Water Quality of Upper Barataria Basin: Impact of Nonpoint Source Pollution Associated with Sugarcane Production

Barataria-Terrebonne National Estuary Program (BTNEP)

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FINAL REPORT

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EXECUTIVE SUMMARY

Barataria-Terrebonne National Estuary Program (BTNEP) and the Louisiana Department of Environmental Quality (LDEQ) selected the upper Barataria Basin in South Louisiana for evaluation of amount of nutrients, suspended sediments and pesticides entering the Basin as result of sugarcane runoff.

In 2000, LDEQ sampled the water bodies in the Barataria Basin and the results of those data were published in the 2002 Water Quality Inventory [305(b)] Report (Louisiana Department of Environmental Quality, 2002). These data indicated that Bayou Chevreuil was not meeting the designated uses for fish and wildlife propagation and that the water quality problems were related to low dissolved oxygen. The suspected causes of the water quality problems included organic enrichment, suspended solids, turbidity and nutrients. The suspected sources of these pollutants included non-irrigated crop production and natural sources. The non-point source pollutants impacting water quality of this watershed (020101) include runoff associated with sugarcane production. Over 200,000 acres of sugarcane are grown in the Barataria/Terrebonne Basin of which 24,000 acres are planted in the project area (Louisiana Extension Service Pub. 2382; American Sugarcane League 2000).

In order to understand why there is low oxygen in these water bodies, LDEQ requires information and data on oxygen-demanding substances (pesticides, nutrients and suspended sediments) entering the water bodies from both agriculture and pristine or forested swamps. In order to implement total maximum daily loads (TMDLs), BTNEP and LDEQ need more data to help them differentiate the natural background loads from the anthropogenic loads. The data from this project will provide BTNEP and LDEQ with information on loading rates from natural swamp and loading rates from sugarcane fields. These data can be incorporated into watershed plans, which will guide efforts to improve water quality within this part of the State.

The overall goal of this project was to quantify nonpoint source pollution in the upper Barataria Basin associated with sugarcane production. The specific objective of the project was to determine the amount of nutrients and pesticides loading to the water bodies from sugarcane runoff.

The study represented two years of runoff sampling. Two field sites in sugarcane production were instrumented with automated water sampling equipment for collecting runoff. The two fields were representative of sugarcane production practice for the area. At each sugarcane field, an ISCO automated water sampler powered by a solar panel and battery was installed at edge-of-field culvert appropriate for sample collection. Flow meters were used in conjunction with this installation (with an area velocity flow meter).

In order to determine the impact of sugarcane runoff on water quality in water bodies receiving runoff, grab water samples were collected from the following four locations during selected rainfall events.

St. James Canal South: south of the discharge of the southernmost field where automated samplers were placed. Runoff from approximately 20,000 acres of sugarcane is diverted through a series of drainage ditches and canals into St. James Canal, which discharges into Bayou Chevreuil. The purpose of this sampling site was to monitor the area immediately impacted by the sugarcane runoff.

Bayou Chevreuil: near the bridge on LA 20. The purpose of this sample was to monitor the response of a lower watershed response and sugarcane runoff and to tie the project with a long-term LDEQ water quality monitoring station.

Swamp Forest Runoff: the site represents an area receiving outflow from a pristine swamp forest. Runoff from this site was used as an index to evaluate background or input to stream (Bayou Chevreuil) from forested wetlands.

St. James Canal North (sponsored b**y** BTNEP**)**: north of the discharge of the northernmost field where automated samplers were placed. The purpose of this sampling site was to monitor the water quality in the St. James Canal before being impacted by the sugarcane runoff.

The farmers at the two sugarcane monitoring sites generally used similar management practices as related to fertilizer, pesticide application and residue mangement. At site one, nitrogen was applied at 120 pounds per acre in April. No phosphorus fertilizer was applied, because Mississippi River alluvial soils are high in phosphorus and sugarcane does not response to phosphorus addition. Metribuzin (Sencor) was applied twice each year at site one. First application was 1.25 pounds per acre in February, and the second time 1 pound per acre at layby in May. The same management practice was applied in both 2005 and 2006 at site one. At site two, nitrogen was applied at 120-140 pounds per acre in April, 2005. Metribuzin (Sencor) was applied once in March at 1.25 pounds per acre. No fertilizer and pesticide were applied at site two in 2006, because site two was in fallow during the year. For site one, the sugarcane stubble was 2nd year in 2005, and 3rd year in 2006. In relation to residue management, at both sites the sugarcane residue was left on the field and not burned following harvest.

Surface runoff was collected following major rainfall events. The amount of rainfall and runoff flow volume was obtained using the rainfall gauge and flow meter integrated with the automatic water sampler. Hydrographs were developed to evaluate the relation between rainfall and runoff volume. Based on the hydrograph, each automatic water sampler was programmed to collect enough runoff samples for all the analysis following major rainfall events. Effluent samples from the instrument sites and the grab samples were based on rainfall provided run-off events. Generally rainfall of greater than 1.5 inches was needed to produce any significant runoff, especially in summer months.

Suspended Solids

St. James Canal North consisted of the same level of suspended solids as in the Bayou Chevreuil. Concentration of suspended solids in the effluent from sugarcane field sites was always higher than concentration in receiving water bodies. St. James Canal South which received runoff from the sugarcane in the area contained significant amount of suspended solids. The concentration of total solids was lower in the downstream Bayou Chevreuil site. The lower suspended solids at the Bayou Chevreuil site were probably attributed to dilution until reaching the original level in St. James Canal North. Suspended solids in runoff from the swamp forest site were the lowest of all. The higher suspended sediment level in St. James Canal South and Bayou Chevreuil as compared to swamp forest was consistent with visual observation. It was clear based on suspended solids that runoff from the rainfall events enter lower water bodies within the drainage basin.

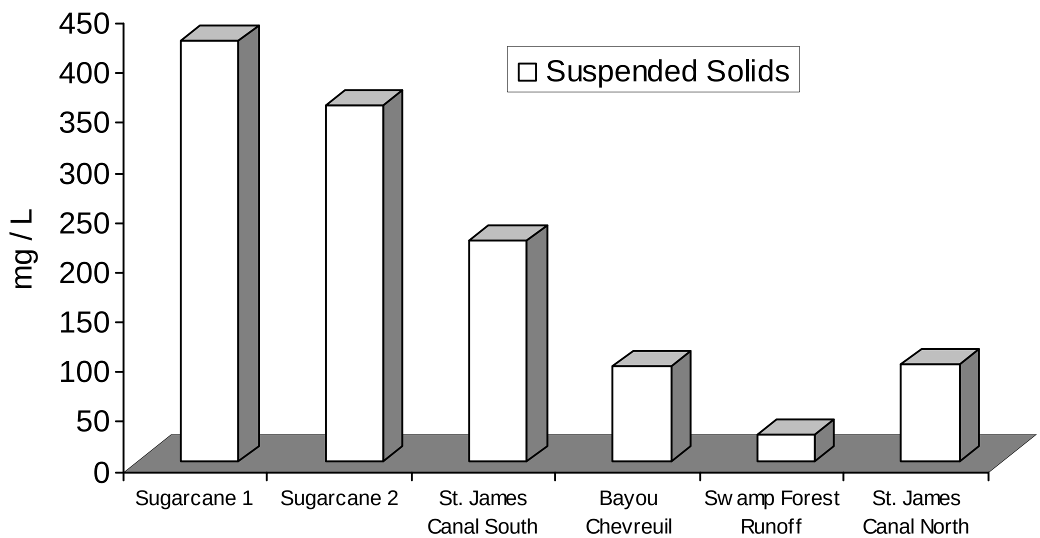

Figure 1. Two-year average concentration of total suspended solids

Nitrogen

TKN was the dominant N component in the runoff. For the inorganic nitrogen portion, nitrate was in greater concentration than ammonium. Nitrogen content was similar in St. James Canal North, St. James Canal South and Bayou Chevreuil. Overall, the concentration in receiving water bodies (St. James Canal South and Bayou Chevreuil) was lower in TKN, ammonium and nitrate nitrogen as compared to concentration in runoff from the two sugarcane field sites. The spike in inorganic nitrogen measured in St. James Canal South following rainfall events paralleled measured loading of nitrogen in runoff from the sugarcane field sites which occurred in the spring months, the time of fertilizer application. The swamp forest runoff showed the lowest nitrogen concentrations, indicating a good buffering effect on N.

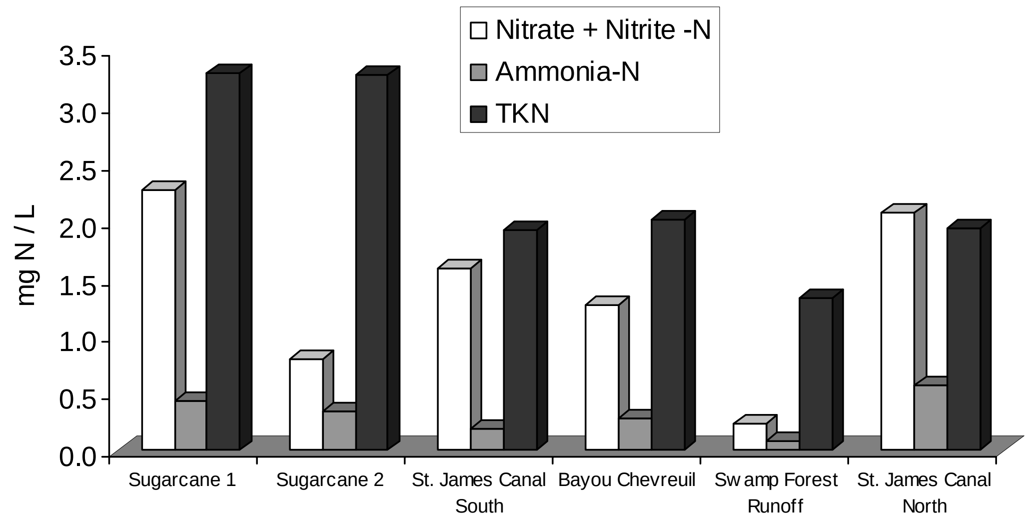

Figure 2. Two-year average concentration of nitrogen

Phosphorus

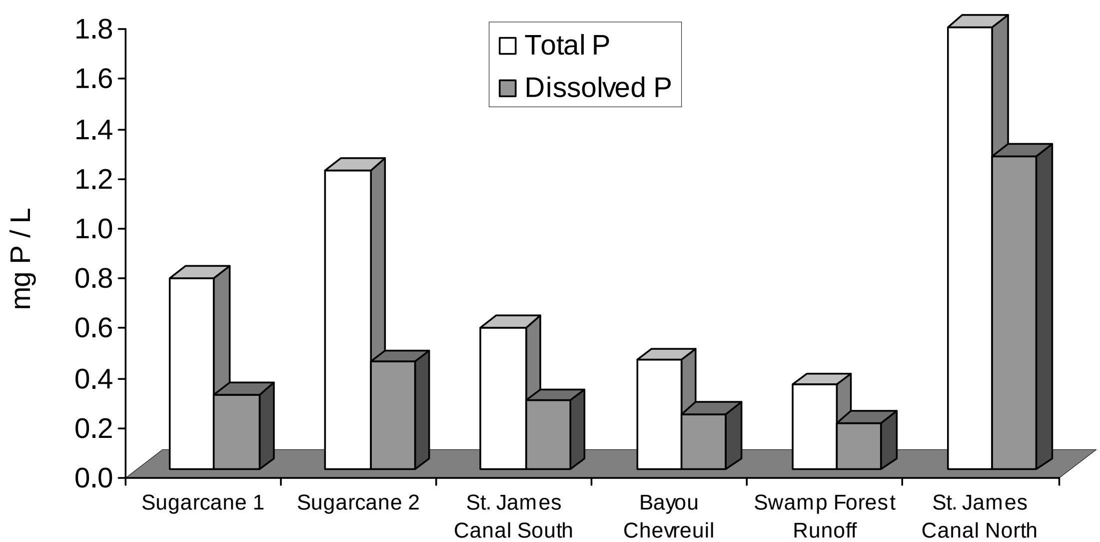

Figure 3. Two-year average concentration of phosphorus

St. James Canal North showed the highest P content of all sampling sites. This might be due to pollution from the adjacent industry facilities (point source pollution). Phosphorus concentrations were higher in runoff from sugarcane fields as compared to levels found in the grab samples taken from St. James Canal South, Bayou Chevreuil, and the swamp forest. Phosphorus concentration was lowest in runoff from swamp forest. Dissolved phosphorus represented approximately 50 percent of the total phosphorus found in the samples. Total phosphorus content was positively correlated with levels of total suspended solids in the water samples.

Pesticides

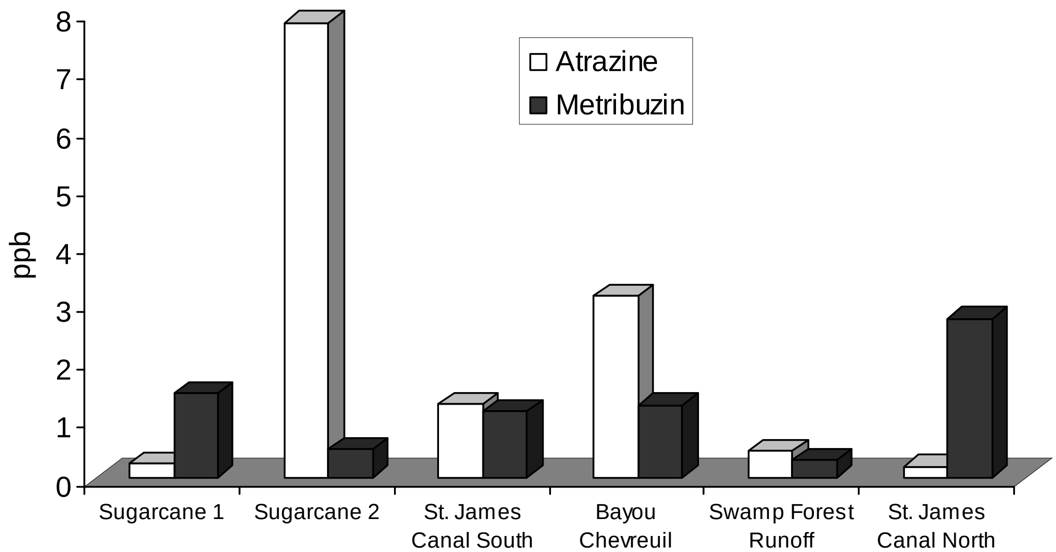

Figure 4. Two-year average concentration of major pesticides

Atrazine and Metribuzin were the major pesticides found in sugarcane runoff. St. James Canal North showed the highest concentration of Metribuzin, probably due to pollution from the nearby industry, but the lowest Atrazine concentration of all sampling sites. Concentration of the two pesticides was higher in samples collected in sugarcane runoff samples. Significant levels of the pesticides were found in St. James Canal South and Bayou Chevreuil, demonstrating that these pesticides were entering the streams and water bodies as a result of sugarcane runoff. There was a spike in Atrazine concentration in St. James Canal South and Bayou Chevreuil in May and June 2005, which paralleled Atrazine loading measured in runoff at sugarcane field site 2.

The water quality measurements conducted over the two years of monitoring effort clearly show nutrients, TSS and pesticides from sugarcane runoff are entering water bodies of northern Barataria Basin. Management practices to reduce loading to the stream and water bodies should include development of edge of field buffer strips. Also directing the runoff through forested wetland would filter sediment, nutrients and pesticides, thereby reducing the amount entering stream and water bodies.

INTRODUCTION

In the 1992 Report to Congress on managing nonpoint source (NPS) pollution, Environmental Protection Agency (EPA) concluded that NPS pollutants are responsible for between one-third and two-thirds of existing and threatening impairments to the state's waters. NPS pollution is pollution generated from diffuse sources, which are not regulated as point sources. Many waterways in the state do not meet the designated use for fish and wildlife propagation. Within Louisiana, approximately 69% and 58% of the river kilometers and lakes assessed, respectively, were impacted by NPS pollution.

Louisiana has identified agriculture as one of the eight categories of NPS pollution. In 1995, Louisiana agricultural enterprises contributed more than 905 billion dollars to Louisiana's economy (Louisiana Extension Service, 1995). To maintain or increase yields of cash crops, fertilizers and pesticides are required on an annual basis. Thus, it is essential to quantify the contribution of each crop to water quality problems. Primary pollutants identified as being of concern in Louisiana surface water include suspended sediments, nutrients (nitrate and phosphate), and organic matter enrichment, all of which contribute to reduced concentrations of dissolved oxygen in bayous, rivers, and lakes.

In 2000, Louisiana Department of Environment Quality (LDEQ) sampled the water bodies in the Barataria Basin and the results of those data were published in the 2002 Water Quality Inventory [305(b)] Report. These data indicated that Bayou Chevreuil was not meeting the designated uses for fish and wildlife propagation and that the water quality problems were related to low dissolved oxygen. The suspected causes of the water quality problems included organic enrichment, suspended solids, turbidity and nutrients. The suspected sources of these pollutants included non-irrigated crop production and natural sources. The non-point source pollutants impacting water quality of this watershed (020101) include runoff associated with sugarcane production. Over 200,000 acres of sugarcane are grown in the Barataria/Terrebonne Basin of which 24,000 acres are planted in the project area (Louisiana Extension Service Pub. 2382; American Sugarcane League 2000).

In order to understand why there is low oxygen in these water bodies, BTNEP and LDEQ needs to obtain information and data on oxygen-demanding substances (pesticides, nutrients and suspended sediments) entering the water bodies from both agriculture and pristine or forested swamps. In order to implement total maximum daily loads (TMDLs), BTNEP and LDEQ needs more data to help them differentiate the natural background loads from the anthropogenic loads. The data from this project will provide BTNEP and LDEQ with information on loading rates from natural swamp and loading rates from sugarcane fields. These data can be incorporated into watershed plans, which will guide implementation of TMDLs within this part of the State.

OBJECTIVE

The project addressed water quality issue associated with sugarcane run-off in the upper reach of the Barataria Basin. Streams and water bodies in the project area were included on the 303(d) list as impaired. The main objectives of this project were to:

1. Quantify NPS pollutant (sediment, nitrogen, phosphorus, pesticides) sources from sugarcane fields in the Bayou Chevreuil watershed;
2. Monitor and quantify the amount of runoff from two sugarcane fields within the Bayou Chevreuil watershed;
3. Monitor and quantify background levels of NPS pollutants in the Bayou Chevreuil watershed and estimate the contribution of swamp and sugarcane run-off to water quality;
4. BTNEP and LDEQ will utilize these data to assist in its efforts to improve water quality for the Bayou Chevreuil watershed;
5. Provide information and recommendations to BTNEP and LDEQ which can be used by sugarcane farmers and other interested parties (NRCS) for reducing amount of NPS pollutants entering in the Bayou Chevreuil watershed; and
6. Summarize findings in the form needed for a watershed implementation plan.

LOCATION OF THE STUDY SITE

Two farmers' fields were selected for the purpose of installing automated sampling equipment in this project. The two fields are representative of sugarcane production practice for the area. At each sugarcane field, an ISCO automated water sampler powered by a solar panel and battery was installed at edge-of-field that drains appropriate for sample collection. A culvert was installed in the drain and the equipment mounted on the top of the culvert. The flow meter was used in conjunction with this installation with an area velocity flow meter.

In order to determine the impact of sugarcane runoff on water quality of lower reach water bodies, a background sampling location with no impact from such runoff, and two impacted locations were selected. Grab water samples were collected from the following three locations:

1. **Swamp Forest Runoff**: the site represents an area receiving outflow from a pristine swamp forest. Runoff from this site will be used as an index to evaluate background or natural conditions.
2. **St. James Canal South**: south of the discharge of the southernmost field where automated samplers are placed. The purpose of this sampling site is to monitor the area immediately impacted by the sugarcane runoff from the fields.
3. **Bayou Chevreuil**: near the bridge on LA 20. The purpose of this sample is to monitor the response of the watershed to swamp and sugarcane runoff and to tie in the project with a long term LDEQ water quality monitoring station.

4. **St. James Canal North**: north of the discharge of the northernmost field where automated samplers were placed. The purpose of this sampling site was to monitor the water quality in the St. James Canal before being impacted by the sugarcane runoff.

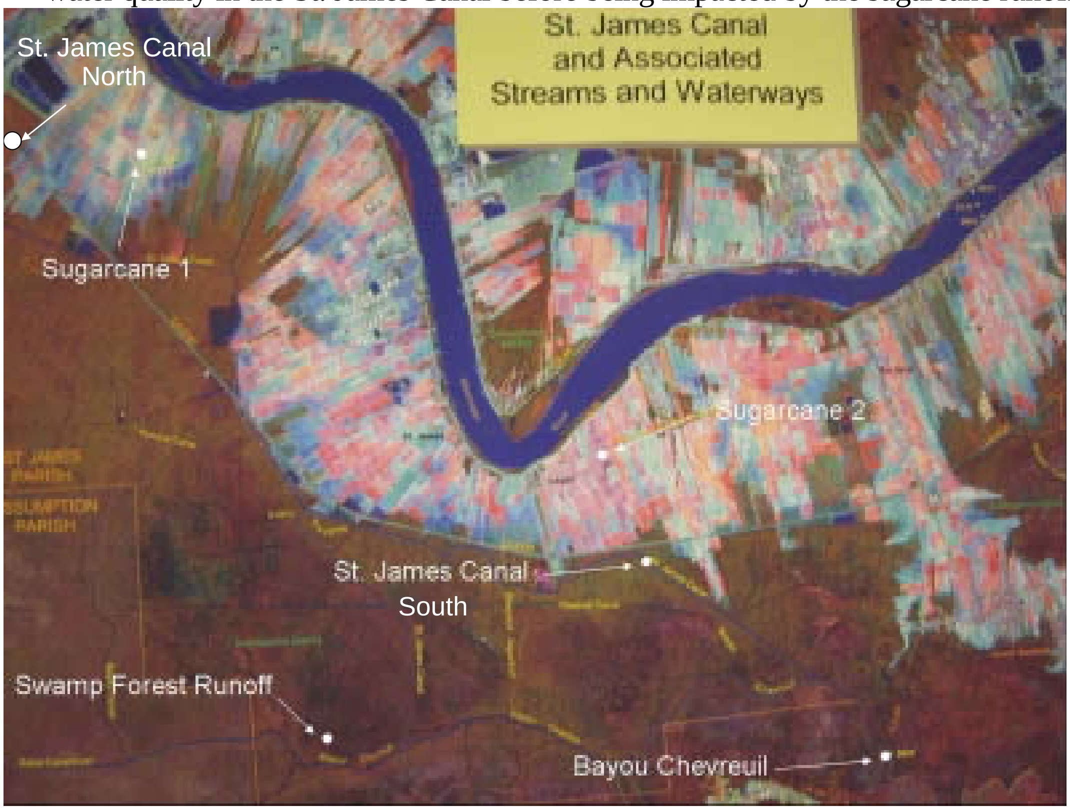

Figure 5. Map of study area and sampling locations

The five sampling locations were marked in the St. James Parish map (Figure 5), and each location was recorded on GPS (Global Positioning System) coordinates (Table 1).

Table 1. Locations of water monitoring stations for this project.

Type of Site	Designation	Latitude and Longitude
Edge-of-field	Sugarcane 1	N30.05032, W90.91288
Edge-of-field	Sugarcane 2	N29.88545, W90.79798
St. James Canal South	SJCS	N29.95844, W90.79098
Bayou Chevreuil	BC	N29.91166, W90.73004
Swamp Forest Run-off	SFR	N29.91817, W90.79017
St. James Canal North	SJCN	N30.06137, W90.95273

SAMPLING APPROACH AND ANALYSIS METHOD

Following set-up of automatic samplers along the edge of the field, surface runoff was collected following several major rainfall events. The amount of rainfall and runoff flow volume was obtained using the rainfall gauge and flow meter integrated with the automatic water sampler. Hydrographs were developed to evaluate the relation between rainfall and runoff volume. According to the hydrograph, each automatic water sampler was programmed to be able to collect enough runoff samples for all the analysis following major rainfall events. The two automatic water samplers were regularly maintained to ensure their functions over this two-year sampling period. The grab sample collection was parallel to the rainfall events in which water samples were collected from automatic water samplers at the farmers' fields.

The Institute for Ecological Infrastructure Engineering at LSU analyzed the water samples for nutrients (Table 2), and the Agchemistry at LSU conducted the pesticide analysis (Table 3). All analysis was subject to appropriate quality control to ensure the data quality (Table 4). This breadth of parameters and number of water quality/quantity data sets provide estimates of contributing NPS losses from sugarcane to water quality of St. James Canals and Bayou Chevreuil.

Table 2. Analytical methods for Institute for Ecological Infrastructure Engineering.

Parameter	Analytical Method	Reference
TKN (Nitrogen Organic C)	SM 4500	APHA 1998
Total NO_3^- and NO_2^-	SM 4500-NO3 E	APHA 1998
Ammonia (ammonia selective electrode)	SM 4500-NH3 D	APHA 1998
Total P	SM4500-PE	APHA 1998
PO_4-P	SM 4500-PE	APHA 1998
TSS (residue-nonfilterable)	SM 2540 D	APHA 1998

APHA. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. A.D. Eaton, L.S. Clesceri, A.E. Greenberg (Eds.). American Public Health Association, American Water Works Association and Water Environment Federation, Washington, DC. ISBN 0-87553-235-7

Table 3. Analytical methods for LSU Agricultural Chemistry Laboratory.

Pesticides	Analytical Method	Reference
Atrazine	EPA 507	Graves 1989*
Metribuzin (Sencor)	EPA 507	Graves 1989*
Pendimethalin (Prowl)	EPA 508	Graves 1989**
Terbacil	EPA 507	Graves 1989*
Trifluralin (Treflan)	EPA 508	Graves 1989**
Esfenvalerate (Asana)	EPA 508	Graves 1989**
Cyfluthrin (Baythroid)	EPA 508	Graves 1989**
Lambda-cyhalothrin (Karate)	EPA 508	Graves 1989**

** Method 507 Revision 2.0: Determination of Nitrogen-and Phosphorus-Containing Pesticides in Water by Gas Chromatography with a Nitrogen-Phosphorus Detector, R.L. Graves 1989, Environmental Monitoring Systems Laboratory/Office of Research and Development/U.S.E.P.A./Cincinnati, Ohio 45268 [Revision 1.0 authored in 1987 by T. Engels (Battelle Columbus Laboratories)--National Pesticide Survey Method 1]*

*** Method 508 Revision 3.0: Determination of Chlorinated Pesticides in Water by Gas Chromatography with an Electron Capture Detector, R.L. Graves 1989, Environmental Monitoring Systems Laboratory/Office of Research and Development/U.S.E.P.A./Cincinnati, Ohio 45268 [Revision 2.0 authored in 1987 by T. Engels (Battelle Columbus Laboratories)--National Pesticide Survey Method 2] (Revision 1.0 authored in 1981 by J.J. Lichtenberg, J.E. Longbottom, T.A. Bellar, J.W. Eichelberger, and R.C. Dressman --EPA 600/4-81-053)*

Table 4. Quality control procedures for water samples.

Parameter	Trip Blank (2 times/ year)	Duplicate	Lab. Control Sample (LCS)	*Matrix Spike Duplicate
TKN	Yes	Yes	Yes	Yes
NO_3^- and NO_2^-	Yes	Yes	Yes	Yes
Ammonia	Yes	Yes	Yes	Yes
Total P	Yes	Yes	Yes	Yes
PO_4-P	Yes	Yes	Yes	Yes
TSS	No	No	Yes	No
Pesticides	Yes	Yes	Yes	Yes

**Matrix Spike Duplicate will be done in the lab on each batch of samples. A sample in batch will be randomly chosen to spike.*

SAMPLING EVENTS DURING THE STUDY PERIOD

Regular field visits and maintenance was conducted 2 or 3 time a month, which included cleaning rain gauges, replacing desiccants for the auto sampler, replacing the sample bottles with clean ones, checking the solar panels and batteries, and so on. In total, 6 sampling events were conducted in 2005 (March 17, May 1, May 31, July 17, August 31, and September 25), and 8 events in 2006 (January 24, February 26, April 27, July 07, August 10, September 13, October 17, and November 08). For each sampling event, the site photos were taken and included in Attachment I.

RELATIONSHIP BETWEEN RAINFALL AND RUNOFF FLOW

The soils at the two sugarcane run-off monitoring sites are located on the natural levee of the Mississippi River. Soils at both sites are associated with the commerce soil series. The soils in this study area are used almost entirely for sugarcane production. Both soil survey map and on site particle size analysis were used for soil type determination. Soil at the site one contained 18% sand, 57% silt and 25% clay, and is classified as a silt loam. The soil at site two was also a commerce but a portion of area in the field was a Vacherie fine sandy loam. Site two located closer to the Mississippi River contained more sand in the surface soil than site one. The sand, silt, and clay percentage was 47.5, 45.0 and 7.5 respectively, which is classified as a sandy loam (Table 5).

Surface runoff, that portion of precipitation that makes its way toward drainage canals, streams, lakes, as surface flow, is the primary mechanism responsible for the transport of NPS pollutants to surface waters. In order to estimate NPS pollutant loads from the sugarcane production, it is necessary to ascertain runoff volumes, and time distribution of runoff rates for a range of rainfall events under different sugarcane field conditions.

The factors affecting runoff can be subdivided into factors associated with precipitation and factors associated with the field/watershed itself. Precipitation sub-factors include rainfall intensity, duration, and area of distribution. Field/watershed sub-factors include size and shape of the field/watershed, orientation of the field/watershed, topography, soil type, and surface culture of the field/watershed area. It is important to understand that it would be impossible to collect and analyze all the runoff water from a field/watershed from even a small storm event, let alone a major one. Therefore, one must try to collect representative runoff samples from representative storm events with which to make estimates of NPS pollutant loading rates. A common strategy is to set up automated water samplers to collect rain event runoff from small (field or plot sized) land areas with specific land-uses. The water samples collected from these specific land-use areas can then be analyzed and conclusions can be drawn about BMP efficacy.

Rainfall is the driving force of surface runoff flow at these two sugarcane sites. The hydrographs, including rainfall and runoff flow, for the two-year measurement are attached with this report (Figure 6 and 7). Drainage area for these two sugarcane fields was estimated by using GPS to mark the field boundary and to calculate. In total, there were 6 sampling activities in 2005, and 8 samples in 2006 taken following rainfall-runoff events. Rainfall and runoff volume from these events were summarized in Table 6. Photos at each sampling events are included in Attachment I.

Analysis of the ratio of runoff flow and rainfall (Table 6) from these rainfall-runoff events shows that, for the same amount of rainfall, the runoff flow volume at the sugarcane site 1 was greater than the sugarcane site 2. This can be partially explained by the difference in their drainage area (Drainage area is estimated to be 15 acre for sugarcane site 1, 10 acre for sugarcane site 2). Probably a more important cause is the difference in field physical properties. The sugarcane site 2 is much sandier than sugarcane site 1 (Table 5), which may result in large amount of the water from precipitation charging to groundwater at the sugarcane site 2, instead of surface runoff. If this is the case, ground water table needs to be considered in future prediction and interpretation of surface runoff following rainfall events. Since this study area is adjacent to the Mississippi River, the River stage at different seasons may play a role in the amount of runoff flow. The results also indicate, for the same field, there is a large variation of runoff volume for a certain amount of rainfall at different years. At this time, it is uncertain about the effect of fallow at the sugarcane site 2 in 2006 on runoff volume.

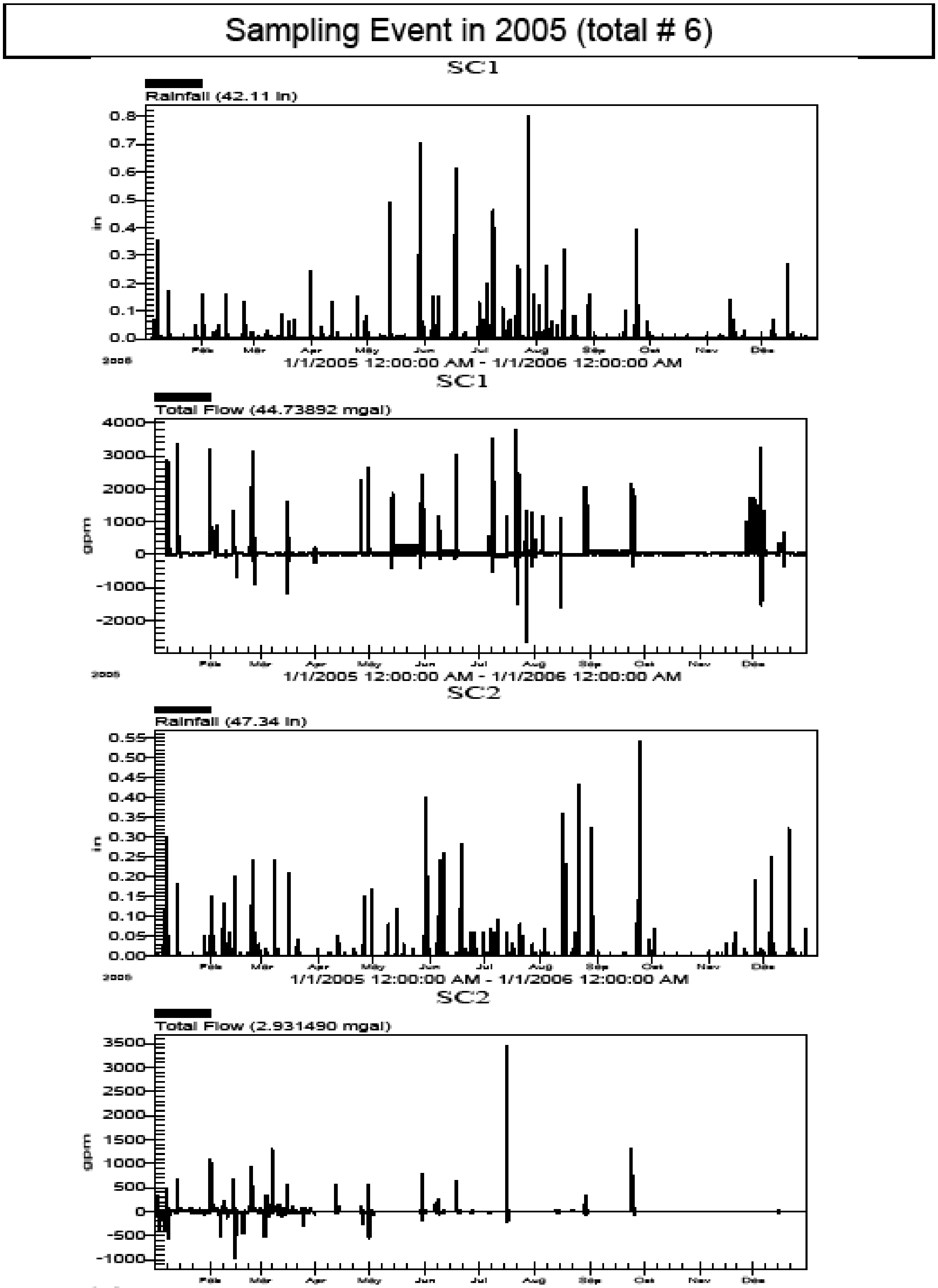

Figure 6. Hydrograph of rainfall and runoff from the two sugarcane sites in 2005

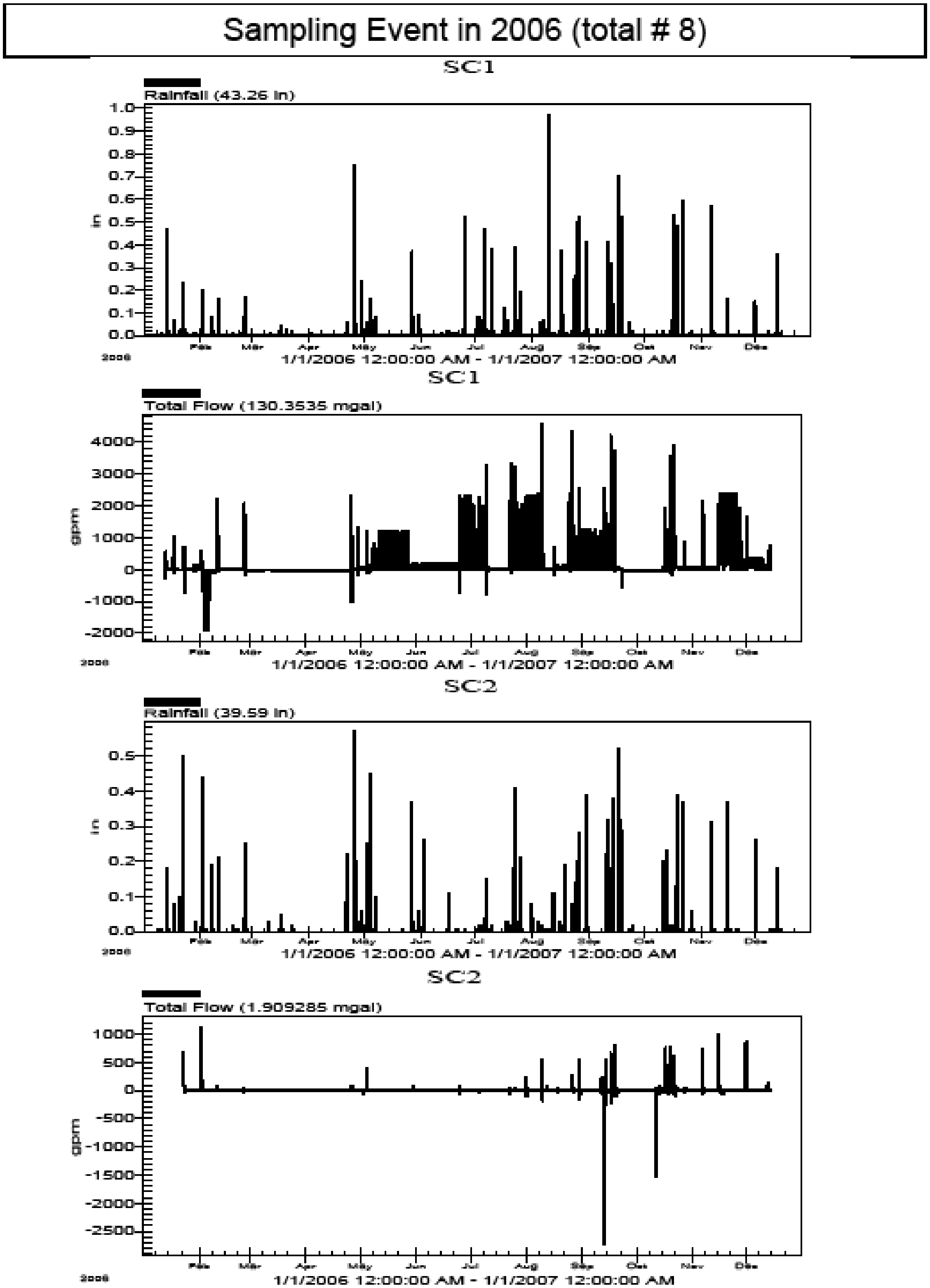

Figure 7. Hydrograph of rainfall and runoff from the two sugarcane sites in 2006

Table 5. Soil physical properties of the two sugarcane sites.

	Soil type	Sand (%)	Silt (%)	Clay (%)
Sugarcane 1	Silt loam	18.3	56.7	25
Sugarcane 2	Sandy loam	47.5	45	7.5

Note: Sugarcane site 2 was fallow in 2006. Drainage area is estimated to be 15 acre for sugarcane site 1, 10 acre for sugarcane site 2.

Table 6. Recorded rainfall and runoff at each sampling event.

Year	Date	No.	SC1		SC2		SC1	SC2
			Rainfall (in)	Flow (Mgal)	Rainfall (in)	Flow (Mgal)	Flow/Rain fall ratio	Flow/Rain fall ratio
2005	17-Mar	#1	0.94	0.172	1.50	0.191	0.18	0.13
	1-May	#2	0.89	0.776	1.63	0.085	0.87	0.05
	31-May	#3	4.15	1.519	3.80	0.209	0.37	0.05
	17-Jul	#4	0.65	0.171	0.74	0.950	0.26	1.28
	31-Aug	#5	3.24	2.047	3.32	0.085	0.63	0.03
	25-Sep	#6	4.47	1.437	7.07	0.648	0.32	0.09
	Total		14.34	6.121	18.06	2.168	0.43	0.12
2006	24-Jan	#1	1.10	0.526	1.56	0.180	0.48	0.12
	26-Feb	#2	1.20	1.647	0.86	0.005	1.37	0.01
	27-Apr	#3	2.53	0.600	2.16	-0.002	0.24	
	7-Jul	#4	0.92	4.456	1.28	0.006	4.84	0.01
	10-Aug	#5	2.88	0.583	0.49	0.084	0.20	0.17
	13-Sep	#6	2.28	3.402	1.96	0.030	1.49	0.02
	17-Oct	#7	2.33	0.782	1.33	0.227	0.34	0.17
	8-Nov	#8	1.36	1.250	1.17	0.081	0.92	0.07
	Total		14.60	13.246	10.81	0.611	0.91	0.06
Total	**2005**		42.11	44.739	47.34	2.931	1.06	0.06
	2006		43.26	130.354	39.59	1.909	3.01	0.05

LOADING OF TOTAL SUSPENDED SOLIDS AND ITS IMPACT

In total, there were 6 sampling activities in 2005, and 8 sampling activities in 2006 conducted following rainfall-runoff events. Original data of total suspended solids (TSS) are included in Attachment II.

The concentrations of TSS in the SJCN varied at different sampling events. Larger volume of runoff was found at the sugarcane site 1, thus the amount of TSS was likely to be diluted in water, compared to sugarcane site 2. Occasionally, sugarcane site 2 showed higher concentration of TSS than sugarcane site 1, especially in 2006. This is likely because the sugarcane site 2 was fallow in 2006. St. James Canal South showed immediate impact by sugarcane runoff, indicated by the higher concentration of TSS, as well as on site observation each time. Lower concentration of TSS found at Bayou Chevreuil was probably due to dilution, since more water came into the Bayou besides from the St. James Canal South. Swamp forest runoff always showed the lowest TSS, indicating a buffering effect of swamp on water quality, which also indicates a good selection of background sampling site.

Loading of TSS from sugarcane runoff into the studied watershed is calculated by the following equation:

Loading of TSS from runoff = Concentration of TSS in runoff water × Runoff volume

Average TSS concentrations at the six sampling locations were summarized in Figure 1. Comparison of TSS loadings from runoff of the two sugarcane sites and the TSS concentrations in the SJCN sampling location is shown in Figure 8. The results show that the TSS loading from the sugarcane site 1 was much larger than the sugarcane site 2. The difference in average TSS concentration of the two sugarcane sites is less than 30%. Therefore, the greater loading of TSS from the sugarcane site 1 was mainly due to larger amount of runoff volume following rainfall events. There was little contribution of TSS loading at the sugarcane site 2 during the fallow season 2006. The TSS concentration at SJCN was independent of the TSS loading from the two sugarcane runoffs. Variations in TSS concentration at the SJCS and BC locations generally followed the pattern of TSS loading from the sugarcane runoff. The SFR location showed little impact by the TSS loading, and remained low during the study period.

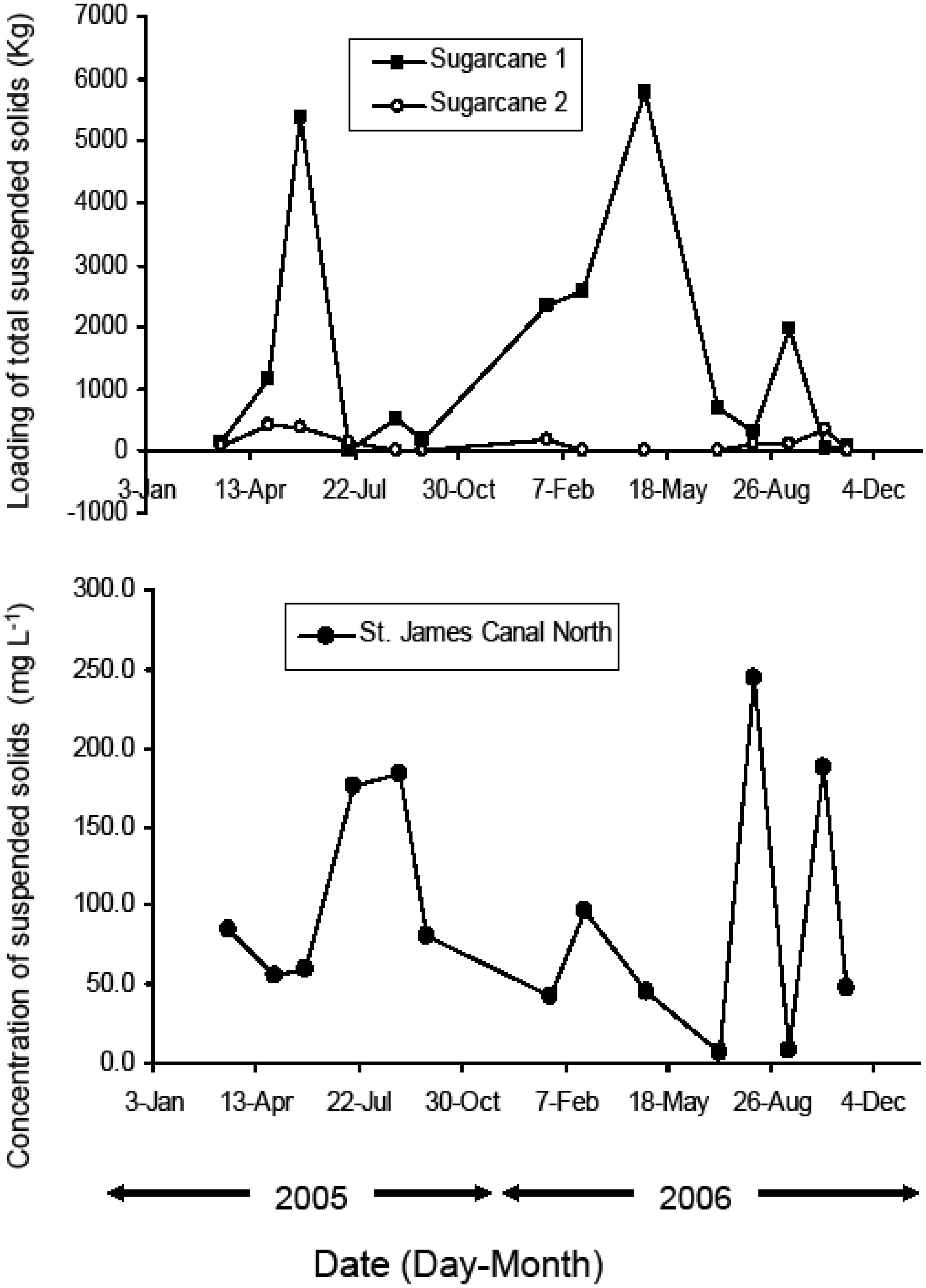

Figure 8. Loadings from the two sugarcane fields and concentrations of total suspended solids at the St. James Canal North site.

LOADING OF NITROGEN AND ITS IMPACT

In total, there were 6 sampling activities in 2005, and 8 sampling activities in 2006 conducted following rainfall-runoff events. Original data of nitrate + nitrite, ammonium and TKN are included in Attachment II.

In general, TKN is the dominant N component in the samples, and nitrate + nitrite concentration was greater than ammonium in inorganic N components. In the fallow season of 2006, N concentration from the sugarcane site 2 was less than in the growing season of 2005. In St. James Canal North, St. James Canal South and Bayou Chevreuil samples, the concentrations of all N components were similar. As expected, the swamp forest runoff showed the lowest N concentrations.

Loading of N from sugarcane runoff into the studied watershed is calculated by the following equation:

Loading of N from runoff = Concentration of N in runoff water × Runoff volume

Average nitrogen concentrations at the six sampling locations were summarized in Figure 2. Comparison of N loadings from runoff of the two sugarcane sites and the N concentrations in the SJCN sampling location is demonstrated in Figures 9, 10 and 11. The results show that the N loading from the sugarcane site 1 was much larger than the sugarcane site 2, mainly due to larger amount of runoff volume following rainfall events. There was little contribution of N loading at the sugarcane site 2 during the fallow season 2006. In general, the variations of N concentration at the SJCS and BC locations generally followed the pattern of N loading from the sugarcane runoff and N concentrations in SJCN. The SFR location showed little impact by the N loading from the sugarcane runoff, and remained low during the study period.

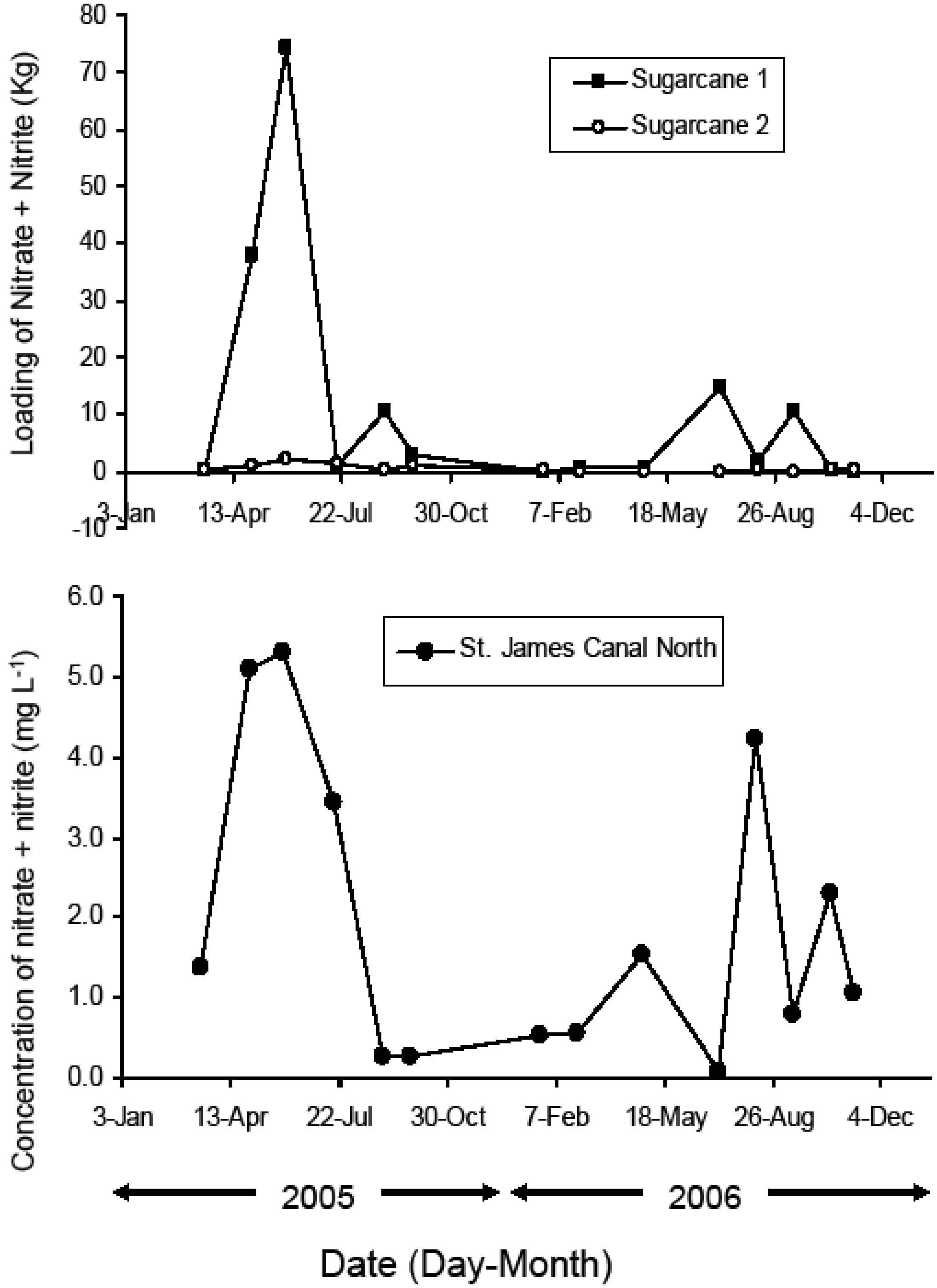

Figure 9. Loadings from the two sugarcane fields and concentrations of nitrate + nitrite at the St. James Canal North site.

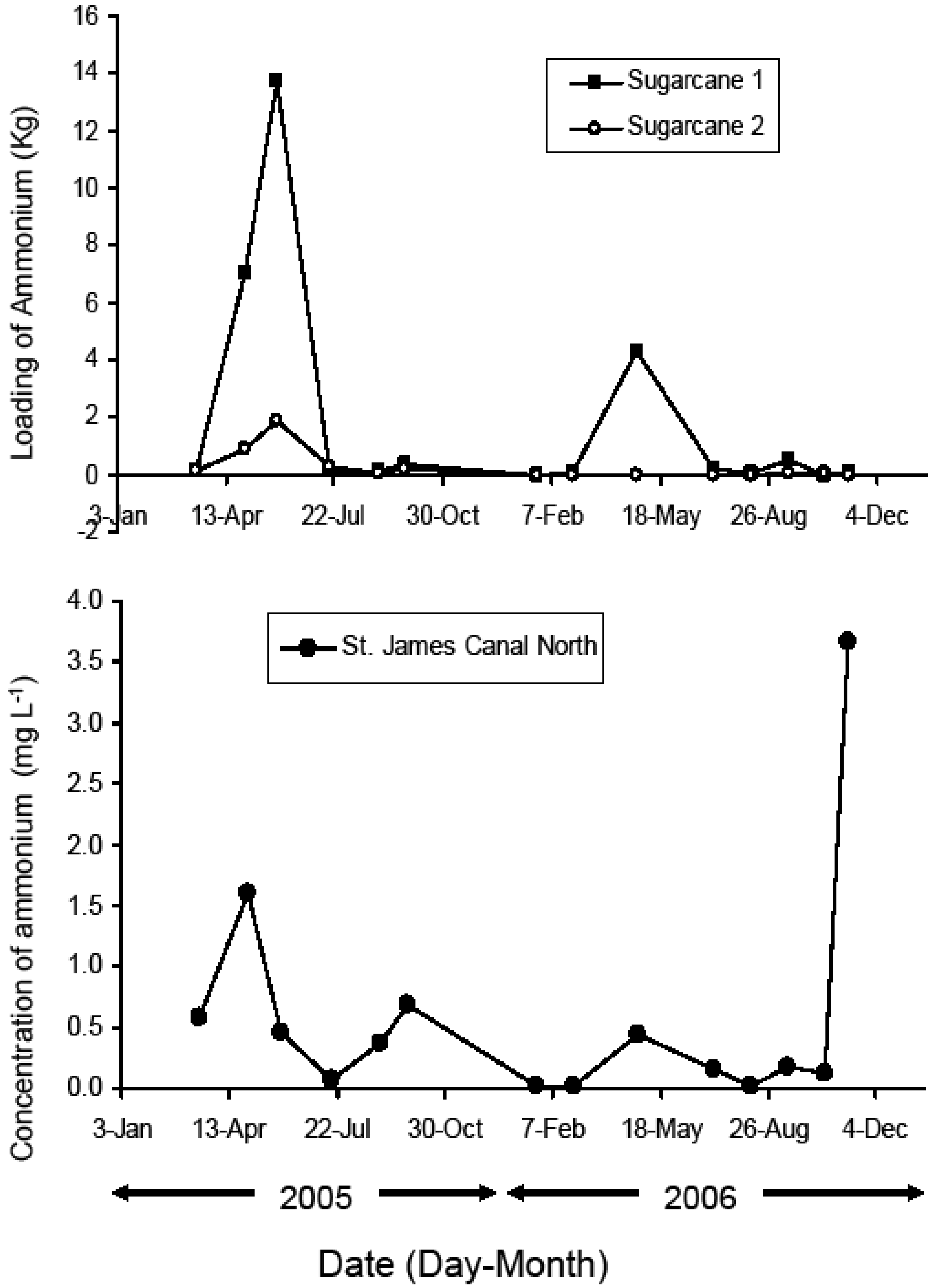

Figure 10. Loadings from the two sugarcane fields and concentrations of ammonium at the St. James Canal North site.

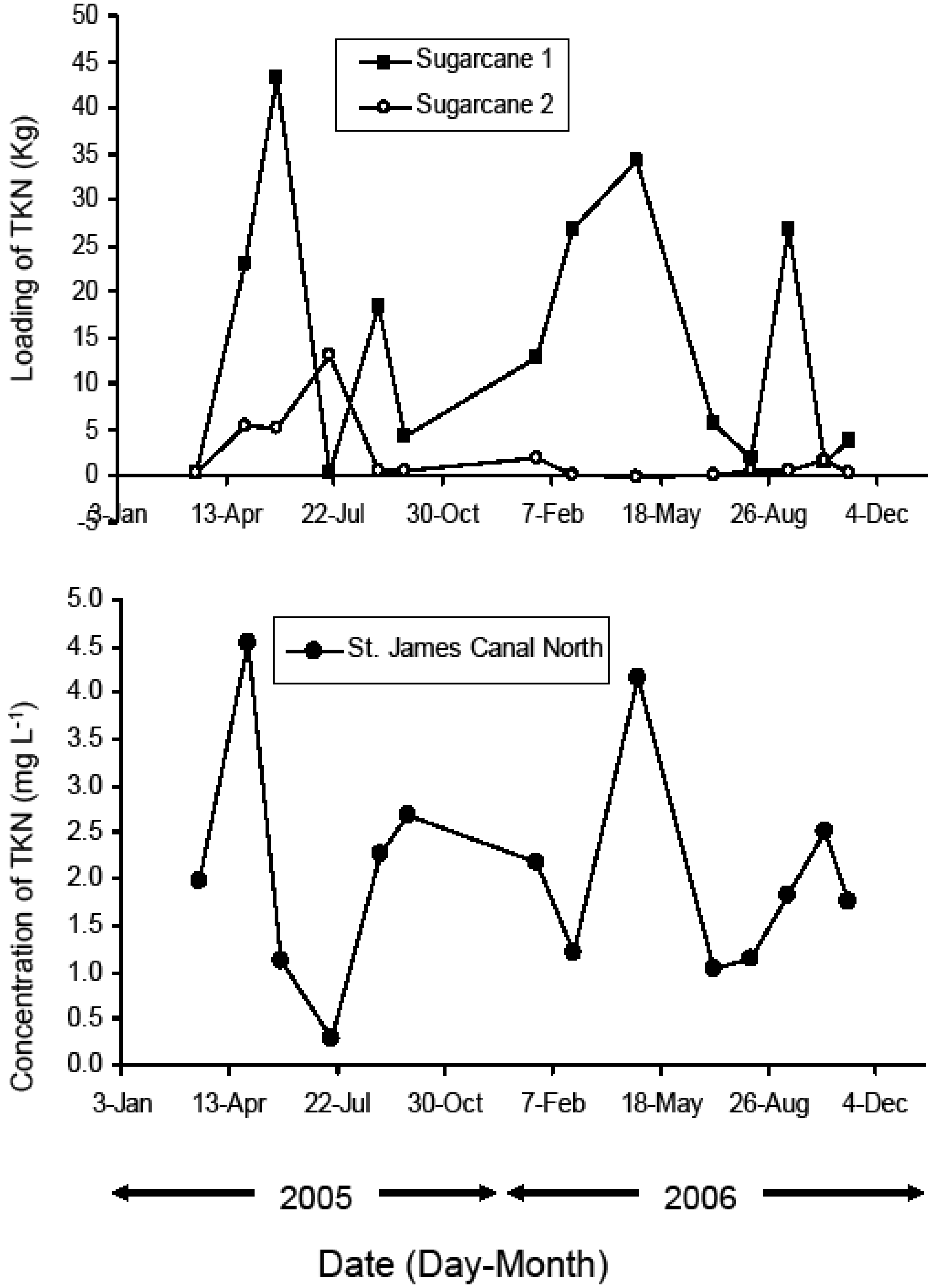

Figure 11. Loadings from the two sugarcane fields and concentrations of TKN at the St. James Canal North site.

LOADING OF PHOSPHORUS AND ITS IMPACT

In total, there were 6 sampling activities in 2005, and 8 sampling activities in 2006 conducted following rainfall-runoff events. Original data of total phosphorus and dissolved phosphorus are included in Attachment II.

SJCN showed the highest P concentration of all sampling sites. There are some industrial facilities nearby. Pollution from industry, especially P pollution, is likely to affect water quality in SJCN site. In general, dissolved phosphorus consisted of about half of the total phosphorus in the samples. There was no clear difference in P concentrations between 2005 and 2006 for the two sugarcane runoff samples. In St. James Canal South and Bayou Chevreuil samples, the P concentrations were similar between these two years. As expected, the swamp forest runoff showed the lowest P concentrations throughout the study period.

Loading of P from sugarcane runoff into the studied watershed is calculated by the following equation:

Loading of P from runoff = Concentration of P in runoff water × Runoff volume

Average phosphorus concentrations at the six sampling locations were summarized in Figure 3. Comparison of P loadings from runoff of the two sugarcane sites and the P concentrations in the SJCN sampling location is shown in Figure 12 and 13. The results show that the P loading from the sugarcane site 1 was larger than the sugarcane site 2, probably mainly due to larger amount of runoff volume following rainfall events. There was much less contribution of P loading at the sugarcane site 2 during the fallow season 2006. In general, the variations of P concentration at the SJCS and BC locations generally followed the pattern of P loading from the sugarcane runoff and P concentration in SJCN. The SFR location remained the lowest concentration of P, but showed similar variation with the SJCS and BC locations, following the P loading from the sugarcane runoff. The results also showed that P content had a good correlation with total suspended solids in the samples.

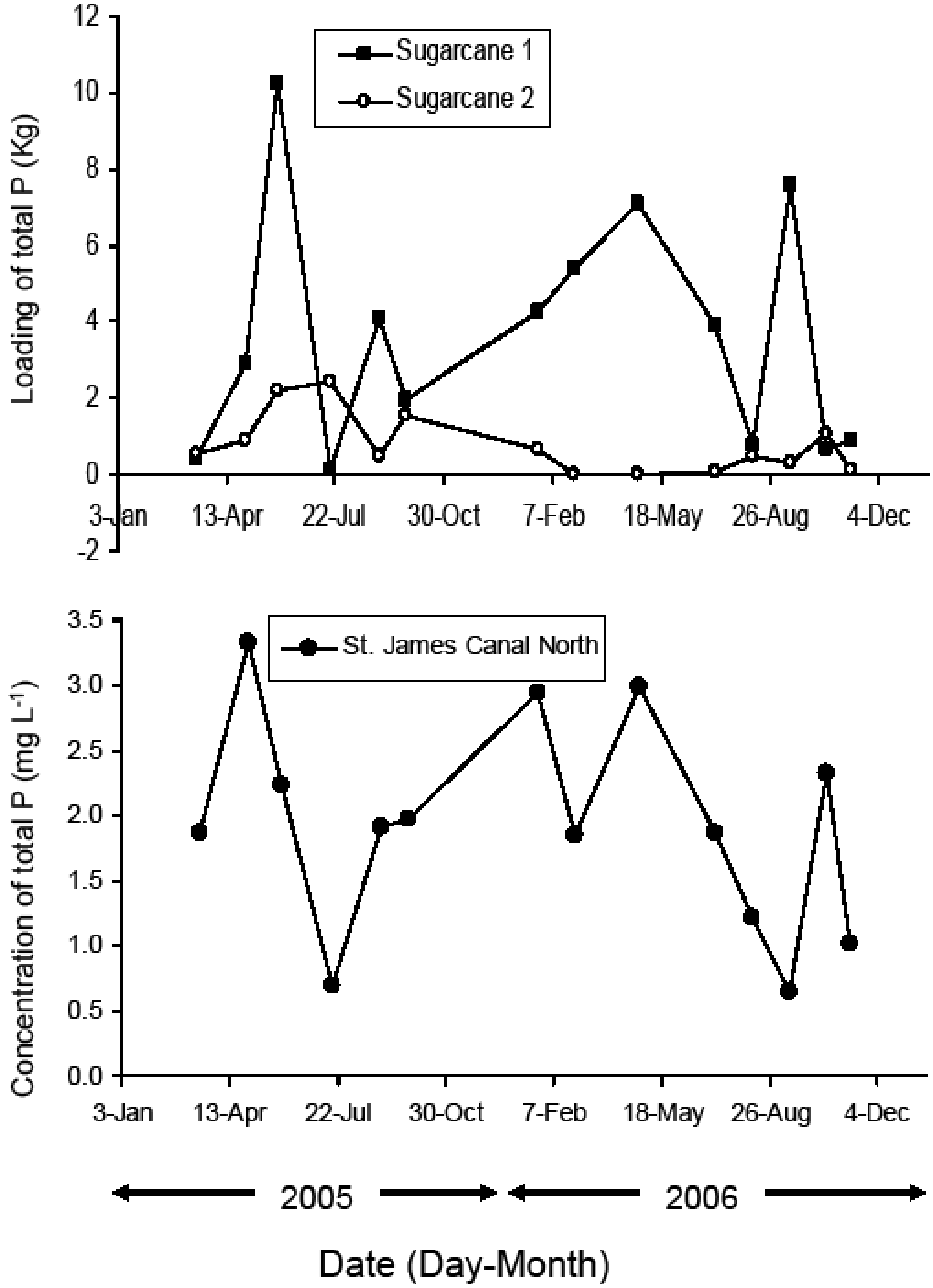

Figure 12. Loadings from the two sugarcane fields and concentrations of total phosphorus at the St. James Canal North site.

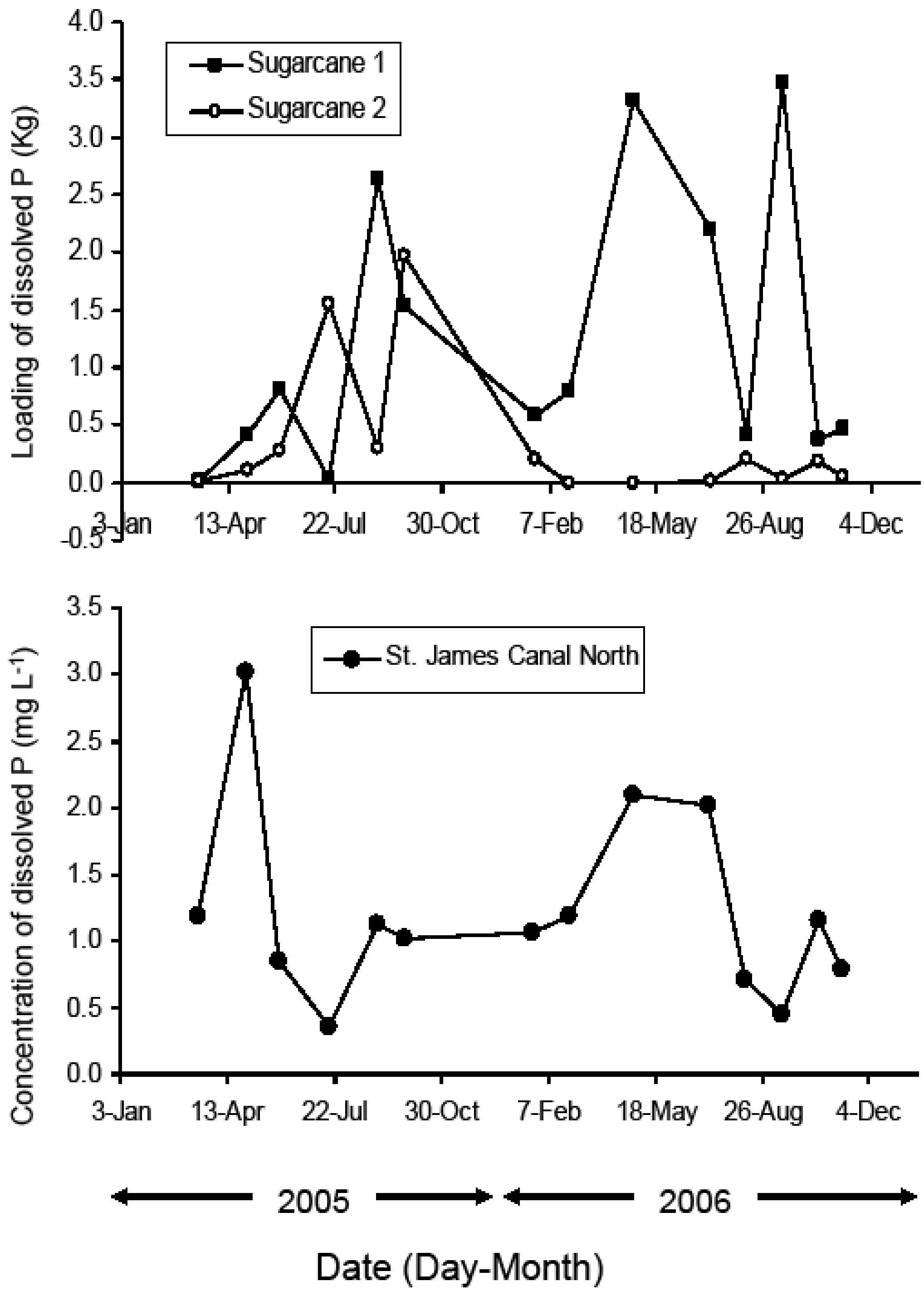

Figure 13. Loadings from the two sugarcane fields and concentrations of dissolved phosphorus at the St. James Canal North site.

LOADING OF PESTICIDES AND THEIR IMPACT

The pesticides included the major spectrum of Atrazine, Metribuzin (Sencor), Pendimethalin (Prowl), Terbacil, Trifluralin (Treflan), Esfenvalerate (Asana), Cyfluthrin (Baythroid), and Lambda-cyhalothrin (Karate). Atrazine and Metribuzin were found the dominant pesticides in this region. In total, there were 6 sampling activities in 2005, and 8 sampling activities in 2006 conducted following rainfall-runoff events. Original data of pesticides are included in Attachment II.

In 2005, Atrazine was the dominant pesticide in the water samples, and sugarcane site 2 showed much higher concentration of Atrazine than sugarcane site 1. In 2006, Metribuzin showed higher concentration than Atrazine in all water samples, and the sugarcane site 1 runoff showed higher concentration of Metribuzin than the sugarcane site 2. The swamp forest runoff showed the lowest pesticides concentrations throughout the study period.

Loading of pesticides from sugarcane runoff into the studied watershed is calculated by the following equation:

Loading of pesticides from runoff = Concentration of pesticides in runoff water × Runoff volume

Average pesticide concentrations at the six sampling locations were summarized in Figure 4. Comparison of pesticides loadings from runoff of the two sugarcane sites and the pesticides concentrations in the SJCN sampling location is demonstrated in Figure 14 and 15. The results show a complicated picture of pesticides loading from sugarcane runoff and its impact to lower water bodies. (1) For Atrazine, the loading mainly came from sugarcane site 2 in 2005. There was only small amount of Atrazine loading from the two sugarcane fields in 2006. SJCN showed trace amount of Atrazine in water. Unlike the nutrient analysis results overall, Atrazine concentration at the BC location was higher than the SJCS location, probably due to impact from other sugarcane fields. (2) For Metribuzin, SJCN showed highest concentration of all sampling locations, which ultimately affect Metribuzin concentration in BC and SJCS locations. Metribuzin loading came from the sugarcane 1 made more contribution than sugarcane 2. The Metribuzin loadings from the sugarcane runoff were greater in 2006 than in 2005. However, Metribuzin concentration at BC and SJCS locations was greater in 2005 than in 2006, a reverse order of loading from sugarcane runoff. The variations of Metribuzin concentration at BC and SJCS locations did not follow the peak loading period from sugarcane runoff, which suggests that background concentration (SJCN) and sources from other sugarcane fields in the watershed played more significant role. Pesticides are trace species in water samples. Farmers are likely to apply different pesticides at different years to reach the best pest control efficiency. Thus, pesticide concentration in water samples may show larger variations than nutrient concentrations.

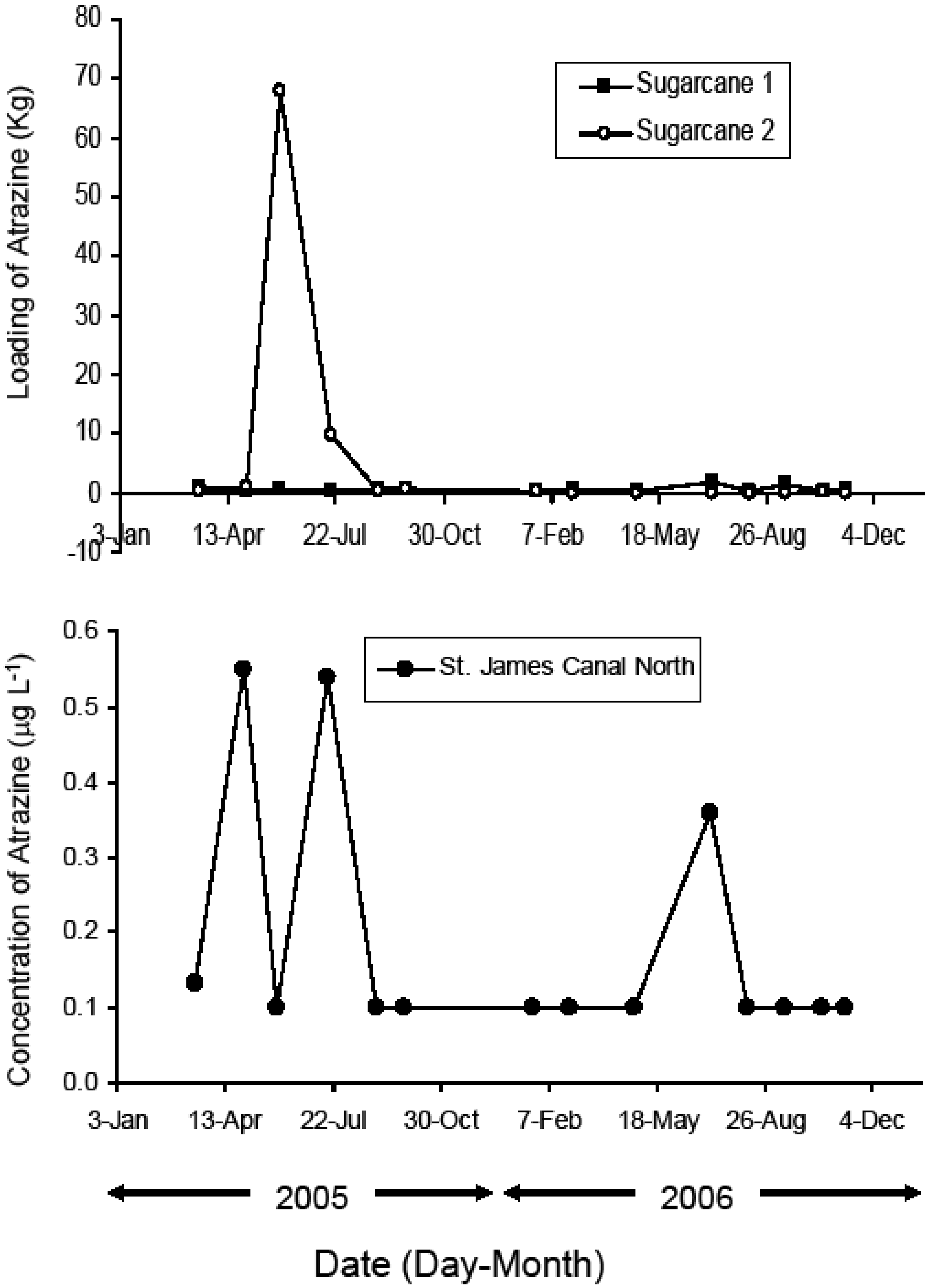

Figure 14. Loadings from the two sugarcane fields and concentrations of Atrazine at the St. James Canal North site.

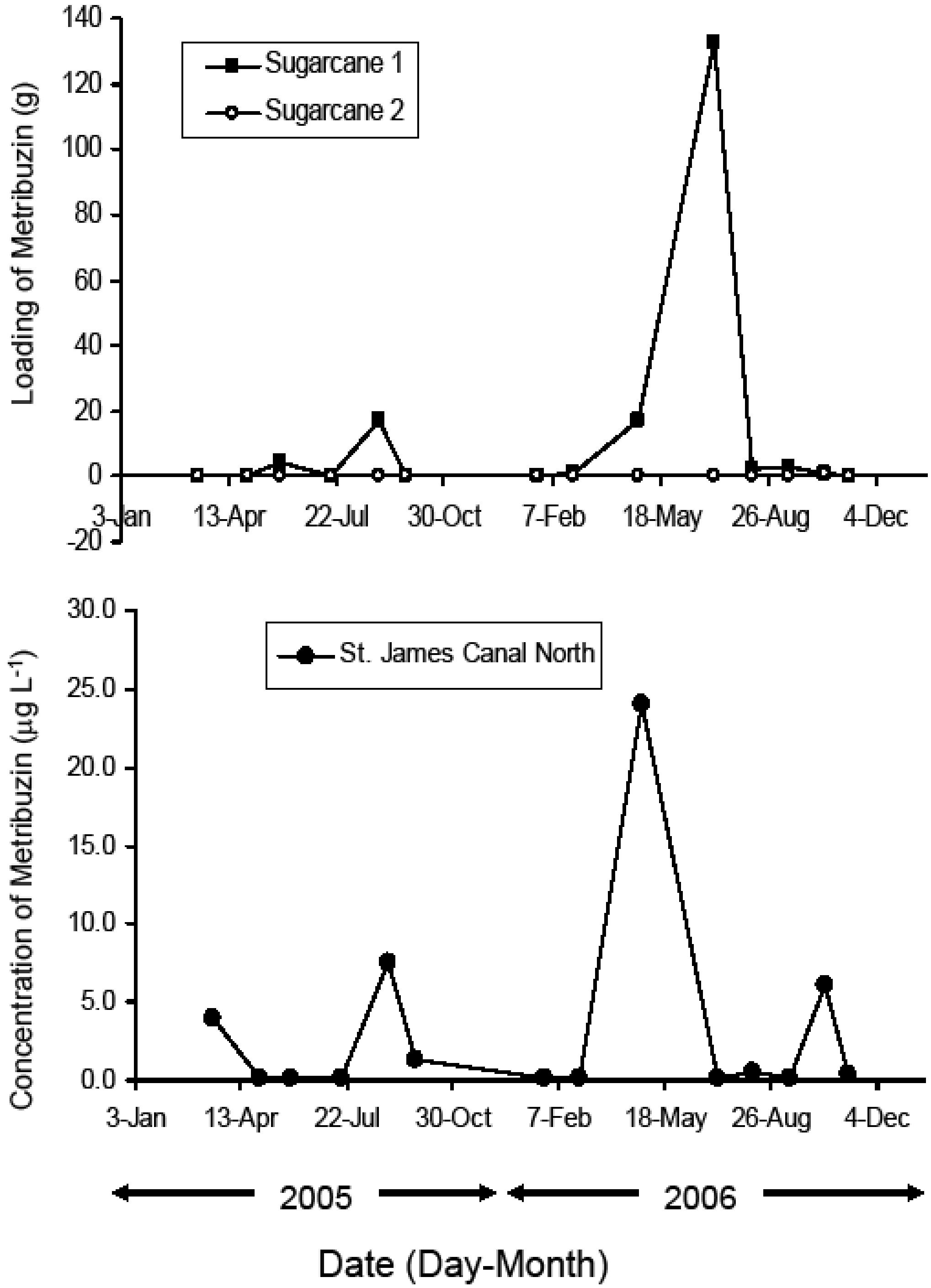

Figure 15. Loadings from the two sugarcane fields and concentrations of Metribuzin at the St. James Canal North site.

RECOMMENDATION FOR REDUCING SOLIDS, NUTRIENTS AND PESTICIDES LOADING

As shown by data in this study, nutrients, suspended solids, and pesticides are entering stream and water bodies in Barataria Basin as result of runoff from sugarcane fields. During major rainfall events in which runoff from sugarcane occurs there was a parallel spike in nutrients, and suspended solids in St. James Canal South, which flows directly into other stream and water bodies.

Agricultural runoff associated with sugarcane production on the elevated natural levees of the Mississippi River is directed through a series of lateral drains that connect to major drainage ditches or canals. These ditches or canals funnel runoff along an elevation gradient to connecting stream water bodies in the Barataria Basin. There is little or no contact with any buffer strips including wetland buffer, which would reduce the amount of suspended sediment, nutrients and pesticides, etc. from entering stream and water bodies within the watershed.

The amount and distribution of the input varied, likely dependent on rainfall, amounts and timing of application of agricultural chemicals and season. The reduction or elimination of these inputs would be a vital step in the restoration of water quality.

A method to reduce amount of nutrients and suspended solids entering receiving stream and water bodies would be vegetative filter strips, sometimes referred to as filter strip or buffer strip, in areas where runoff water leaves a field. Another alternative would be to direct the runoff through a forested wetland. Filter strip or forested wetland is designed to filter out the sediment, organic materials, nutrients, and chemicals carried in runoff water. A vegetative filter strips or wetland is a useful best management practice to reduce the amount of sediment, nutrients and pesticides leaving a field and entering surface water. Effectiveness would depend on soil characteristics, drainage area size, quality of vegetation land use and climate. A filter strip is an edge-of-field best management practice for reducing runoff of soil and contaminants; but should be used in combination with other in-field practices to have the greatest impact on improving and protecting water quality. Vegetative filter strips are most effective at removing sediment, nitrogen, phosphorus and pesticides bound to soil particles.

Filter strips and/or wetland capture sediment and organic material by slowing runoff water. Leaving water is slowed, larger soil and organic particles rapidly settle out. Similar clay particles need greater flow distance to settle out in the filter. Therefore, a large strip width is needed for removing finer soil particle. Moreover, nitrate removal in filter strip mainly occur either as denitrification or plant root uptake. Filter strips work best when water flows at a shallow uniform depth across the filter. If water becomes concentrated in small channels, the effectiveness of the strip is drastically reduced.

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American Sugarcane League, 2000.

Louisiana Department of Environmental Quality, 2002. Water Quality Management Plan, Water Quality Inventory, Section 305(b)/303(d).

Louisiana Extension Service Pub. 2382.

Louisiana Extension Service, 1995.

US EPA, 1999. Methods and guidance for the analysis of water, Version 2. [CD ROM].

Attachment I: Site photos at each sampling event

for

FINAL REPORT

Water Quality of Upper Barataria Basin: Impact of Nonpoint Source Pollution Associated with Sugarcane Production

Barataria-Terrebonne National Estuary Program (BTNEP)

Co sponsored by Louisiana DEQ

Contract Number CFMS 597524, Grant Number C9-996102-08

Sampling Event on March 17, 2005 (# 1, 2005)

Sampling Event on May 1, 2005 (# 2, 2005)

Sampling Event on May 31, 2005 (# 3, 2005)

Sampling Event on July 17, 2005 (# 4, 2005)

Sampling Event on August 31, 2005 (# 5, 2005)

Sampling Event on September 25, 2005 (# 6, 2005)

Sampling Event on January 24, 2006 (# 1, 2006)

Sampling Event on February 26, 2006 (# 2, 2006)

Sampling Event on April 27, 2006 (# 3, 2006)

Sampling Event on July 07, 2006 (# 4, 2006)

Sampling Event on August 10, 2006 (# 5, 2006)

Sampling Event on September 13, 2006 (# 6, 2006)

Sampling Event on October 17, 2006 (# 7, 2006)

Sampling Event on November 08, 2006 (# 8, 2006)

Attachment II: Original data of analysis at each sampling event

for

FINAL REPORT

Water Quality of Upper Barataria Basin: Impact of Nonpoint Source Pollution Associated with Sugarcane Production

Barataria-Terrebonne National Estuary Program (BTNEP)

Co sponsored by Louisiana DEQ

Contract Number CFMS 597524, Grant Number C9-996102-08

Date: 3/17/2005 Category: Nutrient		
Site	Analyte	Result (ppm)
St. James Canal North	Ammonia (as NH3-N)	0.145
St. James Canal North	Nitrate (as NO3-N)	2.20
St. James Canal North	Nitrite (as NO2-N)	0.01
St. James Canal North	Ortho Phosphate-P	0.005
St. James Canal North	Phosphate-P	0.005
St. James Canal North	Phosphorus-P	1.64
St. James Canal North	Suspended Solids	92.2
St. James Canal North	Total Kjeldahl Nitrogen	0.5
Date: 3/17/2005 Category: Pesticides		
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.1
St. James Canal North	Cyfluthrin	0.125
St. James Canal North	Estenvalerate	0.125
St. James Canal North	Lambda-cyhalothrin	0.1
St. James Canal North	Metribuzin	42.7
St. James Canal North	Pendamethalin	0.1
St. James Canal North	Terbacil	0.25
St. James Canal North	Trifluralin	0.1

Date: 5/1/2005 Category: Nutrient		
Site	Analyte	Result (mg/L)
St. James Canal North	Total Phosphate Persulfate-P	3.33
St. James Canal North	Dissolved Phosphorous-P	3.02
St. James Canal North	Nitrate + Nitrite -N	5.11
St. James Canal North	Total Ammonia Nitrogen-N	1.61
St. James Canal North	Total Kjeldahl Nitrogen-N	4.536
St. James Canal North	Solids Analysis	56
Date: 5/1/2005 Category: Pesticides		
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.55
St. James Canal North	Cyfluthrin	0.1
St. James Canal North	Estenvalerate	0.1
St. James Canal North	Lambda-cyhalothrin	0.1
St. James Canal North	Metribuzin	0.1
St. James Canal North	Pendamethalin	0.1
St. James Canal North	Terbacil	0.15
St. James Canal North	Trifluralin	0.1

Date: 5/31/2005 Category: Pesticides		
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.1
St. James Canal North	Cyfluthrin (Baythrold)	0.1
St. James Canal North	Estenvalerate (Asana)	0.1
St. James Canal North	Lambda-cyhalothrin (Karate)	0.1
St. James Canal North	Metribuzin (sencor)	0.1
St. James Canal North	Pendamethalin (Prowl)	0.1
St. James Canal North	Terbacil	0.15
St. James Canal North	Trifluralin (Treflan)	0.1

Date: 5/31/2005 Category: Nutrient		
Site	Analyte	Result (mg/L)
St. James Canal North	Total Phosphate Persulfate-P	2.23
St. James Canal North	Dissolved Phosphorous-P	0.85
St. James Canal North	Nitrate + Nitrite –N	5.324
St. James Canal North	Total Ammonia Nitrogen-N	0.459
St. James Canal North	Total Kjeldahl Nitrogen-N	1.122
St. James Canal North	Solids Analysis	59.1

Date: 7/17/2005 Category: Pesticides		
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.54
St. James Canal North	Cyfluthrin (Baythrold)	0.1
St. James Canal North	Estenvalerate (Asana)	0.1
St. James Canal North	Lambda-cyhalothrin (Karate)	0.1
St. James Canal North	Metribuzin (sencor)	0.1
St. James Canal North	Pendamethalin (Prowl)	0.1
St. James Canal North	Terbacil	0.15
St. James Canal North	Trifluralin (Treflan)	0.1

Date: 7/17/2005 Category: Nutrient		
Site	Analyte	Result (mg/L)
St. James Canal North	Total Phosphate Persulfate-P	0.7
St. James Canal North	Dissolved Phosphorous-P	0.35
St. James Canal North	Nitrate + Nitrite –N	3.424
St. James Canal North	Total Ammonia Nitrogen-N	0.078
St. James Canal North	Total Kjeldahl Nitrogen-N	0.284
St. James Canal North	Solids Analysis	176

Date: 8/31/2005 Category: Pesticides		
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.1
St. James Canal North	Cyfluthrin (Baythrold)	0.1
St. James Canal North	Estenvalerate (Asana)	0.1
St. James Canal North	Lambda-cyhalothrin (Karate)	0.1
St. James Canal North	Metribuzin (sencor)	7.58
St. James Canal North	Pendamethalin (Prowl)	0.1
St. James Canal North	Terbacil	0.15
St. James Canal North	Trifluralin (Treflan)	0.1
Date: 8/31/2005 Category: Nutrient		
Site	Analyte	Result (mg/L)
St. James Canal North	Total Phosphate Persulfate-P	1.91
St. James Canal North	Dissolved Phosphorous-P	1.12
St. James Canal North	Nitrate + Nitrite -N	0.258
St. James Canal North	Total Ammonia Nitrogen-N	0.371
St. James Canal North	Total Kjeldahl Nitrogen-N	2.265
St. James Canal North	Solids Analysis	184

Date: 9/25/2005 Category: Pesticides		
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.1
St. James Canal North	Cyfluthrin (Baythrold)	0.1
St. James Canal North	Estenvalerate (Asana)	0.1
St. James Canal North	Lambda-cyhalothrin (Karate)	0.1
St. James Canal North	Metribuzin (sencor)	1.3
St. James Canal North	Pendamethalin (Prowl)	0.1
St. James Canal North	Terbacil	0.15
St. James Canal North	Trifluralin (Treflan)	0.1
Date: 9/25/2005 Category: Nutrient		
Site	Analyte	Result (mg/L)
St. James Canal North	Total Phosphate Persulfate-P	1.98
St. James Canal North	Dissolved Phosphorous-P	1.01
St. James Canal North	Nitrate + Nitrite -N	0.257
St. James Canal North	Total Ammonia Nitrogen-N	0.695
St. James Canal North	Total Kjeldahl Nitrogen-N	2.681
St. James Canal North	Solids Analysis	81

	Date: 1/24/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	1.06
St. James Canal North	Nitrate + Nitrite	0.528
St. James Canal North	Solids Analysis	42.4
St. James Canal North	Total Ammonia Nitrogen	<0.02
St. James Canal North	Total Kjeldahl Nitrogen	2.172
St. James Canal North	Total Phosphate Persulfate	2.95
	Date: 1/24/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Terbacil	ND @ 0.90 ppb
St. James Canal North	Trifluralin (Treflan)	no results ppb
St. James Canal North	Atrazine	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	ND @ 0.20 ppb
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.40 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb

	Date: 2/26/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	1.183
St. James Canal North	Nitrate + Nitrite	0.547
St. James Canal North	Solids Analysis	96
St. James Canal North	Total Ammonia Nitrogen	<0.02
St. James Canal North	Total Kjeldahl Nitrogen	1.212
St. James Canal North	Total Phosphate Persulfate	1.85
	Date: 2/26/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Terbacil	ND @ 0.30 ppb
St. James Canal North	Trifluralin (Treflan)	ND @ 0.20 ppb
St. James Canal North	Atrazine	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	ND @ 0.20 ppb
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb

	Date: 4/27/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	2.1
St. James Canal North	Nitrate + Nitrite	1.542
St. James Canal North	Solids Analysis	45
St. James Canal North	Total Ammonia Nitrogen	0.441
St. James Canal North	Total Kjeldahl Nitrogen	4.167
St. James Canal North	Total Phosphate Persulfate	2.99
	Date: 4/27/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Estenvalerate (Asana)	<0.20 ppb
St. James Canal North	Terbacil	<0.30 ppb
St. James Canal North	Trifluralin (Treflan)	<0.40 ppb
St. James Canal North	Atrazine	<0.20 ppb
St. James Canal North	Metribuzin (sencor)	24 ppb
St. James Canal North	Pendamethalin (Prowl)	<0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	<0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	<0.20 ppb

	Date: 7/7/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	2.02
St. James Canal North	Nitrate + Nitrite	0.074
St. James Canal North	Solids Analysis	7
St. James Canal North	Total Ammonia Nitrogen	0.151
St. James Canal North	Total Kjeldahl Nitrogen	1.032
St. James Canal North	Total Phosphate Persulfate	1.87
	Date: 7/7/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	0.36
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	ND @ 0.20 ppb
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.20 ppb
St. James Canal North	Terbacil	ND @ 0.30 ppb
St. James Canal North	Trifluralin (Treflan)	ND @ 0.40 ppb

	Date: 8/10/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	0.71
St. James Canal North	Nitrate + Nitrite	4.22
St. James Canal North	Solids Analysis	244
St. James Canal North	Total Ammonia Nitrogen	<0.025
St. James Canal North	Total Kjeldahl Nitrogen	1.14
St. James Canal North	Total Phosphate Persulfate	1.22
	Date: 8/10/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	ND @ 0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	0.54
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.20 ppb
St. James Canal North	Terbacil	not reportable
St. James Canal North	Trifluralin (Treflan)	ND @ 0.20 ppb

	Date: 9/13/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	0.451
St. James Canal North	Nitrate + Nitrite	0.796
St. James Canal North	Solids Analysis	8.5
St. James Canal North	Total Ammonia Nitrogen	0.176
St. James Canal North	Total Kjeldahl Nitrogen	1.83
St. James Canal North	Total Phosphate Persulfate	0.64
	Date: 9/13/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	ND @ 0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	ND @ 0.20 ppb
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.20 ppb
St. James Canal North	Terbacil	ND @ 0.50 ppb
St. James Canal North	Trifluralin (Treflan)	ND @ 0.20 ppb

	Date: 10/17/2006 Category: Nutrient	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	1.152
St. James Canal North	Nitrate + Nitrite	2.302
St. James Canal North	Solids Analysis	187.7
St. James Canal North	Total Ammonia Nitrogen	0.131
St. James Canal North	Total Kjeldahl Nitrogen	2.514
St. James Canal North	Total Phosphate Persulfate	2.34
	Date: 10/17/2006 Category: Pesticides	
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	ND @ 0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	6.09
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.20 ppb
St. James Canal North	Terbacil	ND @ 0.20 ppb
St. James Canal North	Trifluralin (Treflan)	ND @ 0.20 ppb

	Date: 11/8/**2006** **Category: Nutrient**	
Site	Analyte	Result (mg/L)
St. James Canal North	Dissolved Phosphorous	0.79
St. James Canal North	Nitrate + Nitrite	1.064
St. James Canal North	Solids Analysis	48
St. James Canal North	Total Ammonia Nitrogen	3.66
St. James Canal North	Total Kjeldahl Nitrogen	1.764
St. James Canal North	Total Phosphate Persulfate	1.02
	Date: 11/8/**2006** **Category: Pesticides**	
Site	Analyte	Result (ppb)
St. James Canal North	Atrazine	ND @ 0.20 ppb
St. James Canal North	Cyfluthrin (Baythrold)	ND @ 0.20 ppb
St. James Canal North	Estenvalerate (Asana)	ND @ 0.20 ppb
St. James Canal North	Lambda-cyhalothrin (Karate)	ND @ 0.20 ppb
St. James Canal North	Metribuzin (sencor)	0.4
St. James Canal North	Pendamethalin (Prowl)	ND @ 0.20 ppb
St. James Canal North	Trifluralin (Treflan)	ND @ 0.20 ppb