EVALUATION OF THE PERFORMANCE EFFICIENCY OF THE POPPLETON CREEK WET DETENTION POND

Final Report
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Prepared For:

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SECTION 1

INTRODUCTION

This document provides a summary of work efforts conducted by Environmental Research & Design, Inc. (ERD) for the City of Stuart (City) to evaluate the hydrologic and pollution load performance efficiency of the newly constructed Poppleton Creek wet detention pond. The Poppleton Creek basin is an urbanized area located in south-central portions of the City of Stuart between U.S. 1 and Kanner Highway. A location map for the Poppleton Creek wet detention pond site is given on Figure 1-1.

Figure 1-1. Location Map for the Poppleton Creek Pond Site.

Prior to the early-1970s, most of the land within the basin consisted primarily of agricultural operations. Since that time, the basin has undergone rapid development which included extensive ditching and draining of areas in the vicinity of Poppleton Creek and the surrounding wetlands. Much of the existing development was constructed prior to implementation of regulations requiring stormwater treatment, and many areas within the basin discharge untreated runoff directly into Poppleton Creek. Poppleton Creek drains into the St. Lucie River. The St. Lucie River is on the Group 2 Verified List for impaired waterbodies (2004) through the Total Maximum Daily Load (TMDL) program for nutrients, dissolved oxygen, and copper. An overview of flow patterns in Poppleton Creek and location of the pond site in relation to Poppleton Creek and the St. Lucie River is given on Figure 1-2.

Figure 1-2. Flow Patterns in Poppleton Creek and Proximity to the St. Lucie River.

The City of Stuart is currently in the process of constructing retrofit projects in 11 significant drainage basins throughout the City. The Poppleton Creek wet detention pond, the subject of the monitoring program summarized in this document, is one of these projects.

1.1 Project Description

The Poppleton Creek wet detention pond provides treatment for approximately 271 acres in the headwaters of the 525-acre Poppleton Creek drainage basin. Under pre-construction conditions, a channelized portion of Poppleton Creek flowed along the east side of the wet detention pond site. During construction, a portion of the existing channel was filled, forcing all discharges through Poppleton Creek into the wet detention pond. The City of Stuart estimates that the Poppleton Creek wet detention pond will reduce TSS loads by approximately 88% within the 271-acre watershed basin, with phosphorus loadings reduced by 63% and total nitrogen loadings reduced by 23%.

Photographs of Poppleton Creek in the vicinity of the wet detention pond are given on Figure 1-3. In the vicinity of the pond, Poppleton Creek consists of a man-made earthen drainage ditch used for conveyance of runoff from upstream portions of the watershed area. Poppleton Creek discharges under Central Parkway through a 108-inch CMP and has been diverted into the wet detention facility. A photograph of Poppleton Creek north of Central Parkway is given in Figure 1-4. The natural portion of the creek has been filled upstream of this photograph, forcing the water through a diversion canal and into the wet detention pond.

The Poppleton Creek wet detention pond has a surface area of 5.62 acres, with a maximum water depth of approximately 10 ft at the control water elevation. The pond provides a storage volume of approximately 30 ac-ft which is equivalent to 1.33-inch of treatment volume over the untreated areas of the contributing watershed. Approximately 30% of the surface area of the pond is covered with a planted littoral zone. Runoff exits the pond at the northeast corner through a 128-ft wide weir structure containing seven 10-ft wide rectangular notches. A photograph of the outfall structure is given on Figure 1-5. Discharges from the pond rejoin Poppleton Creek downstream from the wet detention pond site. A schematic of the wet detention pond is given on Figure 1-6. A copy of construction plans for the Poppleton Creek wet detention pond facility is given in Appendix A.

Construction for the pond facility was completed during October 2008, and monitoring of the system was initiated during January 2009. Primary funding for construction of the Poppleton Creek wet detention pond system was provided by the Florida Department of Environmental Protection (FDEP) under Agreement No. S0278 in the amount of $779,000 through a TMDL Water Quality Restoration Grant.

Photographs of the wet detention pond at the start of the field monitoring program during January 2009 are given on Figure 1-7. A variety of emergent wetland plants and trees was planted around the perimeter of the pond as part of the nutrient uptake mechanism. However, during January 2009, the vegetation had recently been planted, and the density of the littoral vegetation was relatively low. Photographs of the wet detention facility during May 2009 are given on Figure 1-8. The density of the littoral zone vegetation has increased substantially, with virtually complete cover in many portions of the lake. The growth of littoral vegetation is particularly apparent in the area upstream from the outfall structure where the planted vegetation had extended more than 50 ft into the pond.

As the habitat density and diversity increased within the pond, wildlife utilization of the pond also expanded proportionally. During the field monitoirng program, ERD personnel observed a wide variety of bird species, reptiles, and mammals foraging within the pond (see Figure 1-9).

a. Poppleton Creek South of Central Parkway

b. Culvert Under Central Parkway into Pond

Figure 1-3. Photographs of Poppleton Creek in the Vicinity of the Wet Detention Pond.

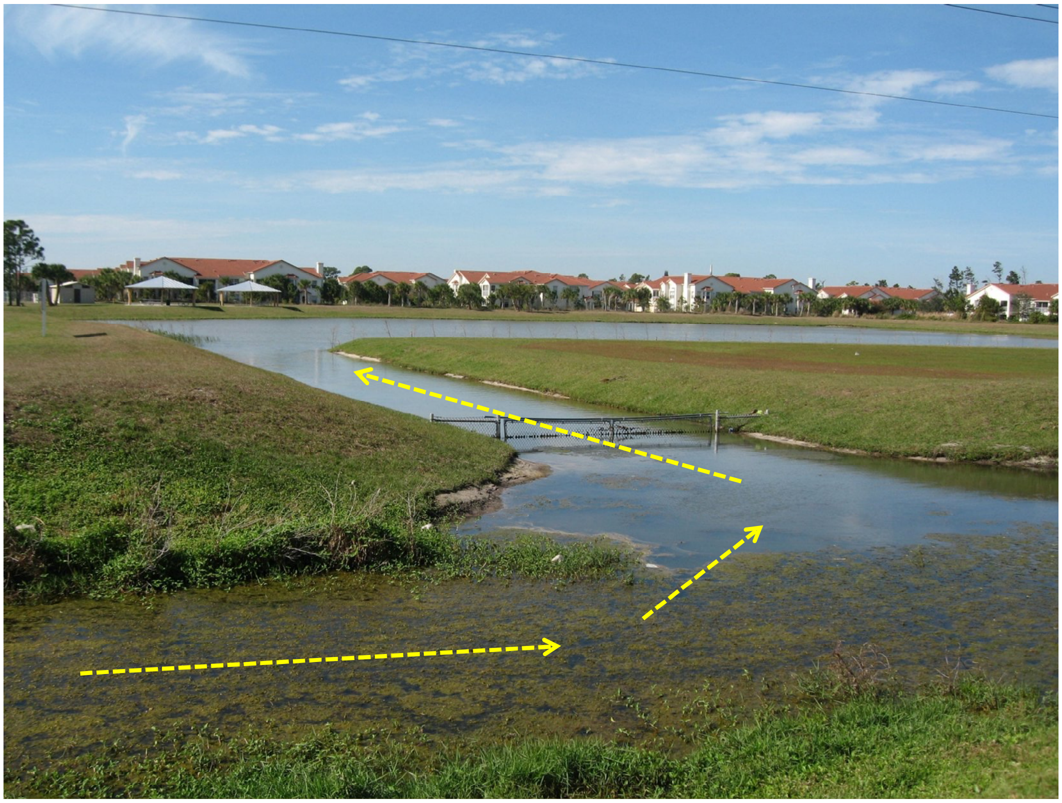


Figure 1-4. Diversion Canal into Wet Detention Pond.

Figure 1-5. Outfall Weir Structure for the Wet Detention Pond.

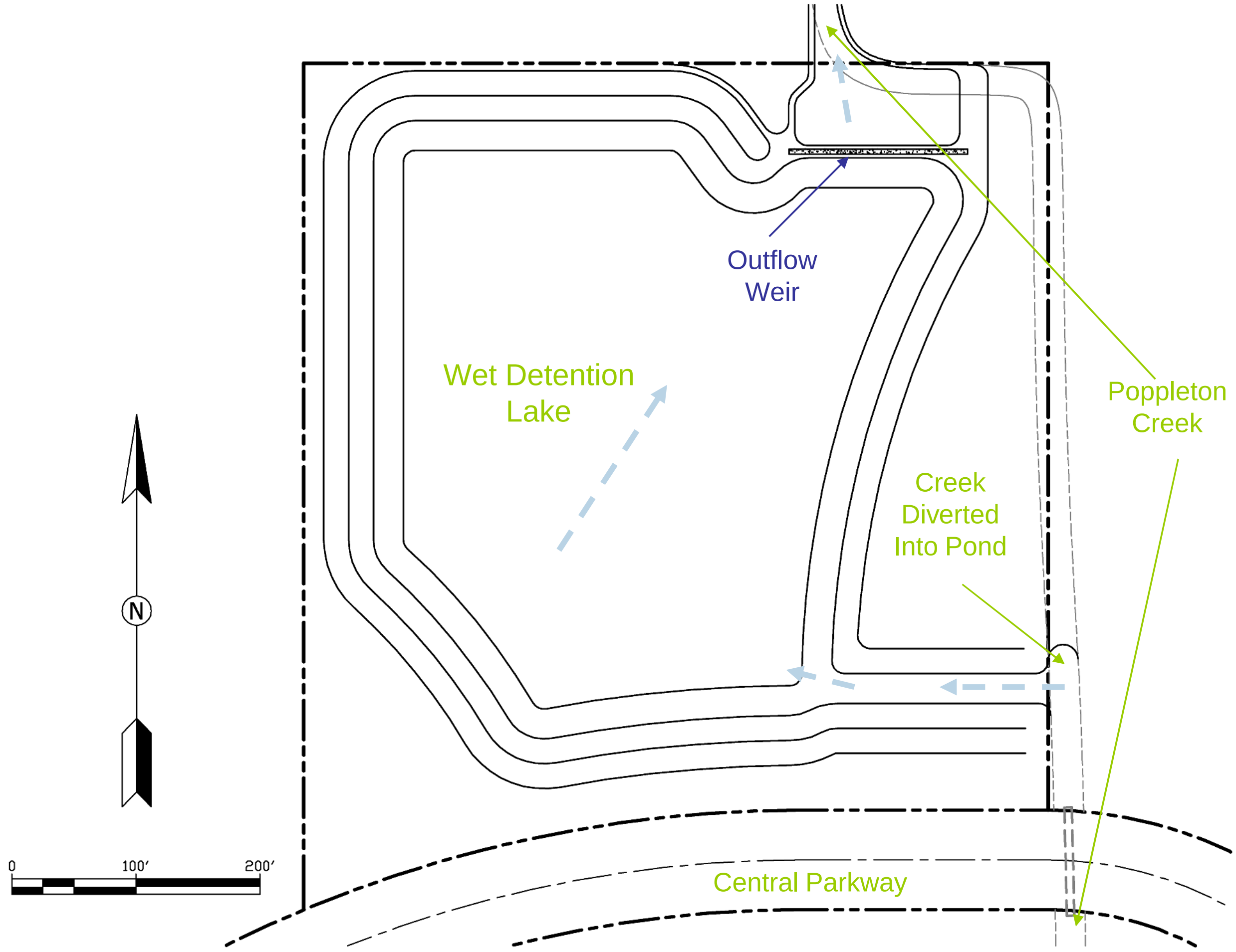


Figure 1-6. Schematic of the Poppleton Creek Detention Pond.

1.2 <u>Work Efforts Performed by ERD</u>

A Quality Assurance Project Plan (QAPP) was developed by ERD during October 2008 which provided details concerning the proposed field monitoring and laboratory analyses. Flow-weighted samples were collected at the creek inflow and downstream from the pond weir structure to evaluate the hydraulic performance efficiency and mass load reductions of the wet detention system. The results of the inflow and overflow monitoring sites are used to document changes in concentrations and load reductions for nitrogen, phosphorus, and TSS. The specific objectives of this research project were to:

1. Evaluate the hydraulic performance of the wet detention pond, and

2. Quantify the pollutant load reductions achieved by the treatment system

Monitoring equipment was installed at the wet detention pond site by ERD during January 2009. Field monitoring was initiated on January 14, 2009 and was continued over a 9-month period until October 14, 2009.

a. West Side of the Pond

b. Upstream from the Outfall Structure

Figure 1-7. Photographs of the Wet Detention Pond During January 2009.

a. West and North Sides of the Pond

b. Upstream from the Outfall Structure

Figure 1-8. Photographs of the Wet Detention Facility During May 2009.

Figure 1-9. Wildlife Utilization at the Wet Detention Pond.

This report has been divided into four separate sections for presentation of results. Section 1 contains an introduction to the report, a description of the Poppleton Creek wet detention pond facility, and a summary of work efforts performed by ERD. Section 2 provides a detailed discussion of the methodology used for field and laboratory evaluations. Section 3 provides a discussion of the hydrologic and water quality results, and a summary is provided in Section 4.

SECTION 2

FIELD AND LABORATORY ACTIVITIES

Field and laboratory investigations were conducted by ERD from January-October 2009 to evaluate the effectiveness of the recently constructed Poppleton Creek wet detention pond. Field monitoring was conducted at the inflow and outflow for the wet detention pond, including a continuous record of discharge rates as well as collection of flow-weighted composite inflow and outflow samples. Laboratory analyses were conducted on collected samples for general parameters and nutrients to assist in quantifying mass removal efficiencies for the system. Specific details of monitoring efforts conducted at the Poppleton Creek wet detention pond site is given in the following sections.

2.1 Drainage Basin Characteristics

The Poppleton Creek drainage basin includes an area of approximately 525 acres in an urbanized drainage basin. The wet detention pond is located approximately mid-way in the drainage basin and receives inflow from 271 acres of the 525-acre overall drainage basin. The remaining 254 acres of the drainage basin discharge into Poppleton Creek downstream from the wet detention facility.

A summary of land uses within the 271-acre portion of the Poppleton Creek watershed treated by the wet detention pond is given in Table 2-1. Approximately half of the contributing drainage basin consists of commercial land uses, with 21% occupied by office residential uses and 15% by medium-density residential.

TABLE 2-1

LAND USES WITHIN THE POPPLETON CREEK WATERSHED TREATED BY THE WET DETENTION POND

LAND USE	AREA (acres)	PERCENT OF TOTAL (%)
Public Open Space	0.7	0.2
Medium-Density Residential	40.85	15.1
Office Residential	57.7	21.3
Institutional	22.13	8.2
Commercial	133.74	49.3
Conservation	1.58	0.6
Industrial	14.3	5.3
TOTAL:	**271**	**100**

2.2 Field Instrumentation and Monitoring

A schematic of the monitoring locations used to evaluate the performance efficiency of the Poppleton Creek wet detention pond is given on Figure 2-1. Monitoring for inflows into the pond was conducted at the 108-inch CMP which conveys Poppleton Creek beneath Central Parkway. A stormwater sampler with integral flow meter was installed on the north side of the culvert, as indicated on Figure 2-2. The autosampler was housed inside an insulated equipment shelter. Sample tubing and an area/velocity flow meter were extended from the equipment shelter into the 108-inch CMP. A Teflon strainer was attached to the end of the sample tubing. The strainer and flow probe were mounted to a 16-inch x 16-inch x 1.5-inch thick concrete pad which was attached to the bottom of the CMP. The autosampler used at this site was a Sigma Model 900MAX, consisting of an automatic sequential stormwater sampler with an integral area/velocity flow meter. The autosampler was programmed to provide continuous measurements of discharges through the 108-inch CMP under both storm event and baseflow conditions, and to collect flow-weighted samples from the pond inflow over a wide variety of flow conditions.

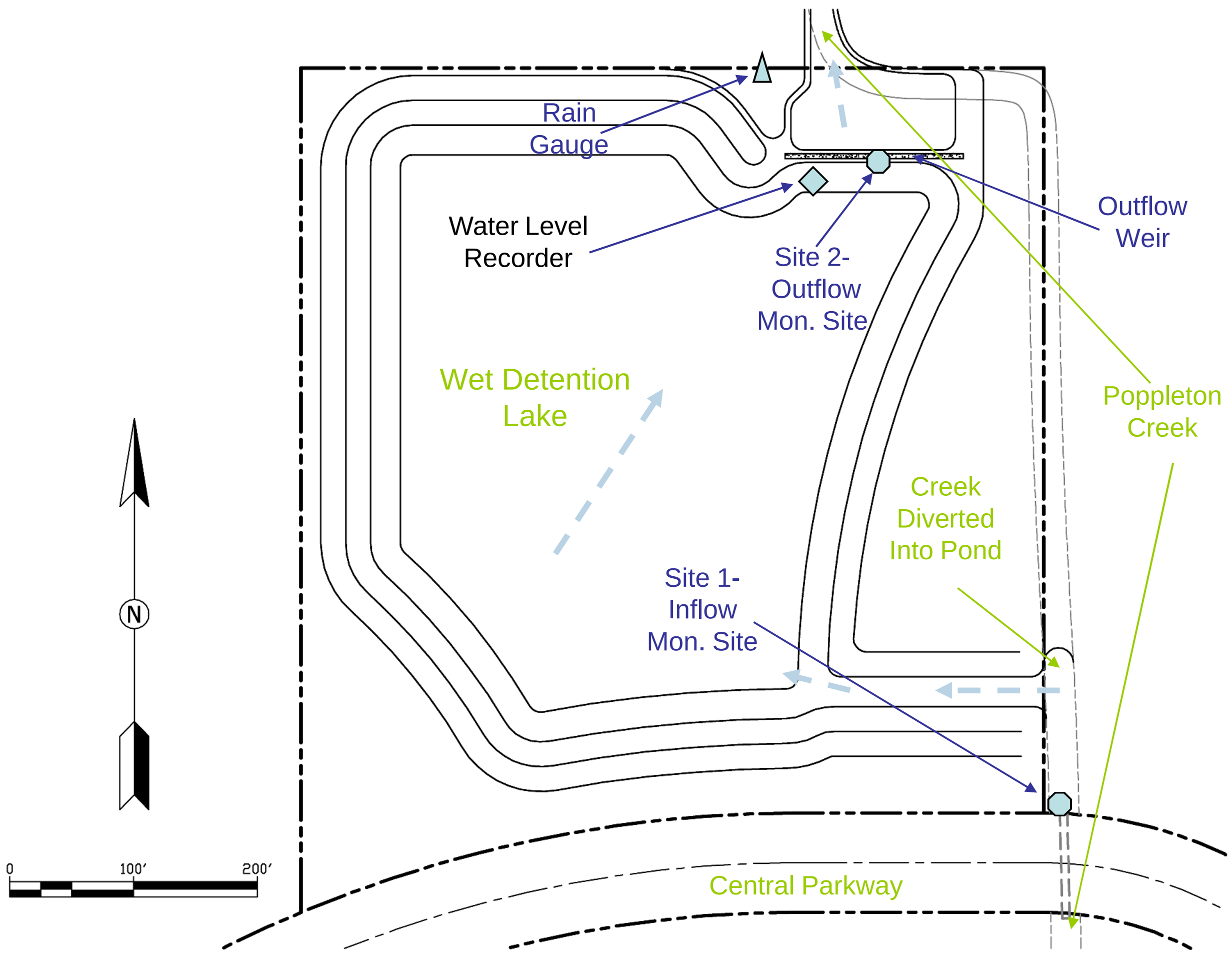


Figure 2-1. Locations for Monitoring Equipment at the Poppleton Creek Wet Detention Pond Site.

Figure 2-2. Poppleton Creek Inflow Monitoring Site.

A photograph of automatic sampling equipment used at the pond outflow monitoring site is given on Figure 2-3. An automatic sequential stormwater sampler with integral flow meter, manufactured by Sigma (Model 900MAX) was installed on top of the elevated portion of the outfall weir structure. The automatic sampler was housed inside an insulated aluminum equipment shelter. Sensor cables and sample tubing were extended from the equipment shelter through a 3-inch PVC line to the appropriate monitoring sites. A photograph of the autosampler tubing is given on Figure 2-4. Both the flow probe and sample intake strainer were attached to the support posts for the wooden walkway which crosses the pond upstream of the outfall structure. The integral flow meter in the autosampler was programmed to provide a continuous record of discharges through the outfall structure, with measurements stored into internal memory at 10-minute intervals. In addition, a digital water level logger (Global Water Model WL16) was installed inside a 2-inch PVC pipe which was also attached to the bottom of the walkway structure. The pressure transducer probe was extended into the pond approximately 10 ft from the walkway structure.

a. Monitoring Site on Outfall Structure

b. Autosampler Inside Insulated Shelter

Figure 2-3. Pond Outflow Monitoring Site.

Figure 2-4. Autosampler Tubing and Water Level Logger.

Flow measurements at the inflow monitoring site (Site 1) were performed using the area/velocity method. The flow probe utilized at this monitoring site provides simultaneous measurements of water depth and flow velocity. The depth measurements are converted into a cross-sectional area based upon the geometry of the pipe, and the velocity of flow is measured directly by the probe. Discharge is then calculated by the flow meter using the Continuity Equation (Q = A x V) in cubic feet per second (cfs).

Flow measurements at the weir overflow monitoring site (Site 2) were performed using a pressure transducer sensor which transforms sensitive measurements of water depth into a discharge rate using a rating curve developed by ERD based on the geometry of the outfall structure. The pressure transducer depth probe was attached to the support structure for the wooden walkway upstream from the diversion weir structure.

Each of the two automatic stormwater samplers contained a single 20-liter composite polyethylene bottle. Both the inflow and outflow samplers were programmed to collect sub-samples in a flow-weighted mode, with each collected sample placed into the composite bottle. Discharges through Poppleton Creek consist of a combination of baseflow and runoff conditions. Inflow hydrographs into the pond do not appear to exhibit distinctly different runoff and baseflow conditions, with more of a gradual increase and decline over an extended period of time. Therefore, inflows into the pond were formed as composite samples which were collected on a flow-weighted basis over the inflow hydrograph between each field monitoring event.

Since 120 VAC power was not available at the site, each of the automatic samplers were operated on gel cell batteries which were replaced on a weekly basis. A total of 19 separate flow-weighted composite samples of inflow were collected at the inflow monitoring site during the field monitoring program. However, discharges from the pond occurred infrequently, with only seven composite discharge samples collected during the monitoring program. All collected inflow and outflow samples were analyzed in the ERD Laboratory for general parameters, common nutrients, and BOD.

Rainfall at the monitoring site was documented using a continuous rainfall recorder attached to a 4-inch x 4-inch wooden post adjacent to the pond outfall. A photograph of the rainfall collector is given in Figure 2-5. The rainfall recorder (Texas Electronics Model 1014-C) produced a continuous record of all rainfall which occurred at the site, with a resolution of 0.01 inch. The rainfall data are stored continuously in a data logger and retrieved by ERD field personnel on a weekly basis. The rainfall record is used to provide information on general rainfall characteristics in the vicinity of the monitoring site and to assist in evaluation of hydrologic inputs from the watershed area.

Figure 2-5. Recording Rain Gauge at the Pond Outfall.

A bulk precipitation collector was also installed by ERD at the monitoring site to characterize nutrient concentrations in bulk precipitation. Bulk precipitation can be a significant contributor to nutrient loadings in waterbodies and is included in this project to develop a more accurate nutrient budget. The bulk precipitation collector consisted of a 12-inch diameter polyethylene funnel which was attached to 5/8-inch sample collection tubing. The bulk precipitation samples were diverted into a 4-liter polyethylene sample container which was retrieved by ERD personnel on a weekly basis. A photograph of the bulk precipitation collector is given in Figure 2-6.

Figure 2-6. Bulk Precipitation Collector at the Inflow Monitoring Site.

2.3 Laboratory Analyses

A summary of laboratory methods and MDLs for analyses conducted on water samples collected during this project is given in Table 2-2. All laboratory analyses were conducted in the ERD Laboratory. The ERD Laboratory is NELAC-certified (No. 1031026). 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.

TABLE 2-2

ANALYTICAL METHODS AND DETECTION LIMITS FOR LABORATORY ANALYSES

PARAMETER	METHOD OF ANALYSIS	METHOD DETECTION LIMITS (MDLs)[1]
pH	EPA-83, Sec. 150.1[2]	N/A
Conductivity	EPA-83, Sec. 120.1[2]	0.3 μmho/cm
Alkalinity	EPA-83, Sec. 310.1[2]	0.5 mg/l
Ammonia	EPA-83, Sec. 350.1[2]	0.005 mg/l
NO_x	EPA-83, Sec. 353.2[2]	0.005 mg/l
TKN	Alkaline Persulfate Digestion[3]	0.01 mg/l
Ortho-P	EPA-83, Sec. 365.1[2]	0.001 mg/l
Total Phosphorus	Alkaline Persulfate Digestion[3]	0.001 mg/l
Turbidity	EPA-83, Sec. 180.1[2]	0.1 NTU
Color	EPA-83, Sec. 110.3[2]	1 Pt-Co Unit
TSS	EPA-83, Sec. 160.2[2]	0.7 mg/l
BOD	SM-19, Sec. 5210B[4]	2 mg/l

1. MDLs are calculated based on the EPA method of determining detection limits
2. Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.
3. FDEP-approved alternate method
4. Standard Methods for the Examination of Water and Wastewater, 19th Ed., 1995.

SECTION 3

RESULTS

Field monitoring, sample collection, and laboratory analyses were conducted by ERD over a 273-day period from January 14-October 14, 2009 to evaluate the hydraulic and pollutant removal efficiencies of the Poppleton Creek wet detention pond in the City of Stuart. A discussion of the results of these efforts is given in the following sections.

3.1 Site Hydrology

3.1.1 Rainfall

3.1.1.1 Rain Event Characteristics

A continuous record of rainfall characteristics was collected at the detention pond monitoring site from January 14-October 14, 2009 using a tipping bucket rainfall collector with a resolution of 0.01 inch and a digital data logging recorder. Characteristics of individual rain events measured at the Poppleton Creek wet detention pond site from January 14-October 14, 2009 are given in Table 3-1. Information is provided for total rainfall, event start time, event end time, event duration, average rainfall intensity, and antecedent dry period for each individual rain event measured at the monitoring site. For purposes of this analysis, average rainfall intensity is calculated as the total rainfall divided by the total event duration.

A total of 30.19 inches of rainfall fell in the vicinity of the wet detention pond over the 273-day monitoring period from a total of 104 separate storm events. A summary of rainfall event characteristics measured at the wet detention pond site is given in Table 3-2. Individual rainfall amounts measured at the pond site range from 0.01-2.08 inches, with an average of 0.29 inches/event. Durations for events measured at the site range from 0.01-7.4 hours, with antecedent dry periods ranging from 0.1-39.7 days.

A comparison of measured and average "normal" rainfall in the vicinity of the Poppleton Creek wet detention pond is given in Figure 3-1. Measured rainfall presented in this figure is based upon the field-measured rain events at the wet detention pond monitoring site presented in Table 3-1, summarized on a monthly basis. Average "normal" rainfall conditions are based upon historical monthly rainfall averages recorded at the City of Stuart Meteorological Site (Site 8620) over the 30-year period from 1971-2000. Comparisons between measured and average "normal" rainfall are provided for the months of February-September 2009 since measurements performed at the site during January and October 2009 represent only partial months. Historical average rainfall during the months of February-September in Stuart is approximately 43.21 inches.

TABLE 3-1

SUMMARY OF RAINFALL MEASURED AT THE POPPLETON CREEK WET DETENTION POND MONITORING SITE FROM JANUARY 14 – OCTOBER 14, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
DATE	TIME	DATE	TIME				
1/30/09	10:44	1/30/09	14:42	0.17	3.97	----------	0.04
2/2/09	3:54	2/2/09	9:31	0.19	5.62	2.6	0.03
3/14/09	2:48	3/14/09	3:35	0.08	0.79	39.7	0.10
3/14/09	7:20	3/14/09	8:22	0.04	1.03	0.2	0.04
3/14/09	18:46	3/14/09	18:46	0.02	0.00	0.4	---
3/18/09	1:14	3/18/09	8:02	0.80	6.80	3.3	0.12
3/19/09	1:48	3/19/09	1:53	0.02	0.08	0.7	0.25
3/19/09	5:29	3/19/09	9:42	0.21	4.21	0.2	0.05
3/21/09	4:10	3/21/09	4:56	0.09	0.77	1.8	0.12
3/21/09	13:33	3/21/09	13:36	0.04	0.05	0.4	0.83
3/23/09	0:45	3/23/09	1:58	0.06	1.23	1.5	0.05
4/14/09	17:08	4/14/09	19:04	0.26	1.94	22.6	0.13
4/20/09	17:45	4/20/09	19:24	0.05	1.66	5.9	0.03
4/21/09	4:45	4/21/09	5:02	0.03	0.29	0.4	0.10
4/21/09	9:00	4/21/09	9:00	0.01	---	0.2	---
5/11/09	15:30	5/11/09	17:26	0.23	1.93	20.3	0.12
5/14/09	22:16	5/14/09	22:32	0.35	0.26	3.2	1.34
5/18/09	11:58	5/18/09	12:07	0.03	0.15	3.6	0.20
5/18/09	16:23	5/19/09	0:39	1.35	8.26	0.2	0.16
5/19/09	3:52	5/19/09	10:57	0.43	7.09	0.1	0.06
5/19/09	17:02	5/19/09	21:46	0.72	4.73	0.3	0.15
5/20/09	13:09	5/20/09	17:28	0.07	4.32	0.6	0.02
5/21/09	0:05	5/21/09	7:26	0.23	7.35	0.3	0.03
5/21/09	10:41	5/21/09	10:41	0.01	---	0.1	---
5/21/09	16:08	5/21/09	16:45	0.06	0.62	0.2	0.10
5/22/09	5:40	5/22/09	5:40	0.01	---	0.5	---
5/22/09	9:24	5/22/09	9:24	0.01	---	0.2	---
5/22/09	12:48	5/22/09	15:10	0.35	2.36	0.1	0.15
5/22/09	18:33	5/22/09	18:49	0.03	0.28	0.1	0.11
5/22/09	22:20	5/23/09	1:40	0.26	3.32	0.1	0.08
5/23/09	5:26	5/23/09	9:23	0.11	3.94	0.2	0.03
5/23/09	14:13	5/23/09	15:01	0.08	0.80	0.2	0.10
5/24/09	1:05	5/24/09	1:05	0.01	---	0.4	---
5/25/09	14:49	5/25/09	16:42	0.27	1.89	1.6	0.14
5/25/09	20:25	5/25/09	22:02	0.16	1.61	0.2	0.10
5/27/09	19:24	5/27/09	20:29	0.02	1.08	1.9	0.02
5/28/09	15:35	5/28/09	18:34	0.75	2.98	0.8	0.25
5/28/09	23:50	5/29/09	1:55	2.05	2.08	0.2	0.99
6/3/09	4:12	6/3/09	4:18	0.04	0.10	5.1	0.39
6/4/09	11:50	6/4/09	11:59	0.04	0.15	1.3	0.27
6/4/09	22:32	6/5/09	0:22	0.11	1.84	0.4	0.06
6/5/09	19:20	6/5/09	19:29	0.37	0.16	0.8	2.32
6/6/09	10:30	6/6/09	10:30	0.01	---	0.6	---
6/6/09	14:12	6/6/09	18:16	0.70	4.06	0.2	0.17
6/7/09	16:37	6/7/09	17:24	0.05	0.78	0.9	0.06
6/23/09	1:37	6/23/09	1:37	0.01	---	15.3	---
6/23/09	5:04	6/23/09	8:48	0.35	3.72	0.1	0.09
6/23/09	14:58	6/23/09	17:34	0.03	2.60	0.3	0.01
6/29/09	9:48	6/29/09	10:25	0.31	0.63	5.7	0.49
6/29/09	14:48	6/29/09	19:23	0.39	4.59	0.2	0.09
6/30/09	14:56	6/30/09	14:56	0.02	0.00	0.8	--

TABLE 3-1 -- CONTINUED

SUMMARY OF RAINFALL MEASURED AT THE POPPLETON CREEK WET DETENTION POND MONITORING SITE FROM JANUARY 14 – OCTOBER 14, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
DATE	TIME	DATE	TIME				
7/1/09	14:05	7/1/09	21:29	0.63	7.41	1.0	0.09
7/2/09	0:43	7/2/09	0:43	0.02	0.00	0.1	---
7/2/09	14:19	7/2/09	20:15	0.80	5.94	0.6	0.13
7/3/09	19:40	7/3/09	20:33	0.06	0.89	1.0	0.07
7/4/09	14:59	7/4/09	15:24	0.19	0.42	0.8	0.45
7/4/09	20:47	7/4/09	21:25	0.10	0.62	0.2	0.16
7/8/09	20:04	7/8/09	20:42	1.46	0.63	3.9	2.33
7/10/09	20:53	7/11/09	0:01	1.22	3.12	2.0	0.39
7/11/09	16:30	7/11/09	16:50	0.32	0.34	0.7	0.94
7/11/09	21:07	7/11/09	21:07	0.01	---	0.2	---
7/12/09	15:31	7/12/09	15:31	0.01	---	0.8	---
7/19/09	16:51	7/19/09	17:01	0.11	0.17	7.1	0.66
7/25/09	13:49	7/25/09	16:16	0.16	2.45	5.9	0.07
7/26/09	16:44	7/26/09	16:44	0.01	---	1.0	---
7/26/09	19:54	7/26/09	19:54	0.01	---	0.1	---
7/27/09	15:55	7/27/09	16:40	0.56	0.75	0.8	0.74
7/28/09	8:57	7/28/09	9:06	0.15	0.16	0.7	0.96
7/29/09	11:30	7/29/09	13:11	0.05	1.69	1.1	0.03
7/30/09	11:19	7/30/09	12:04	0.63	0.76	0.9	0.83
7/31/09	10:41	7/31/09	10:41	0.01	---	0.9	---
8/2/09	13:54	8/2/09	15:33	1.33	1.65	2.1	0.81
8/3/09	12:59	8/3/09	14:04	0.17	1.08	0.9	0.16
8/4/09	13:03	8/4/09	13:14	0.33	0.18	1.0	1.80
8/6/09	12:38	8/6/09	14:17	0.81	1.65	2.0	0.49
8/10/09	17:49	8/10/09	17:50	0.02	0.02	4.1	0.86
8/21/09	20:26	8/21/09	20:32	0.09	0.10	11.1	0.86
8/25/09	0:23	8/25/09	0:41	0.15	0.29	3.2	0.51
8/25/09	4:26	8/25/09	4:47	0.19	0.35	0.2	0.54
8/25/09	9:11	8/25/09	9:11	0.01	---	0.2	---
8/26/09	12:23	8/26/09	13:30	0.26	1.11	1.1	0.23
8/26/09	21:35	8/26/09	21:48	0.19	0.23	0.3	0.84
8/27/09	8:38	8/27/09	8:38	0.01	---	0.5	---
8/29/09	17:57	8/29/09	17:57	0.01	---	2.4	---
9/8/09	21:32	9/8/09	23:45	0.59	2.22	10.1	0.27
9/9/09	5:52	9/9/09	6:14	0.13	0.36	0.3	0.36
9/9/09	23:28	9/9/09	23:32	0.03	0.07	0.7	0.45
9/10/09	6:00	9/10/09	8:26	0.34	2.44	0.3	0.14
9/10/09	13:27	9/10/09	17:21	2.08	3.91	0.2	0.53
9/10/09	23:16	9/10/09	23:17	0.03	0.03	0.2	1.09
9/12/09	9:34	9/12/09	9:34	0.01	---	1.4	---
9/12/09	18:51	9/12/09	20:35	0.71	1.73	0.4	0.41
9/13/09	13:04	9/13/09	17:22	0.29	4.30	0.7	0.07
9/15/09	1:16	9/15/09	1:19	0.04	0.05	1.3	0.78
9/18/09	12:37	9/18/09	12:37	0.01	---	3.5	---
9/19/09	14:41	9/19/09	15:47	1.25	1.11	1.1	1.13
9/22/09	8:36	9/22/09	8:40	0.02	0.07	2.7	0.30
9/23/09	8:27	9/23/09	11:01	0.29	2.56	1.0	0.11
9/23/09	18:51	9/23/09	19:05	0.23	0.22	0.3	1.05
9/25/09	2:43	9/25/09	4:07	0.61	1.39	1.3	0.44
9/26/09	3:45	9/26/09	3:47	0.02	0.03	1.0	0.71
9/27/09	17:33	9/27/09	17:47	0.14	0.22	1.6	0.64
10/2/09	15:22	10/2/09	16:52	0.58	1.51	4.9	0.39
10/6/09	22:39	10/6/09	23:45	0.62	1.10	4.2	0.56
			TOTAL:	**30.19**			

TABLE 3-2

SUMMARY OF RAINFALL CHARACTERISTICS IN THE VICINITY OF THE POPPLETON CREEK WET DETENTION POND FROM JANUARY 14-OCTOBER 14, 2009

PARAMETER	UNITS	MINIMUM VALUE	MAXIMUM VALUE	MEAN EVENT VALUE
Event Rainfall	inches	0.01	2.08	0.29
Event Duration	hours	0.01	7.4	1.81
Average Intensity	inches/hour	0.03	2.33	0.41
Antecedent Dry Period	days	0.1	39.7	2.4

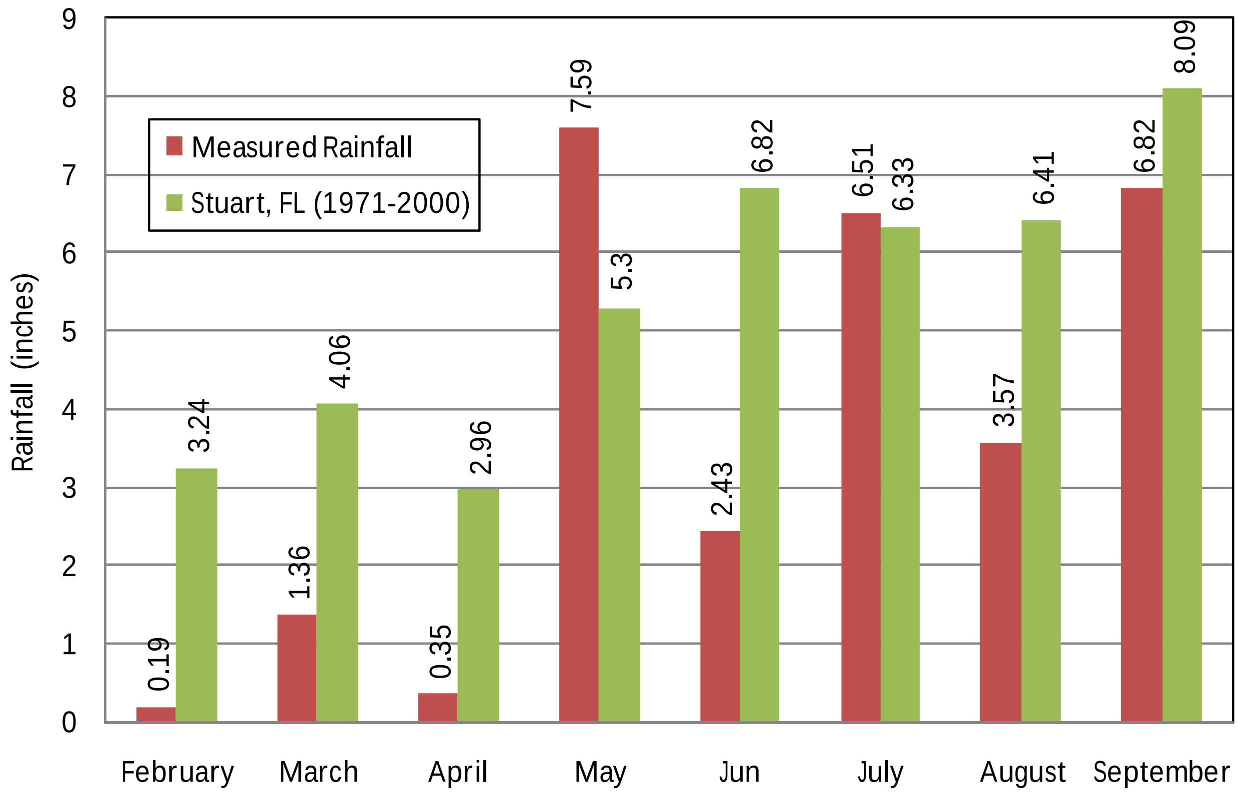


Figure 3-1. Comparison of Average and Measured Rainfall in the Vicinity of the Poppleton Creek Wet Detention Pond Site.

As seen in Figure 3-1, measured rainfall in the vicinity of the wet detention pond site was substantially less than "normal" during 6 of the 8 months included in the monitoring program, with greater than "normal" rainfall observed only during May and July. Overall, the field measured rainfall of 30.02 inches from February-September 2009 is approximately 39% less than the "average" rainfall of 49.50 inches which typically occurs during the period from February-September in the Stuart area.

3.1.1.2 Hydrologic Inputs

Estimated hydrologic inputs from direct precipitation onto the Poppleton Creek wet detention pond surface were calculated by multiplying the rainfall depth for each of the 104 storm events summarized in Table 3-1 times the water surface area within the pond at the time of the rain event. The pond water surface area at the time of a given storm event was calculated based upon a stage-area relationship for the pond developed by ERD from the construction plans provided in Appendix A. Information on water elevations within the pond was obtained from the digital stage recorder installed by ERD. Additional information on pond stages is given in a subsequent section

A summary of estimated monthly hydrologic inputs to the Poppleton Creek wet detention pond from direct precipitation is given in Table 3-3. Hydrologic inputs for the months of January and October reflect only partial months to correspond with the field monitoring dates from January 14-October 14, 2009. The inputs into the pond range from 0.08 ac-ft during January to 3.23 ac-ft during September. The information summarized in Table 3-3 is utilized to develop a hydrologic budget for the pond.

TABLE 3-3

ESTIMATED MEAN MONTHLY HYDROLOGIC INPUTS TO THE POPPLETON CREEK WET DETENTION POND FROM DIRECT PRECIPITATION

MONTH	TOTAL RAINFALL (inches)	HYDROLOGIC INPUTS (ac-ft)
January[1]	0.17	0.08
February	0.19	0.09
March	1.36	0.60
April	0.35	0.15
May	7.59	3.29
June	2.43	1.10
July	6.51	2.97
August	3.57	1.70
September	6.82	3.23
October[2]	1.20	0.57
TOTALS:	**30.19**	**13.78**

1. Reflects period from January 14-31, 2009
2. Reflects period from October 1-14, 2009

3.1.2 Poppleton Creek Inflow

3.1.2.1 Inflow Characteristics

Continuous measurements of discharges from Poppleton Creek into the wet detention pond were conducted from January 14-October 14, 2009. Flow monitoring was conducted inside the 108-inch CMP on the north side of Central Parkway, immediately prior to entering the pond. Flow measurements were conducted using an area/velocity flow meter which provided simultaneous measurements of water depth and flow velocity. The measurements of water depth were converted into a cross-sectional area based upon the pipe geometry.

A graphical summary of inflow hydrographs to the wet detention pond from January 14-October 14, 2009 is given on Figure 3-2. Inflow into the pond was relatively minimal during the initial four months of the monitoring program. A low level baseflow of approximately 0.4 cfs was measured during much of this period. Discharge rates through the Poppleton Creek Canal increased during wet season conditions, particularly toward the end of the wet season conditions during August and September. The maximum measured inflow rate into the pond was approximately 5.5 cfs during late September. Rainfall depths for individual rain events are also included on Figure 3-2 for comparison purposes.

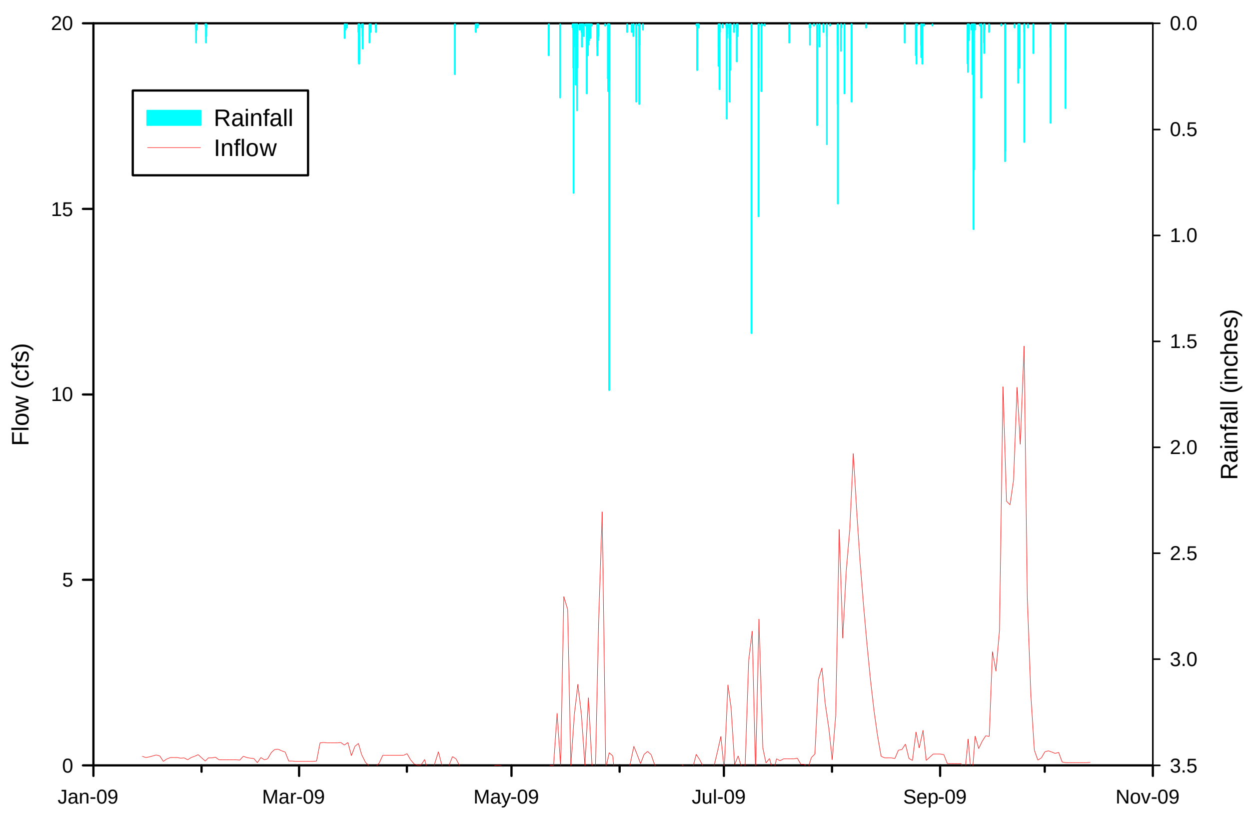


Figure 3-2. Inflow Hydrographs into the Poppleton Creek Wet Detention Pond from January 14-October 14, 2009.

3.1.2.2 Hydrologic Inputs

Estimates of monthly hydrologic inputs into the wet detention pond from the Poppleton Creek inflow were generated by integrating the inflow hydrograph summarized in Figure 3-2 on a monthly basis. A summary of estimated mean monthly hydrologic inputs from Poppleton Creek into the wet detention pond from January 14-October 14, 2009 is given in Table 3-4. Measured monthly inflows into the pond range from a low of 0.42 ac-ft during June to a high of 83.09 ac-ft during September. Overall, Poppleton Creek contributed approximately 219.4 ac-ft of runoff to the wet detention pond during the monitoring period from January 14-October 14, 2009. The information summarized in Table 3-4 is utilized to develop a hydrologic budget for the wet detention pond.

TABLE 3-4

ESTIMATED MEAN MONTHLY HYDROLOGIC INPUTS FROM POPPLETON CREEK INTO THE WET DETENTION POND

MONTH	TOTAL RAINFALL (inches)	HYDROLOGIC INPUTS (ac-ft)
January[1]	0.17	3.72
February	0.19	5.80
March	1.36	9.78
April	0.35	1.05
May	7.59	27.21
June	2.43	0.42
July	6.51	23.90
August	3.57	61.88
September	6.82	83.09
October[2]	1.20	2.51
TOTALS:	**30.19**	**219.4**

1. Reflects period from January 14-31, 2009
2. Reflects period from October 1-14, 2009

An estimate of the runoff coefficient (C value) for the contributing basin area was calculated over the monitoring period from January 14-October 14, 2009. A summary of this analysis is given in Table 3-5. As discussed previously, the contributing basin area to the pond is approximately 271 acres. During the field monitoring program, a total of 30.19 inches of rainfall was recorded at the pond site. This equates to a total rainfall volume over the contributing basin area of 681.8 ac-ft. As indicated in Table 3-4, the pond inflow volume during the field monitoring program was approximately 219.4 ac-ft. The ratio of the runoff inflow to the total rainfall volume, defined as the runoff coefficient or C value, is 0.322. This value suggests that approximately 32.2% of the rainfall which occurred within the contributing basin area entered the wet detention pond as stormwater runoff or baseflow.

TABLE 3-5

ESTIMATED RUNOFF COEFFICIENT (C VALUE) FOR THE CONTRIBUTING BASIN AREA

PARAMETER	VALUE
Contributing Basin Area	271 acres
Total Rainfall[1]	30.19 inches
Total Rainfall Volume[2]	681.8 ac-ft
Pond Inflow	219.4 ac-ft
C Value	0.322

1. Measured rainfall from January 14-October 14, 2009
2. Total rainfall volume over 271-acre watershed

3.1.3 Pond Outflow

3.1.3.1 Discharge Characteristics

Continuous monitoring of discharges from the Poppleton Creek wet detention pond was conducted from January 14-October 14, 2009. As indicated on the construction plans in Appendix A, the outfall structure for the pond consists of a compound rectangular weir, approximately 128 ft in width, containing seven 10-ft wide rectangular notches (Figure 1-5). These notches, referred to as “bleeder notches” in the construction drawings, have an invert elevation of approximately 6.0 ft. The raised portions of the weir structure are referred to as “intermediate weirs”, with a design elevation of 6.50 ft.

A graphical summary of discharge hydrographs from the wet detention pond over the period from January 14-October 14, 2009 is given on Figure 3-3. In general, virtually all inflow into the pond was retained within the pond, with the exception of two relatively limited discharges which occurred during August and September 2009. Both of these discharges occurred following extended periods of rainfall. The water depth discharging through the outfall structure during these events ranged from approximately 0.25-0.75 inch, with discharge occurring only through the four westernmost weir notches. Under these conditions, water did not discharge through the three easternmost notches. The maximum discharge rate during the first event was approximately 4 cfs, with a peak discharge of approximately 5.5 cfs during the second discharge event. Rainfall depths for individual rain events are also included on Figure 3-3 for comparison purposes.

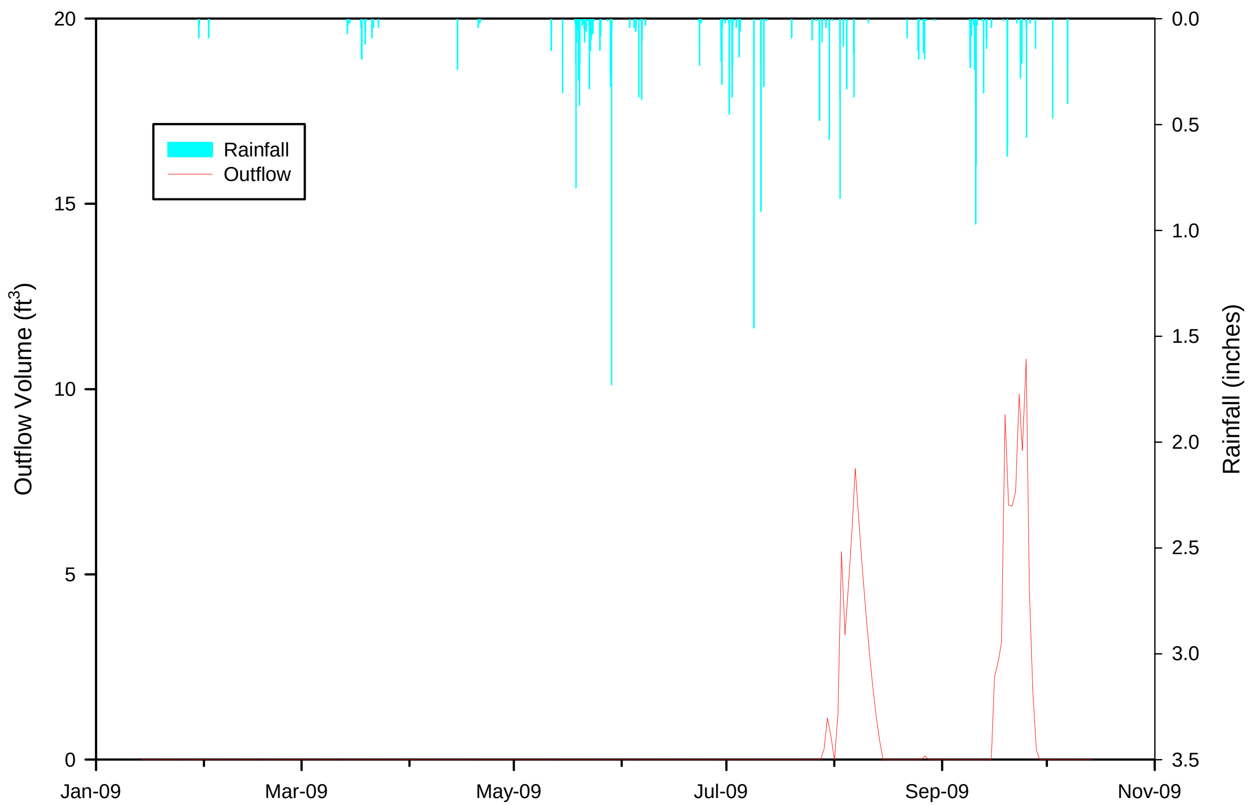


Figure 3-3. Outflow Hydrographs from the Poppleton Creek Wet Detention Pond from January 14-October 14, 2009.

3.1.3.2 Hydrologic Losses

Estimates of monthly hydrologic discharges from the wet detention pond were generated by integrating the discharge hydrographs summarized on Figure 3-3 on a monthly basis. A summary of estimated mean monthly discharges from the wet detention pond from January 14-October 14, 2009 is given in Table 3-6. Measured monthly discharges from the pond ranged from a low of 0 ac-ft during January through June, to a high of 73.9 ac-ft during September. The information summarized in Table 3-6 is utilized in a subsequent section to develop a hydrologic budget for the wet detention pond.

TABLE 3-6

ESTIMATED MEAN MONTHLY HYDROLOGIC DISCHARGES FROM THE WET DETENTION POND

MONTH	HYDROLOGIC DISCHARGES (ac-ft)
January[1]	0.00
February	0.00
March	0.00
April	0.00
May	0.00
June	0.00
July	2.06
August	51.3
September	73.9
October[2]	0.00
TOTALS:	**127.3**

1. Reflects period from January 14-31, 2009
2. Reflects period from October 1-14, 2009

3.1.4 Water Level Elevations

Water level elevations within the Poppleton Creek wet detention pond were recorded on a continuous basis from January 14-October 14, 2009. As indicated on Figure 2-4, the water level logger was attached to the boardwalk structure located upstream from the outfall weir structure. The pressure transducer probe was extended into the pond approximately 10 ft from the walkway structure.

A graphical summary of water surface elevations in the Poppleton Creek wet detention pond from January 14-October 14, 2009 is given on Figure 3-4. At the beginning of the field monitoring program, the water level elevation within the pond was approximately 5.2 ft. Water levels within the pond exhibited a steady decline over the period from January to April due to substantially less than normal rainfall during this period. During early April, the water level within the pond fell below the level of the pressure transducer on the water level recorder. This condition was maintained, with only a few minor exceptions, until late May when multiple rain events caused the water level within the pond to increase substantially, followed by another gradual decline in elevation during the month of June. However, beginning in early July, water levels within the pond approached the control elevation of 6.0 ft, with water levels in excess of the control elevation recorded during late July, early August, and late September.

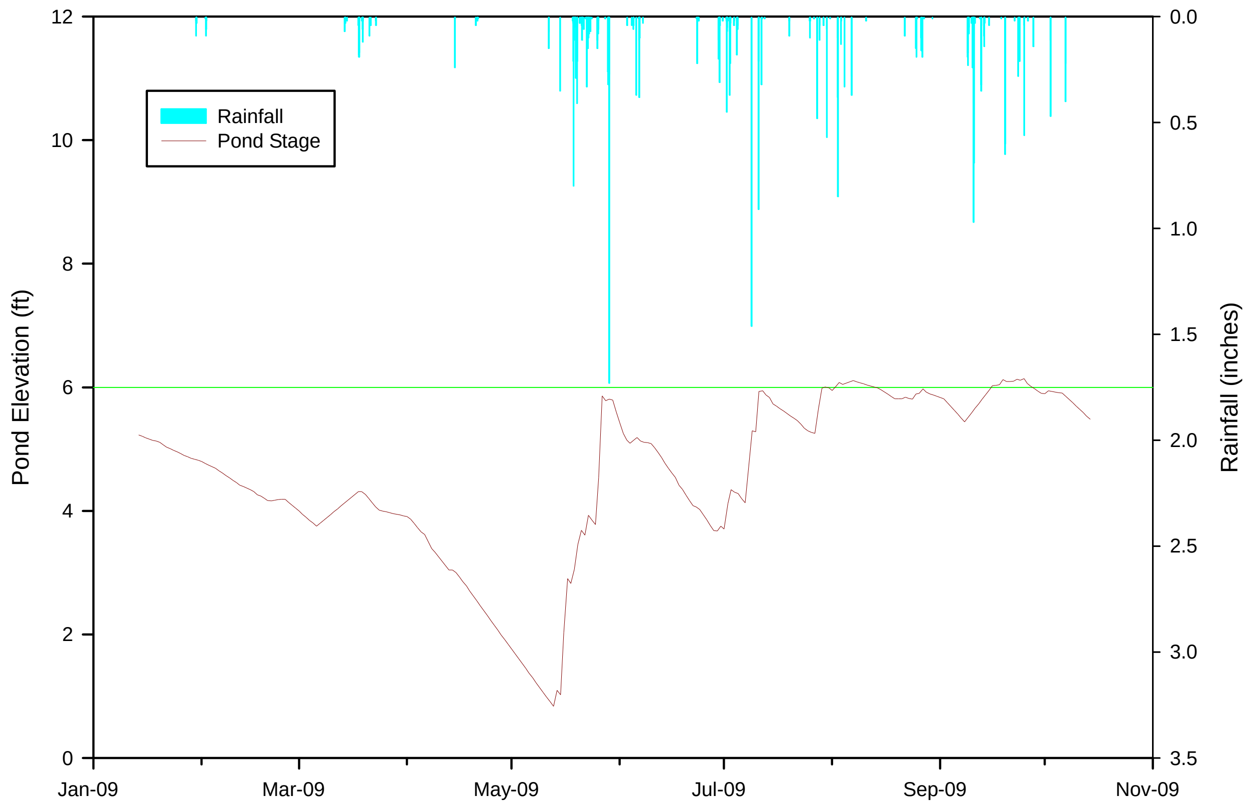


Figure 3-4. Water Surface Elevations in the Poppleton Creek Wet Detention Pond from January 14-October 14, 2009.

3.1.5 Pond Evaporation

Estimates of mean monthly hydrologic losses from the wet detention pond as a result of evaporation were calculated using field measurements of evaporation conducted by ERD at a site on Manatee Creek, south of Stuart. ERD has been conducting continuous measurements of pan evaporation at this site since December 2007 as part of a BMP monitoring project for Martin County. Evaporation data measured at this site were obtained for the period from January 14-October 14, 2009. The evaporation data collected at the Manatee Creek site were converted from pan evaporation to lake evaporation using a standard coefficient of 0.75.

Estimated hydrologic losses from evaporation over the wet detention pond surface were calculated by multiplying the measured evaporation rates at the Manatee Creek site times the mean water surface area within the pond during each month of the monitoring program. The mean water surface area for each month was calculated based upon a stage-area relationship for the pond developed by ERD from the construction plans provided in Appendix A.

A summary of estimated monthly evaporation losses from the Poppleton Creek wet detention pond is given in Table 3-7. Hydrologic losses for the months of January and October reflect partial months only to correspond with the field monitoring dates of January 14-October 14, 2009. Evaporation losses from the pond range from a low of 0.70 ac-ft during January to a high of 2.91 ac-ft during August. During the field monitoring program, evaporation losses removed approximately 19.43 ac-ft of water from the wet detention pond. The information summarized in Table 3-7 is utilized in a subsequent section to develop a hydrologic budget for the pond.

TABLE 3-7

ESTIMATED MEAN MONTHLY HYDROLOGIC EVAPORATION LOSSES FROM THE POPPLETON CREEK WET DETENTION POND

MONTH	EVAPORATION (inches)	HYDROLOGIC LOSSES (ac-ft)
January[1]	1.49	0.70
February	3.06	1.45
March	3.65	1.61
April	6.07	2.60
May	5.02	2.11
June	4.97	2.23
July	5.79	2.64
August	6.11	2.91
September	4.85	2.30
October[2]	1.85	0.88
TOTALS:	**42.86**	**19.43**

1. Reflects period from January 14-31, 2009
2. Reflects period from October 1-14, 2009

3.1.6 Groundwater Losses

During each month of the monitoring program, additional water losses occurred from the wet detention pond which were in excess of the losses estimated from evaporation and discharge through the outfall structure. For purposes of this analysis, this additional loss is assumed to occur as a result of infiltration of water into groundwater beneath the pond. Groundwater losses from the pond were calculated using the equation summarized below:

$$GW_{loss} = \text{Rainfall} + \text{Inflow} - \text{Outflow} - \text{Evaporation} - \Delta\ \text{Storage}$$

The calculations summarized in this equation were performed on a monthly basis for each month of the monitoring program. The change in storage is calculated as the change in water volume within the pond from the beginning to the end of each month.

A summary of estimated mean monthly hydrologic losses from groundwater infiltration at the wet detention pond is given in Table 3-8. Groundwater losses ranged from a low of 4.57 ac-ft during October to a high of 10.19 ac-ft during August. Groundwater losses occurred consistently from the pond throughout the monitoring program.

TABLE 3-8

ESTIMATED MEAN MONTHLY HYDROLOGIC GROUNDWATER LOSSES FROM THE POPPLETON CREEK WET DETENTION POND

MONTH	HYDROLOGIC LOSSES (ac-ft)
January[1]	5.70
February	8.64
March	9.41
April	8.68
May	8.90
June	9.33
July	9.91
August	10.19
September	9.83
October[2]	4.57
TOTALS:	**85.16**

1. Reflects period from January 14-31, 2009
2. Reflects period from October 1-14, 2009

3.1.7 Hydrologic Budget

Monthly hydrologic budgets were developed for the Poppleton Creek wet detention pond over the period from January 14-October 14, 2009 based on the measured or calculated inputs and losses summarized in previous sections. A tabular summary of the monthly hydrologic budget is given in Table 3-9. Information is provided on the volumetric inputs into the pond from Poppleton Creek inflow and rainfall, with hydrologic losses occurring as a result of pond outflow, evaporation, and groundwater infiltration. The difference between the hydrologic inputs and hydrologic losses represents change in storage within the pond.

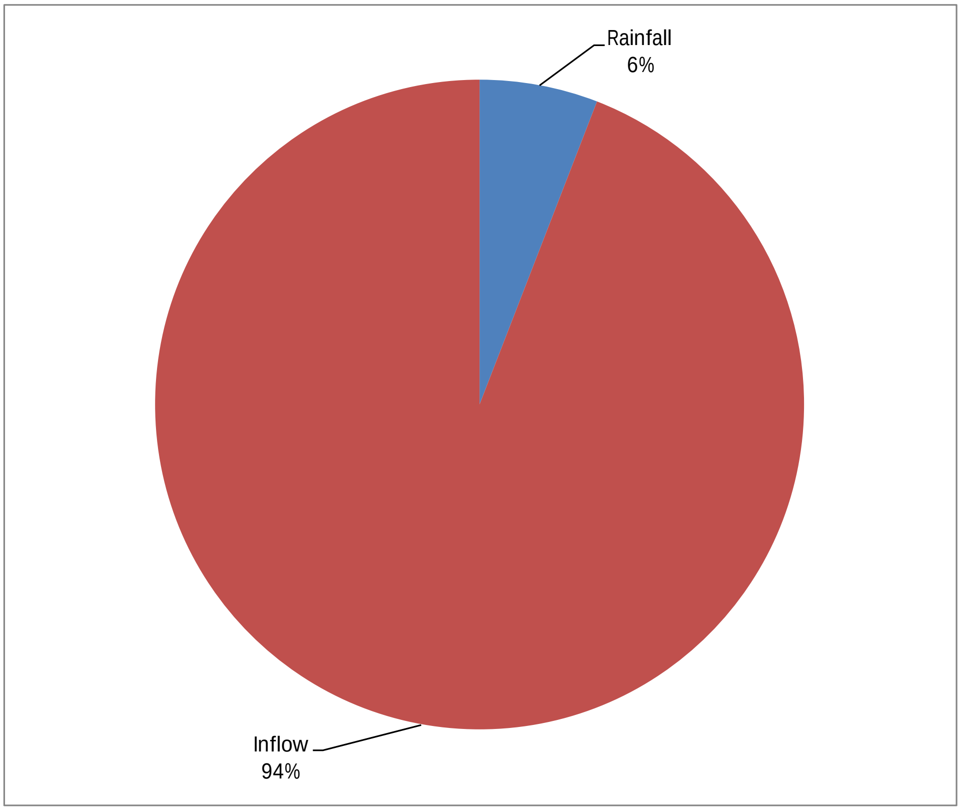
TABLE 3-9

MONTHLY HYDROLOGIC BUDGET FOR THE POPPLETON CREEK WET DETENTION POND FROM JANUARY 14 – OCTOBER 14, 2009

MONTH	HYDROLOGIC INPUTS (ac-ft)			HYDROLOGIC LOSSES (ac-ft)				Δ STORAGE (ac-ft)
	Inflow	Rainfall	Total	Outflow	Evaporation	Groundwater	Total	
January	3.72	0.08	3.80	0.00	0.70	5.70	6.40	-2.60
February	5.80	0.09	5.89	0.00	1.45	8.64	10.09	-4.20
March	9.78	0.60	10.38	0.00	1.61	9.41	11.02	-0.64
April	1.05	0.15	1.20	0.00	2.60	8.68	11.28	-10.08
May	27.21	3.29	30.50	0.00	2.11	8.90	11.01	19.49
June	0.42	1.10	1.52	0.00	2.23	9.33	11.56	-10.04
July	23.90	2.97	26.87	2.06	2.64	9.91	14.61	12.26
August	61.88	1.70	63.58	51.27	2.91	10.19	64.37	-0.79
September	83.09	3.23	86.32	73.91	2.30	9.83	86.04	0.28
October	2.51	0.57	3.08	0.00	0.88	4.57	5.45	-2.37
TOTALS:	**219.36**	**13.78**	**233.14**	**127.24**	**19.43**	**85.16**	**231.83**	**3.91**

During the period from January-April, the pond exhibited a continuing decrease in storage for each monthly period. This decrease in storage corresponds with the decrease in surface water elevations within the pond summarized on Figure 3-4. A substantial increase in water surface elevation and storage occurred as a result of frequent rainfall during May, with a subsequent decrease in storage during June. Overall, the pond increased in storage by approximately 3.91 ac-ft from the beginning to the end of the monitoring program. This coincides with the surface water elevations indicated on Figure 3-4 which reflect a slightly higher water level elevation at the end of the study compared with the initial starting elevation during January.

A graphical comparison of overall hydrologic inputs and losses for the Poppleton Creek wet detention pond is given on Figure 3-5. During the monitoring period, approximately 94% of the hydrologic inputs into the pond occurred as a result of inflow through Poppleton Creek, with approximately 6% contributed by direct rainfall. Approximately 55% of the hydrologic losses from the pond occurred as a result of outflow from the pond during the final months of the monitoring program. Groundwater infiltration contributed approximately 37% of the hydrologic losses, with 8% lost as a result of evaporation.



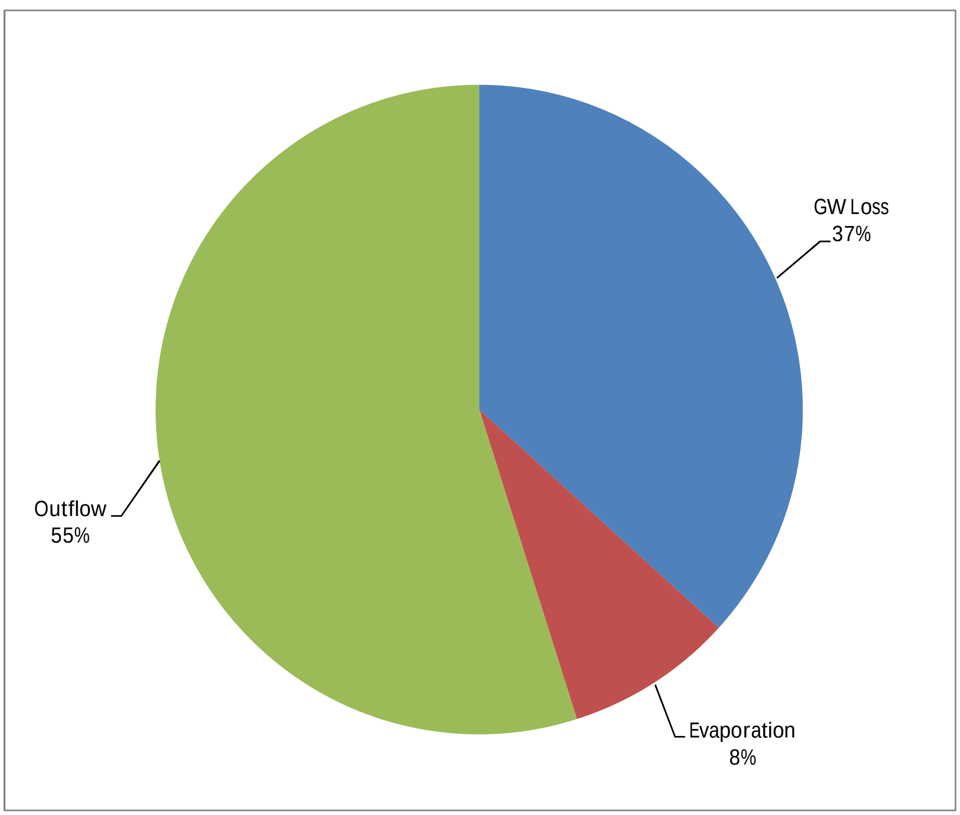


Figure 3-5. Hydrologic Inputs and Losses for the Poppleton Creek Wet Detention Pond.

3.1.8 Pond Detention Time

The pond detention time was calculated for the period from January 14-October 14, 2009 by dividing the estimated pond volume by the total hydrologic inputs summarized in Table 3-9. A summary of estimated detention time for the Poppleton Creek wet detention pond during the monitoring program is given in Table 3-10. Based upon the construction drawings provided in Appendix A, the permanent pool pond volume is approximately 48.85 ac-ft at the outfall control elevation of 6.0 ft. During the monitoring program, a total of 233.1 ac-ft of water entered the pond over a period of 273 days. This equates to a mean detention time of approximately 57 days during the field monitoring program.

TABLE 3-10

ESTIMATED DETENTION TIME FOR THE POPPLETON CREEK WET DETENTION POND

PARAMETER	VALUE
Pond Volume	48.85 ac-ft
Pond Inputs	233.1 ac-ft
Calculation Period	273 days
Mean Detention Time	57 days

3.2 Chemical Characteristics of Monitored Inputs and Outputs

Continuous monitoring and collection of inflow and outflow samples was conducted by ERD at the Poppleton Creek wet detention pond from January 14-October 14, 2009. In addition, bulk precipitation samples were also collected on approximately a weekly basis to identify nutrient inputs to the pond from direct rainfall. A complete listing of the chemical characteristics of individual inflow, outflow, and bulk precipitation samples is given in Appendix B. A discussion of the water quality characteristics of the collected samples is given in the following sections.

3.2.1 Pond Inflow

A total of 19 composite inflow samples was collected at the inflow monitoring site over the period from January 14-October 14, 2009. A summary of the chemical characteristics of pond inflow samples is given in Table 3-11. This table provides a listing of the minimum and maximum values measured in the pond inflow for each evaluated parameter as well as the calculated mean value. The mean values summarized in Table 3-8 reflect the log-transformed mean value for the collected samples since the collected data exhibit a log-normal statistical distribution. In general, inflow into the pond was approximately neutral in pH, with measured values ranging from 6.80-8.36 and an overall mean pH of 7.27. Measured conductivity values in the inflow were low to moderately elevated, with an overall mean of 214 μmho/cm. A relatively wide range of measured alkalinity values was observed in the inflow, ranging from moderately buffered to well buffered. A relatively wide range of turbidity values were also measured at the pond inflow, although the mean turbidity of 11.1 NTU reflects a relatively low value.

TABLE 3-11

SUMMARY OF CHEMICAL CHARACTERISTICS OF POND INFLOW SAMPLES COLLECTED FROM JANUARY 14 – OCTOBER 14, 2009 (n = 19 samples)

PARAMETER	UNITS	MINIMUM	MAXIMUM	MEAN
pH	s.u.	6.80	8.36	7.27
Conductivity	µmho/cm	130	457	214
Alkalinity	mg/l	42.0	156	70.6
NH_3	µg/l	10	459	66
NO_x	µg/l	10	859	23
Dissolved Organic N	µg/l	138	599	310
Particulate N	µg/l	69	2,604	383
Total N	µg/l	402	3,365	1,017
SRP	µg/l	1	45	7
Dissolved Organic P	µg/l	1	31	5
Particulate P	µg/l	27	677	112
Total P	µg/l	36	697	134
Turbidity	NTU	3.4	74.9	11.1
Cd	µg/l	<2	3	1.6
Cr	µg/l	3	12	5.6
Cu	µg/l	3	21	7.2
Zn	µg/l	5	118	22.6

A relatively high degree of variability was observed in measured concentrations of both ammonia and NO_x in the pond inflow, with a factor of approximately 50 between minimum and maximum values for both parameters. However, mean values for these parameters were relatively low in value, with a mean of 66 µg/l for ammonia and 23 µg/l for NO_x. A much lower degree of variability was observed for concentrations of dissolved organic nitrogen, with a 5-fold difference between minimum and maximum values. In contrast, a large degree of variability was observed for particulate nitrogen concentrations, with a 40-fold difference between minimum and maximum values. Measured total nitrogen concentrations ranged from 402-3365 µg/l, with an overall mean of 1017 µg/l. The mean total nitrogen concentration represents a relatively low value for total nitrogen in an urban drainage system. The dominant nitrogen species present in the inflow to the pond was particulate nitrogen which contributed approximately 40% of the total nitrogen measured. Approximately one-third of the total nitrogen was contributed by dissolved organic nitrogen, with the remainder contributed by ammonia and NO_x.

Highly variable concentrations of both SRP and dissolved organic phosphorus were measured in the pond inflow. However, the mean values for these parameters reflect low concentrations with a mean SRP concentration of 7 µg/l and a mean dissolved organic phosphorus concentration of 5 µg/l. A relatively large degree of variability was also observed for particulate phosphorus, with an overall mean of 112 µg/l. A similar degree of variability was observed for total phosphorus, with an overall mean of 134 µg/l. Particulate phosphorus is clearly the dominant phosphorus species present in the pond inflow. The observed mean total phosphorus concentration is relatively low for an urban drainage system.

Relatively low levels of cadmium and chromium were measured at the inflow into the pond, with an overall mean of 1.6 µg/l for cadmium and 5.6 µg/l for chromium. Slightly higher mean concentrations were observed for copper (7.2 µg/l) and zinc (22.6 µg/l).

3.2.2 Pond Outflow

A summary of the chemical characteristics of pond outflow collected at the wet detention pond is given in Table 3-12. The values summarized in this table reflect a total of seven outfall samples collected during the 9-month monitoring program.

TABLE 3-12

SUMMARY OF CHEMICAL CHARACTERISTICS OF POND OUTFLOW SAMPLES COLLECTED FROM JANUARY 14 – OCTOBER 14, 2009 (n = 7 samples)

PARAMETER	UNITS	MINIMUM	MAXIMUM	MEAN
pH	s.u.	6.75	7.26	7.01
Conductivity	µmho/cm	152	195	178
Alkalinity	mg/l	2.2	120	42.0
NH_3	µg/l	5	149	32
NO_x	µg/l	<5	10	<5
Dissolved Organic N	µg/l	256	381	303
Particulate N	µg/l	93	446	174
Total N	µg/l	446	809	556
SRP	µg/l	<1	4	1
Dissolved Organic P	µg/l	2	8	4
Particulate P	µg/l	5	24	11
Total P	µg/l	8	31	17
Turbidity	NTU	1.0	6.9	3.0
Cd	µg/l	<2	3	1.3
Cr	µg/l	4	7	5.9
Cu	µg/l	<2	5	1.7
Zn	µg/l	<2	2	1.1

Discharges from the pond were approximately neutral in pH, with moderate to low values of specific conductivity. Discharges from the pond were also found to be poorly to moderately well buffered, with an overall mean alkalinity of 42.0 mg/l. Turbidity measurements in discharges from the pond were also low in value, with an overall mean turbidity of 3 NTU. In general, mean concentrations for each of these parameters in the pond outflow are lower than concentrations observed for these parameters in the pond inflow.

Relatively low levels of both ammonia and NO_x were observed in discharges from the pond, with a mean ammonia outflow concentration of 58 μg/l and a mean NO_x outflow concentration of <5 μg/l. Each of these values is lower than concentrations for these parameters measured in the pond inflow. Dissolved organic nitrogen concentrations in the pond outflow exhibited a low degree of variability, with a mean concentration of 303 μg/l. A relatively low degree of variability was also observed for particulate nitrogen concentrations, with a mean outflow concentration of 174 μg/l, less than half of the inflow particulate nitrogen concentration. Overall, the mean total nitrogen concentration discharging from the pond was 556 μg/l, a decrease of approximately 45% from nitrogen concentrations at the inflow.

Low concentrations of SRP, dissolved organic phosphorus, and particulate phosphorus were observed in discharges from the pond. Concentrations of each of these parameters are substantially lower in the pond outflow than observed in the pond inflow. The overall mean total phosphorus concentration in the pond outflow was 17 μg/l compared with a mean of 134 μg/l at the pond inflow. Relatively low levels of cadmium, chromium, copper, and zinc were observed in discharges from the pond. Outflow concentrations for all metals, with the exception of chromium, were lower than concentrations measured in the inflow.

3.2.3 <u>Bulk Precipitation</u>

A summary of the chemical characteristics of bulk precipitation samples collected at the detention pond site from January 14-October 14, 2009 is given in Table 3-13. The values summarized in this table reflect a total of 15 bulk precipitation samples collected during the monitoring program.

In general, bulk precipitation samples collected at the pond site were found to be slightly acidic, with measured values ranging from 5.12-6.81 and an overall mean pH of 5.81. Measured conductivity and alkalinity values in the bulk precipitation samples were also low in value, with a mean conductivity of only 18 μmho/cm and a mean alkalinity of only 3.1 mg/l. Turbidity values in the bulk precipitation were also low, with an overall mean of only 2.l NTU.

In general, an extremely high level of variability was observed in measured concentrations for all nitrogen species in bulk precipitation. More than a 500-fold difference was observed between minimum and maximum values for ammonia and NO_x in bulk precipitation samples. However, the mean concentrations for these parameters appear to be relatively low in value and similar to concentrations observed in the pond inflow. A high degree of variability was also observed for dissolved organic nitrogen and particulate nitrogen, with means of 71 μg/l and 123 μg/l, respectively. A very large degree of variability was observed in measured concentrations of total nitrogen, although the overall mean value of 351 μg/l reflects a low concentration.

TABLE 3-13

SUMMARY OF CHEMICAL CHARACTERISTICS OF BULK PRECIPITATION SAMPLES COLLECTED FROM JANUARY 14 – OCTOBER 14, 2009 (n = 15 samples)

PARAMETER	UNITS	MINIMUM	MAXIMUM	MEAN
pH	s.u.	5.12	6.81	5.81
Conductivity	µmho/cm	7	190	18
Alkalinity	mg/l	1.0	32	3.1
NH_3	µg/l	6	4,546	143
NO_x	µg/l	2	1,036	84
Dissolved Organic N	µg/l	<5	5,754	54
Particulate N	µg/l	23	405	123
Total N	µg/l	55	11,407	351
SRP	µg/l	1	634	2
Dissolved Organic P	µg/l	1	42	2
Particulate P	µg/l	1	139	4
Total P	µg/l	1	788	8
Turbidity	NTU	0.9	10.1	2.1
Cd	µg/l	2.0	3	1.2
Cr	µg/l	3	10	5.8
Cu	µg/l	3	19	3.3
Zn	µg/l	12	931	49.7

A high degree of variability was observed in measured concentrations for all of the phosphorus species in bulk precipitation. However, the mean values for these parameters reflect extremely low concentrations of total phosphorus.

As seen in Appendix B, one of the collected bulk precipitation samples was characterized by extremely elevated concentrations for total nitrogen (11,407 µg/l) and for total phosphorus (788 µg/l). These values are approximately 5-10 times higher than the next highest bulk precipitation concentrations measured at the Poppleton Creek site. When elevated nutrient concentrations are measured in bulk precipitation, bird waste is commonly thought to be a likely source of the additional nutrients. However, all bulk precipitation collectors used by ERD contain a bird-excluding monofilament mesh which extends approximately 1 ft above the lip of the collection device, making it impossible for birds to roost on the edge of the collector. ERD has observed bulk precipitation characteristics similar to the elevated event at the Poppleton Creek site on previous projects as a result of soot and ashes from nearby fires, particularly land clearing activities. These previous samples were also characterized by extremely high levels of ammonia, dissolved organic nitrogen, SRP, and total phosphorus, similar to the pattern of values observed at the Poppleton Creek site. However, ERD is not aware of any burning activities which occurred within the vicinity of the pond during the field monitoring program, but mentions this only as a possible explanation for the observed elevated values. The elevated values are not excluded from the data set since a possible explanation could exist for these values. However, since the log-normal mean values are used to reflect the measure of central tendency for this data set, the elevated values for the single bulk precipitation event have a relatively small impact on calculated mean concentrations.

Low to elevated concentrations of heavy metals were observed in bulk precipitation at the wet detention pond site. In general, concentrations of heavy metals in bulk precipitation were similar to concentrations measured in the pond outflow, with the exception of zinc. The mean measured zinc concentration in bulk precipitation of 49.7 μg/l is higher than zinc concentrations measured in either the pond inflow or outflow.

3.2.4 Water Quality Comparison

A graphical statistical comparison of the chemical characteristics of general parameters in pond inflow, pond outflow, and bulk precipitation measured at the Poppleton Creek wet detention pond site is given in Figure 3-6. A graphical summary of data for each parameter is presented in the form of Tukey box plots, also often called "box and whisker plots". The bottom line 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. The **red** horizontal line within the box represents the mean of the data points. The vertical lines, also known as "whiskers", represent the 5 and 95 percentiles for the data sets. Individual values which fall outside of the 5-95 percentile range, sometimes referred to as “outliers”, are indicated as **red dots**.

In general, samples collected at the inflow to the wet detention pond exhibited both a higher degree of variability and higher mean concentration for pH, alkalinity, conductivity, and turbidity than observed in either the outflow or bulk precipitation samples. For each of the parameters summarized on Figure 3-6, samples collected from the pond outflow were found to have lower concentrations than measured at the pond inflow. In contrast, bulk precipitation samples were characterized by a low pH, alkalinity, conductivity, and turbidity.

A graphical summary of statistical variability in nitrogen species measured in the inflow, outflow, and bulk precipitation samples collected at the wet detention pond site is given in Figure 3-7. In general, mean nitrogen concentrations measured in the inflow samples were higher for all nitrogen species than measured in samples collected at the pond outfall. Concentrations of ammonia, particulate nitrogen, and total nitrogen in bulk precipitation appear to be similar to the characteristics measured in the pond outflow. However, NO_x concentrations measured in bulk precipitation were found to be higher than observed in either the inflow or outflow samples.

A graphical summary of statistical variability in phosphorus species measured at the Poppleton Creek site is given in Figure 3-8. In general, phosphorus concentrations measured at the pond inflow are higher than observed in either the pond outflow or bulk precipitation samples. Inflow samples also appear to exhibit a much larger degree of variability in measured concentrations than observed at the outflow monitoring site. Concentrations of phosphorus species in bulk precipitation appear to be similar to those measured at the pond outfall.

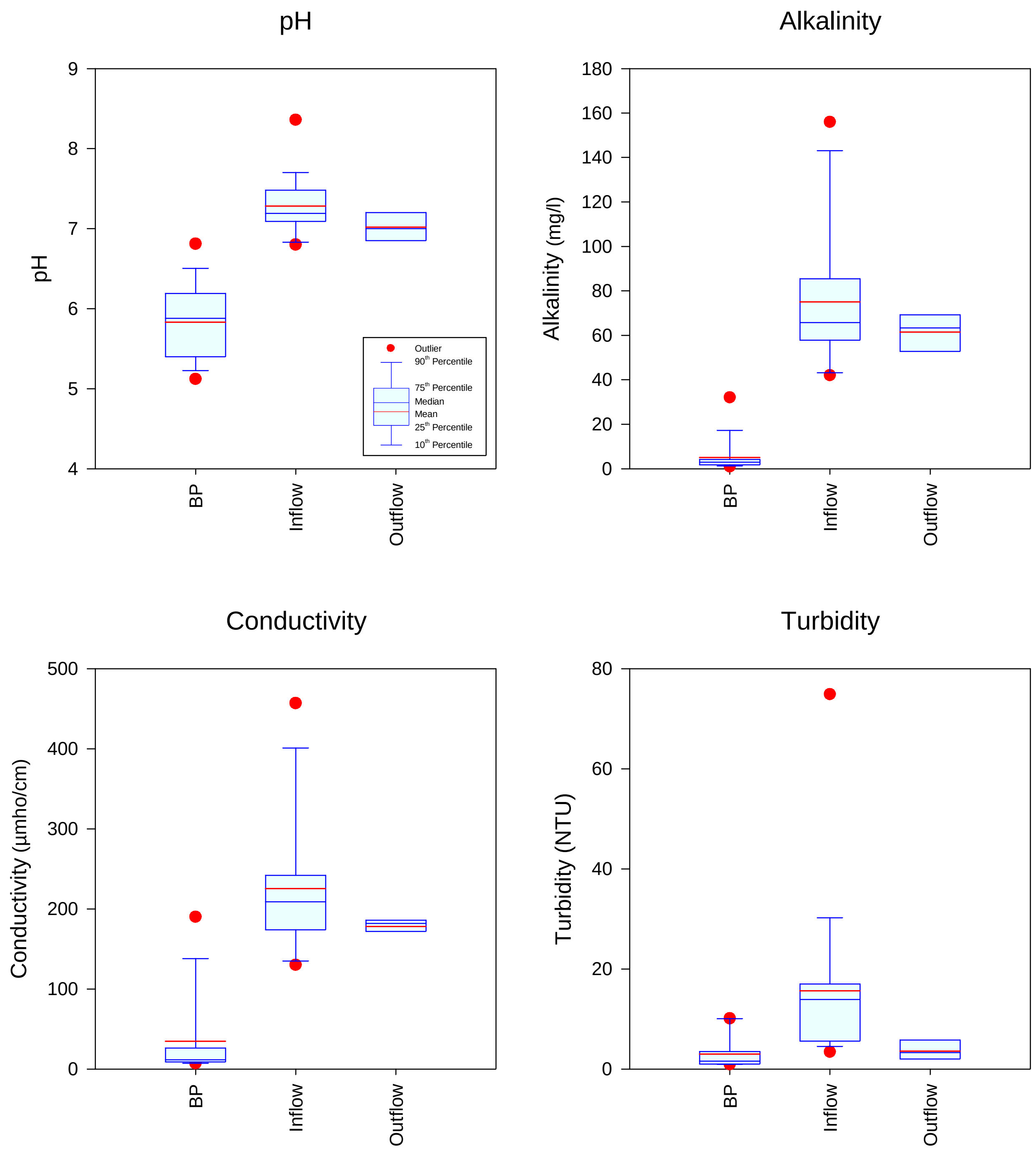


Figure 3-6. Summary of Statistical Variability in General Parameters Measured at the Poppleton Creek Wet Detention Pond Site.

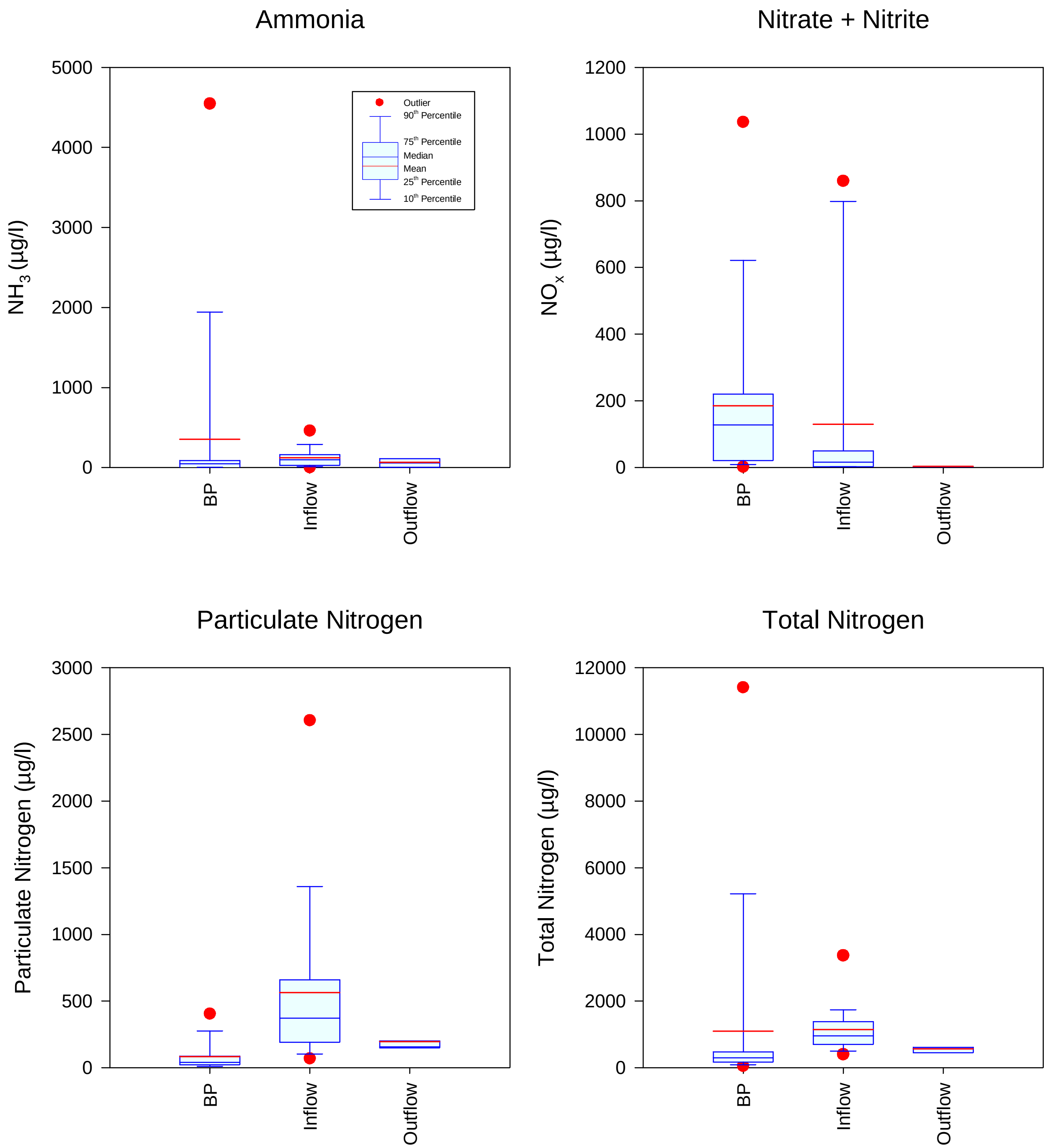


Figure 3-7. Summary of Statistical Variability in Nitrogen Species Measured at the Poppleton Creek Wet Detention Pond Site.

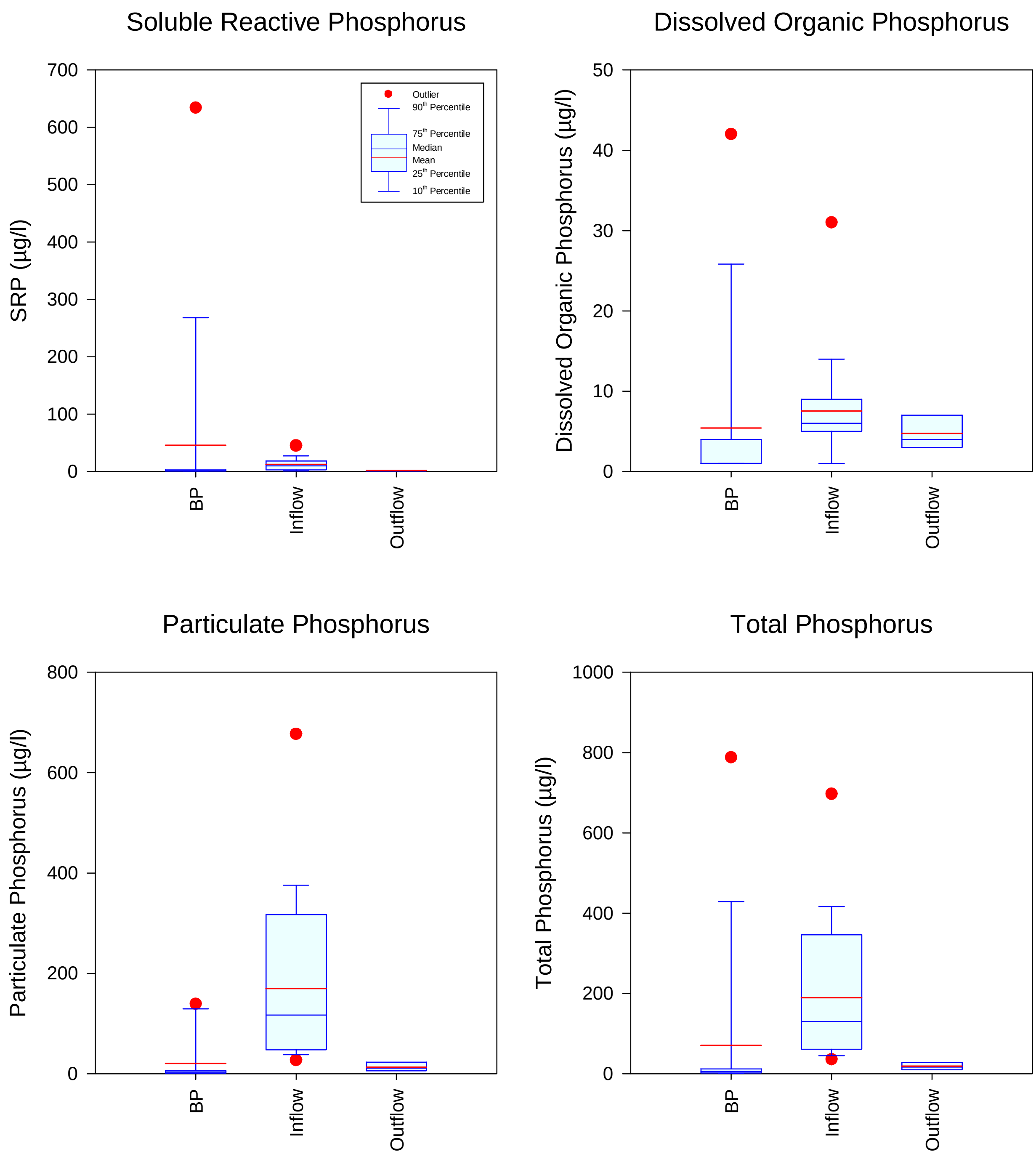


Figure 3-8. Summary of Statistical Variability in Phosphorus Species Measured at the Poppleton Creek Wet Detention Pond Site.

3.3 Pond Removal Efficiencies

Removal efficiencies for the Poppleton Creek wet detention pond were calculated on both a concentration and mass load basis. Changes in concentrations between inflow and outflow sources provide an estimate of the effectiveness of the physical, biological, and chemical processes which occur within the pond that remove constituents from the water column. Mass removal efficiencies incorporate the concentration-based reductions but also include the effects of hydrologic inputs and losses from the pond. A discussion of each of these processes is given in the following sections.

3.3.1 Concentration-Based Reductions

Concentration-based removals within the Poppleton Creek wet detention pond were evaluated by comparing the flow-weighted concentrations of inputs and outputs from the pond. Inputs into the pond are assumed to occur as a result of inflow from Poppleton Creek and bulk precipitation. As indicated on Figure 3-5, inflow through Poppleton Creek contributed approximately 94% of the hydrologic inputs into the pond, with approximately 6% contributed by direct rainfall. A volume weighted inflow concentration was calculated by applying these percentages to the chemical characteristics of pond inflow samples summarized on Table 3-11 and the chemical characteristics of bulk precipitation samples summarized on Table 3-13.

Losses from the pond occur as a result of discharge through the outfall structure as well infiltration into groundwater. The chemical characteristics for both of these losses are generally assumed to be similar to water quality characteristics within the pond. For purposes of this analysis, water quality characteristics within the pond are assumed to be similar to the pond outflow characteristics summarized in Table 3-12.

A summary of volume-weighted concentration-based removals in the Poppleton Creek wet detention pond during the field monitoring program is given in Table 3-14. Reductions in concentrations between the pond inputs and pond outflows occurred for all measured species of total nitrogen, total phosphorus, and heavy metals, with the exceptions of dissolved organic nitrogen and chromium, where small increases in concentrations were observed. Substantial reductions in the remaining nitrogen species were observed within the pond, with a 54% reduction in concentration for ammonia, an 88% reduction for NO_x, a 53% reduction for particulate nitrogen, and a 43% reduction for total nitrogen. Excellent concentration reductions were also observed for phosphorus species, with an 85% reduction for SRP, a 90% reduction for particulate phosphorus, and an 87% reduction in concentration for total phosphorus. Excellent concentration reductions were also achieved for total copper and total zinc, with a relatively low percentage reduction for cadmium. The concentration-based removal efficiencies summarized in Table 3-13 indicate that the physical, biological, and chemical processes within the pond provide substantial reductions in concentrations for both nutrients and heavy metals.

TABLE 3-14

SUMMARY OF VOLUME-WEIGHTED CONCENTRATION-BASED REMOVALS IN THE POPPLETON CREEK WET DETENTION POND

PARAMETER	WEIGHTED CONCENTRATION (μg/l)		PERCENT CHANGE (%)
	Inputs	Outflow	
NH_3	71	32	-54
NO_x	26	3	-88
Dissolved Organic N	295	303	3
Particulate N	368	174	-53
Total N	977	556	-43
SRP	7	1	-85
Dissolved Organic P	5	4	-19
Particulate P	105	11	-90
Total P	126	17	-87
Cd	1.6	1.3	-17
Cr	5.6	5.9	5
Cu	7.0	1.7	-76
Zn	24.2	1.1	-95

3.3.2 Mass Removal Efficiencies

Mass removal efficiencies were calculated for the Poppleton Creek wet detention pond during the field monitoring program by comparing the estimated mass inputs and mass losses for nutrients and heavy metals. This analysis combines the concentration-based removal efficiencies, summarized in Table 3-14, with the hydrologic characteristics of the pond site.

Mass inputs into the pond are assumed to occur as a result of inflow through Poppleton Creek and bulk precipitation. Inputs from these sources during the field monitoring program are calculated by multiplying the mean chemical characteristics of pond inflow (Table 3-11) and bulk precipitation (Table 3-13) times the total hydrologic inputs for inflow and rainfall during the field monitoring program, summarized in Table 3-9. Mass losses from the wet detention pond are assumed to occur as a result of outflow through the discharge structure and losses into groundwater through the pond bottom. For purposes of this analysis, the chemical characteristics of pond outflow (summarized in Table 3-12) is assumed to represent the mean characteristics of discharges through the outfall structure as well as water which infiltrated through the pond bottom. The mean characteristics of pond outflow samples (Table 3-12) are multiplied by the total volumetric losses through the outfall structure and into shallow groundwater (summarized in Table 3-9) during the field monitoring program.

A summary of calculated mass inputs, mass losses, and mass removal for the Poppleton Creek wet detention pond over the period from January 14-October 14, 2009 is given in Table 3-15. During the field monitoring program, the wet detention pond retained approximately 58% of the mass loadings of ammonia, 89% of the mass loadings of NO_x, 57% of the mass loadings of particulate nitrogen, and 48% of the mass loadings of total nitrogen. Excellent removal efficiencies were achieved for phosphorus species, with approximately 87% of the SRP loadings retained within the pond, 91% of the particulate phosphorus loadings, and 88% of the total phosphorus loadings also retained within the pond. Removal of heavy metals within the pond was highly variable, with a mass removal efficiency of 25% for cadmium, 4% for chromium, 78% for copper, and 96% for zinc.

TABLE 3-15

MASS REMOVAL EFFICIENCIES FOR THE POPPLETON CREEK WET DETENTION POND

PARAMETER	MASS INPUTS (kg)			MASS LOSSES (kg)			MASS REMOVAL	
	Inflow	Precip.	Total	Outflow	G.W.	Total	kg	%
NH_3	17.92	2.29	20.21	5.09	3.41	8.50	11.71	58
NO_x	6.13	1.35	7.48	0.48	0.32	0.80	6.68	89
Dissolved Organic N	83.89	0.86	84.75	47.62	31.87	79.49	5.26	6
Particulate N	103.66	1.98	105.64	27.31	18.28	45.58	60.06	57
Total N	275.0	5.65	280.7	87.25	58.40	145.7	135.0	48
SRP	1.94	0.04	1.98	0.16	0.11	0.26	1.72	87
Dissolved Organic P	1.47	0.03	1.50	0.66	0.44	1.11	0.39	26
Particulate P	30.22	0.06	30.27	1.70	1.14	2.84	27.44	91
Total P	36.18	0.13	36.30	2.64	1.76	4.40	31.90	88
Cd	0.43	0.02	0.45	0.20	0.14	0.34	0.11	25
Cr	1.51	0.09	1.60	0.92	0.62	1.54	0.06	4
Cu	1.96	0.05	2.01	0.27	0.18	0.44	1.57	78
Zn	6.12	0.80	6.92	0.17	0.12	0.29	6.63	96

The observed removal efficiencies for total nitrogen and total phosphorus within the Poppleton Creek wet detention pond appear to be slightly higher than removal efficiencies commonly observed by ERD in wet detention ponds with a 57-day detention time. However, a large portion of the removal efficiencies within the pond occurred as a result of the continuous infiltration of water from the pond into groundwater. In general, wet detention ponds with a 57-day detention time commonly exhibit removal efficiencies for total nitrogen of approximately 35-40%, with total phosphorus removals ranging from approximately 70-75%. The more elevated removals for total nitrogen and total phosphorus observed in the Poppleton Creek wet detention pond are due primarily to the additional volumetric and mass losses which occurred through groundwater infiltration.

3.4 Pollutant Removal Costs

Estimates of annual mass removal costs were generated for total nitrogen and total phosphorus in the Poppleton Creek wet detention pond system. However, before this analysis could be performed, estimates of the annual hydrologic and mass loadings to the Poppleton Creek wet detention pond were required. A summary of estimated annual hydrologic and mass loadings to the wet detention pond is given in Table 3-16. As indicated in Table 3-5, the runoff C value for the 271-acre drainage basin during the field monitoring program was approximately 0.322. Average annual rainfall in the Stuart area is approximately 59.53 inches based upon the yearly average recorded at the City of Stuart meteorological site (Site 8620) over the 30-year period from 1971-2000. This equates to an estimated annual inflow volume from the 271-acre basin area of approximately 432.9 ac-ft/yr.

TABLE 3-16

ESTIMATED ANNUAL HYDROLOGIC AND MASS LOADINGS TO THE POPPLETON CREEK WET DETENTION POND

PARAMETER	VALUE
Hydrologic Inputs	
Runoff C Value	0.322
Annual Rainfall	59.53 inches
Inflow Volume	432.9 ac-ft/yr
Total Nitrogen	
Mean Inflow Concentration	1017 µg/l
Mass Inflow	543 kg/yr
Total Phosphorus	
Mean Inflow Concentration	134 µg/l
Mass Inflow	71.5 kg/yr

Estimates of the annual mass loadings of total nitrogen and total phosphorus given in Table 3-17 were calculated by multiplying the mean inflow concentrations for each parameter (summarized in Table 3-11) times the annual inflow volume of 432.9 ac-ft/yr. This calculation indicates that total nitrogen loadings to the pond are approximately 543 kg/yr, with total phosphorus contributing approximately 71.5 kg/yr. Estimates of annual removal efficiencies for total nitrogen and total phosphorus are based upon the concentration-based removals for the pond (summarized in Table 3-14). The concentration-based removals are used since these values reflect the physical, biological, and chemical processes which occur within the pond only and do not consider the additional removal achieved during the monitoring program as a result of the large amount of volumetric retention which occurred within the pond. Therefore, a removal of approximately 43% is assumed for total nitrogen and 87% for total phosphorus. Based upon this analysis, the Poppleton Creek wet detention pond will remove approximately 233.5 kg/yr of total nitrogen and 62.2 kg/yr of total phosphorus from Poppleton Creek.

TABLE 3-17

ESTIMATED ANNUAL LOAD REDUCTIONS FOR TOTAL NITROGEN AND TOTAL PHOSPHORUS IN THE POPPLETON CREEK WET DETENTION POND

PARAMETER	ANNUAL LOADING (kg/yr)	REMOVAL IN POND (%)	ANNUAL LOAD REDUCTION (kg/yr)
Total Nitrogen	543	43	233.5
Total Phosphorus	71.5	87	62.2

An evaluation of estimated present worth costs for the Poppleton Creek wet detention pond is given in Table 3-18. This analysis assumes a construction cost of $1,829,741.78 and an annual maintenance cost of approximately $10,000 per year for 20 years. This equates to an estimated present worth cost of approximately $2,029,741.78.

TABLE 3-18

EVALUATION OF PRESENT WORTH COST FOR THE POPPLETON CREEK WET DETENTION POND

PARAMETER	VALUE
Basin Area	271 acres
Design Detention Treatment Provided	1.33 inches
BMP Construction Costs ($) (Land: $0 + Construction: $1,154,441.32)	$ 1,829,741.78
Annual Maintenance Cost ($)	$ 10,000
Present Worth Cost (20-year) ($)	$ 2,029,741.78

An evaluation of load reduction costs for the Poppleton Creek wet detention pond is given in Table 3-19. The estimated mass removal for total nitrogen and total phosphorus over the 20-year evaluation cycle is divided by the 20-year present worth cost of $2,029,741.78. The resulting present worth costs per kg of pollutant removed are summarized in the last row of Table 3-19. The calculated mass removal costs of $435/kg of nitrogen and $1632/kg of phosphorus removed are similar to present worth costs commonly observed for nutrient removal in wet detention systems.

TABLE 3-19

EVALUATION OF LOAD REDUCTION COSTS FOR THE POPPLETON CREEK WET DETENTION POND

PARAMETER	TOTAL NITROGEN	TOTAL PHOSPHORUS
Annual Mass Removed (kg/yr)	233.5	62.2
Present Worth Cost per kg Removed ($)	435	1632

3.5 Quality Assurance

Supplemental samples were collected during the field monitoring program for quality assurance purposes. These supplemental samples include equipment blanks and duplicate samples, along with supplemental laboratory analyses to evaluate precision and accuracy of the collected data. A summary of QA data collected as part of this project is given in Appendix C.

SECTION 4

SUMMARY

A field monitoring program was conducted by ERD from January-October 2009 to evaluate the performance efficiency of the Poppleton Creek wet detention pond. The wet detention pond is designed to provide wet detention treatment for 1.33 inches of runoff for 271 acres of a 525-acre contributing basin area. Automatic samplers with integral flow meters were used to provide a continuous record of hydrologic inputs and losses for the pond, as well as collect inflow and outflow samples on a flow-weighted basis. A recording rain gauge was also installed adjacent to the monitoring site.

Composite runoff samples were collected during a total of 19 inflow events and 7 outflow events at the pond site. The collected runoff samples were found to be highly variable with respect to chemical characteristics, with moderate to low concentrations for most nitrogen and phosphorus species. Only three significant discharge events were observed over the outfall weir structure during the 273-day monitoring program, which included measured rain events as great as 2.08 inches, suggesting that a large portion of the inflow volume was retained by the pond system.

A supplemental analysis was conducted which estimated that the long-term annual removal efficiency of the wet detention pond system will be approximately 43% for total nitrogen and 87% for total phosphorus. Based upon this estimated performance efficiency and the chemical characteristics of inflow collected at the site, it is estimated that the Poppleton Creek wet detention pond will provide removal for approximately 233.5 kg/yr of total nitrogen and 62.2 kg/yr of total phosphorus at a cost of $435/kg total nitrogen and $1632/kg total phosphorus.

A summary of total project costs is given in Table 4-1. FDEP contributed $770,132.59 (42%) and the City of Stuart contributed $1,059,609.19 (58%) of the total project cost of $1,829,741.78.

TABLE 4-1

SUMMARY OF TOTAL PROJECT COSTS AND FUNDING SOURCES

PROJECT FUNDING ACTIVITY	TOTAL PROJECT COSTS ($)	DEP GRANT FUNDS ($)	CITY OF STUART FUNDS ($)
BMP Implementation	872,161.12	704,742.93	167,418.19
Monitoring	59,263.69	53,096.66	6,167.03
Public Education	1,513.00	1,513.00	--
Grant Adm/Reports	10,780.00	10,780.00	--
Contractual Services	886,023.97	--	886,023.97
TOTAL:	**$ 1,829,741.78**	**$ 770,132.59**	**$ 1,059,609.19**
PERCENTAGE MATCH:		**42**	**58**

APPENDICES

APPENDIX A

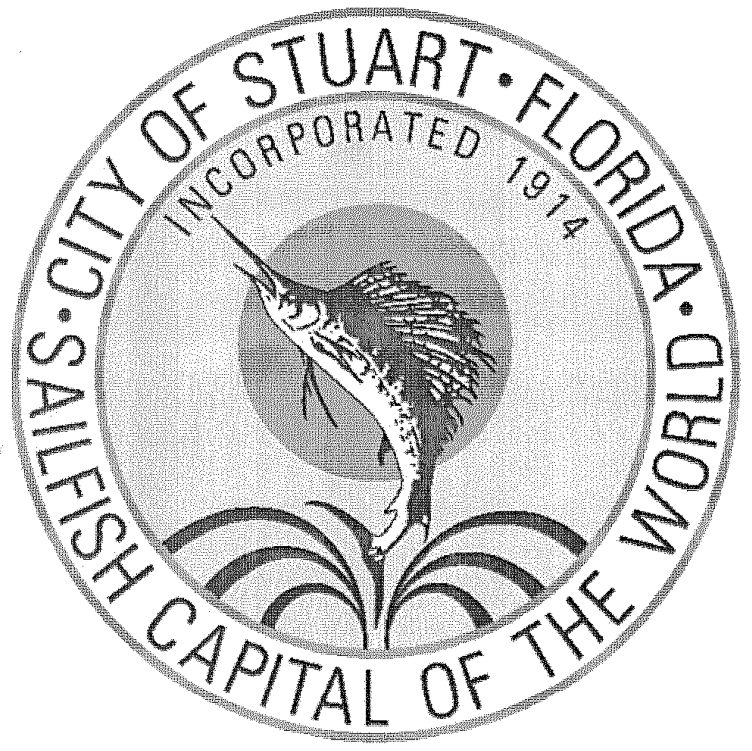
CONSTRUCTION PLANS FOR THE POPPLETON CREEK WET DETENTION POND FACILITY

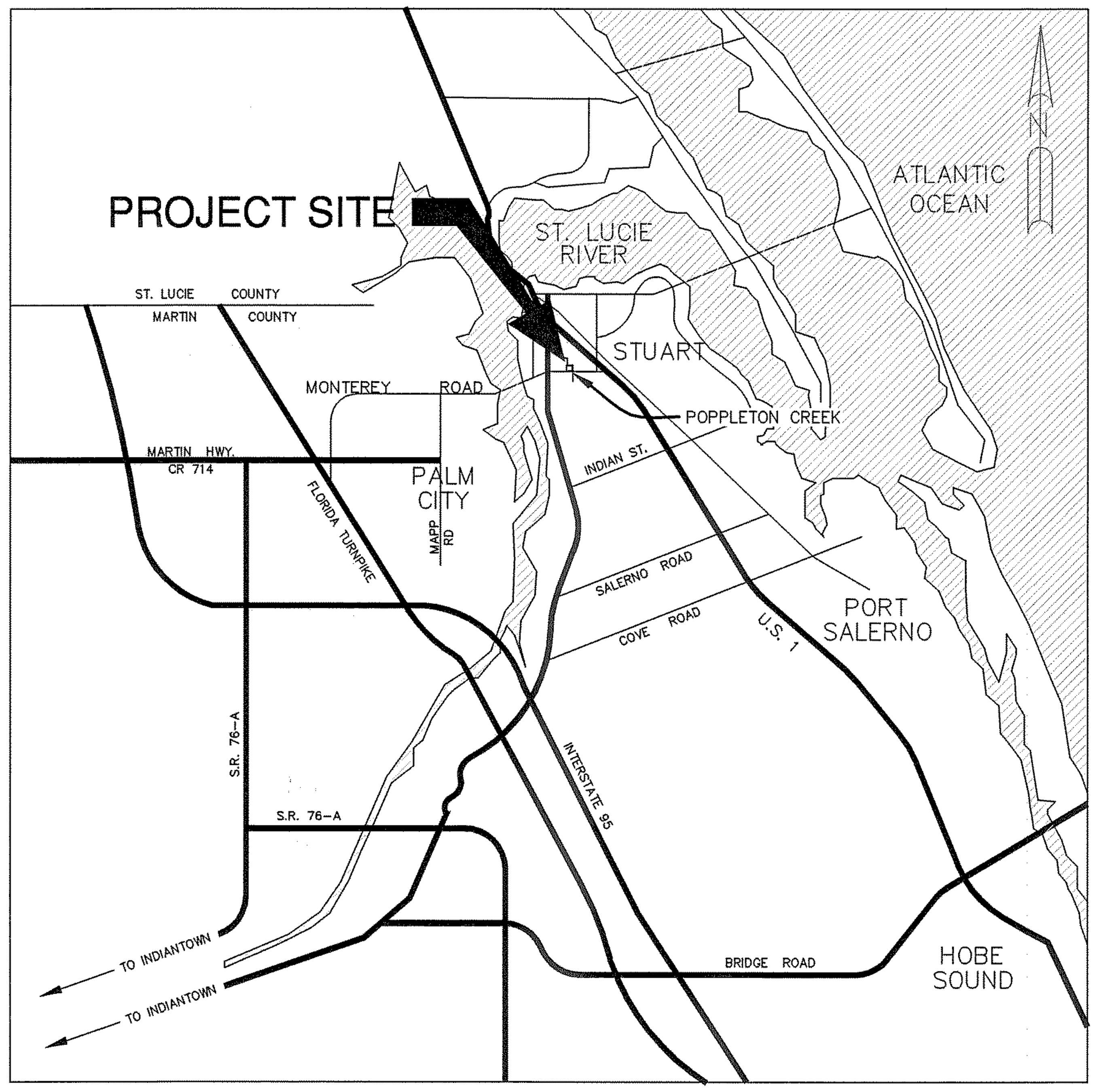
LAKE EXCAVATION AND SITE IMPROVEMENT PLANS
FOR

POPPLETON CREEK

WATERSHED DEVELOPMENT

CITY OF STUART. FLORIDA





LOCATION MAP
N.T.S.
SEC. 8,9 TWP. 38S RGE. 41E

CITY OF STUART, FLORIDA
121 SW FLAGLER AVE.
STUART, FL 34994
PHONE: (772)288-5332 FAX: (772)288-5381

MAYOR	JEFFREY A. KRAUSKOPF
VICE MAYOR	MICHAEL MORTELL
COMMISSIONER	CHARLES S. FOSTER
COMMISSIONER	KARL J. KRUEGER JR.
COMMISSIONER	GENE C. RIFKIN
CITY MANAGER	DAVID COLLIER
CITY ATTORNEY	CARL V. M. COFFIN
PUBLIC WORKS DIR	SAMUEL AMERSON, P.E.

INDEX OF SHEETS

Poppelton Creek

POPPLETON CREEK
WATERSHED DEVELOPMENT

PLANS PREPARED BY:
LACONTE ENGINEERING, INC.
CIVIL ENGINEERING • SITE DESIGN • CONSULTING
3933 SE Fairway East, Stuart, Florida 34997
(772) 223-8071 • FAX (772) 223-8232

REVISION DATES...
10-22-03, 1-20-04, 1-27-04, 3-31-04 5-10-04

SEAL	FILE NAME: LAKE-EN01
	PROJECT: POPPLETON
	PLAN SET: LAKE
PATRICK J. LACONTE, P.E. FLORIDA REG. NO. 41070	SHEET #: 1 OF 9

LACONTE ENGINEERING, INC.
ENGINEERING • SITE DESIGN • CONSULTING
3933 SE Fairway East, Stuart, Florida 34997
(772) 223-8071 • FAX (772) 223-8232

REV	REVISIONS	DATE	BY
1	CHANGE TO LACONTE & REVISIONS PER DEP	10-22-03	PJL
2	CONTAMINATION/DEBRIS REMOVAL TO SHEET 3	1-20-04	PJL
3	REVISE GRADING BETWEEN LAKE AND EX. CREEK	1-27-04	PJL

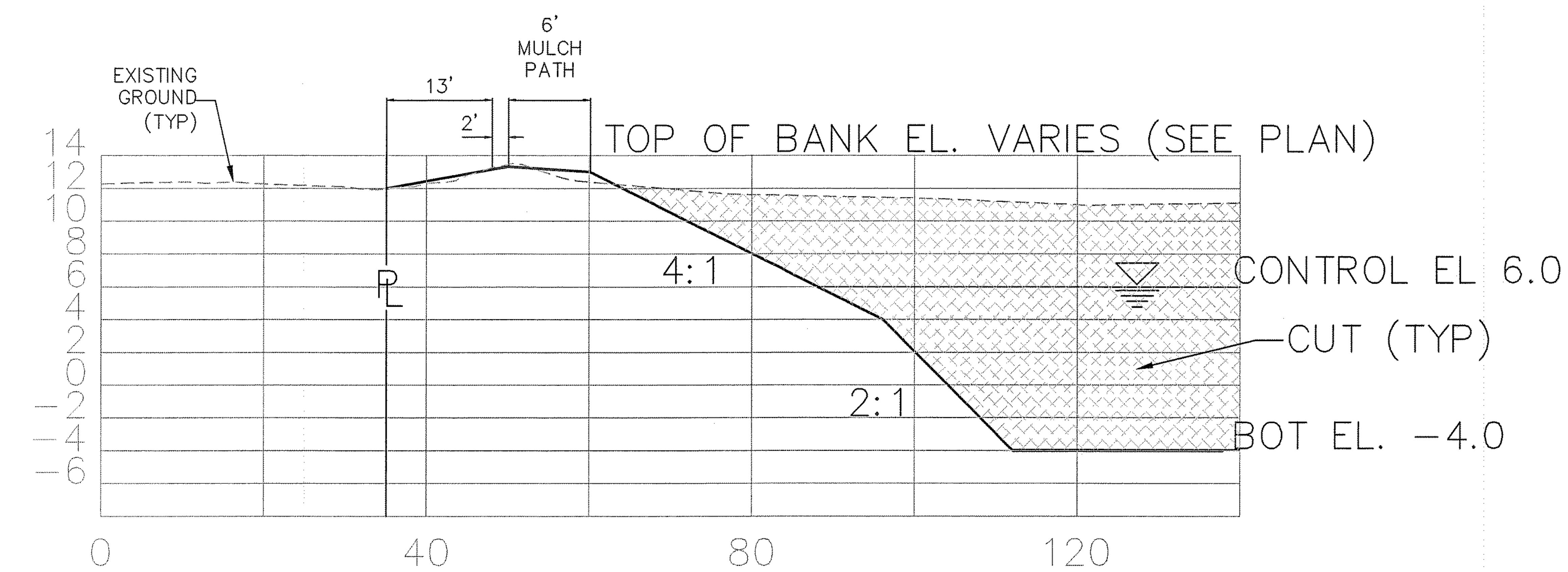
LAKE EXCAVATION PLAN
FOR
POPPLETON CREEK
WATERSHELD DEVELOPMENT

DATE: 6-19-03
SCALE: 1" = 40
DESIGNED BY: GBP/JPM
DRAWN BY: FAM
CHECKED BY: PJL
FILE NAME: LAKE-EN04

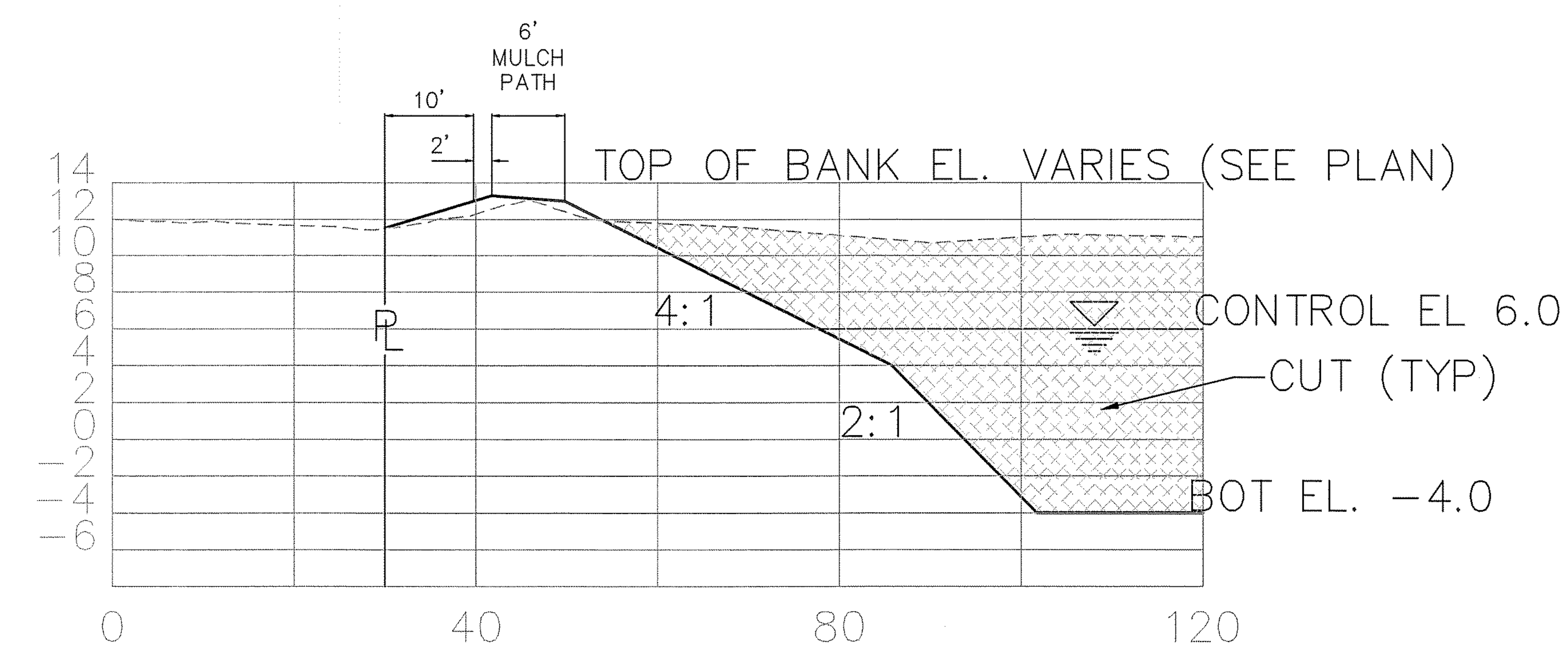
SEAL
PATRICK J. LACONTE, P.E.
FLORIDA REG. NO. 41070

PROJECT: POPPLETON
DRAWING: LAKE
SHEET #: 4 OF 9

SECTION A



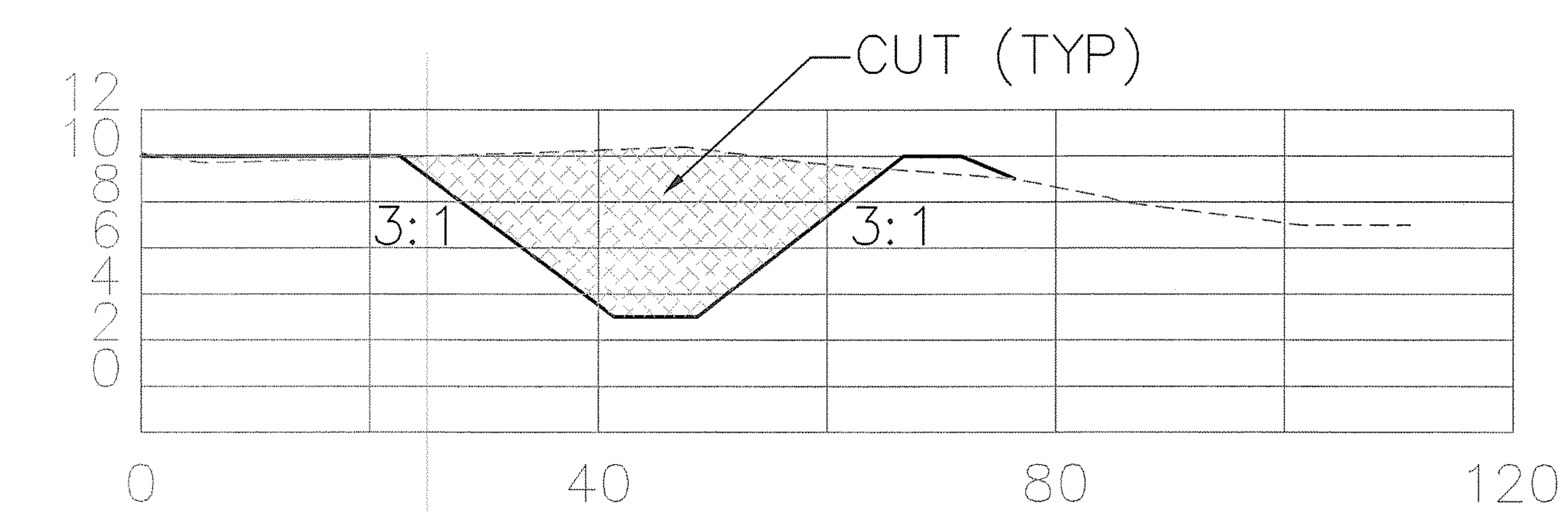
SECTION B



SECTION C

(SEE DETAIL ON SHT 8)

SECTION D



NOTE:
THE PROPOSED LAKE BANK SHALL BE SODDED FROM 1' BELOW CONTROL TO THE TOP OF BANK. ALL OTHER DISTURBED AREAS SHALL BE SEEDED AND MULCHED.

GENERAL NOTES

1. LOCATIONS, ELEVATIONS AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES AND OTHER FEATURES ARE SHOWN TO THE BEST INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE DRAWINGS. THE CONTRACTOR SHALL VERIFY LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES AND OTHER FEATURES AFFECTING THE PROPOSED WORK PRIOR TO CONSTRUCTION, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES, WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.
2. ALL PRIOR IMPROVEMENTS REMOVED OR DAMAGED DURING THE CONSTRUCTION, IF NOT INDICATED TO BE REMOVED SHALL BE REPLACED BY THE CONTRACTOR WITH THE SAME TYPE OF MATERIAL AFFECTED.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING ALL EXISTING ABOVEGROUND, UNDERGROUND, AND ON THE SURFACE STRUCTURES AND UTILITIES AGAINST THE CONSTRUCTION OPERATION THAT MAY CAUSE DAMAGE TO SAID FACILITY.
4. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO VISIT THE SITE PRIOR TO BIDDING THE WORK AND TO PERFORM SUCH TESTS, STUDIES AND SURVEYS, AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO THE ACTUAL SURFACE AND SUBSURFACE CONDITIONS EXISTING AT THE SITE. ACTUAL CONDITIONS THAT DIFFER FROM THOSE SHOWN ON THE DRAWINGS SHALL NOT CONSTITUTE CAUSE FOR EXTRA PAYMENT.
5. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY WHEN A CONFLICT BETWEEN THE DRAWINGS AND ACTUAL CONDITIONS IS DISCOVERED DURING THE COURSE OF CONSTRUCTION.
6. PRIOR TO BEING CONSTRUCTED, ANY CHANGES DUE TO FIELD CONDITIONS OR ANY OTHER DEVIATION FROM THE APPROVED DRAWINGS MUST BE APPROVED BY THE ENGINEER AND THE GOVERNING AUTHORITY HAVING JURISDICTION.
7. THE CONTRACTOR SHALL PROVIDE AT LEAST 48 HOURS NOTICE TO ALL UTILITY OWNERS HAVING FACILITIES IN THE AREA WITHIN AND ADJACENT TO THE PROPOSED CONSTRUCTION TO PERMIT THE LOCATION OF EXISTING UNDERGROUND UTILITIES IN ADVANCE OF CONSTRUCTION.
8. THE CONTRACTOR SHALL GIVE ADEQUATE NOTIFICATION TO ALL AFFECTED UTILITY OWNERS FOR REMOVAL, RELOCATION AND ALTERATION OF THEIR EXISTING FACILITIES.
9. THE CONTRACTOR SHALL NOTIFY ALL APPLICABLE UTILITY OWNERS OF EMERGENCY AND/OR SEVERED UTILITY LINES DURING CONSTRUCTION ACTIVITIES.
10. DURING ALL UNDERGROUND CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING THE APPROPRIATE CLEARANCES FROM ANY PROPOSED OR EXISTING UTILITIES OR STRUCTURES AS REQUIRED BY THE PLANS, SPECIFICATIONS, UTILITY AUTHORITY, AND ANY GOVERNING AGENCY. THE CONTRACTOR MUST NOTIFY THE ENGINEER IMMEDIATELY IF THE APPROPRIATE CLEARANCE IS NOT AVAILABLE.
11. STREET OR HIGHWAY RESTORATION WORK IS TO BE DONE AS PER THE LOCAL OR STATE AGENCY HAVING JURISDICTION.
12. THE CONTRACTOR SHALL COMPLY WITH ALL RULES AND REGULATIONS OF THE STATE, COUNTY AND CITY AUTHORITIES REGARDING CLOSING OR RESTRICTING THE USE OF PUBLIC STREETS OR HIGHWAYS.
13. TRAFFIC CONTROL ON ALL CITY, COUNTY AND STATE HIGHWAY RIGHTS-OF-WAY SHALL MEET THE REQUIREMENTS OF THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES (U.S. DOT/FHA) AND THE REQUIREMENTS OF THE STATE AND ANY LOCAL AGENCY HAVING JURISDICTION.
14. THE CONTRACTOR SHALL PREPARE A CONSTRUCTION WORK SCHEDULE INCLUDING A PLAN SHOWING THE ORDER OF CONSTRUCTION AND PROCEDURES FOR MAINTAINING EXISTING SERVICES DURING CONSTRUCTION.
15. THE CONTRACTOR SHALL PROVIDE A QUALIFIED SUPERINTENDENT TO REMAIN AT THE JOB SITE AT ALL TIMES WHEN WORK IS BEING PERFORMED. THE SUPERINTENDENT SHALL ATTEND ALL SCHEDULED CONSTRUCTION OBSERVATION MEETINGS.
16. THE CONTRACTOR SHALL HAVE AVAILABLE AT THE JOB SITE AT ALL TIMES:
    - ONE (1) SET OF THE "APPROVED" CONSTRUCTION DRAWINGS,
    - ONE (1) COPY OF THE APPLICABLE UTILITY COMPANY'S MINIMUM DESIGN AND CONSTRUCTION STANDARDS",
    - ONE (1) COPY OF ALL CONTRACT DOCUMENTS, AND
    - ONE (1) COPY OF ALL APPLICABLE LOCAL, STATE AND FEDERAL PERMITS REQUIRED FOR CONSTRUCTION.
17. ALL ELEVATIONS REFER TO N.G.V.D. 1929 DATUM, UNLESS OTHERWISE NOTED.
18. ALL CONCRETE SHALL BE 3000 PSI UNLESS OTHERWISE INDICATED AND SHALL BE IN CONFORMANCE WITH THE LATEST A.C.I. BUILDING CODE REQUIREMENTS.
19. THE CONTRACTOR SHALL APPLY SEED AND MULCH OR SOD TO ALL DISTURBED AREAS UPON COMPLETION OF ANY FILLING AND FINAL GRADING ACTIVITIES.
20. ALL EXISTING TREES AND VEGETATION SHALL BE PRESERVED WHEREVER POSSIBLE, UNLESS OTHERWISE NOTED IN THE PLANS.
21. THE CONTRACTOR SHALL GUARANTEE ALL WORK AND MATERIALS FOR A PERIOD OF ONE YEAR FROM THE DATE OF PROJECT ACCEPTANCE, DURING WHICH TIME ALL FAULTY CONSTRUCTION AND/OR MATERIALS SHALL BE CORRECTED AT THE CONTRACTOR'S EXPENSE.

SEDIMENTATION AND EROSION CONTROL

THE CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE DUST, EROSION AND TURBIDITY CONTROL AS NECESSARY. THE CONTRACTOR SHALL INSTALL A TYPE III SILT FENCE PER PLAN ACCORDING TO FDOT INDEX #102, OR OTHER APPROVED SEDIMENTATION BARRIERS AT ANY LIMITS OF CLEARING OR CONSTRUCTION WHERE RUNOFF FROM THE DISTURBED AREA HAS THE POTENTIAL OF FLOWING INTO AN UNDISTURBED AREA, INCLUDING UPLAND PRESERVE. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN ALL EXISTING DRAINAGE AND SURFACE WATER MANAGEMENT AREAS, CONNECTIONS AND STRUCTURES, AS NECESSARY, TO ENSURE THAT FLOODING AND/OR TURBID DISCHARGE DOES NOT OCCUR DURING CONSTRUCTION. THE CONTRACTOR SHALL INSTALL SEDIMENTATION BARRIERS ALONG THE CONSTRUCTION PERIMETER, AS NECESSARY, TO PROTECT OUTSTANDING FLORIDA WATERS, WETLAND PRESERVE AREAS AND BUFFERS FROM SILT AND/OR DISCHARGE OF TURBID WATER FROM THE SITE.

PRIOR TO AND DURING CONSTRUCTION, THE CONTRACTOR SHALL IMPLEMENT AND MAINTAIN ALL SEDIMENTATION AND EROSION CONTROL MEASURES REQUIRED TO RETAIN SEDIMENT ON SITE AND TO PREVENT VIOLATIONS OF STATE WATER QUALITY STANDARDS. SEDIMENTATION AND EROSION CONTROL FEATURES MAY INCLUDE, BUT ARE NOT LIMITED TO, SILT FENCES, SILTATION BARRIERS, GEOTEXTILE FILTER BARRIERS, BAILED HAY OR STRAW BARRIERS, TURBIDITY SCREENS AND SEDIMENTATION BASINS. CONSTRUCTION AND MAINTENANCE OF SEDIMENTATION AND EROSION CONTROL MEASURES SHALL BE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS.

THE CONTRACTOR SHALL CONSTRUCT AND MAINTAIN ALL SEDIMENTATION AND EROSION CONTROL MEASURES AS SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE ENGINEER. IF A SEDIMENTATION AND EROSION CONTROL PLAN IS NOT INCLUDED IN THE APPROVED CONSTRUCTION DRAWINGS, THE CONTRACTOR SHALL PREPARE A SITE-SPECIFIC SEDIMENTATION AND EROSION CONTROL PLAN IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS AND BEST MANAGEMENT PRACTICES. THE CONTRACTOR MUST HAVE THIS PLAN APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.

STORMWATER RETENTION/DETENTION FACILITIES SHALL BE EXCAVATED AND ROUGH GRADED PRIOR TO BUILDING CONSTRUCTION OR CONSTRUCTION OF IMPERVIOUS SURFACES WITHIN THE AREA SERVED BY THESE RETENTION/DETENTION FACILITIES. ADEQUATE MEASURES SHALL BE TAKEN TO PREVENT EROSION PRIOR TO FINAL GRADING AND STABILIZATION OF THE RETENTION/DETENTION FACILITIES.

STABILIZATION MEASURES, INCLUDING BUT NOT LIMITED TO, THE APPLICATION OF SOD OR SEED AND MULCH, SHALL BE INITIATED FOR SEDIMENTATION AND EROSION CONTROL ON ALL DISTURBED AREAS AS SOON AS POSSIBLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN SEVEN (7) DAYS AFTER CONSTRUCTION ACTIVITY HAS CEASED.

THE CONTRACTOR SHALL INSPECT ALL SEDIMENTATION AND EROSION CONTROL MEASURES DAILY DURING CONSTRUCTION. THE CONTRACTOR SHALL IMMEDIATELY CORRECT ANY DEFICIENCIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CORRECTING ANY OFF SITE WATER QUALITY IMPACTS OR OTHER ADVERSE IMPACTS DUE TO SEDIMENTATION AND EROSION FROM THE PROJECT SITE DURING CONSTRUCTION.

EXCAVATION

THE CONTRACTOR SHALL PERFORM ALL EXCAVATION NECESSARY TO ACCOMPLISH THE CONSTRUCTION INDICATED IN THE PLANS. EXCAVATION SHALL BE UNCLASSIFIED REGARDLESS OF MATERIAL ENCOUNTERED. ALL EXCAVATED MATERIAL NOT REQUIRED FOR FILL OR EMBANKMENT, SHALL BE DEPOSITED ON THE SITE, AS DIRECTED BY THE OWNER, OR HIS REPRESENTATIVE. THE CONTRACTOR SHALL DO ALL SHORING NECESSARY TO PERFORM AND PROTECT THE EXCAVATION, AND AS NECESSARY FOR THE SAFETY OF THE WORKERS AND ANY EXISTING FACILITIES IN ACCORDANCE WITH THE STATE OF FLORIDA "TRENCH SAFETY ACT". WHEREVER EXCAVATIONS ARE MADE BELOW THE GRADES INDICATED IN THE PLANS, CLEAN FIRM MATERIAL APPROVED BY THE ENGINEER SHALL BE USED TO RESTORE THE AREA TO THE PROPER GRADE, AND SHALL BE COMPACTED IN ACCORDANCE WITH THE REQUIREMENTS FOR COMPACTION INCLUDED IN THE SPECIFICATIONS.

ALL CONSTRUCTION DEWATERING (WELL POINTS, SUMPS, ETC.) WILL REQUIRE A DEWATERING PERMIT FROM THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT, TO BE OBTAINED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE. THE CONTRACTOR SHALL MAKE PROVISIONS FOR THE STORAGE AND TREATMENT OF ALL DEWATERING EFFLUENT, AND SURFACE WATER RUNOFF DURING CONSTRUCTION TO AVOID ANY POSSIBLE WATER QUALITY VIOLATIONS. ALSO, ALL DEWATERING EFFLUENT AND TURBID RUNOFF MUST BE PREVENTED FROM FLOWING INTO WETLANDS, UPLAND PRESERVE AREAS, AND/OR OFF-SITE.

SEAL

PATRICK J. LACONTE, P.E.
FLORIDA REG. NO. 41070

LACONTE ENGINEERING, INC.
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3933 SE Fairway East, Stuart, Florida 34997
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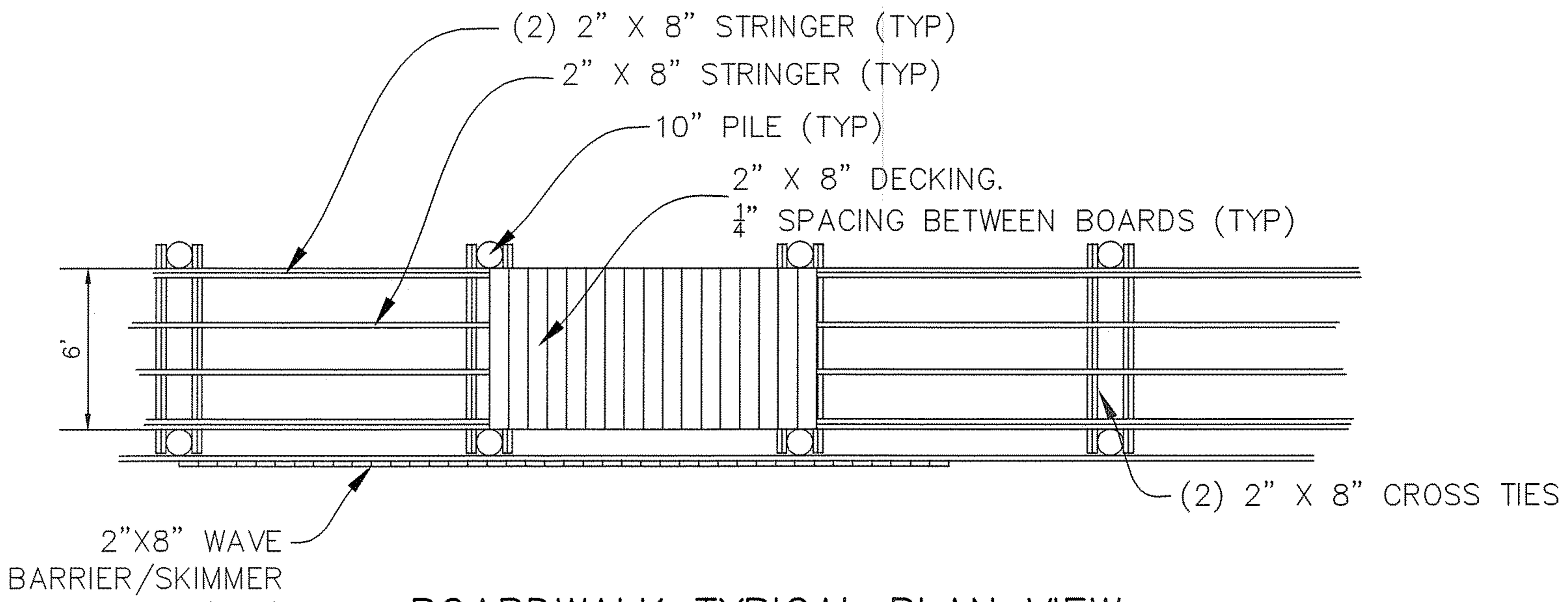
REV	REVISIONS	DATE	BY
1	CHANGE TO LACONTE	10-22-03	PJL
2	CHANGE SHEET NUMBER/REFERENCES	1-20-04	PJL
3	ADD SPECIFICATIONS	3-31-04	PJL

EXCAVATION CROSS SECTIONS & SPECIFICATIONS
FOR
POPPLETON CREEK
WATERSHELD DEVELOPMENT

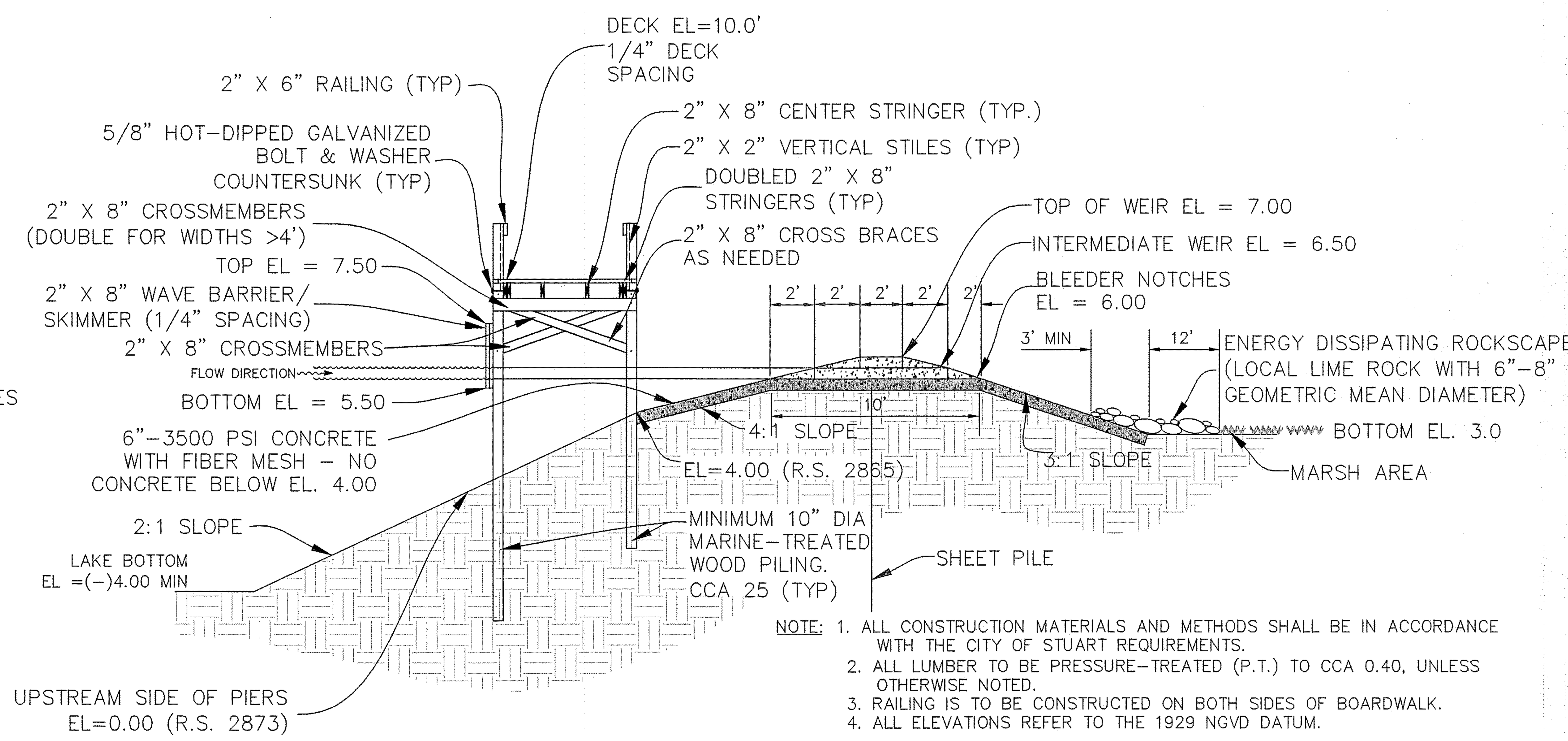
DATE: 6-19-03
SCALE: 10:H, 5:V
DESIGNED BY: GBP/JPM
DRAWN BY: FAM
CHECKED BY: PJL
FILE NAME: LAKE-EN07

PROJECT: POPPLETON
PLAN SET: LAKE
SHEET #: 7 OF 9



BOARDWALK TYPICAL PLAN VIEW

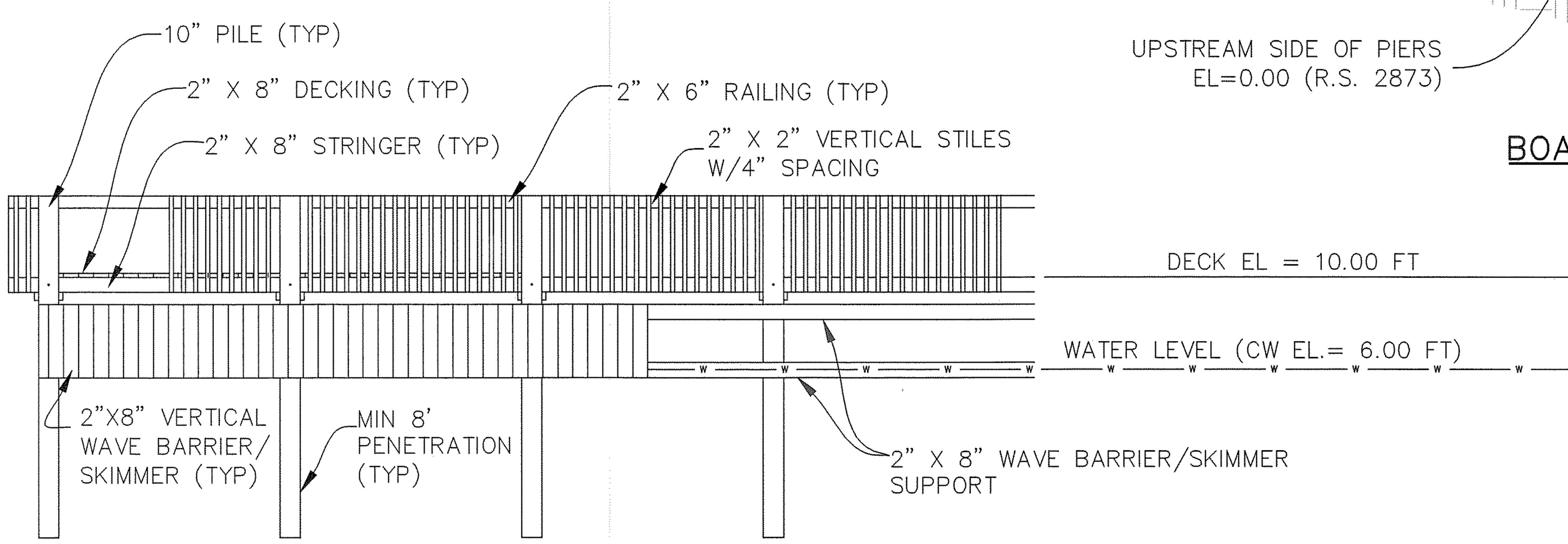
NTS



NOTE: 1. ALL CONSTRUCTION MATERIALS AND METHODS SHALL BE IN ACCORDANCE WITH THE CITY OF STUART REQUIREMENTS.
2. ALL LUMBER TO BE PRESSURE-TREATED (P.T.) TO CCA 0.40, UNLESS OTHERWISE NOTED.
3. RAILING IS TO BE CONSTRUCTED ON BOTH SIDES OF BOARDWALK.
4. ALL ELEVATIONS REFER TO THE 1929 NGVD DATUM.

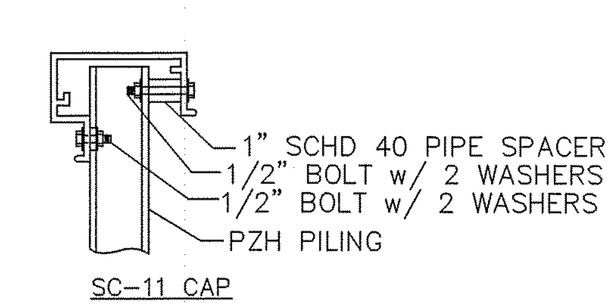
BOARDWALK AND WEIR CROSS SECTION (SECTION C)

(SEE SHT 4)
NTS



BOARDWALK PROFILE

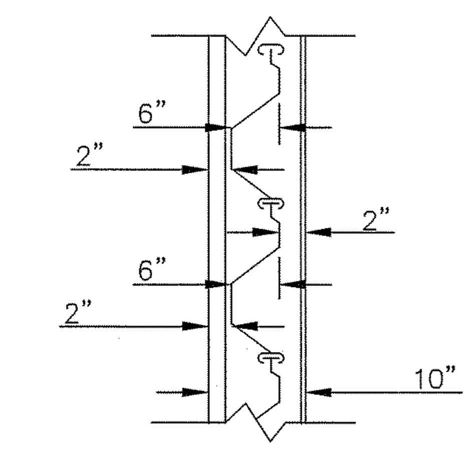
NTS



1. EVERY OTHER PILE WILL RECEIVE A BOLT ON FRONT FACE.
2. A MINIMUM OF 5 PIPE SPACERS TO BE LOCATED ON THE SOIL SIDE OF CAP. ONE EACH SIDE OF JOINT-REST, EVENLY SPACED BETWEEN THE END BOLTS.
3. WHEN AN ANCHOR ROD IS CONNECTED TO THE CAP, PIPE SPACER WILL BE LOCATED BETWEEN THE TIE RODS.
4. ALL BOLTS, NUTS AND WASHERS ARE STAINLESS STEEL.

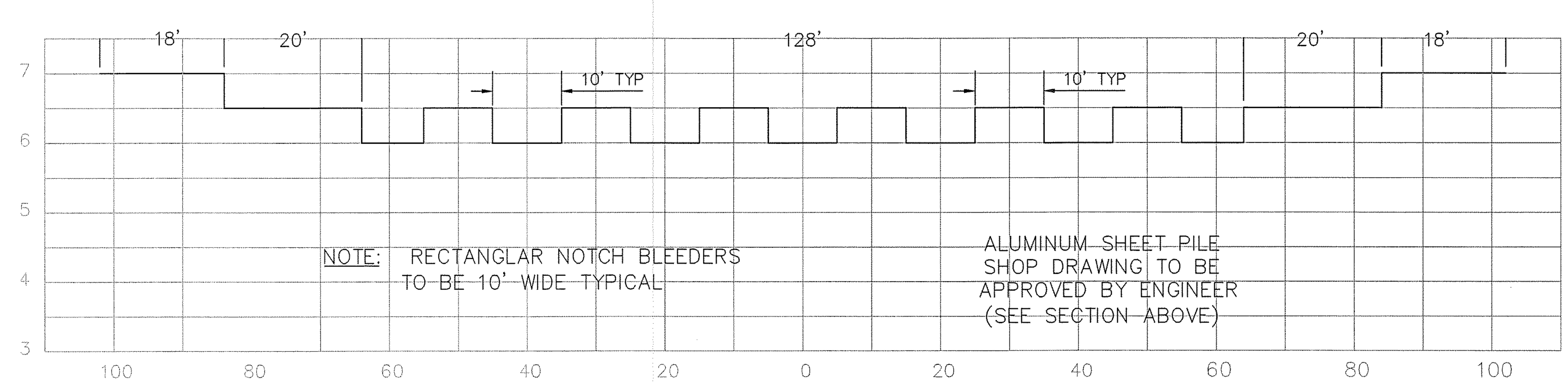
CAP DETAIL

NTS



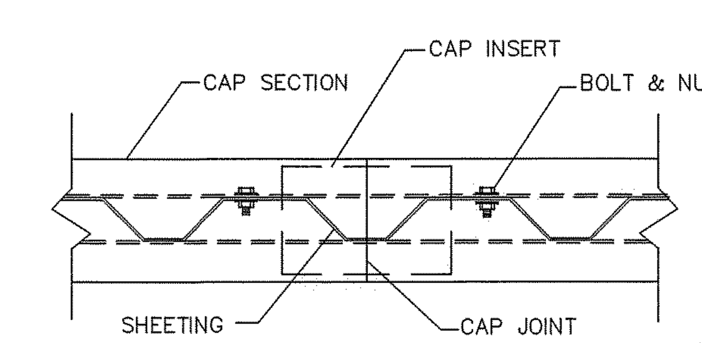
WEIR WALL SECTION

NTS



WEIR PROFILE

NTS



CAP JOINT DETAIL

NTS

CONTRACT NOTE:
BOARDWALK TO BE CONSTRUCTED UNDER "DOCK" CONTRACT, AND WEIR TO BE CONSTRUCTED UNDER "WEIR" CONTRACT, BOTH SEPERATE FROM THE "LAKE" CONTRACT.

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REV	REVISIONS	DATE	BY
1	CHANGE TO LACONTE	10-22-03	PJL
2	CHANGE SHEET NUMBER/REFERENCES	1-20-04	PJL
3	REVISE BOARDWALK DETAILS & ADD CONTRACT NOTE	3-31-04	PJL

PAVING, GRADING AND DRAINAGE DETAILS FOR

POPPLETON CREEK

WATERSHED DEVELOPMENT

DATE: 6-19-03
SCALE: NTS
DESIGNED BY: GBP/JPM
DRAWN BY: FAM
CHECKED BY: PJL
FILE NAME: LAKE-EN08

SEAL

PATRICK J. LACONTE, P.E.
FLORIDA REG. NO. 41070

PROJECT: POPPLETON
PLAN SET: LAKE

APPENDIX B

CHARACTERISTICS OF INFLOW, OUTFLOW, AND BULK PRECIPITATION SAMPLES COLLECTED AT THE POPPLETON CREEK WET DETENTION POND FROM JANUARY 14-OCTOBER 14, 2009

POPPLETON STORMWATER TREATMENT AREA

Results of Laboratory Analyses on Bulk Precipitation Samples (January - October 2009)

Site	Sample Type	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	Turbidity (NTU)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Zn (µg/l)
Rain	Bulk Precip.	3/18/09	6.15	77	2.8	59	2	361	36	458	3	6	3	12	2.3	<2	10	5	931
Rain	Bulk Precip.	05/20/09-05/25/09	5.30	26	1.4	76	128	34	23	261	1	4	4	9	1.3	<2	7	19	120
Rain	Bulk Precip.	05/27/09-06/03/09	5.57	12	3.0	205	220	12	40	477	2	<1	2	4	1.0	<2	5	9	138
Rain	Bulk Precip.	05/27/09-06/03/09	6.81	103	32.0	4546	1036	5754	71	11407	634	15	139	788	10.0	<2	6	15	416
Rain	Bulk Precip.	6/29/09-07/02/09	5.88	9	1.8	6	110	97	188	401	8	<1	2	10	3.5	<2	4	7	42
Rain	Bulk Precip.	07/02/09-07/08/09	6.19	9	3.8	34	170	63	31	298	<1	2	1	3	3.3	<2	8	3	38
Rain	Bulk Precip.	07/09/09-07/14/09	5.99	8	4.2	<5	13	72	78	165	2	2	11	15	3.6	3	6	4	38
Rain	Bulk Precip.	7/15/09-7/19/09	6.30	22	7.4	149	234	300	405	1088	24	42	123	189	10.1	2	3	4	49
Rain	Bulk Precip.	07/25/09-07/30/09	5.40	10	2.2	<5	151	19	<20	184	<1	1	<1	1	0.9	<2	7	3	19
Rain	Bulk Precip.	08/02/09-08/06/09	5.49	9	1.8	<5	96	<5	26	125	1	2	3	6	1.0	<2	5	<2	18
Rain	Bulk Precip.	08/21/09-08/25/09	5.92	190	3.0	88	130	323	159	700	<1	1	6	7	1.6	3	7	<2	64
Rain	Bulk Precip.	08/26/09-08/29/09	6.20	17	4.2	46	106	11	79	242	1	<1	1	2	2.3	<2	6	<2	27
Rain	Bulk Precip.	09/08/09-09/16/09	5.12	7	1.0	<5	21	25	<20	55	1	<1	1	2	1.4	<2	4	<2	16
Rain	Bulk Precip.	09/18/09-09/25/09	5.33	7	2.0	<5	15	12	87	114	3	<1	3	6	1.1	<2	7	<2	13
Rain	Bulk Precip.	09/30/09-10/07/09	5.81	13	3.6	69	345	16	<20	446	<1	<1	1	1	1.0	<2	5	4	12
		average	5.83	35	4.9	353	185	473	84	1095	45	5	20	70	3.0	1.3	6	5	129
		min	5.12	7	1.0	6	2	<5	23	55	1	1	1	1	0.9	2.0	3	3	12
		max	6.81	190	32.0	4546	1036	5754	405	11407	634	42	139	788	10.1	3.0	10	19	931
		median	5.88	12	3.0	73	128	49	75	298	2	2	3	6	1.6	<2	6	5	38
		log-normal mean	5.81	18	3.1	143	84	54	123	351	2	2	4	8	2.1	1.2	6	3.3	50

POPPLETON STORMWATER TREATMENT AREA

Results of Laboratory Analyses on Inflow Samples
(January - October 2009)

Site	Sample Type	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	Turbidity (NTU)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Zn (µg/l)
Site 1	Pond Inflow	01/27/09-02/05/09	7.70	401	143.0	175	50	507	69	801	1	6	38	45	3.4	<2	5	9	20
Site 1		05/18/09 - 05/19/09	8.36	457	156.0	51	373	599	532	1555	9	<1	121	130	15.5	<2	5	9	19
Site 1	Pond Inflow	03/18/09-04/01/09	7.48	223	70.6	64	859	138	295	1356	16	6	117	139	14.4	<2	3	3	57
Site 1	Pond Inflow	03/18/09-04/01/09	7.45	226	70.0	61	798	310	359	1528	18	9	142	169	14.5	<2	3	17	60
Site 1	Pond Inflow	05/18/09 - 05/19/09	7.09	219	43.2	134	193	328	304	959	16	5	73	94	5.7	<2	5	18	93
Site 1	Pond Inflow	5/28/09-5/29/09	7.45	179	57.8	<5	<5	508	166	680	13	31	48	92	5.0	<2	3	9	12
Site 1	Pond Inflow	06/18/09-06/24/09	7.48	285	87.6	10	<5	590	103	703	5	10	41	56	4.5	<2	4	4	6
Site 1	Pond Inflow	6/26/09-07/01/09	7.13	186	61.2	13	39	321	410	783	10	6	45	61	6.8	<2	6	8	13
Site 1	Pond Inflow	06/30/09-07/09/09	7.30	206	61.2	10	<5	273	118	402	4	5	27	36	5.6	<2	4	5	5
Site 1	Pond Inflow	07/09/09-07/14/09	6.83	135	42.0	26	16	265	191	498	18	7	61	86	17.0	<2	5	6	32
Site 1	Pond Inflow	07/15/09-07/21/09	7.53	172	65.0	155	<5	356	873	1388	27	14	376	417	29.7	3	<2	21	38
Site 1	Pond Inflow	07/22/09-07/31/09	7.19	177	56.4	140	30	275	890	1335	20	6	320	346	20.3	<2	10	13	62
Site 1	Pond Inflow	07/31/09-08/07/09	6.96	130	50.0	206	18	244	660	1128	45	5	317	367	15.0	<2	11	17	71
Site 1	Pond Inflow	08/19/09-08/26/09	7.27	242	93.4	81	11	467	548	1107	3	5	195	203	6.7	2	12	4	19
Site 1	Pond Inflow	08/26/09-08/29/09	7.10	174	65.8	287	<5	228	334	853	8	1	80	89	5.5	<2	9	<2	12
Site 1	Pond Inflow	09/08/09-09/16/09	7.14	172	61.6	96	<5	206	373	676	1	3	50	54	7.5	2	9	3	<2
Site 1	Pond Inflow	09/16/09-09/25/09	6.85	251	79.8	459	10	292	2604	3365	11	9	677	697	74.9	<2	12	17	118
Site 1	Pond Inflow	09/25/09-09/27/09	7.19	232	74.8	137	<5	284	525	948	3	11	143	157	13.9	<2	8	9	32
Site 1	Pond Inflow	09/30/09-10/07/09	6.80	209	85.4	161	44	169	1359	1733	<1	3	349	352	30.2	<2	9	4	21
		average	7.28	225	75.0	119	129	335	564	1147	12	8	169	189	15.6	1.2	6.5	9	36
		min	6.80	130	42.0	10	10	138	69	402	1	1	27	36	3.4	<2	3.0	3	5
		max	8.36	457	156.0	459	859	599	2604	3365	45	31	677	697	74.9	3.0	12.0	21	118
		median	7.19	209	65.8	115	42	292	373	959	11	6	117	130	13.9	<2	5.5	9	27
		log-normal mean	7.27	214	70.6	66	23	310	383	1017	7	5	112	134	11.1	1.6	5.6	7	23

POPPLETON STORMWATER TREATMENT AREA

Results of Laboratory Analyses on Pond Discharge Samples (January - October 2009)

Site	Sample Type	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOX (µg/l)	Dis Org N (µg/l)	Part N (µg/l)	TN (µg/l)	SRP (µg/l)	Dis Org P (µg/l)	Part P (µg/l)	TP (µg/l)	Turbidity (NTU)	Cd (µg/l)	Cr (µg/l)	Cu (µg/l)	Zn (µg/l)
Site #2	Outflow	7/31/09	7.26	195	58.8	<5	<5	381	93	479	<1	8	23	31	3.3	<2	7	5	<2
Site #2	Outflow	07/31/09-08/07/09	6.85	186	2.2	5	<5	284	157	446	1	7	12	20	3.4	<2	7	2	<2
Site #2	Outflow	08/07/09-08/11/09	6.93	152	52.8	39	<5	256	155	452	2	4	11	17	6.9	<2	7	2	2
Site #2	Outflow	09/08/09-09/16/09	7.20	172	120.0	57	<5	302	446	809	1	3	24	28	5.8	3	5	<2	<2
Site #2	Outflow	09/16/09-09/25/09	7.00	175	63.4	149	<5	261	159	571	<1	3	5	8	2.6	<2	7	2	<2
Site #2	Outflow	09/26/09-09/30/09	7.12	182	64.0	83	<5	323	202	609	4	6	6	16	2.0	2	5	<2	<2
Site #2	Outflow	09/30/09-10/07/09	6.75	184	69.2	110	10	336	149	605	<1	2	8	10	1.0	<2	4	<2	<2
		average	7.02	178	61.5	64	4	306	194	567	2	5	13	19	3.6	1.4	6.0	2.0	<2
		min	6.75	152	2.2	5	<5	256	93	446	<1	2	5	8	1.0	<2	4.0	<2	<2
		max	7.26	195	120.0	149	10	381	446	809	4	8	24	31	6.9	3.0	7.0	5.0	2
		median	7.00	182	63.4	70	<5	302	157	571	2	4	11	17	3.3	2.5	7.0	2.0	<2
		log-normal mean	7.01	178	42.0	32	3	303	174	556	1	4	11	17	3.03	1.3	5.9	1.7	1.1

APPENDIX C

LABORATORY QA DATA

Poppleton Creek BMP Evaluation Project
Method Blank Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	MEASURED CONC.	MDL
pH	s.u.	03/19/09	5.59	NA
pH	s.u.	03/19/09	5.78	NA
pH	s.u.	04/14/09	5.79	NA
pH	s.u.	04/14/09	5.74	NA
pH	s.u.	04/14/09	5.92	NA
pH	s.u.	06/05/09	5.40	NA
pH	s.u.	06/05/09	5.42	NA
pH	s.u.	06/26/09	5.49	NA
pH	s.u.	06/26/09	5.63	NA
pH	s.u.	07/07/09	5.91	NA
pH	s.u.	07/07/09	5.93	NA
pH	s.u.	07/16/09	5.79	NA
pH	s.u.	07/16/09	5.83	NA
pH	s.u.	08/01/09	5.68	NA
pH	s.u.	08/01/09	5.66	NA
pH	s.u.	08/17/09	5.60	NA
pH	s.u.	08/17/09	5.58	NA
pH	s.u.	08/26/09	5.57	NA
pH	s.u.	08/26/09	5.61	NA
pH	s.u.	09/02/09	5.78	NA
pH	s.u.	09/02/09	5.66	NA
pH	s.u.	09/16/09	5.70	NA
pH	s.u.	10/09/09	4.90	NA
pH	s.u.	10/09/09	4.86	NA
Alkalinity	mg/l	03/19/09	0.8	0.5mg/l
Alkalinity	mg/l	03/19/09	0.8	0.5mg/l
Alkalinity	mg/l	04/14/09	0.8	0.5mg/l
Alkalinity	mg/l	04/14/09	0.8	0.5mg/l
Alkalinity	mg/l	06/05/09	0.8	0.5mg/l
Alkalinity	mg/l	06/05/09	0.8	0.5mg/l
Alkalinity	mg/l	06/26/09	0.8	0.5mg/l
Alkalinity	mg/l	06/26/09	0.8	0.5mg/l
Alkalinity	mg/l	07/07/09	0.8	0.5mg/l
Alkalinity	mg/l	07/07/09	0.8	0.5mg/l
Alkalinity	mg/l	07/16/09	0.8	0.5mg/l
Alkalinity	mg/l	07/16/09	0.8	0.5mg/l
Alkalinity	mg/l	08/01/09	0.8	0.5mg/l
Alkalinity	mg/l	08/01/09	0.8	0.5mg/l
Alkalinity	mg/l	08/17/09	0.8	0.5mg/l
Alkalinity	mg/l	08/17/09	0.8	0.5mg/l

Poppleton Creek BMP Evaluation Project
Method Blank Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	MEASURED CONC.	MDL
Alkalinity	mg/l	08/26/09	0.6	0.5mg/l
Alkalinity	mg/l	08/26/09	0.6	0.5mg/l
Alkalinity	mg/l	09/02/09	0.4	0.5mg/l
Alkalinity	mg/l	09/02/09	0.4	0.5mg/l
Alkalinity	mg/l	09/16/09	0.8	0.5mg/l
Alkalinity	mg/l	09/16/09	0.8	0.5mg/l
Alkalinity	mg/l	10/09/09	0.6	0.5mg/l
Alkalinity	mg/l	10/09/09	0.6	0.5mg/l
Turbidity	NTU	02/06/09	<0.3	0.3NTU
Turbidity	NTU	02/06/09	<0.3	0.3NTU
Turbidity	NTU	03/19/09	<0.3	0.3NTU
Turbidity	NTU	03/19/09	<0.3	0.3NTU
Turbidity	NTU	06/04/09	<0.3	0.3NTU
Turbidity	NTU	06/04/09	<0.3	0.3NTU
Turbidity	NTU	06/26/09	<0.3	0.3NTU
Turbidity	NTU	06/26/09	<0.3	0.3NTU
Turbidity	NTU	07/02/09	<0.3	0.3NTU
Turbidity	NTU	07/02/09	<0.3	0.3NTU
Turbidity	NTU	07/10/09	<0.3	0.3NTU
Turbidity	NTU	07/10/09	<0.3	0.3NTU
Turbidity	NTU	07/16/09	<0.3	0.3NTU
Turbidity	NTU	07/16/09	<0.3	0.3NTU
Turbidity	NTU	07/24/09	<0.3	0.3NTU
Turbidity	NTU	07/24/09	<0.3	0.3NTU
Turbidity	NTU	08/02/09	<0.3	0.3NTU
Turbidity	NTU	08/02/09	<0.3	0.3NTU
Turbidity	NTU	09/30/09	<0.3	0.3NTU
Turbidity	NTU	09/30/09	<0.3	0.3NTU
Turbidity	NTU	10/07/09	<0.3	0.3NTU
Turbidity	NTU	10/07/09	<0.3	0.3NTU
SRP	μg/l	02/06/09	<1	1μg/l
SRP	μg/l	02/06/09	<1	1μg/l
SRP	μg/l	03/19/09	<1	1μg/l
SRP	μg/l	03/19/09	<1	1μg/l
SRP	μg/l	04/03/09	<1	1μg/l
SRP	μg/l	04/03/09	<1	1μg/l
SRP	μg/l	06/26/09	<1	1μg/l
SRP	μg/l	06/26/09	<1	1μg/l
SRP	μg/l	07/08/09	<1	1μg/l
SRP	μg/l	07/08/09	<1	1μg/l

Poppleton Creek BMP Evaluation Project
Method Blank Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	MEASURED CONC.	MDL
SRP	µg/l	07/13/09	<1	1µg/l
SRP	µg/l	07/13/09	<1	1µg/l
SRP	µg/l	07/17/09	<1	1µg/l
SRP	µg/l	07/17/09	<1	1µg/l
SRP	µg/l	07/23/09	<1	1µg/l
SRP	µg/l	07/23/09	<1	1µg/l
SRP	µg/l	08/07/09	<1	1µg/l
SRP	µg/l	08/07/09	<1	1µg/l
SRP	µg/l	08/19/09	<1	1µg/l
SRP	µg/l	08/19/09	<1	1µg/l
SRP	µg/l	08/27/09	<1	1µg/l
SRP	µg/l	08/27/09	<1	1µg/l
SRP	µg/l	09/04/09	<1	1µg/l
SRP	µg/l	09/04/09	<1	1µg/l
SRP	µg/l	09/16/09	<1	5µg/l
SRP	µg/l	09/16/09	<1	5µg/l
NOX-N	µg/l	02/06/09	<5	5µg/l
NOX-N	µg/l	02/06/09	<5	5µg/l
NOX-N	µg/l	03/19/09	<5	5µg/l
NOX-N	µg/l	03/19/09	<5	5µg/l
NOX-N	µg/l	04/03/09	<5	5µg/l
NOX-N	µg/l	04/03/09	<5	5µg/l
NOX-N	µg/l	06/26/09	<5	5µg/l
NOX-N	µg/l	06/26/09	<5	5µg/l
NOX-N	µg/l	07/08/09	<5	5µg/l
NOX-N	µg/l	07/08/09	<5	5µg/l
NOX-N	µg/l	07/13/09	<5	5µg/l
NOX-N	µg/l	07/13/09	<5	5µg/l
NOX-N	µg/l	07/17/09	<5	5µg/l
NOX-N	µg/l	07/17/09	<5	5µg/l
NOX-N	µg/l	07/23/09	<5	5µg/l
NOX-N	µg/l	07/23/09	<5	5µg/l
NOX-N	µg/l	08/07/09	<5	5µg/l
NOX-N	µg/l	08/07/09	<5	5µg/l
NOX-N	µg/l	08/19/09	<5	5µg/l
NOX-N	µg/l	08/19/09	<5	5µg/l
NOX-N	µg/l	08/27/09	<5	5µg/l
NOX-N	µg/l	08/27/09	<5	5µg/l
NOX-N	µg/l	09/04/09	<5	5µg/l
NOX-N	µg/l	09/04/09	<5	5µg/l

Poppleton Creek BMP Evaluation Project
Method Blank Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	MEASURED CONC.	MDL
NOX-N	μg/l	09/16/09	<5	5μg/l
NOX-N	μg/l	09/16/09	<5	5μg/l
Ammonia	μg/l	02/18/09	<5	5μg/l
Ammonia	μg/l	02/18/09	<5	5μg/l
Ammonia	μg/l	04/16/09	<5	5μg/l
Ammonia	μg/l	04/16/09	<5	5μg/l
Ammonia	μg/l	07/22/09	<5	5μg/l
Ammonia	μg/l	07/22/09	<5	5μg/l
Ammonia	μg/l	08/17/09	<5	5μg/l
Ammonia	μg/l	08/17/09	<5	5μg/l
Ammonia	μg/l	08/19/09	<5	5μg/l
Ammonia	μg/l	08/19/09	<5	5μg/l
Ammonia	μg/l	09/18/09	<5	5μg/l
Ammonia	μg/l	09/18/09	<5	5μg/l
Ammonia	μg/l	10/29/09	<5	5μg/l
Ammonia	μg/l	10/29/09	<5	5μg/l
Total N	μg/l	04/27/09	<25	25μg/l
Total N	μg/l	04/27/09	<25	25μg/l
Total N	μg/l	06/09/09	<25	25μg/l
Total N	μg/l	06/09/09	<25	25μg/l
Total N	μg/l	07/01/09	<25	25μg/l
Total N	μg/l	07/01/09	<25	25μg/l
Total N	μg/l	07/01/09	<25	25μg/l
Total N	μg/l	08/12/09	<25	25μg/l
Total N	μg/l	08/12/09	<25	25μg/l
Total N	μg/l	10/15/09	<25	25μg/l
Total P	μg/l	04/27/09	<1	1μg/l
Total P	μg/l	04/27/09	<1	1μg/l
Total P	μg/l	06/09/09	<1	1μg/l
Total P	μg/l	06/09/09	<1	1μg/l
Total P	μg/l	07/01/09	<1	1μg/l
Total P	μg/l	07/01/09	<1	1μg/l
Total P	μg/l	07/01/09	<1	1μg/l
Total P	μg/l	08/12/09	<1	1μg/l
Total P	μg/l	08/12/09	<1	1μg/l
Total P	μg/l	10/15/09	<1	1μg/l
Total P	μg/l	10/15/09	<1	1μg/l
Color	PCU	07/22/09	<1	1PCU
Color	PCU	07/22/09	<1	1PCU
Color	PCU	08/02/09	<1	1PCU

Poppleton Creek BMP Evaluation Project
Method Blank Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	MEASURED CONC.	MDL
Color	PCU	08/02/09	<1	1PCU
Color	PCU	08/17/09	<1	1PCU
Color	PCU	08/17/09	<1	1PCU
Color	PCU	08/27/09	<1	1PCU
Color	PCU	08/27/09	<1	1PCU
Color	PCU	09/03/09	<1	1PCU
Color	PCU	09/03/09	<1	1PCU
Color	PCU	09/17/09	<1	1PCU
Color	PCU	09/17/09	<1	1PCU
Color	PCU	09/25/09	<1	1PCU
Color	PCU	09/25/09	<1	1PCU
Color	PCU	09/30/09	<1	1PCU
Color	PCU	09/30/09	<1	1PCU
Color	PCU	10/08/09	<1	1PCU
Color	PCU	10/08/09	<1	1PCU

Poppleton Creek BMP Evaluation Project
Continuing Calibration Verification Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Turbidity	NTU	06/04/09	0.2	40	4000	0.20	20.2	19.9	98.5%	87-104
Turbidity	NTU	06/04/09	0.2	40	4000	0.20	20.2	19.3	95.5%	87-104
Turbidity	NTU	06/26/09	0.3	40	4000	0.20	20.3	20.6	101%	87-104
Turbidity	NTU	06/26/09	0.3	40	4000	0.20	20.3	20.7	102%	87-104
Turbidity	NTU	07/02/09	0.2	40	4000	0.20	20.2	19.6	97.0%	87-104
Turbidity	NTU	07/02/09	0.3	40	4000	0.20	20.3	19.7	97.0%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	20.0	99.0%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	19.8	98.0%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	19.7	97.5%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	19.5	96.5%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	19.5	96.5%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	19.9	98.5%	87-104
Turbidity	NTU	07/10/09	0.1	40	4000	0.20	20.1	18.8	93.5%	87-104
Turbidity	NTU	07/10/09	0.2	40	4000	0.20	20.2	19.1	94.6%	87-104
Turbidity	NTU	07/16/09	0.1	40	4000	0.10	10.1	9.2	91.1%	87-104
Turbidity	NTU	07/24/09	0.2	40	4000	0.15	15.2	15.5	102%	87-104
Turbidity	NTU	07/24/09	0.2	40	4000	0.15	15.2	15.6	103%	87-104
Turbidity	NTU	07/24/09	0.2	40	4000	0.15	15.2	15.7	103%	87-104
Turbidity	NTU	08/02/09	0.2	40	4000	0.10	10.2	9.7	95.1%	87-104
Turbidity	NTU	08/02/09	0.2	40	4000	0.10	10.2	9.7	95.1%	87-104
Turbidity	NTU	08/02/09	0.2	40	4000	0.10	10.2	9.4	92.2%	87-104
Turbidity	NTU	08/02/09	0.2	40	4000	0.10	10.2	9.6	94.1%	87-104
Turbidity	NTU	09/30/09	0.2	40	4000	0.20	20.2	20.6	102%	87-104
Turbidity	NTU	09/30/09	0.2	40	4000	0.20	20.2	20.3	100%	87-104
Turbidity	NTU	09/30/09	0.2	40	4000	0.20	20.2	19.8	98.0%	87-104
Turbidity	NTU	09/30/09	0.2	40	4000	0.20	20.2	20.7	102%	87-104
Turbidity	NTU	10/07/09	0.2	40	4000	0.30	30.2	30.6	101%	87-104
Turbidity	NTU	10/07/09	0.2	40	4000	0.30	30.2	30.4	101%	87-104
Turbidity	NTU	10/07/09	0.2	40	4000	0.30	30.2	30.2	100%	87-104
SRP	µg/l	02/06/09	0	10	10000	0.225	225	232	103%	92-110
SRP	µg/l	02/06/09	0	10	10000	0.225	225	213	94.7%	92-110
SRP	µg/l	03/19/09	0	10	10000	0.500	500	535	107%	92-110
SRP	µg/l	03/19/09	0	10	10000	0.500	500	540	108%	92-110
SRP	µg/l	03/19/09	0	10	10000	0.500	500	525	105%	92-110
SRP	µg/l	04/03/09	0	10	10000	0.250	250	269	108%	92-110
SRP	µg/l	06/26/09	0	10	10000	0.100	100	105	105%	92-110
SRP	µg/l	07/08/09	0	10	10000	0.225	225	228	101%	92-110
SRP	µg/l	07/08/09	0	10	10000	0.225	225	224	99.6%	92-110
SRP	µg/l	07/13/09	0	10	10000	0.100	100	108	108%	92-110
SRP	µg/l	07/13/09	0	10	10000	0.110	110	111	101%	92-110
SRP	µg/l	07/13/09	0	10	10000	0.110	110	112	102%	92-110
SRP	µg/l	07/17/09	0	10	10000	0.075	75	75	100%	92-110
SRP	µg/l	07/17/09	0	10	10000	0.100	100	104	104%	92-110
SRP	µg/l	07/23/09	0	10	10000	0.100	100	104	104%	92-110
SRP	µg/l	07/23/09	0	10	10000	0.110	110	111	101%	92-110
SRP	µg/l	08/07/09	0	10	10000	0.500	500	497	99.4%	92-110
SRP	µg/l	08/07/09	0	10	10000	0.500	500	504	101%	92-110
SRP	µg/l	08/19/09	0	10	10000	0.100	100	102	102%	92-110

Poppleton Creek BMP Evaluation Project
Continuing Calibration Verification Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
SRP	µg/l	08/19/09	0	10	10000	0.100	100	105	105%	92-110
SRP	µg/l	08/27/09	0	10	10000	0.100	100	109	109%	92-110
SRP	µg/l	08/27/09	0	10	10000	0.100	100	108	108%	92-110
SRP	µg/l	09/04/09	0	10	10000	0.225	225	224	99.6%	92-110
SRP	µg/l	09/04/09	0	10	10000	0.225	225	221	98.2%	92-110
SRP	µg/l	09/16/09	0	10	10000	0.100	100	100	100%	92-110
SRP	µg/l	09/16/09	0	10	10000	0.100	100	100	100%	92-110
NOX-N	µg/l	02/06/09	0	10	100000	0.210	2100	2151	102%	92-108
NOX-N	µg/l	02/06/09	0	10	100000	0.200	2000	1936	96.8%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	2093	105%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	2070	104%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	2052	103%	92-108
NOX-N	µg/l	04/03/09	0	10	100000	0.100	1000	999	100%	92-108
NOX-N	µg/l	06/26/09	0	10	100000	0.100	1000	1006	101%	92-108
NOX-N	µg/l	07/08/09	0	10	100000	0.225	2250	2275	101%	92-108
NOX-N	µg/l	07/08/09	0	10	100000	0.225	2250	2322	103%	92-108
NOX-N	µg/l	07/13/09	0	10	100000	0.100	1000	1056	106%	92-108
NOX-N	µg/l	07/13/09	0	10	100000	0.100	1000	1025	103%	92-108
NOX-N	µg/l	07/13/09	0	10	100000	0.100	1000	1072	107%	92-108
NOX-N	µg/l	07/17/09	0	10	100000	0.100	1000	989	98.9%	92-108
NOX-N	µg/l	07/17/09	0	10	100000	0.100	1000	998	99.8%	92-108
NOX-N	µg/l	07/23/09	0	10	100000	0.100	1000	975	97.5%	92-108
NOX-N	µg/l	07/23/09	0	10	100000	0.100	1000	990	99.0%	92-108
NOX-N	µg/l	08/07/09	0	10	100000	0.500	5000	4842	96.8%	92-108
NOX-N	µg/l	08/07/09	0	10	100000	0.500	5000	4767	95.3%	92-108
NOX-N	µg/l	08/19/09	0	10	100000	0.100	1000	987	98.7%	92-108
NOX-N	µg/l	08/19/09	0	10	100000	0.100	1000	960	96.0%	92-108
NOX-N	µg/l	08/27/09	0	10	100000	0.090	900	907	101%	92-108
NOX-N	µg/l	08/27/09	0	10	100000	0.100	1000	928	92.8%	92-108
NOX-N	µg/l	09/04/09	0	10	100000	0.175	1750	1841	105%	92-108
NOX-N	µg/l	09/04/09	0	10	100000	0.200	2000	1924	96.2%	92-108
NOX-N	µg/l	09/16/09	0	10	100000	0.100	1000	975	97.5%	92-108
NOX-N	µg/l	09/16/09	0	10	100000	0.100	1000	977	97.7%	92-108
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	992	99.2%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	976	97.6%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	990	99.0%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	993	99.3%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1035	104%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1028	103%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1033	103%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	971	97.1%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	972	97.2%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	986	98.6%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	965	96.5%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	971	97.1%	88-120
Ammonia	µg/l	07/22/09	0	10	100000	0.100	1000	997	99.7%	88-120
Ammonia	µg/l	07/22/09	0	10	100000	0.100	1000	997	99.7%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	0.150	150	157	105%	88-120

Poppleton Creek BMP Evaluation Project

Continuing Calibration Verification Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Ammonia	µg/l	08/17/09	0	10	10000	0.150	150	161	107%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	0.150	150	153	102%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	0.150	150	148	98.7%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	0.150	150	159	106%	88-120
Ammonia	µg/l	08/19/09	0	10	10000	0.200	200	199	100%	88-120
Ammonia	µg/l	08/19/09	0	10	10000	0.200	200	199	100%	88-120
Ammonia	µg/l	09/18/09	0	10	8220	1.220	1003	999	99.6%	88-120
Ammonia	µg/l	09/18/09	0	10	8220	1.220	1003	1014	101%	88-120
Ammonia	µg/l	09/18/09	0	10	8220	1.220	1003	1054	105%	88-120
Ammonia	µg/l	10/29/09	0	10	100000	0.100	1000	998	99.8%	88-120
Ammonia	µg/l	10/29/09	0	10	100000	0.100	1000	1038	104%	88-120
Ammonia	µg/l	10/29/09	0	10	100000	0.100	1000	971	97.1%	88-120
Ammonia	µg/l	10/29/09	0	10	100000	0.100	1000	979	97.9%	88-120
Ammonia	µg/l	10/29/09	0	10	100000	0.100	1000	971	97.1%	88-120
Total N	µg/l	04/27/09	0	5	225	5.000	225	223	99.1%	92-110
Total N	µg/l	04/27/09	0	5	250	5.000	250	263	105%	92-110
Total N	µg/l	04/27/09	0	5	250	5.000	250	259	104%	92-110
Total N	µg/l	04/27/09	0	5	200	5.000	200	190	95.0%	92-110
Total N	µg/l	06/09/09	0	5	5500	5.000	5500	5354	97.3%	92-110
Total N	µg/l	06/09/09	0	5	1200	5.000	1200	1224	102%	92-110
Total N	µg/l	06/09/09	0	5	6780	5.000	6780	6588	97.2%	92-110
Total N	µg/l	07/01/09	0	5	1000	5.000	1000	952	95.2%	92-110
Total N	µg/l	07/01/09	0	5	1000	5.000	1000	950	95.0%	92-110
Total N	µg/l	08/12/09	0	5	8000	5.000	8000	8363	105%	92-110
Total N	µg/l	08/12/09	0	5	8000	5.000	8000	8473	106%	92-110
Total N	µg/l	08/12/09	0	5	8000	5.000	8000	8426	105%	92-110
Total N	µg/l	08/12/09	0	5	8000	5.000	8000	7800	97.5%	92-110
Total N	µg/l	08/12/09	0	5	8000	5.000	8000	8345	104%	92-110
Total N	µg/l	10/15/09	0	5	1000	5.000	1000	958	95.8%	92-110
Total N	µg/l	10/15/09	0	5	1000	5.000	1000	977	97.7%	92-110
Total N	µg/l	10/15/09	0	5	1000	5.000	1000	995	100%	92-110
Total P	µg/l	04/27/09	0	5	500	5.000	500	491	98.2%	92-110
Total P	µg/l	04/27/09	0	5	500	5.000	500	488	97.6%	92-110
Total P	µg/l	04/27/09	0	5	500	5.000	500	480	96.0%	92-110
Total P	µg/l	04/27/09	0	5	500	5.000	500	487	97.4%	92-110
Total P	µg/l	06/09/09	0	5	1400	5.000	1400	1316	94.0%	92-110
Total P	µg/l	06/09/09	0	5	1000	5.000	1000	1074	107%	92-110
Total P	µg/l	06/09/09	0	5	1500	5.000	1500	1561	104%	92-110
Total P	µg/l	07/01/09	0	5	1000	5.000	1000	948	94.8%	92-110
Total P	µg/l	07/01/09	0	5	1000	5.000	1000	943	94.3%	92-110
Total P	µg/l	08/12/09	0	5	2200	5.000	2200	2201	100%	92-110
Total P	µg/l	08/12/09	0	5	2200	5.000	2200	2195	100%	92-110
Total P	µg/l	08/12/09	0	5	2200	5.000	2200	2206	100%	92-110
Total P	µg/l	10/15/09	0	5	1100	5.000	1100	1113	101%	92-110
Total P	µg/l	10/15/09	0	5	1000	5.000	1000	922	92.2%	92-110
Total P	µg/l	10/15/09	0	5	1000	5.000	1000	973	97.3%	92-110
Color	PCU	07/22/09	0	25	500	1.00	20	19	95.0%	85-105
Color	PCU	07/22/09	0	25	500	1.00	20	19	95.0%	85-105

Poppleton Creek BMP Evaluation Project
Continuing Calibration Verification Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Color	PCU	07/22/09	0	25	500	1.00	20	19	95.0%	85-105
Color	PCU	07/22/09	0	25	500	1.00	20	19	95.0%	85-105
Color	PCU	07/22/09	0	25	500	1.00	20	19	95.0%	85-105
Color	PCU	08/02/09	0	25	500	1.00	20	18	90.0%	85-105
Color	PCU	08/02/09	0	25	500	1.00	20	18	90.0%	85-105
Color	PCU	08/02/09	0	25	500	1.00	20	17	87.0%	85-105
Color	PCU	08/02/09	0	25	500	1.00	20	17	87.0%	85-105
Color	PCU	08/02/09	0	25	500	1.00	20	17	87.0%	85-105
Color	PCU	08/17/09	0	250	500	7.50	15	15	96.7%	85-105
Color	PCU	08/17/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	08/27/09	0	250	500	7.50	15	15	97.3%	85-105
Color	PCU	09/03/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/03/09	0	250	500	7.50	15	15	98.0%	85-105
Color	PCU	09/03/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/03/09	0	250	500	7.50	15	15	98.7%	85-105
Color	PCU	09/03/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/03/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/17/09	0	250	500	7.50	15	15	101%	85-105
Color	PCU	09/17/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/17/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/17/09	0	250	500	7.50	15	15	99.3%	85-105
Color	PCU	09/17/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/17/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/25/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/25/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/25/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/25/09	0	250	500	7.50	15	15	99.3%	85-105
Color	PCU	09/30/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/30/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/30/09	0	250	500	7.50	15	15	98.7%	85-105
Color	PCU	09/30/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	09/30/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	10/08/09	0	250	500	7.50	15	15	100%	85-105
Color	PCU	10/08/09	0	250	500	7.50	15	15	100%	85-105

Poppleton Creek BMP Evaluation Project
Blank Spike Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Turbidity	NTU	07/24/09	0.2	40	4000	0.15	15.2	15.7	103%	87-104
Turbidity	NTU	08/02/09	0.1	40	4000	0.2	20.1	19.2	95.5%	87-104
Turbidity	NTU	08/02/09	0.1	40	4000	0.2	20.1	18.7	93.0%	87-104
Turbidity	NTU	08/02/09	0.1	40	4000	0.2	20.1	18.6	92.5%	87-104
Turbidity	NTU	09/30/09	0.2	40	4000	0.2	20.2	20.6	102%	87-104
Turbidity	NTU	09/30/09	0.2	40	4000	0.2	20.2	20.4	101%	87-104
Turbidity	NTU	10/07/09	0.2	40	4000	0.3	30.2	30.6	101%	87-104
Turbidity	NTU	10/07/09	0.1	40	4000	0.3	30.1	30.4	101%	87-104
Alkalinity	mg/l	03/19/09	0.8	50	1000	0.6	12.8	12.8	100%	95-105
Alkalinity	mg/l	03/19/09	0.8	50	1000	0.6	12.8	12.6	98.4%	95-105
Alkalinity	mg/l	04/14/09	0.8	50	1000	0.3	6.3	6.2	98.4%	95-105
Alkalinity	mg/l	04/14/09	0.8	50	1000	0.3	5.8	5.8	100%	95-105
Alkalinity	mg/l	06/05/09	0.6	50	1000	0.3	6.6	6.8	103%	95-105
Alkalinity	mg/l	06/05/09	0.6	50	1000	0.3	6.6	6.6	100%	95-105
Alkalinity	mg/l	06/26/09	0.6	50	1000	0.3	6.6	6.4	97.0%	95-105
Alkalinity	mg/l	06/26/09	0.8	50	1000	0.3	6.8	6.8	100%	95-105
Alkalinity	mg/l	07/07/09	0.8	50	1000	0.5	10.8	10.4	96.3%	95-105
Alkalinity	mg/l	07/07/09	1.0	50	1000	0.5	10.0	10.2	102%	95-105
Alkalinity	mg/l	07/16/09	0.8	50	1000	0.5	10.0	10.2	102%	95-105
Alkalinity	mg/l	07/16/09	1.0	50	1000	0.5	10.4	10.4	100%	95-105
Alkalinity	mg/l	08/26/09	0.6	50	1000	0.5	10.6	10.8	102%	95-105
Alkalinity	mg/l	08/26/09	0.8	50	1000	0.5	10.2	10.2	100%	95-105
Alkalinity	mg/l	09/02/09	0.4	50	1000	0.5	10.4	10.0	96.2%	95-105
Alkalinity	mg/l	09/02/09	0.4	50	1000	0.5	10.4	10.4	100%	95-105
Alkalinity	mg/l	09/16/09	0.8	50	1000	0.5	10.8	10.8	100%	95-105
Alkalinity	mg/l	10/09/09	0.6	50	1000	0.4	8.6	8.8	102%	95-105
Alkalinity	mg/l	10/09/09	0.6	50	1000	0.4	8.6	8.4	97.7%	95-105
SRP	μg/l	02/06/09	0	10	10000	0.200	200	207	104%	92-110
SRP	μg/l	02/06/09	0	10	10000	0.210	210	219	104%	92-110
SRP	μg/l	03/19/09	0	10	10000	0.400	400	378	94.5%	92-110
SRP	μg/l	03/19/09	0	10	10000	0.400	400	410	103%	92-110
SRP	μg/l	03/19/09	0	10	10000	0.400	400	419	105%	92-110
SRP	μg/l	03/19/09	0	10	10000	0.400	400	419	105%	92-110
SRP	μg/l	04/03/09	0	10	10000	0.250	250	259	104%	92-110
SRP	μg/l	04/03/09	0	10	10000	0.250	250	260	104%	92-110
SRP	μg/l	06/26/09	0	10	10000	0.100	100	108	108%	92-110
SRP	μg/l	06/26/09	0	10	10000	0.100	100	108	108%	92-110
SRP	μg/l	07/08/09	0	10	10000	0.250	250	247	98.8%	92-110
SRP	μg/l	07/08/09	0	10	10000	0.250	250	249	99.6%	92-110
SRP	μg/l	07/08/09	0	10	10000	0.250	250	254	102%	92-110
SRP	μg/l	07/13/09	0	10	10000	0.225	225	226	100%	92-110
SRP	μg/l	07/13/09	0	10	10000	0.110	110	114	104%	92-110
SRP	μg/l	07/17/09	0	10	10000	0.100	100	95	95.0%	92-110
SRP	μg/l	07/17/09	0	10	10000	0.100	100	104	104%	92-110
SRP	μg/l	07/23/09	0	10	10000	0.100	100	105	105%	92-110

Poppleton Creek BMP Evaluation Project
Blank Spike Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
SRP	µg/l	07/23/09	0	10	10000	0.110	110	110	100%	92-110
SRP	µg/l	08/07/09	0	10	10000	0.500	500	521	104%	92-110
SRP	µg/l	08/07/09	0	10	10000	0.500	500	512	102%	92-110
SRP	µg/l	08/19/09	0	10	10000	0.225	225	225	100%	92-110
SRP	µg/l	08/19/09	0	10	10000	0.225	225	220	97.8%	92-110
SRP	µg/l	08/27/09	0	10	10000	0.450	450	441	98.0%	92-110
SRP	µg/l	08/27/09	0	10	10000	0.450	450	449	99.8%	92-110
SRP	µg/l	09/04/09	0	10	10000	0.225	225	228	101%	92-110
SRP	µg/l	09/04/09	0	10	10000	0.225	225	228	101%	92-110
SRP	µg/l	09/16/09	0	10	10000	0.450	450	476	106%	92-110
SRP	µg/l	09/16/09	0	10	10000	0.450	450	487	108%	92-110
NOX-N	µg/l	02/06/09	0	10	10000	0.175	175	165	94.3%	92-108
NOX-N	µg/l	02/06/09	0	10	10000	0.175	175	175	100%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	1919	96.0%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	2080	104%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	2057	103%	92-108
NOX-N	µg/l	03/19/09	0	10	100000	0.200	2000	2039	102%	92-108
NOX-N	µg/l	04/03/09	0	10	100000	0.110	1100	1146	104%	92-108
NOX-N	µg/l	04/03/09	0	10	100000	0.125	1250	1191	95.3%	92-108
NOX-N	µg/l	06/26/09	0	10	100000	0.055	550	564	103%	92-108
NOX-N	µg/l	06/26/09	0	10	100000	0.050	500	473	94.6%	92-108
NOX-N	µg/l	07/08/09	0	10	100000	0.125	1250	1261	101%	92-108
NOX-N	µg/l	07/08/09	0	10	100000	0.125	1250	1258	101%	92-108
NOX-N	µg/l	07/08/09	0	10	100000	0.125	1250	1319	106%	92-108
NOX-N	µg/l	07/13/09	0	10	10000	0.160	160	165	103%	92-108
NOX-N	µg/l	07/13/09	0	10	10000	0.090	90	89	98.9%	92-108
NOX-N	µg/l	07/17/09	0	10	10000	0.100	100	101	101%	92-108
NOX-N	µg/l	07/17/09	0	10	10000	0.100	100	93	93.0%	92-108
NOX-N	µg/l	07/23/09	0	10	10000	0.085	85	86	101%	92-108
NOX-N	µg/l	07/23/09	0	10	10000	0.080	80	82	103%	92-108
NOX-N	µg/l	08/07/09	0	10	10000	0.400	400	411	103%	92-108
NOX-N	µg/l	08/07/09	0	10	10000	0.400	400	404	101%	92-108
NOX-N	µg/l	08/19/09	0	10	10000	0.175	175	174	99.4%	92-108
NOX-N	µg/l	08/19/09	0	10	10000	0.175	175	171	97.7%	92-108
NOX-N	µg/l	08/27/09	0	10	10000	0.350	350	341	97.4%	92-108
NOX-N	µg/l	08/27/09	0	10	10000	0.350	350	323	92.3%	92-108
NOX-N	µg/l	09/04/09	0	10	10000	0.150	150	152	101%	92-108
NOX-N	µg/l	09/04/09	0	10	10000	0.150	150	154	103%	92-108
NOX-N	µg/l	09/16/09	0	10	100000	0.225	2250	2243	100%	92-108
NOX-N	µg/l	09/16/09	0	10	100000	0.225	2250	2257	100%	92-108
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1042	104%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1025	103%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1041	104%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1042	104%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1081	108%	88-120

Poppleton Creek BMP Evaluation Project

Blank Spike Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Ammonia	µg/l	02/18/09	0	9	100000	0.100	1176	1218	104%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1074	107%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	958	95.8%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	940	94.0%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	957	95.7%	88-120
Ammonia	µg/l	04/16/09	0	10	100000	0.100	1000	941	94.1%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	1.000	1000	997	99.7%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	1.000	1000	946	94.6%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	1.000	1000	1033	103%	88-120
Ammonia	µg/l	08/17/09	0	10	10000	1.000	1000	1035	104%	88-120
Ammonia	µg/l	09/18/09	0	10	50000	0.450	2250	2281	101%	88-120
Ammonia	µg/l	09/18/09	0	10	50000	0.250	1250	1267	101%	88-120
Ammonia	µg/l	09/18/09	0	10	50000	0.450	2250	2271	101%	88-120
Ammonia	µg/l	09/18/09	0	10	10000	1.500	1500	1323	88.2%	88-120
Ammonia	µg/l	09/18/09	0	10	10000	1.500	1500	1351	90.1%	88-120
Ammonia	µg/l	10/29/09	0	10	10000	0.226	226	226	100%	88-120
Ammonia	µg/l	10/29/09	0	10	10000	0.165	165	180	109%	88-120
Ammonia	µg/l	10/29/09	0	10	10000	0.165	165	164	99.4%	88-120
Ammonia	µg/l	10/29/09	0	10	10000	0.150	150	149	99.3%	88-120
Total N	µg/l	04/27/09	0	5	3475	5.000	3475	3268	94.0%	92-110
Total N	µg/l	04/27/09	0	5	3000	5.000	3000	3011	100%	92-110
Total N	µg/l	04/27/09	0	5	3000	5.000	3000	3120	104%	92-110
Total N	µg/l	06/09/09	0	5	5000	5.000	5000	4788	95.8%	92-110
Total N	µg/l	06/09/09	0	5	3500	5.000	3500	3432	98.1%	92-110
Total N	µg/l	06/09/09	0	5	3500	5.000	3500	3536	101%	92-110
Total N	µg/l	07/01/09	0	5	3000	5.000	3000	2923	97.4%	92-110
Total N	µg/l	07/01/09	0	5	3000	5.000	3000	2948	98.3%	92-110
Total N	µg/l	08/12/09	0	5	3000	5.000	3000	3174	106%	92-110
Total N	µg/l	08/12/09	0	5	3000	5.000	3000	3129	104%	92-110
Total N	µg/l	08/12/09	0	5	3000	5.000	3000	3066	102%	92-110
Total N	µg/l	08/12/09	0	5	4000	5.000	4000	3927	98.2%	92-110
Total N	µg/l	08/12/09	0	5	4000	5.000	4000	4186	105%	92-110
Total N	µg/l	10/15/09	0	5	2000	5.000	2000	1918	95.9%	92-110
Total N	µg/l	10/15/09	0	5	3000	5.000	3000	3156	105%	92-110
Total N	µg/l	10/15/09	0	5	3500	5.000	3500	3303	94.4%	92-110
Total N	µg/l	10/15/09	0	5	3000	5.000	3000	3145	105%	92-110
Total N	µg/l	10/15/09	0	5	3000	5.000	3000	3160	105%	92-110
Total P	µg/l	04/27/09	0	5	600	5.000	600	598	99.7%	92-110
Total P	µg/l	04/27/09	0	5	600	5.000	600	618	103%	92-110
Total P	µg/l	04/27/09	0	5	600	5.000	600	607	101%	92-110
Total P	µg/l	06/09/09	0	5	1000	5.000	1000	1019	102%	92-110
Total P	µg/l	06/09/09	0	5	700	5.000	700	691	98.7%	92-110
Total P	µg/l	06/09/09	0	5	800	5.000	800	822	103%	92-110
Total P	µg/l	07/01/09	0	5	1000	5.000	1000	935	93.5%	92-110
Total P	µg/l	07/01/09	0	5	1000	5.000	1000	977	97.7%	92-110

Poppleton Creek BMP Evaluation Project
Blank Spike Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Total P	µg/l	08/12/09	0	5	1100	5.000	1100	1138	103%	92-110
Total P	µg/l	08/12/09	0	5	1500	5.000	1500	1401	93.4%	92-110
Total P	µg/l	08/12/09	0	5	1300	5.000	1300	1264	97.2%	92-110
Total P	µg/l	08/12/09	0	5	1300	5.000	1300	1345	103%	92-110
Total P	µg/l	10/15/09	0	5	1000	5.000	1000	983	98.3%	92-110
Total P	µg/l	10/15/09	0	5	1100	5.000	1100	1072	97.5%	92-110
Total P	µg/l	10/15/09	0	5	1000	5.000	1000	937	93.7%	92-110
Total P	µg/l	10/15/09	0	5	1000	5.000	1000	965	96.5%	92-110

Poppleton Creek BMP Evaluation Project
Blank Spike Recovery Study

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	FINAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Color	PCU	07/22/09	0	25	500	4.0	80	73	92.3%	85-105
Color	PCU	07/22/09	0	25	500	4.0	80	74	92.5%	85-105
Color	PCU	07/22/09	0	25	500	4.0	80	75	93.3%	85-105
Color	PCU	08/02/09	0	25	500	4.0	80	73	92.2%	85-105
Color	PCU	08/17/09	0	25	500	4.0	80	73	92.2%	85-105
Color	PCU	08/27/09	0	25	500	4.0	80	80	100%	85-105
Color	PCU	09/03/09	0	25	500	4.0	80	80	100%	85-105
Color	PCU	09/17/09	0	25	500	4.0	80	77	96.8%	85-105
Color	PCU	09/25/09	0	25	500	4.0	80	77	96.8%	85-105
Color	PCU	09/30/09	0	25	500	4.0	80	77	96.3%	85-105
Color	PCU	10/08/09	0	25	500	4.0	80	77	96.3%	85-105

Poppleton Creek BMP Evaluation Project
Sample Duplicate Recovery

PARAMETERS	UNITS	SAMPLE ID	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
pH	s.u.	09-1006	03/19/09	6.15	6.16	6.16	0.007	0.11	0-4
pH	s.u.	09-1272	04/14/09	7.48	7.45	7.47	0.021	0.28	0-4
pH	s.u.	09-1838	06/05/09	5.57	5.53	5.55	0.028	0.51	0-4
pH	s.u.	09-2037	06/26/09	6.81	6.83	6.82	0.014	0.21	0-4
pH	s.u.	09-2074	07/07/09	5.88	5.86	5.87	0.014	0.24	0-4
pH	s.u.	09-2241	07/16/09	5.99	6.01	6.00	0.014	0.24	0-4
pH	s.u.	09-2393	08/01/09	5.40	5.40	5.40	0.000	0.00	0-4
pH	s.u.	09-2577	08/17/09	5.64	5.61	5.63	0.021	0.38	0-4
pH	s.u.	09-2759	08/26/09	5.92	5.90	5.91	0.014	0.24	0-4
pH	s.u.	09-2902	09/02/09	5.71	5.72	5.72	0.007	0.12	0-4
pH	s.u.	09-3179	09/16/09	5.12	5.12	5.12	0.000	0.00	0-4
pH	s.u.	09-3595	10/09/09	5.81	5.82	5.82	0.007	0.12	0-4
Alkalinity	mg/l	09-1006	03/19/09	2.8	2.8	2.80	0.000	0.00	0-4
Alkalinity	mg/l	09-1272	04/14/09	70.0	69.6	69.80	0.283	0.41	0-4
Alkalinity	mg/l	09-1838	06/05/09	3.0	3.0	105.00	0.000	0.00	0-4
Alkalinity	mg/l	09-2037	06/26/09	32.0	31.6	214.00	0.283	0.13	0-4
Alkalinity	mg/l	09-2074	07/07/09	1.8	1.6	105.00	0.141	0.13	0-4
Alkalinity	mg/l	09-2241	07/16/09	4.2	4.6	214.00	0.283	0.13	0-4
Alkalinity	mg/l	09-2393	08/01/09	2.2	2.6	257.00	0.283	0.11	0-4
Alkalinity	mg/l	09-2577	08/17/09	1.0	0.8	257.00	0.141	0.06	0-4
Alkalinity	mg/l	09-2759	08/26/09	3.0	2.8	257.00	0.141	0.06	0-4
Alkalinity	mg/l	09-2902	09/02/09	0.8	0.8	0.80	0.000	0.00	0-4
Alkalinity	mg/l	09-3179	09/16/09	1.0	1.1	1.06	0.021	2.01	0-4
Alkalinity	mg/l	09-3595	10/09/09	3.6	4.0	257.00	0.283	0.11	0-4
Turbidity	NTU	09-0367	02/06/09	3.4	3.4	3.40	0.000	0.00	0-4
Turbidity	NTU	09-1006	03/19/09	2.3	2.3	2.30	0.000	0.00	0-4
Turbidity	NTU	09-1838	06/04/09	1	1	1.00	0.000	0.00	0-4
Turbidity	NTU	09-2037	06/26/09	10	9.9	9.95	0.071	0.71	0-4
Turbidity	NTU	09-2074	07/02/09	3.5	3.5	3.50	0.000	0.00	0-4
Turbidity	NTU	09-2154	07/10/09	3.3	3.2	3.25	0.071	2.18	0-4
Turbidity	NTU	09-2241	07/16/09	3.6	3.5	3.55	0.071	1.99	0-4
Turbidity	NTU	09-2278	07/24/09	10.1	10.1	10.10	0.000	0.00	0-4
Turbidity	NTU	09-2393	08/02/09	0.9	0.9	0.90	0.000	0.00	0-4
Turbidity	NTU	09-3502	09/30/09	2	2.1	2.05	0.071	3.45	0-4
Turbidity	NTU	09-3594	10/07/09	0.1	0.1	0.10	0.000	0.00	0-4
Specific Conductivity	µmho/cm	09-2154	07/27/09	8.9	8.7	8.80	0.141	1.61	0-5
Specific Conductivity	µmho/cm	09-2241	07/29/09	8.0	8.0	8.00	0.000	0.00	0-5
Specific Conductivity	µmho/cm	09-2277	07/29/09	172	172	172.00	0.000	0.00	0-5
Specific Conductivity	µmho/cm	09-2473	08/13/09	133	133	133.00	0.000	0.00	0-5
Specific Conductivity	µmho/cm	09-2578	09/01/09	1.8	1.8	1.80	0.000	0.00	0-5
Specific Conductivity	µmho/cm	09-3502	10/06/09	182	182	182.00	0.000	0.00	0-5
Specific Conductivity	µmho/cm	09-3593	10/29/09	184	184	184.00	0.000	0.00	0-5

Poppleton Creek BMP Evaluation Project
Sample Duplicate Recovery

PARAMETERS	UNITS	SAMPLE ID	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
SRP	µg/l	09-0367	02/06/09	1	1	1.00	0.000	0.00	0-5
SRP	µg/l	09-1007	03/19/09	0	0	0.10	0.000	0.00	0-5
SRP	µg/l	09-1272	04/03/09	18	20	18.95	0.778	4.10	0-5
SRP	µg/l	09-2037	06/26/09	634	640	637.00	4.243	0.67	0-5
SRP	µg/l	09-2073	07/08/09	10	10	10.00	0.000	0.00	0-5
SRP	µg/l	09-2151	07/13/09	4	3	3.45	0.071	2.05	0-5
SRP	µg/l	09-2241	07/17/09	2	2	2.00	0.000	0.00	0-5
SRP	µg/l	09-2277	07/23/09	27	26	26.50	0.707	2.67	0-5
SRP	µg/l	09-2472	08/07/09	45	45	44.75	0.354	0.79	0-5
SRP	µg/l	09-2576	08/19/09	2	2	1.85	0.071	3.82	0-5
SRP	µg/l	09-2759	08/27/09	0	0	0.10	0.000	0.00	0-5
SRP	µg/l	09-2904	09/04/09	1	1	1.00	0.000	0.00	0-5
SRP	µg/l	09-3179	09/16/09	1	1	1.00	0.000	0.00	0-5
NOX-N	µg/l	09-0367	02/06/09	50	50	50.00	0.000	0.00	0-4
NOX-N	µg/l	09-1007	03/19/09	0.1	0.1	0.10	0.000	0.00	0-4
NOX-N	µg/l	09-1272	04/03/09	798	763	780.50	24.749	3.17	0-4
NOX-N	µg/l	09-2037	06/26/09	1036	1047	1041.50	7.778	0.75	0-4
NOX-N	µg/l	09-2073	07/08/09	39	37	38.00	1.414	3.72	0-4
NOX-N	µg/l	09-2151	07/13/09	1	1	1.00	0.000	0.00	0-4
NOX-N	µg/l	09-2241	07/17/09	13	14	13.70	0.424	3.10	0-4
NOX-N	µg/l	09-2277	07/23/09	4	4	4.00	0.000	0.00	0-4
NOX-N	µg/l	09-2472	08/07/09	18	18	18.00	0.000	0.00	0-4
NOX-N	µg/l	09-2576	08/19/09	2	1	1.48	0.035	2.40	0-4
NOX-N	µg/l	09-2759	08/27/09	130	130	130.00	0.000	0.00	0-4
NOX-N	µg/l	09-2904	09/04/09	106	110	108.00	2.828	2.62	0-4
NOX-N	µg/l	09-3179	09/16/09	21	22	21.50	0.707	3.29	0-4
Ammonia	µg/l	09-0367	02/18/09	175	177	176.0	1.414	0.80	0-10
Ammonia	µg/l	09-1272	04/16/09	61	67	64.00	4.243	6.63	0-10
Ammonia	µg/l	09-2151	07/22/09	14	16	15.0	0.778	5.20	0-10
Ammonia	µg/l	09-2277	08/17/09	155	152	153.50	2.121	1.38	0-10
Ammonia	µg/l	09-2576	08/19/09	39	40	39.5	0.707	1.79	0-10
Ammonia	µg/l	09-2904	09/18/09	46	48	47.00	1.414	3.01	0-10
Ammonia	µg/l	09-3593	10/29/09	109	109	109.0	0.000	0.00	0-10
Total N	µg/l	09-1006fp	04/27/09	458	424	441.0	24.042	5.45	0-6
Total N	µg/l	09-1707p	06/09/09	959	919	939.0	28.284	3.01	0-6
Total N	µg/l	09-1835fp	07/01/09	514	501	507.5	9.192	1.81	0-6
Total N	µg/l	09-2155p	08/12/09	7	6	6.3	0.354	5.66	0-6
Total N	µg/l	09-2393fp	10/15/09	171	165	168.0	4.243	2.53	0-6
Total N	µg/l	09-2475p	10/15/09	125	120	122.5	3.536	2.89	0-6
Total N	µg/l	09-2759fp	10/15/09	541	554	547.5	9.192	1.68	0-6
Total N	µg/l	09-2904p	10/15/09	242	248	245.0	4.243	1.73	0-6
Total N	µg/l	09-3592p	10/15/09	605	596	600.5	6.364	1.06	0-6
Total N	µg/l	09-3595fp	10/15/09	430	433	431.5	2.121	0.49	0-6

Poppleton Creek BMP Evaluation Project
Sample Duplicate Recovery

PARAMETERS	UNITS	SAMPLE ID	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
Total P	µg/l	09-1006fp	04/27/09	9	9	9.00	0.000	0.00	0-5
Total P	µg/l	09-1707p	06/09/09	94	92	93.00	1.414	1.52	0-5
Total P	µg/l	09-1835fp	07/01/09	44	44	44.00	0.000	0.00	0-5
Total P	µg/l	09-2155p	08/12/09	0	0	0.10	0.000	0.00	0-5
Total P	µg/l	09-2393fp	10/15/09	1	1	1.00	0.000	0.00	0-5
Total P	µg/l	09-2475p	10/15/09	6	5	5.40	0.141	2.62	0-5
Total P	µg/l	09-2759fp	10/15/09	1	1	1.00	0.000	0.00	0-5
Total P	µg/l	09-2904p	10/15/09	1	1	1.00	0.000	0.00	0-5
Total P	µg/l	09-3592p	10/15/09	10	11	10.3	0.354	3.45	0-5
Total P	µg/l	09-3595fp	10/15/09	0	0	0.1	0.000	0.00	0-5
Color	PCU	09-2074	07/22/09	2	2	2.00	0.000	0.00	0-5
Color	PCU	09-2151	07/22/09	17	17	17.20	0.283	1.64	0-5
Color	PCU	09-2241	07/22/09	8	8	7.90	0.141	1.79	0-5
Color	PCU	09-2393	08/02/09	1	1	1.00	0.000	0.00	0-5
Color	PCU	09-2578	08/17/09	0	0	0.10	0.000	0.00	0-5
Color	PCU	09-2759	08/27/09	1	1	1.00	0.000	0.00	0-5
Color	PCU	09-2903	09/03/09	0	0	0.10	0.000	0.00	0-5
Color	PCU	09-3179	09/17/09	3	3	2.95	0.071	2.40	0-5
Color	PCU	09-3429	09/25/09	5	5	4.95	0.071	1.43	0-5
Color	PCU	09-3502	09/30/09	31	31	31.05	0.071	0.23	0-5
Color	PCU	09-3595	10/08/09	2	2	2.00	0.000	0.00	0-5

Poppleton Creek BMP Evaluation Project
Matrix Spike Recovery Study

PARAMETERS	UNITS	SAMPLE ID	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPTANCE RANGE
Alkalinity	mg/l	09-2393	08/01/09	2.6	50	1000	0.5	12.6	12.6	100%	95-105
Alkalinity	mg/l	09-2758	08/26/09	2.8	50	1000	0.5	12.8	12.8	100%	95-105
Alkalinity	mg/l	09-2902	09/02/09	0.8	50	1000	0.5	10.8	10.4	96.3%	95-105
Alkalinity	mg/l	09-3595	10/09/09	4.0	50	1000	0.4	12.0	12.4	103%	95-105
SRP	µg/l	09-0367	02/06/09	1	10	10000	0.200	201	203	101%	92-110
SRP	µg/l	09-1007	03/19/09	0	10	10000	0.500	500	506	101%	92-110
SRP	µg/l	09-1272	04/03/09	18	10	10000	0.200	218	235	108%	92-110
SRP	µg/l	09-2037	06/26/09	634	10	10000	0.100	734	712	97.0%	92-110
SRP	µg/l	09-2241	07/17/09	2	10	10000	0.400	402	418	104%	92-110
SRP	µg/l	09-2277	07/23/09	27	10	10000	0.225	252	244	96.8%	92-110
SRP	µg/l	09-2759	08/27/09	0	10	10000	0.350	350	364	104%	92-110
SRP	µg/l	09-2904	09/04/09	1	10	10000	0.425	426	425	100%	92-110
NOX-N	µg/l	09-0367	02/06/09	50	10	8000	0.200	210	213	101%	92-108
NOX-N	µg/l	09-1007	03/19/09	0	10	100000	0.275	2750	2770	101%	92-108
NOX-N	µg/l	09-1272	04/03/09	798	10	100000	0.100	1798	1810	101%	92-108
NOX-N	µg/l	09-2037	06/26/09	1036	10	100000	0.050	1536	1522	99.1%	92-108
NOX-N	µg/l	09-2241	07/17/09	13	10	10000	0.300	313	301	96.2%	92-108
NOX-N	µg/l	09-2277	07/23/09	4	10	10000	0.150	154	162	105%	92-108
NOX-N	µg/l	09-2759	08/27/09	130	10	10000	0.250	380	396	104%	92-108
NOX-N	µg/l	09-2904	09/04/09	106	10	10000	0.300	406	388	95.6%	92-108
Ammonia	µg/l	09-1272	04/16/09	61	10	10000	1.100	1161	1151	99.1%	88-120
Ammonia	µg/l	09-2277	08/17/09	155	10	10000	1.000	1155	1157	100%	88-120
Ammonia	µg/l	09-2904	09/18/09	46	10	10000	1.100	1146	1190	104%	88-120
Ammonia	µg/l	09-3593p	10/29/09	109	10	10000	1.600	1709	1721	101%	88-120
Total N	µg/l	09-1707P	06/09/09	959	5	100000	0.040	1759	1789	102%	92-110
Total N	µg/l	09-2759fp	10/15/09	541	5	100000	0.050	1541	1545	100%	92-110
Total N	µg/l	09-2904p	10/15/09	242	5	100000	0.050	1242	1294	104%	92-110
Total N	µg/l	09-3592p	10/15/09	605	5	100000	0.040	1405	1405	100%	92-110
Total N	µg/l	09-3595fp	10/15/09	430	5	100000	0.060	1630	1681	103%	92-110
Total P	µg/l	09-1707p	06/09/09	72	5	32600	0.040	333	323	97.1%	92-110
Total P	µg/l	09-2759fp	10/15/09	1	5	10000	0.050	101	105	104.0%	92-110
Total P	µg/l	09-2904p	10/15/09	1	5	10000	0.050	101	98	97.0%	92-110
Total P	µg/l	09-3592p	10/15/09	10	5	10000	0.050	110	104	95%	92-110
Total P	µg/l	09-3595fp	10/15/09	0	5	10000	0.050	100	98	98.0%	92-110
Color	PCU	09- 2074	07/22/09	2	25	500	1.000	22	20	94.9%	85-105
Color	PCU	09- 2151	07/22/09	17	25	500	1.000	37	32	86.5%	85-105
Color	PCU	09- 2241	07/22/09	8	25	500	1.000	28	26	94.3%	85-105
Color	PCU	09-2759	08/27/09	1	25	500	0.750	16	15	93.8%	85-105
Color	PCU	09-2905	09/03/09	0	25	500	0.750	15	15	100%	85-105
Color	PCU	09-3429	09/25/09	5	25	500	0.750	20	20	100%	85-105
Color	PCU	09-3595	10/08/09	2	25	500	0.750	17	17	100%	85-105