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TURKEY CREEK WATERSHED MANAGEMENT PROGRAM

WATER QUALITY MONITORING PLAN FOR THE

WATER CONTROL DISTRICT OF SOUTH BREVARD

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CZM CONTRACT No. CM252
FINAL REPORT

December 1990

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801/B

EXECUTIVE SUMMARY

The Water Control District of South Brevard (WCDSB) maintains a large canal network which drains over 99 square miles in South Brevard County between the lower St. Johns River and the Indian River Lagoon. Surface drainage from this area is routed through a large canal system discharging through the MS-1 structure to Turkey Creek which then flows onto the Indian River Lagoon. There has been research undertaken by the St. Johns River Water Management District, the Florida Department of Environmental Regulation, and the Florida Institute of Technology in the last few years surrounding water quality issues within the WCDSB and downstream of the WCDSB in Turkey Creek. Current plans to divert flow from the WCDSB to the lower St. Johns River has also increased attention to water quality issues surrounding WCDSB discharges.

To prepare for future water quality monitoring of their canal system, the WCDSB developed this water quality monitoring plan for future implementation when funds permit. The plan calls for baseline water quality monitoring of each major lateral to canal C-1 as well as storm event sampling and baseline monitoring at each discharge point from the WCDSB jurisdiction. Parameters recommended for sampling include mostly nutrients and suspended solids and some metals. Frequency of sampling, parameters to be sampled and sampling locations were recommended on the basis of pertinent water quality concerns and cost factors. The costs presented are estimates only and are subject to change depending on the sampling undertaken, the timeframe, and the selected Contractor's lab analysis and labor fees.

1.0 INTRODUCTION

The Water Control District of South Brevard (WCDSB) maintains a large canal network which drains over 99 square miles in South Brevard County between the lower St. Johns River and the Indian River Lagoon. The majority of land use within the District consists of suburban residential or agricultural (rangeland) uses. Currently, surface drainage from this area is routed through a large canal system discharging through the MS-1 structure to Turkey Creek which then flows onto the Indian River Lagoon.

Historically, the western portion of the District was part of the lower St. Johns River marsh. However, in 1922 the WCDSB canal system was created and drainage was diverted to Turkey Creek. Recently, the St. Johns River Water Management District and the WCDSB have discussed restoring some of the historical flow from the WCDSB to the St. Johns River. The preliminary plan is to divert C-1 water westward towards a proposed settling pond to be located on the west end of C-1 and from there the water will flow through a natural wet-lands flow-way to the south of the proposed pond and eventually end up in the lower St. Johns River. This will divert some of the flow currently discharged to Turkey Creek and the Indian River Lagoon over to the lower St. Johns River when it is implemented.

The WCDSB has an interest in preparing for future water quality monitoring of their canal system and discharges to waters of the State. There are several objectives for a water quality monitoring program within the WCDSB. The first objective would be to monitor the nutrient loadings and toxics levels in the surface water discharges to the Turkey Creek and/or the lower St. Johns River. Turkey Creek discharges to the Indian River Lagoon which has recently been designated a National Marine Estuary. Recent research document concerns about the WCDSB discharges in terms of suspended matter (Trefrey, 1989), nutrients (Dierberg, 1990 and FDER, 1990) and salinities which may affect the shellfish industry in the Lagoon (Steward, 1989). The lower St. Johns River has been designated as Class I waters of the State, therefore if any WCDSB drainage is diverted to the St. Johns, those discharges must also be monitored, but more specifically for Class I water quality standards. A third objective of water quality monitoring within the WCDSB is to monitor nutrient fluxes per unit area for each of the major subbasins within the District and to observe whether or not storm-water BMP's (Best Management Practices) which may be implemented in the future will be effective in reducing pollutant loadings. A fourth objective of a water quality monitoring program within the WCDSB is to prepare for any future stormwater regulatory programs which may be implemented by the WCDSB and to prepare the WCDSB for any regulatory requirements put on the discharges to the St. Johns and the Indian River Lagoon by the NPDES (National Pollutant Discharge Elimination System) Program. The Contractor who performs the water quality sampling must be aware that the NPDES program has the potential to affect the parameters recommended here for sampling. To meet these objectives, this water quality monitoring plan was developed as part of a Coastal Zone

Management Grant administered by the Florida Department of Environmental Regulation.

2.0 PROPOSED MONITORING

The proposed water quality monitoring network is designed to provide consistently reliable scientific data which will support the long-term monitoring objectives of the WCDSB. This sampling plan will be designed to monitor yearly discharge concentrations during base flow conditions and during storm events. The monitoring network will include bi-monthly grab sampling, automated stormwater sampling and continuous discharge measurements. This plan of water quality sampling was developed with valuable inputs from individuals with the WCDSB, Florida Department of Environmental Regulation (FDER), St. Johns River Water Management District (SJRWMD) and Florida Institute of Technology (FIT).

GRAB SAMPLING

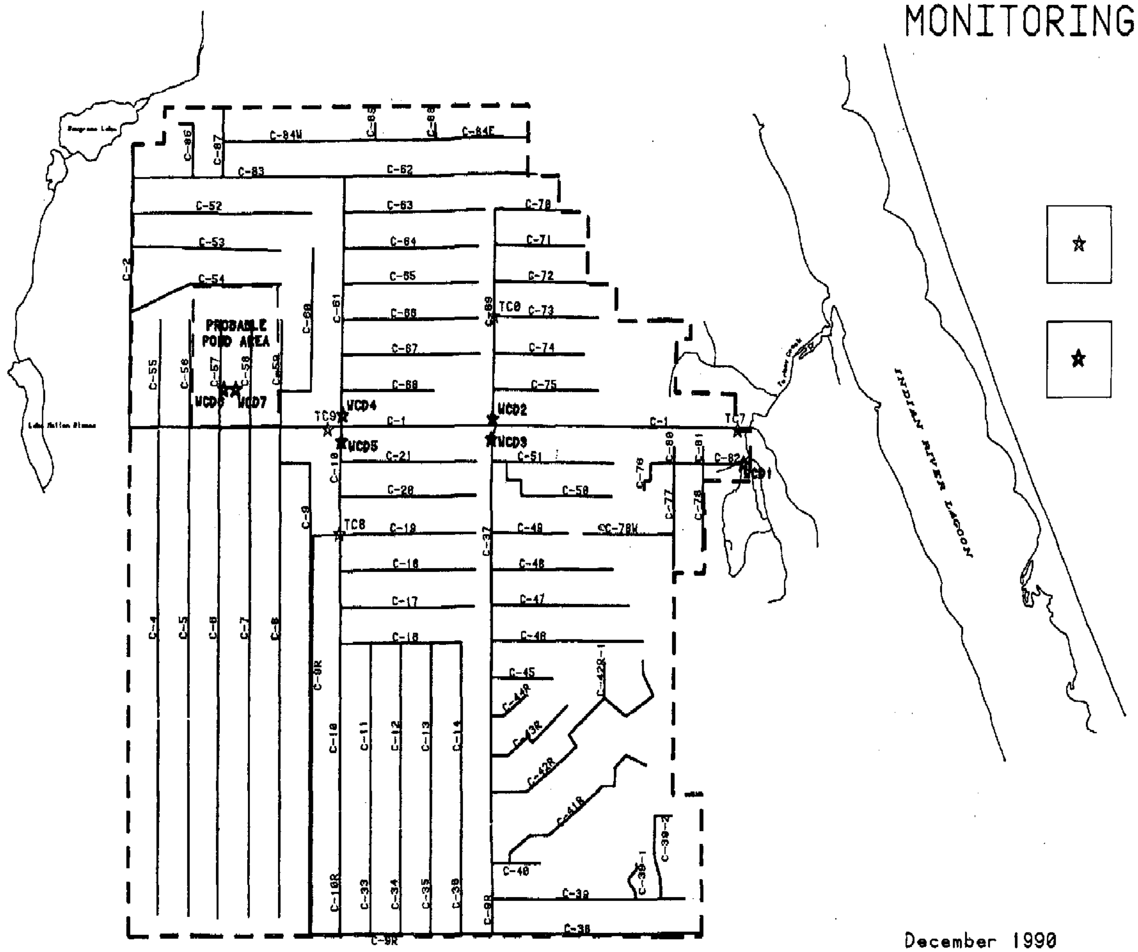
Baseline water quality grab samples will be collected on a bi-monthly basis at the locations shown in Figure 1. Stations were selected based upon the extent and drainage of major sub-basins within the WCDSB and the location of four main lateral canals (Figure 2). Land uses within the major sub-basins vary, however the majority of land uses fall within residential, residential under construction, or agricultural categories (Figure 3). Several sampling locations are proposed at sites which are currently active USGS stream gaging stations and where the SJRWMD and FIT have recently collected water quality samples (shown in red on Figure 1). Additional sampling stations are to be established at the WCDSB water control structure (MS1) and at the discharge of C-82, the only canal within the WCDSB that enters Turkey Creek without passing through C-1 and through the MS1 structure (shown in green on Figure 1). Due to the expected western diversion and construction of a flow-way and settling pond by the SJRWMD in the western part of the WCDSB, monitoring stations are also proposed at the planned inflow and outflow structures of the pond. Since the ponds have not been designed as of this writing, the sampling locations in these areas are approximations. The proposed sampling stations for this plan are described below:

TCO located in the Minton Road canal at the north side of the intersection at Emerson and Minton Roads. There is a USGS gaging station located at this location.

TC8 located on C-10, downstream of C-19. A USGS gaging station is located just downstream at the Malabar Bridge.

TC9 located on C-1, 400 m west of where C-10 and C-62 intersect with C-1. This is also a site of a USGS gaging station.

RECOMMENDED WATER QUALITY MONITORING SITES - WCDSB



Current Water Quality Monitoring Station

Proposed Water Quality Monitoring Station

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Figure 1

MAJOR SUBBASIN BOUNDARIES - WCDSB

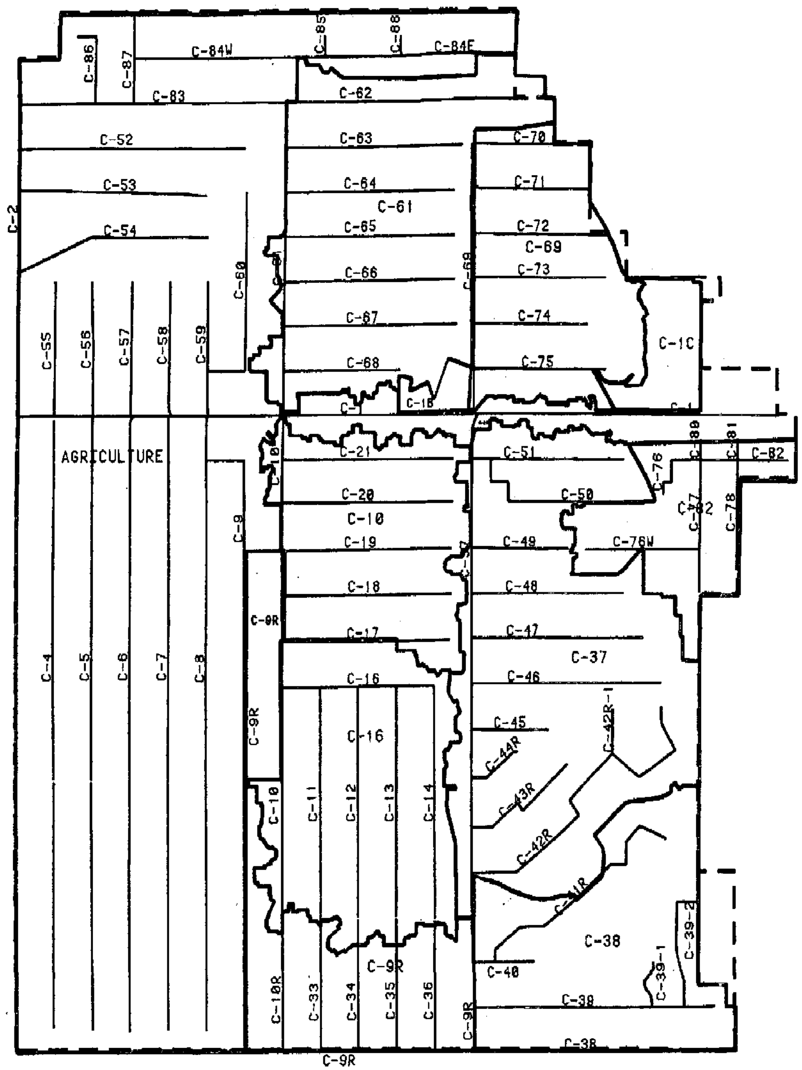

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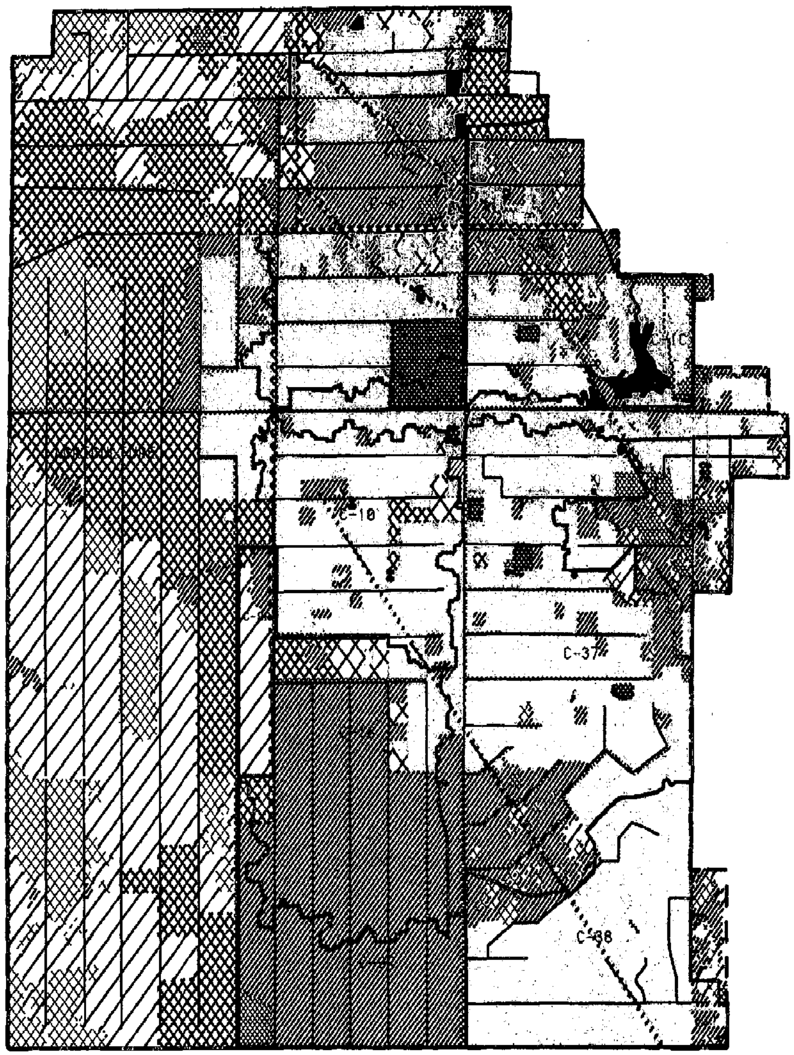
figure 2

WCDSB LANDUSE BY SUB-BASIN



- Residential
- Commercial
- Transportation
- Communications & Utilities
- Institutional
- Recreational
- Open, Altered & Extractive Lands
- Cropland & Pasture
- Orchards, Groves & Nurseries
- Specialty Agriculture
- Rangeland/Brushland
- Forested Uplands
- Water
- Wetlands

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Figure 3

MS1 located at the MS1 water control structure on C-1. Water levels are recorded continuously by use of a rating curve for the structure. This station currently receives runoff from 95 percent of the WCDSB drainage area before discharge into the headwaters of Turkey Creek.

WCD1 located at the terminus of C-82 is the only other discharge point to Turkey Creek. C-82 drains a land area of approximately 2,208 acres. Land use in this sub-basin consists of mixed urban uses.

WCD2 located just upstream of C-1 on C-69 this station receives runoff from approximately 3,712 acres, half of which is covered by residential development and the other half is forested uplands.

WCD3 located just upstream of C-1 on C-37, this station receives runoff from approximately 8,237 acres of primarily residential land use.

WCD4 located just upstream of C-1 on C-61, this station receives runoff from approximately 6,182 acres. Sixty (60) percent of this area is residential and 40 percent is forested uplands.

WCD5 located just upstream of C-1 on C-10, this station receives runoff from approximately 16,614 acres (in sub-basins C-10, C-16, C-9R and C-38) of primarily residential or residential under construction land use.

WCD6 is to be located at the inflow structure of a proposed off-line settling pond at the western end of C-1. The pond is a component of the SJRWMD's proposed future flow-way to the St. Johns River.

WCD7 is to be located at the outfall of the proposed off-line settling pond. This outfall will discharge directly into the SJRWMD flow-way and ultimately to the St. Johns River.

EXISTING STATIONS

Stations TCO, TC9 and TC8 were established by SJRWMD and have been the site of several recent water quality sampling efforts including investigations by Dr. John Trefry and Dr. Forrest Dierberg of FIT. These locations are also USGS continuous recording stream gaging stations. These stream gaging stations currently monitor flows from three WCDSB sub-basins which vary significantly in land use composition. Station TCO receives runoff from a developing urban area located within the City of Palm Bay, station TC8 is currently monitoring flows in an area of rapid residential development, and station TC9 is currently receiving drainage from approximately 24,000 acres of agricultural land use. Station TC9 may suffice as the monitoring site for inflows to the proposed settling pond when constructed.

PROPOSED NEW STATIONS

The installation of several new water quality monitoring stations is considered necessary to characterize water quality conditions within the major lateral canals (C-37, C-69, C-10 and C-61) upstream of the discharge point into C-1. These lateral canals drain approximately 60 percent of the entire WCDSB. Stations WCD 2 through 5 will provide data for the characterization of water quality in those major sub-basins which empty into C-1 and ultimately discharge to Turkey Creek through the MS1 structure. Station WCD 1 is located at the outfall point of C-82 which drains approximately 2,208 acres, or 13 percent of the WCDSB area. C-82 also discharges directly into a tributary of Turkey Creek without passing through the MS1 water control structure. Station MS1 has been established to further characterize water quality within C-1 before it discharges into Turkey Creek. Flows are estimated at this location by use of a discharge-rating curve developed for this presently operational water control structure.

Station WCD 6 and 7 will be established at the inflow and outfall locations of the proposed settling pond to be constructed as part of the western diversion. The data collected at these stations will be used after construction of the pond to determine the treatment efficiency of the pond before the water enters the proposed flow way (Figure 4). The settling pond, once constructed, will be the final point of discharge for a significant volume of runoff from the C-1 drainage area to the St. Johns River.

STORM EVENT SAMPLING

Storm events within the WCDSB are extremely important in the behavior of many total, dissolved, and particulate species of nutrients and metals. During most major storm events that were recently monitored, particulate organic nitrogen was observed by Dierberg (1990) as being mobilized the soonest in four out of five sub-basins studied. In the same study, nitrate-nitrite concentrations showed variable responses with rainfall. This was believed to be caused by the actions of several agricultural land owners who were retaining runoff on their land during storm events to fill small ponds. When rainfall exceeded the capacity of these ponds, water was then discharged over the dike and into the WCDSB canal system. Dr. Dierberg also found that several phosphorous species exhibited the traditional "first flush" response while dissolved organic carbon responded by gradual concentration increases (Figures 5 through 11). As indicated by these results, various targeted species have responded to storm events in variety of ways and in some instances may increase over extended periods of time. Given these results, any attempt to collect representative stormwater samples during major events must incorporate automated sampling over extended periods of time to ensure total hydrograph representation.

Dierberg (1990) also reports that one-third of the annual total nitrogen, one-half of the total phosphorous and one-fourth of the annual dissolved organic carbon were exported in C-1 water at the MS1 water control structure to downstream waters during a six-week period when three major storms occurred. Sediment

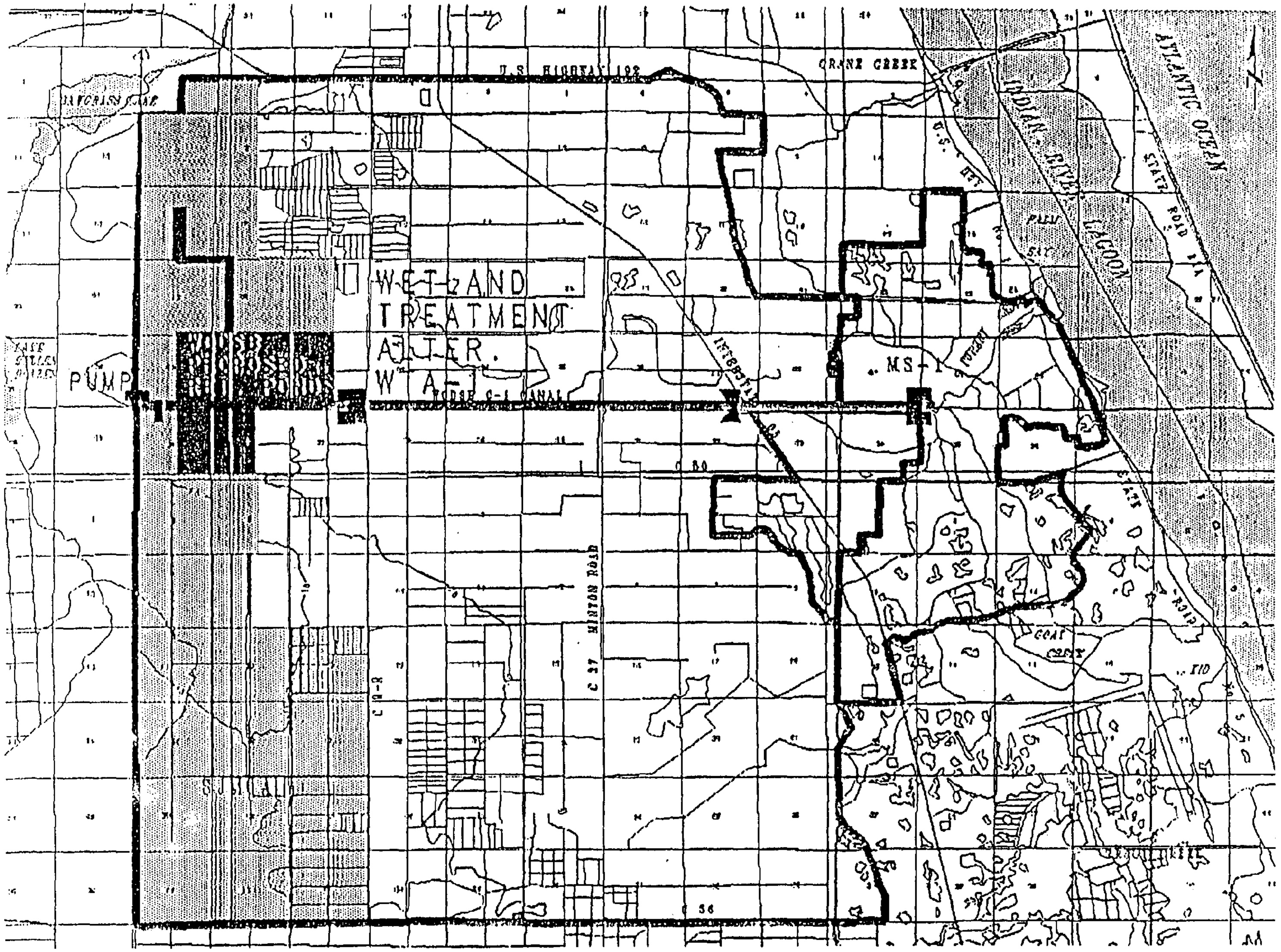


FIGURE 4 - Proposed Flow Way

Source: SJRWMD 1989

loading analyses specific to particulate nutrients and metals were conducted by Dr. John Trefry in investigations for the SJRWMD. Dr. Trefry's findings (Trefry et al 1989) included the following: "...high flows during January 1989 carried 240 metric tons of sediment through Turkey Creek in a 72 hour event. Such transport during a major storm event is equivalent to the amount of suspended sediment carried through Turkey Creek during 2-4 years of normal, non-storm flow."

To augment the bi-monthly grab sampling, storm event sampling will be conducted at stations TC7, TC9 and WCD1. Based upon USGS stream gaging records and Dr. Dierberg's studies, six to eight storms should be captured yearly to provide a representative sample. The storm event sampling should be spread over the entire year to allow for variability caused by seasonality. Since it is sometimes impossible to mobilize personnel during storms events and since storm sampling can be dangerous, the proposed monitoring network will be outfitted with ISCO automatic sampling devices equipped with water level actuators. Approximate stage-discharge relationships for storms previously monitored by Dierberg (1990) will be used to initially set the ISCO water level actuator. Since all of the stormwater sampling locations are also continuous stream gaging sites, each of these locations will be equipped with a water level indicator consisting of a data logger and pressure probe. The data logger will record water levels continuously and will, therefore, provide flow data throughout the storm event. Each captured storm event will also consist of at least 6 to 8 water quality samples composited over the entire hydrograph (see hydrographs in Figures 5-11). WCDSB field personnel will be utilized to retrieve and ship samples when events terminate (i.e., when normal baseline flow conditions return).

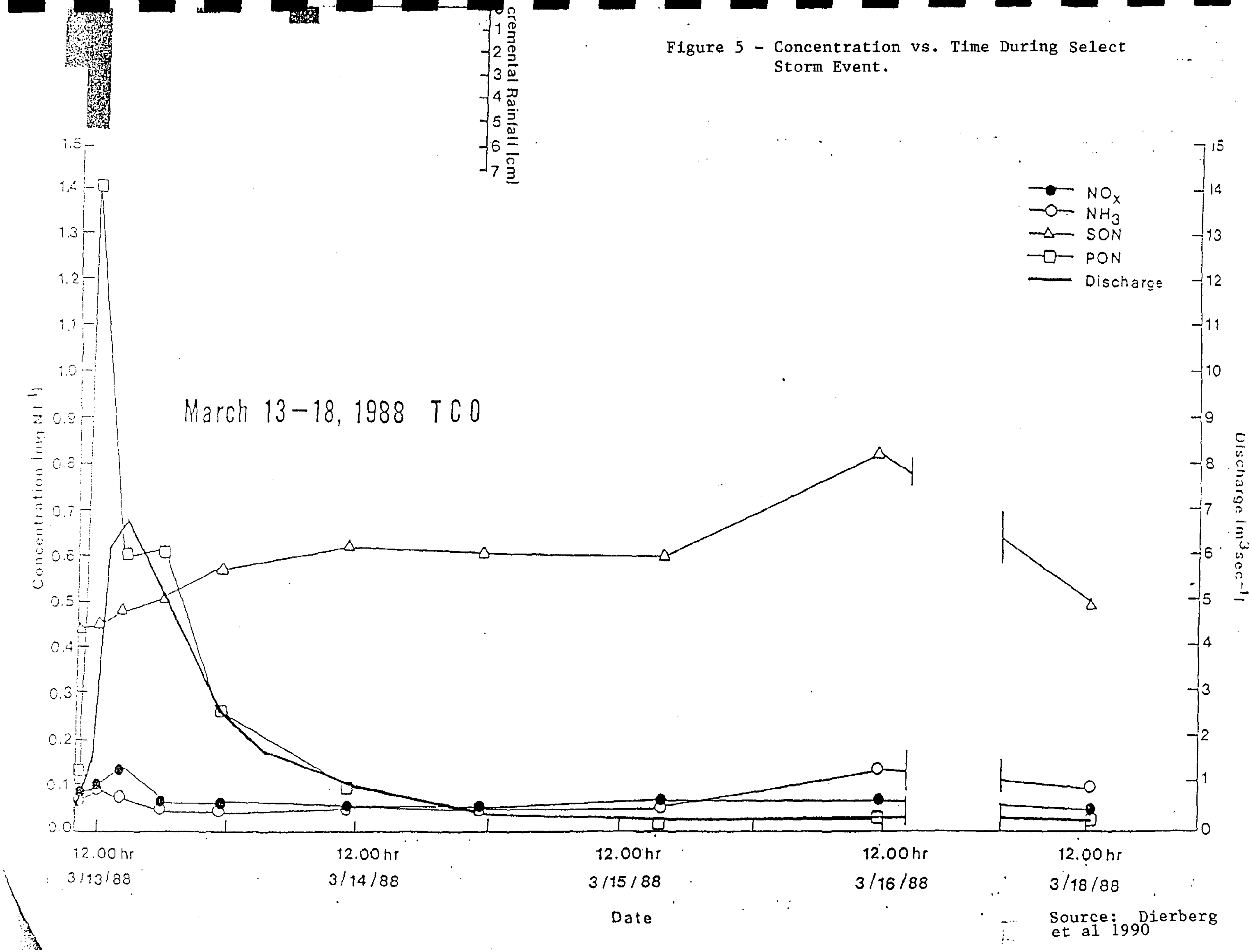
DISCHARGE GAGING

To estimate mass discharge of pollutants, water discharge rates will need to be determined at selected locations. This plan provides for collection of this information by proposing five new streamflow gaging locations in the WCDSB in addition to the four current USGS streamflow gaging stations at TC9, TC7, TC0 and TC8, as indicated on Figure 1. Continuous discharge hydrographs will be developed at each of those locations through application of standard procedures as described below. There are site specific conditions that require consideration, however, and these are discussed further in the next section.

Hydrologic and Hydraulic Conditions within the Watershed

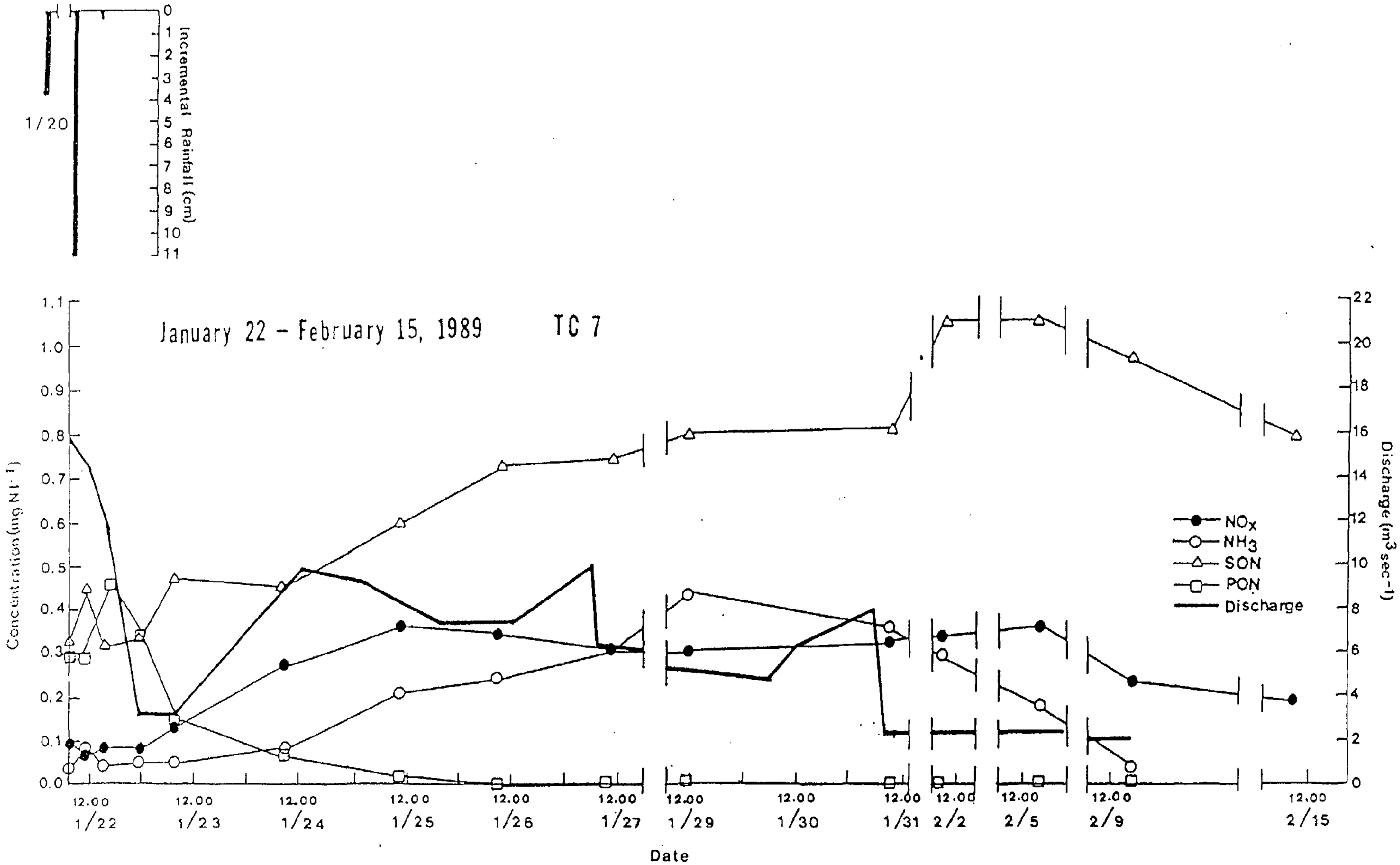
The watershed covers approximately 99 square miles and the relief within that area is less than 20 to 25 feet. The drainage system is almost entirely a man-made system of interconnected canals. There is no long-term discharge data within the watershed, although four USGS streamflow gaging stations have been established within the last year. The "normal" discharge from the MS-1 water control structure at the outlet of the watershed is believed to be approximately 200 cfs or 27 inches/year (Pennell, 1990). This is a relatively high runoff rate, amounting to approximately 2 cfs/sq mile, which indicates that groundwater discharge is a significant component of the discharge.

Figure 5 - Concentration vs. Time During Select Storm Event.



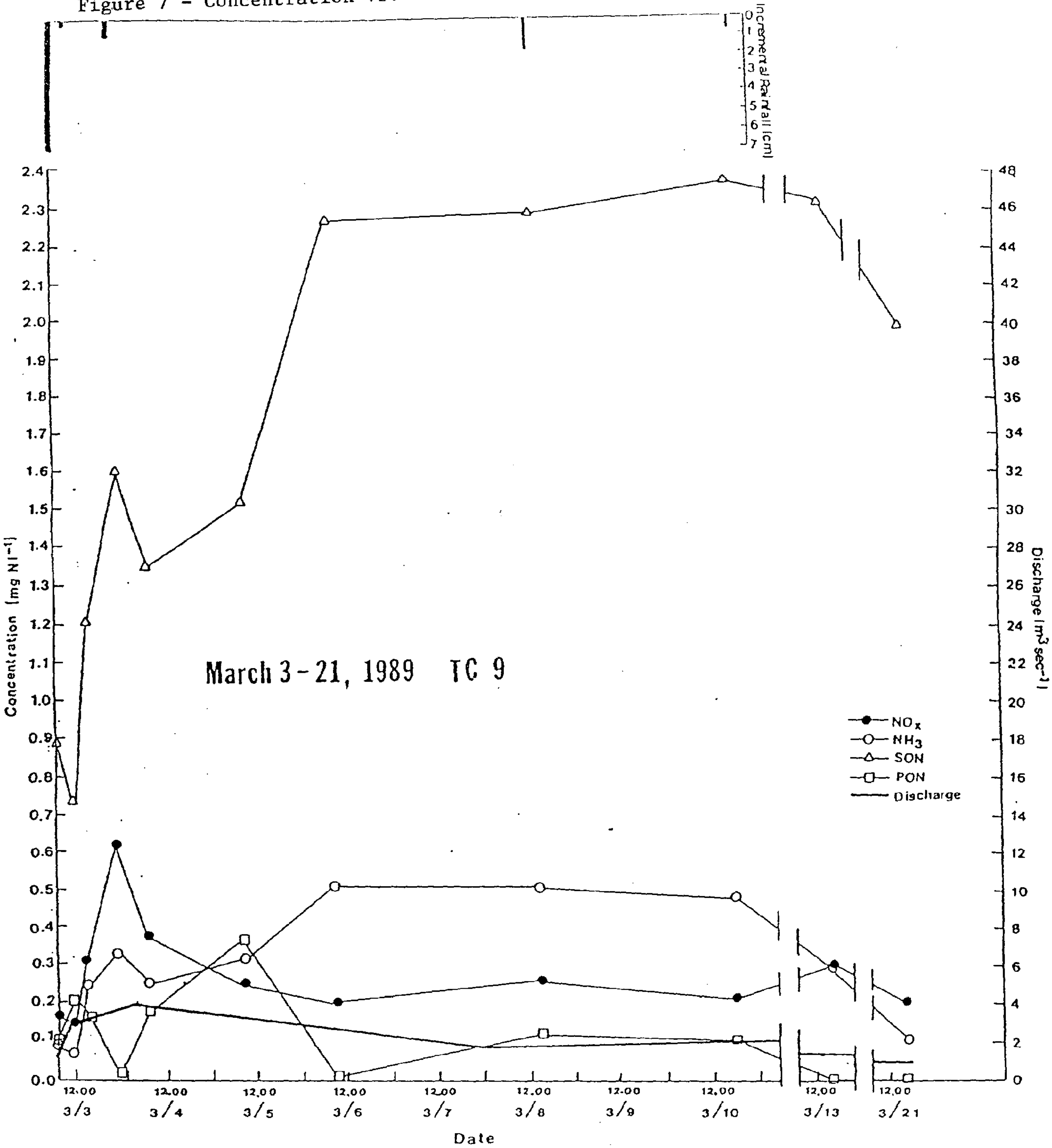
Source: Dierberg et al 1990

Figure 6 - COncentration vs. Time During Select Storm Events



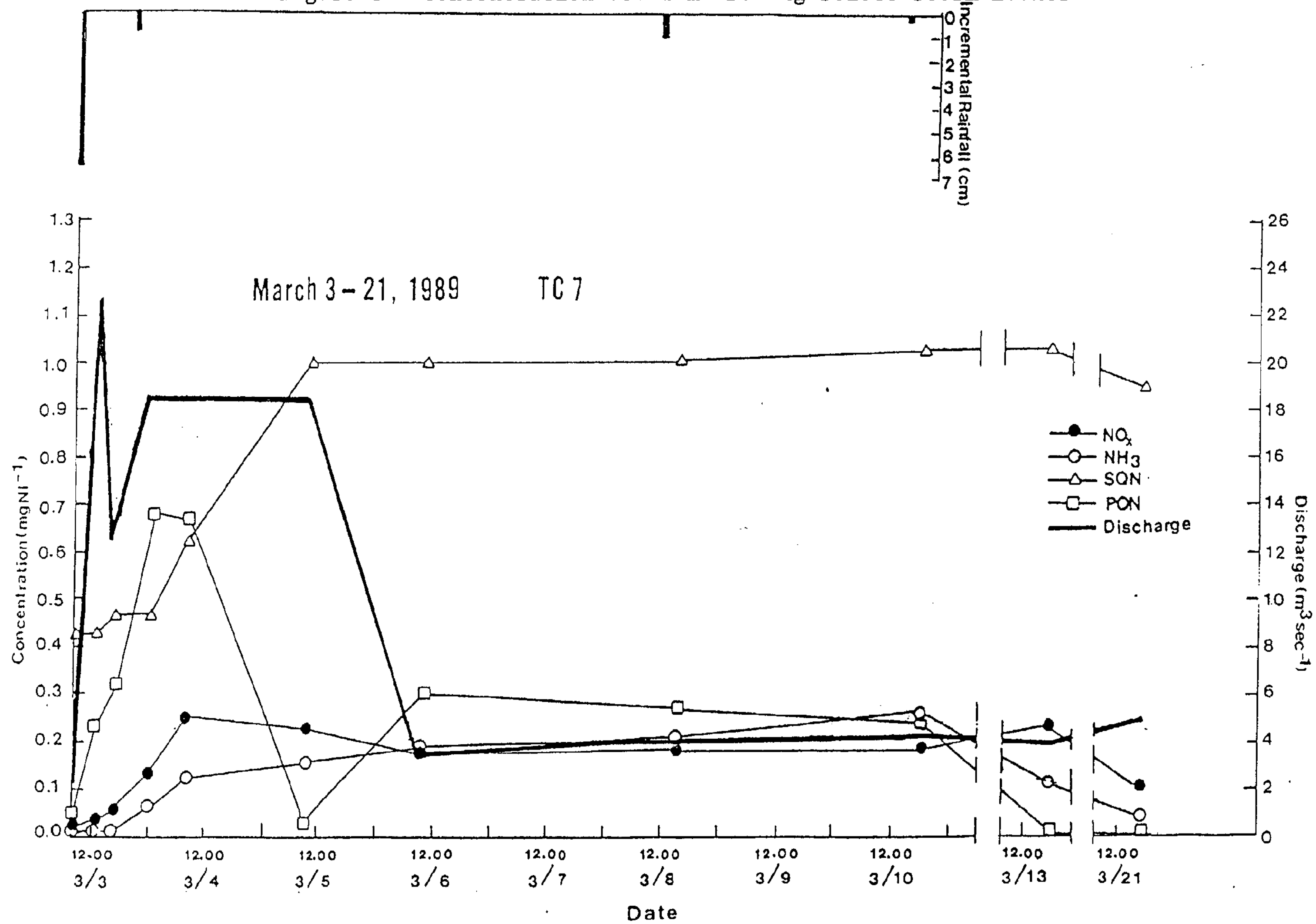
Source: Dierberg et al 1990

Figure 7 - Concentration vs. Time During Select Storm Events



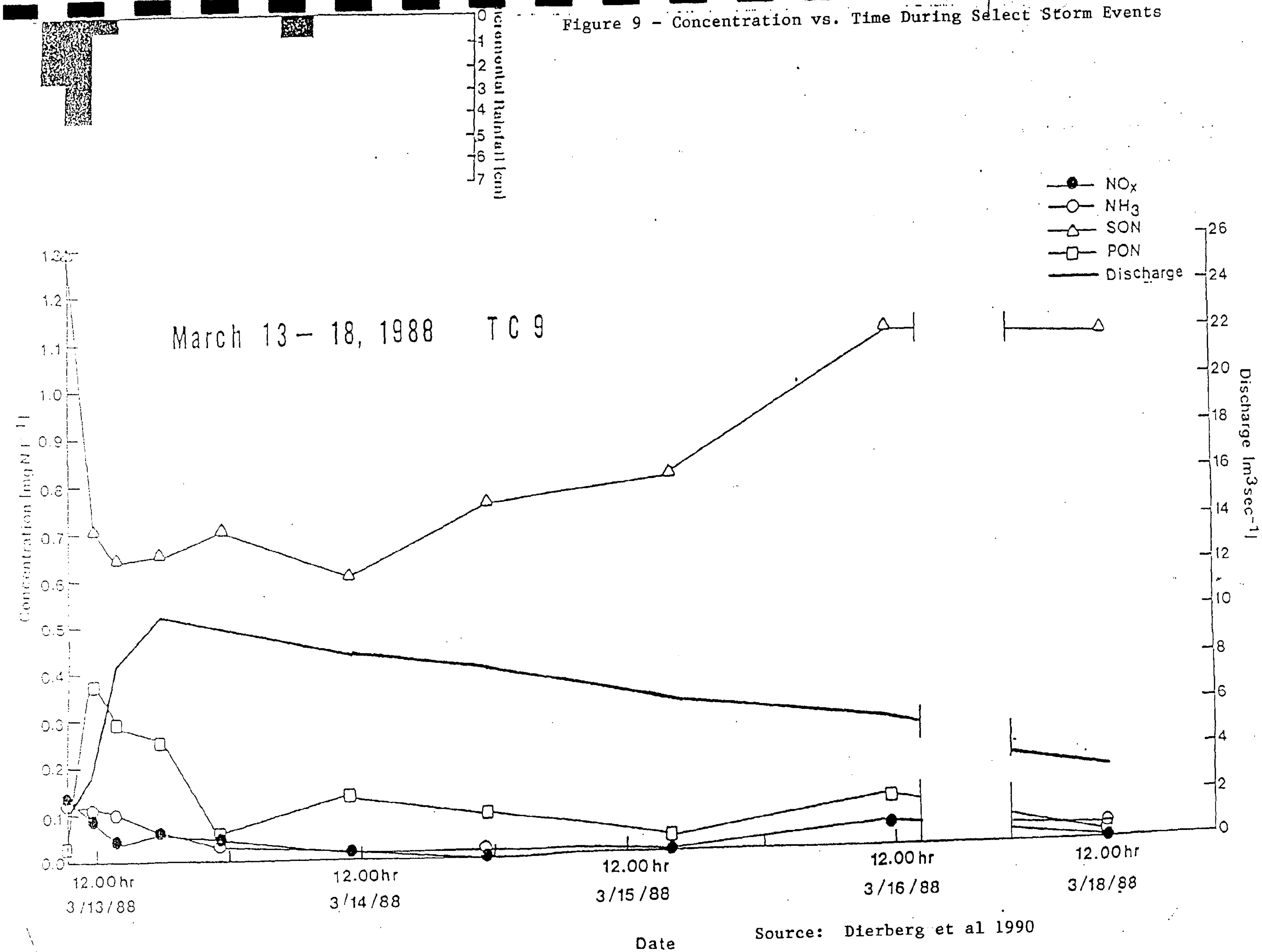
Source: Dierberg et al 1990

Figure 8 - Concentration vs. Time During Select Storm Events



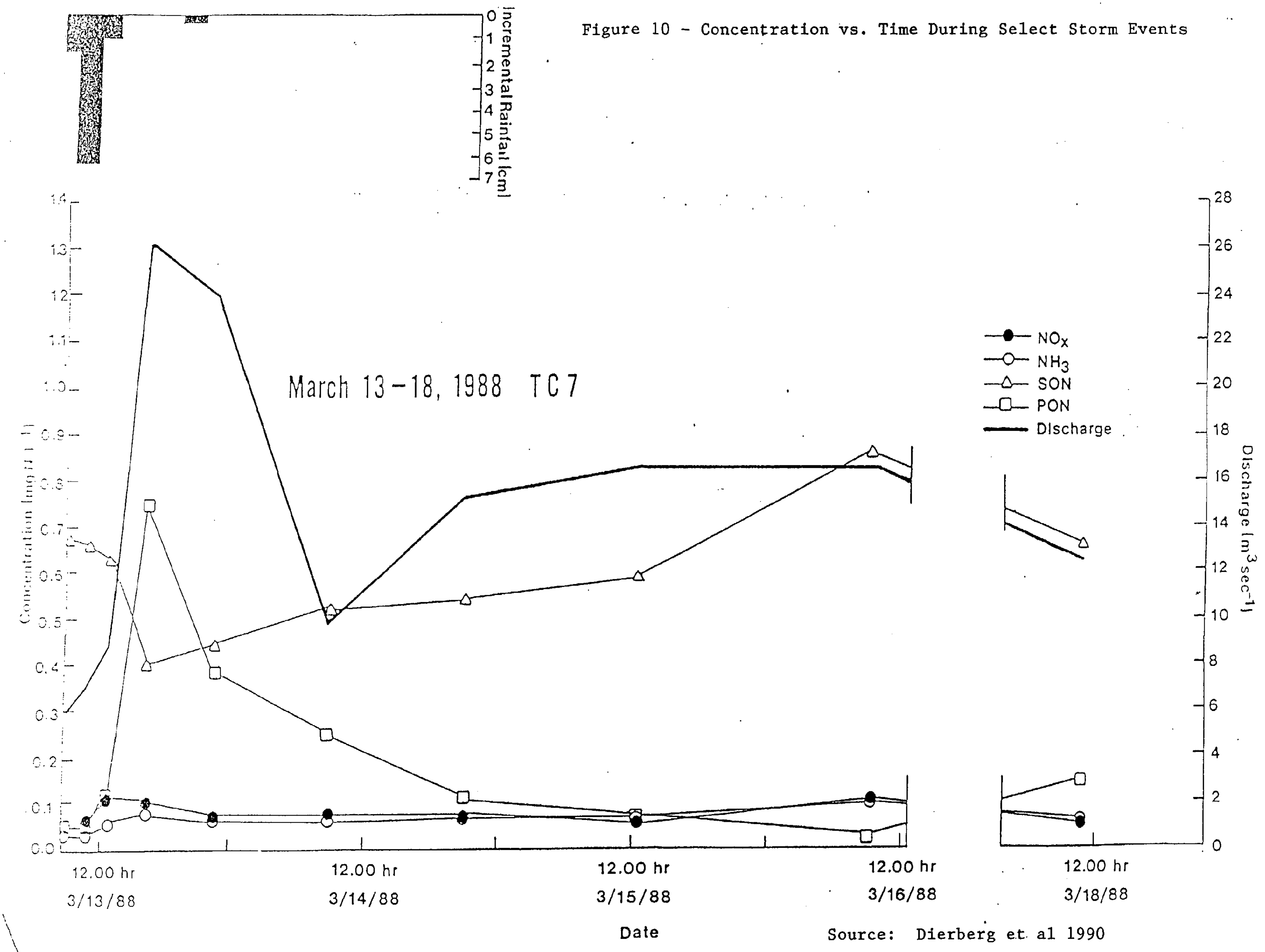
Source: Dierberg et al 1990

Figure 9 - Concentration vs. Time During Select Storm Events



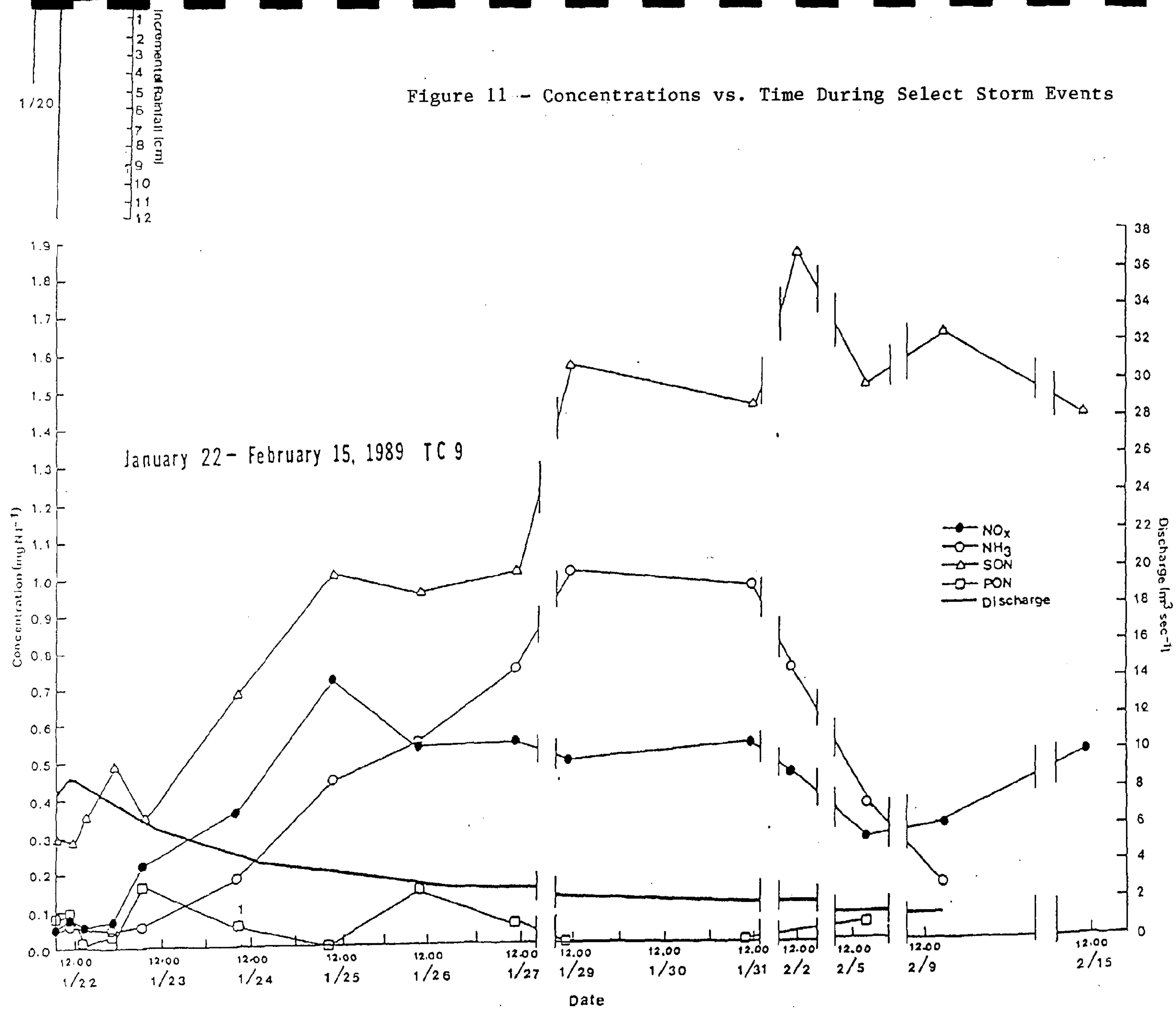
Source: Dierberg et al 1990

Figure 10 - Concentration vs. Time During Select Storm Events



Source: Dierberg et al 1990

Figure 11 - Concentrations vs. Time During Select Storm Events



Source: Dierberg et al 1990

Runoff from significant storms in the watershed occurs typically as "events" of high discharge with durations ranging from a few days to a few weeks. The watershed is partially developed, consisting mostly of planned residential units. Sediment discharge from the developing areas has been identified as being relatively high and should be considered with regard to streamflow gaging station location.

Based on observations by hydraulic engineers (Pennell, 1990; Adkins, 1990) and experience with similar systems, tailwater influences or even reverse flow may occur at points within the canal system during some severe storm event conditions. However, the likelihood of these conditions is considered to be small and the impact on this project would, therefore, also be expected to be minor. Previous water quality monitoring and stream flow gaging activities in the watershed by Florida Institute of Technology and the USGS have not indicated problems with these conditions. It is recognized for the purposes of this plan, however, that these conditions could exist if severe storm events occur. The impact would be poor discharge rate estimates during the high flow period.

The potential impacts of the tailwater influences are reduced by the relatively frequent observations and inspections that will be available during this monitoring time period if implemented as described below. WCDSB personnel should be available to inspect the gaging stations during high flow periods and collect timely discharge measurements, if necessary.

Streamflow Gaging Plan

The WCDSB should establish five new streamflow gaging stations within the watershed at locations on the four main lateral canals (Stations WCD2-WCD5) and at the outlet of C-82 (Station WCD1). These stations should be relatively accessible for frequent inspection. Each station should be equipped with a staff gage and a recording water level instrument. The stations will be referenced to a known datum at the time of installation and rechecked over time for verification. The instrumentation should include a single-channel data logger and pressure probe arrangement to continuously record water levels as shown in Figure 12.

The water quality monitoring Contractor should be available for installation and be able to train WCDSB personnel in use of electronic streamflow gaging equipment. They should also be available to accompany WCDSB personnel to make discharge measurements during the first three gaging efforts. Subsequently, WCDSB personnel can then make regular flow measurements every two weeks and during periods of high flow to establish discharge rating curves for each site. Efforts should be made to obtain flow measurements during any large storm events such that the rating curve contains points throughout the range of recorded water levels. Because of changing land uses and alterations to the canals, discharge rating information may need to be updated periodically.

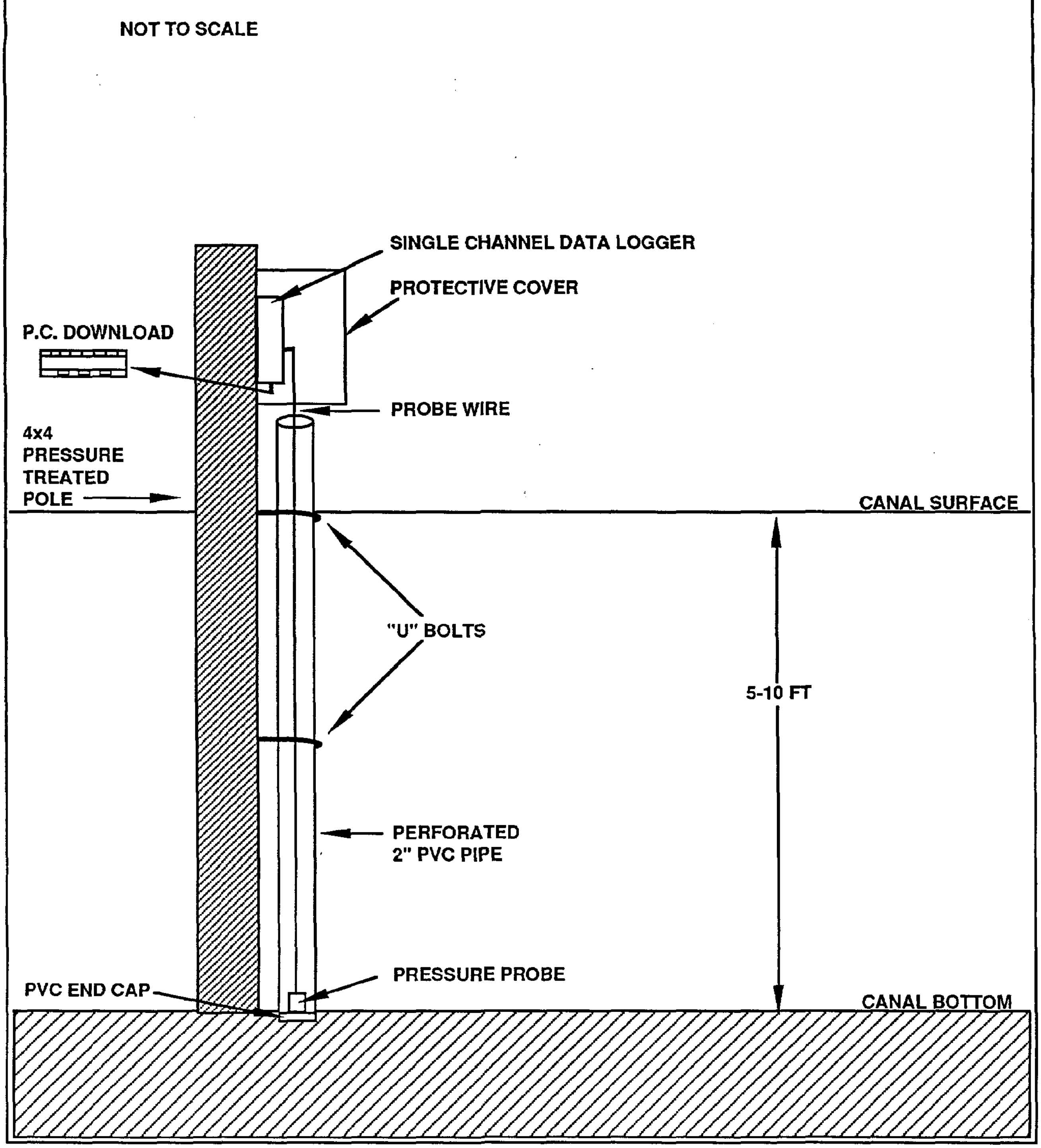


Figure 12
TYPICAL WATER LEVEL RECORDER

SOURCE: ESE, 1990.

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Standard USGS gaging techniques should be used to assure reliable flow data, including use of field data forms. The gaging information should be transmitted promptly to the Contractor for reduction by qualified hydraulic engineers. The accuracy and general quality of the rating information should be evaluated frequently throughout the monitoring period.

Discharge information at the MS-1 structure is anticipated to be available from existing discharge gaging activities that should continue throughout the monitoring period. SJRWMD is currently completing development of a new discharge rating curve for the structure that will be available for estimating continuous discharge hydrographs at that location (Adkins, 1990). There is a potential problem with very high flow rates, however, because of the nature of the MS-1 Amil-type gates that begin to discharge only for high flows (water levels approximately 4 ft above normal). Amil gates operate automatically to maintain a constant upstream water level, making normal discharge rating techniques unusable. This problem will be addressed by detailed hydraulic evaluation or by making discharge measurements as necessary during high flows.

The exact location for installation of the water level measuring equipment and streamflow gaging should consider hydraulic principles, including potential sedimentation impacts. Gaging locations should not be placed near (no closer than approximately 100 ft) a junction of canals or sharp bends where sediment deposition, scouring, or channel adjustments would be anticipated during high flows.

III. ANALYSIS AND DATA REDUCTION

Sample Analysis

The samples which are collected as part of the monitoring program will be analyzed for the parameters in Table 1. The selection of sampling parameters were based in part on previous investigations by Dierberg (1990), Trefry et al (1989) and Joel Steward (SJRWMD, personal communications, November 1990). Field sampling should be conducted by trained technicians and should conform to procedures contained in the Contractor's Quality Assurance/Quality Control (QA/QC) plan. The field team should also obtain measurements of temperature, conductivity, dissolved oxygen, salinity, pH and depth. Field data sheets should be completed at each sampling location (Figure 13). Because of the short holding time for fecal coliform, this analysis will have to be conducted at a laboratory in the Melbourne area. This aspect of the sampling should be arranged prior to the initiation of sampling.

Table 1. LIST OF PARAMETERS AND METHODS

Grab Sample Parameters	Method
Phosphorus, Total, Diss.	EPA 365.1
Nitrogen, TKN, Diss.	EPA 351.2
Carbon, TOC	EPA 9060
Nitrogen, NO2+NO3, Total, Diss.	EPA 353.2
Nitrogen, NH3+NH4	EPA 350.1
Phosphorus, Ortho, Diss.	EPA 365.1
Chlorine, Total Residual	EPA 330.1
Sulfate	EPA 375.4
Alkalinity Total	EPA 310.1
Residue, Diss., Total	EPA 160.1
Residue, Susp.	EPA 160.2
Aluminum, Total	EPA 6010
Calcium, Total	EPA 6010
Chromium, Total	EPA 6010
Copper, Total	EPA 6010
Iron, Total	EPA 6010
Lead, Total	EPA 239.2
Magnesium, Total	EPA 6010
Manganese, Total	EPA 6010
Potassium, Total	EPA 6010
Sodium, Total	EPA 6010
Oil and Grease, IR	EPA 413.2
Coliforms, Total	EPA 908.A
Coliforms, Fecal	EPA 908.C

Stormwater Sample Parameters	
Nitrogen, NO2+NO3, Total, Diss.	EPA 353.2
Nitrogen, TKN, Diss.	EPA 351.2
Phosphorus, Total, Diss.	EPA 365.1
Residue, Susp.	EPA 160.2

Figure 13 - Field Data Sheet

PROJECT INFORMATION

PROJECT NAME: ______________________

CLIENT: ______________ PROJECT NO: ______________

LOCATION: ______________________

GENERAL SITE OBSERVATIONS

STATION NO: ______________ DATE: ______________

WATER BODY TYPE: ______________________

SUBSTRATE: ______________ VEGETATION: ______________

LIGHT CONDITIONS: ______________ PHOTOGRAPH NO: ______________

METEOROLOGICAL

WIND SPD (mph, kts, m/s): ______________ WIND DIR (°T, °M): ______________

DRY TEMP (°C, °F): ______________ WET TEMP (°C, °F): ______________

CLOUD COVER (%, oktas): ______________ RAINFALL (Y?, N?, mm, cm, in): ______________

PRESS (mm, Torr, in): ______________ WEATHER: ______________

WATER QUALITY

TIME &/OR LOCATION	DEPTH (m, ft)	COND (umhos/cm)	TEMP (°C, °F)	pH (su)	DO (mg/L)

SECCHI (cm, m, ft): ______________ SAMPLE NO: ______________

SAMPLE FRACTIONS: ______________________

Source: ESE, 1990

Data Reduction

Total loadings estimates at each of the streamflow gaging locations will be calculated by the integration of a discharge-concentration relationship and the continuous discharge record. To accomplish this task will require the development of a discharge-concentration relationship for each parameter at each monitoring location.

The Contractor should evaluate and analyze the concentration and the discharge data collected not only during this monitoring program, but from previous monitoring efforts in this watershed as well. Quality assurance considerations should be given to the historical data, including careful review to assure data consistency of that data with the data collected from this sampling effort. The discharge-concentration relationships will be analyzed statistically, considering typical types of relationships. FDER (1990) determined from data collected in the watershed that the best model is provided by log-log relationships. For this relationship, a statistical determination of the constants a and b in the equation $Concentration = aQ^b$ will be determined from the data and be used to calculate flux per unit area for nutrient and/or metal loadings. The Contractor should realize, however, that this method is not the only one used to calculate loadings. Nutrient and sediment loadings calculated from analysis in this sampling program should be compared to findings of research currently underway at FIT which will determine estimates of mass loadings by sub-basin and the role of Best Management Practices (BMPs) in reducing these loadings.

IV. WATER QUALITY MONITORING COSTS

The cost figures included on the next page are conservative estimates only, produced by Environmental Science and Engineering (ESE) given their in-house lab costs and labor costs. The estimated costs are divided into first year and subsequent annual estimates due to the high initial costs associated with purchase of the equipment and installation. The cost of the annual water quality sampling after the first year may be reduced if the same Contractor installs the initial stream gaging and water quality sampling equipment.

ESTIMATED COSTS

First Year	Installation and Purchase of Stream Gaging Equipment and Preparation of Discharge Rating Curves	$30,000
	Water Quality Sampling & Anaylsis and Flow Data Analysis (First Year includes purchase and installation of sampling and gaging equipment)	103,000
Second Year &	Annual Water Quality Sampling and Analyses, and Flow Data Analyses (after first year)	*$56,000

* This price effective only if metals not found in first year sampling.

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9. Performing Organization Name and Address	10. Project/Task/Work Unit No.
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12. Sponsoring Organization Name and Address U.S. Dept. of Commerce/NOAA OCRM 1825 Connecticut A., N.W. Washington D.C. 20235 Dept. of Env. Mgmt. Coastal Management 2600 Blair Stone Rd. Tallahassee, FL 32399	13. Type of Report & Period Covered Final
	14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Water Control District of South Brevard (WCDSB) maintains a large canal network which drains over 99 square miles in South Brevard County between the lower St. Johns River and the Indian River Lagoon. Surface drainage from this area is routed through a large canal system discharging through the MS-1 structure to Turkey Creek which then flows onto the Indian River Lagoon. Currently, there are proposed plans to divert some of this drainage to the historical western flow towards the lower St. Johns River. To prepare for future water quality monitoring of their canal system, the WCDSB developed this water quality monitoring plan for future implementation when funds permit. This plan includes discussion of sampling sites, flow gaging, parameters to be sampled, proposed analytical methods and estimated costs of implementation.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

Coastal zone management/ Turkey Creek, Florida/Indian River Lagoon/Water Quality Monitoring/St. Johns River, Florida

c. COSATI Field/Group

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(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35)