Performance Evaluation of the Palm Bay Basin 7 Wet Detention Pond

Final Report

Prepared for:

City of Palm Bay

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Prepared By:

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SECTION 1

INTRODUCTION

The Palm Bay Basin 7 watershed consists of approximately 110 acres north of Turkey Creek between Robert J. Conlon Blvd. and the Florida East Coast Railroad. Palm Bay Road dissects the basin in an east/west direction near its center. Areas within Basin 7 have a history of severe flooding, and the basin is currently listed as a "high priority basin" by the City of Palm Bay. In addition, Basin 7 contains few stormwater treatment facilities and discharges largely untreated runoff directly into Turkey Creek, a tributary of the Indian River Lagoon.

During 1998, the City of Palm Bay contracted with the St. Johns River Water Management District (SJRWMD), through Contract No. 98W363, to implement best management practices (BMPs) for Basin 7 to resolve flooding concerns and to concurrently reduce stormwater associated pollutant loadings to Turkey Creek. A wet detention stormwater management pond was designed and constructed by the City of Palm Bay to provide treatment for a substantial portion of the total runoff generated within Basin 7. A location map for the wet detention pond site (prior to construction) is given in Figure 1-1. Prior to construction of the wet detention pond, all stormwater from Basin 7 discharged directly into Turkey Creek through a single outfall, without treatment. The wet detention pond was designed to intercept the historical flow of untreated runoff, and the existing outfall was rerouted through a wetlands area and vegetated canal system.

The contract between the City of Palm Bay and SJRWMD requires that the performance efficiency of the wet detention pond be monitored to document the reductions in pollutant loadings to Turkey Creek. During August 2000, the City of Palm Bay entered into an contract with Environmental Research & Design, Inc. (ERD) to conduct performance efficiency monitoring of the Basin 7 wet detention pond. Site instrumentation was installed by ERD during March-April 2002. Field monitoring was initiated during May 2002, and data was collected to estimate the percent reductions in loadings of total nitrogen, total phosphorus, and suspended solids achieved

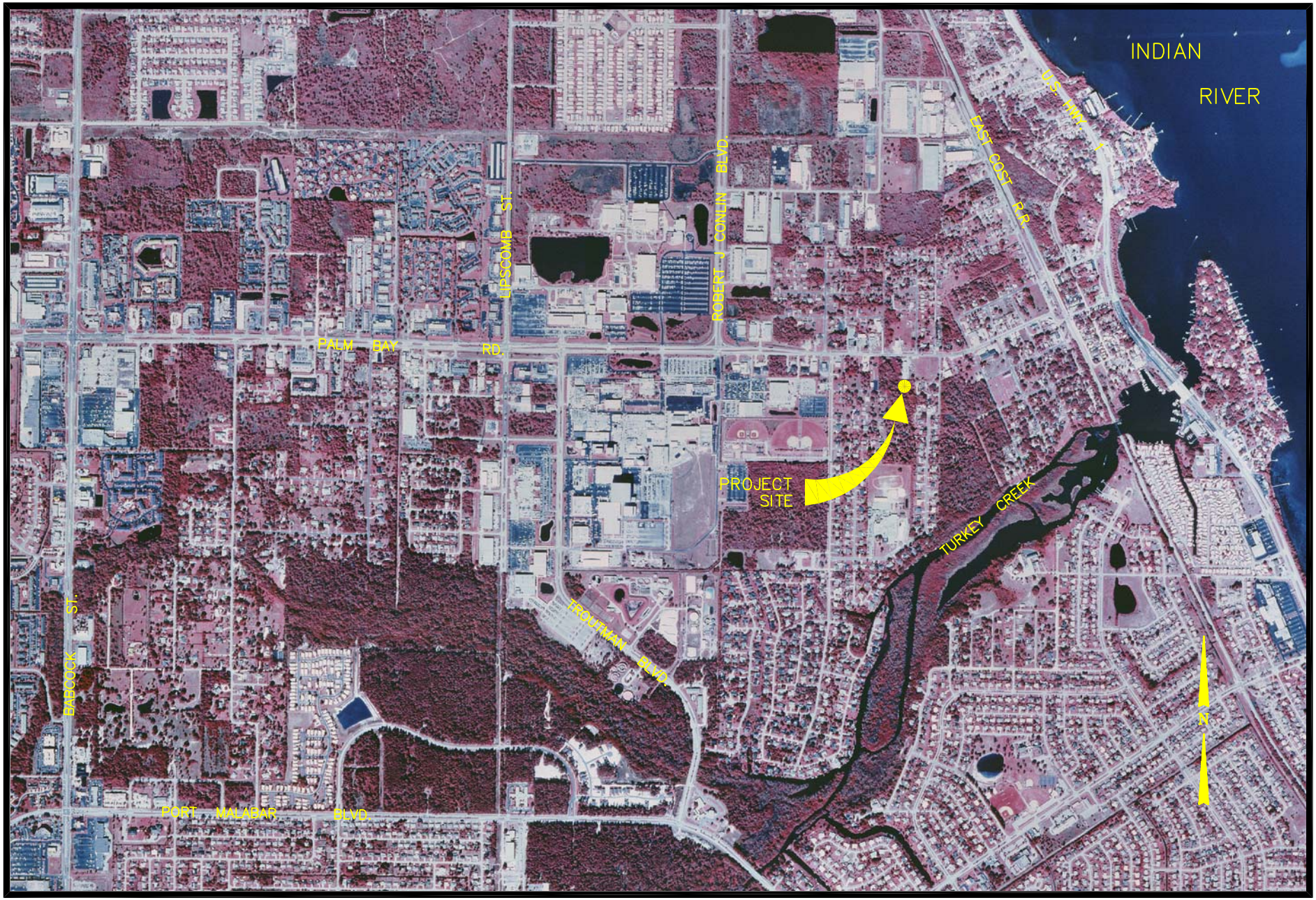

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Figure 1-1. Location Map for the Palm Bay Basin 7 Detention Pond Site.

within the wet detention facility. A detailed hydrologic budget was also performed to assist in evaluation of the overall system performance efficiency. The contract between ERD and the City of Palm Bay specified a 6-month monitoring period, although actual field monitoring activities were performed by ERD over a period of eight months.

The analyses and conclusions expressed in this report are based upon field monitoring and laboratory analyses performed by ERD from May-December 2002. Continuous monitoring of hydrologic and water quality characteristics were performed at the Basin 7 wet detention pond site to provide a detailed hydrologic and mass balance budget, and allow estimation of the overall performance efficiency of the pond. Hydrologic and water quality monitoring were performed for runoff inputs, pond outflow, pond surface water, site evaporation, and shallow groundwater.

This report has been divided into three separate sections for presentation and analysis of the field and laboratory activities. Section 1 contains an introduction to the report and provides a summary of the work efforts performed by ERD. Section 2 contains a description of the field monitoring and laboratory analyses conducted by ERD. A discussion of the results of the field and laboratory activities is given in Section 3.

SECTION 2

FIELD AND LABORATORY ACTIVITIES

2.1 Description of the Study Site

Field and laboratory investigations were conducted from May-December 2002 to evaluate the hydraulic and water quality characteristics of the recently constructed wet detention pond system for Basin 7. As indicated on Figure 1-1, the project site is located in Brevard County, Florida, within the City of Palm Bay, immediately south of Palm Bay Road, approximately mid-way between Robert J. Conlon Blvd. and U.S. 1. The wet detention pond itself is not visible on Figure 1-1 since the pond was constructed subsequent to the 1999 aerial photography utilized for preparation of Figure 1-1.

The Basin 7 wet detention pond was constructed during 2001-2002 by the City of Palm Bay to provide stormwater treatment for a large portion of Palm Bay Basin 7. The overall basin area consists of approximately 110 acres, with 71.5 acres of the basin discharging to the wet detention pond. Land use within Basin 7 consists of a mixture of single-family, commercial, and institutional land uses.

Prior to construction of the wet detention pond, untreated stormwater runoff from Basin 7 discharged south from Palm Bay Road through the pond site into a drainage easement which ultimately discharged into Turkey Creek. Following construction of the wet detention pond, the runoff flow was diverted due west into a vegetated drainage canal which discharges into Turkey Creek at a new location.

Stage-storage relationships for the Basin 7 wet detention pond are given in Table 2-1 based upon record drawings (dated 1/28/02) for the pond provided by the City of Palm Bay. The normal water level within the pond is regulated by 6-inch PVC outfall bleeder pipe with an invert elevation of 14.32 ft (NGVD) based upon a field survey performed by the City of Palm Bay. At the assumed

control elevation of 14.32 ft (NGVD), the wet detention pond has a surface area of approximately 2.23 ac and a permanent pool volume of approximately 13.87 ac-ft.

TABLE 2-1

STAGE-STORAGE RELATIONSHIPS FOR THE BASIN 7 WET DETENTION POND

STAGE (ft, NGVD)	AREA (ac)	VOLUME (ac-ft)
4.0	0.33	0.0
6.0	0.97	1.30
12.0	1.64	9.11
14.0	2.13	12.88
19.0	3.55	27.08

Other than overland flow in the immediate vicinity of the pond, stormwater runoff enters the pond primarily through a 66-inch RCP at the northwest corner of the pond. According to record drawings provided by the City of Palm Bay, the invert of the 66-inch RCP in the pond is 9.40 ft (NGVD). At the water control elevation of 14.32 ft, the 66-inch RCP exhibits partial flow conditions as it enters the detention pond.

Discharges from the pond are controlled by an outfall structure located on the east side of the pond. Details of the outfall structure are illustrated on Figure 2-1. Discharges from the wet detention pond are controlled primarily by the 6-inch PVC bleed-down orifice with an invert elevation of 14.32 ft. When runoff inputs into the pond reach an elevation of 15.95 ft (NGVD), water from the pond can begin flowing through a rectangular overflow weir which is approximately 102 inches wide and 15 inches tall. Water discharging through this overflow weir must first pass under a fiberglass skimmer to prevent floatable debris and oil and grease from discharging directly through the overflow weir. Discharges from the pond enter a 43-inch x 68-inch ERCP which travels approximately 609 ft before discharging into an open vegetated drainage canal.

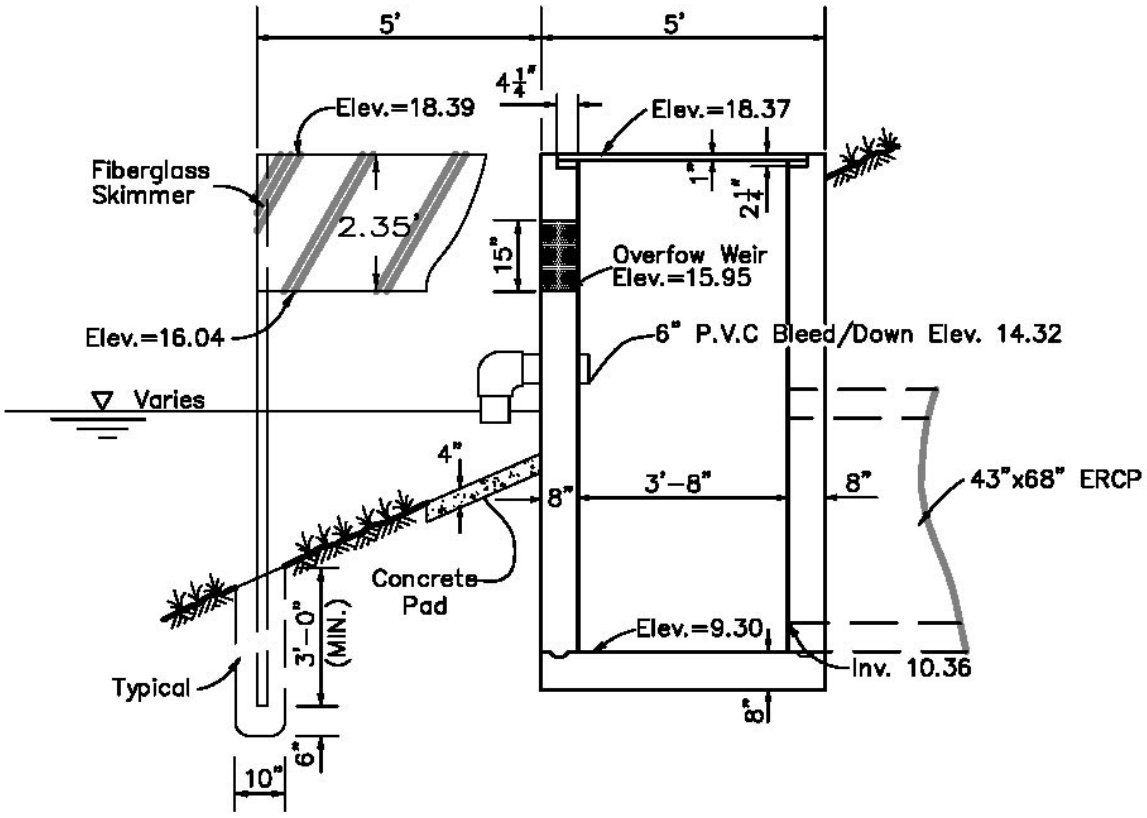


Figure 2-1. Detail of the Outfall Control Structure for the Basin 7 Wet Detention Pond.

Under natural conditions, soils in Basin 7 are characterized as sandy soils with a relatively high water table and a high runoff potential. However, drainage conveyance systems in portions of the watershed are poorly defined, resulting in significant ponding and depressional storage during rain events.

2.2 Field Instrumentation and Monitoring

A schematic of field instrumentation used as the Basin 7 detention pond site is given in Figure 2-2. Instrumentation was installed to allow estimation of a complete hydrologic budget for the pond site, including flow monitoring equipment at the primary inflow and outflow, a recording rain gauge, a pond water level recorder, and a Class A pan evaporimeter. Shallow groundwater monitoring wells were also installed to allow estimation of losses or inputs as a result of groundwater seepage. Details of these installations are given in the following sections.

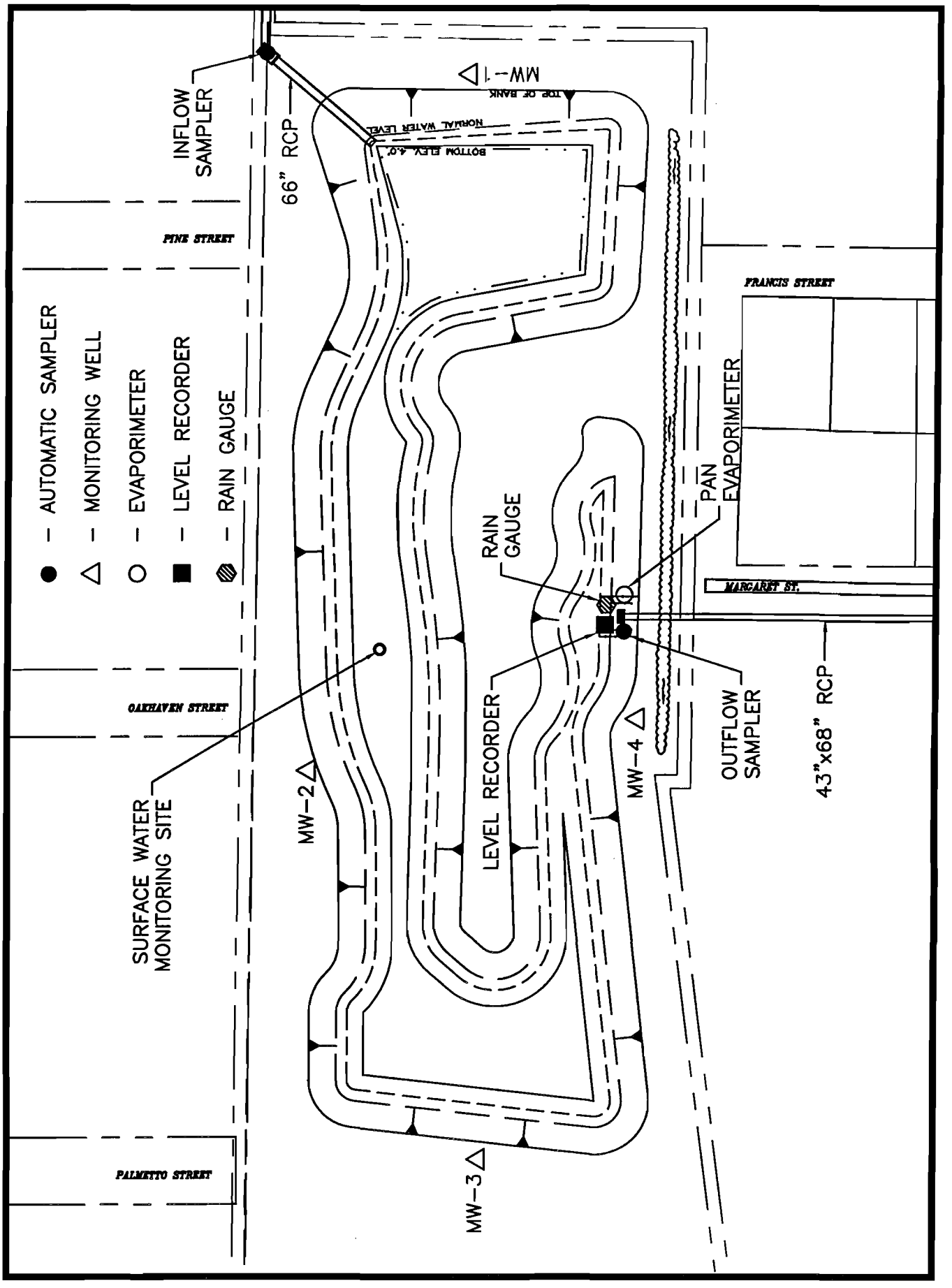


Figure 2-2. Field Instrumentation at the Basin 7 Monitoring Site.

2.2.1 Inflow Monitoring

The primary inflow into the Basin 7 wet detention pond consists of a 66-inch RCP which enters at the northwest corner of the pond. The stormsewer line originates at Palm Bay Road and travels approximately 296 ft due south to a 4-ft x 8-ft concrete junction box. Another section of 66-inch RCP travels southeast from the box, approximately 95 ft, into the wet detention pond.

Inflow monitoring was performed for the wet detention pond in the 66-inch RCP immediately downstream from the 4-ft x 8-ft junction box. An automatic sequential stormwater sampler with integral flow meter, manufactured by Sigma (Model No. 900 MAX-AV) was installed at the site to provide a continuous hydrograph record of inputs into the detention pond. The automatic sampler was housed inside an insulated aluminum equipment shelter, mounted on top of the 4-ft x 8-ft concrete junction box, with sensor cables and sample tubing extending through the top of the box into the 66-inch RCP to the point of sample collection. The integral flow meter was programmed to provide a continuous record of hydraulic inputs into the pond at this location, with measurements stored into internal memory at 10-minute intervals.

The automatic stormwater sampler contained 24 one-liter polyethylene bottles and was programmed to collect stormwater samples in a flow-weighted sample mode. A single flow-weighted composite stormwater sample was generated from each monitored storm event by combining the individual flow-weighted samples for a given event to form a single composite sample. Since 120 VAC power was not available at the site, the stormwater collector was operated on gel cell batteries which were replaced on a weekly basis. A total of 21 separate flow-weighted composite samples of stormwater runoff was collected at the inflow site during the 8-month monitoring program.

Flow measurements were performed at the inflow monitoring sites using the velocity/cross-sectional area method. A velocity-depth probe was inserted into the 66-inch RCP immediately downstream from the junction box. This probe performed simultaneous measurements of water velocity and depth. The depth measurements were converted into a cross-sectional area based upon the geometry of the pipe and multiplied by the measured velocity of flow to obtain a measurement

of the discharge rate through the pipe in cubic feet per second (cfs). In general, measurable flow at the inflow site was observed only during storm events. No significant baseflow occurred at the inflow monitoring location during the monitoring period.

2.2.2 Outfall Monitoring

A second automatic sequential sampler (Sigma Model 800 SL) was installed at the outflow from the pond to provide a continuous record of total discharges from the system. A sharp-crested rectangular weir was constructed across the entrance to the 43-inch x 68-inch RCP which discharges from the outfall structure. A 90° V-notch weir was inserted in the center of the rectangular weir, creating a compound weir structure, to improve discharge measurements under low flow conditions. All discharges from the pond, through either the 6-inch PVC bleed down pipe or the rectangular overflow weir, entered the outfall structure and passed through either the V-notch or rectangular portions of the weir before entering the 43-inch x 68-inch outfall pipe.

The vast majority of discharges through the outfall structure utilized the V-notched portion of the weir only. However, larger flow rates, particularly following extreme rain events, utilized both the rectangular and V-notched portions of the weir. The discharge over the compound weir was calculated by applying standard discharge equations for the V-notch and weir segments of the outfall structure. Discharge through the 90° V-notch weir was calculated according to the following equation:

$$Q = K H^{2.5}$$

where:

Q = discharge (cfs)

H = head on weir (ft)

K = discharge coefficient (2.50 for 90° V-notch)

When the V-notch weir reached the maximum depth of 6 inches, the flow essentially converted to contracted rectangular weir flow, with the weir portion of the flow calculated according to the following weir equation:

$$Q = K\ (L - 0.2\,H)\ H^{1.5}$$

where:

Q	=	discharge (cfs)
H	=	head on weir (ft)
L	=	crest length (4.5 ft)
K	=	discharge coefficient (3.33 for sharp-crested weir)

The automatic outfall sampler contained 24 one-liter polyethylene bottles and was programmed to collect outflow samples on a flow-weighted basis. Since 120 VAC power was not available at the site, the stormwater collector was operated on a gel cell battery which was replaced on a weekly basis. The outflow sampler was programmed to collect samples on a flow-weighted basis and provide a continuous hydrograph of discharges from the pond, with measurements stored into internal memory at 10-minute intervals. The automatic sampler was housed inside an aluminum insulated equipment shelter with sensor cables and sample tubing extending into the outfall structure to the point of sample collection. A total of 18 separate flow-weighted composite samples of pond discharge was collected at the outfall monitoring site during the 8-month monitoring program.

2.2.3 Rainfall, Evaporation, and Water Level

A recording rainfall gauge was also installed at the outfall monitoring location, adjacent to the outfall sampler. The rainfall recorder (Texas Electronics Model 1014-C) produced a continuous record of all rainfall which occurred on the site. This record is used to provide information on

rainfall characteristics at the site during the monitoring program, and to assist in development of an overall hydrologic budget.

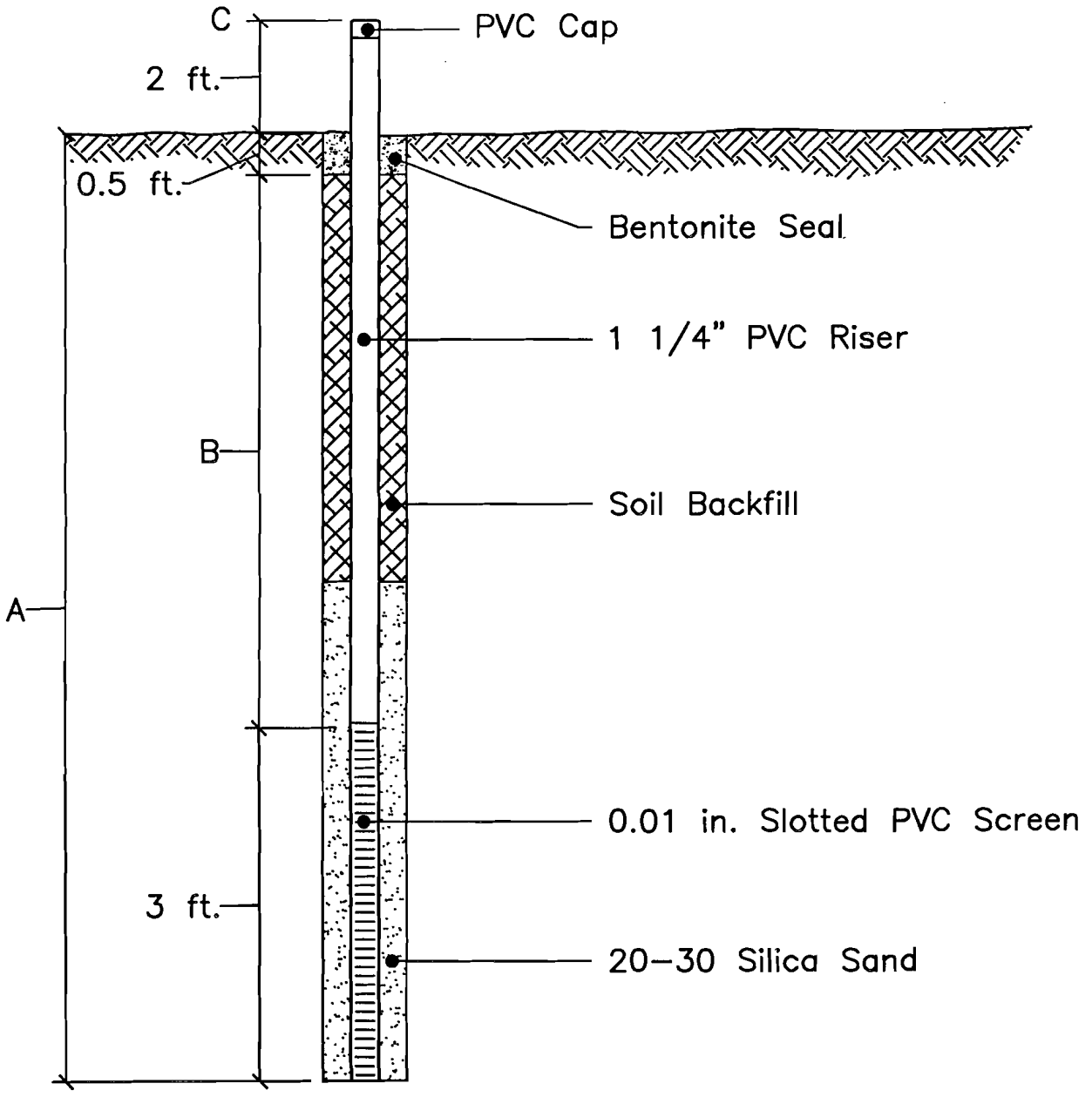
A Class A pan evaporimeter was also installed on a level wooden platform adjacent to the recording rain gauge on top of the concrete outfall structure. Evaporation losses were recorded during each visit to the site. Water from the pond was added to the evaporimeter as necessary for make-up purposes.

A sensitive pressure transducer type water level recorder (Manufactured by Global Water) was installed inside a perforated 2-inch PVC pipe which was mounted to the concrete outfall structure. The pipe was extended to a point approximately 4 ft below the normal water level of the pond. Electronics for the water level recorder were housed in a watertight housing mounted on top of the 2-inch PVC. The water level recorder provided a continuous record of changes in surface water elevations at 10-minute intervals. Data was retrieved from the unit approximately twice each month.

2.2.4 Piezometer/Monitoring Wells

A series of groundwater piezometers was also installed at the detention pond site to provide information on horizontal groundwater gradients in the vicinity of the pond. Each piezometer was constructed of 1.25-inch diameter PVC attached to a 3-ft long section of 1.25-inch diameter slotted PVC. Bore holes were augered for each piezometer which extended approximately 5 ft below the ground surface at each site. The piezometers were then inserted into the open bore holes and backfilled with clean silica sand. The top 6 inches of each bore hole was packed with bentonite clay to minimize downward migration of water through the permeable sand media.

Four separate piezometers/monitoring wells were installed adjacent to the wet detention pond at locations indicated on Figure 2-2. Construction details of the four monitoring wells are given in Figure 2-3. Piezometric elevations were collected from each of the four piezometers on approximately a weekly basis using a water level recorder manufactured by SoilTest.



Monitoring Well Number	A (ft.)	B (ft.)	C (ft., NGVD)
1	7.79	4.29	19.49
2	6.06	2.56	19.37
3	5.35	1.85	19.22
4	6.48	2.98	20.09

Figure 2-3. Construction Details for Palm Bay Basin 7 Groundwater Monitoring Wells Installed May 11, 2002.

Shallow groundwater samples were collected from each of the piezometers on a monthly basis over the monitoring period. Each of the wells was purged prior to sampling according to FDEP protocol, and a single sample for laboratory analyses was collected from each well using a battery operated peristaltic pump. Each of the collected samples was field-filtered using a disposable 0.45-micron groundwater filter manufactured by Geotech. An unfiltered sample was also collected from each well for analysis of TSS. Field measurements of temperature, pH, dissolved oxygen, specific conductivity, and oxidation-reduction potential (ORP) were also measured at each monitoring well by pumping water through a flow-through cell attached to a Hydrolab H20 water quality monitor.

2.2.5 Pond Surface Water

Surface water monitoring was conducted in the pond on approximately a weekly basis during the monitoring program. Location of the pond surface water monitoring site is indicated on Figure 2-2. A composite surface water sample was collected by combining equal amounts of surface water collected from top, middle, and bottom portions of the water column of the pond. Field measurements of pH, temperature, conductivity, dissolved oxygen, and ORP were also collected at the time of sample collection using a Hydrolab H20 water quality monitor.

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. Details on field operations, laboratory procedures, and quality assurance methodologies are provided in the FDEP-approved Comprehensive Quality Assurance Plan No. 870322G for Environmental Research & Design, Inc. In addition, a Quality Assurance Project Plan (QAPP), outlining the specific field and laboratory procedures to be conducted for this project, was submitted and approved by SJRWMD prior to initiation of any field and laboratory activities.

TABLE 2-2

ANALYTICAL METHODS AND DETECTION LIMITS FOR LABORATORY ANALYSES

MEASUREMENT PARAMETER	METHOD	METHOD DETECTION LIMITS (MDLs)[1]
Ammonia-N (NH_3-N)	EPA-83, Sec. 350.1[2]	0.01 mg/l
Nitrate + Nitrite (NO_x-N)	EPA-83, Sec. 353.3	0.004 mg/l
Total Nitrogen	Alkaline Persulfate Digestion[3]	0.03 mg/l
Orthophosphorus	SM-19, Sec. 4500-P E.[4]	0.001 mg/l
Total Phosphorus	Alkaline Persulfate Digestion[3]	0.001 mg/l
TSS	EPA-83, Sec. 160.2	0.7 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 for stormwater, surface water, pond outflow, and shallow groundwater were conducted at the Basin 7 wet detention pond over an 8-month period from May-December 2002. Hydrologic monitoring of rainfall, evaporation, water surface elevation, and groundwater piezometric levels were also performed over the same period. A discussion of the results of these tasks is given in the following sections.

3.1 Site Hydrology

As discussed in previous sections, a wide range of hydrologic information was collected at the Basin 7 wet detention pond site. This information was collected to: (1) provide information on hydrologic characteristics of rain events used for characterization of stormwater runoff; (2) assist in evaluation of a hydrologic budget for the pond site; and (3) evaluate the direction of shallow groundwater movement at the pond site. In general, hydrologic information is presented as it relates to understanding and quantifying these three areas.

3.1.1 Rainfall Characteristics

A continuous record of rainfall characteristics was collected at the Basin 7 wet detention pond site from May 1-December 31, 2002 using a tipping-bucket rainfall collector with a resolution of 0.01 inch and a digital data logging recorder. The characteristics of individual rain events measured at the Basin 7 project site are given in Table 3-1. A continuous record of rainfall characteristics was maintained throughout the entire study period. For each individual rain event, information on total rainfall, event starting time, event ending time, event duration, average rainfall intensity, and antecedent dry period are included in Table 3-1. Average rainfall intensity is calculated as the total rainfall divided by the total event duration.

TABLE 3-1

SUMMARY OF RAINFALL MEASURED AT THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

EVENT START		EVENT END		TOTAL RAINFALL (in)	DURATION (hrs)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (in/hr)
DATE	TIME	DATE	TIME				
5/6/02	4:39	5/6/02	5:32	0.02	0.87	---	0.02
5/7/02	16:05	5/7/02	16:10	0.02	0.08	1.4	0.24
5/19/02	6:42	5/19/02	12:21	0.93	5.65	11.6	0.16
5/19/02	19:25	5/19/02	21:23	0.03	1.96	0.3	0.02
5/22/02	18:46	5/22/02	21:14	0.20	2.46	2.9	0.08
5/23/02	0:09	5/23/02	0:10	0.03	0.02	0.1	1.77
5/28/02	0:12	5/28/02	3:05	0.06	2.89	5.0	0.02
5/30/02	21:16	5/31/02	0:04	0.13	2.80	2.8	0.05
5/31/02	11:26	5/31/02	17:15	0.13	5.82	0.5	0.02
5/31/02	21:09	5/31/02	21:09	0.01	---	0.2	---
6/7/02	12:17	6/7/02	12:17	0.01	---	6.6	---
6/7/02	20:55	6/7/02	21:28	0.17	0.55	0.4	0.31
6/8/02	11:34	6/8/02	13:12	0.61	1.64	0.6	0.37
6/10/02	19:47	6/10/02	20:02	0.12	0.25	2.3	0.49
6/14/02	14:28	6/14/02	15:08	0.12	0.66	3.8	0.18
6/14/02	23:05	6/14/02	23:05	0.01	---	0.3	---
6/16/02	15:48	6/16/02	23:11	0.40	7.39	1.7	0.05
6/17/02	13:35	6/17/02	16:59	0.62	3.40	0.6	0.18
6/18/02	18:27	6/18/02	21:32	0.72	3.07	1.1	0.23
6/19/02	13:36	6/19/02	23:36	1.52	10.00	0.7	0.15
6/20/02	17:34	6/21/02	1:26	0.81	7.87	0.7	0.10
6/21/02	12:32	6/21/02	21:32	1.49	9.00	0.5	0.17
6/25/02	12:08	6/25/02	12:41	0.18	0.55	3.6	0.33
6/26/02	14:25	6/26/02	15:37	0.48	1.20	1.1	0.40
6/27/02	12:14	6/27/02	12:14	0.01	---	0.9	---
6/30/02	16:02	6/30/02	18:42	0.43	2.67	3.2	0.16
7/1/02	13:05	7/1/02	13:34	0.26	0.48	0.8	0.55
7/4/02	16:33	7/4/02	19:12	0.84	2.65	3.1	0.32
7/5/02	13:15	7/5/02	18:16	1.07	5.02	0.8	0.21
7/8/02	0:39	7/8/02	1:43	0.11	1.07	2.3	0.10
7/8/02	10:29	7/8/02	12:20	0.24	1.85	0.4	0.13

TABLE 3-1 -- CONTINUED

SUMMARY OF RAINFALL MEASURED AT THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

EVENT START		EVENT END		TOTAL RAINFALL (in)	DURATION (hrs)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (in/hr)
DATE	TIME	DATE	TIME				
7/9/02	10:26	7/9/02	10:57	0.09	0.52	0.9	0.17
7/10/02	8:09	7/10/02	9:27	0.41	1.30	0.9	0.32
7/12/02	13:31	7/12/02	16:51	0.19	3.33	2.2	0.06
7/13/02	13:28	7/13/02	13:39	0.25	0.17	0.9	1.48
7/17/02	6:41	7/17/02	6:54	0.06	0.22	3.7	0.27
7/20/02	13:37	7/20/02	19:21	0.45	5.75	3.3	0.08
7/21/02	13:09	7/21/02	17:10	0.15	4.01	0.7	0.04
8/1/02	19:36	8/1/02	21:57	0.27	2.35	11.1	0.11
8/2/02	14:26	8/2/02	16:13	0.76	1.78	0.7	0.43
8/3/02	15:03	8/3/02	16:04	0.21	1.02	1.0	0.21
8/4/02	21:54	8/4/02	23:37	0.28	1.72	1.2	0.16
8/5/02	21:36	8/5/02	21:55	0.24	0.32	0.9	0.76
8/8/02	17:20	8/8/02	19:26	0.52	2.10	2.8	0.25
8/9/02	8:12	8/9/02	9:38	0.09	1.43	0.5	0.06
8/11/02	6:53	8/11/02	19:41	2.89	12.80	1.9	0.23
8/12/02	21:17	8/12/02	23:43	0.53	2.43	1.1	0.22
8/17/02	4:06	8/17/02	6:32	0.72	2.43	4.2	0.30
8/17/02	14:29	8/17/02	15:08	0.31	0.65	0.3	0.48
8/18/02	6:01	8/18/02	18:43	0.19	12.70	0.6	0.01
8/19/02	5:23	8/19/02	17:56	0.30	12.55	0.4	0.02
8/19/02	22:13	8/19/02	22:31	0.04	0.30	0.2	0.13
8/30/02	2:07	8/30/02	3:37	0.06	1.50	10.2	0.04
8/30/02	22:46	8/31/02	1:19	0.17	2.54	0.8	0.07
9/2/02	14:00	9/2/02	21:54	0.76	7.90	2.5	0.10
9/23/02	16:10	9/23/02	19:26	0.18	3.27	20.8	0.06
9/24/02	6:24	9/24/02	7:03	0.13	0.66	0.5	0.20
9/24/02	19:16	9/24/02	20:10	0.10	0.90	0.5	0.11
9/26/02	14:48	9/26/02	15:03	0.08	0.25	1.8	0.32
9/27/02	13:54	9/27/02	14:19	0.14	0.43	1.0	0.33
9/30/02	6:48	9/30/02	6:48	0.01	---	2.7	---
9/30/02	14:44	9/30/02	14:46	0.04	0.04	0.3	1.02

TABLE 3-1 -- CONTINUED

SUMMARY OF RAINFALL MEASURED AT THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

EVENT START		EVENT END		TOTAL RAINFALL (in)	DURATION (hr)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (in/hr)
DATE	TIME	DATE	TIME				
10/1/02	15:01	10/1/02	15:11	0.04	0.17	1.0	0.24
10/14/02	3:19	10/14/02	6:15	0.42	2.94	12.5	0.14
10/14/02	13:10	10/14/02	14:23	0.10	1.22	0.3	0.08
10/15/02	17:19	10/15/02	17:38	0.03	0.32	1.1	0.10
10/16/02	8:50	10/16/02	8:50	0.01	---	0.6	---
10/21/02	16:56	10/21/02	17:56	0.06	1.00	5.3	0.06
10/23/02	2:21	10/23/02	5:09	0.62	2.79	1.4	0.22
10/24/02	1:02	10/24/02	1:33	0.03	0.52	0.8	0.06
10/24/02	16:30	10/24/02	22:35	1.41	6.07	0.6	0.23
11/13/02	11:52	11/13/02	11:52	0.01	---	19.6	---
11/16/02	7:50	11/16/02	19:49	0.75	11.99	2.8	0.06
11/16/02	23:18	11/16/02	23:18	0.01	---	0.1	---
11/17/02	7:11	11/17/02	11:02	0.16	3.86	0.3	0.04
11/21/02	2:30	11/21/02	3:04	0.05	0.58	3.6	0.09
12/6/02	2:32	12/6/02	4:19	0.17	1.78	15.0	0.10
12/6/02	8:07	12/6/02	8:33	0.08	0.43	0.2	0.18
12/6/02	17:41	12/6/02	17:41	0.01	---	0.4	---
12/9/02	13:47	12/10/02	5:51	5.92	16.07	2.8	0.37
12/10/02	10:10	12/10/02	10:35	0.14	0.41	0.2	0.34
12/13/02	11:51	12/13/02	15:37	1.24	3.77	3.1	0.33
12/20/02	11:15	12/20/02	13:06	0.31	1.83	6.8	0.17
12/24/02	14:21	12/24/02	16:40	0.38	2.32	4.1	0.16
12/25/02	0:10	12/25/02	5:03	1.37	4.88	0.3	0.28
			Total:	**35.72**			

A total of 35.72 inches of rainfall fell at the Basin 7 wet detention pond site over the 8-month monitoring period from a total of 85 separate storm events. A summary of rainfall characteristics measured at the Basin 7 wet detention pond is given in Table 3-2. Individual rainfall amounts measured at the site range from 0.01-5.92 inches, with an average of 0.42 inches/event. Durations for events measured at the site range 0.02-16.7 hours, with antecedent dry periods ranging from 0.12-20.76 days.

TABLE 3-2

SUMMARY OF RAINFALL CHARACTERISTICS MEASURED AT THE BASIN 7 WET DETENTION POND SITE FROM MAY-DECEMBER 2002

PARAMETER	UNITS	MINIMUM VALUE	MAXIMUM VALUE	MEAN VALUE
Event Rainfall	in	0.01	5.92	0.42
Event Duration	hr	0.02	16.07	3.05
Average Intensity	in/hr	0.01	1.77	0.24
Antecedent Dry Period	days	0.12	20.76	2.66

A comparison of measured and typical "average" rainfall at the Basin 7 site is given in Figure 3-1. Measured rainfall presented in this figure is based upon the field-measured rain events presented in Table 3-1, summarized on a monthly basis. "Average" rainfall conditions are based upon historical monthly rainfall averages recorded at the Melbourne Meteorological Station over the 53-year period from 1948-2000. This site appears to be the closest long-term meteorological station for the Basin 7 monitoring site.

As seen in Figure 3-1, measured rainfall at the Basin 7 site was less than "normal" during five of the eight months included in the monitoring program. Rainfall measured at the Basin 7 pond during June, August, and December appears to be somewhat greater than average rainfall conditions. Overall, the measured rainfall of 35.72 inches at the Basin 7 site from May-December

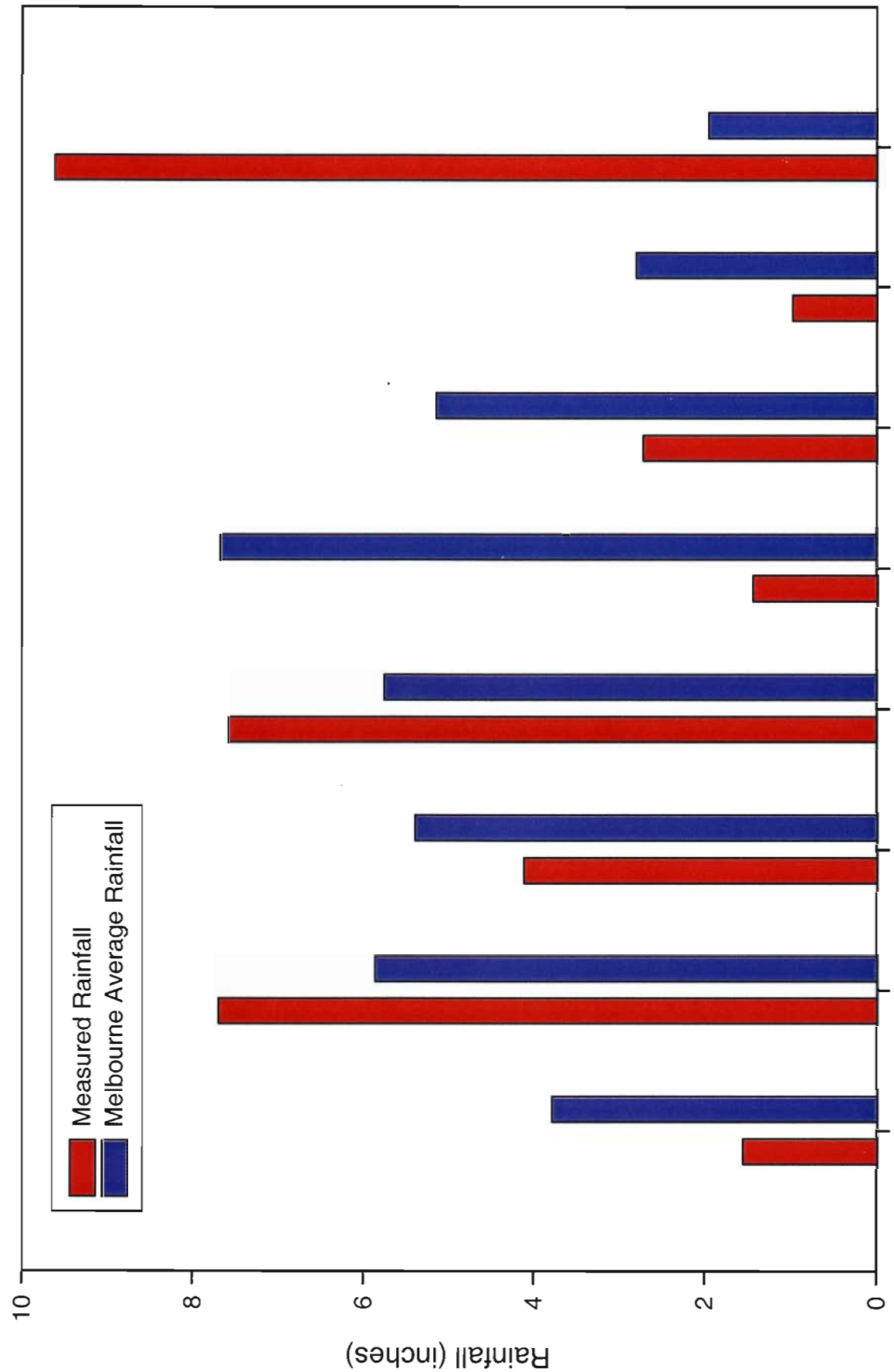


Figure 3-1. Comparison of Average and Measured Rainfall at the Basin 7 Wet Detention Pond Site

2002 is approximately 7% less than the "average" rainfall of 38.4 inches which typically occurs during the period from May-December in the Palm Bay area.

3.1.2 Fluctuations in Pond Water Surface Elevations

Water surface elevations in the Basin 7 wet detention pond were measured on a continuous basis from May 5-December 31, 2002 using a water level pressure transducer with digital data logger. Relationships between total daily rainfall and pond surface elevations at the Basin 7 project site are summarized in Figure 3-2. Monthly relationships between total daily rainfall and pond surface elevations at the project site are provided in Appendix A. In general, pond surface elevations respond rapidly to rain events, with a gradual drawdown occurring over a period of 5-7 days. Water surface elevations exhibited a maximum fluctuation of approximately 4.02 ft within the pond during the study period.

Measured minimum, maximum, and average water surface elevations during the monitoring period are summarized in Table 3-3. Water levels within the pond exceeded the control elevation during approximately 50% of the study period, with water surface elevations less than the control elevation during the remaining period. During periods of low rainfall, the pond water surface elevation dropped below the invert elevation of the 6-inch outfall pipe. The measured minimum water level within the pond of 12.85 ft (NGVD) is approximately 1.47 ft below the invert elevation of the 6-inch pipe. The maximum water surface elevation within the pond of 16.87 ft is approximately 2.55 ft above the control elevation for the pond. Water surface elevations within the pond exceeded the overflow weir elevation of 15.95, as indicated in Figure 2-1, on two separate occasions during the 8-month monitoring program.

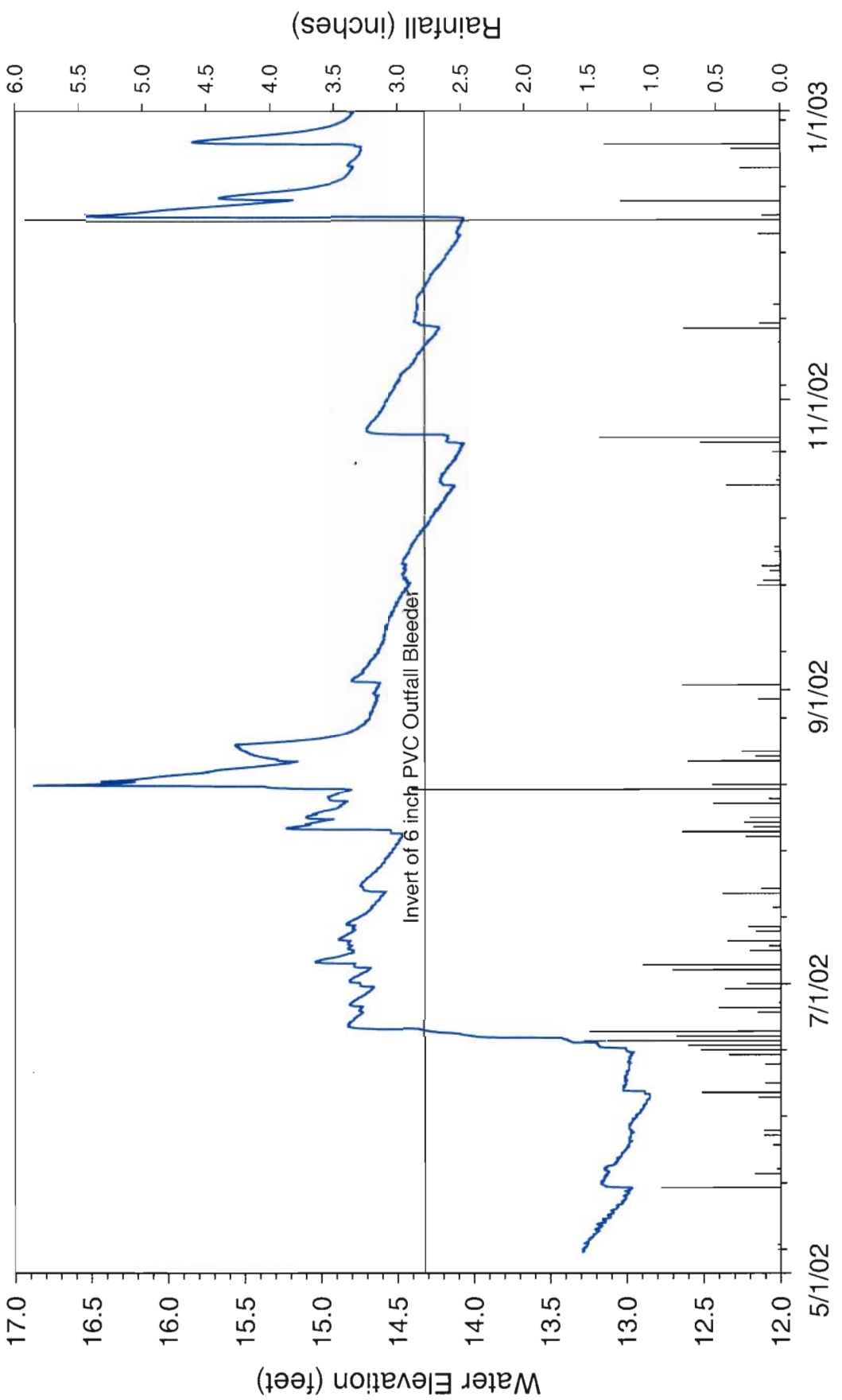


Figure 3-2. Relationships between daily rainfall and pond surface elevations at the Basin 7 wet detention pond.

TABLE 3-3

SUMMARY OF POND WATER LEVELS AT THE BASIN 7 PROJECT SITE

PARAMETER	ELEVATION (ft, NGVD)
Control Elevation[1]	14.32
Measured Minimum Water Stage	12.85
Measured Maximum Water Stage	16.87
Mean Water Level	14.45
Design Peak Stage	18.37

1. Invert elevation of the 6-inch PVC bleed down pipe

3.1.3 Fluctuations in Groundwater Piezometric Elevations

A complete listing of groundwater piezometric elevations measured at the Basin 7 project site from May-December 2002 is given in Appendix B for each of the four shallow monitoring wells. A graphical summary of piezometric elevations measured in the four shallow monitoring wells is given in Figure 3-3. Measured piezometric elevations within the pond are also included on Figure 3-3 for comparison purposes, based upon pond piezometric elevations at the time of measurements performed in the monitoring wells.

In general, groundwater piezometric elevations on the north, south, and east sides of the wet detention pond appear to be approximately equal to or less than the water surface water level within the pond throughout the majority of the monitoring period. However, groundwater piezometric elevations measured in MW-2, located on the west side of the pond, were greater than pond surface elevations on each of the weekly monitoring events. Differences in piezometric elevations between MW-2 and the pond surface range from approximately 0.3-0.8 ft.

Based upon the relationships presented in Figure 3-3, water from the pond appears to discharge to shallow groundwater on the north, south, and east sides of the pond. However, along

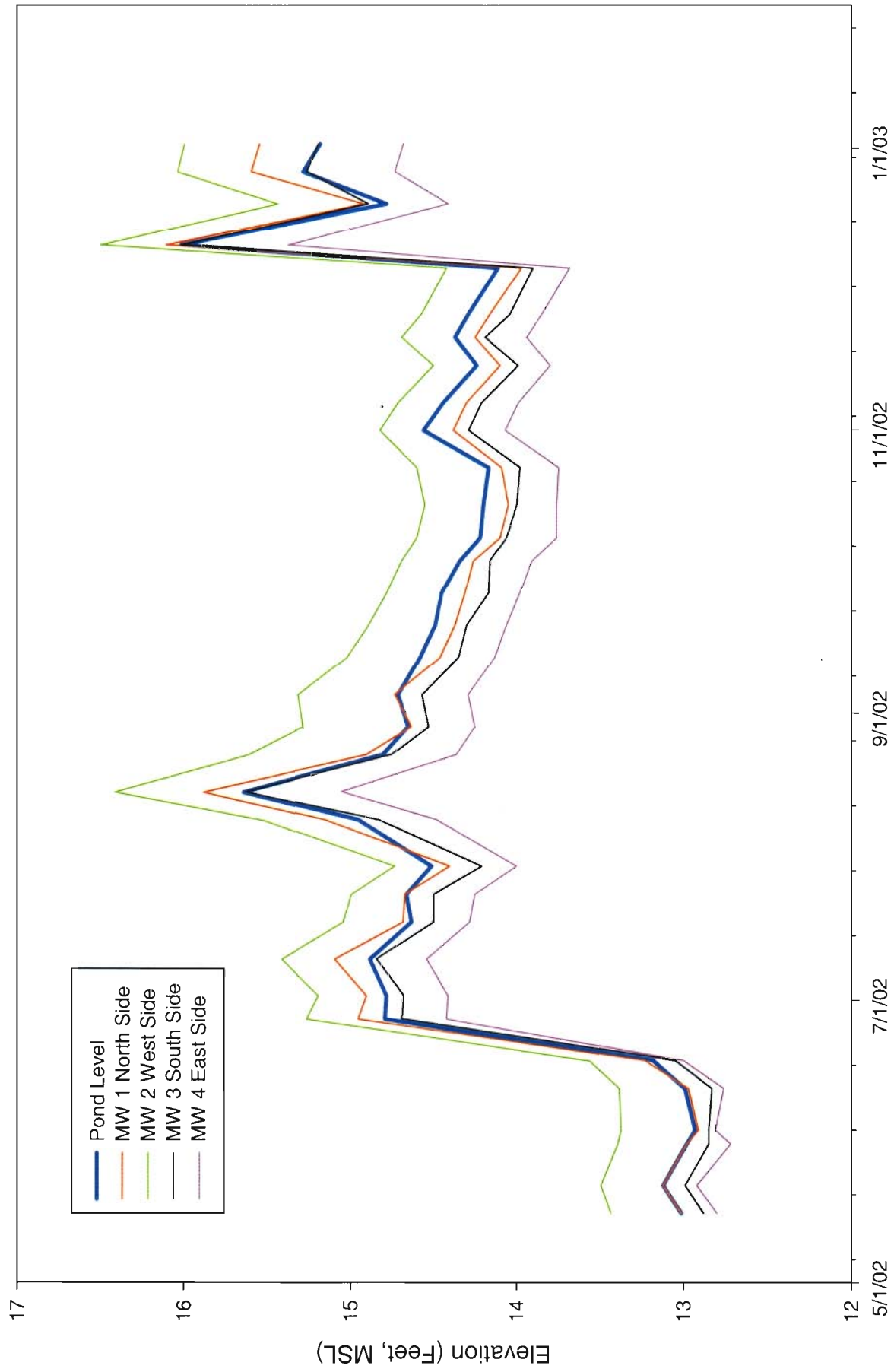


Figure 3-3. Fluctuations in piezometric elevations in shallow monitoring wells at the Basin 7 site.

the west side of the pond, it appears that shallow groundwater may be entering the pond on a continuous basis. However, the low permeability of the fine-grained soils present at the pond site probably limits the ability of water to move either into or out of the detention pond by groundwater.

3.1.4 Estimates of Pond Evaporation

As discussed in Section 2.2.4, a Class A pan evaporimeter was installed on a level wooden platform adjacent to the outfall structure of the pond. Evaporation measurements were recorded at approximately one week intervals and corrected for rainfall occurring during the monitoring interval. A complete listing of evaporation measurements performed at the Basin 7 site is given in Appendix C. Mean daily evaporative losses measured at the Basin 7 project site from May-December 2002 are summarized in Figure 3-4. Total daily evaporative losses at the site range from a high of 0.70 cm/day in August to a low of 0.22 cm/day during November.

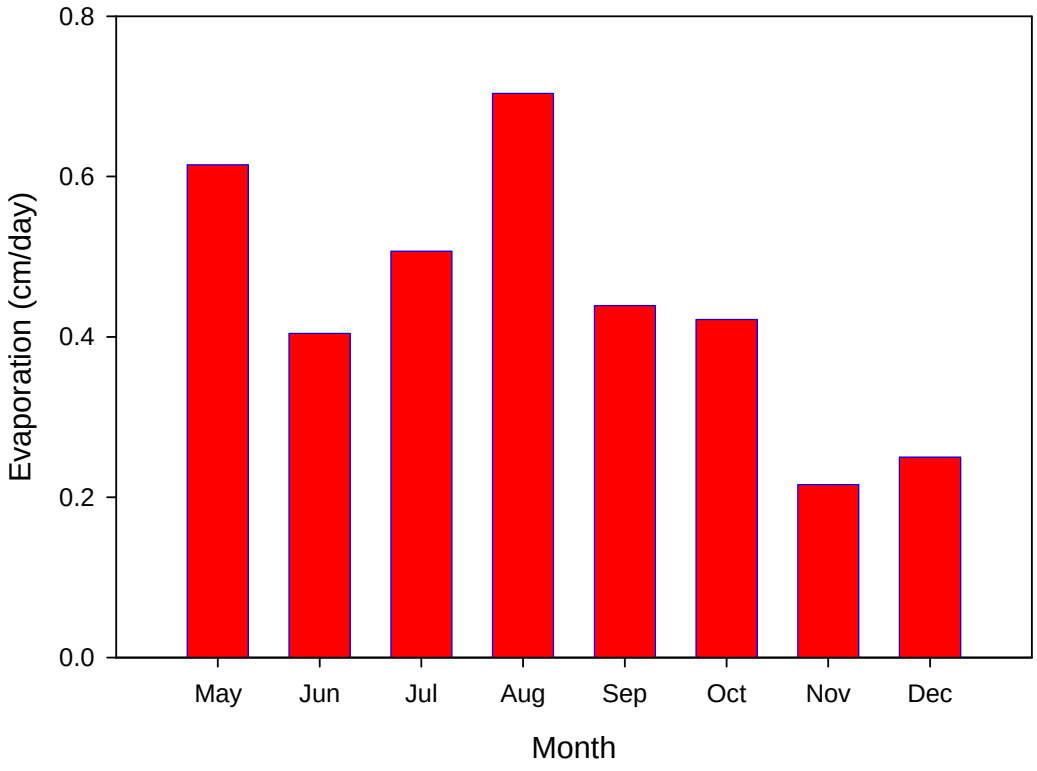


Figure 3-4. Mean Daily Evaporation Losses Measured at the Basin 7 Project Site from May-December 2002.

3.1.5 Estimates of Inputs and Losses from Rainfall and Evaporation

Estimates of hydrologic inputs and losses from direct precipitation and evaporation at the Basin 7 wet detention pond were calculated for the 8-month period from May-December 2002. Rain event characteristics were obtained from the summary of daily rainfall provided in Table 3-1. For each measured rain event, the total rainfall depth is multiplied by the wetted pond area to produce an estimate of the amount of water entering the pond as a result of rainfall for each rain event. Estimates of total rainfall from rain events are summed for each month to provide an estimate of total hydrologic inputs from rainfall into the pond on a monthly basis.

A regression was performed between pond water elevation and pond surface area so that the area at the time of an individual rain event could be estimated based upon the pond surface elevation at the start of the rain event. The following regression equation is utilized to estimate pond surface area (y) as a function of pond stage (x):

$$y = -15.461x^4 + 746.45x^3 - 12{,}310x^2 + 88{,}404x - 186{,}250 \qquad R^2=1.00$$

where:

y = pond surface area (ft2)

x = pond stage (ft, NGVD)

Estimates of water surface evaporation losses were also conducted on a daily basis. The average water surface elevation for each day is calculated, and the corresponding pond surface area is estimated using the regression equation. The evaporative loss for each day is then calculated based upon the mean daily evaporative losses for a given month, based upon the mean daily evaporation rates summarized in Figure 3-4, and the estimated pond surface area for the evaluated day. The total quantity of monthly evaporation loss is calculated by summing the daily evaporation losses for each month. Estimates of daily rainfall inputs and evaporative losses are summarized in Appendix D and are used in a subsequent section to perform a hydrologic budget for the pond.

3.1.6 Stormwater Inputs

Continuous inflow hydrographs were recorded at the Basin 7 wet detention pond at 10-minute intervals from May-December 2002. The continuous inflow hydrographs provided information on total daily volume and cumulative total volume for the period of record.

Estimated daily inputs from stormwater runoff entering the wet detention pond are summarized in Appendix D. No measurable dry weather baseflow was observed entering the pond during the monitoring program. In general, daily runoff inputs appear to be highly correlated with the daily rainfall measured at the pond site. Runoff inputs during each monthly monitoring period are summed to provide estimates of total runoff inputs for each month. This information is utilized in subsequent sections for preparation of a hydrologic budget for the pond and to estimate mass loadings into the pond from stormwater runoff. A summary of rainfall-runoff relationships at the Basin 7 wet detention pond from May-December 2002 is given in Table 3-4.

TABLE 3-4

SUMMARY OF RAINFALL-RUNOFF RELATIONSHIPS AT THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

MONTH	RAINFALL (inches)	RUNOFF (ft^3)	RUNOFFF COEFFICIENT (C Value)
May	1.56	11,669	0.029
June	7.70	188,232	0.094
July	4.12	157,596	0.147
August	7.58	775,792	0.394
September	1.44	53,626	0.143
October	2.72	66,587	0.094
November	0.98	7,542	0.030
December	9.62	488,313	0.196
TOTAL:	**35.72**	**1,749,358**	**0.189**

Calculated monthly runoff coefficients for the 71.5-acre basin area discharging to the wet detention pond are summarized in the final column of Table 3-4. These calculated coefficients (C values) represent the fraction of rainfall within the basin which entered the wet detention pond as stormwater runoff. Calculated runoff coefficients range from a low of 0.029 in May, indicating that only 2.9% of the rainfall within the basin actually reached the wet detention pond as stormwater runoff, to a high of 0.394 in August, indicating that 39.4% of the rainfall reached the wet detention pond in the form of stormwater runoff. The overall runoff coefficient for the basin during the 8-month monitoring program is 0.189.

3.1.7 Pond Outflow

Continuous hydrographs of outflow from the wet detention pond were collected using a Sigma sequential automatic sampler with integral flow recorder (Model 900 MAX) from May-December 2002. In addition to a complete hydrograph with measurements recorded at 10-minute intervals, these records also contain information on total daily volume and cumulative volume over the period of record. A complete listing of daily outflow discharges from the pond is given in Appendix D.

As indicated in Figure 3-2, discharge from the pond was discontinuous during portions of the monitoring period. No discharges from the pond were recorded from May through mid-June. Significant pond discharge began in mid- to late-June, and continued through mid-September. No significant discharge from the pond was recorded from mid-September until late-October when discharge was recorded for a period of approximately 10 days. Very little discharge from the pond was recorded during November-early December, when discharge from the pond began to occur on a relatively constant basis.

3.1.8 Monthly Hydrologic Budget

A monthly hydrologic budget for the wet detention pond site is given in Table 3-5. Direct inputs into the pond include stormwater runoff and rainfall. Monthly estimates of stormwater inputs from stormwater and direct rainfall are obtained from information provided in Appendix D.

Direct outputs from the pond include discharges through the outflow structure and losses due to evaporation. Losses from the pond due to discharges through the outflow structure are obtained by summing the daily outflow estimates from the pond over each of the monthly monitoring periods, based upon the information contained in Appendix D. Estimates of losses due to evaporation are also obtained from information provided in Appendix D.

TABLE 3-5

MONTHLY HYDROLOGIC BUDGET FOR THE BASIN 7 WET DETENTION POND

MONTH	INPUTS (ft^3)			CHANGE IN POND VOLUME (ft^3)	OUTPUTS (ft^3)		
	DIRECT RAINFALL	STORM-WATER	GROUND-WATER		OUTFLOW	EVAPOR-ATION	GROUND-WATER
May	10,584	11,669	0	-27,250	0	44,730	4,774
June	58,404	188,232	1,231	160,857	51,638	35,372	0
July	35,586	157,596	12,794	-27,289	180,502	52,762	0
August	69,168	775,792	35,157	17,056	785,056	78,005	0
September	12,036	53,626	12,908	-22,993	58,265	43,298	0
October	21,612	66,587	0	15,919	23,953	41,646	6,681
November	7,905	7,542	0	-37,954	671	20,768	31,962
December	85,119	488,313	17,362	-7,626	571,711	26,709	0
TOTAL:	**300,413**	**1,749,358**	**79,452**	**70,720**	**1,671,796**	**343,290**	**43,417**

Inputs or losses as a result of groundwater flow are calculated as the difference between hydraulic inputs and outputs according to the following relationship:

Net Groundwater Gain/Loss =

Rainfall + Stormwater - Outflow - Evaporation + Change in Pond Volume

The calculated groundwater values reflect net gains or losses resulting from all groundwater interactions over each monthly period.

Over the 8-month monitoring period, the dominant input into the pond is stormwater runoff which contributes 82% of the average inputs into the system. Direct rainfall on the pond surface contributes approximately 14% of the measured inputs, with groundwater inflow contributing approximately 4% on a net basis. Discharges through the outfall structure contribute 81% of the total losses from the pond, with 17% resulting from evaporation from the water surface, and 2% from groundwater losses. A graphical presentation of hydrologic inputs and losses at the wet detention pond site is given in Figure 3-5.

3.1.9 Estimation of Hydraulic Residence Time

An estimate of the average hydraulic residence time within the wet detention pond was performed by dividing the estimated mean pond volume of 14.27 ac-ft by the sum of the total monthly inputs summarized in Table 3-5. The net sum of the monthly hydrologic inputs is equal to 2,129,223 ft^3, or approximately 48.88 ac-ft. For purposes of this calculation, it is assumed that the hydrologic budget summarized in Table 3-5 covers a period of approximately 240 days.

Based upon this methodology, the mean residence time within the pond is approximately 70.1 days. Hydraulic residence time within the pond is regulated primarily by inputs of stormwater runoff and is directly related to the total rainfall occurring during a given period.

3.2 Chemical Characteristics of Monitored Inputs and Outputs

A summary of sample collection activities performed at the Basin 7 wet detention pond site from May-December 2002 is given in Table 3-6. A total of 21 separate stormwater inflow samples was collected at the pond during the 8-month monitoring program. Composite samples of outflow were conducted on a continuous basis, with 18 separate samples collected, representing a composite of sub-samples collected over a period ranging from approximately 1-11 days. Pond surface water was collected on approximately a weekly basis, with 35 separate samples collected over the 8-month monitoring period. In addition, a total of 32 separate shallow groundwater samples was also collected to document potential groundwater inputs into the pond. A complete listing of the results of laboratory analyses performed on stormwater runoff, pond outflow, surface water, and shallow groundwater is given in Appendix E.

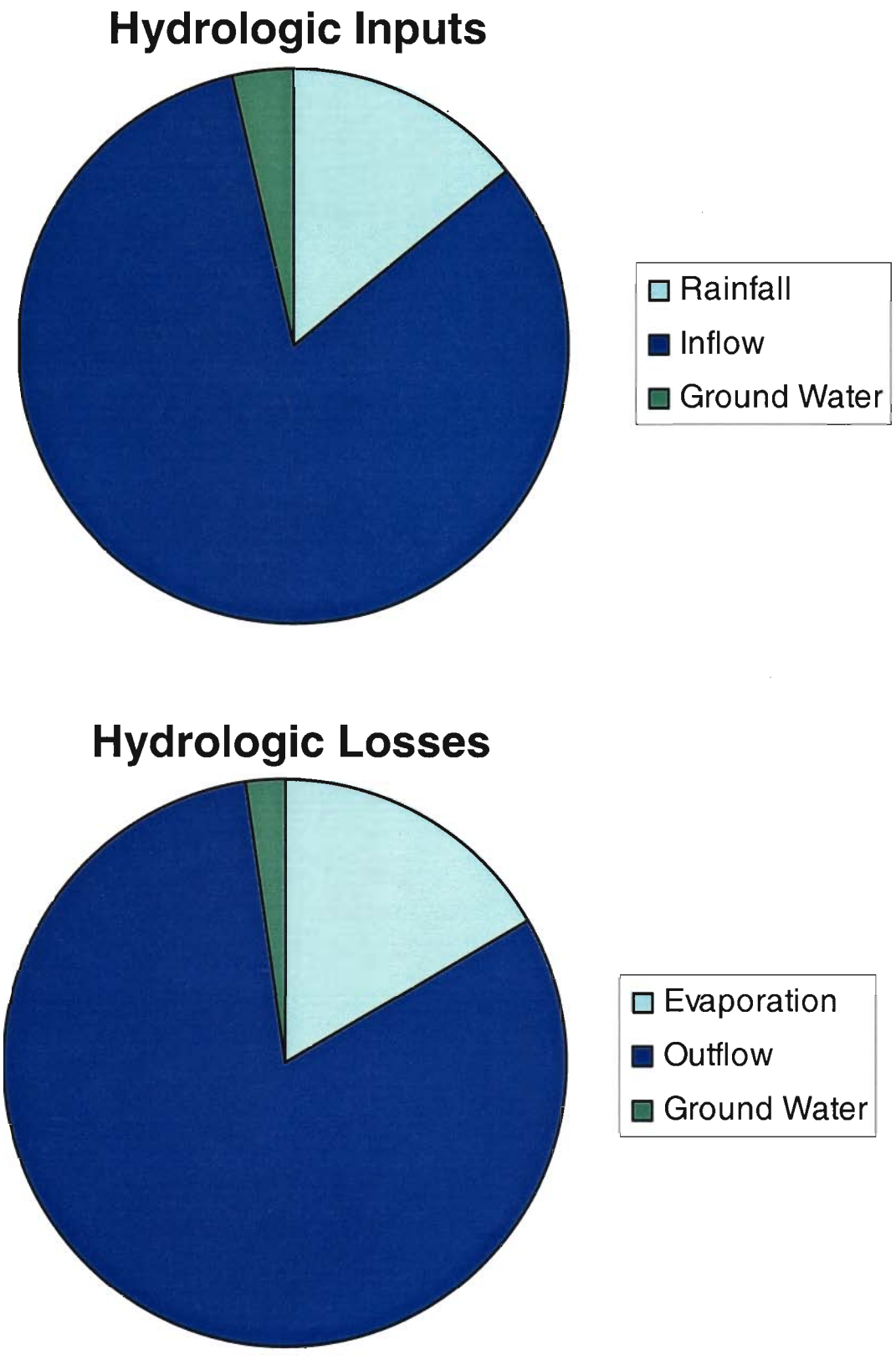


Figure 3-5. Comparison of Hydrologic Inputs and Losses at the Basin 7 Pond.

TABLE 3-6

SUMMARY OF SAMPLE COLLECTION PERFORMED AT THE BASIN 7 SITE

SAMPLE TYPE	NUMBER OF SAMPLES COLLECTED
Stormwater Runoff	21
Pond Outfall	18
Pond Surface	35
Shallow Groundwater	32

3.2.1 Stormwater Runoff

Stormwater runoff entering the Basin 7 wet detention pond was monitored over a wide range of rainfall characteristics, with total rainfall for monitored events ranging from 0.13-5.92 inches and antecedent dry period conditions ranging from 0.3-15.0 days. A complete listing of the chemical characteristics of the individual storm events measured at the Basin 7 site is given in Appendix E.1. Each of the values for stormwater runoff provided in these tables represents a flow-weighted event mean concentration (emc) for each monitored rain event.

A statistical summary of mean characteristics of stormwater runoff entering the Basin 7 wet detention pond from May-December 2002 is given in Table 3-7. Runoff inputs into the pond were found to be highly variable for several measured parameters, based upon the calculated coefficient of variation values (C.V.) for each parameter. The coefficient of variation is defined as the standard deviation expressed as a percentage of the mean. In general, C.V. values of approximately 100 or more are thought to reflect high degrees of variability, while values substantially less than 100 are thought to indicate relatively low degrees of variability. Based upon the calculated C.V. values for runoff inputs, a high degree of variability is apparent for ammonia, NO_x, dissolved orthophosphorus, and TSS.

TABLE 3-7

MEAN CHARACTERISTICS OF STORMWATER RUNOFF ENTERING THE BASIN 7 POND FROM MAY-DECEMBER 2002

PARAMETER	UNITS	RANGE OF VALUES		MEAN	C.V.
		MINIMUM	MAXIMUM		
pH	s.u.	7.18	8.21	7.65	3
Spec. Conductivity	µmho/cm	689	852	764	7
NH_3-N	µg/l	< 5	297	93	85
NO_x	µg/l	< 5	753	110	150
Organic N	µg/l	770	1701	1022	26
Total N	µg/l	858	1967	1225	23
Diss. Ortho-P	µg/l	1	52	19	82
Total P	µg/l	14	183	79	63
TSS	mg/l	2.2	38.4	9.8	98

In general, stormwater runoff measured at the Basin 7 site is approximately neutral in pH, with measured pH values ranging from 7.18-8.21, and an overall mean pH of 7.65. Specific conductivity in runoff inputs into the pond appear to be somewhat elevated, with an overall mean of only 764 µmho/cm. In general, TSS concentrations in stormwater runoff appear to be relatively low in value, with an overall mean of only 9.8 mg/l. This value is substantially lower than TSS concentrations commonly observed in urban runoff.

In general, runoff inputs entering the Basin 7 wet detention pond appear to be relatively dilute in chemical characteristics compared with runoff concentrations commonly observed in commercial and residential watersheds. The dominant nitrogen species in runoff inputs into the pond is organic nitrogen which comprises 83% of the total nitrogen measured. Mean concentrations of ammonia and NO_x are relatively similar in runoff inflow, together comprising only 17% of the total nitrogen inputs. The overall total nitrogen mean concentration of 1286 µg/l is approximately 50% less than concentrations typically observed in residential and commercial areas.

Similar to the trends observed for total nitrogen species, measured concentrations of phosphorus species in stormwater runoff entering the Basin 7 pond appear to be relatively dilute compared to values commonly observed in urban runoff. The mean total phosphorus concentration of 79 μg/l is approximately one-half to one-third of values commonly observed. Dissolved orthophosphorus, with a mean concentration of 19 μg/l, comprises only 24% of the total phosphorus measured.

The relatively dilute characteristics of stormwater constituents measured at the Basin 7 site is probably related to the large amount of swale drainage systems and overland flow present within sub-basin areas discharging to the detention pond. The swale and overland flow areas act as pre-treatment systems which reduce input concentrations of chemical constituents in the stormwater runoff.

3.2.2 Pond Outflow

Pond outflow was collected on a continuous basis at the Basin 7 wet detention pond over the 8-month monitoring program. In general, composite samples of pond outflow were collected on a flow-weighted basis over collection periods ranging from approximately 1-11 days. A complete listing of laboratory analyses performed on outflow samples collected at the wet detention pond is given in Appendix E.2. Each of the values presented in this appendix reflect flow-weighted emc values for each monitoring period.

Mean characteristics of outflow from the wet detention pond from May-December 2002 are summarized in Table 3-8. In general, characteristics of discharges from the wet detention pond appear to be substantially less variable than observed in runoff inputs into the pond.

Discharges from the Basin 7 detention pond were collected as composite samples with collection intervals ranging from 1-11 days. A total of 18 separate pond outflow samples was collected and analyzed during the 8-month monitoring period. A complete listing of chemical characteristics for each of the 18 monitored outflow events is given in Appendix E.2.

TABLE 3-8

MEAN CHARACTERISTICS OF OUTFLOW SAMPLES AT THE BASIN 7 POND FROM MAY-DECEMBER 2002

PARAMETER	UNITS	RANGE OF VALUES		MEAN	C.V.
		MINIMUM	MAXIMUM		
pH	s.u.	6.58	7.54	6.95	4
Spec. Conductivity	μmho/cm	489	853	701	15
NH_3-N	μg/l	< 5	148	63	66
NO_x	μg/l	< 5	92	26	107
Organic N	μg/l	616	1661	895	26
Total N	μg/l	680	1762	984	25
Diss. Ortho-P	μg/l	< 1	57	9	137
Total P	μg/l	16	103	45	57
TSS	mg/l	0.8	5.8	2.9	48

A summary of mean characteristics of outflow samples collected at the Basin 7 wet detention pond from May-December 2002 is given in Table 3-8. In general, discharges from the wet detention pond were found to be approximately neutral in pH, with an overall mean pH of 6.95 and measured values ranging from 6.58-7.54. Specific conductivity in discharges at the outflow are moderate to high in value, with an overall mean of 701 μmho/cm. Measured TSS concentrations in discharges from the pond were found to be relatively low in value, with an overall mean of only 2.9 mg/l.

A high degree of variability is apparent in measured concentrations of several nutrient species, including NO_x and dissolved orthophosphorus. On an average basis, measured concentrations of ammonia and NO_x in outflow from the pond are low in value, with mean concentrations of 63 μg/l and 26 μg/l, respectively. The dominant nitrogen species in discharges from the pond is organic nitrogen, which comprises approximately 91% of the total nitrogen

measured. The overall mean total nitrogen concentration of 984 μg/l is relatively low in value, particularly in comparison with concentrations measured in runoff inputs into the pond.

In general, measured phosphorus species in discharges from the pond appear to be relatively low in value. Although a high degree of variability is apparent for measured dissolved orthophosphorus concentrations, the overall mean value of 9 μg/l is relatively low, and substantially lower than the mean concentration measured in stormwater runoff. The mean total phosphorus concentration of 45 μg/l is also relatively low in value and substantially lower than the mean total phosphorus concentration measured in runoff inputs.

3.2.3 Pond Surface Water

Pond surface water was monitored on approximately a weekly basis from May-December 2002. Each monitoring event included measurements of field parameters, including pH, temperature, specific conductivity, dissolved oxygen, oxidation-reduction potential (ORP), and turbidity. Field measurements were performed at depths of 0.25 m and 0.5 m below the water surface, and at 0.5 m intervals until the pond bottom. A complete listing of field measurements performed in the wet detention pond from May-December 2002 is given in Appendix F.

A comparison of mean monthly vertical profiles of temperature, pH, dissolved oxygen, and specific conductivity measured in the wet detention pond is given in Figure 3-6. In general, temperature within the wet detention pond decreases slightly with increasing water depth. However, the decreases in temperature appear to be relatively uniform, and no evidence of classical thermal stratification is apparent in field profiles collected within the pond. Measured field pH values also appear to decrease steadily with increasing water column depth. Measured surface pH values within the pond range from approximately 7.2-7.7, with bottom pH measurements ranging from approximately 6.7-7.3.

A general trend of increasing specific conductivity with increasing water depth is also apparent within the wet detention pond. This increase in specific conductivity may be due to either internal recycling of nutrients from the bottom sediments under reduced conditions or it may reflect

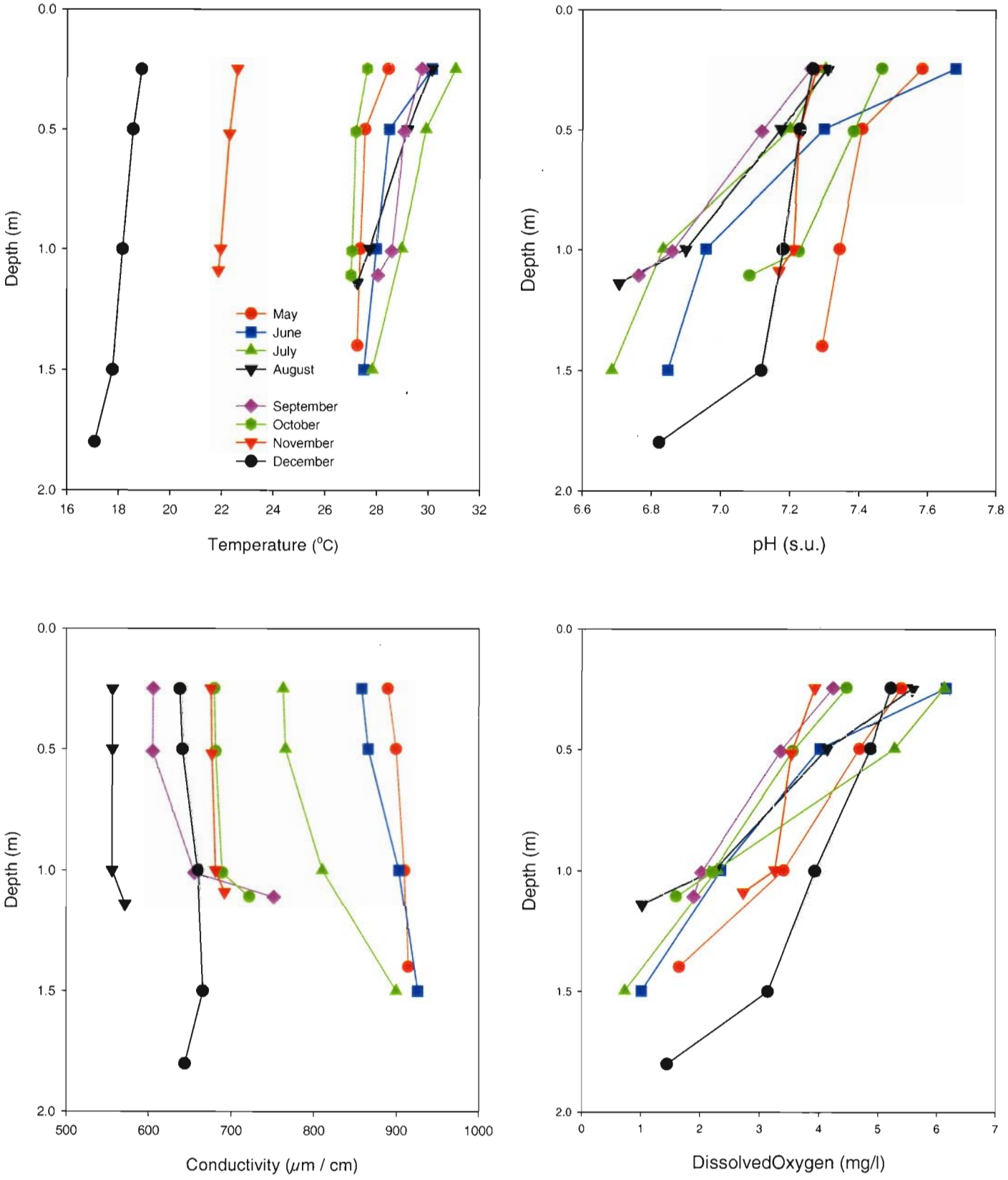


Figure 3-6. Mean Monthly Vertical Profiles in the Basin 7 Wet Detention Pond.

inputs of high ionic strength groundwater in the vicinity of the surface water monitoring location. The site selected for surface water monitoring within the wet detention pond is adjacent to the west side of the wet detention pond, where groundwater inflow is thought to occur into the pond.

In general, dissolved oxygen concentrations appear to decrease rapidly with increasing water depth within the pond. Surface concentrations are typically low in value, ranging from approximately 3.5-6 mg/l. Approximately five of the eight surface water monitoring events exhibited surface dissolved oxygen concentrations less than the Class III surface water criterion of 5 mg/l. Dissolved oxygen concentrations near the pond bottom range from approximately 1-2 mg/l on a majority of the monitoring dates. Based upon measured ORP values, the water column in this portion of the pond appears to exhibit reduced conditions during the majority of the monitoring events.

A summary of mean physical and chemical characteristics of surface water within the Basin 7 pond from May-December 2002 is given in Table 3-9. Based upon the calculated C.V. values, only a few parameters appear to exhibit significant variability in measured concentrations between the weekly monitoring events. A relatively high degree of variability appears to exist for measured concentrations of ammonia, NO_x, and orthophosphorus. Variability in the remaining parameters appears to be relatively low.

In general, surface water within the wet detention pond is approximately neutral in pH, with mean measured pH values ranging from 6.59-7.68. The pond also exhibits a relatively high specific conductivity, with values ranging from 512-1071 μmho/cm, and an overall mean of 731 μmho/cm. Dissolved oxygen concentrations within the pond are typically low, with a majority of the measured values less than the Class III surface water criterion of 5 mg/l. Dissolved oxygen saturation is also low within the pond, ranging from 7-55% with an overall mean of only 33%. However, in spite of the relatively low dissolved oxygen concentrations within the pond observed on certain occasions, the main waterbody of the pond appears to exhibit oxidized conditions most of the time.

TABLE 3-9

MEAN CHARACTERISTICS OF SURFACE WATER ENTERING THE BASIN 7 POND FROM MAY-DECEMBER 2002

PARAMETER	UNITS	RANGE OF VALUES		MEAN	C.V.
		MINIMUM	MAXIMUM		
pH	s.u.	6.59	7.68	7.06	4
Temperature	°C	16.24	30.54	25.71	16
Spec. Conductivity	µmho/cm	512	1071	731	18
TDS	mg/l	< 1	685	456	25
Diss. Oxygen	mg/l	0.5	5.1	2.7	42
D.O. Saturation	%	7	55	33	38
ORP	mV	186	661	512	17
Alkalinity	mg/l	1.7	6.5	3.3	31
NH_3-N	µg/l	< 5	270	62	86
NO_x	µg/l	< 5	96	16	115
Organic N	µg/l	652	1810	996	27
Total N	µg/l	703	1919	1075	25
Diss. Ortho-P	µg/l	< 1	71	9	164
Total P	µg/l	18	161	50	70
TSS	mg/l	1.4	7.6	3.3	46

Measured nitrogen species within the pond appear to be relatively low in value, particularly for inorganic nitrogen species of ammonia and NO_x. The dominant nitrogen species within the pond is organic nitrogen which comprises approximately 93% of the total nitrogen measured, with ammonia and NO_x together comprising the remaining 7%. The overall mean total nitrogen concentration of 1075 µg/l in the pond is approximately 16% lower than the mean total nitrogen concentration measured in stormwater runoff.

Measured phosphorus concentrations within the pond also appear to be relatively low in value. Orthophosphorus concentrations comprise only 18% of the total phosphorus within the pond. The overall total phosphorus mean concentration of 50 μg/l is approximately 40% lower than the mean inflow concentration observed in stormwater runoff. Measured TSS concentrations are also substantially lower in the surface water, as well as lower in variability, compared with characteristics of stormwater inputs.

A statistical comparison of nitrogen species in stormwater, surface water, and pond outflow at the Basin 7 wet detention pond is given in Figure 3-7. In general, surface water and pond outflow appear to exhibit lower measured concentrations, as well as a lower degree of variability in measured concentrations, compared with values measured in stormwater runoff. This trend is particularly apparent for ammonia, NO_x, and total nitrogen.

A statistical comparison of phosphorus species and TSS in stormwater, surface water, and pond outflow at the Basin 7 wet detention pond is provided in Figure 3-8. Similar to the trends observed for nitrogen species, species of orthophosphorus and TSS appear to be lower in concentration and substantially less variable in surface water and outflow samples, compared with characteristics measured in stormwater runoff. The lower variability observed for nutrients and TSS is a function of removal and attenuation processes for pollutants which occur within the wet detention pond.

3.2.4 Characteristics of Shallow Groundwater

Groundwater samples were collected from four shallow groundwater piezometers at the Basin 7 wet detention pond site on a monthly basis from May-December 2002. A total of eight separate groundwater samples was collected from each of the four monitoring well locations. Specific locations for each of the monitoring wells are indicated on Figure 2-2. A complete listing of the chemical characteristics of shallow groundwater samples measured on each of the separate monitoring dates is given in Appendix E.4. All shallow groundwater samples were field-filtered using a 0.45 micron groundwater filter, and laboratory analyses presented in Appendix E.4

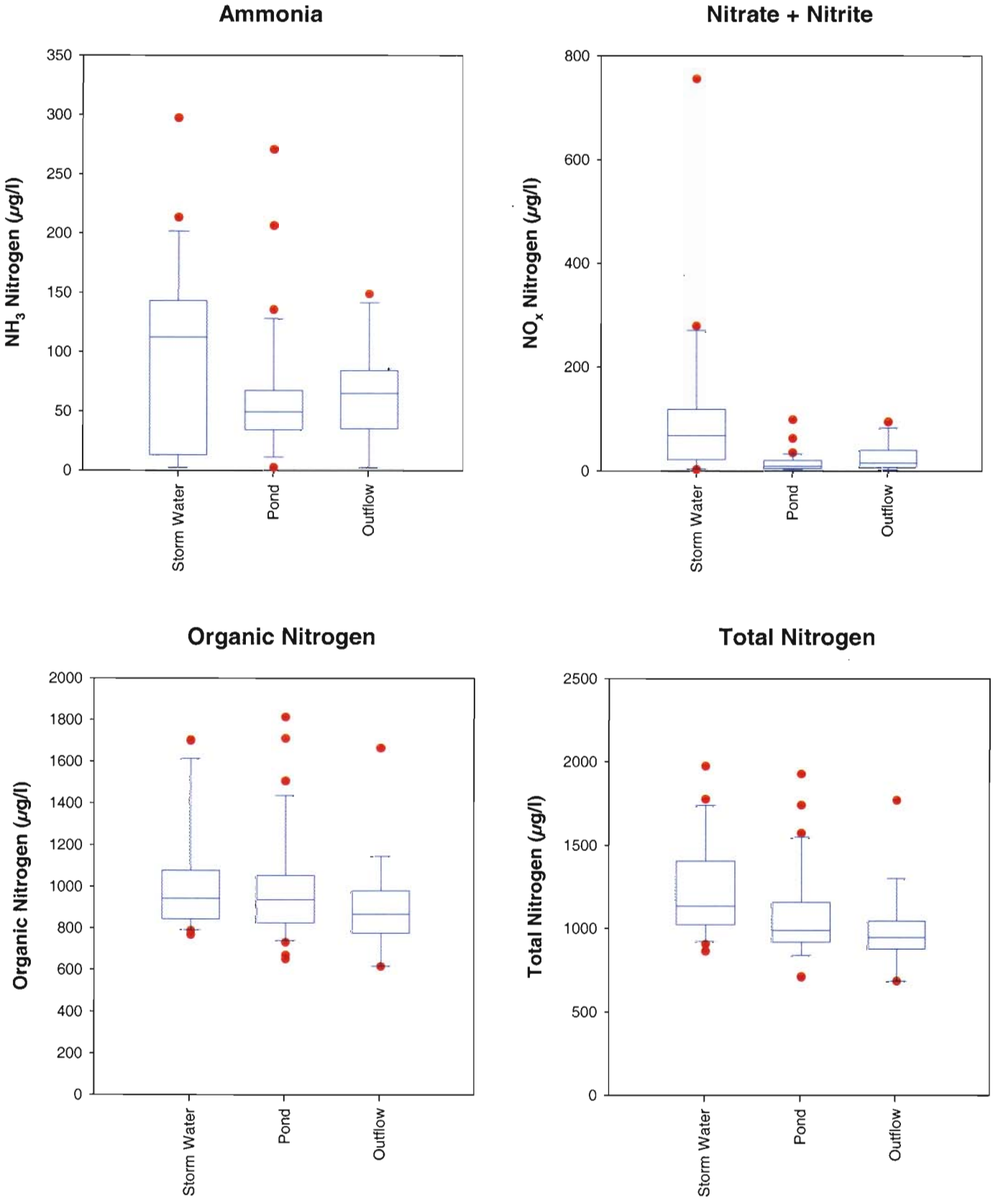


Figure 3-7. Statistical Comparison of Characteristics of Nitrogen Species in Stormwater, Surface Water, and Pond Outflow at the Basin 7 Wet Detention Pond.

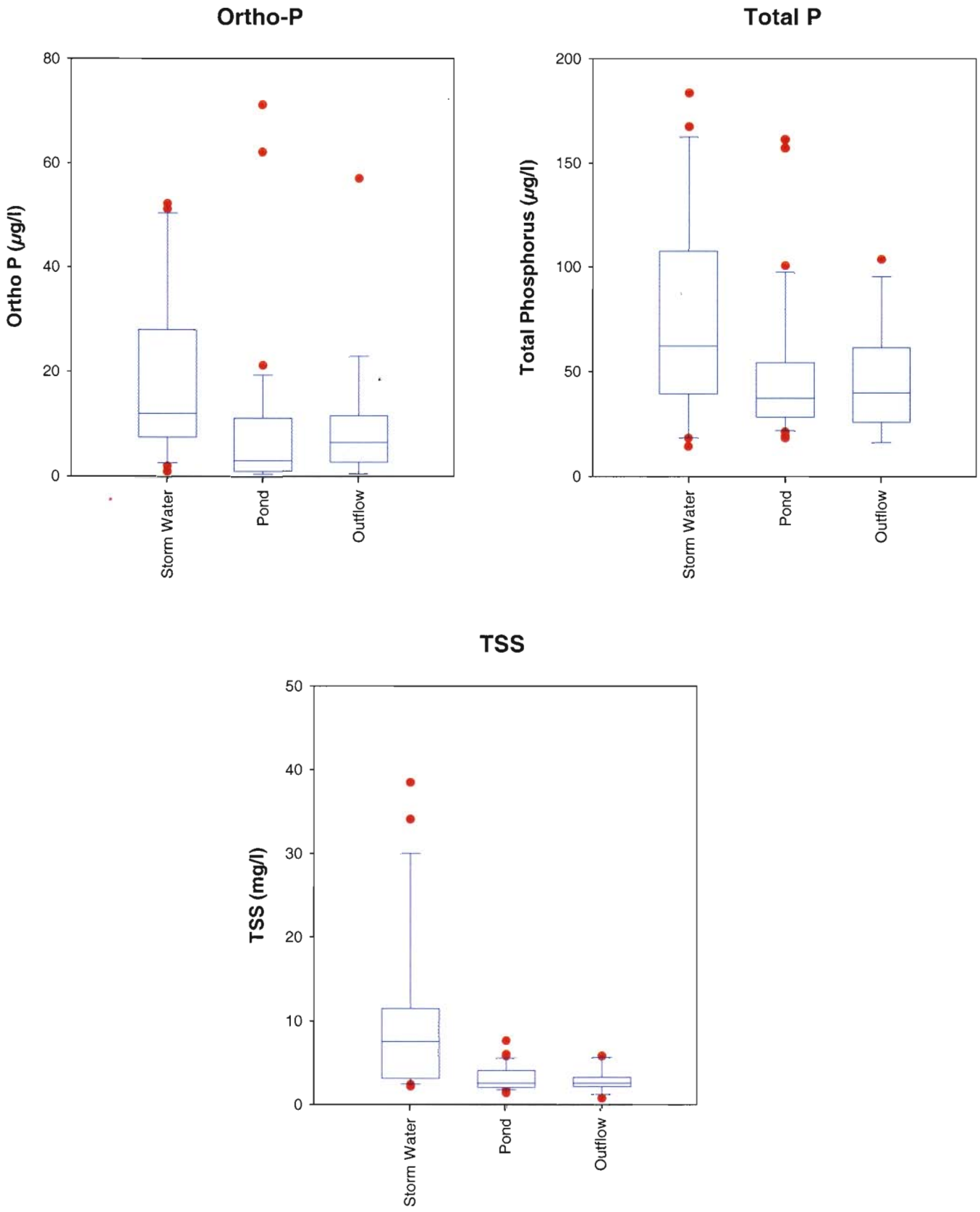


Figure 3-8. Statistical Comparison of Characteristics of Phosphorus and TSS in Stormwater, Surface Water, and Pond Outflow at the Basin 7 Wet Detention Pond.

represent the results of field-filtered samples, with the exception of TSS, which was performed on a separate unfiltered sample.

A comparison of mean characteristics of shallow groundwater samples collected at the four monitoring locations is given in Table 3-10. In general, groundwater measured at the site appears to be slightly acidic, with mean pH values ranging from 4.99-6.51 between the four monitoring sites. Groundwater samples are also characterized by moderately elevated specific conductivity values which range from 408-782 μmho/cm between the four sites. Groundwater collected from the monitoring wells is also low in dissolved oxygen, with reduced conditions observed at each of the four sites, based upon measured oxidation-reduction potential (ORP) values. Measured ORP values at the four sites range from 97-146 mV. In general, measured ORP values less than 200 mV indicate a reduced environment, while ORPs in excess of 200 mV typically indicate oxidized conditions.

In general, measured concentrations of nutrient species appear to be highly variable between the four monitoring sites. Extremely elevated levels of ammonia were observed in MW-1, with a mean concentration of 1783 μg/l. This site is also characterized by elevated concentrations of dissolved organic nitrogen and an elevated total nitrogen concentration of 3955 μg/l. Soil profiles at this site encountered during installation of the monitoring well indicate highly organic hydric soils, possibly from a wetland area which previously existed in this location. Hydric soils are often characterized by elevated concentrations of both ammonia and organic nitrogen.

Substantially lower concentrations of nitrogen species were observed at the remaining monitoring well sites, with relatively low levels of ammonia. The dominant nitrogen species in each of the monitoring wells is dissolved organic nitrogen which comprises 55-82% of the nitrogen measured at each site. Measured NO_x concentrations are extremely low in value at each of the four monitoring sites. The lowest concentrations of measured nitrogen species are present in MW-2 which is used to estimate the chemical characteristics of groundwater inflow into the pond.

Similar to the trends observed for nitrogen species, a high degree of variability is also apparent in measured phosphorus species at the four monitoring well sites. Measured total

phosphorus concentrations range from a low of 24 µg/l at MW-1 to a high of 265 µg/l at MW-3. Dissolved orthophosphorus is the dominant phosphorus species present in the shallow groundwater, comprising 77-92% of the total phosphorus measured at each of the four sites.

TABLE 3-10

MEAN CHARACTERISTICS OF SHALLOW GROUNDWATER SAMPLES COLLECTED AT THE BASIN 7 POND FROM MAY-DECEMBER 2002

PARAMETER	UNITS	MEAN CHARACTERISTICS			
		MW-1	MW-2	MW-3	MW-4
pH	s.u.	4.99	5.87	5.54	6.51
Temperature	°C	26.54	25.89	25.55	25.88
Spec. Conductivity	µmho/cm	687	782	408	712
TDS	mg/l	440	500	261	456
Diss. Oxygen	mg/l	1.9	1.6	2.2	2.2
D.O. Saturation	%	24	19	27	27
ORP	mV	100	124	146	97
NH_3-N	µg/l	1783	159	326	367
NO_x	µg/l	13	16	63	10
Organic N	µg/l	2160	795	1116	640
Total N	µg/l	3955	971	1505	1017
Diss. Ortho-P	µg/l	22	156	228	60
Total P	µg/l	24	202	265	71
TSS[1]	mg/l	14.4	62.1	169	126

1. Unfiltered samples

3.3 Performance Efficiency

Performance efficiency of the Basin 7 wet detention pond was calculated on both a mass removal and concentration basis over the monitoring period from May-December 2002. Evaluation of concentration-based efficiencies are often useful in examining pollutant attenuation mechanisms since concentration-based efficiencies are independent of mass changes resulting from hydrologic losses which may occur within the system. The results of these analyses are discussed in the following sections.

3.3.1 Concentration-Based Efficiency

An estimate was prepared of the mean flow-weighted concentration of inflow entering the Basin 7 wet detention pond from the combined inputs of stormwater runoff, groundwater seepage, and bulk precipitation. Weighted concentrations were developed for runoff inputs during the monitoring period based upon the mean runoff characteristics measured during each month of the monitoring program and the total estimated runoff volume entering the pond during each monthly period, based upon the hydrologic balance presented in Appendix D. An overall weighted runoff inflow concentration is then calculated based on the mean monthly chemical characteristics of runoff inputs and the measured monthly runoff inflow volumes.

A weighted inflow concentration was also calculated for groundwater inputs into the pond based upon the assumption that groundwater inflow is similar in chemical characteristics to groundwater measured at MW-2. This assumption appears reasonable since this is the only monitoring location which exhibited a positive piezometric gradient into the pond throughout the monitoring period.

Chemical characteristics of bulk precipitation inputs into the pond were also estimated based upon a combination of bulk precipitation data collected within the Indian River Lagoon (IRL) by SJRWMD and previous research projects performed by ERD which characterize bulk precipitation in the Central and South Florida areas. Bulk precipitation characteristics (concentration basis) for orthophosphorus, total phosphorus, NO_x, NH_3, and TKN were provided

by SJRWMD based on atmospheric deposition data collected in the IRL at Coconut Point south of Sebastian (site No. IRLATMIRL141) from May-September 2002 and November-December 2002.

Bulk precipitation characteristics for TSS were obtained from previous ERD research. During 1992-1993, ERD performed a detailed evaluation of a wet detention with filtration system, located in DeBary, Florida, for the SJRWMD. As part of this evaluation, continuous collection of bulk precipitation was performed on a weekly basis for approximately six months. A total of 17 separate bulk precipitation samples were collected and analyzed.

A summary of mean monthly atmospheric deposition data measured at the IRL and Debary monitoring sites is given in Table 3-11. The concentration values listed in this table are assumed to be reflective of atmospheric deposition at the Basin 7 detention pond site during the 8-month monitoring program.

After overall weighted concentrations were calculated for each of the inputs into the pond system, an overall combined inflow concentration was calculated by utilizing the weighted chemical characteristics for each input and the relative volume of flow estimated for each hydrologic input into the pond. This process resulted in an estimate of the weighted combined inflow characteristics into the pond for use in comparing concentration changes during migration through the system.

Weighted concentrations were also calculated for discharges from the pond system based upon mean monthly chemical characteristics of pond outflow and the measured pond discharge volume for each month of the monitoring program. Concentrations of calculated losses to shallow groundwater are assumed to have chemical characteristics similar to the mean monthly pond surface water characteristics, with volumetric discharges based on the hydrologic budget presented in Table 3-5. An overall flow-weighted discharge concentration was also calculated for each parameter over the monitoring period. The results of this analysis, along with estimates of the combined input concentrations into the pond, are summarized in Table 3-12.

TABLE 3-11

ASSUMED BULK PRECIPITATION CHARACTERISTICS AT THE BASIN 7 WET DETENTION POND SITE FROM MAY-DECEMBER 2002

MONTH	MONTHLY 2002 AVERAGES[1]						TSS[2] (mg/l)
	NO_x (µg/l)	NH_3 (µg/l)	Organic N (µg/l)	Total N (µg/l)	Ortho-P (µg/l)	Total P (µg/l)	
5	156	120	63	339	6	6	6.2
6	118	59	183	359	6	6	6.2
7	84	27	35	146	6	6	6.2
8	207	106	30	344	6	6	6.2
9	191	61	22	274	6	6	6.2
10	145	44	88	277	6	6	6.2
11	100	51	41	192	6	6	6.2
12	35	28	42	105	6	6	6.2
Mean	**125**	**61**	**51**	**237**	**6**	**6**	**6.2**

1. Mean monthly values reported as part of the Indian River Lagoon Atmospheric Deposition Monitoring Program during May-September 2002 and November-December 2002 at Coconut Point south of Sebastian (IRLATMIRL141). The listed values for October are from October 2001.

2. Harper, H.H. and Herr, J.L. (1993). "Treatment Efficiencies of Detention with Filtration Systems." Final Report to the St. Johns River Water Management District for Project No. 90B103, August 1993.

A summary of estimated concentration-based removal efficiencies for combined inputs and outputs at the Basin 7 wet detention pond from May-December 2002 is given in Table 3-13. Relatively good concentration-based reductions are achieved for each of the measured nutrient species and TSS. Nutrient reductions of approximately 37% are achieved for ammonia, with an 85% reduction in concentrations of NO_x, 22% reduction for organic nitrogen, and 30% reduction in total nitrogen concentrations. Orthophosphorus concentrations are reduced by approximately 66%, with total phosphorus reduced by 53%, and TSS reduced by 75%.

TABLE 3-12

SUMMARY OF FLOW-WEIGHTED CONCENTRATIONS OF INFLOW AND OUTFLOW AT THE BASIN 7 DETENTION POND

A. Combined Inflow[1]

MONTH	VOLUME (ft^3)	FLOW-WEIGHTED CONCENTRATION						
		NH_3 (µg/l)	NO_x (µg/l)	Org. N (µg/l)	Total N (µg/l)	Ortho-P (µg/l)	Total P (µg/l)	TSS (mg/l)
May	22,254	106	132	566	803	13	44	8.1
June	247,867	50	600	643	1,293	10	85	9.7
July	205,975	66	98	740	905	11	42	6.0
August	880,116	68	62	1,117	1,247	36	93	6.5
September	78,571	100	153	1,040	1,294	53	126	8.1
October	88,199	123	129	802	1,054	26	53	4.8
November	15,447	85	70	520	674	6	30	14.3
December	590,794	74	34	769	877	22	81	11.2
Overall:	**2,172,640**	**71**	**127**	**903**	**1,101**	**27**	**83**	**8.2**

B. Pond Outflow

MONTH	VOLUME (ft^3)	FLOW-WEIGHTED CONCENTRATION						
		NH_3 (µg/l)	NO_x (µg/l)	Org. N (µg/l)	Total N (µg/l)	Ortho-P (µg/l)	Total P (µg/l)	TSS (mg/l)
May	0	--	--	--	--	--	--	--
June	51,638	55	18	662	734	3	28	3.0
July	180,502	81	13	859	952	5	31	2.8
August	785,056	79	29	898	1,006	17	49	1.9
September	58,265	90	57	960	1,106	8	62	3.7
October	23,953	81	20	1,661	1,762	3	33	5.6
November	671	63	26	895	984	9	45	2.9
December	571,711	8	19	805	832	13	56	2.8
Overall:	**1,671,796**	**44**	**19**	**702**	**766**	**11**	**39**	**2.0**

1. Represents combined inputs from runoff, groundwater seepage, and bulk precipitation

TABLE 3-13

ESTIMATED CONCENTRATION-BASED REMOVAL EFFICIENCIES FOR COMBINED INPUTS AND OUTPUTS AT THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

PARAMETER	CHANGE IN CONCENTRATION BETWEEN INFLOW AND OUTFLOW (%)
NH_3	-37
NO_x	-85
Organic N	-22
Total N	-30
Ortho-P	-66
Total P	-53
TSS	-75

3.3.2 Mass Removal Efficiencies

Estimates of mass loadings entering the Basin 7 wet detention pond were calculated for each of the inputs discussed in the previous sections by multiplying the weighted average concentrations for measured parameters over each monthly period times the estimated flow volume associated with the particular input for the evaluated month. Estimates of mass loading inputs were calculated for stormwater runoff, bulk precipitation, and groundwater inflow. A summary of estimated mass loadings entering the Basin 7 wet detention pond from each of the evaluated inputs is given in Appendix G. The estimated mass loadings summarized in Appendix G for the individual inputs are summed together to provide an overall estimate of mass loadings entering the Basin 7 pond from all combined sources through each month of the monitoring program. A summary of the overall mass inputs is given in Table 3-14.

Estimates of the total mass loadings discharging from the outflow were calculated by multiplying the mean monthly pond outfall concentration times the measured pond discharge for each monthly period. The resulting mass discharges from the pond are also summarized in Table

TABLE 3-14

SUMMARY OF OVERALL MASS LOADINGS IN INPUTS AND LOSSES FROM THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

A. Total Inputs[1]

MONTH	MASS LOADING (kg)						
	NH_3	NO_x	Org. N	Total N	Ortho-P	Total P	TSS
May	0.07	0.08	0.36	0.51	0.01	0.03	5.1
June	0.35	4.20	4.51	9.06	0.07	0.60	67.8
July	0.39	0.57	4.31	5.27	0.07	0.25	35.0
August	1.68	1.54	27.8	31.0	0.91	2.31	162
September	0.22	0.34	2.31	2.87	0.12	0.28	18.1
October	0.31	0.32	2.00	2.63	0.06	0.13	12.0
November	0.04	0.03	0.23	0.29	0.01	0.01	6.3
December	1.24	0.57	12.8	14.6	0.37	1.36	186
Total:	**4.29**	**7.66**	**54.4**	**66.3**	**1.61**	**4.97**	**492**

B. Total Losses[2]

MONTH	MASS LOADING (kg)						
	NH_3	NO_x	Org. N	Total N	Ortho-P	Total P	TSS
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June	0.08	0.03	0.97	1.07	0.00	0.04	4.38
July	0.41	0.06	4.38	4.86	0.03	0.16	14.2
August	1.76	0.65	19.9	22.3	0.38	1.09	42.7
September	0.15	0.09	1.58	1.82	0.01	0.10	6.10
October	0.05	0.01	1.12	1.19	0.00	0.02	3.79
November	0.00	0.00	0.02	0.02	0.00	0.00	0.06
December	0.14	0.30	13.0	13.4	0.20	0.90	45.7
Total:	**2.59**	**1.14**	**41.0**	**44.7**	**0.63**	**2.31**	**117**

1. Includes combined mass inputs from runoff, net groundwater inflow, and bulk precipitation
2. Includes mass losses through outfall structure only

3-14. These values represent the total mass discharging through the outfall structure only. Although mass is also lost to groundwater discharge during a few months, these mass losses are not included in the losses summarized in Table 3-14.

Estimated monthly mass removal efficiencies for the Basin 7 wet detention pond from May-December 2002 are summarized in Table 3-15, based upon the information provided in Table 3-14. The removal efficiencies presented in Table 3-15 reflect the change in mass from the combined inflows to the surface outflow of the pond system.

TABLE 3-15

ESTIMATED MONTHLY MASS REMOVAL EFFICIENCIES FOR THE BASIN 7 WET DETENTION POND FROM MAY-DECEMBER 2002

MONTH	PERCENT REMOVAL (%)						
	NH_3	NO_x	Org. N	Total N	Ortho-P	Total P	TSS
May[1]	100	100	100	100	100	100	100
June	77	99	79	88	95	93	94
July	-7	89	-2	8	61	37	60
August	-4	58	28	28	58	53	74
September	34	73	32	37	89	64	66
October	82	96	44	55	97	83	68
November	97	98	93	94	93	93	99
December	89	47	-1	8	46	34	75

1. Mass removal is assigned as 100% since no water left the pond during this month

Monthly mass removal efficiencies for ammonia within the pond system are highly variable throughout the monitoring period. Calculated mass removal efficiencies range from -7% during July to 100% during May, when no outfall discharges occurred from the pond. Good monthly

removal efficiencies are achieved for NO_x within the pond, with monthly removal efficiencies ranging from 73-100%. A high degree of variability is also apparent in monthly mass removal efficiencies for both organic nitrogen and total nitrogen, although net mass retention was observed for total nitrogen during each month of the monitoring program.

Mass retention of phosphorus species within the Basin 7 wet detention pond appears to exhibit substantially less variability than observed for many of the nitrogen species. Monthly mass retention of orthophosphorus ranges from 46-100%, with mass retention of total phosphorus ranging from 34-100%. Mass retention of TSS within the system is relatively consistent throughout the monitoring program, with monthly removal efficiencies ranging from 60-100%.

Calculated overall mass removal efficiencies for the Basin 7 wet detention pond over the 8-month monitoring program are summarized in Table 3-16. The overall efficiency of the pond is calculated as:

$$Removal\ \ Efficiency\ (\%) = \left(\frac{Total\ \ Mass\ \ Inputs\ -\ Mass\ \ Discharges\ \ Through\ \ Outfall}{Total\ \ Mass\ \ Inputs} \right) x\ 100$$

Total mass inputs and losses from surface water discharges for the wet detention pond are provided in Table 3-16 for each of the evaluated parameters. Calculated removal efficiencies are presented in the final column of Table 3-16. Removal of nitrogen species within the detention pond appears to be somewhat variable, with a 40% removal efficiency for NH_3, 85% removal for NO_x, 25% removal for organic nitrogen, and 33% mass removal efficiency for total nitrogen. Mass removal efficiencies for phosphorus species appear to be more consistent, with a 61% removal for orthophosphorus and a 54% removal for total phosphorus. On an overall basis, approximately 76% of the total inputs of TSS were retained within the system.

TABLE 3-16

OVERALL MASS REMOVAL EFFICIENCIES FOR THE BASIN 7 WET DETENTION POND

PARAMETER	MASS INPUTS[1] (kg)	OUTFALL LOSSES[2] (kg)	REMOVAL EFFICIENCY
NH_3	4.29	2.59	40
NO_x	7.66	1.14	85
Organic N	54.4	41.0	25
Total N	66.3	44.7	33
Ortho-P	1.61	0.63	61
Total P	4.97	2.31	54
TSS	492	117	76

1. Includes combined mass inputs from runoff, net groundwater inflow, and bulk precipitation
2. Includes mass losses through outfall structure only

The removal efficiencies summarized in Table 3-16 for the Basin 7 wet detention pond are similar to values typically observed in wet detention systems within the State of Florida. Based upon a literature review performed by Harper (1995), wet detention systems in the State of Florida typically achieve removal efficiencies of approximately 26% for total nitrogen, 65% for total phosphorus, and 75% for TSS.

3.4 Impacts of Basin 7 Wet Detention Pond on Loadings to Turkey Creek

The Basin 7 watershed covers approximately 110 acres of residential and commercial areas which have historically discharged untreated stormwater runoff directly into Turkey Creek. As a result of construction of the Palm Bay Basin 7 wet detention pond, which provides treatment for 71.5 acres of the basin, a substantial portion of the historical loadings to Turkey Creek from Basin 7 have been removed.

Estimates of the reductions in mass loadings to Turkey Creek are calculated based upon the summary of inflow and outflow loadings at the Basin 7 wet detention pond presented in Table 3-14. Estimates of inputs into the wet detention pond, summarized in Table 3-14, are assumed to represent historical loadings to Turkey Creek in the absence of the wet detention pond. The outflow loadings summarized in Table 3-14 reflect estimates of mass loadings discharging to Turkey Creek following construction of the wet detention pond. The difference between the input and output loadings represents the reduction in mass loadings achieved as a result of this system.

A summary of estimated reductions in mass loadings to Turkey Creek as a result of the Basin 7 wet detention pond is given in Table 3-17, based upon the estimated mass inputs and losses for the wet detention pond summarized in Table 3-14. The estimated mass reductions obtained by subtracting mass losses from mass inputs represents the load reduction to Turkey Creek over the 240-day monitoring period for the Basin 7 project. This mass retention is extrapolated to an annual basis by multiplying the mass retention values obtained during the study period times the ratio of average rainfall which occurs at the Palm Bay site to rainfall measured during the monitoring program. For purposes of this analysis, it is assumed that a total of 35.72 inches of rainfall fell at the site during the 240-day monitoring program. Average annual rainfall at the Melbourne weather station for the period from 1948-2001 is approximately 48.69 inches per year.

A summary of estimated annual reductions in mass loadings to Turkey Creek as a result of the Basin 7 wet detention pond is given at the bottom of Table 3-17. Operation of the wet detention pond will reduce mass loadings of ammonia by approximately 2.3 kg/yr, with a 8.9 kg/yr reduction in NO_x, a 18.2 kg/yr reduction in organic nitrogen, and a 29.4 kg/yr reduction in total nitrogen. The wet detention pond will also reduce loadings of orthophosphorus to Turkey Creek by approximately 1.3 kg/yr, with a 3.6 kg/yr reduction in total phosphorus, and a 511 kg/yr reduction in TSS.

TABLE 3-17

ESTIMATED REDUCTIONS IN MASS LOADINGS TO TURKEY CREEK AS A RESULT OF THE BASIN 7 WET DETENTION POND

MONTH	MASS LOADINGS (kg)						
	NH_3	NO_x	Org. N	Total N	Ortho-P	Total P	TSS
May	0.07	0.08	0.36	0.51	0.01	0.03	5.1
June	0.27	4.18	3.54	7.99	0.07	0.56	63.4
July	-0.03	0.51	-0.07	0.41	0.04	0.09	20.8
August	-0.08	0.90	7.88	8.71	0.53	1.21	119
September	0.07	0.25	0.73	1.05	0.11	0.18	12.0
October	0.25	0.31	0.88	1.44	0.06	0.11	8.2
November	0.04	0.03	0.21	0.28	0.00	0.01	6.2
December	1.10	0.27	-0.17	1.20	0.17	0.46	141
Total for Monitoring Period:	**1.70**	**6.52**	**13.36**	**21.57**	**0.98**	**2.65**	**375**
Estimated Annual Mass Reduction:	2.3	8.9	18.2	29.4	1.3	3.6	511