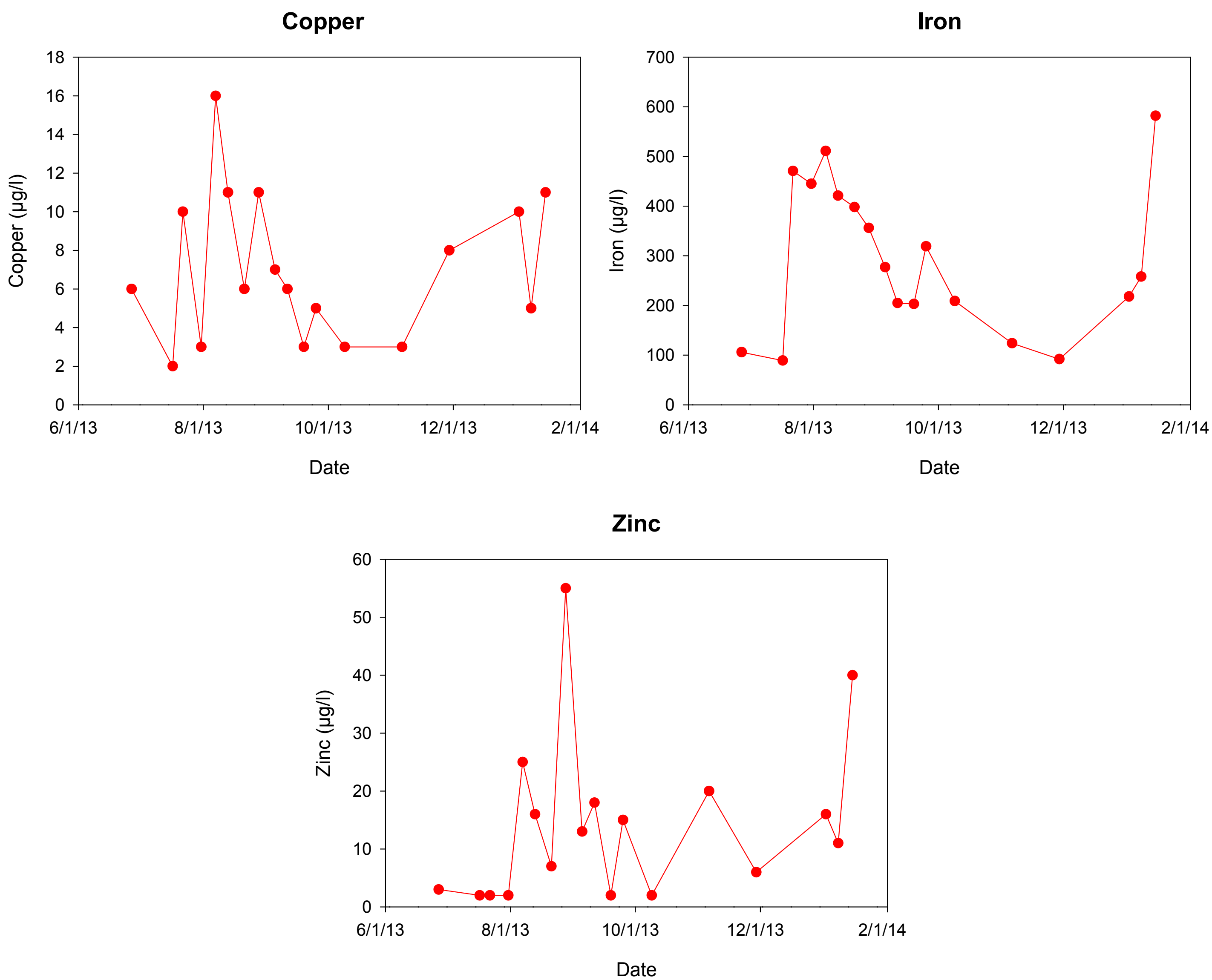


Figure 4-50. Characteristics of Outflow Concentrations of Copper, Iron, and Zinc at the Lake Concord Suntree Baffle Box Site.

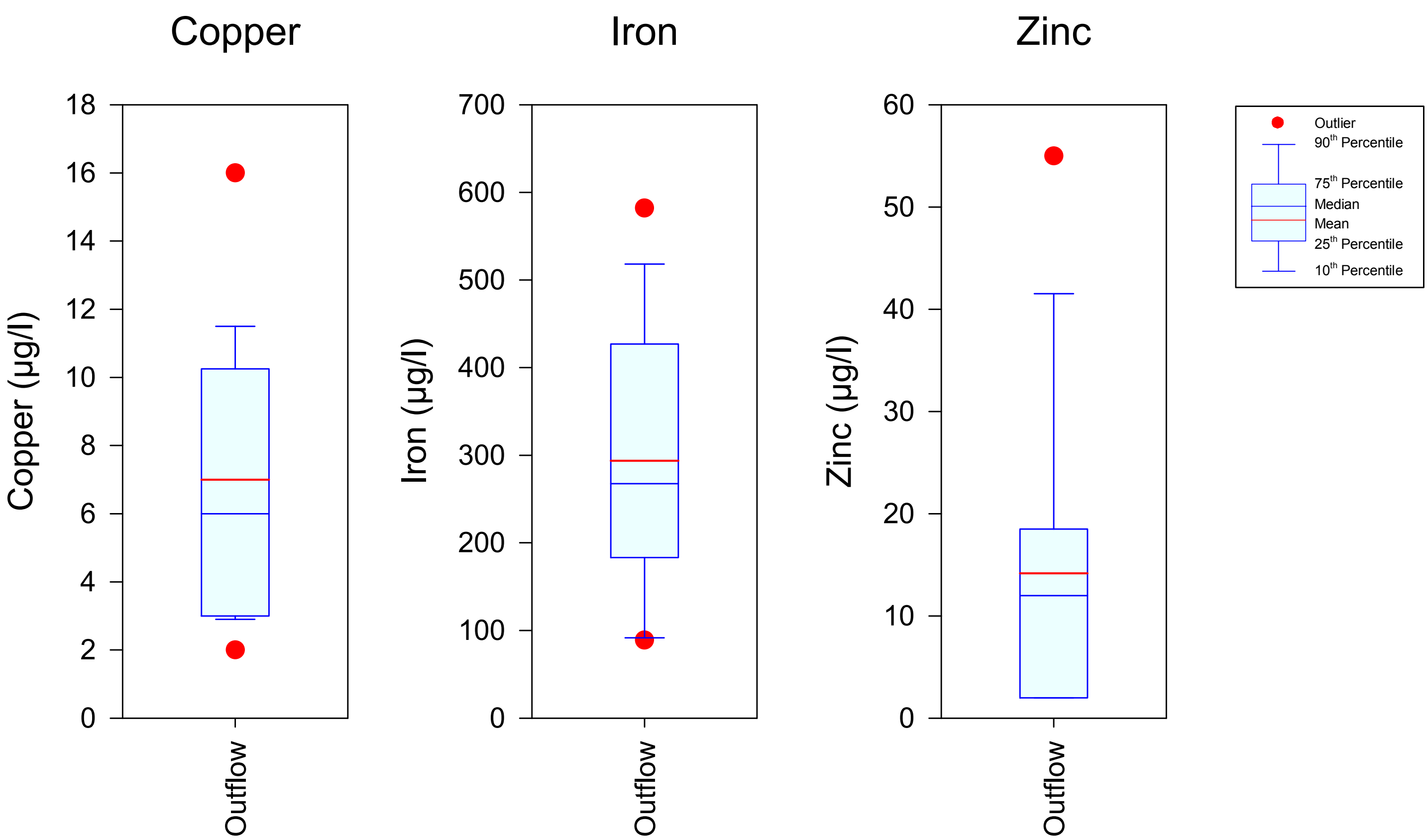


Figure 4-51. Statistical Summary of Outflow Concentrations of Copper, Iron, and Zinc at the Lake Concord Suntree Baffle Box Site.

4.2.5.5 Characteristics of Unit Discharges

A tabular summary of the characteristics of discharges from the Lake Concord Suntree unit is given on Table 4-20. Total nitrogen in discharges from the baffle box unit were comprised primarily of NO_x, dissolved organic nitrogen, and particulate nitrogen, with a much smaller contribution from ammonia. Phosphorus discharges from the unit were comprised primarily of SRP and particulate phosphorus, with a relatively small component for dissolved organic phosphorus.

Discharges from the unit were characterized by low levels of turbidity and TSS, with a moderate degree of color. Discharge concentrations of fecal coliform ranged from 200-1,400 cfu/100 ml, with an overall geometric mean of 529 cfu/100 ml. No evidence of growth of fecal coliform bacteria was observed at this site. Relatively low levels of copper, iron, and zinc were observed in discharge from the unit in spite of the somewhat high degree of variability observed in the measured values.

TABLE 4-20

CHARACTERISTICS OF DISCHARGES FROM THE LAKE CONCORD BAFFLE BOX UNIT

PARAMETER	UNITS	MINIMUM VALUE	MAXIMUM VALUE	GEOMETRIC MEAN
pH	s.u.	6.97	8.18	7.51
Alkalinity	mg/l	40.4	214	93.6
Conductivity	μmho/cm	112	548	227
NH_3	μg/l	3	224	8
NO_x	μg/l	5	533	171
Diss. Organic N	μg/l	25	575	130
Particulate N	μg/l	20	389	113
Total N	μg/l	209	1,271	546
SRP	μg/l	2	169	42
Diss. Organic P	μg/l	2	12	6
Particulate P	μg/l	5	153	30
Total P	μg/l	35	212	93
Turbidity	NTU	0.3	18.6	4.1
Color	Pt-Co	12	45	25
TSS	mg/l	0.8	108	10.6
Fecal Coliform	cfu/100 ml	200	1,400	529
Copper	μg/l	2	16	6.0
Iron	μg/l	89	582	252
Zinc	μg/l	2	55	8

4.3 Quantity and Quality of Collected Solids

As discussed in Section 3.2, clean-out operations were conducted on three separate occasions for each of the five monitored GPS units as part of the field monitoring program. The initial cleaning of the GPS units occurred immediately prior to initiation of the field monitoring program, and the quantity of material removed during these clean-out operations was not quantified.

After start-up of the field monitoring program, each of the five monitored GPS units were cleaned on two separate occasions, with one clean-out operation near the mid-point of the field monitoring program and the final at the completion of the field monitoring program. The collected solids from each of the units were transported to a City maintenance facility and deposited. The volume of the material removed was estimated by ERD, and a well-mixed sub-sample of the solid material was collected and returned to the ERD Laboratory for physical and chemical characterization. Photographs of solids collected from each of the five GPS units are given on Figures 3-16 and 3-17.

A similar cleaning process and schedule was conducted for each of the inlet basket structures installed on San Pablo Avenue. Solids were removed from each of the inlet baskets and placed into a graduated polyethylene bucket so that the quantity of material removed could be determined. The sample was then well mixed, and a sub-sample was returned to the ERD Laboratory for physical and chemical characterization.

4.3.1 GPS Units

A tabular summary of solids removed from each of the five Casselberry GPS units during the two clean-out operations is given on Table 4-21. The initial clean-outs were conducted during the period from September 9-11, 2013, with the final clean-outs occurring during the period from January 13-February 3, 2014.

TABLE 4-21

SUMMARY OF SOLIDS REMOVED FROM THE CASSELBERRY GPS UNITS

SITE	UNIT TYPE	CLEAN-OUT DATE	VOLUME REMOVED (ft^3)	DESCRIPTION	CLEAN-OUT DATE	VOLUME REMOVED (ft^3)	DESCRIPTION	TOTAL VOLUME REMOVED (ft^3)
Lake Hodge	EcoVault®	9/9/13	8.57	Few leaves, mostly silt and sand	1/20/14	6.31	Leaves, debris, and sand	14.88
Gee Creek	EcoVault®	9/9/13	9.54	Few leaves, mostly silt and sand	1/13/14	5.96	Leaves, debris, and sand	15.50
San Pablo	EcoVault®	9/10/13	29.3	Mostly leaves, some silt and sand	1/22/14	25.5	Mostly leaves, debris, and sand	54.81
Lake Concord	Suntree Baffle Box	9/10/13	4.27	Few leaves, mostly silt and sand	1/20/14	10.1	Mostly leaves	14.34
San Pablo	CDS Unit	9/11/13	4.47	Few leaves, mostly silt and sand	2/3/14	3.60	Mostly leaves	8.07

During the initial cleaning operation, a total of approximately 8.57 ft^3 of solids was removed from the Lake Hodge EcoVault® unit, with 9.54 ft^3 removed from the Gee Creek EcoVault® unit. However, a substantially higher volume of solids, approximately 29.3 ft^3, was removed from the San Pablo EcoVault® unit. Relatively similar solids volumes, ranging from 4.27-4.47 ft^3, were removed from the Suntree baffle box and CDS units. Material from each of the five GPS units was described as leaves, debris, and fine sand.

During the final clean-out operation, a lower volume of solids was removed from the Lake Hodge and Gee Creek EcoVault® sites. The solids volume removed from the Lake Hodge EcoVault® site during January 2014 was approximately 44% of the volume removed during September 2013, while the solids removed from the Gee Creek EcoVault® site reflected only 21% of the volume removed during September 2013. In contrast, a relatively large volume of solids was collected in the San Pablo EcoVault® structure during both the September 2013 and January 2014 clean-out operations, with 29.3 ft^3 collected during September 2013 and 25.5 ft^3 collected during January 2014. The material removed from each of the EcoVault® units was primarily leaves, with smaller amounts of debris and sand.

During the second clean-out operation, a total of 10.1 ft^3 of material was removed from the Lake Concord Suntree baffle box unit, compared with 4.27 ft^3 during September 2013. However, at the San Pablo CDS unit, only 3.6 ft^3 of solids was removed during the final clean-out, compared with 4.47 ft^3 removed during September 2013.

Overall, the total volume of solids removed during the field monitoring program by the Lake Hodge EcoVault®, Gee Creek EcoVault®, Lake Concord Suntree baffle box, and San Pablo CDS unit were relatively similar in value, ranging from 8.07-14.34 ft^3. However, a substantially larger solids volume of 54.8 ft^3 was removed from the San Pablo EcoVault® site. The substantially larger volume collected at this site is probably related more to the characteristics of the watershed areas than the affinity of the unit to retain solids. The San Pablo EcoVault® sub-basin contains a large amount of tree cover, and accumulations of leaves, vegetation, and sand are frequently observed in roadway areas. The additional collected volume is comprised primarily of leaves, rather than road debris or sand.

A summary of physical-chemical characteristics of solids at the Casselberry GPS sites is given on Table 4-22 for both the September 2013 and January/February 2014 solids collection dates. In general, measured pH values of solids collected at each of the five GPS sites were relatively similar in value, ranging from approximately 6.36-6.86, with the exception of pH in the Lake Concord Suntree baffle box unit solids which exhibited a somewhat lower pH value of 5.79 during the second clean-out event.

As discussed in Section 3.2.2, the contents of the vactor truck from each of the GPS sites were deposited in a City-owned maintenance facility, and the free water was allowed to drain for approximately one hour prior to sample collection. As a result, the measured moisture contents summarized in Table 4-22 reflect the partially dewatered solids and are not necessarily the moisture content of the solids material as it was stored inside each of the five units. However, differences in observed moisture contents may be indicative of the type of solid materials which were collected. Measured solids contents of the collected sump materials ranged from 32.0-87.2% during the September 2013 clean-out events, increasing at most sites to values ranging from 47.3-67.4% during the January 2014 clean-out event.

A large difference was observed in measured organic contents between the two clean-out events. During the September 2013 event, a low level of organic matter was present in solids collected from each of the five units, suggesting that the solids consisted primarily of inert material such as soils and roadway grit. However, substantially higher organic contents were observed during the January 2014 clean-out events, with measured values ranging from 19.1-54.7%. The increased organic contents observed during this event are a reflection of the large amount of organic matter, such as leaves and other vegetation debris, collected in each of the units during this event.

TABLE 4-22

PHYSICAL-CHEMICAL CHARACTERISTICS OF COLLECTED SOLIDS FROM THE CASSELBERRY GPS SITES

SITE	DATE COLLECTED	PARAMETER												
		Volume (ft^3)	pH (s.u.)	Moisture Content (%)	Organic Content (%)	Density		Total Solids (kg dry)	Concentration (µg/g dry)		Concentration (µg/cm^3 dry)		Mass Load (g)	
						g/cm^3 wet	g/cm^3 dry		Total N	Total P	Total N	Total P	Total N	Total P
Lake Hodge EcoVault®	9/9/13	8.57	6.58	32.0	1.9	2.00	1.68	330	421	122	708	205	139	40
Gee Creek EcoVault®	9/9/13	9.54	6.38	51.1	1.6	1.72	1.21	228	497	112	603	135	113	25
San Pablo EcoVault®	9/10/13	29.31	6.74	87.2	1.0	1.19	0.32	126	361	89	115	28	46	11
Concord Suntree Baffle Box	9/10/13	4.27	6.62	67.6	1.4	1.48	0.80	58	403	193	324	155	23	11
San Pablo CDS Unit	9/11/13	4.47	6.36	38.5	1.8	1.91	1.52	148	288	97	437	147	43	14
Lake Hodge EcoVault®	1/20/14	3.31	6.86	62.6	24.7	1.43	0.80	50	974	161	779	129	49	8.1
Gee Creek EcoVault®	1/13/14	1.96	6.67	67.4	32.6	1.33	0.66	24	517	101	342	67	12	2.4
San Pablo EcoVault®	1/22/14	25.50	6.79	72.5	49.1	1.22	0.49	242	932	159	458	78	225	39
Concord Suntree Baffle Box	1/20/14	10.07	5.79	59.0	54.7	1.29	0.70	151	553	66	387	46	83	10
San Pablo CDS Unit	2/3/14	3.60	6.40	47.3	26.7	1.59	1.11	85	799	175	890	195	68	15

Measured wet and dry density values for the collected solids are also provided in Table 4-22. The wet density values are impacted by the moisture content of the collected samples, but the dry densities are impacted primarily by the characteristics of the solid material. Measured dry densities at the five Casselberry GPS sites during the September 2013 initial clean-out event ranged from 0.32-1.68 g/cm^3, with higher density values reflecting solids comprised primarily of inorganic sand and silt and lower density values reflecting leaves and vegetation. Somewhat lower dry density values were measured at four of the five GPS sites during the January/February 2014 clean-out events, with dry density values ranging from 0.66-1.11 g/cm^3. The lower dry density values observed during the second clean-out reflect a higher composition of leaves and organic matter compared with the initial clean-out event and are consistent with the substantially higher organic contents observed which confirm the presence of a large amount of organic vegetation matter in addition to inert sand and silt.

Measured nitrogen contents in the collected solids during September 2013 were relatively similar at the EcoVault® and Suntree baffle box sites, ranging from 361-497 μg/g (dry weight), with a somewhat lower nitrogen content of 288 μg/g (dry weight) measured in solids collected from the CDS unit. Substantially higher total nitrogen concentrations were observed in solids collected during the January/February 2014 clean-out event, with measured values ranging from 517-974 μg/g (dry weight). The additional nitrogen content of solids collected during this event reflect the impacts from the large amount of leaves and vegetation debris present in the solids collected during the final event. Overall, total nitrogen concentrations observed in solids collected from the Casselberry GPS sites are similar to values measured by ERD in other GPS studies. Measured nitrogen concentrations in units of μg/cm^3 (dry weight) are also provided in Table 4-22 and were obtained by multiplying the dry weight concentration (μg/g dry) times the dry density.

Measured concentrations of total phosphorus in the GPS solids were relatively similar at the EcoVault® and Suntree baffle box sites during the initial clean-out event, with measured values ranging from 89-193 μg/g (dry weight), with a relatively low total phosphorus concentration of 97 μg/g (dry weight) measured in the solids collected from the San Pablo CDS unit. Phosphorus concentrations in solids collected from the GPS sites during January/February 2014 were similar in value to concentrations observed during September 2013 at three of the five sites. In contrast to the trend observed for total nitrogen, there does not appear to be a significant difference in phosphorus concentrations measured during the two separate events. Measured phosphorus concentrations in units of μg/cm^3 (dry weight) are also provided in Table 4-22 and were obtained by multiplying the dry weight concentration (μg/g dry) times the dry density.

A summary of estimated mass loads of nitrogen and phosphorus removed from each of the five Casselberry GPS sites during the two separate clean-out operations is also provided in Table 4-22. In general, the mass of nitrogen removed from the Lake Hodge and Gee Creek EcoVault® sites during the September 2013 clean-out event was relatively similar, ranging from 113-139 g. A somewhat lower amount of total nitrogen was removed by the San Pablo EcoVault® system (46 g), although a larger volume of material was collected at this site. Even lower nitrogen loadings, ranging from 23-45 g, were removed from the Suntree baffle box and San Pablo CDS units during the initial cleaning.

During the January/February 2014 clean-out event, a high degree of variability was observed in measured nitrogen mass removals at the five Casselberry GPS sites, ranging from a low of 12 g at the Gee Creek EcoVault® unit to a high of 225 g at the San Pablo EcoVault® site. The observed differences in nitrogen mass removals between the two monitoring events are largely due to differences in nitrogen content of the solids. As indicated by the dry weight nitrogen concentrations in the collected solids, the nitrogen removal observed during the September 2013 clean-out event was equivalent to 0.029-0.050% of the total mass of solids removed. The nitrogen content of solids during the second clean-out event was approximately double the initial event, ranging from 0.052-0.097% of the overall solids removed.

In general, relatively similar phosphorus mass load removals were observed for the Lake Hodge and Gee Creek EcoVault® sites and at the Lake Concord Suntree baffle box, San Pablo EcoVault®, and San Pablo CDS sites. In contrast to the trends observed for total nitrogen, lower phosphorus mass loadings were removed at three of the five GPS sites during the January/February 2014 clean-out event compared with the September 2013 clean-out event. The only system which did not exhibit a significant reduction in phosphorus removal between the first and second clean-out events was the San Pablo EcoVault® unit which removed a much larger quantity of phosphorus during the January event. The phosphorus load removed by the GPS devices during the September 2013 event comprised approximately 0.003-0.021% of the total mass removed and 0.007-0.018% of the overall mass removed during the final clean-out event.

During the September 2013 clean-out event, approximately 58-330 kg of dry solids was removed at the Casselberry GPS sites, with the highest mass load removals occurring at the Lake Hodge and Gee Creek EcoVault® sites. Load reductions at the San Pablo EcoVault® and San Pablo CDS unit sites were approximately equal in value and about half of the solids removal observed at the Lake Hodge and Gee Creek EcoVault® sites. A somewhat lower total mass removal of 58 kg was observed at the Lake Concord Suntree baffle box site. In contrast, a higher degree of variability was observed in measured mass removals during the January/February 2014 event. Relatively similar mass load reductions were achieved at the Lake Hodge and Gee Creek sites, although the mass reductions were substantially lower than observed during September 2013, with substantially higher solids removal rates occurred at the San Pablo EcoVault® and Suntree baffle box sites.

4.3.2 Inlet Baskets

A summary of solids removed from the Casselberry inlet baskets is given on Table 4-23. Information is provided for each of the three inlet basket sites located on San Pablo Avenue. During the initial September 2013 clean-out event, a relatively similar volume, ranging from 0.09-0.11 ft^3, was removed from each of the three baskets. Similar volumes were also removed from each of the three baskets during the January/February 2014 clean-out event, ranging from 0.40-0.47 ft^3. Overall, the three baskets removed 0.50-0.56 ft^3 of material during the field monitoring program.

TABLE 4-23

SUMMARY OF SOLIDS REMOVED FROM THE CASSELBERRY INLET BASKETS

SITE	UNIT TYPE	CLEAN-OUT DATE	VOLUME REMOVED (ft^3)	DESCRIPTION	CLEAN-OUT DATE	VOLUME REMOVED (ft^3)	DESCRIPTION	TOTAL VOLUME REMOVED (ft^3)
680 San Pablo	Inlet Basket	9/10/13	0.11	Some leaves, debris, sand	1/22/14	0.43	Mostly leaves with debris and sand	0.54
668 San Pablo	Inlet Basket	9/10/13	0.09	Some leaves, debris, sand	1/22/14	0.47	Mostly leaves with debris and sand	0.56
669 San Pablo	Inlet Basket	9/10/13	0.10	Some leaves, debris, sand	1/22/14	0.40	Mostly leaves with debris and sand	0.50

A summary of physical-chemical characteristics of solids collected from the inlet baskets is given on Table 4-24. Solids collected from each of the baskets were similar in pH, with measured values ranging from 6.34-6.49 during the two clean-out events. Measured moisture contents were also similar between the two events, ranging from 44.8-67.3%. Unlike solids collected from the GPS units which was partially dewatered before sampling, the inlet basket solids were collected directly from each unit and the measured moisture contents reflect the moisture of the solids in the unit as collected.

Measured organic contents at each of the sites increased somewhat from the September 2013 to the January/February 2014 clean-out events, indicating a larger proportion of vegetation and organic matter during the final clean-out event. Measured dry density values during the initial clean-out ranged from 0.51-1.12 g/cm^3, reflecting a mixture of organic matter and inert material. However, substantially lower dry densities were observed during the second clean-out event, indicating a larger proportion of organic matter at each of the sites.

In general, measured nitrogen concentrations in the collected solids appear to be similar to nitrogen concentrations measured in solids collected from the baffle box and CDS sites during both the first and second clean-out events. In contrast, measured total phosphorus concentrations in solids collected from the inlet baskets appear to be somewhat greater in value than solids collected from the baffle box and CDS units.

Overall, the three inlet baskets removed from 0.6-1.1 g of total nitrogen during the September 2013 event, increasing to 5.5-5.9 g during the final clean-out event. A similar pattern was also observed for total phosphorus, with 0.4-0.9 g removed per basket during the September 2013 event, increasing to 1.3-1.7 g per basket during the final clean-out event. Overall, the fraction of nitrogen in the collected solids from the inlet baskets was relatively similar to the nitrogen content measured in the baffle box and CDS units. A similar pattern is also apparent for total phosphorus, although the fraction of total phosphorus appears to be slightly greater in the inlet baskets than in the baffle box and CDS units during both events. Overall, approximately 1.2-2.5 kg of total dry solids was removed from the inlet baskets during the initial clean-out operation, increasing to 5.1-6.6 kg of dry solids during the final clean-out event.

TABLE 4-24

PHYSICAL-CHEMICAL CHARACTERISTICS OF COLLECTED SOLIDS FROM THE CASSELBERRY INLET BASKETS

SITE	DATE COLLECTED	PARAMETER												
		Volume (ft^3)	pH (s.u.)	Moisture Content (%)	Organic Content (%)	Density		Total Solids (kg dry)	Concentration (µg/g dry)		Concentration (µg/cm^3 dry)		Mass Load (g)	
						g/cm^3 wet	g/cm^3 dry		Total N	Total P	Total N	Total P	Total N	Total P
668 San Pablo Inlet	9/10/13	0.09	6.34	58.6	25.6	1.47	0.88	1.5	459	332	405	292	0.7	0.5
669 San Pablo Inlet	9/10/13	0.10	6.41	44.8	32.1	1.57	1.12	2.5	435	360	489	404	1.1	0.9
680 San Pablo Inlet	9/10/13	0.11	6.37	67.3	65.2	1.18	0.51	1.2	531	321	270	163	0.6	0.4
668 San Pablo Inlet	1/22/14	0.47	6.49	61.1	53.3	1.28	0.67	6.6	881	263	592	177	5.8	1.7
669 San Pablo Inlet	1/22/14	0.40	6.46	57.6	75.3	1.17	0.60	5.7	1029	281	614	167	5.9	1.6
680 San Pablo Inlet	1/22/14	0.43	6.37	64.6	68.9	1.18	0.53	5.1	1074	250	571	133	5.5	1.3

4.4 Mass Removals

Estimates of overall mass removals were calculated for each of the five Casselberry GPS devices. A discussion of overall mass removals is provided in the following sections. This analysis is divided into two separate discussions based upon similarities in methodologies used to estimate overall performance efficiencies.

4.4.1 EcoVault® Units

Mass balances for the EcoVault® units are provided in the following sections. An overall mass removal analysis is provided based upon a comparison of inflow and outflow mass loadings for each of the evaluated parameters. A second analysis is also provided to identify the specific components (collection in sump or removal in "Baffle Buddy") responsible for removal of the measured parameters.

4.4.1.1 Comparison of Inflow and Outflow Mass Loadings

Estimates of monthly mass loadings were calculated for each of the evaluated laboratory parameters at the inflow and outflow monitoring sites for each of the three EcoVault® units. Monthly mass loadings were calculated by multiplying mean monthly water quality characteristics for each parameter in the inflow and the outflow times the monthly volume which passed through each system. Average monthly concentrations were calculated as the geometric mean of all measurements for a given parameter conducted during each of the monthly periods, or partial periods, included in the field monitoring program. The geometric mean values are then multiplied by the monthly inflow volume to generate estimates of mass loadings on a monthly basis. A summary of mean monthly concentrations at each of the monitoring sites for each evaluated laboratory parameter is given in Appendix D.1. Calculations of monthly mass loadings, based upon the mean monthly concentrations and monthly inflow volumes, are provided in Appendix D.2.

4.4.1.1.1 Total Nitrogen

A summary of calculated overall mass loadings for each of the evaluated parameters at the inflow and outflow monitoring locations is given in Table 4-25. During the field monitoring program, approximately 9,195 g of total nitrogen entered the Lake Hodge EcoVault® baffle box system, with approximately 7,866 g of total nitrogen discharged from the system, resulting in an overall retention of approximately 14% for total nitrogen within the Lake Hodge EcoVault® unit. This removal of total nitrogen was achieved primarily by reducing loadings of dissolved organic nitrogen and particulate nitrogen. A net increase in loadings was observed for ammonia and NO_x within the EcoVault® unit.

A much smaller nitrogen removal efficiency was observed at the Gee Creek EcoVault® site, with 7,481 g of total nitrogen entering the system and 7,348 g leaving the system, resulting in an overall mass load reduction of approximately 2%. In general, mass loadings for each of the nitrogen species, with the exception of NO_x, were lower in value at the Gee Creek EcoVault® site than observed at the Lake Hodge site. Net mass retention was observed for ammonia, dissolved organic nitrogen, and particulate nitrogen, although the overall load reductions were relatively small in value for each of these parameters. A substantial export of NO_x occurred from the Gee Creek EcoVault® site which offset the majority of mass reductions observed for the other nitrogen species, resulting in the observed overall load reduction of approximately 2%.

TABLE 4-25

CALCULATED MASS INPUTS AND LOSSES FOR EVALUATED PARAMETERS AT THE ECOVAULT® MONITORING LOCATIONS

SITE DESCRIPTION	DEVICE TYPE	MONITORING LOCATION	PARAMETER												
			NH_3 (g)	NO_x (g)	Diss. Org. N (g)	Part. N (g)	Total N (g)	SRP (g)	Diss. Org. P (g)	Part. P (g)	Total P (g)	TSS (kg)	Copper (g)	Iron (g)	Zinc (g)
Lake Hodge	EcoVault® Baffle Box	Inflow	490	826	3,038	2,991	9,195	2,134	211	1,694	4,592	1,042	97.1	6,650	187
		Outflow	1,120	1,631	2,614	2,502	7,866	1,179	225	589	1,993	209	42.2	4,536	56.6
	Mass Removal	In-Out	-630	-805	424	489	1,329	955	-15	1,105	2,600	833	55	2,114	131
		%	-129	-97	14	16	14	45	-7	65	57	80	57	32	70
Gee Creek	EcoVault® Baffle Box	Inflow	111	3,677	2,458	944	7,481	310	59.2	698	1,102	417	121	6,867	155
		Outflow	48.4	4,151	1,885	830	7,348	253	40.0	283	654	92.5	38.8	3,619	24.1
	Mass Removal	In-Out	62	-475	573	114	133	58	19	414	448	325	83	3,248	130
		%	56	-13	23	12	2	19	32	59	41	78	68	47	84
San Pablo	EcoVault® Baffle Box	Inflow	997	3,477	2,901	2,715	11,017	939	61.8	944	2,035	396	100	5,531	177
		Outflow	1,029	2,630	1,820	2,814	9,519	1,009	111	649	1,820	148	84.9	4,571	142
	Mass Removal	In-Out	-32	848	1,081	-99	1,498	-70	-49	295	215	248	15	960	36
		%	-3	24	37	-4	14	-7	-79	31	11	63	15	17	20

At the San Pablo EcoVault®, approximately 11,017 g of total nitrogen entered the system, compared with 9,519 g exiting the system, resulting in an overall mass load reduction of approximately 14%. This reduction primarily occurred as a result of reductions in measured concentrations of NO_x and dissolved organic nitrogen, while increases in mass occurred within the EcoVault® unit for ammonia and particulate nitrogen.

Overall, mass load reductions in nitrogen ranged from 2-14% in the EcoVault® units. The EcoVault® systems appear to reduce concentrations of dissolved organic nitrogen and particulate nitrogen on a relatively consistent basis, with highly variable load reductions observed for ammonia and NO_x.

4.4.1.1.2 Total Phosphorus

A substantially higher removal efficiency was observed for total phosphorus in each of the three EcoVault® units, with a 57% mass load reduction observed at the Lake Hodge site, 41% reduction observed at the Gee Creek site, and 11% reduction in total phosphorus observed at the San Pablo site. The observed phosphorus removals at the Lake Hodge and Gee Creek sites occurred primarily by removal of particulate phosphorus, although substantial reductions were also observed in measured concentrations of SRP. The observed reductions in SRP appear to be related to the "Baffle Buddy" filter system located at the EcoVault® outfall.

The lowest observed mass load removal for total phosphorus occurred at the San Pablo EcoVault® site. Photographs of this site under normal operating conditions are provided on Figure 4-52. The EcoVault® system at this site contained standing water throughout most of the field monitoring program, presumably due to clogging of the bleeder pipe retrofit that was installed in a pre-existing sump structure downstream of the baffle box. City of Casselberry maintenance personnel cleared the clogging on multiple occasions, but the conditions returned relatively quickly. The water levels within the EcoVault® unit were often above the level of the screen layer, indicating that at least a portion of the captured solids and debris were stored under wet conditions. Vegetation stored under wet conditions has been shown to release large amounts of phosphorus within a period of 24 hours. These wet conditions appear to have substantially reduced the removal capacity of the system for retention of SRP and also resulted in a substantial release of dissolved organic phosphorus within the unit. The relatively low overall observed removal mass load reduction for total phosphorus of 11% observed at the San Pablo site appears to have been highly impacted by the hydraulic conditions within the EcoVault® unit.

a. Floating leaves between storm events

b. Standing water above screen

c. Typical water elevation in unit

d. Floating leaves and vegetation debris

Figure 4-52. Photographs of the San Pablo EcoVault® Site Under Normal Operating Conditions.

4.4.1.1.3 TSS

Each of the EcoVault® systems resulted in significant reductions in loadings of TSS, ranging from 63% at the San Pablo EcoVault® site to 80% at the Lake Hodge EcoVault® site. It should be noted that the Lake Hodge site had a substantially larger mass input of TSS during the field monitoring program compared with mass TSS loadings to the Gee Creek or San Pablo EcoVault® units. The higher level of mass loading of TSS at the Lake Hodge site may be at least partly responsible for the observed higher mass removal efficiencies at this location.

4.4.1.1.4 Metals

Each of the EcoVault® units exhibited relatively significant mass load reductions for copper, iron, and zinc. Removal of total copper ranged from 15% at the San Pablo EcoVault® site to 68% at the Gee Creek EcoVault® site, with mass removal for total iron ranging from 17% at the San Pablo site to 47% at the Gee Creek site. A similar pattern was also observed for zinc, with mass load reductions ranging from 20-84%.

In general, load reductions for metals were relatively similar in value at the Lake Hodge and Gee Creek EcoVault® sites, with substantially lower values observed at the San Pablo EcoVault® site. As discussed previously, both the Lake Hodge and Gee Creek sites appeared to perform well hydraulically with no evidence of standing water in these units at any time. In addition, each of these two units was equipped with the Vault-Ox® insert which is designed to maintain oxidized conditions within the water column. The San Pablo EcoVault® system did not contain the Vault-Ox® units and was maintained in a submerged condition throughout much of the study. As a result, reduction in removal efficiencies for each of the three metals was low in value, although a positive removal efficiency was observed at each site. Storage conditions within the unit clearly appear to impact removal efficiencies for certain stormwater parameters.

4.4.1.1.5 Mass Removal Summary

A summary of observed mass removal efficiencies for total nitrogen, total phosphorus, and TSS in the EcoVault® units is given in Table 4-26. In general, removal efficiencies for total nitrogen were relatively low in value, ranging from approximately 2-14%. A substantially higher removal efficiency was observed for total phosphorus, ranging from 41-57% at the Osceola Trail sites, decreasing to 11% at the San Pablo EcoVault® site. The reduced mass removal for total phosphorus observed at this site is thought to be associated with the periodic flooded conditions which occurred in the unit. Mass load reductions for TSS were good in each of the three units, ranging from 63-80%.

TABLE 4-26

MASS REMOVAL SUMMARY FOR THE EcoVault® UNITS

SITE / UNIT	MASS REMOVAL (%)		
	Total N	Total P	TSS
Lake Hodge EcoVault®	14	57	80
Gee Creek EcoVault®	2	41	78
San Pablo EcoVault®	14	11	63

4.4.1.2 Evaluation of Removal Processes

Removal processes in typical GPS units rely upon separation and collection of incoming solids contained in the stormwater flow. Solids are collected on screening devices, if present, as well as in the sump area of the unit. The mass load reduction achieved by these systems is simply the sum of the mass loadings retained on the screens and in the sump sediments. However, in addition to the typical screens and sump areas, the EcoVault® units also contained the "Baffle Buddy" outlet filters, illustrated on Figure 2-1. This filter system contains a patented surfactant-modified aluminosilicate solid which, according to the manufacturer, is designed to absorb "cations and anions such as phosphates, ammonia, dissolved heavy metals, hydrocarbons, fecal bacteria, and a variety of organic compounds". Therefore, when identifying processes responsible for pollutant removal in the EcoVault® unit, the impacts of the filter system must also be considered. An analysis of observed removal mechanisms for total nitrogen, total phosphorus, and TSS is given in the following sections.

4.4.1.2.1 Total Nitrogen

A summary of mass inputs and outputs for each of the evaluated nitrogen species in the three EcoVault® units was provided in Table 4-25. Mass loadings of particulate nitrogen are likely to accumulate within the sump area of the unit as well as on the screens in the form of leaves and vegetation. However, removal of dissolved species (such as ammonia, NO_x, and dissolved organic nitrogen), if present, would be expected to occur within the filter system since these dissolved nitrogen species would generally be expected to pass through a GPS unit relatively unchanged.

Although the EcoVault® manufacturer claims that the outlet filter is designed to remove ammonia, this project found no evidence of significant removal of ammonia within the EcoVault® units. In fact, increases in ammonia were observed between the inflow and outflow for both the Lake Hodge and San Pablo EcoVault® units, with a small mass load reduction for ammonia observed at the Gee Creek EcoVault® site. No significant removal of NO_x was observed within the units, and in fact, an increase in NO_x was observed between the inflow and outflow in both the Lake Hodge and Gee Creek EcoVault® units.

In contrast, a consistent positive load reduction was observed for dissolved organic nitrogen, with mass load reductions ranging from 14-37% between the three units. It is possible that a portion of the dissolved organic nitrogen is being retained within the outfall filter system. However, it is also possible that the Vault-Ox® inserts (which are designed to maintain oxidized conditions within the units) are oxidizing dissolved organic nitrogen into either ammonia or NO_x which would explain the observed increases in loadings for these parameters between the inflow and outflow monitoring locations.

In summary, the primary mechanism for removal of total nitrogen within the EcoVault® units appears to be removal of particulate matter, although a reduction in dissolved organic nitrogen may occur within the filter system as well. Since the primary removal mechanism for total nitrogen appears to be removal of particulate nitrogen, then the removal effectiveness for total nitrogen in the EcoVault® units is highly correlated with the percentage of particulate nitrogen present in the runoff inflow. As indicated on Table 4-25, approximately 33% of the total nitrogen loading at the Lake Hodge site and 25% of the total nitrogen loading at the San Pablo site consisted of particulate nitrogen. Each of these units obtained a 14% removal for total nitrogen. However, at the Gee Creek EcoVault® site, particulate nitrogen contributed only 13% of the total nitrogen loading, resulting in a smaller pool of nitrogen which could be removed within the system, which was only approximately 2% for this unit.

A summary of estimated mass removal compartments for total nitrogen at the three EcoVault® sites is given in Table 4-27. The inflow and outflow loadings reflect the loadings provided on Table 4-25 and in Appendix D.2. The sump nitrogen loadings are obtained from the information summarized in Table 4-22. The sum of the material collected in the sump plus the mass measured in the discharge should approximately equal the mass inflow into the system. As indicated on Table 4-27, the total nitrogen mass contained in the sump and outflow matches the measured inflow nitrogen loadings relatively well for the Gee Creek EcoVault® site, but is somewhat lower than the measured inflow mass for the Lake Hodge and San Pablo EcoVault® sites. These discrepancies may indicate that particulate nitrogen was retained in the outflow filter and lost from the mass accounting provided in Table 4-27.

TABLE 4-27

MASS REMOVAL COMPARTMENTS FOR TOTAL NITROGEN

SITE / UNIT	TOTAL NITROGEN MASS (g)			
	Inflow	Sump	Outflow	Total[1]
Lake Hodge EcoVault®	9,195	188	7,866	8,054
Gee Creek EcoVault®	7,481	125	7,348	7,473
San Pablo EcoVault®	11,017	271	9,519	9,790

1. Sum of sump and outflow loadings

4.4.1.2.2 Total Phosphorus

In typical GPS units, removal for total phosphorus would be expected to occur primarily by settling and removal of particulate phosphorus matter. However, since the outlet filters contain an aluminum silicate compound, removal of dissolved phosphorus species (primarily SRP) would also be expected. The outlet filter may also remove a portion of the particulate matter which is not retained in the sump.

As indicated on Table 4-25, significant removals of particulate phosphorus occurred in each of the three units, ranging from 31-65%. A substantial removal of SRP was also observed in the Lake Hodge and Gee Creek units, presumably resulting from dissolved phosphorus removed within the outlet filter system. In contrast, a slight increase in SRP mass loadings was observed within the unit at the San Pablo site. It is likely that the outlet filter also retained SRP at this site as well. However, due to the submerged conditions which were frequently observed within the unit, release of SRP from vegetation was also occurring at a rate which exceeded the uptake capacity of the filter system, resulting in an overall net gain of SRP between the inflow and outflow of this unit. The submerged conditions have also provided an opportunity for portions of the flow to bypass the filter altogether, allowing the released SRP in the sump to discharge directly from the unit.

A summary of mass removal compartments for total phosphorus in the EcoVault® units is given in Table 4-28. Information on the mass of phosphorus retained within the sump area of each unit was obtained from Table 4-22. Estimates of the mass of SRP retained within the outlet filter system were obtained based upon the input and output mass loadings for SRP summarized on Table 4-25. For total phosphorus, the phosphorus contained within the sump plus phosphorus retained within the filter plus outflow phosphorus loadings should equal the inflow into the system. For each of the EcoVault® systems, the sum of the phosphorus retained in the unit plus the outflow mass loading is substantially less than the measured inflow phosphorus loading, suggesting that an additional significant removal mechanism exists, such as retention of particulate phosphorus in the outflow filter, which is not included in the mass balance analysis.

TABLE 4-28

MASS REMOVAL COMPARTMENTS FOR TOTAL PHOSPHORUS

SITE / UNIT	TOTAL PHOSPHORUS MASS (g)				
	Inflow	Sump	Filter	Outflow	Total[1]
Lake Hodge EcoVault®	4,592	48	955	1,993	2,996
Gee Creek EcoVault®	1,102	27	58	654	739
San Pablo EcoVault®	2,035	50	-70	1,820	1,800

1. Sum of sump + filter + outflow loadings

The performance efficiency of traditional GPS devices can be determined fairly accurately by measuring the mass loadings in the discharge from the system and the mass accumulated within the sump of the unit. However, the presence of the outlet filter in EcoVault® units requires that the inflow must also be measured. The inflow monitoring adds an additional level of complexity to the overall monitoring protocol and introduces an additional source of error in attempting to compartmentalize material collected within the sump and the outlet filter and reconciling the measured outflow mass loadings with the mass inflows and removal processes. In addition, portions of the material collected within the sump are not measured as part of the inflow which may be responsible for some of the observed errors in mass balance components at the EcoVault® sites in addition to retention of particulate matter in the outflow filters.

4.4.1.2.3 TSS

For TSS, the dominant removal mechanism is simple gravity settling within the sump of the unit. A summary of mass removal compartments for TSS is given on Table 4-29. Information is provided on the mass of TSS collected from the sump area of each of the units based upon the information included in Table 4-22. Inflow and outflow TSS loadings are also provided based upon information summarized in Table 4-25.

TABLE 4-29

MASS REMOVAL COMPARTMENTS FOR TSS

SITE / UNIT	TSS MASS (kg)			
	Inflow	Sump	Outflow	Total
Lake Hodge EcoVault®	1,042	446	209	655
Gee Creek EcoVault®	417	318	92	410
San Pablo EcoVault®	396	368	148	516

Overall, a relatively good agreement was obtained between the measured inflow loading and calculated loadings from the sump and discharge sites for the Gee Creek and San Pablo EcoVault® sites. A slightly larger difference was observed at the Lake Hodge site. It should be noted that the measured TSS in the sump includes some solids which may not have been accurately measured at the inflow location due to the size or density of the solids. In addition, some of the solids may be removed within the outflow filter system which would further complicate the evaluation of mass removal mechanisms for TSS.

4.4.1.2.4 Metals

As indicated on Table 4-25, positive mass removals were obtained in each of the three units for each of the evaluated metals based upon a comparison of inflow and outflow loadings. Relatively similar removal efficiencies for copper, iron, and zinc were obtained in the Lake Hodge and Gee Creek EcoVault® sites. However, somewhat lower removal efficiencies were obtained at the San Pablo site which was submerged during portions of the study and also did not contain the Vault-Ox® inserts.

Since metals were not measured on the solids collected from the sumps, there is no way to determine if the observed removals for metals occurred as a result of sedimentation of solids or filtration of dissolved metals within the outlet filter. However, the San Pablo unit (which exhibited substantially lower metal removal efficiencies) also had an outlet filter system similar to the Gee Creek and Lake Hodge sites, suggesting that the filter system may not be a significant factor in removal. The Lake Hodge and Gee Creek sites also had the Vault-Ox® inserts which maintained oxidized conditions within the unit, and may have caused some of the metals to precipitate out as either oxides or hydroxides, accumulating into the sump. If this assumption is true, then the Vault-Ox® insert appears to substantially enhance the overall effectiveness of the system for stormwater metals.

4.4.2 Suntree Baffle Box and CDS Units

Mass removal efficiencies for the Suntree baffle box and CDS units were calculated using the method outlined in Section 3.1.4.1. Using this method, only the outflow from the unit was monitored along with the solids collected within the sump. The sum of the mass loadings discharging from the unit plus the mass loadings retained within the sump area is equal to the input mass which is then compared to the discharge mass to calculate the overall removal effectiveness.

A summary of overall mass removals for the Suntree baffle box and CDS units is given on Table 4-30. Information on the mass of nitrogen, phosphorus, and TSS collected in the sump areas is obtained from Table 4-22. Information on the mass of nitrogen, phosphorus, and TSS in discharges from each of the units from the monthly mass balances for these units is summarized in Appendix D.2. The calculated total mass loading for each of these parameters (summarized in Table 4-30) is assumed to reflect the input loading into each of the units.

The accumulated mass of total nitrogen, total phosphorus, and TSS in the Suntree baffle box and CDS units were very similar in value in spite of a large degree of variability in input loadings to each of the two units. Overall, the Suntree baffle box unit exhibited a total nitrogen removal of approximately 1.6%, with a slightly higher nitrogen removal of 4.2% for the CDS unit. Similarly, the Suntree baffle box removed approximately 2.6% of the phosphorus loading to the system, with a removal of approximately 9.3% for the San Pablo CDS unit. Overall mass load removals for TSS ranged from 66% for the Suntree baffle box to 92% for the CDS unit.

TABLE 4-30

OVERALL MASS REMOVALS FOR THE SUNTREE BAFFLE BOX AND CDS UNITS

SITE / UNIT	TOTAL NITROGEN MASS (g)			TOTAL PHOSPHORUS MASS (g)			TSS MASS (kg)			MASS REMOVAL (%)		
	Sump	Outflow	Total	Sump	Outflow	Total	Sump	Outflow	Total	Total N	Total P	TSS
Lake Concord Suntree Baffle Box	106	6,578	6,684	21	787	808	209	109	318	1.6	2.6	66
San Pablo CDS Unit	111	2,553	2,664	29	282	311	233	19	252	4.2	9.3	92

In general, the observed mass loadings for the Suntree baffle box and CDS unit (summarized in Table 4-30) are similar to mass removals commonly observed for these systems. However, the CDS unit appeared to exhibit a slightly higher affinity for removal of total nitrogen, total phosphorus, and TSS than was observed within the Suntree baffle box. This difference is somewhat surprising since CDS units have been shown by ERD in previous projects to develop extended anoxic conditions in the lower sump area which would tend to reduce the effectiveness of the system for removal of total phosphorus. In contrast, Suntree baffle box units typically exhibit oxidized conditions due to the large surface area provided for each of the internal chambers and the increased ability to re-oxygenate the water. However, it is unlikely, given the variability in the measured field data, that the observed differences between the Suntree baffle box unit and CDS unit are statistically significant.

4.4.3 Mass Removal Summary

A summary of measured mass removal efficiencies for the evaluated GPS devices is given on Table 4-31. In general, the EcoVault® units appear to exhibit a higher degree of nitrogen removal than either the Suntree baffle box or CDS unit. However, the observed removals for total nitrogen are generally low in value, ranging from approximately 2-14%. None of the evaluated devices appear to be suitable for a project where significant load reductions for total nitrogen are desired.

Excellent removal efficiencies for total phosphorus were obtained in both the Lake Hodge and Gee Creek EcoVault® sites. Each of these sites was equipped with the outlet filter as well as the Vault-Ox® inserts. The level of phosphorus removal observed in these units is generally much greater than is commonly observed in typical GPS devices. The EcoVault® system without the Vault-Ox® insert, along with the Suntree baffle box and CDS unit, exhibited removal efficiencies ranging from approximately 3-9% which is typical of the range of values commonly observed for GPS units. The combination of the outlet filter system and the Vault-Ox® (concepts which are unique to the EcoVault® system) appear to substantially enhance phosphorus load reductions compared with the other devices.

TABLE 4-31

SUMMARY OF MEASURED REMOVAL EFFICIENCIES FOR THE EVALUATED GPS DEVICES

SITE / UNIT	TOTAL NITROGEN	TOTAL PHOSPHORUS	TSS
Lake Hodge EcoVault®	14	57	80
Gee Creek EcoVault®	2	41	78
San Pablo EcoVault®	14	11	63
Lake Concord Suntree Baffle Box	1.6	2.6	66
San Pablo CDS Unit	4.2	9.3	92

Each of the evaluated GPS devices resulted in significant reductions in TSS, ranging from 63-92%. The lowest load reduction for TSS was obtained with the San Pablo EcoVault®, with the highest observed removals obtained in the CDS unit. However, the observed differences in solids removal rates may be more related to the watershed characteristics and the resulting solids characteristics than any significant differences between the five units for removal of suspended matter.

4.4.4 Extrapolation to an Annual Cycle

The analyses summarized in the previous sections reflect the performance efficiencies for each of the evaluated units over the 214-day period from June 15, 2013-January 15, 2014. During this period, rainfall amounts ranging from approximately 27-33 inches were measured at the monitoring sites, reflecting approximately 65% of the normal annual rainfall in the general area. Therefore, the estimated load reductions achieved during the study period do not accurately predict the mass load reductions which would occur over an annual cycle.

An analysis of estimated annual mass loadings for each of the evaluated GPS sites is given in Table 4-32. Measured rainfall depths, inflow volumes, and mass loadings of total nitrogen, total phosphorus, and TSS are provided for the monitoring period from June 2013-January 2014 based upon information provided in previous sections. The measured values over the monitoring period are converted to average annual values by multiplying by the ratio of the annual average rainfall of approximately 51.31 inches for the Sanford area to the measured rainfall during the field monitoring program. This analysis generates an estimate of the anticipated inflow volumes and mass loadings which would occur on an annual basis.

TABLE 4-32

ESTIMATED ANNUAL LOADINGS AT THE EVALUATED GPS SITES

SITE DESCRIPTION	DEVICE TYPE	MONITORING LOCATION	JUNE 2013-JANUARY 2014					AVERAGE ANNUAL				
			Rainfall (inches)	Inflow Volume (ac-ft)	Total N (g)	Total P (g)	TSS (kg)	Rainfall (inches)	Inflow Volume (ac-ft)	Total N (g)	Total P (g)	TSS (kg)
Lake Hodge	EcoVault®	Inflow	32.82	10.8	9,195	4,592	1,042	51.31	16.9	14,376	7,179	1,629
Gee Creek	EcoVault®	Inflow	32.82	6.56	7,481	1,102	417	51.31	10.3	11,695	1,723	652
San Pablo	EcoVault®	Inflow	27.38	9.31	11,017	2,035	396	51.31	17.4	20,645	3,814	742
Lake Concord	Suntree Baffle Box	Outflow	31.09	7.44	6,578	787	109	51.31	12.3	10,856	1,299	180
San Pablo	CDS Unit	Outflow	27.38	2.22	2,553	282	19	51.31	4.2	4,785	528	36.2

A summary of estimated annual mass removals at the evaluated GPS sites is given on Table 4-33 based upon the measured annual load reductions for nitrogen, phosphorus, and TSS (summarized on Table 4-31). Estimates of annual load reductions are provided for total nitrogen, total phosphorus, and TSS by multiplying the measured load reductions times the estimated annual mass loadings for each parameter. Overall, the constructed GPS units will remove approximately 5.5 kg (12.1 lbs) of total nitrogen, 5.3 kg (11.7 lbs) of total phosphorus, and 2,431 kg (5,360 lbs) of TSS from the sub-basin areas each year.

TABLE 4-33

ESTIMATED ANNUAL MASS REMOVALS AT THE EVALUATED GPS SITES

SITE DESCRIPTION	DEVICE TYPE	ANNUAL LOADING (kg/yr)			LOAD REDUCTION (%)			LOAD REDUCTION (kg/yr)		
		Total N	Total P	TSS	Total N	Total P	TSS	Total N	Total P	TSS
Lake Hodge	EcoVault®	14.4	7.2	1,629	14	57	80	2.01	4.09	1,303
Gee Creek	EcoVault®	11.7	1.7	652	1.8	41	78	0.21	0.71	509
San Pablo	EcoVault®	20.6	3.8	742	14	11	63	2.89	0.42	467
Lake Concord	Suntree Baffle Box	10.9	1.3	180	1.6	2.6	66	0.17	0.03	119
San Pablo	CDS Unit	4.8	0.5	36	4.2	9.3	92	0.20	0.05	33
							TOTAL:	**5.5**	**5.3**	**2,431**

4.5 Construction and O&M Costs

4.5.1 Implementation Costs

A summary of implementation costs for the monitored Casselberry GPS devices is given on Table 4-34 based on information supplied by the City of Casselberry. For the Lake Hodge EcoVault®, Gee Creek EcoVault®, San Pablo EcoVault®, and the San Pablo inlet insert sites, actual costs were provided by the City and include permitting, design, construction, staff, and supplies. Monitoring costs are also provided for comparison purposes, although monitoring is not considered to be part of the construction costs for the systems. Implementation costs for the San Pablo CDS unit and the Lake Concord Suntree baffle box were provided separately by the City and include all of the previous listed items with the exception of permitting since each of these projects was constructed as part of a larger public works project.

TABLE 4-34

SUMMARY OF IMPLEMENTATION COSTS FOR THE MONITORED CASSELBERRY GPS DEVICES

CATEGORY	SITE ($)						TOTAL ($)
	Lake Hodge EcoVault®	Gee Creek EcoVault®	San Pablo EcoVault®	San Pablo Inserts	San Pablo CDS	Lake Concord Suntree Baffle Box	
Permitting	2,500	2,500	200	0	0	0	5,200
Design	25,000	25,000	36,000	0	25,000	25,000	136,000
Construction	117,000	117,000	71,890	4,500	54,423	32,000	396,813
Construction Inspection	9,000	9,000	9,000	0	0	0	27,000
Land	0	0	0	0	0	0	0
Staff	1,935	1,935	1,935	0	1,935	1,935	9,675
Supplies	200	200	200	0	200	200	1,000
Monitoring	19,500	19,500	19,500	2,500	19,500	19,500	100,000
Totals:	**$ 175,135**	**$ 175,135**	**$ 138,725**	**$ 7,000**	**$ 101,058**	**$ 78,635**	**$ 675,688**

Overall, implementation costs for the installed GPS devices ranged from approximately $78,635 for the Lake Concord Suntree baffle box unit to $175,135 for the Lake Hodge and Gee Creek EcoVault® sites. The overall cost of the implemented GPS devices, including monitoring, is approximately $675,688. Please note that the overall implementation cost does not match the amounts listed in the TMDL Grant since only three of the five GPS devices funded by the TMDL Grant were included in the performance evaluation.

4.5.2 Annual O&M Costs

A summary of estimated O&M costs for the installed GPS units is given on Table 4-35 based upon information provided by the City of Casselberry. Each of the evaluated units requires semi-annual clean-outs with an estimated cost of $750/year for the EcoVault®, CDS, and Suntree baffle box units. An estimated annual clean-out cost of $250/year is assumed for the inlet baskets. Both the Suntree baffle box and the San Pablo inlet baskets contain storm booms which require semi-annual replacement at a cost of $87 for the Suntree baffle box and $96 for the inlet baskets. Each of the EcoVault® units also requires replacement of the Baffle Buddy filter on an annual basis, with costs ranging from $846/year for the San Pablo EcoVault® site to $1,190/year each for the Lake Hodge and Gee Creek EcoVault® sites. In addition, the Lake Hodge and Gee Creek EcoVault® sites also contain the Vault-Ox® inserts which are changed quarterly at an estimated annual cost of $1,175/unit. Overall, O&M costs range from a low of approximately $346/year for the inlet baskets to a high of $3,115/year for the Lake Hodge and Gee Creek EcoVault® sites.

TABLE 4-35

SUMMARY OF ESTIMATED ANNUAL O&M COSTS FOR THE INSTALLED GPS UNITS

PARAMETER	ANNUAL COST ($)					
	Lake Hodge EcoVault®	Gee Creek EcoVault®	San Pablo EcoVault®	San Pablo CDS	Lake Concord Suntree Baffle Box	San Pablo Inlet Baskets (3 units)
Clean-out (2/year)	750	750	750	750	750	250
Storm Boom Replacement (2/year)	--	--	--	--	87	96
Baffle Buddy Filters (1/ year)	1,190	1,190	846	--	--	--
Vault-Ox® (4/year)	1,175	1,175	--	--	--	--
TOTALS:	**$ 3,115**	**$ 3,115**	**$ 1,596**	**$ 750**	**$ 837**	**$ 346**

4.5.3 Present Worth Mass Removal Costs

Present worth costs were calculated for each of the evaluated GPS units using an interest rate of 4% and a 20-year life cycle. The present worth costs were calculated by adding the construction costs for each of the units (excluding monitoring costs) to 20 years of annual O&M costs based on an interest rate of 4%. Mass removal costs were then calculated by dividing the 20-year present worth costs by estimated mass load reductions over the 20-year life cycle period.

A summary of present worth and mass removal costs for the evaluated GPS units is given on Table 4-36. The lowest nitrogen removal costs, ranging from $2,481-9,395/kg, were achieved in the Lake Hodge and San Pablo EcoVault® units and the inlet basket inserts. Each of the remaining evaluated units had nitrogen removal costs ranging from $20,738-47,135/kg.

TABLE 4-36

SUMMARY OF PRESENT WORTH AND MASS REMOVAL COSTS FOR THE EVALUATED GPS UNITS (i = 0.04; n = 20; P/A = 13.59)

PARAMETER	UNITS	LAKE HODGE EcoVault®			GEE CREEK EcoVault®			SAN PABLO EcoVault®		
		Total N	Total P	TSS	Total N	Total P	TSS	Total N	Total P	TSS
Load Reduction										
Annual	kg/yr	2.01	4.09	1,303	0.21	0.71	509	2.84	0.42	467
20-year	kg	40.2	81.8	26,060	4.2	14.2	10,100	56.8	8.4	9,340
Costs										
Construction	$	155,635	155,635	155,635	155,635	155,635	155,635	119,225	119,225	119,225
O&M	$	3,115	3,115	3,115	3,115	3,115	3,115	1,596	1,596	1,596
20-year Present Worth	$	197,968	197,968	197,968	197,968	197,968	197,968	140,915	140,915	140,915
Removal Cost	**$/kg**	**4,925**	**2,420**	**7.60**	**47,135**	**13,941**	**19.45**	**2,481**	**16,776**	**15.09**

PARAMETER	UNITS	SAN PABLO CDS			LAKE CONCORD SUNTREE BAFFLE BOX			SAN PABLO INLET BASKET INSERTS		
		Total N	Total P	TSS	Total N	Total P	TSS	Total N	Total P	TSS
Load Reduction										
Annual	kg/yr	0.20	0.05	3.3	0.17	0.03	119	0.037	0.012	42.4
20-year	kg	4.0	1.0	660	3.4	0.6	2,380	0.74	0.24	848
Costs										
Construction	$	81,558	81,558	81,558	59,135	59,135	59,135	2,250	2,250	2,250
O&M	$	750	750	750	837	837	837	346	346	346
20-year Present Worth	$	91,751	91,751	91,751	70,510	70,510	70,510	6,952	6,952	6,952
Removal Cost	**$/kg**	**22,938**	**91,751**	**139**	**20,738**	**117,517**	**29.63**	**9,395**	**28,967**	**8.20**

Measured phosphorus removal costs were highly variable among the evaluated units, ranging from a low of $2,420/kg for the Lake Hodge EcoVault® site to $117,517/kg for the Lake Concord Suntree baffle box site. With the exception of the Lake Hodge EcoVault® site, phosphorus removal costs for the remaining units exceeded approximately $14,000/kg. These values reflect extremely elevated phosphorus removal costs and are likely related to a combination of low phosphorus loadings within the evaluated watersheds combined with relatively low phosphorus removal efficiencies. Measured TSS removal costs were also highly variable, ranging from $7.60/kg in the Lake Hodge EcoVault® to $139/kg for the San Pablo CDS unit.

A comparison of mass removal costs for the evaluated GPS units is given in Table 4-37. Nitrogen mass removal costs of approximately $10,000/kg or less were obtained in the Lake Hodge and San Pablo EcoVault® units and San Pablo inlet basket inserts, with removal costs ranging from $20,738-47,135/kg at the remaining sites. However, relatively low nitrogen loading rates were observed at each of the monitored sites, and the observed elevated mass removal costs may be highly impacted by the limiting amount of nitrogen available for removal.

TABLE 4-37

COMPARISON OF MASS REMOVAL COSTS FOR THE EVALUATED GPS UNITS

UNIT	MASS REMOVAL COST ($/kg)		
	Total Nitrogen	**Total Phosphorus**	**TSS**
Lake Hodge EcoVault®	4,925	2,420	7.60
Gee Creek EcoVault®	47,135	13,941	19.45
San Pablo EcoVault®	2,481	16,776	15.09
Suntree Baffle Box	20,738	117,517	29.63
San Pablo CDS	22,938	91,751	139
San Pablo Inlet Basket Inserts	9,395	28,967	8.00

Mass removal costs for phosphorus were highly variable at the monitoring sites, with the lowest phosphorus removal cost of $2,420/kg obtained at the Lake Hodge EcoVault® site. Phosphorus removal costs at the remaining sites were at least an order of magnitude greater than removal costs observed at the Lake Hodge EcoVault® site. An extremely elevated phosphorus removal cost of $117,517/kg was observed at the Suntree baffle box site. Each of the sites with elevated phosphorus removal costs was characterized by extremely low phosphorus loading rates which may be at least partially responsible for the observed elevated mass removal costs.

The Lake Hodge EcoVault® site also achieved the lowest mass removal costs for TSS of $7.60/kg. A similar mass removal cost of $8.20/kg was obtained for the inlet basket structures. The Gee Creek and San Pablo EcoVault® sites exhibited TSS removal costs of approximately $15-20/kg, increasing to $30/kg in the Suntree baffle box and $139/kg in the San Pablo CDS unit.

Overall, the San Pablo EcoVault® unit exhibited the lowest present worth mass removal costs for total nitrogen, with the lowest removal costs for total phosphorus and TSS observed in the Lake Hodge EcoVault® unit. Relatively low nitrogen removal costs were also observed for the inlet basket inserts for both total nitrogen and TSS. However, substantially elevated nitrogen removal costs were observed for each of the remaining units, ranging from $20,738/kg in the Suntree baffle box to $47,135/kg in the Gee Creek EcoVault®. The elevated nitrogen removal costs observed at these sites may be partially related to relatively low nitrogen loadings into each of the units. Substantially elevated phosphorus removal costs were also observed in the Gee Creek EcoVault®, San Pablo EcoVault®, Suntree baffle box, San Pablo CDS, and inlet basket inserts, ranging from $13,941/kg in the Gee Creek EcoVault® to $117,517/kg in the Lake Concord Suntree baffle box unit. The San Pablo CDS unit also exhibited a substantially elevated removal cost for TSS of $139/kg, compared with TSS removal costs in the other units ranging from $7.60-30/kg.

SECTION 5

SUMMARY AND DISCUSSION

A field monitoring program was conducted by ERD from June 15, 2013-January 15, 2014 to evaluate the performance efficiencies of five Gross Pollutant Separator (GPS) units and three curb inlet basket inserts installed within the City of Casselberry. Two of the evaluated units consisted of Ecosense EcoVault® units equipped with multiple Vault-Ox® inserts. The third evaluated unit was also an Ecosense EcoVault® unit installed without Vault-Ox® inserts. The fourth unit consisted of a Contech CDS unit, with the final unit consisting of a Suntree 2nd Generation Nutrient Separating Baffle Box. Three high-capacity inlet baskets, manufactured by Suntree, were also evaluated.

Automatic samplers with integral flow meters were installed at the inflows and outflows for each of the three EcoVault® units. Field monitoring for the CDS and Suntree baffle box units was conducted only at the discharge. Autosamplers at each of the five monitoring sites were equipped with integral flow meters and were programmed to provide a continuous record of hydrologic inflows and to collect inflow and outflow samples in a flow-weighted mode. Recording rain gauges were also installed in the vicinity of each of the monitoring units.

Collected solids within each of the GPS units were removed by personnel from the City of Casselberry prior to the initiation of the field monitoring program to provide cleaned units to start the field monitoring program. Clean-out operations were conducted again approximately mid-way through the field monitoring program as well as at the completion of the field monitoring program. The volume and mass of solids collected during each of the clean-out operations was measured and quantified by ERD.

Rainfall during the field monitoring program from mid-June to mid-January was slightly less than normal at each of the sites. Continuous records of hydrologic inputs/outputs for each of the five GPS monitoring sites were recorded at 15-minute intervals during the field monitoring program, allowing quantification of the volume of runoff that discharged through each of the units. Over the 214-day field monitoring program, 136 composite inflow and outflow samples were collected at the five monitoring sites and analyzed in the ERD Laboratory for general parameters, nutrients, and selected metals. In general, relatively low concentrations of nutrients and TSS were measured at each of the inflow monitoring sites, particularly at the Gee Creek site where the mean total nitrogen and total phosphorus concentrations in the raw runoff were approximately one-third to one-half of concentrations commonly observed in residential runoff. The low nutrient concentrations observed at this site are likely related to pre-treatment provided by the grassed swale drainage system.

Performance efficiencies for each of the GPS sites were calculated by comparing inflow and outflow mass loadings for nutrients and TSS. Uptake of dissolved ions was also considered for the EcoVault® units which contained aluminum-based outflow filter systems.

Each of the units appeared to function well hydraulically during the field monitoring program, with the exception of the San Pablo EcoVault® site. This site maintained a pool of standing water throughout much of the field monitoring program, in spite of the baffle box discharge being well above the elevation of the receiving water. As a result, solids were collected and stored under submerged conditions during at least portions of the field monitoring program.

Overall mass removal efficiencies for total nitrogen in the evaluated GPS devices ranged from approximately 2-14%, with 14% removals achieved in two of the three EcoVault® units and 2% removal observed for total nitrogen in the remaining EcoVault® unit. The reduced removal observed in the third EcoVault® unit (Gee Creek site) is thought to be related to low inflow concentrations of nitrogen and particulate matter from the watershed areas as a result of the swale drainage system. Nitrogen removal in the Suntree baffle box and CDS units ranged from approximately 2-4%, which is slightly lower than nitrogen removals commonly observed for these units in other studies.

Excellent total phosphorus removals were obtained in the two EcoVault® systems which contained the Vault-Ox® inserts, with phosphorus mass load reductions ranging from 41-57%. A total phosphorus removal of only 11% was achieved in the third EcoVault® unit which did not contain the Vault-Ox® insert (San Pablo) and also exhibited flooded conditions throughout much of the study. Removal efficiencies for total phosphorus in the Suntree baffle box and CDS units were equal to 3% and 9%, respectively. This study suggests that the Vault-Ox® inserts may be at least partially responsible for the additional phosphorus removal achieved within the two EcoVault® units equipped with this option by maintaining oxidized conditions that minimize the solubility of phosphorus species. Each of the EcoVault® units also contained an outflow filter system designed to absorb phosphorus and other ions, and a significant portion of the phosphorus load reductions observed at the Lake Hodge and Gee Creek EcoVault® sites is due to retention of dissolved phosphorus within the outlet filter.

Each of the units exhibited excellent removals for suspended solids, ranging from 63-92%. TSS removals in this range are typical of values commonly observed in GPS devices.

Estimates were conducted of the annual mass loading of nitrogen, phosphorus, and TSS generated in each of the evaluated sub-basins by multiplying the observed mass loadings during the field monitoring program times the ratio of annual "normal" rainfall to rainfall measured during the field monitoring program. The measured load reductions were then applied to the estimated annual loadings to provide estimates of annual load reductions achieved by the installed GPS units. Overall, the five evaluated units are anticipated to remove approximately 2.9 kg/yr of total nitrogen, 5.3 kg/yr of total phosphorus, and 2,431 kg/yr of TSS. Additional relatively minimal load reductions will also be achieved in the basket inlet devices.

Present worth and mass removal costs were also calculated for each of the evaluated GPS units. Nitrogen mass removal costs were highly variable, ranging from approximately $2,481-47,135 for the evaluated units. Nitrogen removal costs less than $10,000/kg were observed only in the Lake Hodge and San Pablo EcoVault® units and the inlet basket inserts. The high observed mass removal costs for total nitrogen in the other units are thought to be primarily related to the extremely low nitrogen loading present in the monitored watersheds and the corresponding reduced opportunity for collection of nitrogen-containing solids.

Highly variable mass removal costs were obtained for total phosphorus, with the lowest removal cost of $2,420/kg obtained in the Lake Hodge EcoVault® unit. Phosphorus mass removal costs for the remaining units were approximately an order of magnitude greater, ranging from $13,941-117,517/kg. A large portion of these elevated phosphorus removal costs is due to low phosphorus loadings in the retrofitted watersheds, although differences in operational characteristics between the different units may also be a significant factor.

Mass removal costs for TSS ranged from approximately $8-30/kg for each of the evaluated units except the San Pablo CDS unit where a TSS removal cost of $139/kg was measured.

The lowest mass removal costs were achieved in the Lake Hodge EcoVault® unit for total phosphorus and TSS, with the lowest mass removal cost for nitrogen observed in the San Pablo EcoVault® unit. Some of the highest observed mass removal costs occurred at the Gee Creek EcoVault® site, Suntree baffle box site, and the San Pablo CDS site. The elevated mass removal costs at the Gee Creek EcoVault® site are thought to be due to low watershed loadings, while the elevated mass load removal costs for the San Pablo CDS unit is thought to be a combination of relatively low loadings and the inability of the system to retain dissolved constituents due to the isolated permanently wet sump area.

Overall, the EcoVault® baffle box system appears to provide a substantial improvement to the standard baffle box design by incorporating the outlet adsorption filter system and the Vault-Ox® units which maintain oxidized conditions within the unit. The observed mass removal costs for the EcoVault® at the Lake Hodge site are some of the lowest mass removal costs measured by ERD in GPS units. However, it is obvious that factors other than baffle box design impact the overall effectiveness of a GPS device, including watershed loadings and degree of particulate matter within the watershed.

APPENDICES

APPENDIX A

PRODUCT LITERATURE FOR THE EVALUATED DEVICES

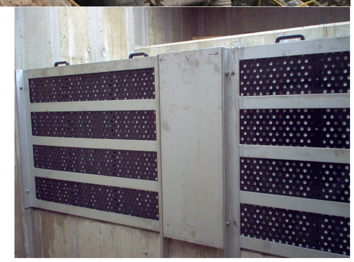
A.1: ESI EcoVault® Baffle Box
A.2: ESI Vault-Ox® System
A.3: Contech CDS Unit
A.4: Suntree Nutrient Separating Baffle Box
A.5: Suntree High-Capacity Curb Inlet Basket

A.1: ESI EcoVault® Baffle Box

www.EcoSenseInt.com

The **ESI EcoVault®** is a precast concrete stormwater treatment structure that removes:

Sediments	Nutrients
Trash	Metals
Organics	Oils and Grease



The Baffle Buddy Cassette Filter, with ESI MZ medium, a patented surfactant modified alumino silicate, absorbs cations and anions such as:

Phosphates-PO_4	Hydrocarbons
Ammonia-NH_4	Fecal Bacteria

Dissolved Heavy Metals

PCB, BTX, PCE, THM

Pentachlorophenol

Creosote

Non-ionic surfactants

Ask about improving performance in your stormwater treatment device with Vault-Ox® SSRC

EcoSense International

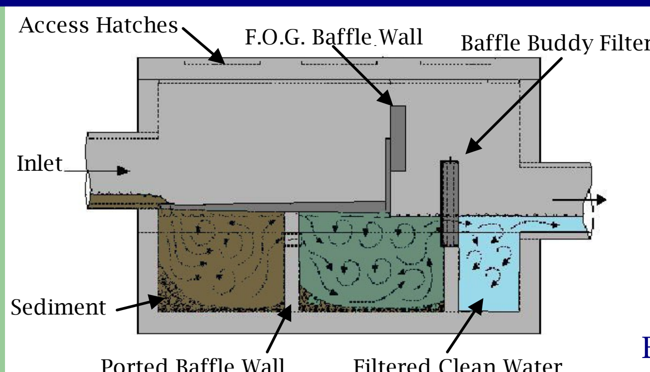
EcoVault®

Simple Solutions to Water Pollution

EcoSense International, Inc.

1800 Huntington Lane
Rockledge, Florida
32955 USA

Phone: 321-636-6708
Fax: 321-636-6710
operations@ecosenseint.com
www.ecosenseint.com



EcoVault® treats the continuous flow while debris screens span the entire box, creating extensive storage volume.

Multi-piece construction to minimize lifting and freight.

Baffle Buddy Cassette Filter becomes the final internal weir wall.

Debris screens are made of aluminum or Stainless Steel.

ESI MZ Filter medium is superior to traditional clay materials because it is rigid and stable, even in aqueous conditions.

Phosphorus Absorptive media!

Technology is based on slowing the flow's velocity to facilitate settling.

Baffles impede forward movement of settling particles.

Debris screens raise trash and leaves out of the water to greatly reduce decomposition.

EcoSense International

ESI offers products that prevent anoxic conditions and effectively remediates the standing water left between storm events.

Model Size L x W (ft x ft)	Typical Pipe Size (in)	80% TSS[1] Removal Efficiency Flow (cfs)	Screen Storage Capacity (cf)	Sediment Chamber Capacity (cf)	Total Contaminant Capacity (cf)
5 x 11	12 to 30	15	87	150	237
6 x 12	18 to 36	24	144	201	345
8 x 14	30 to 54	32	324	321	645
8 x 16	36 to 54	40	360	369	729
10 x 16	42 to 66	45	550	465	1015
12 x 20	54 to 72	55	1008	945	1953

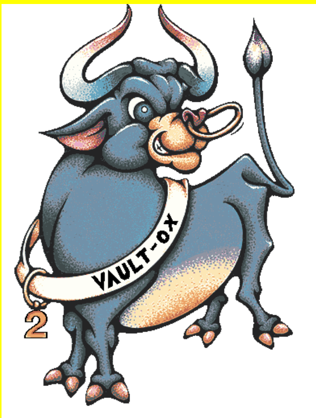
Servicing the EcoVault® is easy with the accessible hatches and requires a vacuum truck.

Custom sizes are available to meet your specific application

[1] *Pandit*, *Ashok*, Ph.D., P.E. & Gopatakrishnan, Ganash; "Physical Modeling of A Stormwater Sediment Removal Box"; Jun. *1996*

A.2: ESI Vault-Ox® System

www.EcoSenseInt.com



The US EPA defines "Green Chemistry" as any product or process which reduces toxicity to the environment.

Designed to improve the quality of *Static or Inter-Event Stormwater*, Vault-Ox® is a proprietary blend of two active ingredients and will:

- Improve Dissolved Oxygen
- Immobilize Phosphorus
- Elevate and Buffer pH
- Absorb Nitrogen
- Enhance Aerobic Activity
- Promote Oxidation of Organics
- Lower COD / BOD
- Absorb Heavy Metals

A Source of Alkalinity:

- Increases the formation of calcite and apatite, increasing the phosphorus binding capacity of calcium.
- Prevents acidification of water when sulfides are oxidized
- Reduces free H2S concentrations
- Counters acid rain

A Source of ion exchange absorption / adsorption:

- Removal of Ammonia produced by aerobic digestion
- Removal of Heavy Metals from solution
- Effective in the absorption of Mercury, Arsenic, chromium, copper, lead, zinc, cobalt, nickel, barium, antimony

EcoSense International

Vault-Ox®

Simple Solutions to Water Pollution

Vault-Ox® alters the static stormwater environment.

Many pathogenic bacteria are strict anaerobes. Fecal/Coliform bacteria are typically facultative anaerobes. The static water found in underground drainage/ storage structures quickly becomes anoxic/anaerobic, lacking or completely absent of oxygen. At neutral pH Vault-Ox® releases oxygen and calcium, improving DO, elevating and buffering pH: $2CaO_2+2H_2O \longrightarrow 2Ca(OH)_2+O_2$

At lower pH, Vault-Ox® dissolves faster and produces increasing amounts of hydrogen peroxide: $CaO_2+2H^+ \longrightarrow Ca^{2+} + H_2O_2$

Peroxide generated leads to a number of beneficial reactions:

Oxidation of Sulfides; Fenton oxidation; Fe2+ Oxidation

$H_2O_2 + OH^- \longrightarrow H_2O + HOO^-$; $2H_2O_2 \longrightarrow 2H_2O + O_2$; $H_2O_2 + FE^{2+} \longrightarrow HO$

Marino and Gannon, 1991 Tested storm drain sediments during dry weather periods and found "Extended bacterial survival in sediments to survival in water… FC and FS in sediments remained stable for up to 6 days (the maximum inter-storm dry period)".

GPI Southeast, in the Final Report – Baffle Box Effectiveness Monitoring Project, 2010 reports "net exports of fecal coliforms and anaerobic conditions…" and suggest "probable causes for FC growth in baffle boxes are the inter-event anaerobic conditions…" and also points out "…use of any water storing box can lead to increased FC counts to water bodies".

Introducing SSRC:
Static Stormwater Remediation Chemistry

EcoSense International, Inc.™
1800 Huntington Lane
Rockledge, Florida 32955
USA

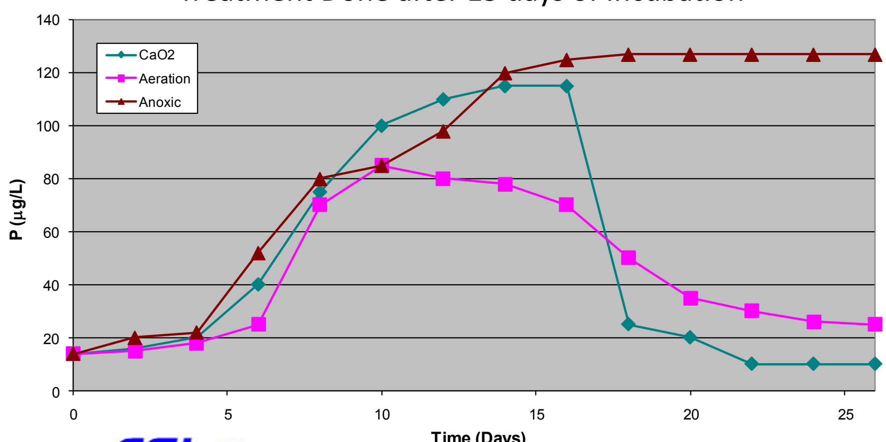
Phone: 321-636-6708
Fax: 321-636-6710
Operations@ecosenseint.com

Addition of Vault-Ox® with natural Z-100 have desirable selective ion exchange and absorption properties that can be utilized in the removal of:

- Ammonia from wastewater/stormwater
- Heavy Metals from industrial process, waste and stormwaters
- Effective in the adsorption of aluminum, antimony, arsenic, barium, cadmium, chromium, colbalt, copper, iron, lead, magnesium, manganese, mercury and nickel
- Enhanced oxidation of sulfides
- Enhanced oxidation of heavy metals
- Enhanced oxidation of pyrites producing sulfuric acid and Fe^{3+}
- Fe^{3+} becomes available for phosphorus immobilization

GRASS AND LEAF DECOMPOSITION AND NUTRIENT RELEASE STUDY UNDER WET CONDITIONS, Strynchuk, Royal and England, 1999. Reported "the majority of organic based pollutants, which leach from grass clippings and leaves into water will be released within 1 to 22 days…BOD peaked at 9 days…most of the phosphorus was released in the first day…".

Treatment Done after 15 days of Incubation



Zhang et al, Water Science & Tech., 50, 173 (2004

Vault-Ox® infusion module.
Vault-Ox® can be inexpensively retro-fitted into any storm water structure or retention pond

ESI
EcoSense International

Retention Pond before treatment

Retention Pond – 6 Weeks Later
2lb/acre.ft CaO_2 + Enzymes

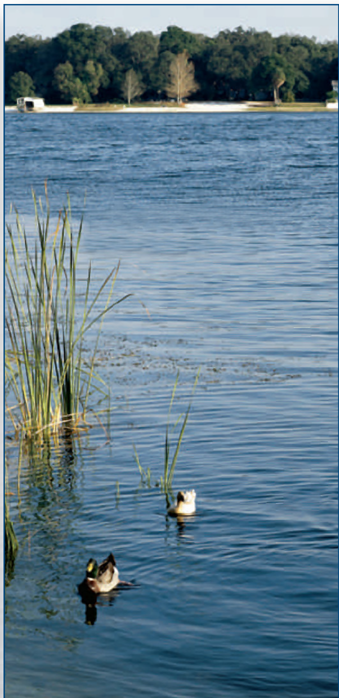
A.3: Contech CDS Unit

UrbanGreen™ Hydrodynamic Separation

Pretreatment for Green Stormwater Solutions

Before CDS®

After CDS®



HDS Benefits

- Cost effective method of gross pollutant removal
- Pretreatment reduces size and increases longevity of land based BMPs
- Variety of sizes to meet range of applications and flows
- Easy, low-cost maintenance

HDS Applications

- Pre-treatment for rainwater harvesting/stormwater reuse
- Pre-treatment for infiltration and bioretention
- Urban retrofit/redevelopment
- Sediment and trash protection for ponds/lakes
- Pump protection

CDS Features

- Captures and retains 100% of floatables and neutrally buoyant debris 2.4 mm or larger
- Proven removal of solids, oil and grease
- Patented indirect screening capability keeps screen from clogging
- Retention of all captured pollutants, even at high flows
- Easy access to remove captured pollutants
- Performance verified by NJCAT and WA Ecology
- Flexible design
  - Allows for multiple inlet pipes
  - In-line, grate, and curb inlet configurations
  - Easily installed in existing storm drain



CONTECH®
ENGINEERED SOLUTIONS

Hydrodynamic Separation

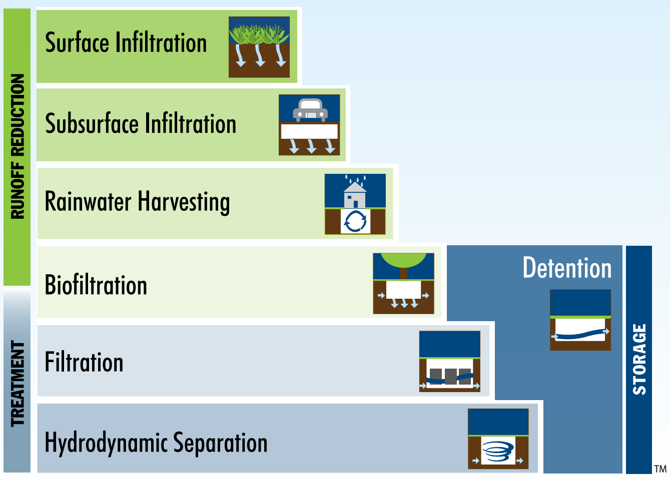
Solutions Guide

URBANGREEN®

Hydrodynamic Separation

Selecting the right stormwater solution just got easier...

It's simple to choose the right low impact development (LID) solution to achieve your runoff reduction goals with the Contech UrbanGreen Staircase. First, select the runoff reduction practices that are most appropriate for your site, paying particular attention to pretreatment needs. If the entire design storm cannot be retained, select a treatment best management practice (BMP) for the balance. Finally, select a detention system to address any outstanding downstream erosion.



Removing Pollutants with Hydrodynamic Separation

Hydrodynamic separators are some of the first technologies to be developed for treating stormwater. Our hydrodynamic separation (HDS) products have been providing reliable stormwater treatment solutions for more than 20 years. With performance proven in the lab and in the field at sites across the country, these systems are widely accepted for effective solids removal. They are an optimal choice for pretreatment systems, especially efficient on gross solids, trash and debris, while also removing total suspended solids (TSS).

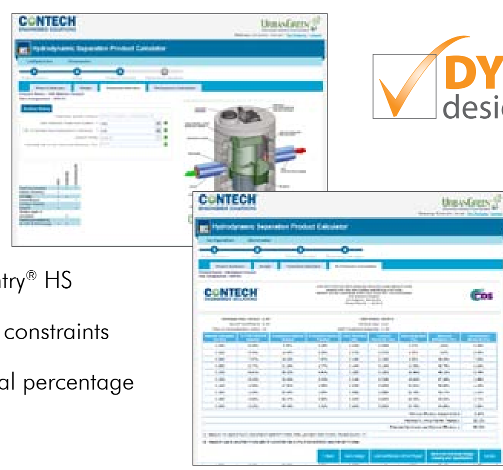
Fundamentals of HDS

- Create a low velocity vortex action to:
  - Increase efficiency by increasing length of flow path and eliminating short circuiting
  - Concentrate solids in stable, low velocity flow field
- Incorporate flow controls to:
  - Minimize turbulence and velocity
  - Prevent flow surges and resuspension
  - Retain floating pollutants. Provide easy access to captured pollutants to make maintenance easy

Learn more about hydrodynamic separation at www.ContechES/stormwater

DYOHDS™ Tool

Design Your Own Hydrodynamic Separator



DYO Project design made easy.

Features

- Choose from three HDS technologies - CDS®, Vortechs® & VortSentry® HS
- Site specific questions ensure the selected unit will comply with site constraints
- Unit size based on selected mean particle size and targeted removal percentage
- Localized rainfall data allows for region specific designs
- PDF report includes detailed performance calculations, specification and standard drawing for the unit that was sized

Design Your Own (DYO) Hydrodynamic Separator online at www.ContechES.com/dyohds

Applications

HDS products work well as standalone or end-of-pipe treatment systems and can easily be implemented in a retrofit scenario. They are particularly effective at removal of solids, trash and debris – and can help you meet TMDL requirements for these pollutants. HDS systems are also optimal pretreatment systems – and an important building block in a low impact development (LID) design. By removing solids, trash and debris prior to detention, infiltration or re-use systems, you can significantly increase their service life.

Water Quality

HDS products provide high-performance stormwater pollutant removal. These systems are effective in removing solids to meet water quality goals and can be designed to achieve site treatment goals for TSS or oil.

Pretreatment for Low Impact Development (LID) Designs

Hydrodynamic separation systems installed as pretreatment reduce downstream loading to reduce maintenance

Inlet and Outlet Pollution Control

Our HDS products are especially effective for solids and trash and debris. They can be installed at either the inlet or outlet of a drainage system to prevent pollutants from being discharged into lakes, streams or the ocean.

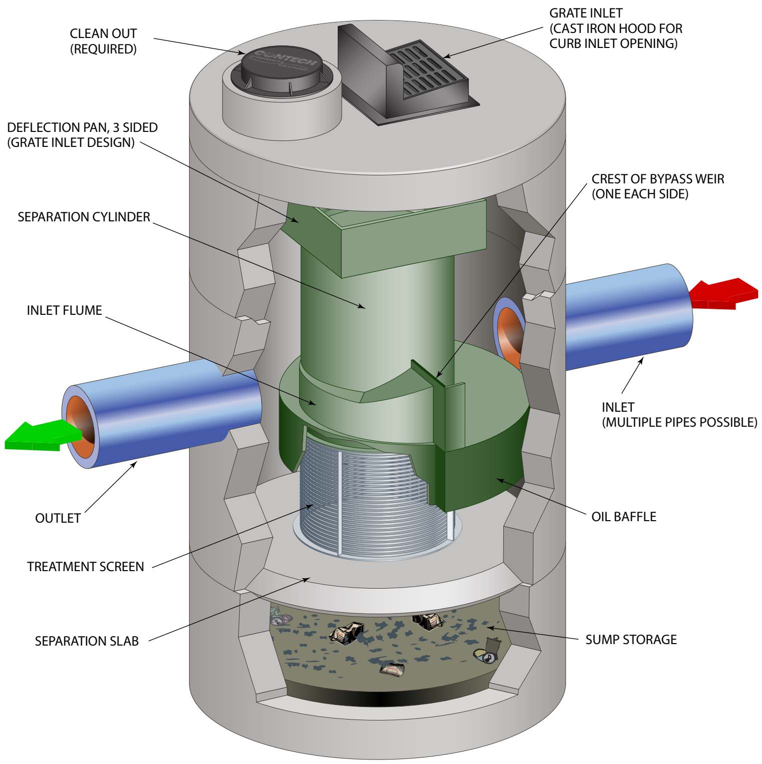
VortSentry HS is an effective option where space is limited

A Vortechs protects detention system from sediment build-up and reduces maintenance

CDS unit installed to remove trash before entering Lake Meritt in Oakland, CA

CDS®

The CDS is a swirl concentrator hybrid technology that provides continuous deflective separation – a combination of swirl concentration and patented indirect screening – into a uniquely capable product. It effectively screens, separates and traps debris, sediment and oil from stormwater runoff and is an ideal system to meet trash Total Maximum Daily Load (TMDL) requirements.



Features & Benefits

One-of-a-Kind Screening Technology

- Captures and retains 100% of floatables and neutrally buoyant debris 2.4mm or larger
- Effectively removes solids down to 100μm
- Self-cleaning screen – the only non-blocking screening technology available
- Water velocities within the swirl chamber continually shear debris off the screen to keep it clean
- Various screening apertures available

Proven Performance

- Performance verified by NJ CAT and WA Ecology

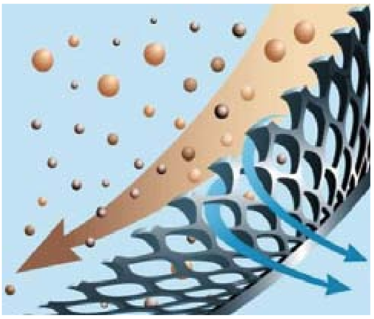
Excellent Pollutant Retention

- Isolated Storage Sump eliminates scour potential
- Oil Baffle improves hydrocarbon removal

Multiple Options to Meet Site-Specific Needs

- Inline, offline, grate inlet and drop inlet configuration
- Accepts multiple pipe inlets and 90-180° angles – eliminate the need for junction manholes
- Internal and external peak bypass options available

CDS removes fine sediments and trash debris



Continuous deflective separation — water velocities within the swirl chamber continually shear debris off the screen to keep it clean

Maintenance

All stormwater treatment systems – whether natural or manufactured –should be maintained regularly. Despite the widespread implementation of BMPs, water quality goals will not be met if the treatment structures are not properly cleaned and maintained.

Systems vary in their maintenance needs, and the selection of a cost-effective and easy-to-access treatment system can mean a huge difference in maintenance expenses for years to come.

We design our products to minimize maintenance and make it as easy and inexpensive as possible to keep our systems working properly.

A vacuum truck excavates pollutants from the systems

Inspection

Inspection is the key to effective maintenance. Pollutant deposition and transport may vary from year to year and site to site. Semi-annual inspections will help ensure that the system is cleaned out at the appropriate time. Inspections should be performed more frequently where site conditions may cause rapid accumulation of pollutants.

Vortechs, VortSentry and VortSentry HS

These systems should be cleaned out when sediment has accumulated to a specific depth (refer to the respective maintenance guidelines for details). Maintaining these systems is easiest when there is no flow entering the system. A vacuum truck is generally the most effective and convenient method of excavating pollutants from the systems.

A CDS unit can be easily cleaned out in less than 30 minutes

CDS

The recommended cleanout of solids within the CDS unit's sump should occur at 75% of the sump capacity. Access to the CDS unit is typically achieved through two manhole access covers – one allows inspection and cleanout of the separation chamber and sump, and another allows inspection and cleanout of sediment captured and retained behind the screen. A vacuum truck is recommended for cleanout of the CDS unit and can be easily accomplished in less than 30 minutes for most installations.

Find maintenance information for all our products at www.ContechES.com/maintenance ❖ ❖ ❖

Next Steps

Learn more

See our HDS systems in action. Flash animations available at **www.ContechES.com/videos**

Connect with us

We're always available to make your job easier. Contact your local project consultant for design assistance. Search online at **www.ContechES.com**. While you're there, be sure to check out our upcoming seminar schedule or request an in-house technical presentation.

Start a Project

If you are ready to begin a project, visit us at **www.ContechES.com/designtoolbox**

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, retaining walls, sanitary sewer, stormwater, erosion control and soil stabilization products.

For more information, visit our web site: www.ContechES.com or call 800.338.1122

The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266 related foreign patents or other patents pending.

The Stormwater Management StormFilter, MFS and CDS are trademarks, registered trademarks, or licensed trademarks of Contech Engineered Solutions LLC.

CONTECH® ENGINEERED SOLUTIONS

Get Social With Us!

We print our brochures entirely on Forest Stewardship Council certified paper. FSC certification ensures that the paper in our brochures contain fiber from well-managed and responsibly harvested forests that meet strict environmental and socioeconomic standards.

FSC

UGHDS Brochure 2/14 PDF Revision

A.4: Suntree Nutrient Separating Baffle Box


Nutrient Separating
Baffle Box
Fits Within Existing Easements
Hydrocarbon Removal
Almost No Head Loss
Always Treats Entire Flow
Retrofits Existing Systems
Easy & Quick To Install
Meets NPDES Phase 2
The 2nd Generation Baffle Box
Up To
90% Removal
Of Total Suspended Solids
at less than half the
cost of competing
systems.
Patented
Suntree
Technologies Inc.
798 Clearlake Road
Cocoa, FL 32922
Ph: 321-637-7552
www.suntreetech.com

Nutrient Separating Baffle Box

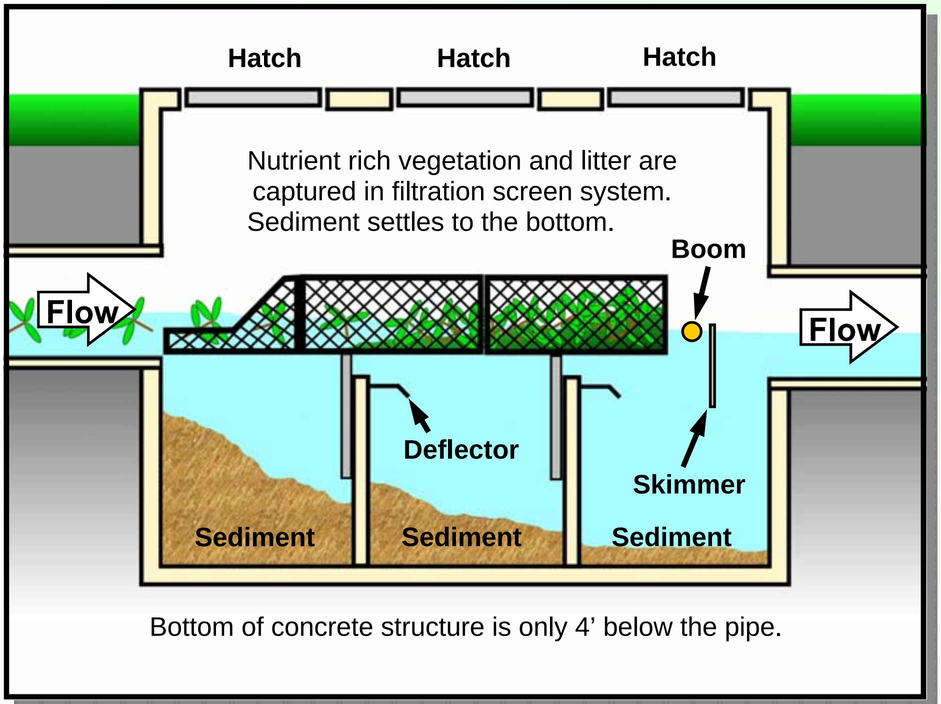
Functional Description

During The Storm Event

Captures foliage, litter, sediment, phosphates, hydrocarbons… Everything!

Turbulence deflectors prevent captured sediment from re-suspending.

Hydrocarbons collect in front of skimmer and are absorbed by Storm Boom.



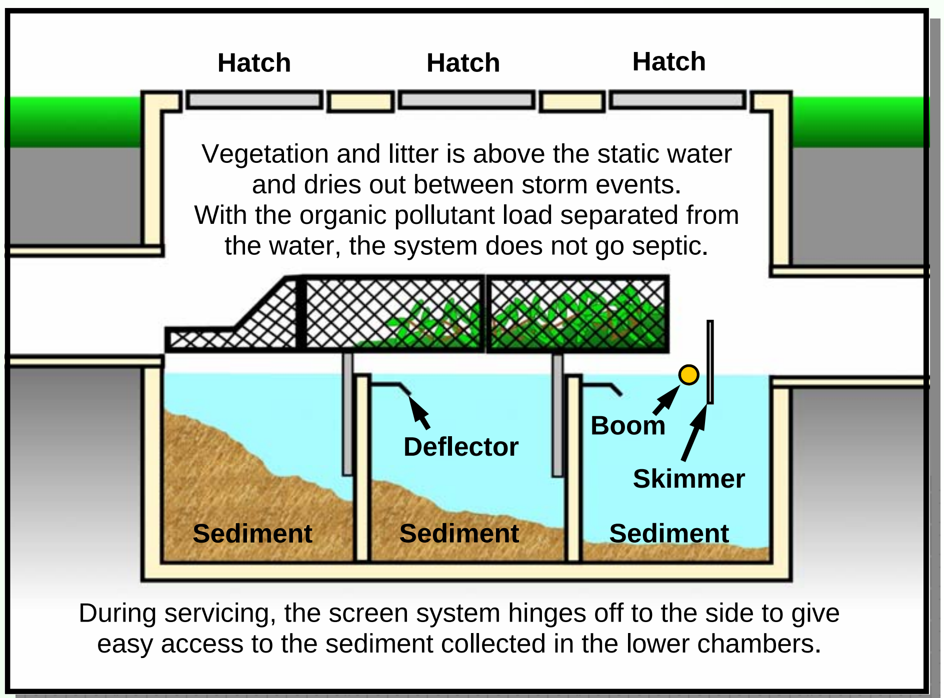
Patented

After The Storm Event

The System Stays Healthy!

Nutrient pollutant load is not lost to static water and flushed out at the next storm event.

Separating organic matter from the static water prevents bacterial buildup.



No Chance For A Bacterial Discharge!

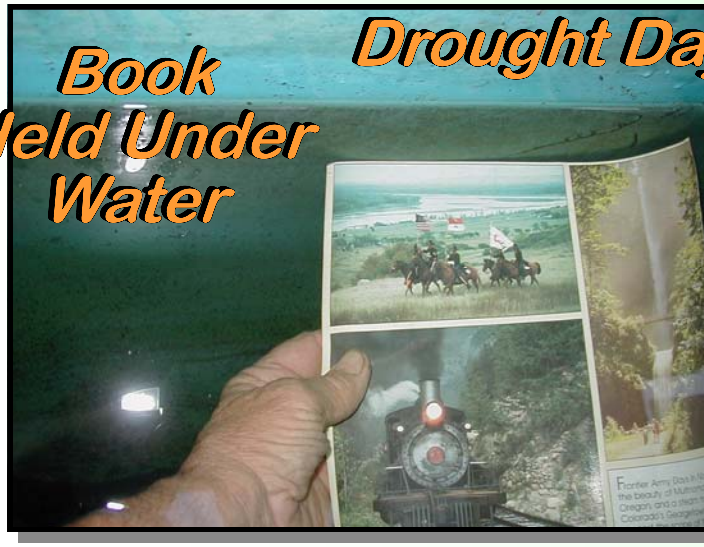
Nutrient Separating Baffle Box

Captured Debris

Not All Stormwater Systems Are Created Equal

To the right is a photo of the back page of a road atlas being held 10” underwater in a *Nutrient Separating Baffle Box.*

After a couple of months with no rain, the water still has no smell and is clear. The sediment can be clearly seen on the bottom, and small fish and critters have established a happy and healthy ecosystem within the structure.



If you are reluctant to touch the water in your stormwater filtration system because it is septic, then you have a problem because the next storm event will flush out your system into the environment.

To the left is a view of 5790 pounds of sediment collected in a Nutrient *Separating Baffle Box* just 30 days after installation.

To the right is a view of foliage and litter collected within the screen system of a *Nutrient Separating Baffle Box*.

Sizing The Nutrient Separating Baffle Box

Because the entire flow is always treated and head loss is so minimal, determining the appropriate size of *Nutrient Separating Baffle Box* for a project is more often an element of pipe size than flow rate.

Model #	Inside Width	Inside Length	Standard Height *	Recommended Pipe Sizes
NSBB-2-4	2’	4’	5’	4” to 12”
NSBB-3-6	3’	6’	7’	8” to 18”
NSBB-4-8	4’	8’	7’	12” to 18”
NSBB-5-10	5’	10’	7’	12” to 30”
NSBB-6-12	6’	12’	7’	18” to 36”
NSBB-8-14	8’	14’	8’ 4”	36” to 54”
NSBB-10-14	10’	14’	8’ 4”	42” to 60”
NSBB-10-16	10’	16’	10’ 5”	48” to 72”
NSBB-12-20	12’	20’	11’	54” to 72”

Custom sizes are available. ***Height can vary as needed**

Please Call Suntree For Assistance Or Advice

- **Because water flow is not ducted off line for treatment, head loss is minimal and comparable to a large square catchbasin. Because of this, existing stormwater systems can be retrofitted with a Nutrient Separating Baffle Box, without compromising the original design specifications of the existing stormwater system.**

- **All structures are load rated for at least H-20. Standard wall construction of the structure is 6” thick steel re-enforced concrete. Concrete wall thickness can be more heavily reinforced and thicker upon request.**

- **A wide variety of manhole lids and hatches, and dampers to block off water flow during servicing, can be incorporated into the structure.**

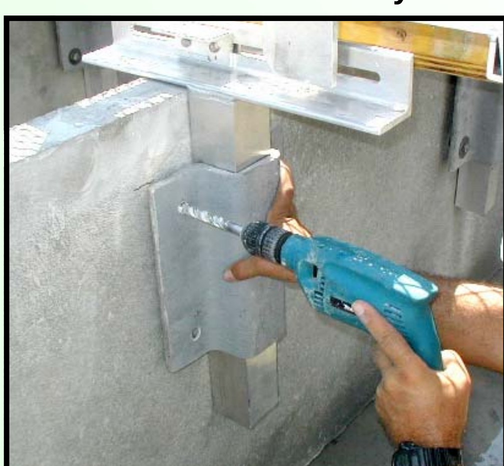
- **Screen systems have stainless steel screens bolted into a heavy duty aluminum framework. The screen systems are hinged to give easy access to the lower chambers, and have a wide range of adjustments to accommodate unforeseen variables during installation.**

Pre-assembly Of The Nutrient Separating Baffle Box

The internal components are installed prior to delivery to the job site.

Turbulence deflectors are attached to the tops of the baffles with stainless steel bolts. Several bolts per deflector are required.

Four brackets, held in place with 4 stainless steel bolts each, secure the screen system to the baffles. The screen system includes a wide range of positional adjustment.



Suntree Technologies Inc.

Setting The Structure

Installation Of A Nutrient Separating Baffle Box In Perry Florida

As Easy to Install As A Large Square Catchbasin

The hole was dug starting at 10:00am. By 3:00pm the same day, the entire structure was set in place with most of the backfilling done.

Step 1: Set lower half

Step 2: Hook up pipes

Step 3: Put sealant on joint

Step 4: Set upper half

Less Expensive To Install Than Other Systems

Because installation is so fast, the risk of washouts when retrofitting existing stormwater systems is dramatically reduced.

Ready to position inflow pipe and seal pipes with grout

No Problem For Custom Configurations

Notice the custom pipe fitting on the inflow end. It is designed to accommodate two 18” RCP side by side. To block off the water flow of submerged or partially submerged pipes during servicing, internal damper systems are available.

A Suntree representative is always available to oversee installation to ensure a successful project.

Suntree Technologies Inc.
798 Clearlake Road, Cocoa, FL 32922
Ph: 321-637-7552 FAX: 321-637-7554
www.suntreetech.com

A.5:   Suntree High-Capacity Curb Inlet Basket

Lifts Out Through Manhole

Suntree Technologies Inc.

798 Clearlake Road, Cocoa, FL 32922
Ph: 321-637-7552 FAX: 321-637-7554
www.suntreetech.com

5 Year Warranty

Curb Inlet Basket

High Capacity

Patented

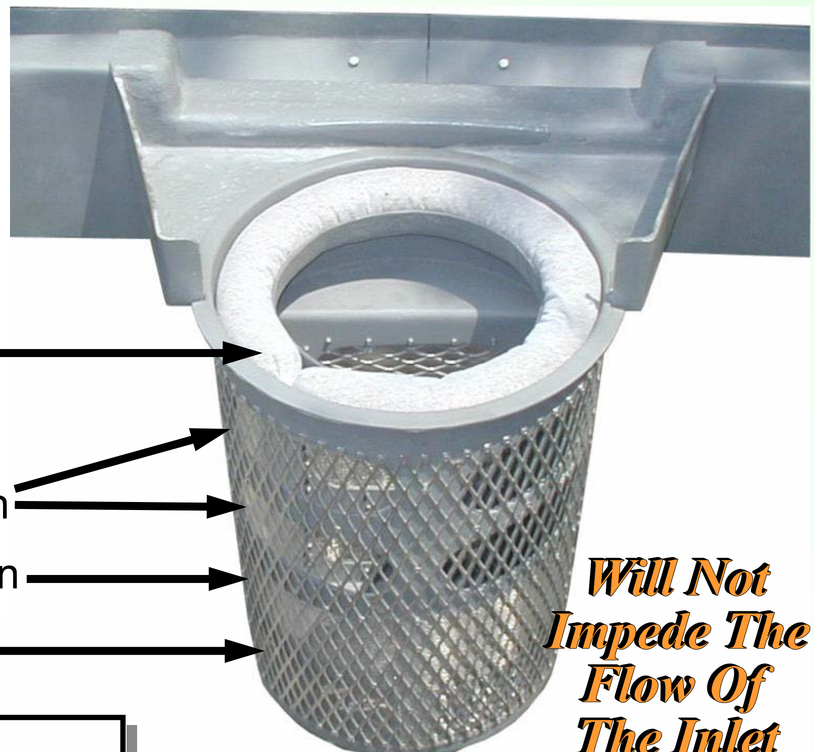
Multi-Stage Filtration

Screens of Different Sieve Sizes Optimize Filtration And Water Flow

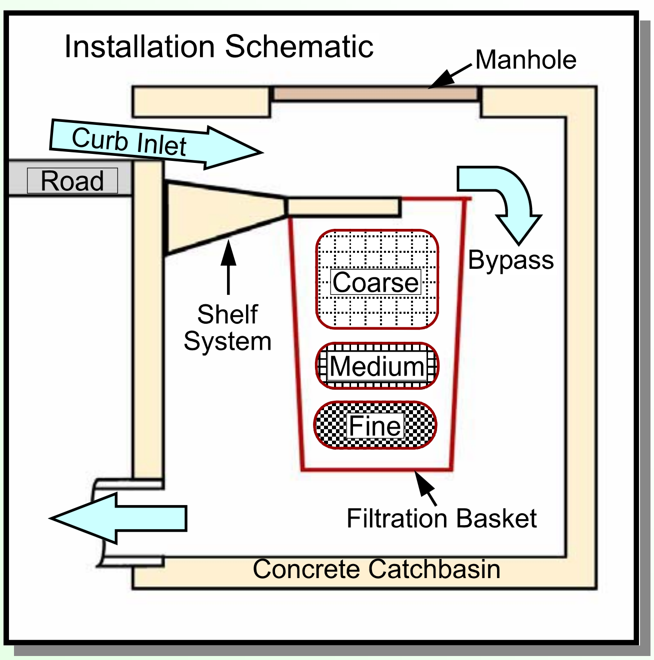
- Storm Boom

Stainless Steel Screens

- Coarse Sieve Size Screen
- Medium Sieve Size Screen
- Fine Sieve Size Screen
(Fine sieve size screen also on bottom)



Will Not Impede The Flow Of The Inlet



For use in inlets where the only access is through a manhole.

A shelf system directs water flow into the filtration basket and positions the basket directly under the manhole for easy access. If necessary, the water flow can bypass the entire filtration system simply by flowing past the filter and into the catchbasin.

The Strength of Fiberglass And Stainless Steel Combine To Capture Hundreds Of Pounds Of Debris

Lakeland, Florida

High Capacity Curb Inlet Basket

South Side of Hibriten Way & Lake Hollingsworth DR
November 5, 2002

Above: View of the curb inlet showing that the only access is through a manhole.

Right: View of full ***High Capacity Curb Inlet Basket*** immediately after the manhole lid was removed.

A total of **200.5 pounds** of debris was removed having a volume of **123 quarts**. The foliage weighed **140.4 pounds** and the sediment weighed **56.2 pounds**. A large quantity of palm nuts was captured by this unit.

Left: The ***Curb Inlet Basket*** has been removed and can be easily emptied by hand without the need of a vacuum truck.

Captures Sediment, Foliage, Phosphates, Litter, Hydrocarbons...Everything! Then Drains Dry!

APPENDIX B

SELECTED CONSTRUCTION DRAWINGS FOR THE EVALUATED GPS UNITS

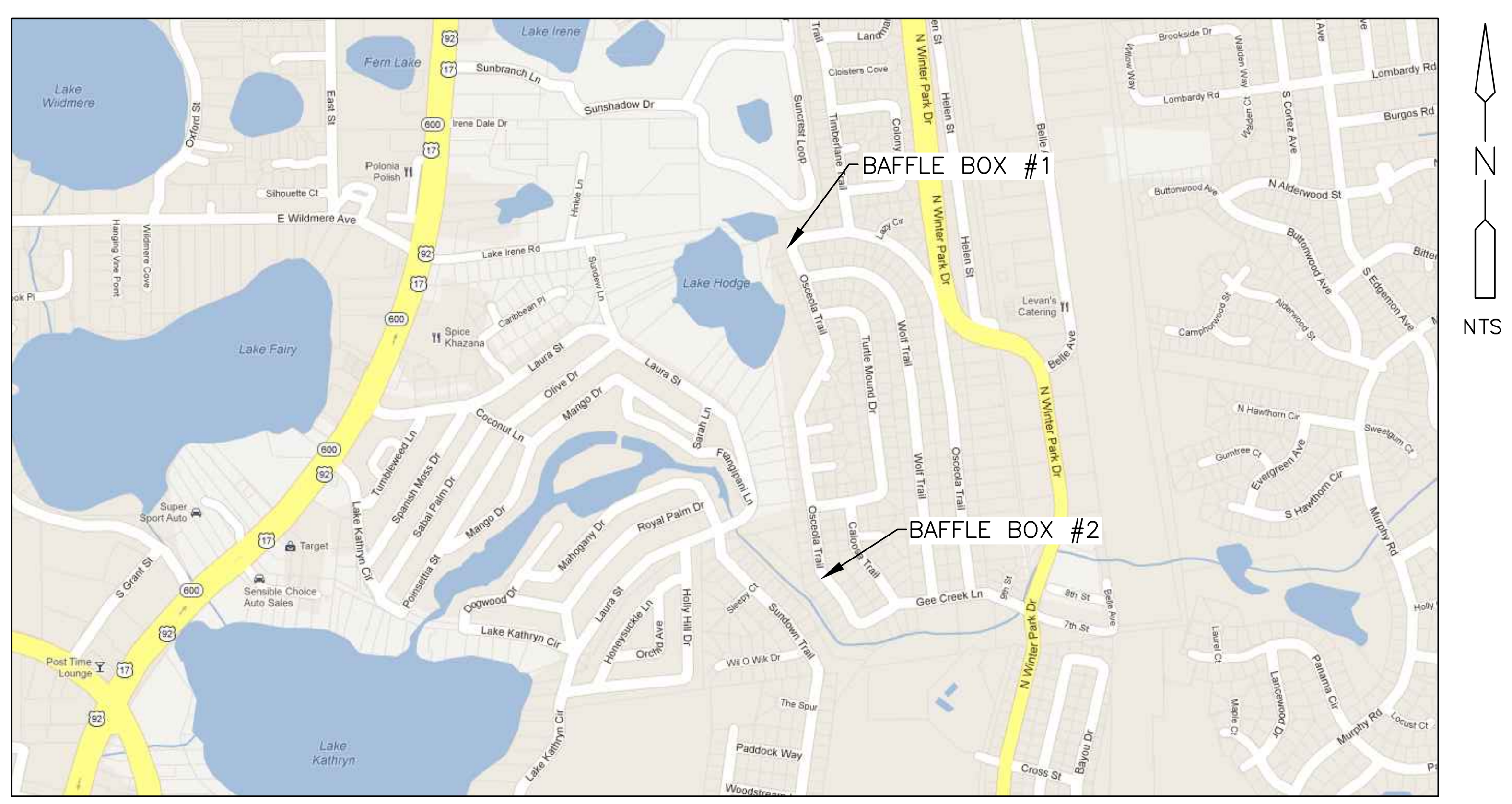
B.1: Osceola Trail Sites
B.2: Howell Creek Sites
B.3: San Pablo CDS
B.4: Lake Concord Baffle Box

B.1: Osceola Trail Sites

CITY OF CASSELBERRY
PUBLIC WORKS DEPARTMENT

OSCEOLA TRAIL
(LAKE HODGE & GEE CREEK)
BAFFLE BOXES

PROJECT NO. PW 1101-B



PROJECT SITE LOCATION

MAYOR/CITY COMMISSIONER
CHARLENE GLANCY

VICE MAYOR/CITY COMMISSIONER
JON MILLER

CITY COMMISSIONER
SUSAN DOERNER

CITY COMMISSIONER
SANDRA SOLOMON

CITY COMMISSIONER
COLLEEN HUFFORD

CITY MANAGER
BARBARA LIPSCOMB

PREPARED FOR :
PUBLIC WORKS
PUBLIC WORKS DIRECTOR, MARK D. GISCLAR, MPA
ASST. PUBLIC WORKS DIRECTOR/CITY ENGINEER, KELLY HANS BROCK, PH.D., P.E., CFM

CAMP DRESSER & McKEE INC.
2301 MAITLAND CENTER PARKWAY, SUITE 300
MAITLAND, FLORIDA 32751
407 660-2552, Fax: 407 875-1161
CERT. OF AUTHORIZATION NO. 20

CDM PROJECT NO. 61762-79557

INDEX OF PLANS

AS-BUILT SURVEY

ASBUILT COMPLETED BY:

COVER SHEET	Drawn by: RT	LAYOUT SERVICES, INC. LAND SURVEYING & MAPPING 3380 S PARK AVE STE 7 TITUSVILLE, FL. 32780 (321) 759-2779 (321) 264-9748 (FAX)
Certified to: CITY OF CASSELBERRY	Checked by: JZ Scale: N/A Date: 4/5/12 Project # 11-169 FB	
I hereby certify that the survey shown hereon is true and correct to the best of my knowledge and belief, based on actual measurements taken in the field. This survey meets the Minimum Technical Standards as set forth by the Florida Board of Professional Land Surveyors in Chapter 5J-17, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes. UNLESS IT BEARS THE SIGNATURE AND ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER THIS DRAWING SKETCH, PLAT OR MAP IS FOR INFORMATIONAL PURPOSES ONLY AND IS NOT VALID. James Zimmerman Professional Land Surveyor No. 6545 State of Florida	DATE	REVISIONS

GENERAL NOTES

1. ALL ELEVATIONS ARE REFERRED TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
2. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN ACCORDING TO THE BEST INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE PLANS, BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL VERIFY AND AGREE TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES AFFECTING HIS WORK.
3. CONTRACTOR SHALL VERIFY ALL UTILITIES AND NOTIFY THE CITY OF CASSELBERRY PUBLIC WORKS DEPARTMENT, 3 WORKING DAYS PRIOR TO DIGGING IN ANY PORTION OF THE SITE.
4. PUBLIC LAND CORNERS OR COUNTY MONUMENTS WITHIN THE LIMITS OF CONSTRUCTION ARE TO BE PROTECTED. IF A CORNER MONUMENT IS IN DANGER OF BEING DESTROYED OR DISTURBED AND HAS NOT BEEN PROPERLY REFERENCED, THE CONTRACTOR SHALL NOTIFY THE CITY OF CASSELBERRY PUBLIC WORKS ENGINEERING WITHOUT DELAY, BY TELEPHONE. CONTACT MR. KELLY BROCK, ASST. PUBLIC WORKS DIRECTOR/CITY ENGINEER, 95 TRIPLET LAKE DRIVE, CASSELBERRY, FL, 32707, Phone: (407) 262-7725 x1235
5. ALL SURVEY CORNERS INDICATED ON THE PLANS SHALL BE REFERENCED AND CERTIFIED BY A REGISTERED PROFESSIONAL LAND SURVEYOR PRIOR TO COMMENCEMENT OF CONSTRUCTION. ALL CORNERS DESTROYED OR OBLITERATED BY CONSTRUCTION SHALL BE RESET AND SO CERTIFIED BY THE LAND SURVEYOR PRIOR TO THE COMPLETION OF THE PROJECT. CERTIFIED SKETCHES SHALL BE SUBMITTED TO:
   CITY OF CASSELBERRY ENGINEERING DIVISION
   KELLY BROCK
   95 TRIPLET LAKE DRIVE
   CASSELBERRY, FL
   (407) 262-7725
6. TOPOGRAPHIC SURVEY WAS PERFORMED BY: SOUTHEASTERN SURVEYING AND MAPPING CORP. 6500 ALL AMERICAN BOULEVARD, ORLANDO, FLORIDA 32810-4350 PHONE: 407-647-8898
7. THE CONTRACTOR SHALL CONTACT THE ENGINEER'S OFFICE IMMEDIATELY UPON FINDING ANY CONFLICTS DURING CONSTRUCTION ON ANY IMPROVEMENTS SHOWN ON THE DRAWINGS.
8. EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE IN PLACE PRIOR TO BEGINNING ANY DEMOLITION OR CONSTRUCTION. THEY SHALL BE INSTALLED TO THE LIMITS SHOWN IN THE DRAWINGS, AS REQUIRED IN THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS (SEE EROSION CONTROL NOTES).
9. ALL STATIONING AND OFFSET REFERS TO CONSTRUCTION BASELINE AND CENTERLINE OF STRUCTURE UNLESS OTHERWISE NOTED ON PLANS.
10. EXISTING UTILITIES AND FACILITIES SHOWN ON THE DRAWINGS WERE LOCATED FROM THE UTILITY OWNER'S RECORDS OF UNDERGROUND FACILITIES. GUARANTEE IS NOT MADE THAT ALL EXISTING FACILITIES ARE SHOWN NOR THAT THOSE FACILITIES SHOWN ARE ENTIRELY ACCURATE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE COORDINATION OF EXISTING UTILITIES.
11. THE CONTRACTOR SHALL, BY REPAIR OR REPLACEMENT, RETURN TO EQUAL OR BETTER CONDITION ALL PAVEMENT, SIDEWALK, LAWNS, UTILITIES AND OTHER ITEMS DAMAGED BY THIS CONSTRUCTION ACTIVITY.
12. DURING CONSTRUCTION THE CONTRACTOR IS RESPONSIBLE FOR REMOVAL, PROTECTION, AND REPLACEMENT OF ITEMS ON PRIVATE PROPERTY AND PUBLIC RIGHTS OF WAY SUCH AS SPRINKLERS, FENCES, SOD, SHRUBS, TREES, SURVEYING MARKERS, ETC.
13. PRIOR TO EXCAVATING IN THE VICINITY OF A GAS LINE, THE CONTRACTOR SHALL NOTIFY THE GAS UTILITY OWNER IN ACCORDANCE WITH THE REQUIREMENTS OF FLORIDA STATUTES, PROTECTION OF UNDERGROUND PIPELINES F.S. 553.851, CH 17-143.
14. GOVERNING STANDARDS AND SPECIFICATIONS: FLORIDA DEPARTMENT OF TRANSPORTATION DESIGN STANDARDS (LATEST EDITION), STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION (LATEST EDITION) AS AMENDED BY THE CONTRACT DOCUMENTS, CITY OF CASSELBERRY'S UTILITIES STANDARDS AND SPECIFICATIONS MANUAL (LATEST EDITION), CITY OF CASSELBERRY UNIFIED LAND DEVELOPMENT REGULATIONS AND CODE OF ORDINANCES.
15. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL UTILITIES THAT MAY EXIST, ABOVE OR BELOW GROUND.
16. ALL BRUSH, STRIPPINGS OR UNSUITABLE MATERIAL SHALL BE DISPOSED OF OFF-SITE AT THE CONTRACTOR'S EXPENSE.
17. A DE-WATERING PERMIT MAY BE REQUIRED BY THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT PRIOR TO ANY PUMPING, ETC. AND SHALL BE OBTAINED BY THE CONTRACTOR.
18. MEASURES SHALL BE TAKEN BY THE CONTRACTOR TO ENSURE THAT ADEQUATE EROSION AND SEDIMENT CONTROL ARE MAINTAINED AT ALL TIMES DURING THE PROJECT (SEE EROSION CONTROL NOTES).
19. ALL PRIVATE AND PUBLIC PROPERTY AFFECTED BY THIS WORK SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN THE CONDITION EXISTING PRIOR TO COMMENCING CONSTRUCTION UNLESS SPECIFICALLY EXEMPTED BY THE PLANS. COSTS TO BE INCIDENTAL TO OTHER CONSTRUCTION AND NO EXTRA COMPENSATION TO BE ALLOWED.
20. INSTALLATION OF ALL STORM SEWERS, INLETS, MANHOLES, AND APPURTENANCES SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE APPLICABLE SECTIONS OF THE FLORIDA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS, OR AS INDICATED ON THE DRAWINGS.
21. THE LIMITS OF CONSTRUCTION SHOWN ON THE PLANS SHALL BE STRICTLY OBSERVED BY THE CONTRACTOR. ALL INGRESS, EGRESS AND TRAFFIC PATTERNS ON THE SITE SHALL BE WITHIN THE LIMITS OF CONSTRUCTION SHOWN ON THE DRAWINGS.
22. NO REPRESENTATION IS MADE REGARDING BALANCED EARTHWORK. ANY EXCESS MATERIAL, OR MATERIAL NOT SUITABLE FOR USE AS BACKFILL SHALL BE DISPOSED OF BY THE CONTRACTOR AT AN OFF-SITE LOCATION APPROVED TO ACCEPT SUCH MATERIAL.
23. SOILS CLASSIFIED AS A-8 (ORGANIC MUCK TO SANDY PEAT) MAY BE USED AS TOP SOIL, UPON ENGINEER'S APPROVAL, IN LIEU OF STOCKPILING OR OFF-SITE DISPOSAL. A-8 MATERIAL UTILIZED AS TOPSOIL SHALL NOT EXCEED 6" IN DEPTH.
24. IN AREAS REQUIRING FILL MATERIAL, THE CONTRACTOR WILL STRIP OR OTHERWISE REMOVE ALL VEGETATION SUCH AS BRUSH, HEAVY SODS, HEAVY GROWTH OF GRASS, DECAYED VEGETABLE MATTER, RUBBISH AND ANY OTHER DELETERIOUS MATERIAL BEFORE FILLING IS STARTED. IMMEDIATELY PRIOR TO THE PLACING OF FILL MATERIALS, THE ENTIRE AREA UPON WHICH FILL IS TO BE PLACED, SHALL BE SCARIFIED.
25. ALL REINFORCED CONCRETE PIPE (RCP) SHALL BE MINIMUM CLASS III.
26. WATER AND SEWER CROSSING(S):

    WHERE WATER MAINS MUST PASS OVER STORM, SANITARY AND/OR EFFLUENT REUSE LINES AND A MINIMUM CLEARANCE OF 18" CANNOT BE MAINTAINED, THE WATER MAIN SHALL BE CONSTRUCTED OF MECHANICAL JOINT DUCTILE IRON PIPE 10' EQUIDISTANT EACH SIDE OF THE CROSSING AND PROVIDE A 6" MINIMUM CLEARANCE BETWEEN THE WATER MAIN AND THE OTHER UTILITY.
27. ABSOLUTELY NO WORK WILL BE ALLOWED WITHIN ANY CONSERVATION AREA, BUFFER AREA, MITIGATION AREA, OR DESIGNATED WETLAND AREA UNLESS SO SPECIFICALLY DESCRIBED BY THE PLANS AND GRANTED BY REASON OF PERMIT FROM THE GOVERNMENTAL ENTITY HAVING JURISDICTION OVER SAID AREA.

EROSION CONTROL

IT IS THE CONTRACTORS RESPONSIBILITY TO IMPLEMENT THE EROSION AND TURBIDITY CONTROLS AS SHOWN ON THE PLAN SHEET C-3. IT IS ALSO THE CONTRACTORS RESPONSIBILITY TO ENSURE THESE CONTROLS ARE PROPERLY INSTALLED, MAINTAINED AND FUNCTIONING PROPERLY TO PREVENT TURBID OR POLLUTED WATER FROM LEAVING THE PROJECT SITE. THE CONTRACTOR WILL ADJUST THE EROSION AND TURBIDITY CONTROLS SHOWN ON C-3 AND ADD ADDITIONAL CONTROL MEASURES, AS REQUIRED TO ENSURE THE SITE MEETS ALL FEDERAL, STATE AND LOCAL EROSION AND TURBIDITY CONTROL REQUIREMENTS. THE FOLLOWING BEST MANAGEMENT PRACTICES WILL BE IMPLEMENTED BY THE CONTRACTOR AS REQUIRED BY THE EROSION AND TURBIDITY CONTROL PLAN AND AS REQUIRED BY THE REGULATORY AGENCIES.

1. SEDIMENT BASINS, TRAPS, PERIMETER DITCHES, SEDIMENT BARRIERS, SILT FENCES, TURBIDITY BARRIERS, INLET PROTECTION AND OTHER MEASURES INTENDED TO TRAP SEDIMENT SHALL BE CONSTRUCTED AS A FIRST STEP BEFORE ANY LAND-DISTURBING TAKES PLACE TO MEET THE EROSION AND TURBIDITY REQUIREMENTS IMPOSED ON THE PROJECT.
2. ALL SEDIMENT CONTROL MEASURES ARE TO BE ADJUSTED TO MEET FIELD CONDITIONS AT THE TIME OF CONSTRUCTION AND BE CONSTRUCTED PRIOR TO ANY GRADING OR DISTURBANCE OF EXISTING SURFACE MATERIAL ON BALANCE OF SITE. PERIMETER SEDIMENT BARRIERS SHALL BE CONSTRUCTED TO PREVENT SEDIMENT OR TRASH FROM FLOWING OR FLOATING ON TO ADJACENT PROPERTIES.
3. DURING CONSTRUCTION OF THE PROJECT. SOIL STOCK PILES SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING MEASURES. THE CONTRACTOR IS RESPONSIBLE FOR THE TEMPORARY PROTECTIONS AND PERMANENT STABILIZATION OF ALL SOIL STOCKPILES ON SITE AS WELL AS SOIL INTENTIONALLY TRANSPORTED FROM THE PROJECT SITE.
4. AFTER ANY SIGNIFICANT RAINFALL SEDIMENT CONTROL STRUCTURES WILL BE INSPECTED FOR INTEGRITY. ANY DAMAGED DEVICES SHALL BE REPAIRED IMMEDIATELY.
5. CONCENTRATED RUNOFF SHALL NOT FLOW DOWN CUT OR FILL SLOPES UNLESS CONTAINED WITHIN AN ADEQUATE TEMPORARY OR PERMANENT CHANNEL, FLUME OR SLOPE DRAIN STRUCTURE.
6. WHENEVER WATER SEEPS FROM A SLOPE FACE ADEQUATE DRAINAGE OR OTHER PROTECTION SHALL BE PROVIDED.
7. SEDIMENT WILL BE PREVENTED FROM ENTERING ANY STORM DRAIN SYSTEM, DITCH, OR CHANNEL. ALL STORM SEWER INLETS THAT ARE MADE OPERABLE DURING CONSTRUCTION SHALL BE PROTECTED SO THAT SEDIMENT-LADEN WATER CANNOT ENTER THE CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR OTHERWISE TREATED TO REMOVE SEDIMENT.
8. BEFORE TEMPORARY OR NEWLY CONSTRUCTED STORMWATER CONVEYANCE CHANNELS ARE MADE OPERATIONAL ADEQUATE OUTLET PROTECTION AND ANY REQUIRED TEMPORARY OR PERMANENT CHANNEL LINING SHALL BE INSTALLED IN BOTH THE CONVEYANCE CHANNEL AND RECEIVING CHANNEL.
9. WHEN WORK IN A LIVE WATERCOURSE IS PERFORMED, PRECAUTIONS SHALL BE TAKEN TO MINIMIZE ENRICHMENT. CONTROL SEDIMENT TRANSPORT AND STABILIZE THE WORK AREA TO THE GREATEST EXTENT POSSIBLE DURING CONSTRUCTION. NON-ERODIBLE MATERIAL SHALL BE USED FOR THE CONSTRUCTION OF CAUSEWAYS AND COFFERDAMS. EARTHEN FILL MAY BE USED FOR THESE STRUCTURES IF ARMORED BY NON-ERODIBLE COVER MATERIALS.
10. STOCKPILING MATERIAL: NO EXCAVATED MATERIAL SHALL BE STOCKPILED IN SUCH A MANNER AS TO DIRECT RUNOFF DIRECTLY OFF THE PROJECT SITE INTO ANY ADJACENT WATER BODY OR STORM WATER COLLECTION FACILITY.
11. EXPOSED AREA LIMITATION: THE SURFACE AREA OF OPEN, RAW ERODIBLE SOIL EXPOSED BY CLEARING AND GRUBBING OPERATIONS OR EXCAVATION AND FILLING OPERATIONS SHALL EXCEED 1 ACRE. THE CONTRACTOR WILL BE RESPONSIBLE FOR PREPARING A STORMWATER POLLUTION PREVENTION PLAN (SWPPP) IN ACCORDANCE WITH FDEP NPDES REGULATIONS. THE CONTRACTOR WILL BE RESPONSIBLE FOR SUBMITTING A NOTICE ON INTENT (NOI) TO FDEP FORTY-EIGHT (48) HOURS PRIOR TO COMMENCING CONSTRUCTION.
12. TEMPORARY SEEDING: AREAS OPENED BY CONSTRUCTION OPERATIONS AND THAT ARE NOT ANTICIPATED TO BE RE-EXCAVATED OR DRESSED AND RECEIVE FINAL GRASSING TREATMENT WITHIN 30 DAYS SHALL BE SEEDED WITH A QUICK GROWING GRASS SPECIES WHICH WILL PROVIDE AN EARLY COVER DURING THE SEASON IN WHICH IT IS PLANTED AND WILL NOT LATER COMPETE WITH THE PERMANENT GRASSING.
13. TEMPORARY SEEDING AND MULCHING: SLOPES STEEPER THAN 6:1 THAT FALL WITHIN THE CATEGORY ESTABLISHED IN PARAGRAPH 12 ABOVE LOOSE MEASURE OF MULCH MATERIAL CUT INTO THE SOIL OF THE SEEDED AREA ADEQUATE TO PREVENT MOVEMENT OF SEED AND MULCH.
14. TEMPORARY GRASSING: THE SEEDED OR SEEDED AND MULCHED AREA(S) SHALL BE ROLLED AND WATERED OR HYDROMULCHED OR OTHER SUITABLE METHODS IF REQUIRED TO ASSURE OPTIMUM GROWING CONDITIONS FOR THE ESTABLISHMENT OF A GOOD GRASS COVER. TEMPORARY GRASSING SHALL BE THE SAME MIX & AMOUNT REQUIRED FOR PERMANENT GRASSING IN THE CONTRACT SPECIFICATIONS.
15. TEMPORARY REGRASSING : IF, AFTER 14 DAYS FROM SEEDING, THE TEMPORARY GRASSED AREAS HAVE NOT ATTAINED A MINIMUM OF 75 PERCENT GOOD GRASS COVER, THE AREA WILL BE REWORKED AND ADDITIONAL SEED APPLIED SUFFICIENT TO ESTABLISH THE DESIRED VEGETATIVE COVER.
16. MAINTENANCE: ALL FEATURES OF THE PROJECT DESIGNED AND CONSTRUCTED TO PREVENT EROSION AND SEDIMENT SHALL BE MAINTAINED DURING THE LIFE OF THE CONSTRUCTION SO AS TO FUNCTION AS THEY WERE ORIGINALLY DESIGNED AND CONSTRUCTED.
17. PERMANENT EROSION CONTROL: THE EROSION CONTROL FACILITIES OF THE PROJECT SHOULD BE DESIGNED TO MINIMIZE THE IMPACT ON THE OFF SITE FACILITIES.
18. PERMANENT SODDED: ALL AREAS WHICH HAVE BEEN DISTURBED BY CONSTRUCTION WILL BE SODDED.
19. ALL SLOPES 3:1 OR STEEPER NOT SODDED SHALL BE SEEDED AND MULCHED.
20. THE CONTRACTOR SHALL AT ALL TIMES PROVIDE FOR THE ADEQUATE CONVEYANCE OF STORMWATER VIA ALL EXISTING STORMWATER CONDUITS TO THEIR RESPECTIVE OUTFALLS. WORK ADJACENT TO OR REPLACING AN EXISTING STORMWATER SYSTEM MUST ALSO PROVIDE FOR ADEQUATE CONVEYANCE AT ALL TIMES DURING CONSTRUCTION. MEASURES TO PROVIDE THIS CONVEYANCE MAY INCLUDE DIVERSION SYSTEMS OR BYPASS PUMPING.

UTILITY OWNERS & CONTACTS

1. THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITY COMPANY FORTY-EIGHT (48) HOURS IN ADVANCE OF ANY EXCAVATION INVOLVING ITS UTILITIES SO THAT A COMPANY REPRESENTATIVE CAN BE PRESENT. THE LOCATION OF THE UTILITIES SHOWN IN THE PLANS ARE APPROXIMATE ONLY. THE EXACT LOCATION SHALL BE DETERMINED BY THE CONTRACTOR DURING CONSTRUCTION.

   UTILITY OWNERS:

   CITY OF CASSELBERRY PUBLIC WORKS
   DAVE LANKFORD
   407-262-7725 X1224

   BRIGHTHOUSE
   MARVIN USRY
   407-656-1162

   PROGRESS ENERGY
   800-700-8744

   CENTURYLINK
   DOUG WHITAKER
   407-830-3458

   AT&T
   PAM COTE
   407-539-0644
2. THE CONTRACTOR SHALL USE THE SERVICES OF SUNSHINE STATE-ONE CALL UTILITY LOCATOR A MINIMUM OF 48 HOURS PRIOR TO THE COMMENCEMENT OF WORK. (SUNSHINE STATE-ONE CALL 811.

MAINTENANCE OF TRAFFIC

1. ACCESS FOR LOCAL TRAFFIC WITH DESTINATIONS WITHIN THE PROJECT LIMITS SHALL BE MAINTAINED. IF DURING CONSTRUCTION ACCESS FOR LOCAL TRAFFIC IS CHANGED, THEN THE CONTRACTOR SHALL NOTIFY THE OWNER A MINIMUM OF THREE (3) WORKING DAYS IN ADVANCE. IF DURING CONSTRUCTION ROAD CLOSURES ARE REQUIRED, THEN THE CONTRACTOR SHALL NOTIFY THE CITY OF CANDLEBERRY A MINIMUM OF FIVE (5) WORKING DAYS IN ADVANCE.
2. PRIOR TO COMMENCING WORK, THE CONTRACTOR SHALL FURNISH, ERECT AND MAINTAIN ALL BARRICADES, WARNING SIGNS, AND MARKINGS FOR HAZARDS AND THE CONTROL OF TRAFFIC, IN REASONABLE CONFORMITY WITH THE U.S. DEPARTMENT OF TRANSPORTATION MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS (LATEST EDITION), STE, CITY OF CASSELBERRY, SUCH AS TO EFFECTIVELY PREVENT ACCIDENTS IN ALL PLACES WHERE THE WORK CAUSES OBSTRUCTION TO THE NORMAL TRAFFIC OR CONSTITUTES IN ANY WAY A HAZARD TO THE PUBLIC.
3. MAINTENANCE OF TRAFFIC PLANS (MOT), ARE REQUIRED TO BE SUBMITTED BY THE CONTRACTOR. THESE PLANS SHOULD BE SUBMITTED AND APPROVED BY THE CITY OF CASSELBERRY AT LEAST 14 DAYS PRIOR TO MOBILIZATION.

GEOTECHNICAL NOTES

GENERAL

CONTRACTOR SHALL REFER TO "GEOTECHNICAL ENGINEERING EVALUATION PROPOSED BAFFLE BOXES AT LAKE HODGE AND GEE CREEK OUTFALLS, CITY OF CASSELBERRY, FLORIDA" TECHNICAL MEMORANDUM DATED NOVEMBER, 2010, PREPARED BY CDM. THIS REPORT IS AVAILABLE FOR REVIEW BY THE CONTRACTOR.

DURING CONSTRUCTION, THE CONTRACTOR SHALL PROTECT AND PRESERVE ALL ADJACENT EXISTING FACILITIES AND STRUCTURES.

DEWATERING

THE CONTRACTOR SHALL ANTICIPATE THAT DEWATERING WILL BE REQUIRED TO FACILITATE CONSTRUCTION BELOW THE GROUNDWATER TABLE. DEWATERING BY SUMP PUMPING ALONE IS NOT ANTICIPATED TO BE ADEQUATE FOR PROPER PREPARATION/COMPACTION OF THE FOUNDATION CONSTRUCTION SOILS. ALL STRUCTURES AND PIPELINES SHALL BE CONSTRUCTED IN THE DRY. THE CONTRACTOR SHALL USE WELL POINTS, SUMPS, GRAVEL DRAINAGE BLANKET, SOCK DRAINS, OR A COMBINATION OF THESE METHODS TO DEWATER EXCAVATIONS BELOW THE GROUNDWATER TABLE.

THE DEWATERING SYSTEM(S) SHALL BE DESIGNED BY A REGISTERED PROFESSIONAL ENGINEER OF THE STATE OF FLORIDA WITH AT LEAST 5 YEARS OF EXPERIENCE WITH SIMILAR WORK HIRED BY THE CONTRACTOR TO ASSIST IN DEVELOPMENT OF DETAILED DEWATERING SYSTEM AND EXCAVATION SUPPORT SYSTEMS. DETAILED SUBMITTALS ON THE DEWATERING SYSTEM SHALL BE PROVIDED BY THE CONTRACTOR TO CDM FOR REVIEW AND COMMENTS.

THE DEWATERING SYSTEM SHALL BE ADEQUATE TO MAINTAIN A DRY, UNDISTURBED SUBGRADE AT ALL TIMES DURING CONSTRUCTION. ALL EXCAVATION AND CONSTRUCTION SHALL BE CONDUCTED "IN-THE-DRY". TO COMPLETE THE WORK AND AVOID DISTURBANCE TO THE SUBGRADE SOILS, THE GROUNDWATER LEVELS SHALL BE LOWERED TO AT LEAST 2 FEET BELOW THE LOWEST EXCAVATION LEVEL PRIOR TO EXCAVATION. GROUNDWATER LEVEL SHALL BE MAINTAINED AT LEAST 2 FEET BELOW THE BOTTOM OF ANY EXCAVATION TO MAINTAIN A DRAINED CONDITION SUITABLE FOR SUBGRADE PREPARATION FOR BAFFLE BOX AND PIPELINE PLACEMENT AND BACKFILL COMPACTION.

DEWATERING SYSTEMS SHALL NOT BE DECOMMISSIONED UNTIL BACKFILLING OPERATIONS ARE COMPLETE. DECOMMISSIONING SHOULD BE ADDRESSED IN THE DEWATERING SUBMITTAL.

EXCAVATION AND EXCAVATION SUPPORT

THE CONTRACTOR SHALL ANTICIPATE THAT TEMPORARY EXCAVATION SUPPORT SYSTEMS IN COMBINATION WITH LOWERING THE GROUNDWATER LEVEL WITHIN EXCAVATIONS WILL BE NEEDED TO FACILITATE CONSTRUCTION. THE DESIGN AND SELECTION OF THE TYPE(S) OF EXCAVATION AND SUPPORT SYSTEMS SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

EXCAVATION SUPPORT SYSTEMS SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF FLORIDA HIRED BY THE CONTRACTOR. THE CONTRACTOR SHALL PROVIDE DETAILED SUBMITTALS OF THE EXCAVATION SUPPORT DESIGN FOR REVIEW AND COMMENTS BY CDM.

NON-VIBRATION INSTALLATION METHODS SHALL BE USED FOR SHORING SYSTEMS.

ALL EXCAVATIONS, EXCAVATION SUPPORT SYSTEMS, AND SIDE SLOPES FOR TEMPORARY EXCAVATIONS SHALL BE DESIGNED IN COMPLIANCE WITH ALL APPLICABLE OSHA AND STATE REGULATIONS. EXCAVATION STANDARDS ARE REGULATED UNDER OSHA 29 CFR PART 1926 FOR PROTECTION OF EMPLOYEES. EXCAVATIONS 5 FEET OR GREATER IN DEPTH REQUIRE AN ADEQUATE PROTECTIVE SYSTEM (SLOPING, BENCHING, SHORING, ETC.).

THE CONTRACTOR SHALL TAKE CARE TO AVOID DISTURBANCE OF THE EXPOSED SUBGRADE BY SCHEDULING EXCAVATIONS TO LIMIT THE DURATION OF OPEN CUTS, SLOPING THE BOTTOMS OF THE EXCAVATIONS TO FACILITATE DRAINAGE, AND PROVIDING BERMS TO LIMIT RUNOFF INTO THE EXCAVATIONS. IN ADDITION, EXCAVATED MATERIAL TO BE REUSED AS FILL SHALL BE SAFELY STOCKPILED AT LEAST 10 FEET BEHIND THE TOP OF SLOPES IN SUCH A MANNER THAT PROMOTES RUNOFF AND LIMITS SATURATION OF THE MATERIALS.

COMPACTION

HEAVY VIBRATORY COMPACTION EQUIPMENT SHALL NOT BE USED.

CARE SHALL BE TAKEN TO AVOID EXCESS TRAFFIC ON THE EXCAVATED SUBGRADES PRIOR TO PLACEMENT OF THE STRUCTURAL FILL OR CONCRETE FOUNDATIONS. SUBGRADES SHALL BE COMPACTED PRIOR TO THE PLACEMENT OF FILL MATERIALS. ANY UNSTABLE OR UNSUITABLE MATERIAL PRESENT AT THE SUBGRADE LEVEL SHALL BE REMOVED AND REPLACED WITH COMPACTED STRUCTURAL FILL.

CONTRACTOR SHALL BE RESPONSIBLE FOR EFFECTIVE EARTHWORK MANAGEMENT IN ORDER TO ALLOW FOR REWORKING AND AERATING SOILS EXCAVATED FROM BELOW THE PRECONSTRUCTION GROUNDWATER TABLE TO REDUCE MOISTURE CONTENTS TO LEVELS SUITABLE FOR REPLACEMENT AND COMPACTION. MOISTURE CONTENTS SHALL BE CONTROLLED TO WITHIN +/- 2% OF OPTIMUM MOISTURE AS ESTABLISHED BY THE MODIFIED PROCTOR MOISTURE DENSITY RELATIONSHIP OF ASTM D 1557.

IN-PLACE DENSITY TESTING

IN-PLACE DENSITY TESTS SHALL BE PERFORMED BY AN APPROVED GEOTECHNICAL ENGINEERING TESTING FIRM AT THE FOLLOWING MINIMUM FREQUENCIES, OR AS DIRECTED BY THE ENGINEER:

- FILL AND BACKFILL OF STRUCTURES – AT LEAST ONE TEST ON COMPACTED SUBGRADE PER 2500 SQUARE FEET AND AT LEAST ONE TEST PER 12-INCH LIFT OF BACKFILL.
- PIPE BEDDING AND BACKFILL AT LEAST ONE TEST ON PIPE BEDDING OR COMPACTED SUBGRADE PER 100 LINEAR FEET OF PIPE AND AT LEAST ONE TEST PER 12-INCH LIFT OF BACKFILL PER 100 LINEAR FEET.

AREAS THAT FAIL TO ACHIEVE THE RECOMMENDED COMPACTION CRITERIA SHALL BE REWORKED AND RETESTED PRIOR TO PROCEEDING WITH SUBSEQUENT PHASES OF CONSTRUCTION. ALL COSTS ASSOCIATED WITH REWORKING AND RETESTING SHALL BE BORNE BY THE CONTRACTOR.

PIPE BEDDING AND PIPE BACKFILL

SUBGRADE SOILS BENEATH THE PROPOSED PIPES SHALL BE COMPACTED TO ACHIEVE A DENSITY OF AT LEAST 95 PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557 TO A DEPTH OF 1 FOOT BELOW THE PIPES. ANY UNSUITABLE LOOSE OR SOFT SOILS AT SUBGRADE LEVEL SHALL BE REMOVED AND REPLACED WITH SUITABLE, COMPACTED STRUCTURAL FILL.

HAUNCHING BACKFILL FOR THE PROPOSED PIPES SHALL BE PLACED AND COMPACTED TO THE CENTERLINE OF THE PIPES. BLOCKING SHALL NOT BE USED TO RAISE THE PIPES TO GRADE. BELL HOLES SHALL BE PROVIDED AT EACH JOINT TO PERMIT THE JOINT TO BE ASSEMBLED WHILE MAINTAINING UNIFORM PIPE SUPPORT.

TRENCH BACKFILL SHALL BE PLACED IN SIMULTANEOUS LIFTS ON EITHER SIDE OF THE PIPES AND BOX CULVERT AND COMPACTED IN SUCH A MANNER AS TO ENSURE INTIMATE CONTACT WITH THE SIDES OF THE PIPES AND BOX CULVERT.

BACKFILL SOILS PLACED AGAINST THE PIPE AND BOX CULVERT AND TO AT LEAST 12 INCHES OVER THE PIPE AND BOX CULVERT SHALL BE STRUCTURAL FILL THAT CONTAINS NO STONES LARGER THAN 2 INCHES. THE REMAINDER OF THE TRENCH SHALL BE BACKFILLED USING ON-SITE EXCAVATED SOILS, PROVIDED THE EXCAVATED SOILS ARE SUBSTANTIALLY FREE OF ORGANIC MATERIAL, WOOD, TRASH, OR OTHER DELETERIOUS OR OBJECTIONABLE MATERIALS AND CAN BE READILY PLACED AND COMPACTED.

TRENCH BACKFILL SHALL BE PLACED IN LEVEL LIFTS NOT TO EXCEED 6 INCHES IN UNCOMPACTED THICKNESS AND COMPACTED TO ACHIEVE A DENSITY OF AT LEAST 95 PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557.

SPECIAL CARE SHALL BE EXERCISED DURING THE COMPACTION PROCESS TO NOT DAMAGE THE PIPES.

STRUCTURES

THE "FOOTPRINT" AREA OF THE PROPOSED STRUCTURES, PLUS A HORIZONTAL MARGIN OF 3 FEET, SHALL BE EXCAVATED TO THE PROPOSED BOTTOM ELEVATION OF THE STRUCTURE. THE EXPOSED SUBGRADE SOILS SHALL BE COMPACTED TO AT LEAST 95 PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557 TO A DEPTH OF 12 INCHES.

BACKFILL PLACED ADJACENT TO THE WALLS OF THE STRUCTURES (WITHIN THE EXCAVATION) SHALL BE PLACED SIMULTANEOUSLY ON ALL SIDES OF THE STRUCTURE IN LEVEL LIFTS NOT TO EXCEED 8 INCHES IN UNCOMPACTED THICKNESS AND COMPACTED TO ACHIEVE A DENSITY OF BETWEEN 95 AND 97 PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557. OVER-COMPACTION OF THE BACKFILL SOILS SHALL BE AVOIDED.

BACKFILL PLACED ABOVE THE STRUCTURES SHALL BE PLACED IN LEVEL LIFTS NO THICKER THAN 8 INCHES IN UNCOMPACTED THICKNESS AND COMPACTED TO AT LEAST 98 PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557. FINAL BACKFILL PLACED OVER THE BAFFLE BOXES SHALL EXTEND TO THE SIDEWALLS OF THE EXCAVATION AND SHALL BE COMPACTED TO AT LEAST 95 PERCENT OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557. CARE SHALL BE TAKEN TO ENSURE THAT THE BAFFLE BOXES ARE NOT DAMAGED DURING THE COMPACTION PROCESS.

FILL AND BACKFILL REQUIREMENTS

TOPSOIL AND PAVEMENT MATERIALS SHALL NOT BE RE-USED AS FILL OR BACKFILL. THE CONTRACTOR IS RESPONSIBLE FOR THE DECISION TO REUSE EXISTING SOILS OR IMPORT FROM OFFSITE.

SEE SPECIFICATION 02310 SITE GRADING FOR FILL MATERIAL REQUIREMENTS.

LEGEND & ABBREVIATIONS

	= BENCHMARK
	= CONCRETE MONUMENT
	= FLAT GRATE INLET
	= IRON PIPE
	= IRON ROD
	= MAILBOX
	= MANHOLE
	= NAIL W/DISC
TH	= TEST HOLE
	= TREE
	= TRAFFIC SIGN
	= WATER VALVE
—UCL—	= BURIED CABLE LINE
—UE—	= BURIED ELECTRICAL LINE
—W—	= BURIED WATER LINE
—x—	= CHAIN LINK FENCE
— — —	= RIGHT OF WAY, EASEMENT
	= TREE LINE
CONC.	= CONCRETE
CMP	= CORRUGATED METAL PIPE
EL	= ELEVATION
FF ELEV	= FINISHED FLOOR ELEVATION
ID	= IDENTIFICATION
INV.	= INVERT
LF	= LINEAR FEET
LB	= LICENSED BUSINESS
NAVD	= NATIONAL AMERICAN VERTICAL DATUM
NAD	= NORTH AMERICAN DATUM
ORB	= OFFICIAL RECORDS BOOK
PK	= PARKER KALON
PLS	= PROFESSIONAL LAND SURVEYOR
RLS	= REGISTERED LAND SURVEYOR
RCP	= REINFORCED CONCRETE PIPE
ERCP	= ELLIPTICAL REINFORCED CONCRETE PIPE
R/W	= RIGHT OF WAY
SPT	= STANDARD PENETRATION TEST
SSMC	= SOUTHEASTERN SURVEYING AND MAPPING CORPORATION
SY	= SQUARE YARD
TH	= TEST HOLE
TRAV. PT.	= TRAVERSE POINT
TOB	= TOP OF BANK
TYP	= TYPICAL
WM	= WATER MAIN
DBI	= DRAIN BASIN INLET
+55.90	= AS-BUILT SPOT ELEVATION

SURVEYOR'S NOTES:

1. THE PURPOSE OF THIS SURVEY IS TO SHOW THE HORIZONTAL AND VERTICAL LOCATIONS OF THE STORM DRAINAGE IMPROVEMENTS FOR THE OSCEOLA TRAIL BAFFLE BOXES PROJECT.
2. ELEVATIONS BASED ON BENCHMARKS SHOWN ON CONSTRUCTION PLANS AND ARE REPRESENTED BY THE SURVEYOR AT THE TIME OF SURVEY.
3. ALL UTILITIES SHOWN, EXCEPT FOR THE NEW STORM DRAINAGE AND WATER MAIN, WERE NOT LOCATED BY THIS SURVEY AND ARE ON THE DRAWING PREVIOUSLY LOCATED BY ANOTHER SURVEY.
4. AS-BUILT DATA IN BOLD.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY: R. THOMPSON
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: APRIL 5, 2012

I hereby certify that the survey shown hereon is true and correct to the best of my knowledge and belief, based on actual measurements taken in the field. This survey meets the Minimum Technical Standards as set forth by the Florida Board of Professional Land Surveyors in Chapter 5J-17, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes.

UNLESS IT BEARS THE SIGNATURE AND ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER THIS DRAWING SKETCH, PLAT OR MAP IS FOR INFORMATIONAL PURPOSES ONLY AND IS NOT VALID.

LAYOUT SERVICES, INC.
3380 S PARK AVE STE 7
TITUSVILLE, FL. 32780
(321) 759-2779
(321) 264-9748 (FAX)

James Zimmerman
Professional Land Surveyor No. 6545
State of Florida

CITY OF CASSELBERRY
OSCEOLA TRAIL
(LAKE HODGE & GEE CREEK)
BAFFLE BOXES

GENERAL NOTES / LEGEND
ABBREVIATIONS

PROJECT NO. 61762-79557
FILE NAME: G001NOTES
SHEET NO.
G-1

AS-BUILT SURVEY

DATE:
BETH K. WHIKEHART, P.E.
P.E NO. 66649

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY:
DRAWN BY: R. THOMPSON
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE: APRIL 5, 2012

I hereby certify that the survey shown hereon is true and correct to the best of my knowledge and belief, based on actual measurements taken in the field. This survey meets the Minimum Technical Standards as set forth by the Florida Board of Professional Land Surveyors in Chapter 5J-17, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes.

UNLESS IT BEARS THE SIGNATURE AND ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER THIS DRAWING SKETCH, PLAT OR MAP IS FOR INFORMATIONAL PURPOSES ONLY AND IS NOT VALID.

LAYOUT SERVICES, INC.
3380 S PARK AVE STE 7 TITUSVILLE, FL 32780 (321) 759-2779 (321) 264-9749 (FAX)

James Zimmerman
Professional Land Surveyor No. 6545
State of Florida

CITY OF CASSELBERRY

OSCEOLA TRAIL
(LAKE HODGE & GEE CREEK)
BAFFLE BOXES

PLAN AND PROFILE

PROJECT NO. 61762-79557
FILE NAME: C003PLPF
SHEET NO.
C-3

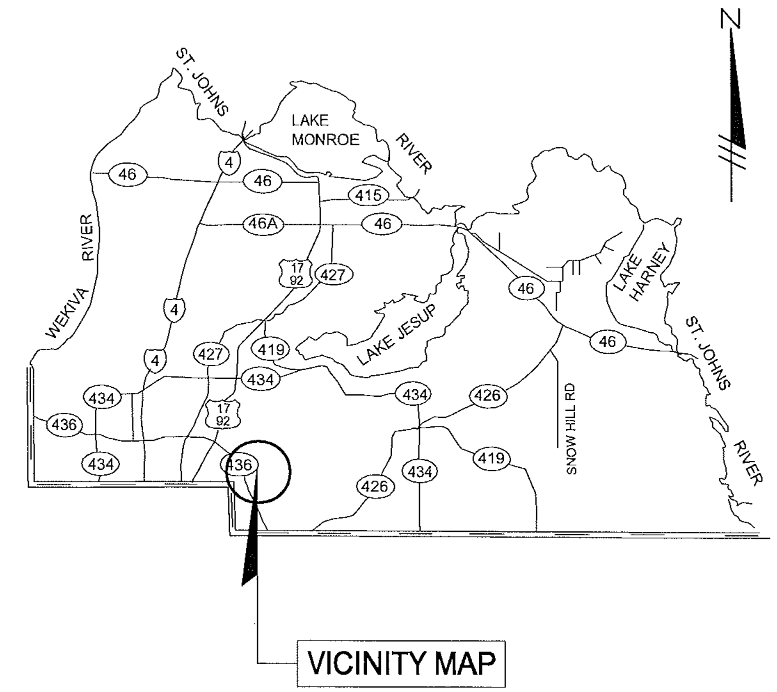
AS-BUILT SURVEY

B.2: Howell Creek Sites

CITY OF CASSELBERRY

SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

90% SUBMITTAL

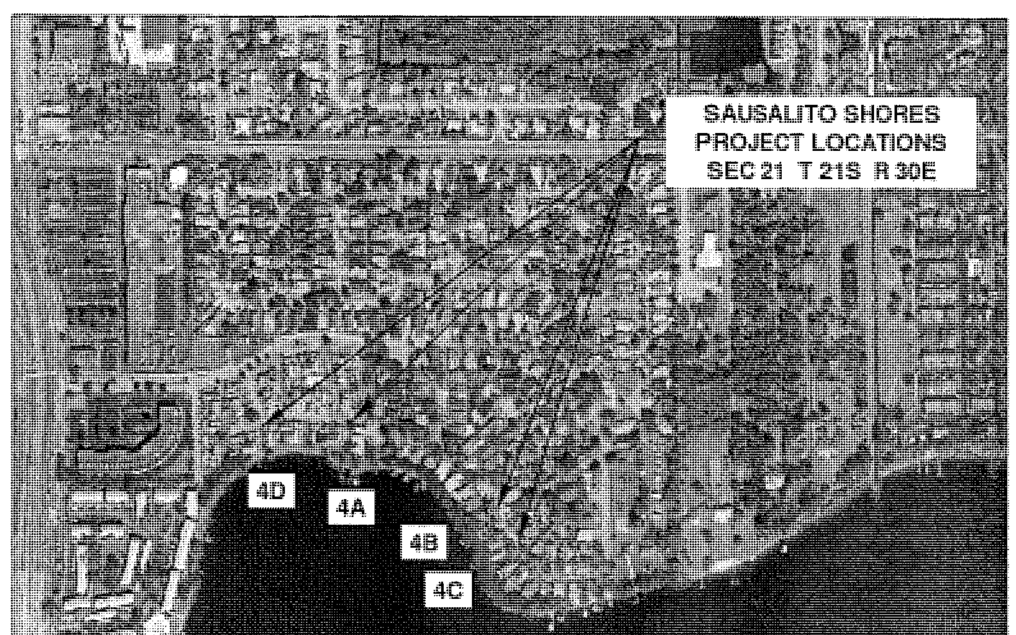


VICINITY MAP

INDEX OF CONSTRUCTION PLANS:

ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN CHANGED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

REVISIONS		
BY	DATE	DESCRIPTION



PROJECT LOCATION

MAYOR / **COMMISSIONER**
CHARLENE GLANCY

CITY MANAGER
BARBARA LIPSCOMB

PUBLIC WORKS DIRECTOR
ED TORRES, M.S., P.E.

ASSISTANT PUBLIC WORKS DIRECTOR
MARK GISCLAR

VICE MAYOR / COMMISSIONER
SANDRA SOLOMON

COMMISSIONERS
SUSAN DOERNER
JON MILLER
COLLEEN S. HUFFORD

CITY CLERK
DONNA GARDNER

PLANS PREPARED BY:

HDR

HDR ENGINEERING, INC.
315 E. ROBINSON ST., STE. 400
ORLANDO, FL 32801
407-420-4200
CERTIFICATE OF AUTHORIZATION NO. 4213

ENGINEER OF RECORD: PAMELA G. MILLER, P.E.

P.E. NO.: 60382

GENERAL NOTES

1. ALL CONSTRUCTION, MATERIALS, INSPECTION, AND TESTING SHALL, AS A MINIMUM, CONFORM TO CITY OF CASSELBERRY MASTER SPECIFICATIONS. IN THE ABSENCE OF A SPECIFICATION FDOT STANDARD SPECIFICATIONS FOR ROAD & BRIDGE CONSTRUCTION DATED 2010 AND FDOT DESIGN STANDARDS DATED JULY 2010.
2. UNSUITABLE MATERIALS SHALL BE REMOVED FROM CONSTRUCTION AREAS AND BACKFILLED WITH SUITABLE FDOT APPROVED MATERIALS. UNSUITABLE MATERIAL SHALL BE DISPOSED OF OFF SITE BY THE CONTRACTOR.
3. ALL PERSONAL PROPERTY WITHIN THE RIGHT-OF-WAY SHALL BE RELOCATED BY THE PROPERTY OWNER OR IT SHALL BE REMOVED BY THE CONTRACTOR AS NECESSARY TO CONSTRUCT THE PROJECT IN ACCORDANCE WITH THE PLANS.
4. ALL PRIVATE AND PUBLIC PROPERTY AFFECTED BY THE CONSTRUCTION WORK SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN THE EXISTING PRE-CONSTRUCTION CONDITION, UNLESS OTHERWISE NOTED.
5. ANY DRAINAGE PROBLEMS EXISTING BEFORE AND DURING CONSTRUCTION SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
6. TEMPORARY DRAINAGE SHALL BE PROVIDED DURING CONSTRUCTION TO ELIMINATE ANY FLOODING OF PRIVATE PROPERTY.
7. DURING CONSTRUCTION, TRAFFIC SHALL BE MAINTAINED IN ACCORDANCE WITH THE NOVEMBER 2003 FHWA "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" (MUTCD), AS REFERENCED BY FDOT.
8. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO COMPLY WITH THE CURRENT STATE OF FLORIDA UNDERGROUND FACILITY DAMAGE PREVENTION AND SAFETY ACT AND/OR RELATED STATE LAW. THE UTILITY INFORMATION SHOWN IN THESE PLANS IS BEING PROVIDED IN AN EFFORT TO ASSIST THE CONTRACTOR BY LISTING UTILITIES THAT MAY PROVIDE SERVICE IN THE APPROXIMATE AREA OF THE PROPOSED CONSTRUCTION. THE CONTRACTOR SHOULD ASSUME OTHER UTILITIES THAT ARE NOT LISTED MAY PROVIDE SERVICE IN THE APPROXIMATE AREA OF THE PROPOSED CONSTRUCTION.
9. THE PROJECT AREA SHALL BE CLEARED OF ALL OBSTRUCTIONS INCLUDING BUT NOT LIMITED TO SHRUBS, WEEDS, TREES, AND OTHER FORMS OF TRASH OR DEBRIS. THESE OBSTRUCTIONS SHALL BE SATISFACTORILY DISPOSED OF OFF SITE, IN AREAS PROVIDED BY THE CONTRACTOR.
10. ALL EXISTING DRAINAGE STRUCTURES ARE TO REMAIN UNLESS OTHERWISE NOTED IN THE PLANS.
11. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONTACT ALL UTILITY COMPANIES AND SUNSHINE STATE UTILITY LOCATES AT 811 OR 1(800) 432-4770, ONE (1) WEEK PRIOR TO COMMENCEMENT OF CONSTRUCTION AND HAVE OWNERS OF SAID UTILITIES ADJUST UTILITIES AS NECESSARY. THE CONTRACTOR SHALL COOPERATE WITH UTILITY COMPANIES DURING RELOCATION. ANY DELAY OR INCONVENIENCE OF THE VARIOUS UTILITIES SHALL BE INCIDENTAL TO THE CONTRACT AND NO EXTRA COMPENSATION WILL BE ALLOWED.
12. ANY PUBLIC LAND CORNER OR COUNTY MONUMENT WITHIN THE LIMITS OF CONSTRUCTION IS TO BE PROTECTED. IF A MONUMENT IS IN DANGER OF BEING DESTROYED AND HAS NOT BEEN PROPERLY REFERENCED, THE CONSTRUCTION MANAGER SHOULD NOTIFY THE CITY OF CASSELBERRY IMMEDIATELY AT (407) 262-7725.
13. ALL TREES AND FENCING WITHIN THE RIGHT-OF-WAY TO REMAIN UNLESS OTHERWISE NOTED.
14. THE SURVEY PROVIDED ON THE DRAWINGS IS BASED UPON FIELD CONDITIONS THAT EXISTED AT THE TIME OF SURVEY. CONTRACTOR SHALL FIELD VERIFY FEATURES AND UTILITIES PRIOR TO CONSTRUCTION.
15. CONTRACTOR SHALL REGRADE TO CONTOURS AND SLOPES SHOWN ON PLANS PRIOR TO PLACEMENT OF EROSION CONTROL MAT, SOD, OR PERMANENT EROSION CONTROL DEVICES.
16. CONTRACTOR SHALL REGRADE AND FILL AREAS THAT HAVE ERODED WITHIN WORK AREA SHOWN ON PLANS. CLEAN FILL FREE OF DEBRIS, ROOTS, ROCK COBBLES, AND ORGANICS SHALL BE USED.
17. CONTRACTOR SHALL KEEP ONE LANE OF TRAFFIC OPEN AT ALL TIMES DURING CONSTRUCTION. MOT SHALL BE IN ACCORDANCE WITH FDOT REQUIREMENTS.

EROSION AND SEDIMENT CONTROL NOTES

1. THE CONTRACTOR SHALL PERFORM EROSION CONTROL MEASURES IN ACCORDANCE WITH: SECTION 103 OF THE STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, LATEST EDITION; DETAILS CONTAINED IN THE PLANS; AS DIRECTED BY THE ENGINEER; AND BY THE CITY OF CASSELBERRY.
2. THE STORMWATER MANAGEMENT FACILITIES SHALL BE CONSTRUCTED DURING THE BEGINNING OF CONSTRUCTION.
3. ALL DISTURBED AREAS SHALL BE SODDED AFTER GRADING IS COMPLETED TO PREVENT EROSION.
4. DURING CONSTRUCTION THE CONTRACTOR SHALL TAKE ALL REASONABLE MEASURES TO INSURE AGAINST POLLUTING, SILTING OR DISTURBING TO SUCH AN EXTENT AS TO CAUSE AN INCREASE IN TURBIDITY BEYOND THOSE ALLOWED BY THE STATE OF FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION TO THE EXISTING WATER BODIES. SUCH MEASURES SHALL INCLUDE, BUT NOT LIMITED TO, CONSTRUCTION OF TEMPORARY EROSION CONTROL STRUCTURES SUCH AS SEDIMENT BASINS, SEDIMENT CHECKS OR SILT BARRIERS. THE MEASURES DELINEATED ABOVE ARE THE MINIMUM REQUIRED, WITH ADDITIONAL CONTROLS TO BE UTILIZED AS NEEDED, DEPENDENT UPON ACTUAL SITE CONDITIONS AND CONSTRUCTION OPERATIONS.
5. IN THE EVENT THAT THE EROSION PREVENTION AND CONTROL DEVICES SHOWN IN THE EROSION CONTROL PLAN, PROVIDED BY THE CONTRACTOR, PROVE NOT TO BE EFFECTIVE, ALTERNATE METHODS FOR MAINTAINING STATE WATER QUALITY STANDARDS FOR DISCHARGE FROM THE CONSTRUCTION SITE WILL BE REQUIRED. ALL ALTERNATE EROSION PREVENTION AND CONTROL DEVICES MUST BE APPROVED BY THE CITY ENGINEER PRIOR TO PLACEMENT.
6. ALL SURFACE WATER DISCHARGE FROM THE CONSTRUCTION SITE, INCLUDING DEWATERING DISCHARGE, SHALL MEET STATE WATER QUALITY STANDARDS PRIOR TO REACHING ANY WATERS OF THE STATE INCLUDING WETLANDS.
7. THE EROSION CONTROL MEASURES PER F.D.O.T STANDARD INDEX NO.102 AND NO. 103 ARE THE MINIMUM REQUIRED. ADDITIONAL EROSION CONTROL MEASURES MAY BE REQUIRED DUE TO CONDITIONS AS DETEREMINED BY THE REGULATORY AGENCIES.

UTILITY COMPANIES

AT&T DISTRIBUTION FL
146 ORANGE PLACE
MAITLAND, FL 32751
(407) 539-0644
PAM COTE

BRIGHT HOUSE NETWORKS, LLC
844 MAGUIRE ROAD
OCOEE, FL 34761
(407) 532-8509
MARVIN USRY

CITY OF CASSELBERRY UTILITIES
95 TRIPLET LAKE DRIVE
CASSELBERRY, FL 32707
(407) 262-7725 EXT. 1236
ALAN AMBLER

EMBARQ
921 1ST STREET
ALTAMONTE SPRINGS, FL 32701
(407) 830-3458
DOUG WITAKER

TECO PEOPLES GAS
60 W ROBINSON ST
ORLANDO, FL 32801
(407) 420-6609
DEBORAH FRAZIER

PROGRESS ENERGY
CUSTOMER SERVICE CENTER
(800) 700-8744

LEGEND & ABBREVIATIONS:

= WETLAND JURISDICTIONAL BOUNDARY MARKER
= CLEAN OUT
= MANHOLE
= FIRE HYDRANT
= IRON PIPE
= IRON ROD
= LIGHT POLE
= MAILBOX
= NAIL W/DISC
= NON-TRAFFIC SIGN
= TRAFFIC SIGN
= ELECTRIC SERVICE METER
= WATER METER
= WATER VALVE
A/C = AIR CONDITIONING UNIT
= BACKFLOW PREVENTER
h = BENCH
= FLAT GRATE INLET
= POST/BOLLARD

C = BURIED CABLE TV PEDESTAL
T = BURIED TELEPHONE PEDESTAL
= WATER SPIGOT
LS = LIFT STATION
= SEWER VALVE
IRR = IRRIGATION VALVE
SB = SOIL BORING
EOI = END OF INFORMATION
-BEL- = BURIED ELECTRICAL LINE
-FM- = FORCE MAIN
-WL- = WATER LINE
-SS- = GRAVITY SANITARY SEWER
-BCL- = BURIED CABLE LINE
-BTL- = BURIED TELEPHONE LINE
-G- = BURIED GAS LINE
VCP = VITRIFIED CLAY PIPE
DIP = DUCTILE IRON PIPE
ID = IDENTIFICATION

INV. = INVERT
ABS = BLACK PLASTIC PIPE
RCP = REINFORCED CONCRETE PIPE
-O- = BOARD FENCE
-X- = CHAIN LINK FENCE
LS = LICENSED SURVEYOR
LB = LICENSED BUSINESS
FF ELEV = FINISHED FLOOR ELEVATION
TRAV. PT. = TRAVERSE POINT
NAD = NORTH AMERICAN DATUM
NAVD = NORTH AMERICAN VERTICAL DATUM
SSMC = SOUTHEASTERN SURVEYING & MAPPING CORPORATION

SIZE SHOWN IS TRUNK DIAMETER IN INCHES

= PALM
= TREE

BB = BOTTLE BRUSH
CIT = CITRUS
CY = CYPRESS
H = HOLLY
JU = JUNIPER
LI = LIGUSTRUM
M = MAPLE
MA = MAGNOLIA
MY = MYRTLE
O = OAK
PI = PINE
S = SYCAMORE
* = FICHUS

HDR
HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382
(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

GENERAL NOTES

FILENAME: C2 General Notes
SCALE: N.T.S.

C2

Borys, David Monday, March 22, 2010 10:30:25 AM P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C2 General Notes.dwg

SUMMARY OF PROJECT PAY ITEMS

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY PLAN	QUANTITY FINAL
101-1	MOBILIZATION (7% MAX)	LS	1	
102-1	MAINTENANCE OF TRAFFIC (7% MAX)	LS	1	
104-11	FLOATING TURBIDITY BARRIER	LF	150	
104-12	STAKED TURBIDITY BARRIER - NYLON REINFORCED PVC	LF	35	
104-13-1	STAKED SILT FENCE (TYPE III)	LF	411	
104-16	ROCK BAGS	EA	8	
110-1-1	CLEARING AND GRUBBING (15% MAX)	LS	1	
121-70	FLOWABLE FILL	CY	5.5	
160-6	STABILIZED SUBBASE	SY	275	
285-706	BASE OPTIONAL (BASE GROUP 04)	SY	275	
334-1-12	SUPERPAVE ASPHALTIC CONC TRAFFIC B	TN	15	
425-1331	INLET, CURB, TYPE P-3, <10'	EA	1	
425-2-91	MANHOLE, J-8, <10'	EA	1	
430174102	PIPE CULVERT, OPTIONAL MATERIAL , ROUND, 36"	LF	7	
520-3	VALLEY GUTTER - CONCRETE	LF	40	
522-1	SIDEWALK CONCRETE, 4" THICK	SY	18	
570-1-2	PERFORMANCE TURF, SOD	SY	140	
1050-11213	6" PVC PIPE	LF	59	
10002-1	ECOSENSE ECOVAULT BAFFLE BOX, 8 X 14, 24" RCP	EA	1	
10002-2	ECOSENSE ECOVAULT BAFFLE BOX, 8 X 14, 36" RCP	EA	1	
10002-3	ECOSENSE ECOVAULT BAFFLE BOX, 8 X 14, 48" RCP	EA	1	
10003-1	SUNTREE TECH. INLET BASKET - HIGH CAPACITY - 24" TALL	EA	2	
10003-2	SUNTREE TECH. INLET BASKET - HIGH CAPACITY - 16" TALL	EA	1	
10004	SUNTREE TECH. GRATE INLET SKIMMER BOX - FDOT TYPE C	EA	1	
10005	AGRI DRAIN CORP. CHECK VALVE - 6" PVC MODEL CV06	EA	2	

PAY ITEM NOTES

102-1 INCLUDES THE COST OF ALL ITEMS NECESSARY FOR TRAFFIC CONTROL THAT ARE NOT SPECIFICALLY INCLUDED IN THE ROADWAY SUMMARY OF PAY ITEMS, I.E. SIGNS, BARRICADES, FLAGMAN, ETC. IN ACCORDANCE WITH F.D.O.T. STANDARD SPECIFICATIONS AND PROCEDURES. PLEASE NOTE THAT ONE LANE OF TRAFFIC SHALL BE KEPT OPEN AT ALL TIMES.

110-1-1 INCLUDES THE COST OF REMOVAL AND DISPOSAL OF ALL OBSTRUCTIONS, INCLUDING BUT NOT LIMITED TO TREES, SHRUBS, THE TRIMMING OF TREES AND SHRUBS, AND ALL OTHER ITEMS IN ORDER TO CONSTRUCT THE PROJECT. THESE OBSTRUCTIONS SHALL BE DISPOSED OF OFF SITE, IN AREAS PROVIDED BY THE CONTRACTOR.

121-70 FLOWABLE FILL TO BE USED AS NECESSARY FOR GROUTING AROUND PIPE CONNECTIONS. QUANTITY IS ESTIMATE ONLY.

142-70 FILL SAND SHALL BE UNIFIED SOIL CRITERIA TYPE SP OR SM AND SHALL BE USED FOR THE BACKFILLING OF THE ASPHALT REPAIR AREA, AS SPECIFIED ON SHEET C5. FILL SAND SHALL BE FREE OF ROCK COBBLES, ROOTS, OR OTHER ORGANIC MATTER. QUANTITIES INCLUDE A 20% COMPACTION FACTOR AND A 25% TRUCK MEASURE FACTOR.

570-1-2 SOD SHALL BE BAHIA AND SHALL CONSIST OF AND BE INSTALLED PER FDOT SPECIFICATIONS SECTION 575.

10002-X USE SPECIFIED ECOSENSE ECOVAULT MODEL OR ENGINEER OF RECORD AND CITY OF CASSELBERRY'S APPROVED EQUIVALENT.

10003-X USE SPECIFIED SUNTREE TECHNOLOGIES INC. MODEL OR ENGINEER OF RECORD AND CITY OF CASSELBERRY'S APPROVED EQUIVALENT.

10004 USE SPECIFIED SUNTREE TECHNOLOGIES INC. MODEL OR ENGINEER OF RECORD AND CITY OF CASSELBERRY'S APPROVED EQUIVALENT.

10005 USE SPECIFIED AGRI DRAIN CORPORATION CHECK VALVE MODEL CV06 OR ENGINEER OF RECORD AND CITY OF CASSELBERRY'S APPROVED EQUIVALENT.

NOTE: THE CONTRACTOR'S BID SHALL BE COMPREHENSIVE AND INCLUDE ALL LABOR, MATERIALS, AND EQUIPMENT INCLUDING ANY ITEMS NOT FOUND IN THE SUMMARY OF PAY ITEMS BUT NECESSARY TO COMPLETE THE PROJECT. QUANTITIES CALCULATED BASED UPON EMERGENCY NATURE OF PROJECT. ACTUAL QUANTITIES MAY VARY DEPENDING UPON CONDITIONS ENCOUNTERED DURING CONSTRUCTION.

P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C3 Pay Items.dwg

Borys, David Tuesday, March 30, 2010 3:24:07 PM

HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

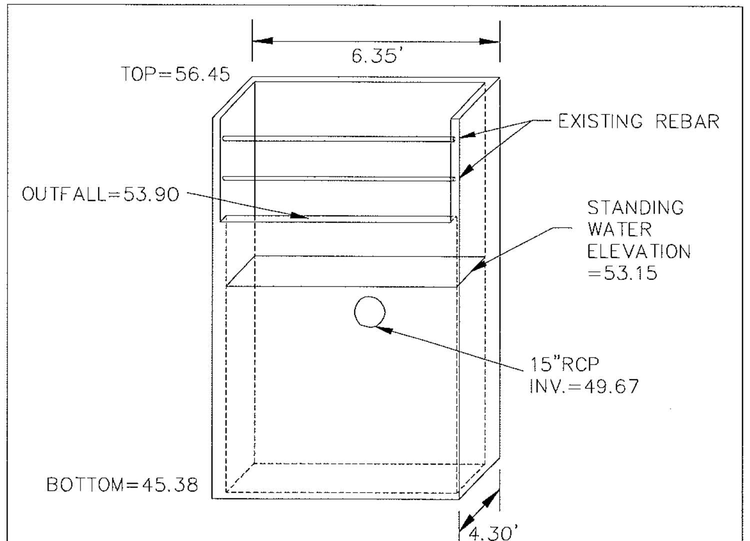
(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

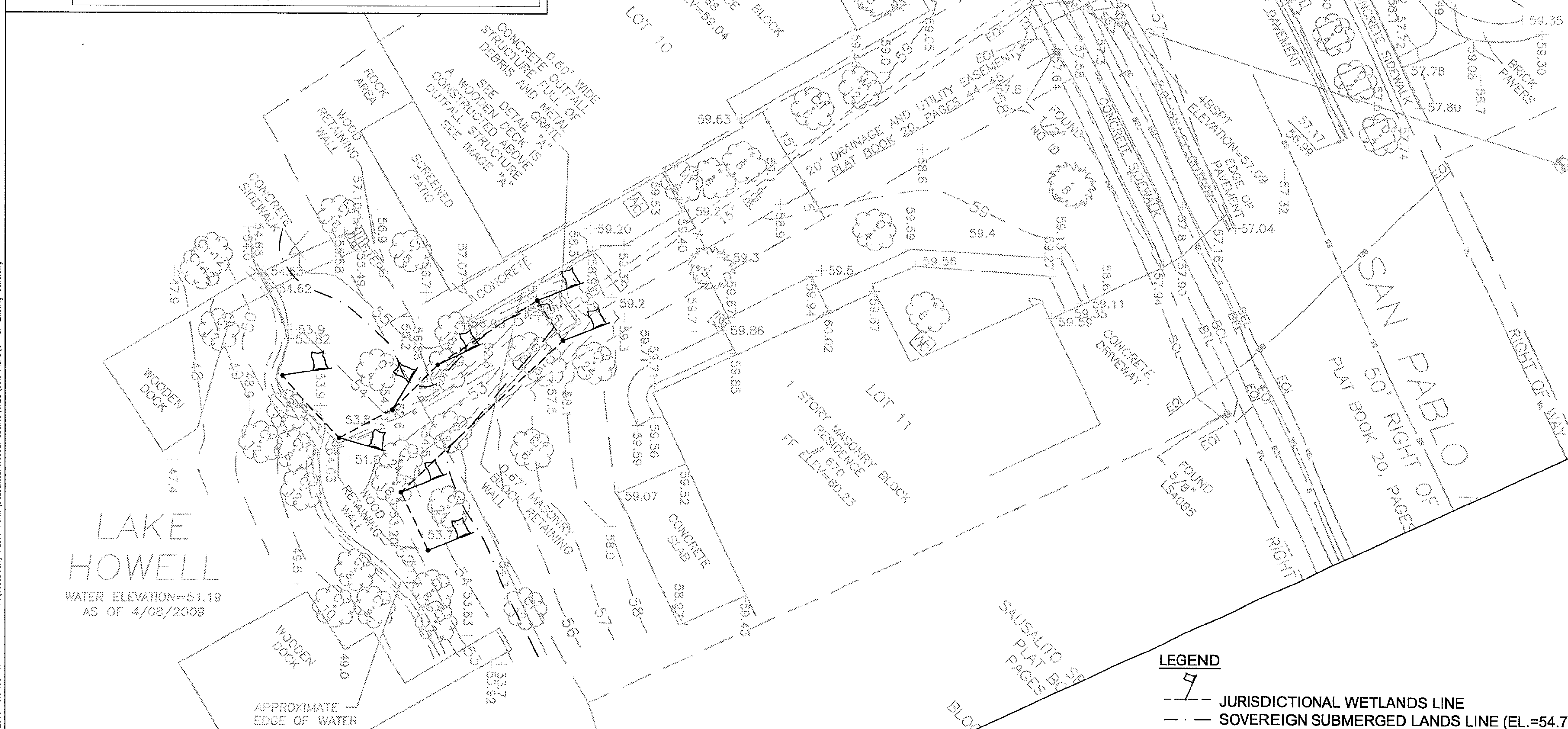
SUMMARY OF PAY ITEMS

FILENAME C3 PAY ITEMS
SCALE N.T.S.

C3

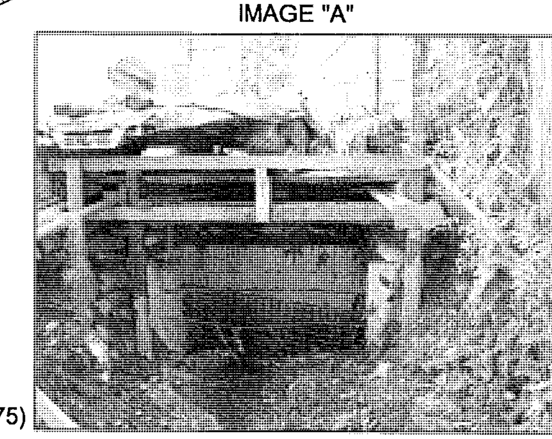


EXISTING OUTFALL STRUCTURE
DETAIL "A"



LEGEND
- JURISDICTIONAL WETLANDS LINE
- SOVEREIGN SUBMERGED LANDS LINE (EL.=54.75)

IMAGE "A"



PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D.BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

ISSUE	DATE	DESCRIPTION
–	–	–

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

(DATE)

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

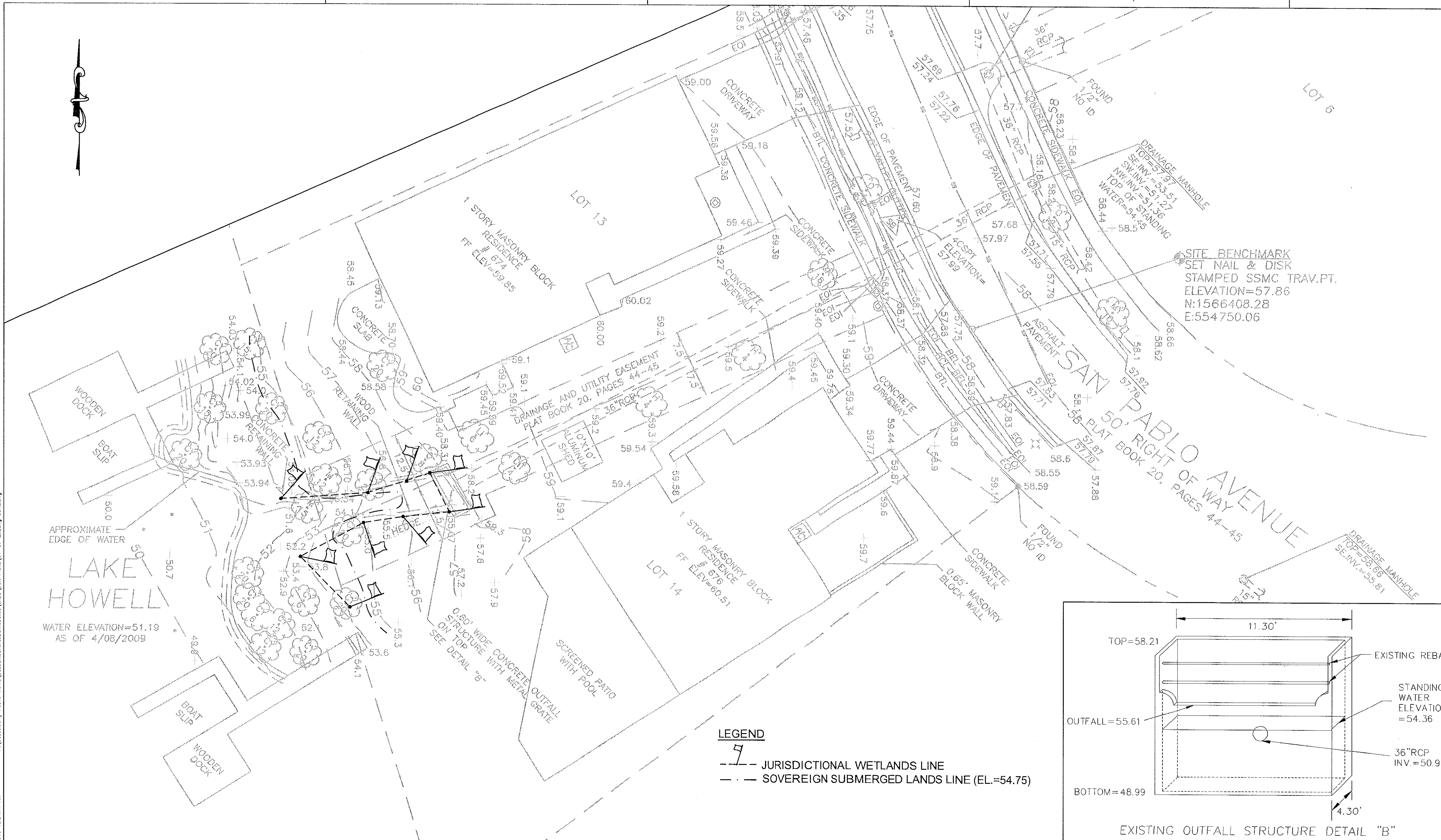
CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

EXISTING CONDITIONS
SITE 4B

0 10' 20'

FILENAME	C4–C7 EXISTING COND.
SCALE	1" = 20'

C5



HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	T. YAZGHI
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

EXISTING CONDITIONS
SITE 4C

0 10' 20'

FILENAME C4–C7 EXISTING COND.
SCALE 1" = 20'

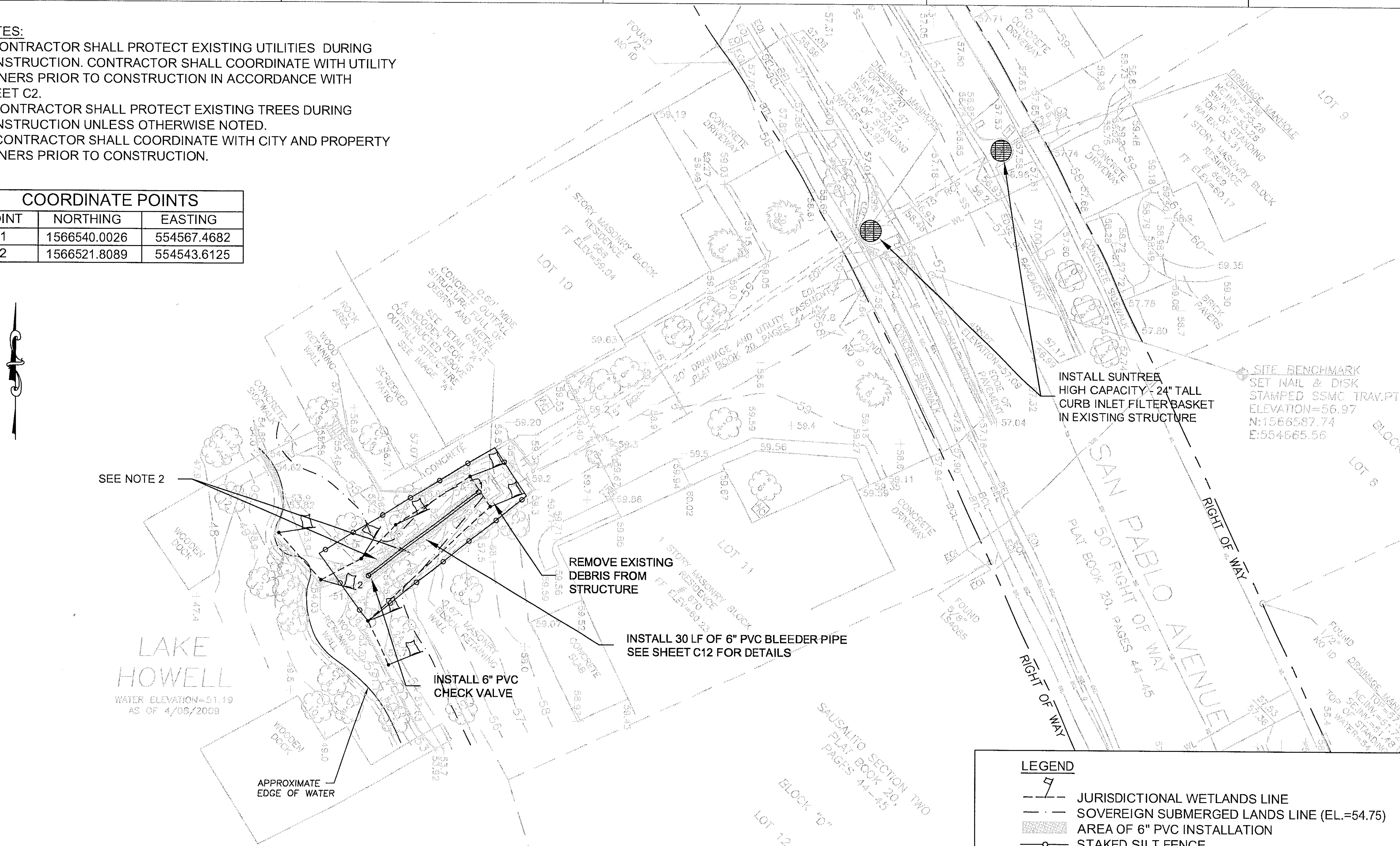
C6

P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C4-C7 Existing Cond.dwg
Monday, March 22, 2010 10:31:11 AM
Borys, David

NOTES:

1. CONTRACTOR SHALL PROTECT EXISTING UTILITIES DURING CONSTRUCTION. CONTRACTOR SHALL COORDINATE WITH UTILITY OWNERS PRIOR TO CONSTRUCTION IN ACCORDANCE WITH SHEET C2.
2. CONTRACTOR SHALL PROTECT EXISTING TREES DURING CONSTRUCTION UNLESS OTHERWISE NOTED.
3. CONTRACTOR SHALL COORDINATE WITH CITY AND PROPERTY OWNERS PRIOR TO CONSTRUCTION.

COORDINATE POINTS		
POINT	NORTHING	EASTING
1	1566540.0026	554567.4682
2	1566521.8089	554543.6125



LEGEND

- JURISDICTIONAL WETLANDS LINE
- SOVEREIGN SUBMERGED LANDS LINE (EL.=54.75)
- AREA OF 6" PVC INSTALLATION
- STAKED SILT FENCE

HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

PROPOSED CONDITIONS
SITE 4B

0 10' 20'

FILENAME C8-C11 PROP. COND.
SCALE 1" = 20'

C9

P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C8-C11 Prop Cond.dwg
Borys, David Tuesday, March 30, 2010 1:42:22 PM

LEGEND

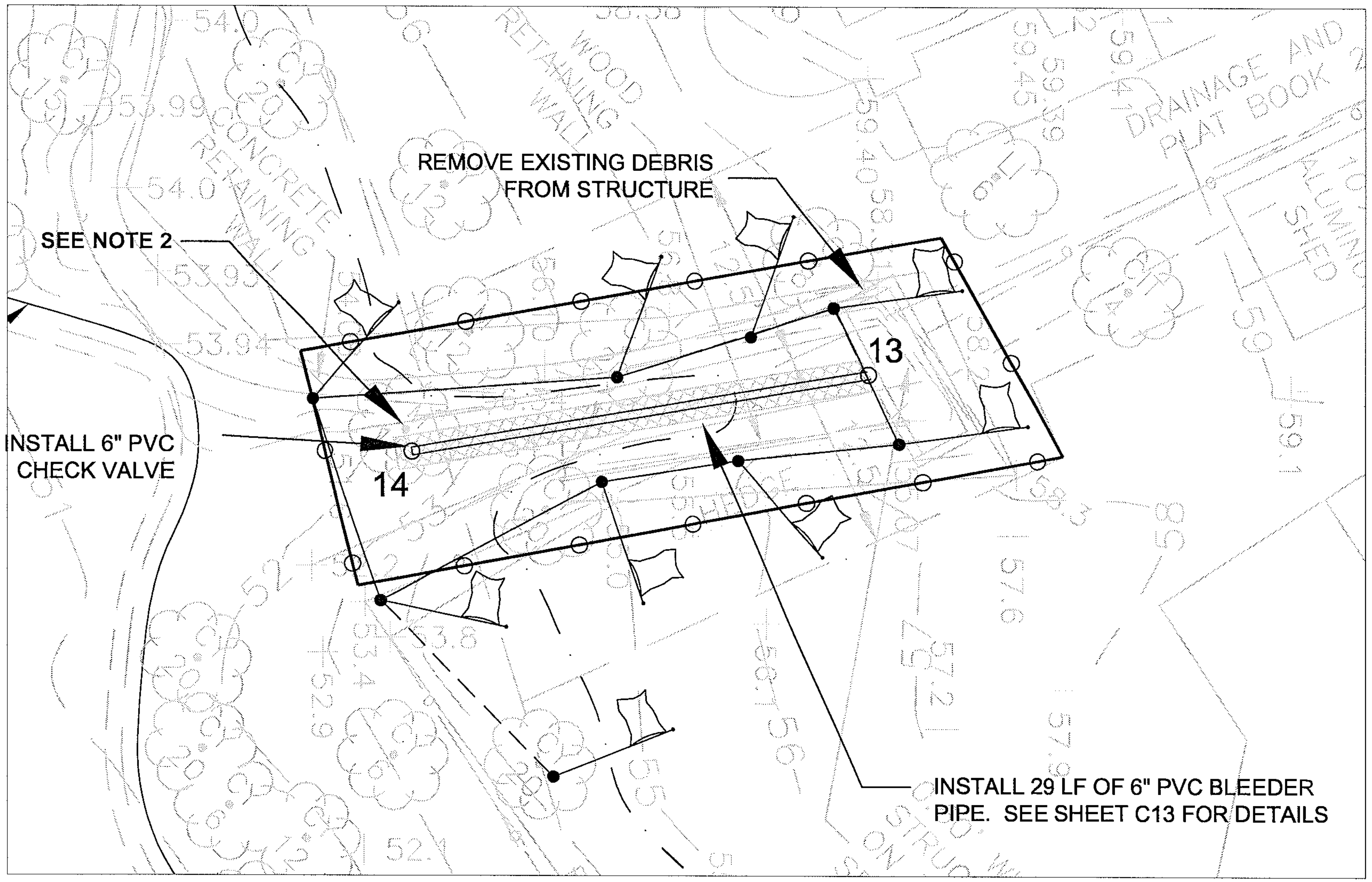
- JURISDICTIONAL WETLANDS LINE
- SOVEREIGN SUBMERGED LANDS LINE (EL.=54.75)
- REMOVE AND REPLACE ASPHALT PAVEMENT
- REMOVE AND REPLACE SOD
- REMOVE AND REPLACE CONCRETE
- AREA OF 6" PVC INSTALLATION
- STAKED SILT FENCE

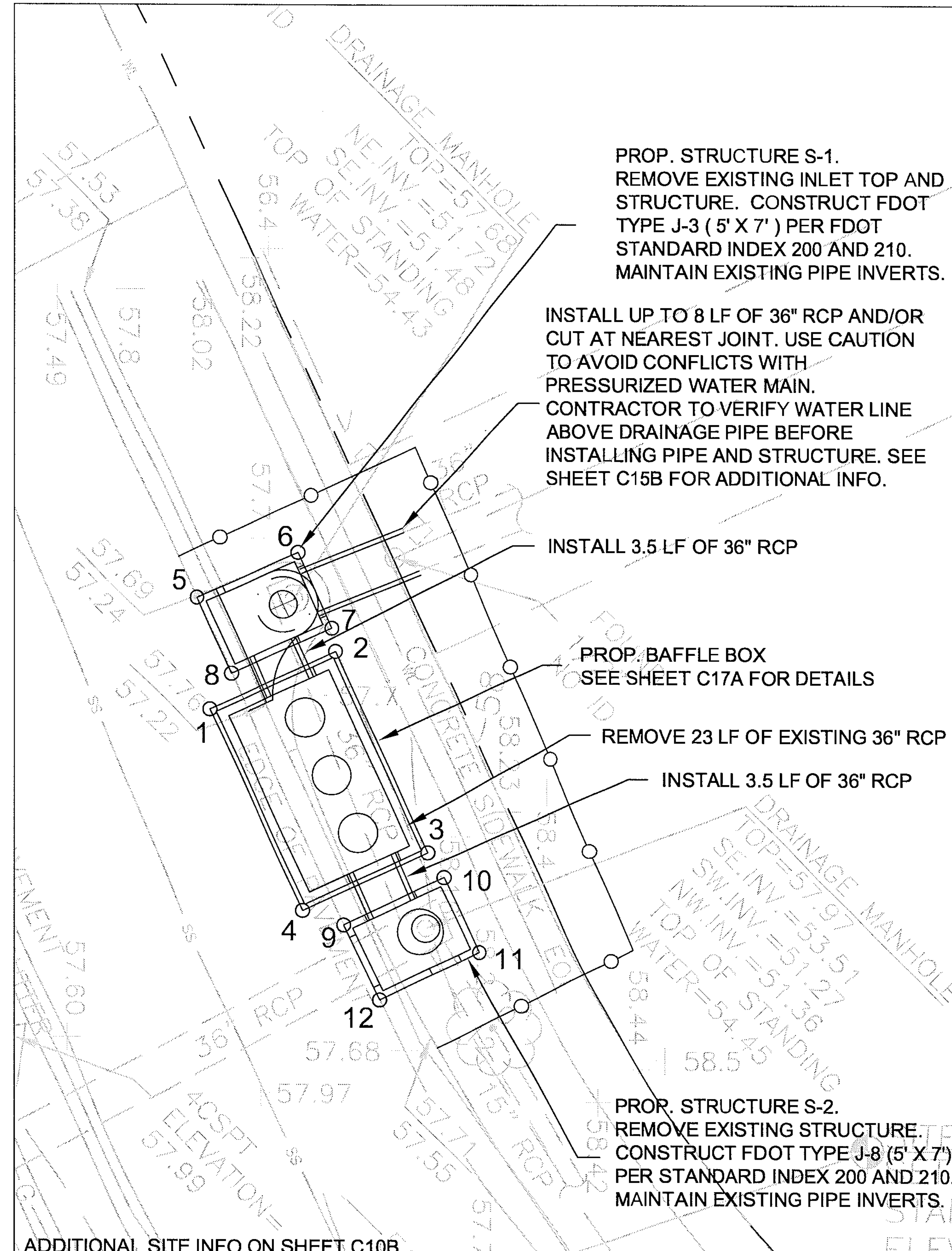
NOTES:
1. CONTRACTOR SHALL MATCH EXISTING INVERT AT MANHOLE.
2. CONTRACTOR SHALL PROTECT EXISTING UTILITIES DURING CONSTRUCTION. CONTRACTOR SHALL COORDINATE WITH UTILITY OWNERS PRIOR TO CONSTRUCTION IN ACCORDANCE WITH SHEET C2.
3. CONTRACTOR SHALL PROTECT EXISTING TREES DURING CONSTRUCTION UNLESS OTHERWISE NOTED.
4. CONTRACTOR SHALL COORDINATE WITH CITY AND PROPERTY OWNERS PRIOR TO CONSTRUCTION.
5. CONTRACTOR SHALL MAINTAIN EXISTING INVERTS AT UPSTREAM MANHOLE AND AT DOWNSTREAM OUTFALL.

COORDINATE POINTS

POINT	NORTHING	EASTING
1	1566455.8912	554747.6199
2	1566460.0776	554756.7014
3	1566445.5472	554763.3996
4	1566441.3608	554754.3181
5	1566463.9600	554746.6700
6	1566467.2229	554753.9716
7	1566461.7489	554756.4284
8	1566458.4732	554749.1298
9	1566440.3247	554757.3152
10	1566443.7703	554764.5351
11	1566438.3556	554767.1186
12	1566434.9022	554759.9024
13	1566372.2760	554634.3460
14	1566367.4626	554605.8423

ALL BAFFLE BOX POINTS REFERENCED FROM OUTSIDE CORNER OF BASE SLAB.





HDR
HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382
(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

PROPOSED CONDITIONS
SITE 4C

0 5' 10'

FILENAME C8-C11 PROP. COND.
SCALE 1" = 10'

C10A

P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C8-C11 Prop Cond.dwg
Tuesday, March 30, 2010 3:33:49 PM
Borys, David

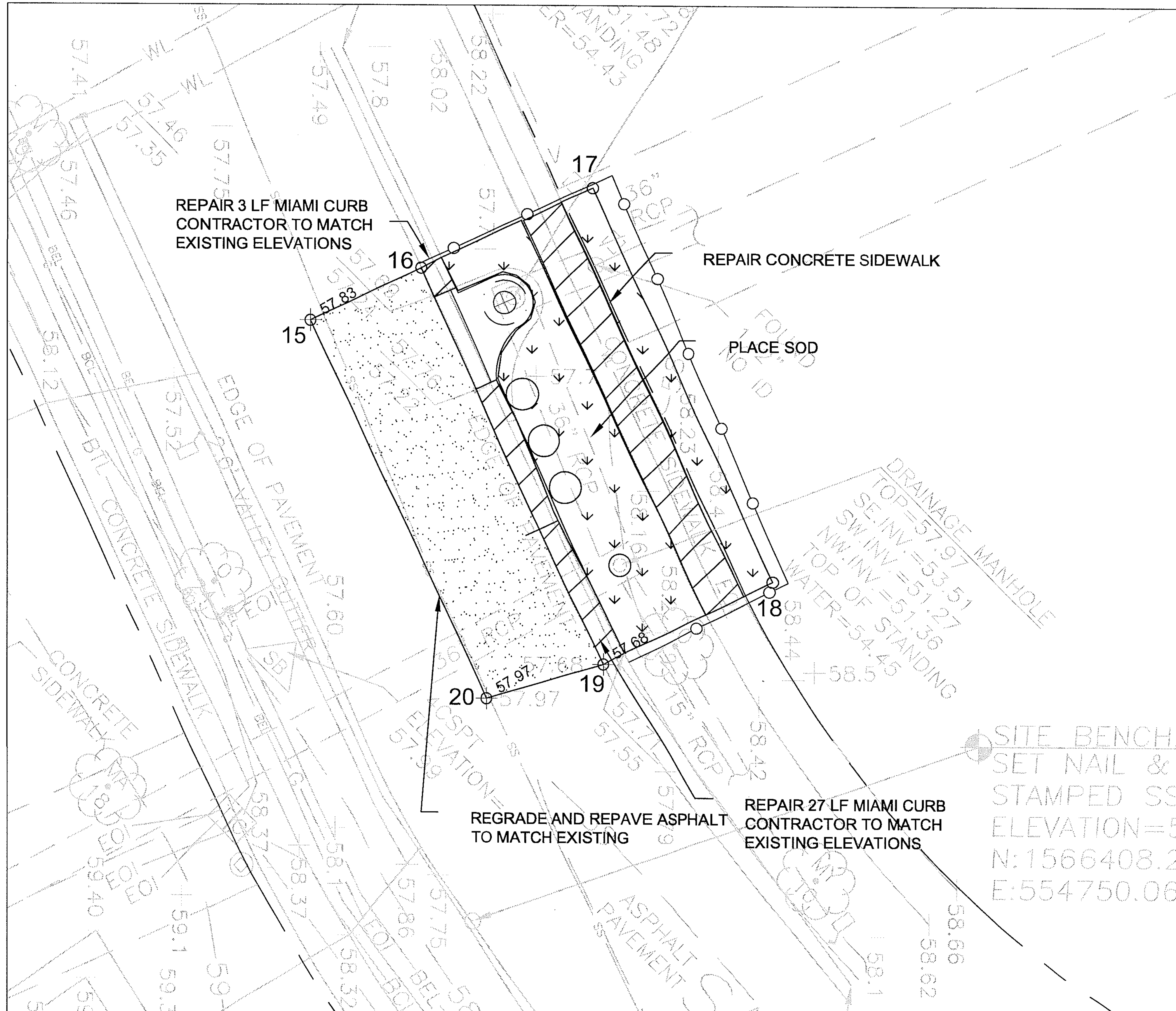
LEGEND

- JURISDICTIONAL WETLANDS LINE
- SOVEREIGN SUBMERGED LANDS LINE (EL.=54.75)
- REMOVE AND REPLACE ASPHALT PAVEMENT
- REMOVE AND REPLACE SOD
- REMOVE AND REPLACE CONCRETE
- STAKED SILT FENCE

COORDINATE POINTS		
POINT	NORTHING	EASTING
15	1566461.8398	554735.7109
16	1566466.5326	554745.4559
17	1566473.7050	554760.7300
18	1566438.6194	554776.8875
19	1566431.2300	554761.7300
20	1566428.1600	554751.3000

NOTES:

1. CONTRACTOR SHALL MATCH EXISTING INVERT AT MANHOLE.
2. CONTRACTOR SHALL PROTECT EXISTING UTILITIES DURING CONSTRUCTION. CONTRACTOR SHALL COORDINATE WITH UTILITY OWNERS PRIOR TO CONSTRUCTION IN ACCORDANCE WITH SHEET C2.
3. CONTRACTOR SHALL PROTECT EXISTING TREES DURING CONSTRUCTION UNLESS OTHERWISE NOTED.
4. CONTRACTOR SHALL COORDINATE WITH CITY AND PROPERTY OWNERS PRIOR TO CONSTRUCTION.
5. CONTRACTOR SHALL MAINTAIN EXISTING INVERTS AT UPSTREAM MANHOLE AND AT DOWNSTREAM OUTFALL.



HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1949
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382
(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

PROPOSED CONDITIONS
SITE 4C

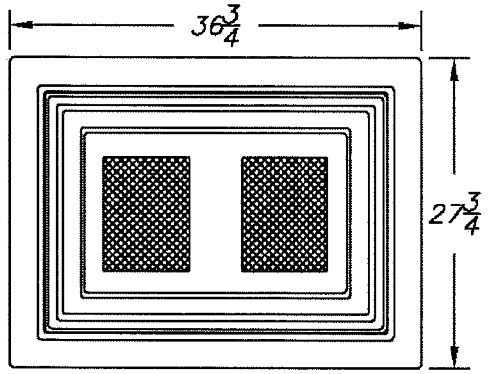
0 5' 10'

FILENAME C8-C11 PROP. COND.
SCALE 1" = 10'

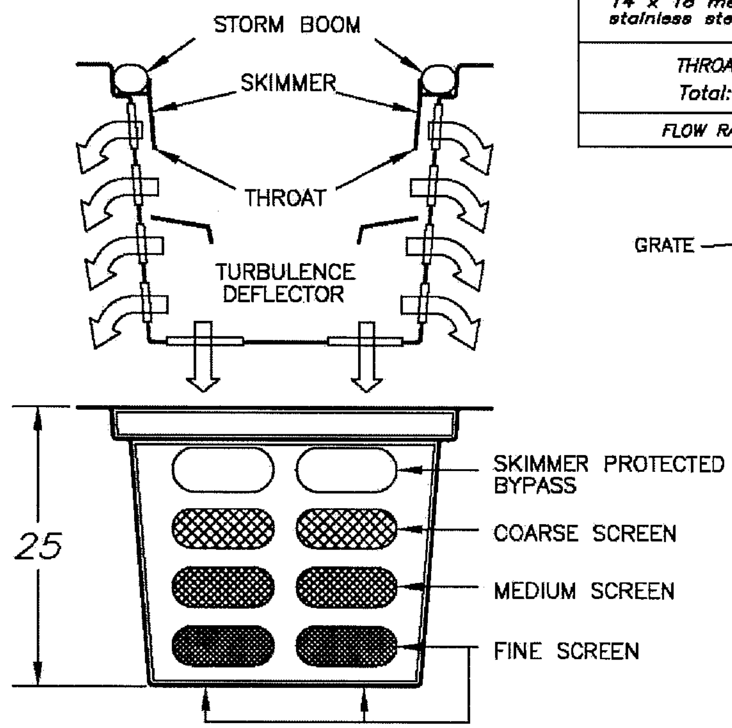
C10B

Borys, David Tuesday, March 30, 2010 1:45:26 PM P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C8-C11 Prop Cond.dwg

Part # GISB-C-28-36-25



FLOW SCHEMATIC



SIDE VIEW

BOX MANUFACTURED FROM MARINE GRADE FIBERGLASS & GEL COATED FOR UV PROTECTION

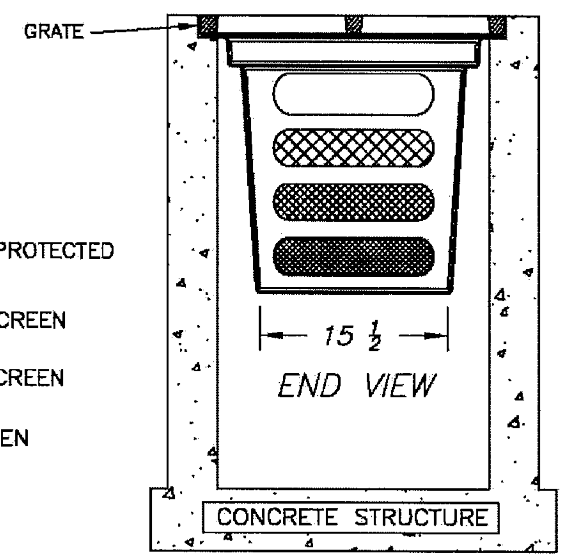
5 YEAR MANUFACTURERS WARRANTY

PATENTED

ALL FILTER SCREENS ARE STAINLESS STEEL

Flow Specifications

Description of filter opening	Percent Open (Based on Screen Dimensions)	Total Square Inches per Unit	Square Inches of Total Unobstructed Openings	Flow Rate (Cubic Feet per Second)
Skimmer protected By-Pass	100%	211.4	211.4	7.4 cfs
Coarse Screen 3/4" x 1-3/4" stainless steel flattened expanded	62%	187.2	116.1	5.0 cfs
Medium Screen 10x10 mesh stainless steel	56%	187.2	104.9	5.2cfs
Fine screen 14 x 18 mesh stainless steel	68%	239.8	163.1	9.2 cfs
THROAT FLOW RATE Total: 12.2 cfs		TREATED FLOW RATE Total: 19.4 cfs		
FLOW RATES BASED ON UNOBSTRUCTED OPENINGS				

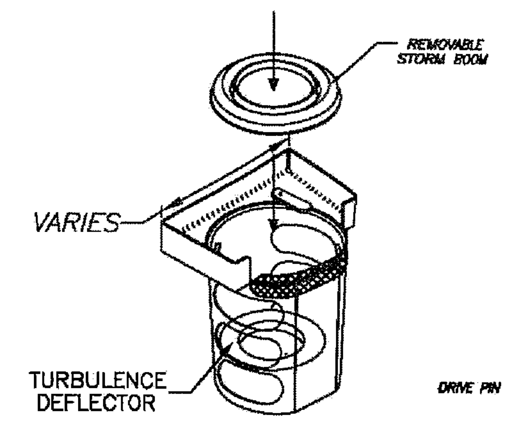


REMOVE GRATE
INSERT GISB
REINSTALL GRATE

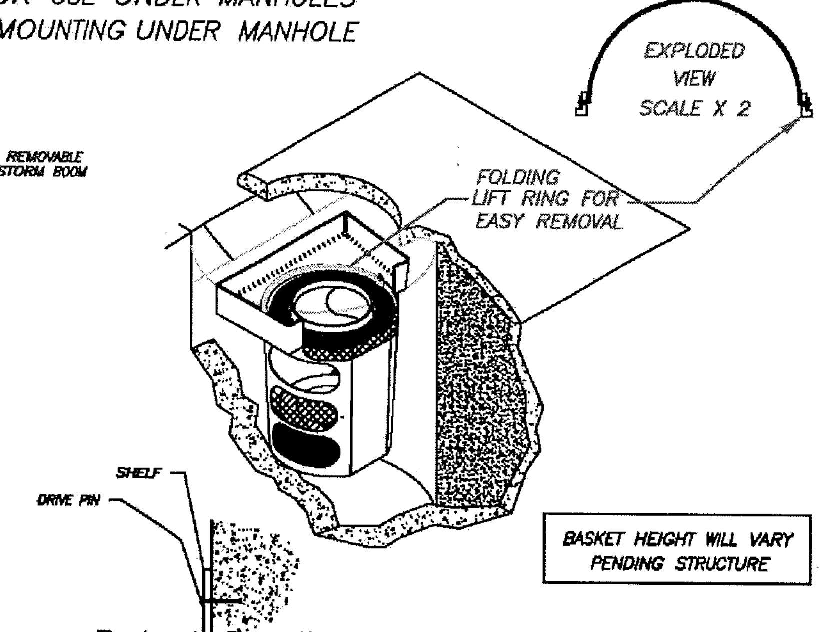
SUNTREE QUALITY PRODUCTS ARE BUILT FOR EASY CLEANING AND ARE DESIGNED TO BE PERMANENT INFRASTRUCTURE AND SHOULD LAST FOR DECADES.

SUNTREE TECHNOLOGIES 798 CLEARLAKE RD. SUITE #2 COCOA FL. 32922 TEL. 321-637-7552 FAX 321-637-7554	PROJECT:	
GRATE INLET SKIMMER BOX FOR FLORIDA DOT TYPE C INLET STRUCTURES.	REVISIONS:	DATE:
DATE: 04/12/04 SCALE:SF = 15	REVISIONS:	DATE:
DRAFTER: N.R.B. UNITS =INCHES	REVISIONS:	DATE:

ENVIRO-SAFE HIGH CAPACITY ROUND GRATE INLET SKIMMER BOX SYSTEM FOR USE UNDER MANHOLES
ROUND GISB FOR MOUNTING UNDER MANHOLE



DETAIL OF PARTS
FIGURE 1



Patent Pending.

FIGURE 2
DETAIL OF INSTALLATION

FLOW RATES per Basket				
$Q = SO*c_d*A\sqrt{2*g*h}$ c_d = [illegible] = .67				
	SO	A(ft^2)	h (ft)	Q ($\frac{ft^3}{s}$)
TOP SIDE	1	135.22	5.50	3.42
CENTER SIDE	.62	130.36	11.5	2.95
BOTTOM SIDE	.56	125.50	17.50	3.17
BOTTOM	.68	63.14	20.81	2.11
TOTAL				11.65

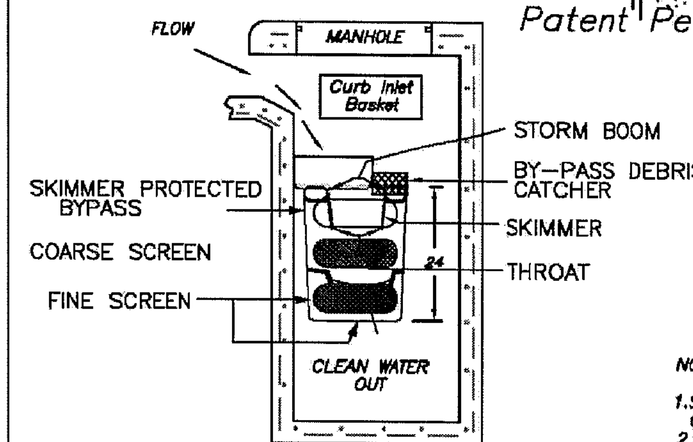


FIGURE 3
DETAIL OF PROCESS

REMOVABLE BASKET CATCHES EVERYTHING AND MAY BE REMOVED THROUGH MANHOLE WITHOUT ENTRY.

NOTES:

1. SHELF SYSTEM PROVIDES FOR ENTIRE COVERAGE OF INLET OPENING SO TO DIVERT ALL FLOW TO BASKET.
2. SHELF SYSTEM MANUFACTURED FROM MARINE GRADE FIBERGLASS,GEL COATED FOR UV PROTECTION.
3. SHELF SYSTEM ATTACHED TO THE CATCH BASIN WITH NON-CORROSIVE HARDWARE.
4. FILTRATION BASKET STRUCTURE MANUFACTURED OF MARINE GRADE FIBERGLASS,GEL COATED FOR UV PROTECTION.
5. FILTRATION BASKET FINE SCREEN AND COARSE CONTAINMENT SCREEN MANUFACTURED FROM STAINLESS STEEL.
6. FILTRATION BASKET HOLDS BOOM OF ABSORBENT MEDIA TO CAPTURE HYDROCARBONS. BOOM IS EASILY REPLACED WITHOUT REMOVING MOUNTING HARDWARE.
7. FILTRATION BASKET LOCATION IS DIRECTLY UNDER MANHOLE FOR EASY MAINTENANCE.

5 YEAR MANUFACTURERS WARRANTY

PATENTED

ALL FILTER SCREENS ARE STAINLESS STEEL

SUNTREE QUALITY PRODUCTS ARE BUILT FOR EASY CLEANING AND ARE DESIGNED TO BE PERMANENT INFRASTRUCTURE AND SHOULD LAST FOR DECADES.

SUNTREE TECHNOLOGIES 798 CLEARLAKE RD. SUITE #2 COCOA FL. 32922 TEL. 321-637-7552 FAX 321-637-7554	PROJECT:	
CURB INLET BASKET SYSTEM	REVISIONS:	DATE:
DATE: 06/02/08 SCALE:SF = 15	REVISIONS:	DATE:
DRAFTER: M.S.K. UNITS =INCHES	REVISIONS:	DATE:

NOTE: ALL DRAWINGS BY OTHERS. PROVIDED FOR INFORMATIONAL PURPOSESE ONLY. ENGINEER ONLY CERTIFIES SELECTION OF ITEMS SHOWN.

HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	B. SHRADER
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

(DATE)

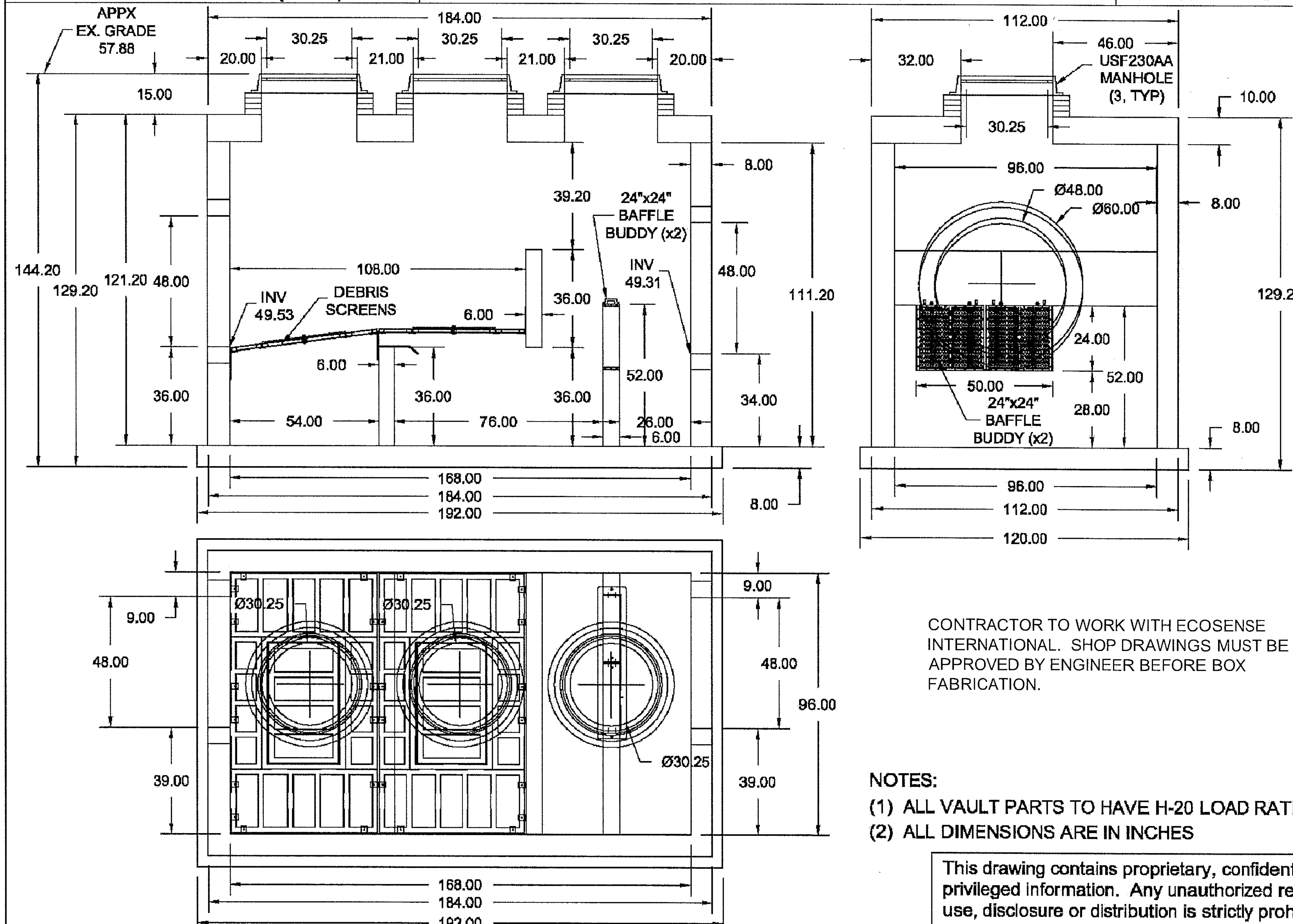
CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

SITE DETAILS

FILENAME	C12-C14 SITE DETAILS
SCALE	N.T.S.

C14A

JOB: CASSELBERRY (8x14) | DESCRIPTION: STORMWATER QUALITY VAULT, PRECAST CONCRETE | PART# VAULT 4a



CONTRACTOR TO WORK WITH ECOSENSE INTERNATIONAL. SHOP DRAWINGS MUST BE APPROVED BY ENGINEER BEFORE BOX FABRICATION.

NOTES:

(1) ALL VAULT PARTS TO HAVE H-20 LOAD RATING

(2) ALL DIMENSIONS ARE IN INCHES

DRAWN BY: GUTTERSON

APPROVED BY:

EcoSense

sht 1 of 1

DATE: 07-24-09

NOTE: ALL DRAWINGS BY OTHERS. PROVIDED FOR INFORMATIONAL PURPOSESE ONLY. ENGINEER ONLY CERTIFIES SELECTION OF ITEMS SHOWN.

HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION
–	–	–

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

BAFFLE BOX DETAIL
SITE 4A

FILENAME C14 B–B DETAILS

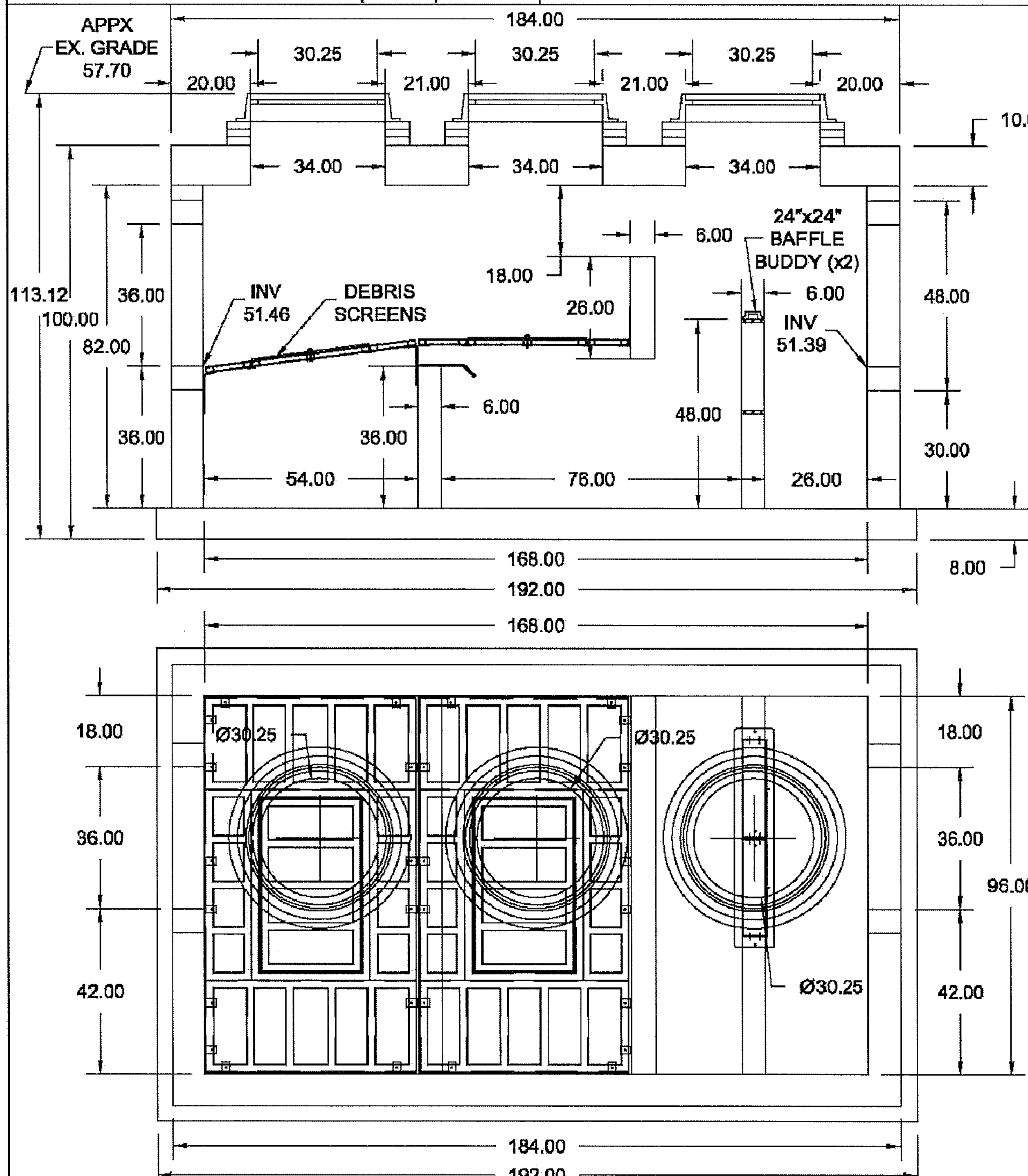
SCALE N.T.S.

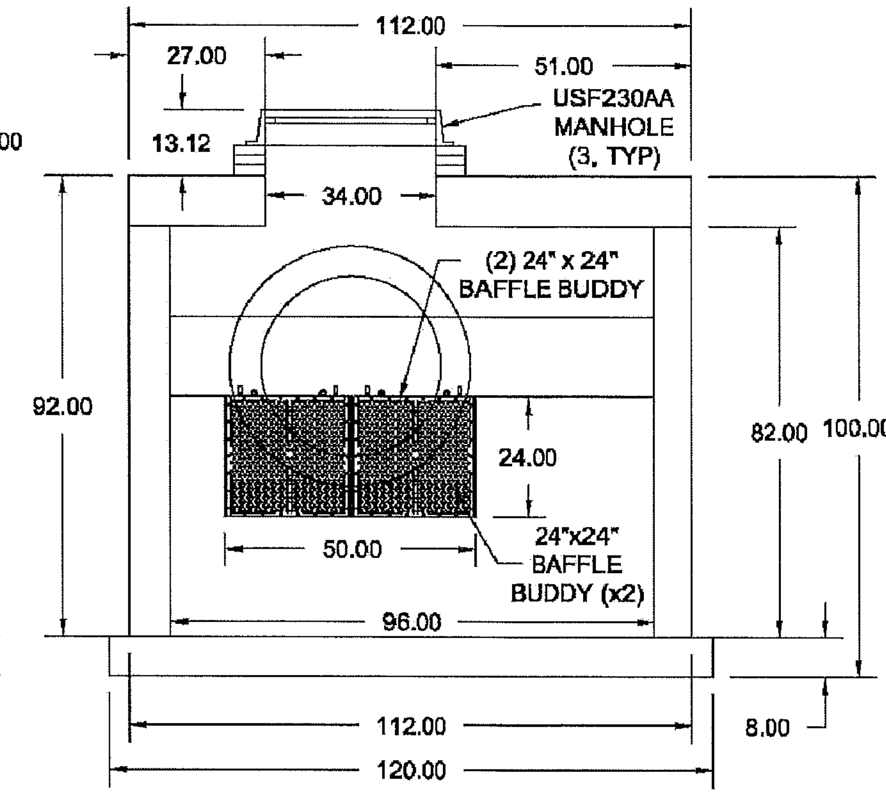
C16

P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C16-C18 Baffle Box Details.dwg

Borys, David Tuesday, March 30, 2010 3:42:33 PM

JOB: CASSELBERRY (8x14) | DESCRIPTION: STORMWATER QUALITY VAULT, PRECAST CONCRETE | PART# VAULT 4c





CONTRACTOR TO WORK WITH ECOSENSE INTERNATIONAL. SHOP DRAWINGS MUST BE APPROVED BY ENGINEER BEFORE BOX FABRICATION.

NOTES:

(1) ALL VAULT PARTS TO HAVE H-20 LOAD RATING

(2) ALL DIMENSIONS ARE IN INCHES

DRAWN BY: GUTTERSON

APPROVED BY:

EcoSense

sht 1 of 1

DATE: 02-24-10

NOTE: ALL DRAWINGS BY OTHERS. PROVIDED FOR INFORMATIONAL PURPOSESE ONLY. ENGINEER ONLY CERTIFIES SELECTION OF ITEMS SHOWN.

HDR

HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1948
www.hdrinc.com
CA 4213

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	PAMELA G. MILLER
PROJECT ENGINEER	V. BURKE
ENGINEER INTERN	D. BORYS
ENGINEER INTERN	
DRAWN BY	
PROJECT NUMBER	000000000107171

(SIGNATURE)
PAMELA G. MILLER, P.E.
FL. P.E. LICENSE NO.: 60382

(DATE)

CITY OF CASSELBERRY
SAUSALITO SHORES
OUTFALL IMPROVEMENT PROJECT
AT LAKE HOWELL

BAFFLE BOX DETAIL
SITE 4C

FILENAME C14 B-B DETAILS

SCALE N.T.S.

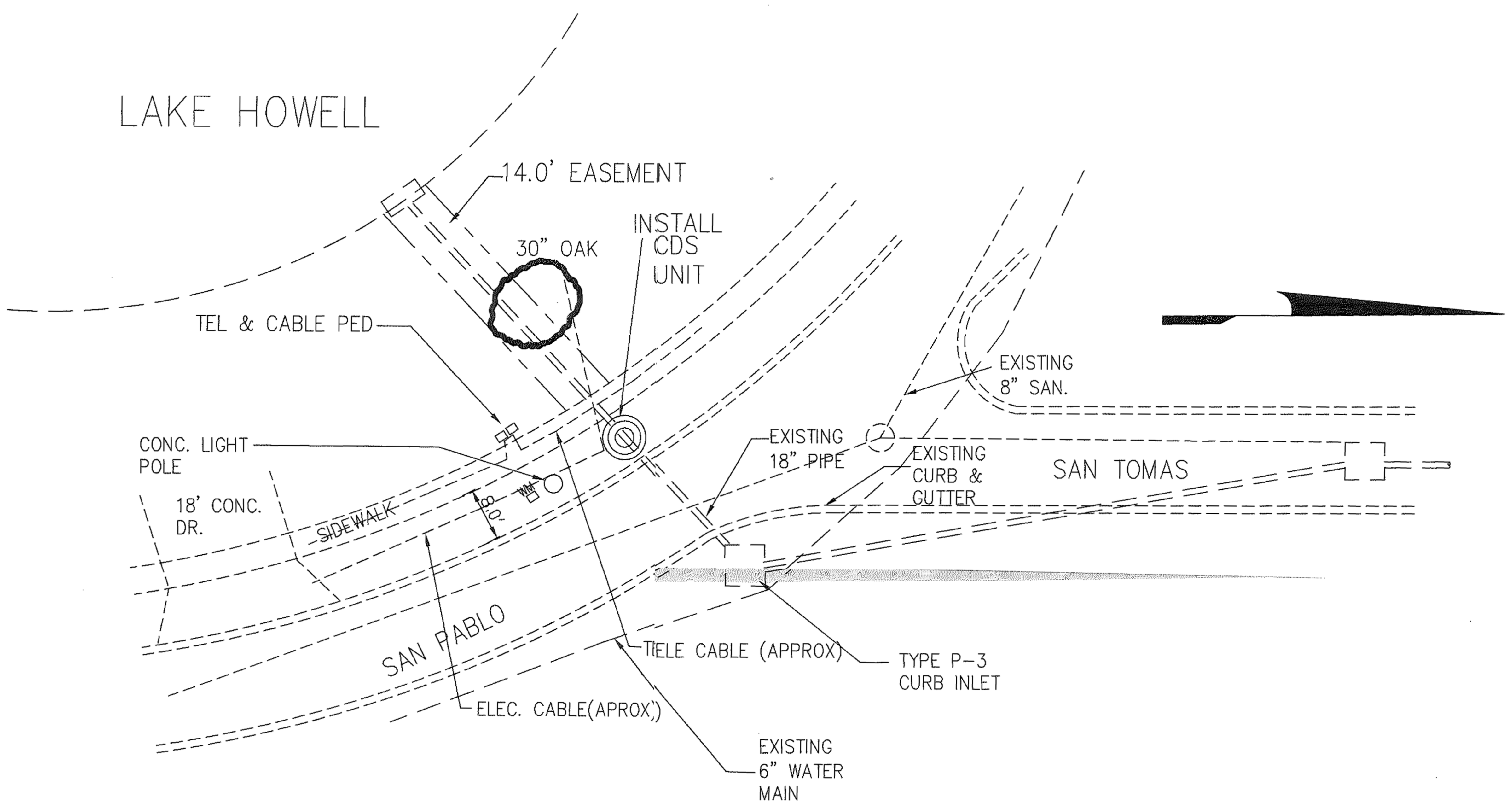
C17A

P:\Casselberry Public Works\SausalitoShoresBaffleBoxes\CADD\90% Plans\C16-C18 Baffle Box Details.dwg

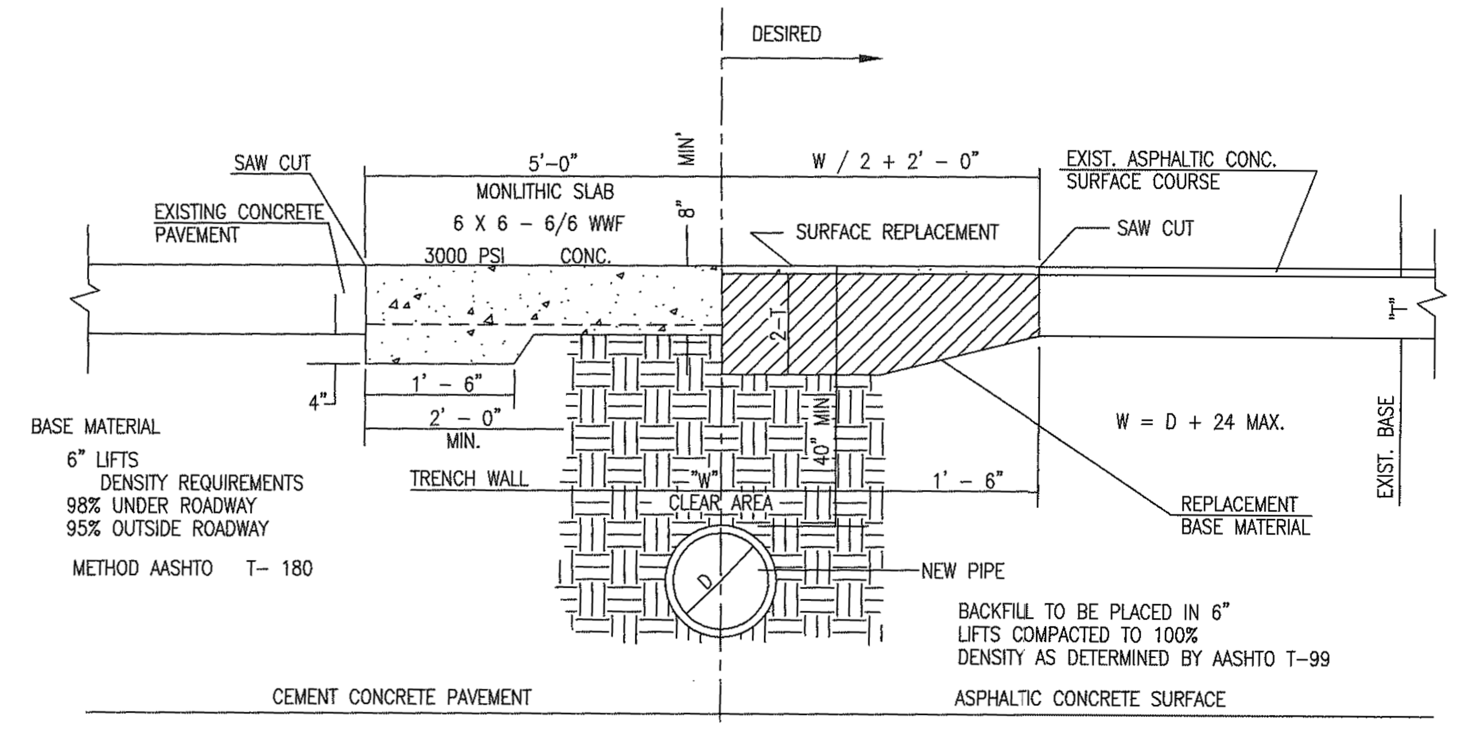
Tuesday, March 30, 2010 3:42:48 PM

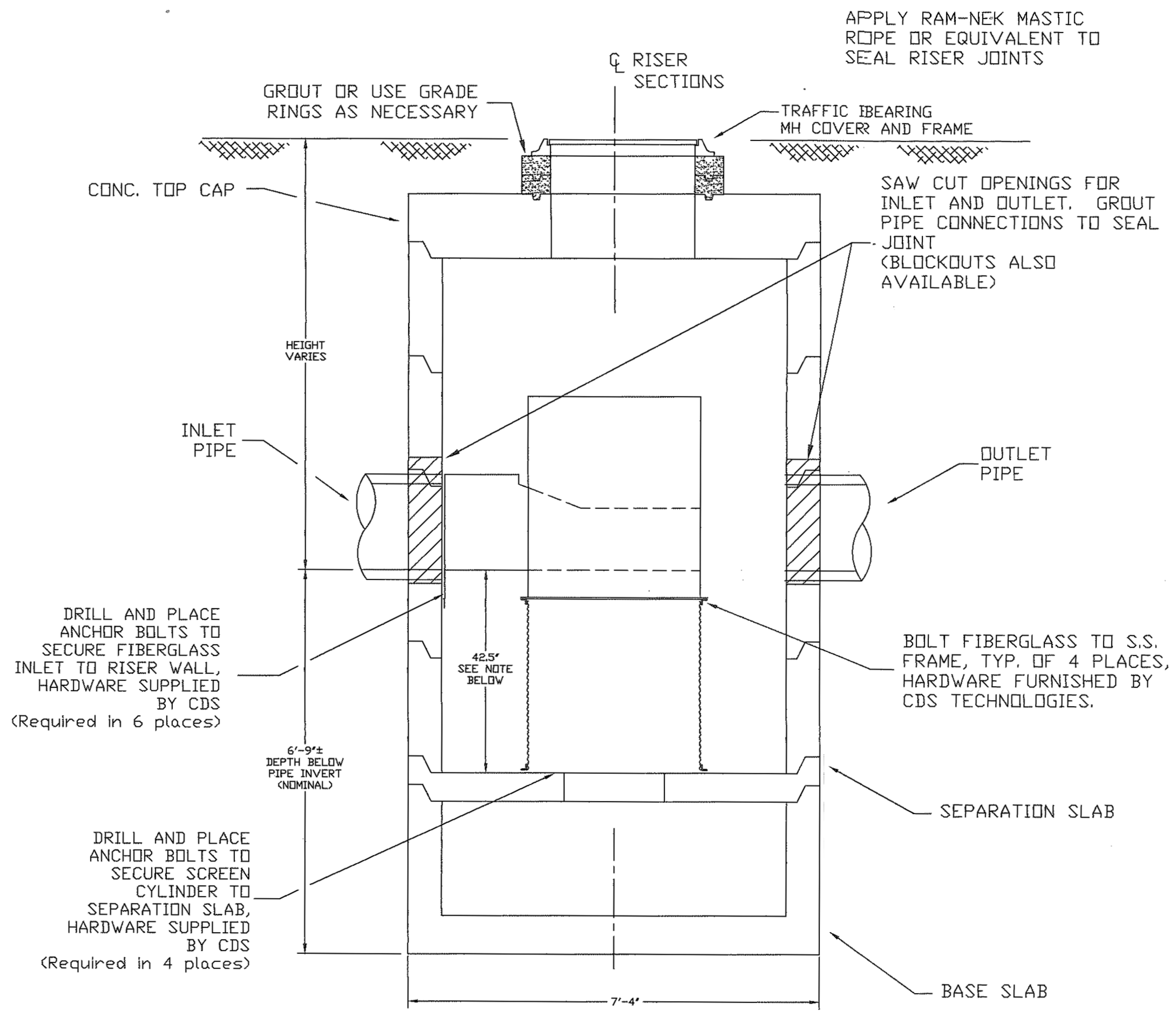
Borys, David

B.3: San Pablo CDS

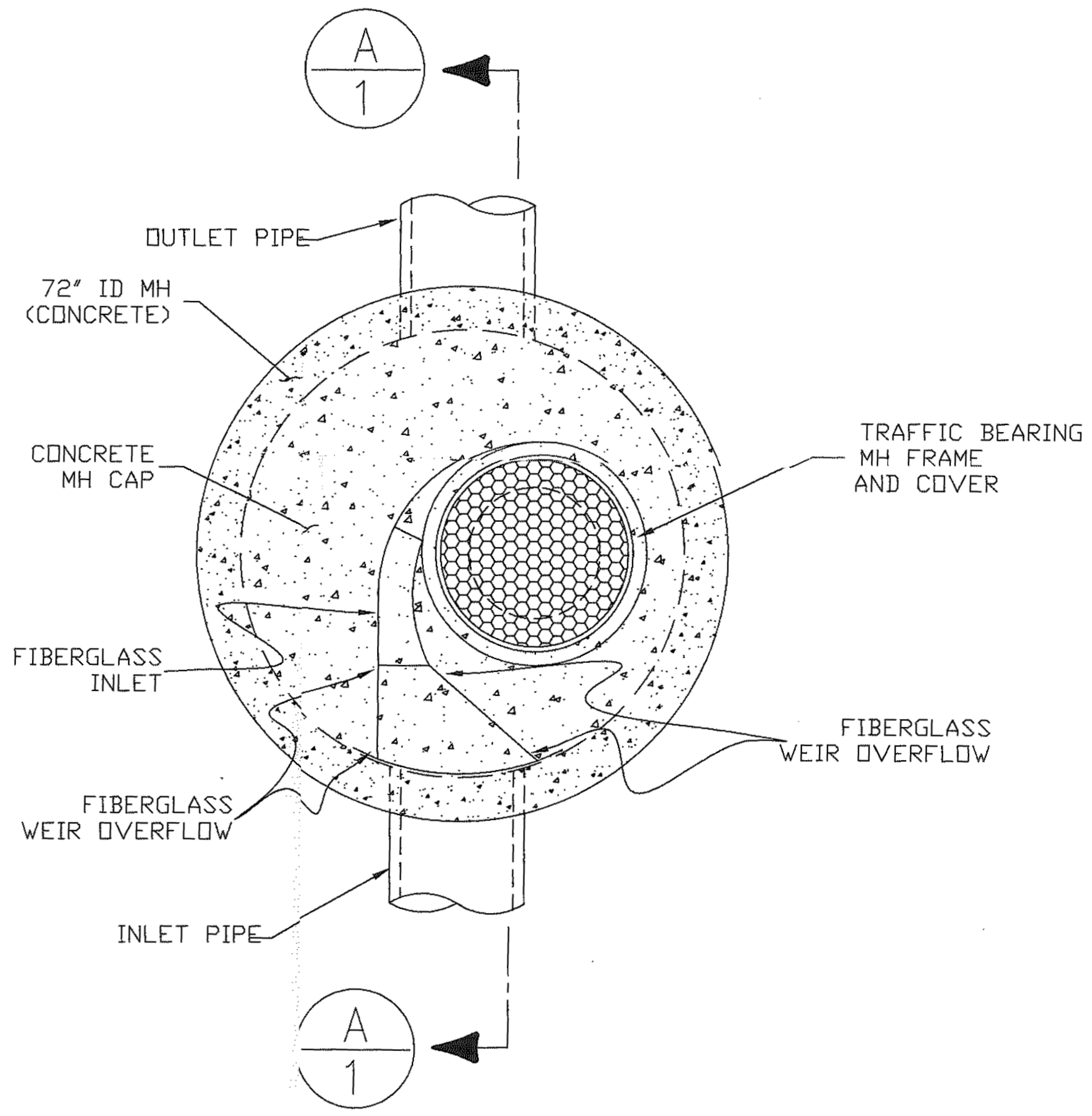


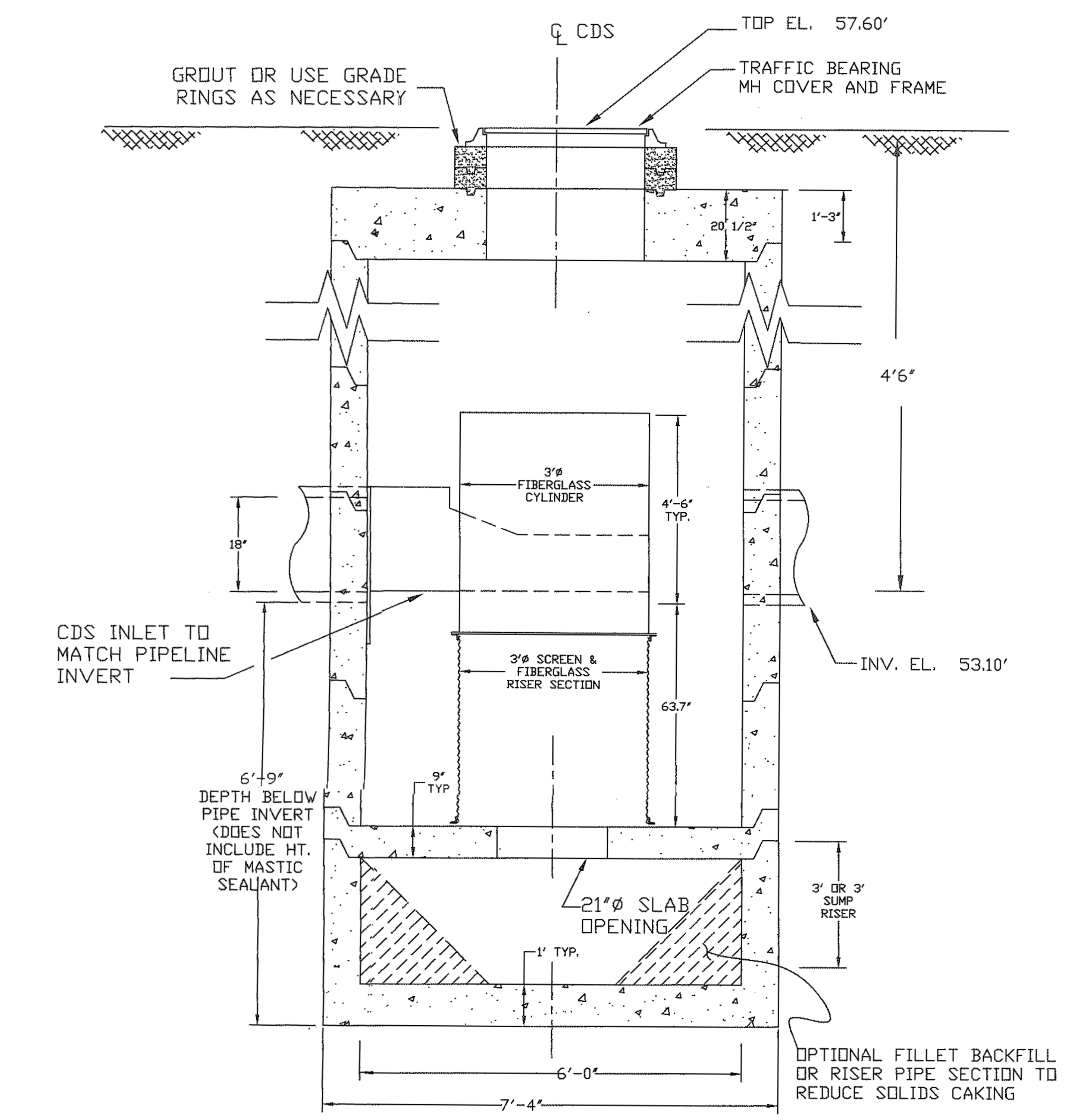
TYPICAL ROADWAY OPEN CUT OR REPAIR DETAIL AND TRANSITION TO EXISTING PAVEMENT





CONSTRUCTION NOTES



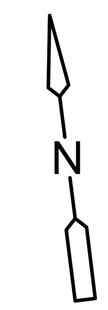


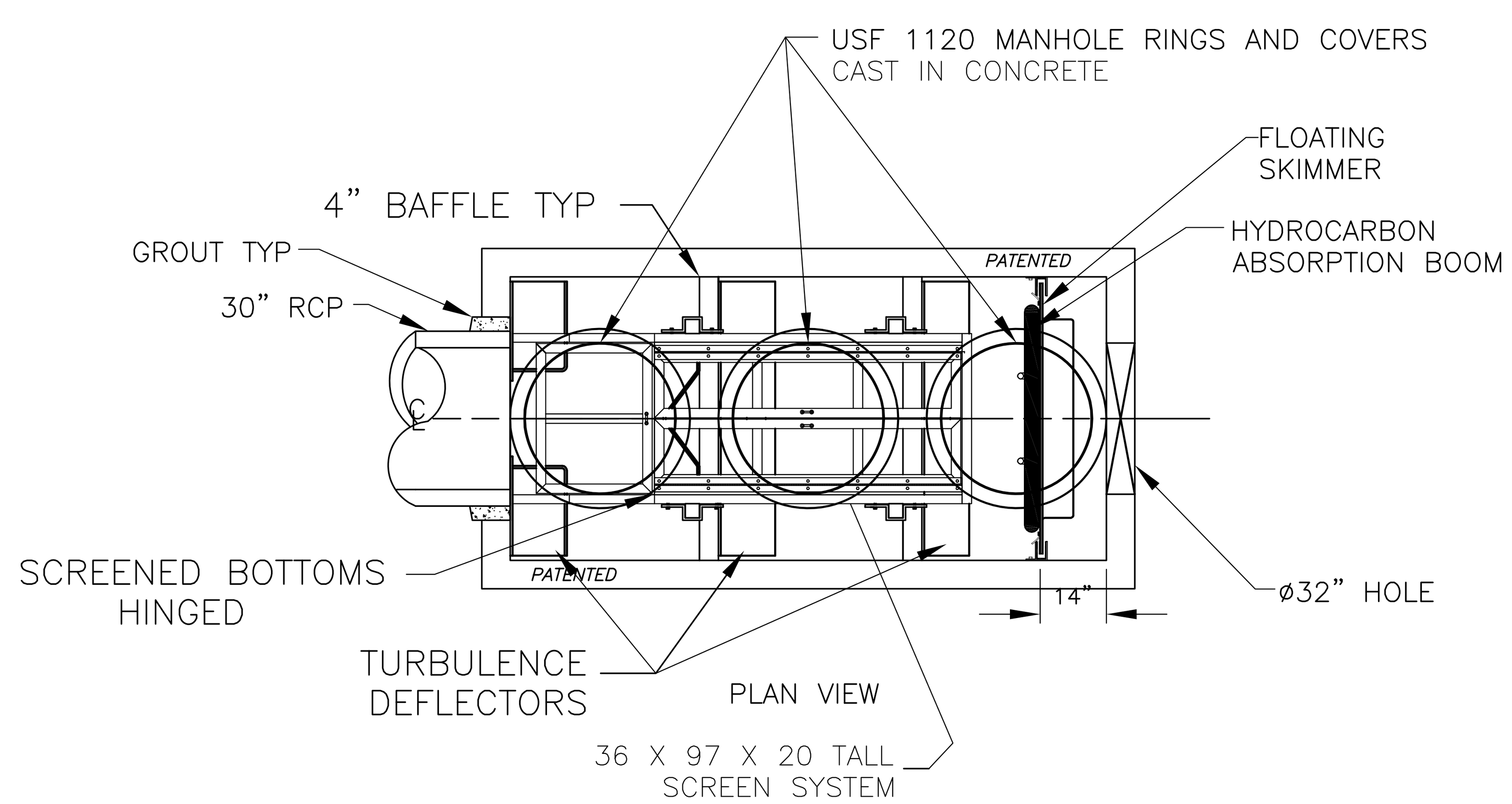
A/1 ELEVATION VIEW

CDS TECHNOLOGIES	CITY OF CASSELBERRY SAN PABLO STORMWATER TREATMENT UNIT	PMSU30_28 FL-99-013	DATE: 4/14/00	FILE: FL-99-013 DRAWN BY: FRT REVISIONS: JBH	1

E:\FRTRINIDAD\CDS\FL-98-009-C1.DWG\1=32, REV. DATE: 12/13/98

B.4: Lake Concord Baffle Box





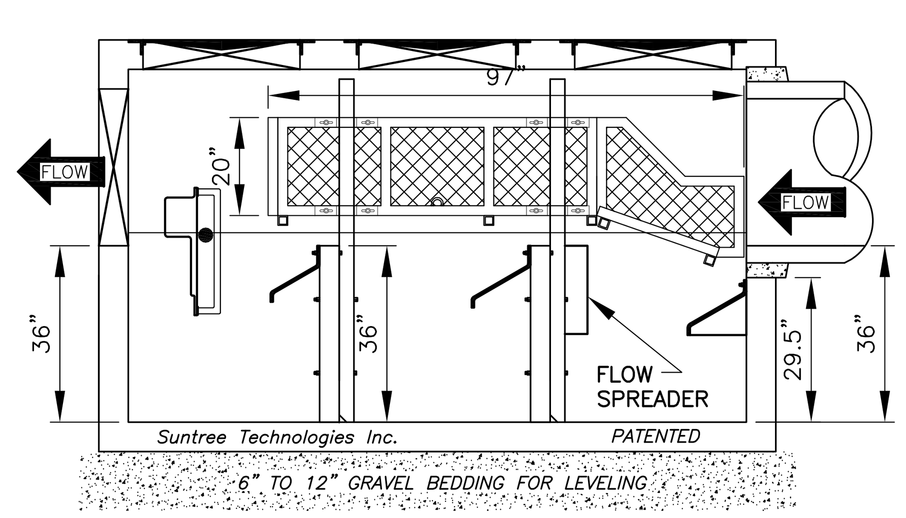
PLAN
3/8" = 1'-0"

NOTES:

1. CONCRETE 28 DAY COMPRESSIVE STRENGTH fc–5,000 PSI.
2. REINFORCING: ASTM A–615, GRADE 60.
3. SUPPORTS AN H20 LOADING AS INDICATED BY AASHTO.
4. JOINT SEALANT: BUTYL RUBBER SS–S–00210
5. ALL WALL, TOP, AND BOTTOM ARE 6" THICK.
6. INFLOW AND OUTFLOW PIPES ARE TO BE FLUSH WITH THE INSIDE SURFACE OF THE CONCRETE STRUCTURE. (CAN NOT INTRUDE BEYOND FLUSH)
7. HINGED LIDS FOR THE SCREEN SYSTEM ARE AVAILABLE UPON REQUEST.
8. BAFFLES WILL BE SEALED WITH GROUT TO FORM THREE WATER TIGHT CHAMBERS.
9. BAFFLE BOX INSTALLATION SHALL BE PERFORMED ACCORDING TO MANUFACTURERS RECOMMENDATIONS.

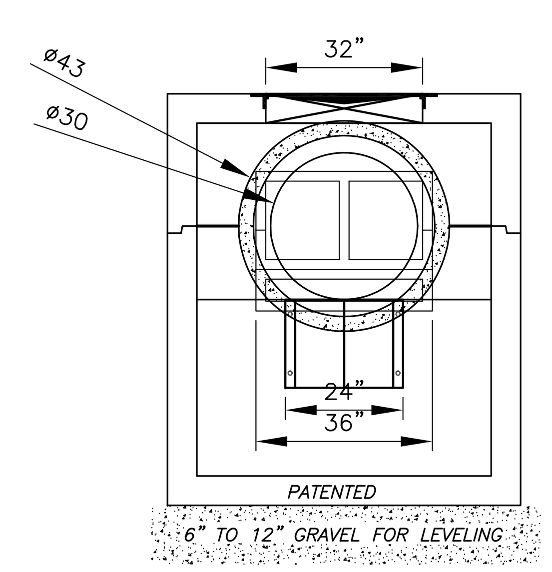
INSTALLATION NOTES:

1. INFLOW AND OUTFLOW PIPES ARE TO BE FLUSH WITH THE INSIDE SURFACE OF THE CONCRETE STRUCTURE. (CAN NOT INTRUDE BEYOND FLUSH)
2. INVERT OF OUTFLOW PIPE SHOULD BE EVEN WITH THE TOP OF THE BAFFLES.
3. BAFFLES SHOULD BE SEALED WITH GROUT.
4. THE BOTTOM OF THE SKIMMER SHOULD BE 6" BELOW THE INVERT OF THE OUTFLOW PIPE.
5. INVERT OF THE INFLOW PIPE SHOULD NOT BE BELOW THE INVERT OF THE OUTFLOW PIPE.



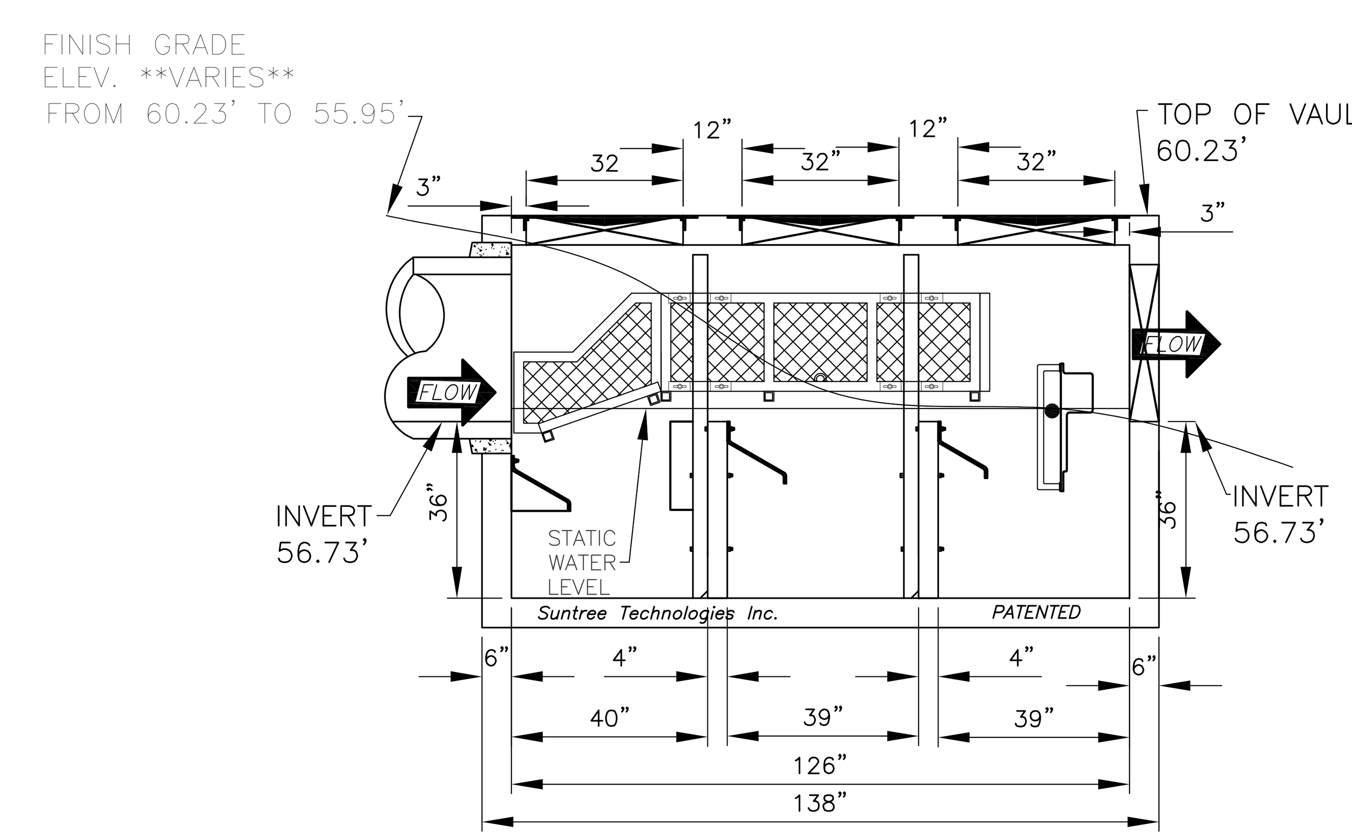
REAR VIEW

SECTION 1
3/8" = 1'-0"



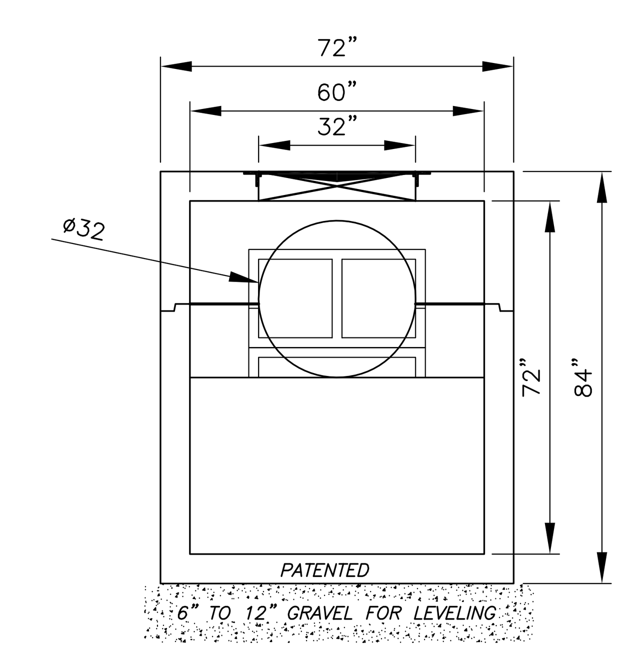
LEFT END VIEW

SECTION 2
3/8" = 1'-0"



FRONT VIEW

SECTION 3
3/8" = 1'-0"



RIGHT END VIEW

SECTION 4
3/8" = 1'-0"

DATE:
BRIAN K. WILLIAMS
P.E NO. 64086

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: B. STOLTZ
DRAWN BY: D. BUCKLAND
SHEET CHK'D BY: D. HONOUR
CROSS CHK'D BY: J. WITTIG
APPROVED BY: B. WILLIAMS
DATE: NOVEMBER 2008

CDM
Camp Dresser & McKee Inc.
2301 Maitland Center Parkway, Suite 300
Maitland, FL 32751
Tel: (407) 660-2552
FL COA No. EB-0000020
consulting • engineering • construction • operations

CITY OF CASSELBERRY
ANNIVERSARY PARK
LAKE CONCORD STORMWATER PARK

BAFFLE BOX NO. 2

PROJECT NO. 61762–61938
FILE NAME: CD02BBDT
SHEET NO.
CD-2

APPENDIX C

RESULTS OF LABORATORY ANALYSES CONDUCTED ON THE GPS INFLOW AND OUTFLOW SAMPLES

Chemical Characteristics of Inflow and Outflow Samples Collected from Casselberry Gross Pollutant Separators from June 2013 - January 2014

Site Description	Device Type	Monitoring Location	Date Collected	pH (s.u.)	Alkalinity (mg/L)	Conductivity (µmho/cm)	NH_3 (µg/L)	NO_X (µg/L)	Diss. Org. N (µg/L)	Part. N (µg/L)	Total N (µg/L)	SRP (µg/L)	Diss. Org. P (µg/L)	Part. P (µg/L)	Total P (µg/L)	Turbidity (NTU)	Color (Pt-Co)	TSS (mg/L)	Fecal (cfu/100 mL)	Copper (µg/L)	Iron (µg/L)	Zinc (µg/L)
Lake Hodge	EcoVault	Inflow	6/27/13	7.33	98.2	208	28	185	287	39	539	99	4	42	145	2.1	30	4.0	138	3	284	12
Lake Hodge	EcoVault	Inflow	7/5/13	6.71	29.8	71	3	51	322	50	426	48	7	73	128	2.4	24	89.2	x	8	163	53
Lake Hodge	EcoVault	Inflow	7/17/13	6.49	18.2	42	3	33	140	175	351	180	1	34	215	3.1	32	11.2	TNTC	2	42	2
Lake Hodge	EcoVault	Inflow	7/22/13	7.12	120	241	159	3	132	145	439	120	22	45	187	5.9	38	437	2,600	12	1,138	31
Lake Hodge	EcoVault	Inflow	7/31/13	7.06	101	206	32	5	359	143	539	64	13	111	188	1.6	30	106	x	5	532	15
Lake Hodge	EcoVault	Inflow	8/7/13	6.67	70.4	191	3	7	396	185	591	38	14	108	160	9.1	32	63.6	7,200	3	393	2
Lake Hodge	EcoVault	Inflow	8/21/13	6.98	57.0	141	223	18	120	402	763	746	251	202	1,199	44.0	88	89.2	x	8	457	12
Lake Hodge	EcoVault	Inflow	8/28/13	6.92	63.6	172	470	15	157	2,088	2,730	353	15	733	1,101	61.5	41	483	x	49	4,830	43
Lake Hodge	EcoVault	Inflow	9/5/13	6.89	46.6	134	183	41	183	26	433	377	14	241	632	18.8	39	457	10,560	7	458	37
Lake Hodge	EcoVault	Inflow	9/11/13	6.99	70.6	306	45	3	195	18	261	250	2	39	291	1.2	50	2.8	x	4	202	2
Lake Hodge	EcoVault	Inflow	9/19/13	7.77	140	312	3	1,074	228	18	1,323	217	19	103	339	5.3	46	89.2	120	4	454	6
Lake Hodge	EcoVault	Inflow	9/25/13	6.95	114	223	131	40	274	634	1,079	205	27	275	507	15.6	52	88.8	x	9	965	79
Lake Hodge	EcoVault	Inflow	10/9/13	6.51	34.4	77	7	14	179	303	503	101	5	55	161	2.4	29	43.0	x	6	234	23
Lake Hodge	EcoVault	Inflow	11/6/13	6.78	26.2	76	3	31	107	201	342	122	8	37	167	3.4	28	116	x	5	196	16
Lake Hodge	EcoVault	Inflow	11/29/13	6.89	41.8	94	3	49	205	14	271	141	11	238	390	5.4	38	58.6	x	18	691	68
Lake Hodge	EcoVault	Inflow	1/2/14	7.09	49.4	113	9	15	350	129	503	255	32	44	331	8.3	34	36.2	x	8	390	21
Lake Hodge	EcoVault	Inflow	1/15/14	6.89	32.6	98	18	188	236	551	993	111	3	447	561	73.0	25	516	x	41	221	26
		Minimum Value:		**6.49**	**18.2**	**42**	**3**	**3**	**107**	**14**	**261**	**38**	**1**	**34**	**128**	**1.2**	**24**	**2.8**	**120**	**2**	**42**	**2**
		Maximum Value:		**7.77**	**140**	**312**	**470**	**1,074**	**396**	**2,088**	**2,730**	**746**	**251**	**733**	**1,199**	**73.0**	**88**	**516**	**10,560**	**49**	**4,830**	**79**
		Median Value:		**6.92**	**57.0**	**141**	**18**	**31**	**205**	**145**	**503**	**141**	**13**	**103**	**291**	**5.4**	**34**	**89.2**	**2,600**	**7.0**	**393**	**21**
		Geometric Mean:		**6.94**	**56.0**	**138**	**20**	**27**	**211**	**123**	**577**	**153**	**11**	**104**	**306**	**6.9**	**37**	**70.8**	**1,268**	**7.4**	**390**	**16**
Lake Hodge	EcoVault	Outflow	6/27/13	7.32	172	353	52	326	187	90	655	39	10	6	55	0.9	14	1.6	52	3	155	5
Lake Hodge	EcoVault	Outflow	7/5/13	7.10	82.8	176	46	90	238	97	471	48	9	15	72	1.3	28	1.7	x	2	92	9
Lake Hodge	EcoVault	Outflow	7/17/13	7.14	59.8	125	71	29	136	209	445	136	2	19	157	1.5	37	4.0	10,240	2	140	2
Lake Hodge	EcoVault	Outflow	7/22/13	7.40	123	241	188	4	222	424	838	50	9	196	255	1.9	27	2.4	533	6	1,046	2
Lake Hodge	EcoVault	Outflow	7/31/13	7.27	90.4	186	126	131	291	80	628	45	5	26	76	1.6	24	4.6	x	3	486	6
Lake Hodge	EcoVault	Outflow	8/7/13	7.08	116	248	76	75	592	45	788	57	6	67	130	1.6	32	3.6	1,000	3	514	2
Lake Hodge	EcoVault	Outflow	8/21/13	6.79	49.0	132	218	242	125	173	758	729	233	46	1,008	1.5	76	18.8	x	5	655	2
Lake Hodge	EcoVault	Outflow	8/28/13	6.31	33.4	75	76	166	82	304	628	230	154	23	407	10.0	29	104	x	6	861	2
Lake Hodge	EcoVault	Outflow	9/5/13	7.06	43.6	100	60	75	85	195	415	210	13	32	255	3.0	33	33.0	1,950	10	85	29
Lake Hodge	EcoVault	Outflow	9/11/13	6.72	22.8	207	48	168	23	58	297	49	20	21	90	0.6	18	1.4	x	8	334	10
Lake Hodge	EcoVault	Outflow	9/19/13	7.35	135	302	3	635	231	120	989	140	25	13	178	1.1	33	2.2	1	5	115	3
Lake Hodge	EcoVault	Outflow	9/25/13	6.47	36.4	257	265	149	112	206	732	648	151	172	971	3.6	66	38.6	x	7	575	39
Lake Hodge	EcoVault	Outflow	10/9/13	7.73	98.6	207	225	12	302	90	629	87	17	49	153	1.1	36	1.6	x	2	475	2
Lake Hodge	EcoVault	Outflow	11/6/13	6.81	25.0	76	5	26	221	83	335	123	7	23	153	2.2	29	6.4	x	3	104	10
Lake Hodge	EcoVault	Outflow	11/29/13	7.32	38.4	89	11	69	169	54	303	152	7	32	191	1.5	35	1.6	x	5	124	2
Lake Hodge	EcoVault	Outflow	1/2/14	6.99	47.2	106	83	37	231	107	458	230	56	43	329	1.8	28	3.6	x	5	308	5
Lake Hodge	EcoVault	Outflow	1/15/14	6.80	27.4	59	47	491	160	412	1,110	149	11	245	405	15.4	23	143	x	12	720	5
		Minimum Value:		**6.31**	**22.8**	**59**	**3**	**4**	**23**	**45**	**297**	**39**	**2**	**6**	**55**	**0.6**	**14**	**1.4**	**1**	**2**	**85**	**2**
		Maximum Value:		**7.73**	**172**	**353**	**265**	**635**	**592**	**424**	**1,110**	**729**	**233**	**245**	**1,008**	**15.4**	**76**	**143**	**10,240**	**12**	**1,046**	**39**
		Median Value:		**7.08**	**49.0**	**176**	**71**	**90**	**187**	**107**	**628**	**136**	**11**	**32**	**178**	**1.6**	**29**	**3.6**	**767**	**5.0**	**334**	**5.0**
		Geometric Mean:		**7.03**	**58.4**	**152**	**56**	**85**	**165**	**129**	**573**	**122**	**17**	**36**	**202**	**2.0**	**31**	**6.2**	**287**	**4.4**	**291**	**4.7**

Chemical Characteristics of Inflow and Outflow Samples Collected from Casselberry Gross Pollutant Separators from June 2013 - January 2014

Site Description	Device Type	Monitoring Location	Date Collected	pH (s.u.)	Alkalinity (mg/L)	Conductivity (µmho/cm)	NH_3 (µg/L)	NO_x (µg/L)	Diss. Org. N (µg/L)	Part. N (µg/L)	Total N (µg/L)	SRP (µg/L)	Diss. Org. P (µg/L)	Part. P (µg/L)	Total P (µg/L)	Turbidity (NTU)	Color (Pt-Co)	TSS (mg/L)	Fecal (cfu/100 mL)	Copper (µg/L)	Iron (µg/L)	Zinc (µg/L)
Gee Creek	EcoVault	Inflow	6/27/13	7.17	80.0	206	3	631	367	38	1,039	31	9	20	60	8.9	52	2.7	18	2	245	4
Gee Creek	EcoVault	Inflow	7/5/13	7.22	83.4	251	3	890	351	226	1,470	23	5	89	117	14.7	52	90.8	x	41	387	22
Gee Creek	EcoVault	Inflow	7/11/13	7.36	117	285	3	670	177	185	1,035	37	8	47	92	10.6	50	61.8	x	46	338	14
Gee Creek	EcoVault	Inflow	7/17/13	7.21	68.2	148	79	693	113	101	986	119	9	71	199	4.5	41	49.6	88	9	227	6
Gee Creek	EcoVault	Inflow	7/22/13	7.01	88.0	437	35	611	396	40	1,082	27	23	75	125	10.1	47	58.4	667	21	743	10
Gee Creek	EcoVault	Inflow	7/31/13	7.61	113	261	44	467	40	509	1,060	27	5	153	185	14.0	60	87.6	x	42	1,512	19
Gee Creek	EcoVault	Inflow	8/7/13	6.86	74.4	174	3	551	297	60	911	28	34	7	69	3.7	43	113	120	2	331	7
Gee Creek	EcoVault	Inflow	8/13/13	7.63	182	396	3	443	312	50	808	17	11	57	85	9.7	60	70.8	x	12	684	18
Gee Creek	EcoVault	Inflow	8/21/13	7.51	120	285	3	262	412	82	759	36	2	63	101	8.3	71	31.6	x	25	1,997	23
Gee Creek	EcoVault	Inflow	8/28/13	7.19	108	249	67	266	341	174	848	60	2	140	202	17.5	59	79.2	1,160	30	1,278	40
Gee Creek	EcoVault	Inflow	9/5/13	7.64	60.2	273	3	638	169	226	1,036	79	7	179	265	24.4	53	163	3,680	16	935	22
Gee Creek	EcoVault	Inflow	9/11/13	6.94	89.0	225	82	846	236	154	1,318	13	4	221	238	10.3	59	57.2	x	10	1,203	55
Gee Creek	EcoVault	Inflow	9/19/13	7.56	107	271	43	579	272	161	1,055	26	3	126	155	28.7	60	85.4	560	15	143	27
Gee Creek	EcoVault	Inflow	9/25/13	7.46	114	219	3	480	335	145	963	25	20	76	121	6.1	81	20.6	x	13	1,000	7
Gee Creek	EcoVault	Inflow	10/1/13	7.76	111	261	3	622	123	126	874	41	17	38	96	6.6	74	18.2	x	9	833	4
Gee Creek	EcoVault	Inflow	10/9/13	7.23	117	292	3	304	144	58	509	30	6	92	128	11.9	69	54.8	x	10	580	63
Gee Creek	EcoVault	Inflow	10/17/13	7.31	122	293	3	342	182	77	604	44	15	52	111	13.0	60	68.0	x	9	975	18
Gee Creek	EcoVault	Inflow	11/6/13	7.71	119	285	3	307	150	65	525	69	5	91	165	6.5	64	48.4	x	12	606	9
Gee Creek	EcoVault	Inflow	11/29/13	7.82	120	295	3	209	260	53	525	38	5	83	126	14.1	66	84.0	x	11	807	17
Gee Creek	EcoVault	Inflow	1/2/14	7.31	69.0	213	74	239	266	457	1,036	126	23	286	435	49.0	59	166	x	12	1,832	37
		Minimum Value:		**6.86**	**60.2**	**148**	**3**	**209**	**40**	**38**	**509**	**13**	**2**	**7**	**60**	**3.7**	**41**	**2.7**	**18**	**2**	**143**	**4**
		Maximum Value:		**7.82**	**182**	**437**	**82**	**890**	**412**	**509**	**1,470**	**126**	**34**	**286**	**435**	**49.0**	**81**	**166**	**3,680**	**46**	**1,997**	**63**
		Median Value:		**7.34**	**109.5**	**266**	**3**	**516**	**263**	**114**	**975**	**34**	**8**	**80**	**126**	**10.5**	**60**	**64.9**	**560**	**12**	**775**	**18**
		Geometric Mean:		**7.37**	**99.7**	**258**	**8**	**461**	**219**	**112**	**887**	**37**	**8**	**75**	**137**	**11.2**	**58**	**54.7**	**314**	**13**	**669**	**16**
Gee Creek	EcoVault	Outflow	6/27/13	7.02	86.8	235	3	1,028	171	20	1,222	51	4	17	72	11.2	57	2.1	2	6	329	2
Gee Creek	EcoVault	Outflow	7/5/13	7.51	88.0	231	3	1,035	272	35	1,345	19	2	24	45	5.3	51	11.1	x	4	168	2
Gee Creek	EcoVault	Outflow	7/11/13	7.65	94.8	239	3	851	325	26	1,205	6	4	26	36	8.7	50	17.4	x	2	247	2
Gee Creek	EcoVault	Outflow	7/17/13	7.37	76.6	181	3	278	376	66	723	112	4	25	141	9.1	48	13.4	303	2	212	2
Gee Creek	EcoVault	Outflow	7/22/13	6.92	46.0	166	18	206	166	34	424	31	16	30	77	12.3	43	21.4	100	8	1,137	6
Gee Creek	EcoVault	Outflow	7/31/13	7.65	91.4	233	30	624	24	399	1,077	11	8	22	41	4.7	64	8.2	x	5	751	8
Gee Creek	EcoVault	Outflow	8/7/13	7.39	85.4	241	3	717	434	165	1,319	11	3	67	81	7.1	53	14.0	120	4	367	2
Gee Creek	EcoVault	Outflow	8/13/13	7.61	116	291	3	604	213	167	987	7	2	30	39	7.1	58	13.2	x	4	458	2
Gee Creek	EcoVault	Outflow	8/21/13	7.62	108	258	3	244	399	105	751	20	6	40	66	3.8	65	25.8	x	4	725	2
Gee Creek	EcoVault	Outflow	8/28/13	7.37	64.2	160	3	412	156	110	681	71	9	25	105	4.8	61	7.2	1,214	3	335	6
Gee Creek	EcoVault	Outflow	9/5/13	7.42	77.4	191	3	525	166	632	1,326	81	4	15	100	3.3	59	5.6	2,920	5	401	2
Gee Creek	EcoVault	Outflow	9/11/13	7.38	72.0	282	3	599	382	112	1,096	46	5	39	90	6.6	68	15.2	x	7	887	9
Gee Creek	EcoVault	Outflow	9/19/13	7.51	101	249	235	537	99	255	1,126	21	32	502	555	7.0	22	14.4	1	10	433	2
Gee Creek	EcoVault	Outflow	9/25/13	7.48	107	283	16	260	192	186	654	22	6	3	31	7.8	71	11.4	x	5	505	3
Gee Creek	EcoVault	Outflow	10/1/13	7.62	107	248	3	113	403	85	604	5	4	46	55	10.1	69	15.2	x	5	602	13
Gee Creek	EcoVault	Outflow	10/9/13	7.41	96.6	235	3	148	174	602	927	33	4	53	90	8.9	62	14.6	x	5	561	2
Gee Creek	EcoVault	Outflow	10/17/13	7.55	114	280	3	8	417	22	450	18	6	26	50	7.0	58	10.4	x	5	476	2
Gee Creek	EcoVault	Outflow	11/6/13	7.66	134	300	3	13	146	131	293	12	8	47	67	7.4	59	12.8	x	6	462	22
Gee Creek	EcoVault	Outflow	11/29/13	7.76	119	301	3	32	217	29	281	9	4	36	49	4.3	63	12.6	x	8	287	2
Gee Creek	EcoVault	Outflow	1/2/14	7.51	73.0	175	3	9	307	111	430	97	2	77	176	7.6	64	17.6	x	4	602	4
		Minimum Value:		**6.92**	**46.0**	**160**	**3**	**8**	**24**	**20**	**281**	**5**	**2**	**3**	**31**	**3.3**	**22**	**2.1**	**1**	**2**	**168**	**2**
		Maximum Value:		**7.76**	**134**	**301**	**235**	**1,035**	**434**	**632**	**1,345**	**112**	**32**	**502**	**555**	**12.3**	**71**	**25.8**	**2,920**	**10**	**1,137**	**22**
		Median Value:		**7.51**	**93.1**	**240**	**3**	**345**	**215**	**111**	**839**	**21**	**4**	**30**	**70**	**7.1**	**59**	**13.3**	**120**	**5.0**	**460**	**2.0**
		Geometric Mean:		**7.47**	**90.4**	**235**	**5**	**211**	**215**	**99**	**760**	**23**	**5**	**33**	**74**	**6.8**	**56**	**11.9**	**82**	**4.7**	**447**	**3.4**

Chemical Characteristics of Inflow and Outflow Samples Collected from Casselberry Gross Pollutant Separators from June 2013 - January 2014

Site Description	Device Type	Monitoring Location	Date Collected	pH (s.u.)	Alkalinity (mg/L)	Conductivity (μmho/cm)	NH_3 (μg/L)	NO_x (μg/L)	Diss. Org. N (μg/L)	Part. N (μg/L)	Total N (μg/L)	SRP (μg/L)	Diss. Org. P (μg/L)	Part. P (μg/L)	Total P (μg/L)	Turbidity (NTU)	Color (Pt-Co)	TSS (mg/L)	Fecal (cfu/100 mL)	Copper (μg/L)	Iron (μg/L)	Zinc (μg/L)
San Pablo	EcoVault	Inflow	7/17/13	7.09	65.8	206	137	180	205	248	770	98	5	40	143	4.5	43	8.0	5,367	9	766	7
San Pablo	EcoVault	Inflow	7/22/13	6.98	113	311	295	311	460	302	1,368	83	7	167	257	33.3	39	191	1,333	17	1,299	48
San Pablo	EcoVault	Inflow	7/31/13	7.47	126	311	158	1,113	181	440	1,892	55	6	69	130	5.4	52	41.0	x	8	636	6
San Pablo	EcoVault	Inflow	8/7/13	6.92	80.4	273	3	583	244	346	1,176	40	4	190	234	13.6	35	233	5,160	16	536	32
San Pablo	EcoVault	Inflow	8/13/13	7.57	106	335	134	623	470	107	1,334	73	4	44	121	5.4	38	28.6	x	6	108	3
San Pablo	EcoVault	Inflow	8/21/13	7.42	107	331	48	586	302	158	1,094	61	4	116	181	2.8	35	55.0	x	10	796	29
San Pablo	EcoVault	Inflow	8/28/13	6.77	36.4	95	44	200	106	157	507	92	5	108	205	6.1	22	54.8	x	10	455	34
San Pablo	EcoVault	Inflow	9/5/13	6.92	80.4	217	213	127	273	51	664	163	2	19	184	4.9	36	20.4	5,200	8	279	7
San Pablo	EcoVault	Inflow	9/11/13	7.23	79.4	230	275	275	580	332	1,462	77	3	23	103	1.4	45	7.4	x	9	211	25
San Pablo	EcoVault	Inflow	9/19/13	6.88	68.6	197	49	12	472	118	651	76	10	57	143	4.0	64	6.6	28,200	9	202	11
San Pablo	EcoVault	Inflow	9/25/13	7.57	109	198	3	428	257	117	805	82	13	71	166	9.2	37	10.6	x	6	203	4
San Pablo	EcoVault	Inflow	10/9/13	6.71	67.6	173	3	121	62	604	790	77	7	82	166	3.5	47	13.0	x	3	287	13
San Pablo	EcoVault	Inflow	1/2/14	7.05	91.8	236	10	40	282	493	825	91	6	288	385	14.2	42	50.6	x	11	611	40
San Pablo	EcoVault	Inflow	1/15/14	6.83	44.0	104	3	29	251	147	430	134	7	88	229	4.7	47	25.4	x	9	355	38
		Minimum Value:		**6.71**	**36.4**	**95**	**3**	**12**	**62**	**51**	**430**	**40**	**2**	**19**	**103**	**1.4**	**22**	**6.6**	**1,333**	**3**	**108**	**3**
		Maximum Value:		**7.57**	**126**	**335**	**295**	**1,113**	**580**	**604**	**1,892**	**163**	**13**	**288**	**385**	**33.3**	**64**	**233**	**28,200**	**17**	**1,299**	**48**
		Median Value:		**7.02**	**80.4**	**224**	**49**	**238**	**257**	**203**	**815**	**80**	**6**	**77**	**174**	**5.2**	**41**	**27.0**	**5,200**	**9.0**	**405**	**19**
		Geometric Mean:		**7.09**	**79.5**	**216**	**35**	**188**	**245**	**209**	**905**	**81**	**5**	**75**	**178**	**5.9**	**40**	**28.4**	**5,581**	**8.7**	**392**	**15**
San Pablo	EcoVault	Outflow	7/17/13	7.23	86.4	236	176	169	17	385	747	100	6	41	147	3.7	44	7.4	5,650	8	541	5
San Pablo	EcoVault	Outflow	7/22/13	7.31	128	329	134	642	208	382	1,366	65	30	10	105	4.9	44	9.0	333	8	1,198	8
San Pablo	EcoVault	Outflow	7/31/13	7.43	106	329	198	972	470	77	1,717	72	16	10	98	2.0	42	2.0	x	3	285	4
San Pablo	EcoVault	Outflow	8/7/13	6.96	89.8	278	86	502	430	286	1,304	24	11	123	158	9.0	44	62.0	13,400	15	471	41
San Pablo	EcoVault	Outflow	8/13/13	7.48	117	341	155	426	356	134	1,071	63	12	46	121	3.0	43	9.4	x	14	101	10
San Pablo	EcoVault	Outflow	8/21/13	7.05	106	338	3	58	435	72	568	38	11	69	118	4.4	45	22.8	x	10	454	12
San Pablo	EcoVault	Outflow	8/28/13	7.09	4.0	98	71	199	137	95	502	94	2	60	156	4.9	22	15.0	x	6	308	59
San Pablo	EcoVault	Outflow	9/5/13	6.87	42.8	117	108	248	114	502	972	197	7	92	296	10.5	33	69.6	2,500	15	311	19
San Pablo	EcoVault	Outflow	9/11/13	7.04	102	218	205	279	143	636	1,263	73	8	70	151	7.0	48	7.8	x	6	274	6
San Pablo	EcoVault	Outflow	9/19/13	6.94	106	292	332	56	106	421	915	143	12	80	235	3.0	49	7.2	14,000	6	508	8
San Pablo	EcoVault	Outflow	9/25/13	7.59	114	208	3	343	156	158	660	97	24	101	222	1.6	38	10.8	x	5	282	6
San Pablo	EcoVault	Outflow	10/9/13	6.65	48.0	123	24	283	59	158	524	79	6	73	158	4.9	46	16.8	x	5	381	13
San Pablo	EcoVault	Outflow	1/2/14	7.13	91.4	227	3	87	329	292	711	132	44	123	299	9.7	44	19.2	x	6	336	15
San Pablo	EcoVault	Outflow	1/15/14	7.54	36.6	89	8	27	362	306	703	112	6	105	223	4.8	33	44.4	x	7	261	48
		Minimum Value:		**6.65**	**4.0**	**89**	**3**	**27**	**17**	**72**	**502**	**24**	**2**	**10**	**98**	**1.6**	**22**	**2.0**	**333**	**3**	**101**	**4**
		Maximum Value:		**7.59**	**128**	**341**	**332**	**972**	**556**	**636**	**1,717**	**197**	**44**	**123**	**299**	**10.5**	**49**	**70**	**14,000**	**15**	**1,198**	**59**
		Median Value:		**7.11**	**97**	**232**	**97**	**264**	**208**	**289**	**831**	**87**	**11**	**72**	**157**	**4.9**	**44**	**12.9**	**5,650**	**6.5**	**324**	**11**
		Geometric Mean:		**7.16**	**67.9**	**209**	**46**	**205**	**194**	**226**	**867**	**82**	**11**	**58**	**167**	**4.6**	**40**	**14.4**	**3,883**	**7.4**	**355**	**13**

Chemical Characteristics of Inflow and Outflow Samples Collected from Casselberry Gross Pollutant Separators from June 2013 - January 2014

Site Description	Device Type	Monitoring Location	Date Collected	pH (s.u.)	Alkalinity (mg/L)	Conductivity (µmho/cm)	NH_3 (µg/L)	NO_X (µg/L)	Diss. Org. N (µg/L)	Part. N (µg/L)	Total N (µg/L)	SRP (µg/L)	Diss. Org. P (µg/L)	Part. P (µg/L)	Total P (µg/L)	Turbidity (NTU)	Color (Pt-Co)	TSS (mg/L)	Fecal (cfu/100 mL)	Copper (µg/L)	Iron (µg/L)	Zinc (µg/L)
Lake Concord	SunTree B/B	Outflow	6/27/13	7.80	180	418	3	304	575	389	1,271	48	12	6	66	1.6	14	0.9	2B	6	106	3
Lake Concord	SunTree B/B	Outflow	7/17/13	7.90	108	233	3	279	109	75	466	55	2	11	68	6.5	29	12.4	TNTC	2	89	2
Lake Concord	SunTree B/B	Outflow	7/22/13	7.82	62.4	150	11	76	185	121	393	2	2	31	35	5.2	19	6.8	200		471	2
Lake Concord	SunTree B/B	Outflow	7/31/13	7.51	186	398	3	497	283	31	814	35	4	21	60	1.9	18	3.8	x	3	445	2
Lake Concord	SunTree B/B	Outflow	8/7/13	7.23	60.6	127	3	257	79	217	556	37	2	10	49	5.7	21	26.8	1,400	16	511	25
Lake Concord	SunTree B/B	Outflow	8/13/13	7.52	214	548	224	301	236	106	867	47	5	72	124	1.6	29	3.0	x	11	421	16
Lake Concord	SunTree B/B	Outflow	8/21/13	7.31	204	435	28	335	492	20	875	35	11	32	78	2.8	45	9.8	x	6	398	7
Lake Concord	SunTree B/B	Outflow	8/28/13	7.86	113	246	7	329	207	257	800	56	4	115	175	18.2	22	68.8	x	11	356	55
Lake Concord	SunTree B/B	Outflow	9/5/13	7.21	52.2	121	12	278	231	88	609	98	11	70	179	18.6	33	108	1,000	7	277	13
Lake Concord	SunTree B/B	Outflow	9/11/13	8.18	126	135	3	482	98	66	649	56	5	16	77	7.2	24	11.8	x	6	205	18
Lake Concord	SunTree B/B	Outflow	9/19/13	7.59	202	475	3	533	180	84	800	21	7	22	50	1.7	21	2.8	280	3	203	2
Lake Concord	SunTree B/B	Outflow	9/25/13	7.04	48.2	421	3	124	49	360	536	59	6	72	137	6.4	28	16.8	x	5	319	15
Lake Concord	SunTree B/B	Outflow	10/9/13	6.97	106	223	3	5	56	286	350	36	11	57	104	5.9	33	6.4	x	3	209	2
Lake Concord	SunTree B/B	Outflow	11/6/13	7.68	106	296	3	55	68	117	243	169	12	5	186	0.3	12	0.8	x	3	124	20
Lake Concord	SunTree B/B	Outflow	11/29/13	7.44	42.8	115	3	63	41	102	209	37	12	24	73	2.8	45	9.0	x	8	92	6
Lake Concord	SunTree B/B	Outflow	1/2/14	7.19	53.0	132	24	99	149	122	394	81	9	48	138	6.5	33	39.6	x	10	218	16
Lake Concord	SunTree B/B	Outflow	1/8/14	7.77	68.0	165	83	255	162	35	535	42	7	48	97	3.2	26	18.2	x	5	258	11
Lake Concord	SunTree B/B	Outflow	1/15/14	7.35	40.4	112	10	150	25	276	461	54	5	153	212	12.9	24	91.9	x	11	582	40
		Minimum Value:		**6.97**	**40.4**	**112**	**3**	**5**	**25**	**20**	**209**	**2**	**2**	**5**	**35**	**0.3**	**12**	**0.8**	**200**	**2**	**89**	**2**
		Maximum Value:		**8.18**	**214**	**548**	**224**	**533**	**575**	**389**	**1,271**	**169**	**12**	**153**	**212**	**18.6**	**45**	**108**	**1,400**	**16**	**582**	**55**
		Median Value:		**7.52**	**106**	**228**	**3**	**268**	**156**	**112**	**546**	**48**	**7**	**32**	**88**	**5.5**	**25**	**10.8**	**640**	**6.0**	**268**	**12**
		Geometric Mean:		**7.51**	**93.6**	**227**	**8**	**171**	**130**	**113**	**546**	**42**	**6**	**30**	**93**	**4.1**	**25**	**10.6**	**529**	**5.8**	**252**	**8.4**
San Pablo	CDS Unit	Outflow	6/27/13	7.26	115	313	3	830	199	240	1,272	47	8	19	74	5.0	47	3.4	20	4	297	2
San Pablo	CDS Unit	Outflow	7/5/13	7.79	119	323	3	861	330	51	1,245	46	3	10	59	2.0	39	2.3	x	4	131	2
San Pablo	CDS Unit	Outflow	7/22/13	7.27	142	316	172	540	289	171	1,172	46	2	2	50	2.2	46	1.2	120	8	316	3
San Pablo	CDS Unit	Outflow	7/31/13	7.45	131	348	42	816	368	14	1,240	53	9	14	76	4.8	54	4.6	x	6	329	4
San Pablo	CDS Unit	Outflow	8/7/13	6.89	37.8	98	3	333	172	98	606	54	1	97	152	10.3	19	24.2	120	4	449	8
San Pablo	CDS Unit	Outflow	8/13/13	7.91	118	327	3	887	456	244	1,590	111	2	177	290	31.1	38	77.2	x	13	710	35
San Pablo	CDS Unit	Outflow	8/21/13	7.43	104	274	9	362	232	116	719	81	9	22	112	2.6	51	5.4	x	4	440	4
San Pablo	CDS Unit	Outflow	8/28/13	7.14	93.6	245	176	540	106	66	888	69	12	64	145	3.5	37	7.0	x	2	357	11
San Pablo	CDS Unit	Outflow	9/5/13	6.97	125	326	112	509	76	28	725	48	4	8	60	2.3	39	2.8	560	5	253	2
San Pablo	CDS Unit	Outflow	9/11/13	7.93	108	225	3	489	107	118	717	50	8	24	82	7.6	31	24.6	x	4	240	8
San Pablo	CDS Unit	Outflow	9/19/13	7.11	77.0	189	45	299	174	81	599	55	7	9	71	1.6	42	1.8	680	15	184	5
San Pablo	CDS Unit	Outflow	9/25/13	6.65	26.2	165	3	145	200	140	488	50	10	83	143	3.2	20	6.8	x	6	237	24
San Pablo	CDS Unit	Outflow	10/1/13	6.99	128	334	388	170	433	25	1,016	41	4	23	68	2.1	41	4.8	x	3	364	10
San Pablo	CDS Unit	Outflow	10/9/13	6.95	59.8	161	8	288	388	71	755	44	9	33	86	3.3	48	3.8	x	4	176	12
San Pablo	CDS Unit	Outflow	1/2/14	6.84	56.4	142	45	8	112	229	394	73	4	92	169	4.1	35	1.8	x	3	272	3
San Pablo	CDS Unit	Outflow	1/15/14	6.74	34.0	76	64	21	274	541	900	61	8	153	222	8.8	30	49.0	x	4	227	13
		Minimum Value:		**6.65**	**26.2**	**76**	**3**	**8**	**76**	**14**	**394**	**41**	**1**	**2**	**50**	**1.6**	**19**	**1.2**	**20**	**2**	**131**	**2**
		Maximum Value:		**7.93**	**142**	**348**	**388**	**887**	**456**	**541**	**1,590**	**111**	**12**	**177**	**290**	**31.1**	**54**	**77.2**	**680**	**15**	**710**	**35**
		Median Value:		**7.13**	**106**	**260**	**26**	**426**	**216**	**107**	**822**	**52**	**8**	**24**	**84**	**3.4**	**39**	**4.7**	**120**	**4.0**	**285**	**6.5**
		Geometric Mean:		**7.20**	**82.3**	**221**	**19**	**282**	**214**	**95**	**837**	**56**	**5**	**29**	**102**	**4.1**	**37**	**6.1**	**161**	**4.8**	**287**	**6.2**

APPENDIX D

MASS LOADING CALCULATIONS AND DOCUMENTATION

D.1: Calculated Mean Monthly Concentrations of Measured Parameters at the GPS Monitoring Sites

D.2: Calculated Monthly Mass Loadings for Measured Parameters at the GPS Monitoring Sites

D.1: Calculated Mean Monthly Concentrations of Measured Parameters at the GPS Monitoring Sites

Mean Monthly Chemical Characteristics of Inflow and Outflow Samples Collected from Casselberry Gross Pollutant Separators from June 2013 - January 2014

Site Description	Device Type	Monitoring Location	Date Collected	pH (s.u.)	Alkalinity (mg/L)	Conductivity (µmho/cm)	NH_3 (µg/L)	NO_X (µg/L)	Diss. Org. N (µg/L)	Part. N (µg/L)	Total N (µg/L)	SRP (µg/L)	Diss. Org. P (µg/L)	Part. P (µg/L)	Total P (µg/L)	Turbidity (NTU)	Color (Pt-Co)	TSS (mg/L)	Fecal (cfu/100 mL)	Copper	Iron	Zinc
Lake Hodge	Ecosense B/B	Inflow	June	7.33	98.2	208	28	185	287	39	539	99	4	42	145	2.1	30	4.0	138	3	284	12
			July	6.84	50.6	110	15	13	215	116	434	90	7	59	176	2.9	31	82.5	2,600	6	254	15
			August	6.86	63.4	167	68	12	195	537	1,072	215	37	252	596	29.1	49	139.9	7,200	11	954	10
			September	7.14	85.1	231	42	48	217	48	634	254	11	128	422	6.6	46	56.4	1,126	6	449	14
			October	6.51	34.4	77	7	14	179	303	503	101	5	55	161	2.4	29	43.0	x	6	234	23
			November	6.83	33.1	85	3	39	148	53	304	131	9	94	255	4.3	33	82.4	x	9	368	33
			December	6.91	36.4	94	6	45	206	119	464	149	10	115	332	10.3	31	106.2	x	13	329	28
			January	6.99	40.1	105	13	53	287	267	707	168	10	140	431	24.6	29	136.7	x	18	294	23
Lake Hodge	Ecosense B/B	Outflow	June	7.32	172	353	52	326	187	90	655	39	10	6	55	0.9	14	1.6	52	3	155	5
			July	7.23	82.8	176	46	90	238	97	471	48	9	15	72	1.3	28	1.7	x	2	92	9
			August	6.72	59.8	125	71	29	136	209	445	136	2	19	157	1.5	37	4.0	10,240	2	140	2
			September	6.84	123	241	188	4	222	424	838	50	9	196	255	1.9	27	2.4	533	6	1,046	2
			October	7.73	90.4	186	126	131	291	80	628	45	5	26	76	1.6	24	4.6	x	3	486	6
			November	7.06	116	248	76	75	592	45	788	57	6	67	130	1.6	32	3.6	x	3	514	2
			December	6.98	49.0	132	218	242	125	173	758	729	233	46	1,008	1.5	76	18.8	x	5	655	2
			January	6.89	33.4	75	76	166	82	304	628	230	154	23	407	10.0	29	104.0	x	6	861	2
Gee Creek	Ecosense B/B	Inflow	June	7.17	80.0	206	3	631	367	38	1,039	31	9	20	60	8.9	52	2.7	18	2	245	4
			July	7.28	92.1	261	16	652	162	154	1,115	37	8	81	138	10.0	50	67.7	242	27	507	13
			August	7.44	133	304	8	314	353	89	804	33	4	80	120	11.2	63	56.2	1,160	21	1,204	25
			September	7.31	103	237	22	617	278	153	1,102	20	6	128	165	12.2	66	46.5	560	12	556	22
			October	7.43	117	282	3	401	148	83	645	38	12	57	111	10.1	67	40.8	x	9	778	17
			November	7.76	119	290	3	253	197	59	525	51	5	87	144	9.6	65	63.8	x	11	699	12
			December	7.53	90.8	249	15	246	229	164	737	80	11	158	250	21.7	62	102.9	x	12	1,132	21
			January	7.31	69.0	213	74	239	266	457	1,036	126	23	286	435	49.0	59	166.0	x	12	1,832	37
Gee Creek	Ecosense B/B	Outflow	June	7.02	86.8	235	3	1,028	171	20	1,222	51	4	17	72	11.2	57	2.1	2	6	329	2
			July	7.41	76.9	208	7	501	168	61	882	21	5	25	59	7.5	51	13.5	174	4	376	3
			August	7.50	91.0	232	3	457	275	134	903	18	4	38	68	5.5	59	13.6	382	4	449	3
			September	7.46	92.0	271	22	437	194	174	931	28	10	39	116	7.1	47	13.6	1	7	579	4
			October	7.53	106	254	3	51	308	104	632	14	5	40	63	8.6	63	13.2	x	5	544	4
			November	7.71	126	300	3	20	178	62	287	10	6	41	57	5.6	61	12.7	x	7	364	7
			December	7.61	96.0	229	3	14	234	83	351	32	3	56	100	6.5	62	15.0	x	5	468	5
			January	7.51	73.0	175	3	9	307	111	430	97	2	77	176	7.6	64	17.6	x	4	602	4
San Pablo	Ecosense B/B	Inflow	June	7.21	85.4	244	110	407	252	211	1,067	75	5	80	167	6.5	37	41.9	x	9	540	13
			July	7.18	97.8	271	186	396	257	321	1,258	76	6	77	168	9.3	44	39.7	2,675	11	859	13
			August	7.24	74.5	220	66	418	247	138	904	74	4	82	165	4.5	31	44.2	x	8	339	14
			September	7.14	83.1	210	54	116	372	124	845	94	5	36	146	4.0	44	10.1	12,110	8	222	9
			October	6.71	67.6	173	3	121	62	604	790	77	7	82	166	3.5	47	13.0	x	3	287	13
			November	6.82	65.5	165	4	64	128	403	686	92	7	114	222	5.3	46	21.6	x	5	366	23
			December	6.88	64.5	161	5	47	185	329	639	101	7	135	257	6.6	45	27.8	x	7	413	30
			January	6.94	63.6	157	5	34	266	269	596	110	6	159	297	8.2	44	35.9	x	10	466	39
San Pablo	Ecosense B/B	Outflow	June	7.23	86.4	236	176	169	17	385	747	100	6	41	147	3.7	44	7.4	5,650	8	541	5
			July	7.32	105	295	167	472	118	225	1,206	78	14	16	115	3.3	43	5.1	1,372	6	570	5
			August	7.20	36.7	224	32	170	277	97	673	61	6	58	131	4.0	35	14.8	x	9	242	19
			September	7.10	85.2	198	69	191	128	382	928	119	11	85	220	4.3	41	14.3	5,916	7	332	9
			October	6.65	48.0	123	24	283	59	158	524	79	6	73	158	4.9	46	16.8	x	5	381	13
			November	6.98	52.7	132	11	117	143	217	609	98	10	91	202	5.8	42	22.1	x	6	336	19
			December	7.16	55.2	137	7	75	222	255	656	109	13	102	228	6.3	40	25.4	x	6	315	22
			January	7.33	57.8	142	5	48	345	299	707	122	16	114	258	6.8	38	29.2	x	6	296	27

Mean Monthly Chemical Characteristics of Inflow and Outflow Samples Collected from Casselberry Gross Pollutant Separators from June 2013 - January 2014

Site Description	Device Type	Monitoring Location	Date Collected	pH (s.u.)	Alkalinity (mg/L)	Conductivity (µmho/cm)	NH_3 (µg/L)	NO_X (µg/L)	Diss. Org. N (µg/L)	Part. N (µg/L)	Total N (µg/L)	SRP (µg/L)	Diss. Org. P (µg/L)	Part. P (µg/L)	Total P (µg/L)	Turbidity (NTU)	Color (Pt-Co)	TSS (mg/L)	Fecal (cfu/100 mL)	Copper	Iron	Zinc
Lake Concord	SunTree B/B	Outflow	June	7.80	180	418	3	304	575	389	1,271	48	12	6	66	1.6	14	0.9	x	6	106	3
			July	7.74	108	240	5	219	179	66	530	16	3	19	52	4.0	21	6.8	200	4	265	2
			August	7.48	131	294	19	304	209	104	762	43	5	40	95	4.6	28	15.3	1,400	10	418	20
			September	7.49	89.5	239	4	307	119	115	642	51	7	36	99	6.2	26	15.6	529	5	246	9
			October	6.97	106	223	3	5	56	286	350	36	11	57	104	5.9	33	6.4	x	3	209	2
			November	7.56	67.4	184	3	59	53	109	225	79	12	11	117	0.9	23	2.7	x	5	107	11
			December	7.50	59.5	158	9	96	67	107	322	67	9	28	128	2.4	25	10.4	x	6	185	14
			January	7.43	52.6	135	27	156	85	106	460	57	7	71	142	6.4	27	40.5	x	8	320	19
San Pablo	CDS Unit	Outflow	June	7.26	115	313	3	830	199	240	1,272	47	8	19	74	5.0	47	3.4	20	4	297	2
			July	7.50	130	329	28	724	327	50	1,219	48	4	7	61	2.8	46	2.3	120	6	239	3
			August	7.33	81.2	215	11	490	210	116	886	76	4	70	164	7.3	34	16.3	120	5	473	11
			September	7.15	72.2	219	15	322	130	78	624	51	7	19	84	3.1	32	5.4	617	7	227	7
			October	6.97	87.5	232	56	221	410	42	876	42	6	28	76	2.6	44	4.3	x	3	253	11
			November	6.88	61.9	155	55	54	268	122	722	53	6	57	122	4.0	38	6.3	x	3	251	8
			December	6.83	52.1	127	54	26	217	207	656	60	6	82	154	4.9	35	7.7	x	3	250	7
			January	6.79	43.8	104	54	13	175	352	595	67	6	119	194	6.0	32	9.4	x	3	248	6

D.2: Calculated Monthly Mass Loadings for Measured Parameters at the GPS Monitoring Sites

Calculated Monthly Mass Loadings for Evaluated Parameters at the Inflow and Outflow Monitoring Locations

Site Description	Device Type	Monitoring Location	Month	Inflow Vol. (ac-ft)	NH_3 (g)	NO_X (g)	Diss. Org. N (g)	Part. N (g)	Total N (g)	SRP (g)	Diss. Org. P (g)	Part. P (g)	Total P (g)	TSS (Kg)	Copper (g)	Iron (g)	Zinc (g)
Lake Hodge	Ecosense B/B	Inflow	June	2.56	88	584	906	123	1,702	313	13	133	458	13	9.5	897	38
			July	2.09	38	32	554	299	1,118	233	17	153	455	213	14	654	38
			August	3.13	262	48	754	2,075	4,137	832	145	973	2,299	540	41	3,681	39
			September	1.65	86	98	442	98	1,290	518	22	260	858	115	11	913	28
			October	0.47	4	8	104	176	292	59	3	32	93	25	3.5	136	13
			November	0.26	1	12	47	17	98	42	3	30	82	26	3.0	118	11
			December	0.11	1	6	28	16	63	20	1	16	45	14.4	1.8	45	3.8
			January	0.57	9	37	202	187	497	118	7	99	303	96	13	206	16
			Totals:	10.84	490	826	3,038	2,991	9,195	2,134	211	1,694	4,592	1,042	97	6,650	187
Lake Hodge	Ecosense B/B	Outflow	June	2.56	164	1,029	590	284	2,068	123	32	19	174	5.1	9.5	489	16
			July	2.09	119	232	613	250	1,214	124	23	39	186	4.4	5.2	237	23
			August	3.13	274	112	525	807	1,718	525	8	73	606	15.4	7.7	540	7.7
			September	1.65	383	8	452	863	1,705	102	18	399	519	4.9	12	2,128	4.1
			October	0.47	73	76	169	46	364	26	3	15	44	2.7	1.7	282	3.5
			November	0.26	24	24	190	14	253	18	2	21	42	1.2	1.0	165	0.6
			December	0.11	30	33	17	23	103	99	32	6	137	2.6	0.7	89	0.3
			January	0.57	53	117	58	214	441	162	108	16	286	73	4.2	605	1.4
			Totals:	10.84	1,120	1,631	2,614	2,502	7,866	1,179	225	589	1,993	109	42	4,536	57
Gee Creek	Ecosense B/B	Inflow	June	1.36	5	1,058	616	64	1,743	52	15	34	101	4.5	3.4	411	6.7
			July	0.70	14	563	140	133	962	32	7	70	119	58	24	437	11
			August	2.65	28	1,025	1,152	292	2,628	109	12	260	393	184	68	3,935	83
			September	0.87	24	662	298	164	1,183	22	7	138	177	50	13	597	23
			October	0.38	1	188	69	39	302	18	5	27	52	19.1	4.4	365	7.8
			November	0.13	0	41	32	9	84	8	1	14	23	10.2	1.8	112	2.0
			December	0.06	1	18	17	12	55	6	1	12	19	7.6	0.9	84	1.6
			January	0.41	37	121	134	231	524	64	12	145	220	84	6.1	926	19
			Totals:	6.56	111	3,677	2,458	944	7,481	310	59	698	1,102	417	121	6,867	155
Gee Creek	Ecosense B/B	Outflow	June	1.36	5	1,724	287	34	2,050	86	7	29	121	3.5	10	552	3.4
			July	0.70	6	432	145	52	762	18	5	22	51	11.7	3.1	325	2.8
			August	2.65	10	1,493	900	437	2,952	59	14	123	224	44	12	1,469	8.6
			September	0.87	24	469	208	187	999	30	11	42	124	14.6	7.6	621	4.1
			October	0.38	1	24	144	49	296	7	2	19	29	6.2	2.3	255	1.7
			November	0.13	0	3	29	10	46	2	1	7	9	2.0	1.1	58	1.1
			December	0.06	0	1	17	6	26	2	0	4	7	1.1	0.4	35	0.4
			January	0.41	2	5	155	56	217	49	1	39	89	8.9	2.0	304	2.0
			Totals:	6.56	48	4,151	1,885	830	7,348	253	40	283	654	92	39	3,619	24
San Pablo	Ecosense B/B	Inflow	June	1.77	241	889	550	460	2,329	165	11	174	364	91	21	1,178	29
			July	2.00	458	978	635	791	3,104	189	15	191	415	98	26	2,118	31
			August	2.50	202	1,289	761	427	2,789	229	13	253	509	136	26	1,047	44
			September	1.30	87	186	597	198	1,354	151	8	58	233	16	13	355	15
			October	0.37	1	55	28	276	360	35	3	37	76	5.9	1.4	131	5.9
			November	0.50	2	40	79	249	423	57	4	70	137	13.3	3.4	225	14
			December	0.35	2	20	80	142	276	44	3	58	111	12.0	3.2	178	13
			January	0.52	4	22	171	173	382	71	4	102	190	23	6.4	299	25
			Totals:	9.31	997	3,477	2,901	2,715	11,017	939	62	944	2,035	396	100	5,531	177

Calculated Monthly Mass Loadings for Evaluated Parameters at the Inflow and Outflow Monitoring Locations

Site Description	Device Type	Monitoring Location	Month	Inflow Vol. (ac-ft)	NH_3 (g)	NO_X (g)	Diss. Org. N (g)	Part. N (g)	Total N (g)	SRP (g)	Diss. Org. P (g)	Part. P (g)	Total P (g)	TSS (Kg)	Copper (g)	Iron (g)	Zinc (g)
San Pablo	Ecosense B/B	Outflow	June	1.77	384	369	37	840	1,631	218	13	89	321	16.2	17	1,181	11
			July	2.00	412	1,165	292	554	2,973	191	35	39	283	12.6	14	1,405	13
			August	2.50	99	524	854	299	2,076	188	20	177	403	46	29	745	59
			September	1.30	110	306	205	612	1,488	191	18	136	352	23	12	533	14
			October	0.37	11	129	27	72	239	36	3	33	72	7.7	2.3	174	5.9
			November	0.50	7	72	88	134	375	60	6	56	125	13.7	3.5	207	12
			December	0.35	3	33	96	110	283	47	5	44	99	11.0	2.6	136	10
			January	0.52	3	31	221	192	453	78	10	73	166	18.7	4.2	190	17
			Totals:	9.31	1,029	2,630	1,820	2,814	9,519	1,009	111	649	1,820	148	85	4,571	142
Lake Concord	SunTree B/B	Outflow	June	1.23	5	461	872	590	1,928	73	18	9	100	1.4	9.1	161	4.6
			July	1.66	9	449	366	134	1,086	32	5	39	107	14.0	8.0	543	4.1
			August	1.95	46	731	502	251	1,833	103	11	97	229	37	25	1,005	48
			September	1.65	9	624	242	234	1,306	104	14	74	201	32	10	501	19
			October	0.13	0	1	9	46	56	6	2	9	17	1.0	0.5	34	0.3
			November	0.24	1	17	16	32	67	23	4	3	34	0.8	1.5	32	3.2
			December	0.15	2	18	12	20	60	12	2	5	24	1.9	1.2	34	2.7
			January	0.43	14	83	45	56	244	30	4	37	75	21	4.3	170	10
			Totals:	7.44	86	2,384	2,064	1,363	6,578	384	59	275	787	109	60	2,479	91
San Pablo	CDS Unit	Outflow	June	0.41	2	420	101	121	643	24	4	10	37	1.7	2.0	150	1.0
			July	0.44	15	393	178	27	661	26	2	4	33	1.3	3.1	130	1.6
			August	0.49	7	296	127	70	535	46	2	42	99	9.9	2.7	286	6.4
			September	0.55	10	219	88	53	423	34	5	13	57	3.7	4.4	154	4.5
			October	0.08	5	22	40	4	86	4	1	3	8	0.4	0.3	25	1.1
			November	0.11	7	7	36	17	98	7	1	8	17	0.9	0.5	34	1.1
			December	0.04	3	1	11	10	32	3	0	4	8	0.4	0.2	12	0.4
			January	0.10	7	2	22	43	73	8	1	15	24	1.2	0.4	31	0.8
			Totals:	2.22	55	1,359	602	346	2,553	153	15	98	282	19	14	821	17