PCB Transport in the Ft. Edward Area

T.J. Tofflemire

From about 1948 to 1973, G.E. discharged PCB from two plants to the Hudson River. For many years, there was a dam at Ft. Edward and the water was 15 feet higher than now. Sawdust, timber waste and cinders entered the river from paper mills. Large quantities of lead entered the river from Ciba Giegy (formerly Hercules) over about the same time period as PCB. Shale chips, quartz and feldspar sands along with coal fragments and cinders also entered the area from upriver (1). This mixture of rather coarse trashy sediment formed the five remnant deposits, which were left above water when the dam at Ft. Edward was removed in 1973. Technical Paper 56(2) documents the sediment contamination. The Mean PCB value for Area 1 was 20 ppm; Area 2, 5 ppm; Area 3, 65 ppm; Area 4 and 4A, 25-40 ppm and area 5, 250 ppm. Figure 1 shows typical remnant deposit3 sediment before ripraping and Figure 2 the remnant deposit locations.

Three types of PCB transport will be addressed herein: (1) Water transport at both low and high flows; (2) Dredging transport and (3) Air transport. Acknowledgement is given to USGS for the water data, to Boyce Thompson Institute for the air data and to NYS Department of Transportation for the dredging records. NYSDEC has done various field investigations and sampling efforts to identify PCB sources in the Ft. Edward-Hudson Falls area.

Water Transport

There is a U.S.G.S. water monitoring station at the 197 bridge across Rogers Island. PCB monitoring there began in 1976, although a good data base was not taken until 1978. The sampling and analysis procedures by U.S.G.S. are documented elsewhere (3).

Depth integrated water samples were taken. Barnes (4) noted that PCB transport in kg/day at low flow has decreased as follows at Rogers Island: 1978: 1.02; 1979: 1.24; 1980: 0.81; 1981: 0.43; 1982: 0.45; and 1983: 0.34.

In 1980 and in 1981, tag line sampling studies were done by U.S.G.S. to try to answer the question; "Where are PCB's found at the Rogers Island Station coming from?" The two studies yielded similar results so only the 1981 study will be discussed. Rhodamine WT dye was fed at a constant rate near the G.E. outfall, where noted on Figure 2. At each point across the tag line, PCB and dye samples were taken, and velocity and depth were measured. The river flow on July 6, 1981 was 990 cfs (28 cum/s) and the east channel conveyed 48% of this flow.

Figures 3, 4, and 5 show the PCB concentration and load versus distance from the east bank. The PCB concentration was higher on the east bank, and the loading for the first 50 feet was only about 20% of the total cross section load. Area 1 island and Area 2 showed no increased PCB concentration in nearby water samples. The total PCB loads were as follows:

	kg PCB/day	
X section 0	.20	(.054) within 50' of east bank
X section 1	.28	
X section 2	.27	(.054) within 50' of east bank
Rogers Island (E.C.)	.195	(.028) additional PCB from east bank
" " (W.C.)	.125	
Rogers Island (Total)	.32	

There was a 37% increase in load from X section 0 to Rogers Island, but 63% of the PCB entered above X section 0 and probably above area 1. Of this upstream source, about 27% was conveyed within 50 feet of the east bank. If it is assumed that all of the .054 kg PCB stayed in the east channel and (.28 - .054) is split on a flow proportion between east and west channels, then .028 additional PCB came from the east bank (perhaps area 5 or Rogers Island East channel bottom).

Figures 6 and 7 show the distribution of the dye spreading from the east bank. At section 2, 65% of the dye was still within 50 feet of the east bank and almost 100% within 120 feet of the bank. At Rogers Island, a small portion of the dye split to the west channel. The data indicates that at low flow most of the PCB from an east bank source near the Remnant deposits would stay in the east channel at Rogers Island. The PCB concentrations in both the East and West channels have been decreasing with time; however, for the 1978 through 1981 data, the concentration ratio (EC/WC) remained about was two or three to one at low flow (5).

High flow PCB comparisons by U.S.G.S. are noted below:

Date	Flow cum/sec	Flow cfs	PCB Conc. ug/l E.C.	PCB Conc. ug/l W.C.
March 27, 1979	570	20,100	2.6	.1
April 28, 1979	910	32,100	1.9	.0
March 22, 1980	410	14,400	.6	.1
April 11, 1980	620	21,900	.2	.1
February 21, 1981	640	22,600	.3	.0
April 18, 1982	725	25,500	.41	.04
April 19, 1982	785	27,700	.26	.10

Also at high flow, the East channel carries more PCB than the West channel as noted on the curves on the right side of Figure 8.

At low flow over 50% of the PCB passes a .45 μ filter. At high flow over 90% is particulate at the Waterford Rt. 4 bridge (3). Large volumes of river water were centrifuged at 9,400 G and the particulate on the bowls was analyzed for PCB. The data for Rogers Island is noted below (6). PCB was higher in the east channel.

Location	Date	Flow cfs	Susp. Solids ppm	Bowl 1 PCB - ug/g	Calc. Part PCB - ug/l
East Ch.	6/28/78	3050	3.5	73.8	.26
West Ch.	6/29/78	3020	3.5	32.0	.11
East Ch.	3/28/79	15400	-	45.2	-
West Ch.	3/29/79	19600	20	12.5	.25

The U.S.G.S. noted a higher percentage of lower chlorinated PCB is in the Rogers Island samples when compared with down river samples, based on 1978-1981 samples (3). On the other hand, Dr. Bush (7) noted more of the highly chlorinated PCB is N.E. of Rogers Island in a 1983 water sample, although small concentrations of 2-chlorinated PCB's were also noted. Later sampling gave slightly different results, however.

During the spring of 1981, freshwater bivalves were placed in cages in the river at the Moreau Pumping Station about one mile down stream of Route 87 bridge. In two weeks, the clams accumulated 6.25 ug/g of 1016 and less than .05 ug/g of 1254 (8). Although most water samples by the U.S.G.S. taken at the Glens Falls station have been less than the .1 ug/l PCB detection limit formerly used, a few samples were .1 ug/l. In addition, several samples taken by DEC and by U.S.G.S. at the Baker Falls Bridge have had .2 ppb of PCB. Five different rain samples collected in rain gutters in open fields near lock 7 contained .1 ug/l of 1242 in 1979.

As noted in Technical Paper 56 (2), PCB and lead concentrations in the sediments are correlated (r: .69). Lead is adsorped by organic matter and wood as is PCB. Lead was discharged in large quantities from Hercules Chem. (now Ciba Giegy) over about the same time period as PCB. Lead is log normally distributed as is PCB in the Hudson. Table 1 compares the mean lead values from U.S.G.S. data at low flow for various stations in the Hudson (5). There has been a significant increase in lead at Corinth and again at Ft. Edward due to the past lead discharges. Natural radioactive lead 210 can be distinguished from recent lead used by industries (9).

Table 1 - 1972-1982 Lead Data - ug/l

	Log-base 10			
Station	Mean	Sd	Antilog of Mean	Number of values
*Sacandaga River	.16	.43	1.44	14
*Spier Falls, Corinth	.69	.35	4.90	16
*Glens Falls	.57	.50	3.72	53
Fort Edward	.76	.57	5.71	74
Schuylerville	.75	.46	5.69	33
Stillwater	.72	.51	5.23	71
Waterford Rt. 4	.78	.48	6.03	146
Waterford Water Plant	.80	.48	6.29	83

*These stations are all upriver from Hercules (CibaGiegy)

The DEC sampling of sewers, treatment plants, rock seepage, etc., revealed no major sources of PCB. More sampling of bioconcentrators of PCB, such as clams in stations above the Remnant Deposits, is suggested to better identify the upstream source. The rain sampling data is considered inadequate to fully document rain PCB concentrations.

Air Transport

PCB's have been volatilizing from the remnant deposit sediments. A less rate of 280lb/yr was estimated in 1979 (6). Air samples taken in 1978 by DEC over area 3A were as high as 10 ng/m^3 over sediments containing 1000 ppm of PCB (10). Buckley (11) measured plants for PCB at 18 stations and air for PCB at 6 stations in 1981 and 1982. From prior calibration plots (10) air PCB values can be predicted from integrated plant values. The data is shown in Figure 9 for 1 meter height. All but one value was less than the 1000 ng/m^3 NISOH recommended limit and NYSDH guidelines for dredging sites. The 1982 data summarized below shows a decrease from 1981. Air PCB's along down river areas have also been decreasing with time. Another air source of PCB in the area has been the G.E. Ft. Edward plant property. This has also been decreasing with time (5).

Mean Air PCB Values from Plant Data - ng/m^3

	Area 3	Area 4	Area 5
1981 Mean	447	309, 90*	298
1982 Mean	321	257	207
NIOSH Std.	1000	-	-

Source: Boyce Thompson Institute: (90)* ave. with outlier value omitted.

The volatilization rate of PCB from soil decreases greatly with increasing organic carbon content of the soil (10). Vegetation can add this organic carbon.

Dredging Transport

One way of noting scour of the remnant deposit is by observing downstream deposition and dredging. These deposits are coarse sands with large wood fragments and can be identified by their characteristic appearance. PCB analysis on size fractions has shown that medium sized sands with wood fragments contain more PCB than fine sands with no wood fragments.

Records of dredging history since 1950 were provided by NYSDOT (13). Certain river areas are sediment traps and frequent dredging areas, if near the main channel. The pattern of dredging changed considerably after removal of the Ft. Edward dam in 1973.

Dates	Lock 7 to Bouy 212	Rogers Island E and W Channels
1951 - 1973	275,298 yd^3	168,010 yd^3
1973 - 1979	351,760 yd^3	475,298 yd^3
1979 - 1983	None	None

The heavy dredging in the Rogers Island area in 1973 to 1979 was due to remnant deposit scour. Reports by Malcolm Pirnie document this (14, 15). As of June 1984, NYSDOT has noted no sediment deposits near Ft. Edward. The lack of the need for dredging in the Ft. Edward area since 1979, in spite of several big floods, is indicative of the Remnant Deposits becoming more stable and less susceptable to scour. It is interesting to note that 6510 yd^3 of cinders were removed from the Ft. Edward Terminal from 1961 to 1965 and placed by the terminal wall and spread on roads. Locating deposits of these black cinders might provide another dating tool for the sediments in addition to Cs 137 and Pb 210. The cinders were exposed to primarily 1242 from G.E. (16).

Discussion and Summary

The water transport at Rogers Island is decreasing with time, although a small unidentified source of PCB north of Area 1 of the Remnant deposits may still be present. PCB concentrations and transport is greater in the east channel than in the west channel at both low and high flows. At low flow, about 25% of the PCB passing Rogers Island appeared to be coming from east bank or east channel bottom sources. About 46% of the PCB passing the Rogers Island station appeared to come from unknown sources north of Area 1. The rest of the PCB appeared to be coming from the broad river bottom area, which is,for the most part, rock.

It is suggested that these upstream sources be located and sampling by some type of integrating and concentrating systems that integrate PCB from water over several weeks. Fresh water clams would provide one method; however, they may preferentially bioaccumulate more of the higher chlorinated isomers.

The remnant deposits no longer appear to be scouring at substantial rates bacause no typical deposition of the remnant deposits in frequent dredging areas down stream has been noted since 1979, in spite of several large floods.

Air PCB values in the remnant deposit areas are decreasing with time. The last sampling was in 1982. Depletion of PCB from the surface layer and the build up of organic carbon in the top soil due to increased vegetation on areas 4 and 5 probably aids this process.

Since PCB exposure by inhalation is an intregrative process that would require considerable time on the remnant deposits to accumulate high doses of PCB, some type of integrating air sampling over the remnant deposits is suggested. Plant sampling would provide one method.

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100100

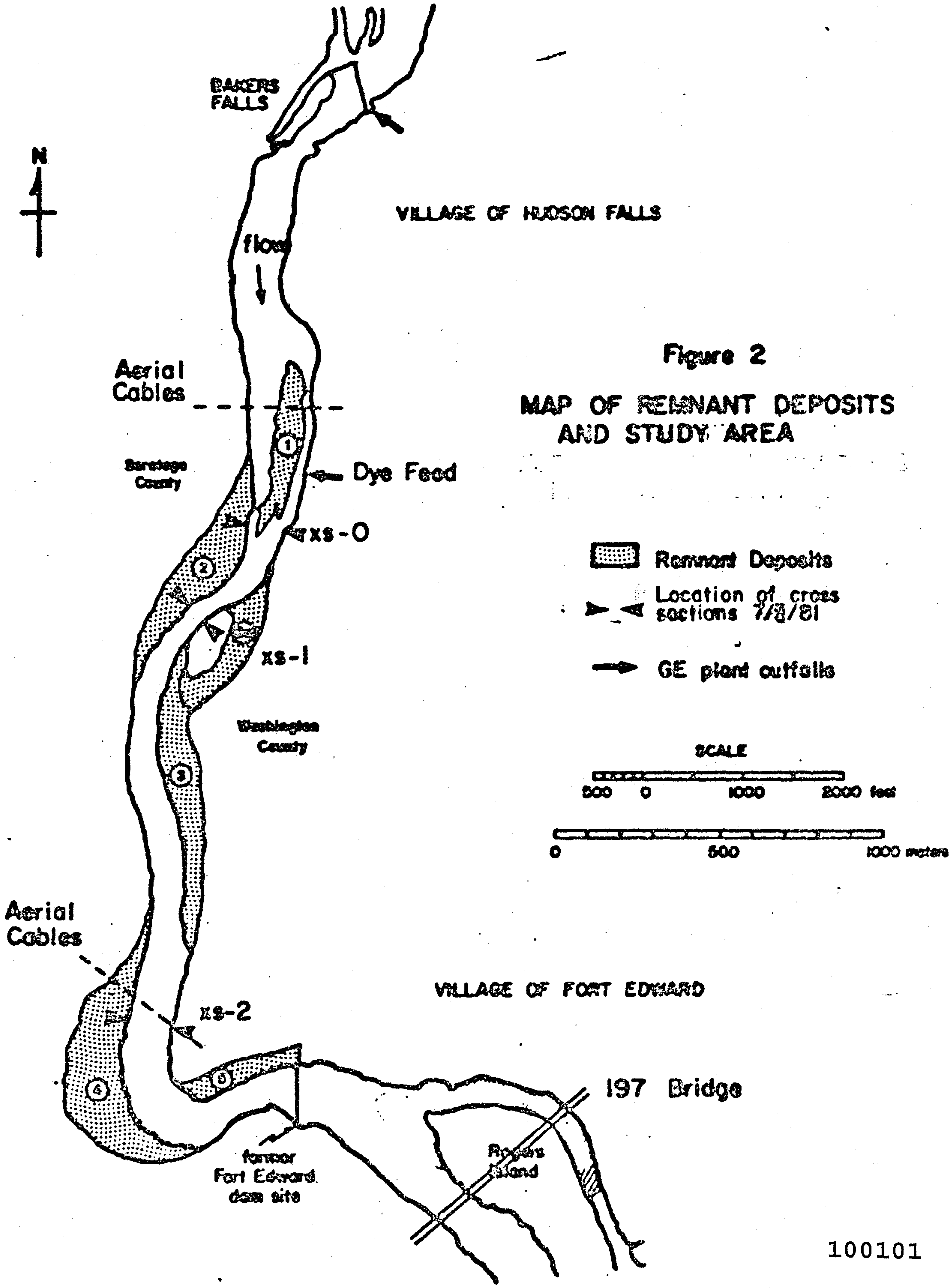
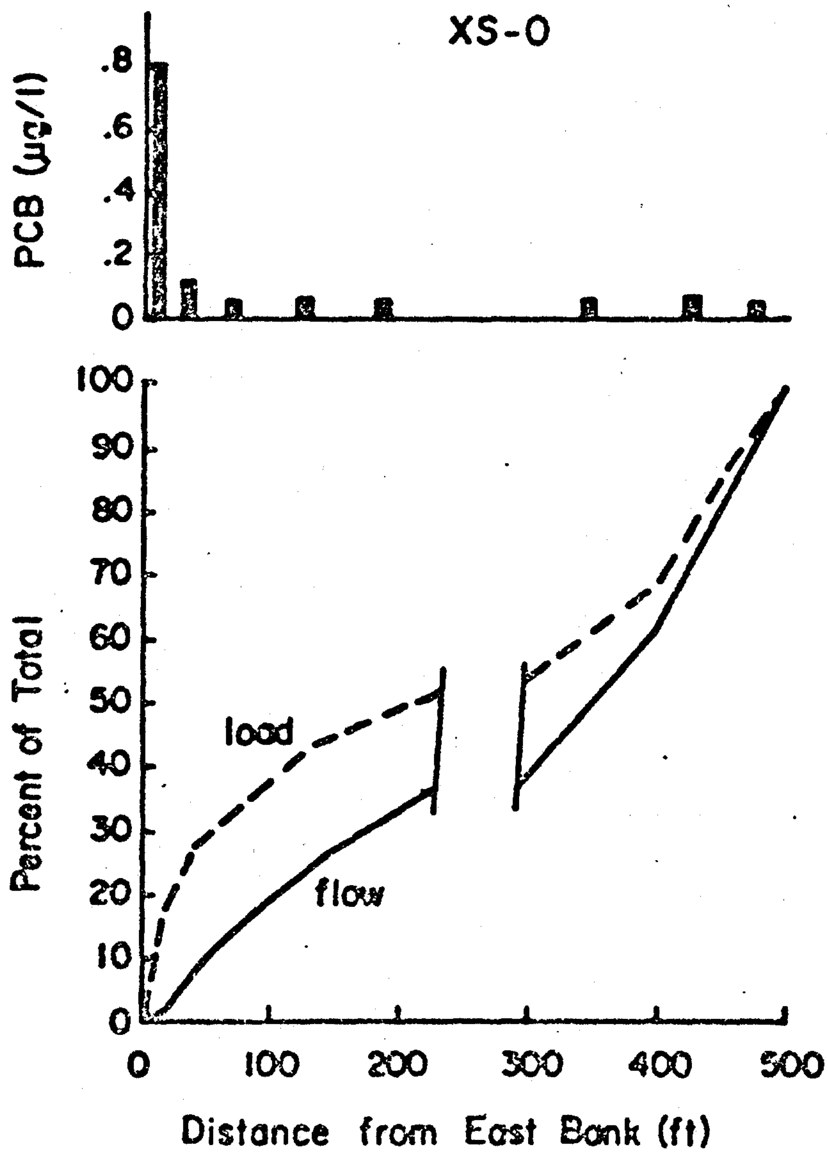
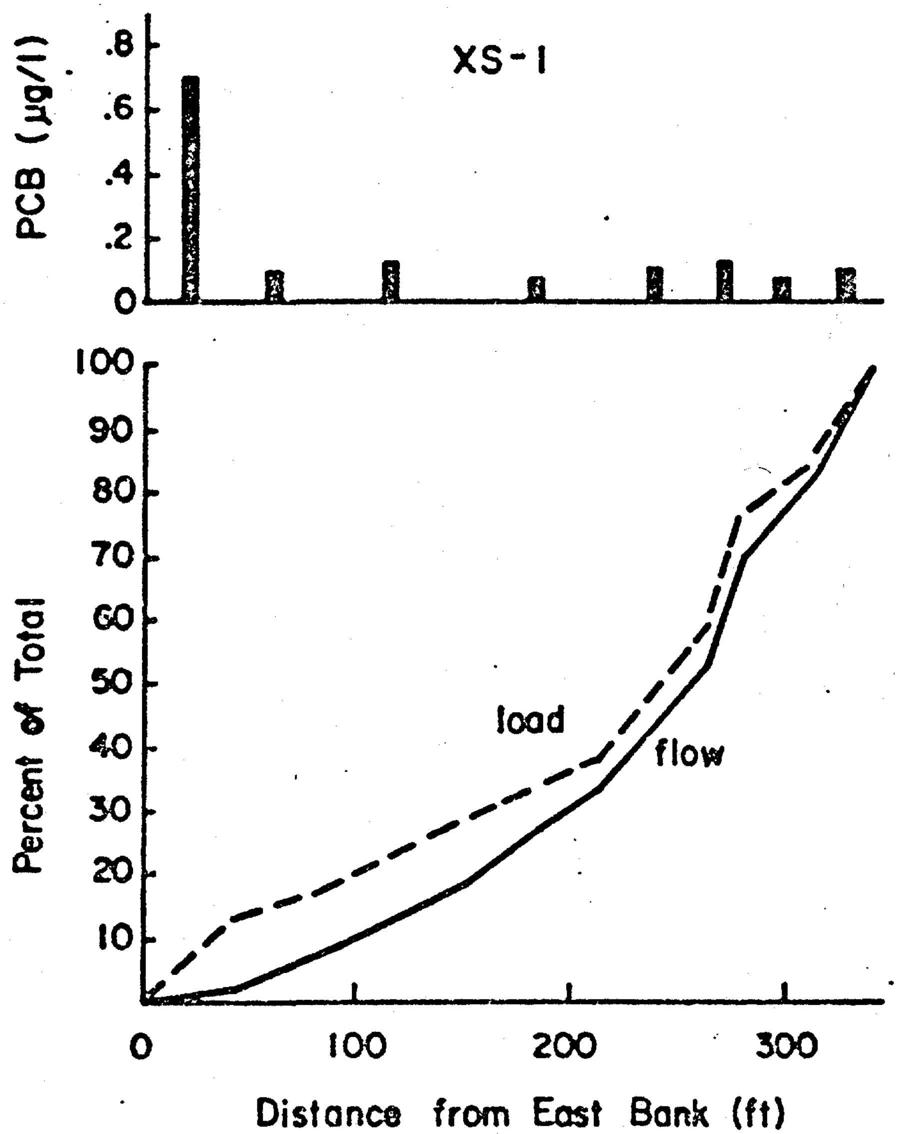


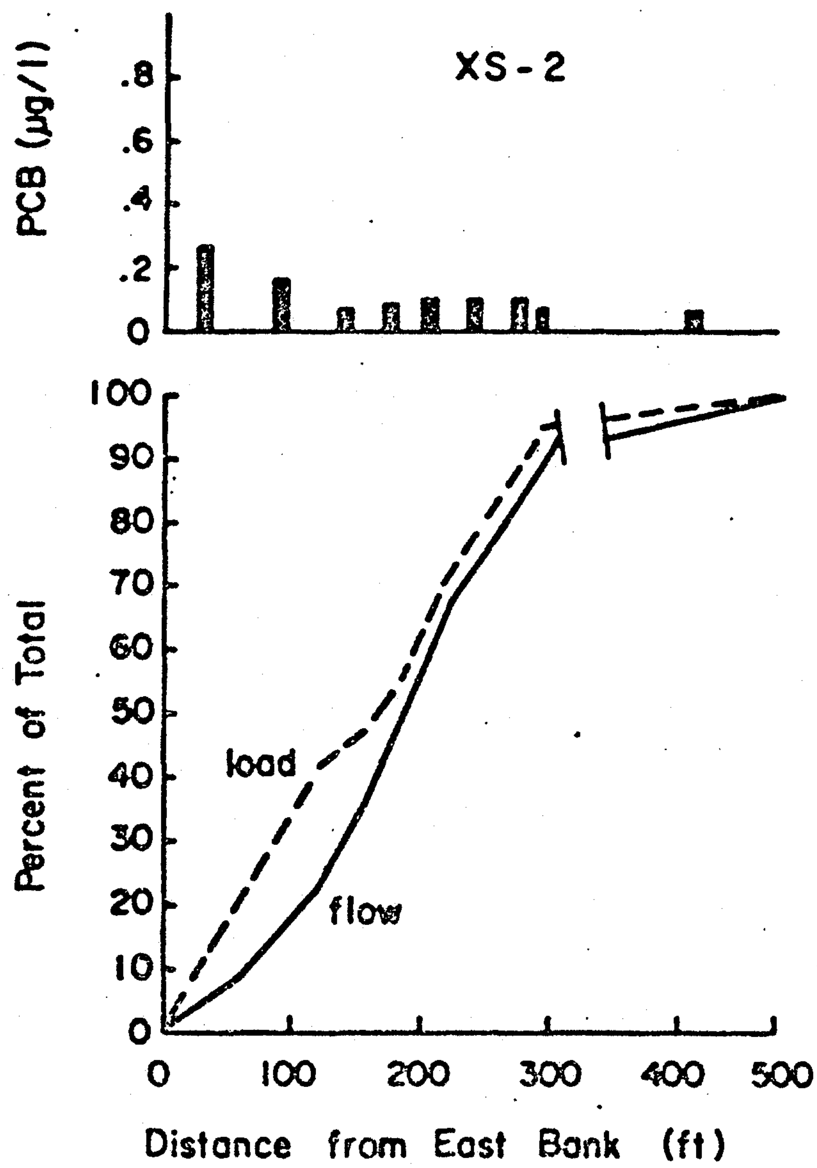
Figure 2

MAP OF REMNANT DEPOSITS AND STUDY AREA

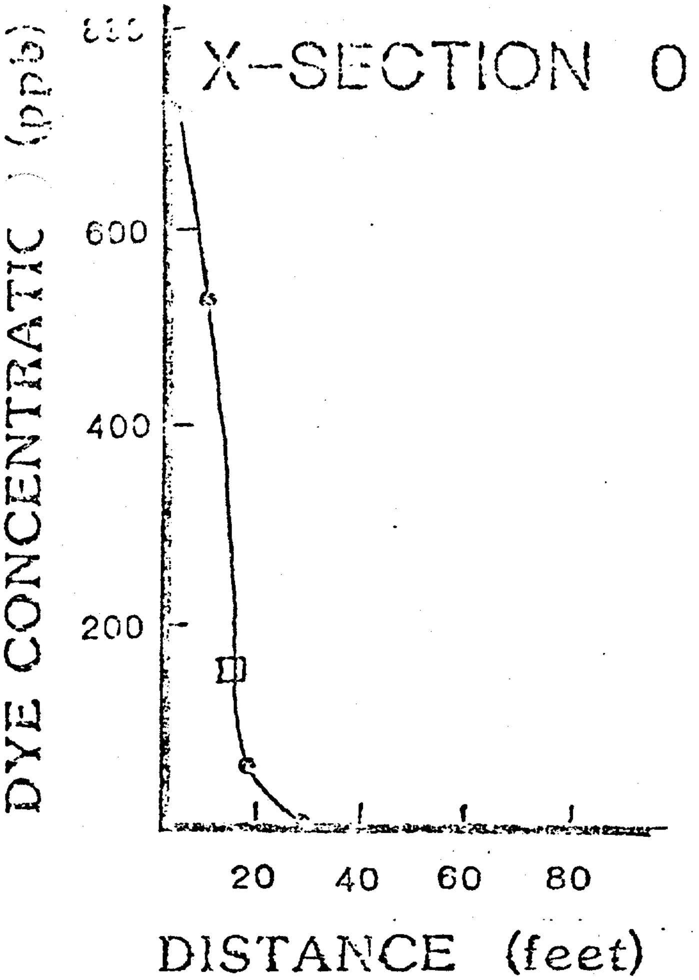
100101

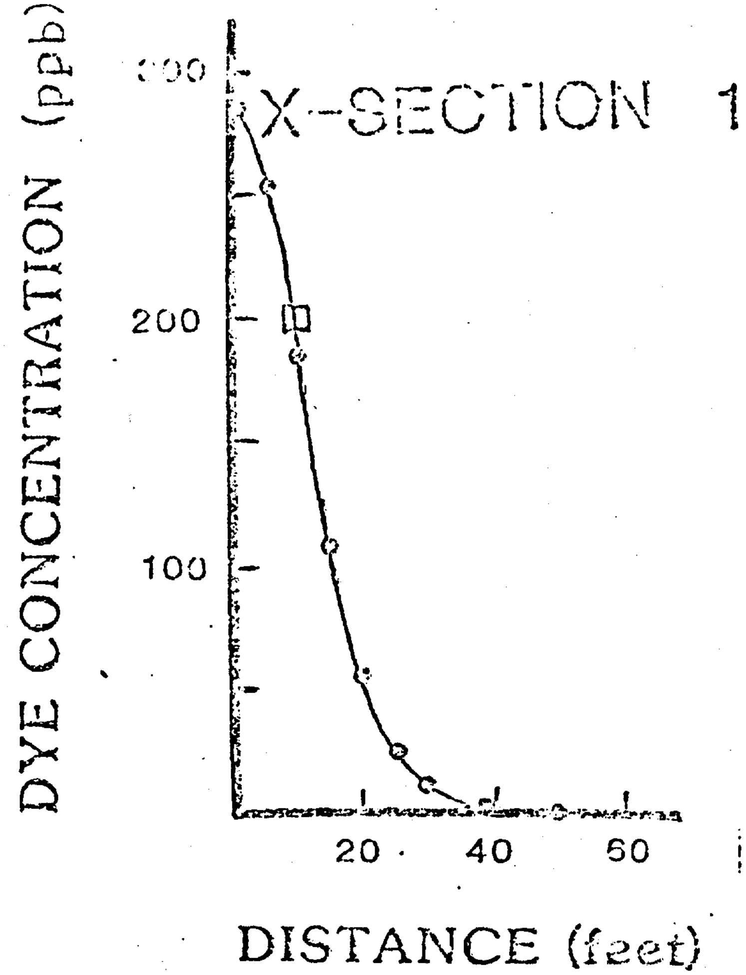

XS-O
PCB (µg/l)
.8
.6
.4
.2
0
100
90
80
70
60
50
40
30
20
10
0
Percent of Total
load
flow
0
100
200
300
400
500
Distance from East Bank (ft)

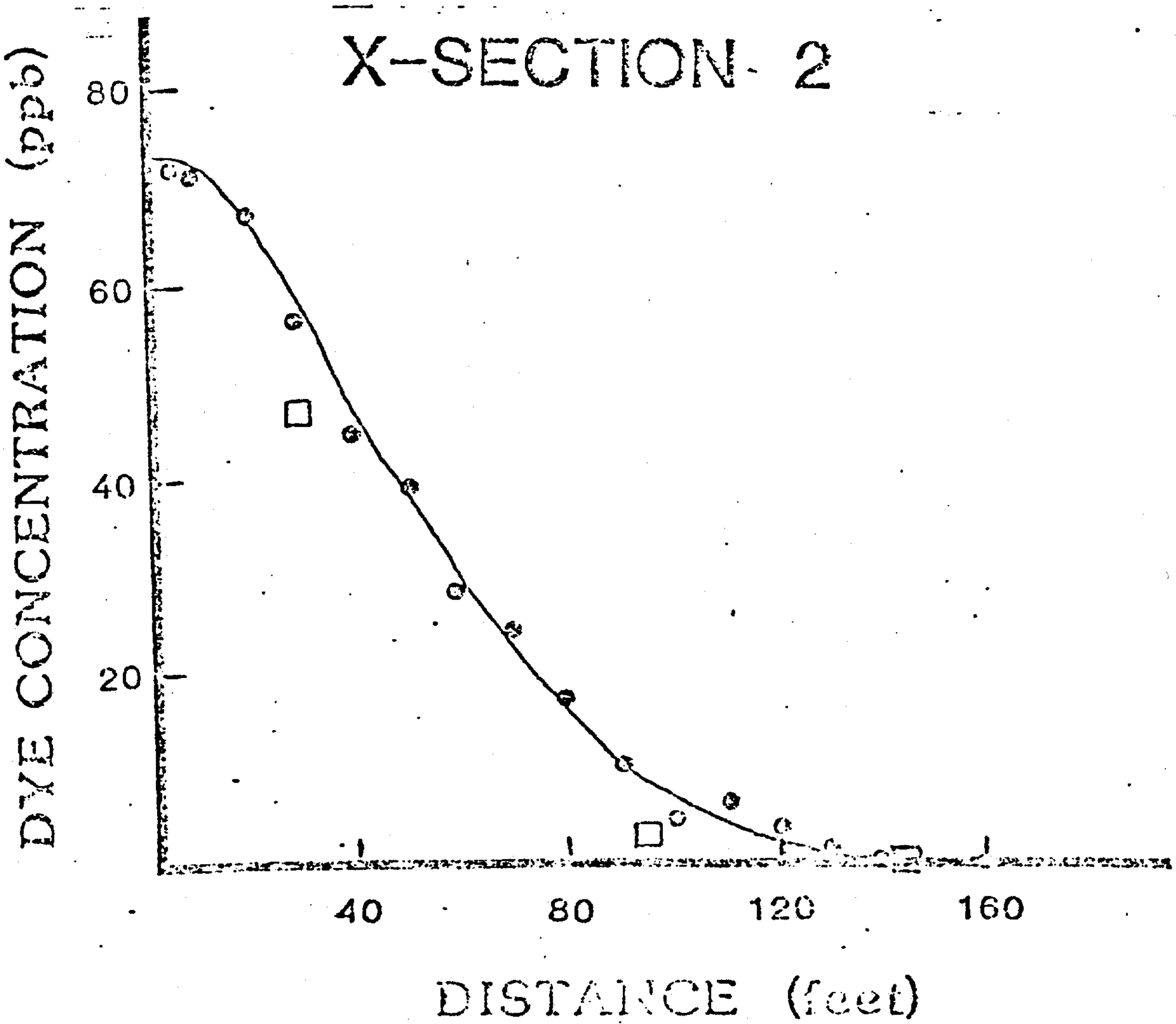

XS-1
PCB (µg/l)
.8
.6
.4
.2
0
100
90
80
70
60
50
40
30
20
10
Percent of Total
load
flow
0
100
200
300
Distance from East Bank (ft)



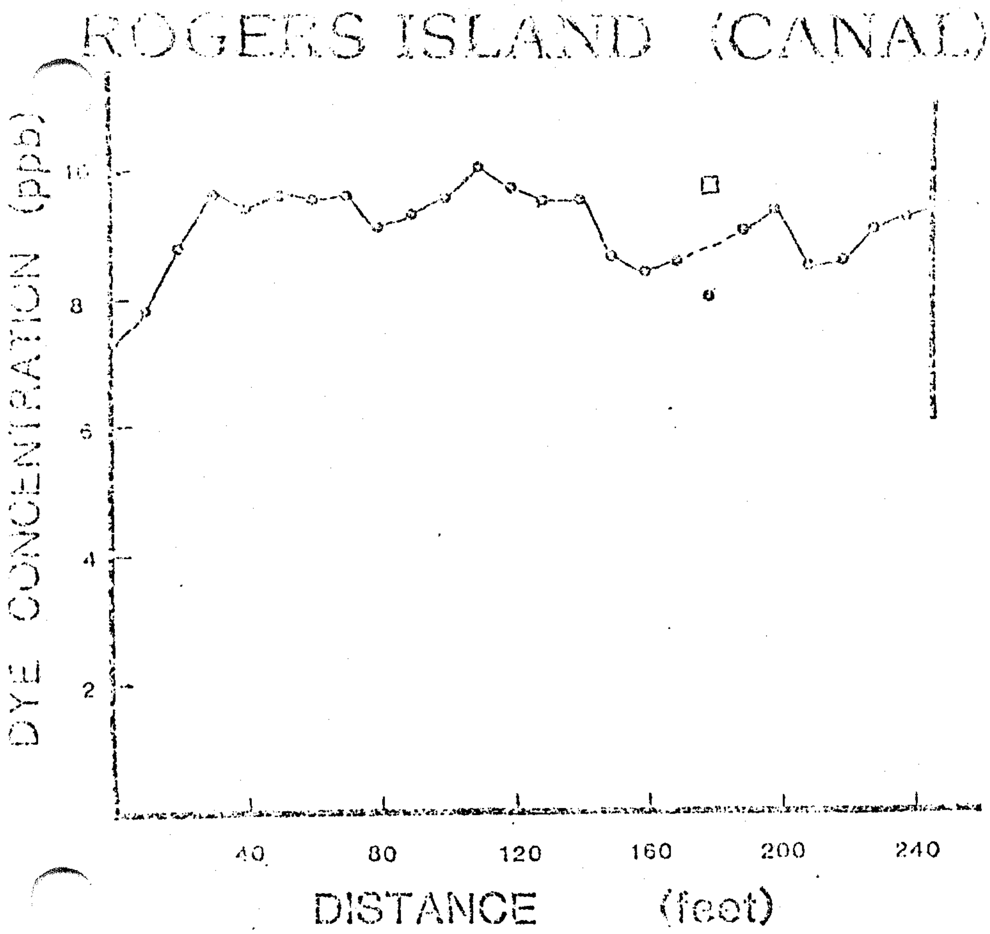
XS-2
PCB (µg/l)
.8
.6
.4
.2
0
Percent of Total
100
90
80
70
60
50
40
30
20
10
0
load
flow
0
100
200
300
400
500
Distance from East Bank (ft)

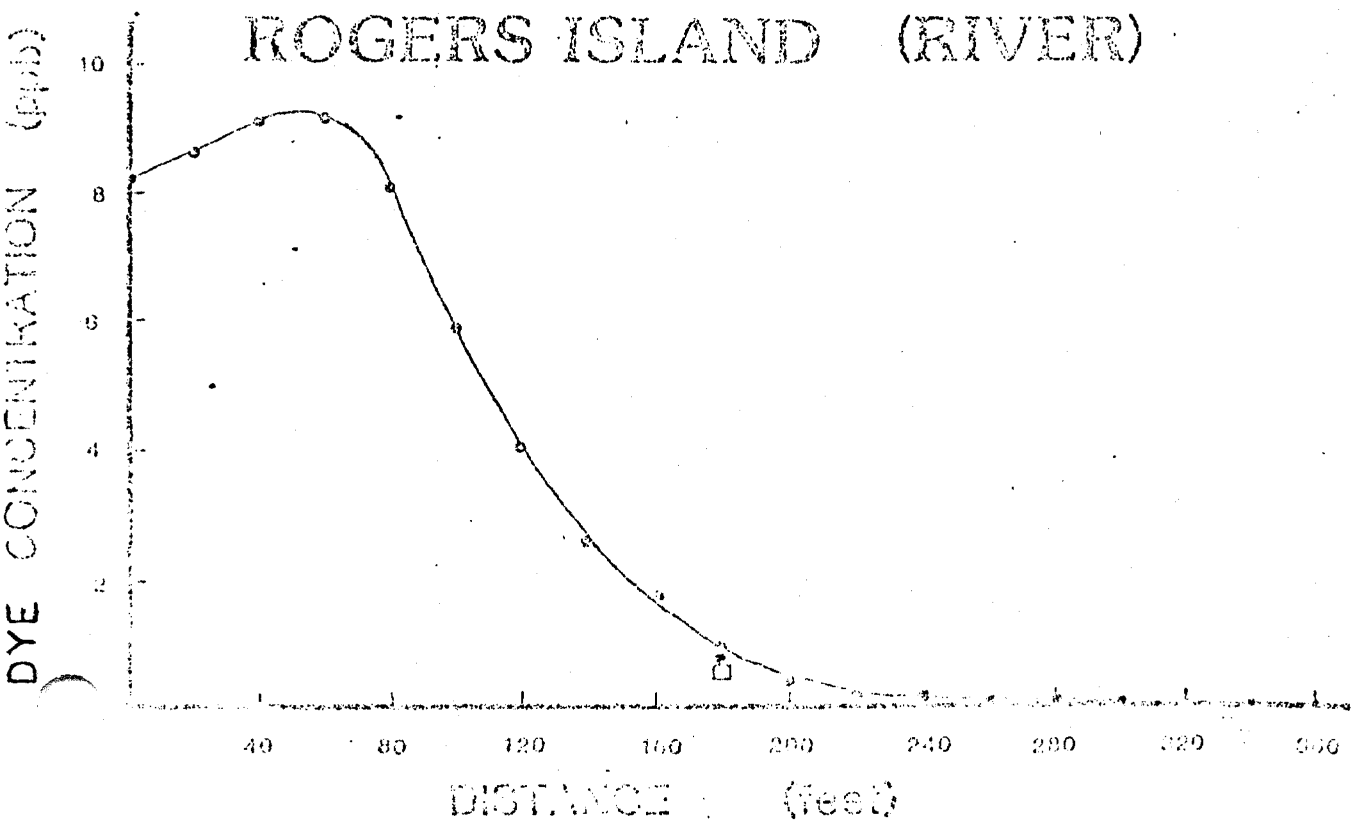

X–SECTION 0
DYE CONCENTRATIC (ppb)
200
400
600
20
40
60
80
DISTANCE (feet)

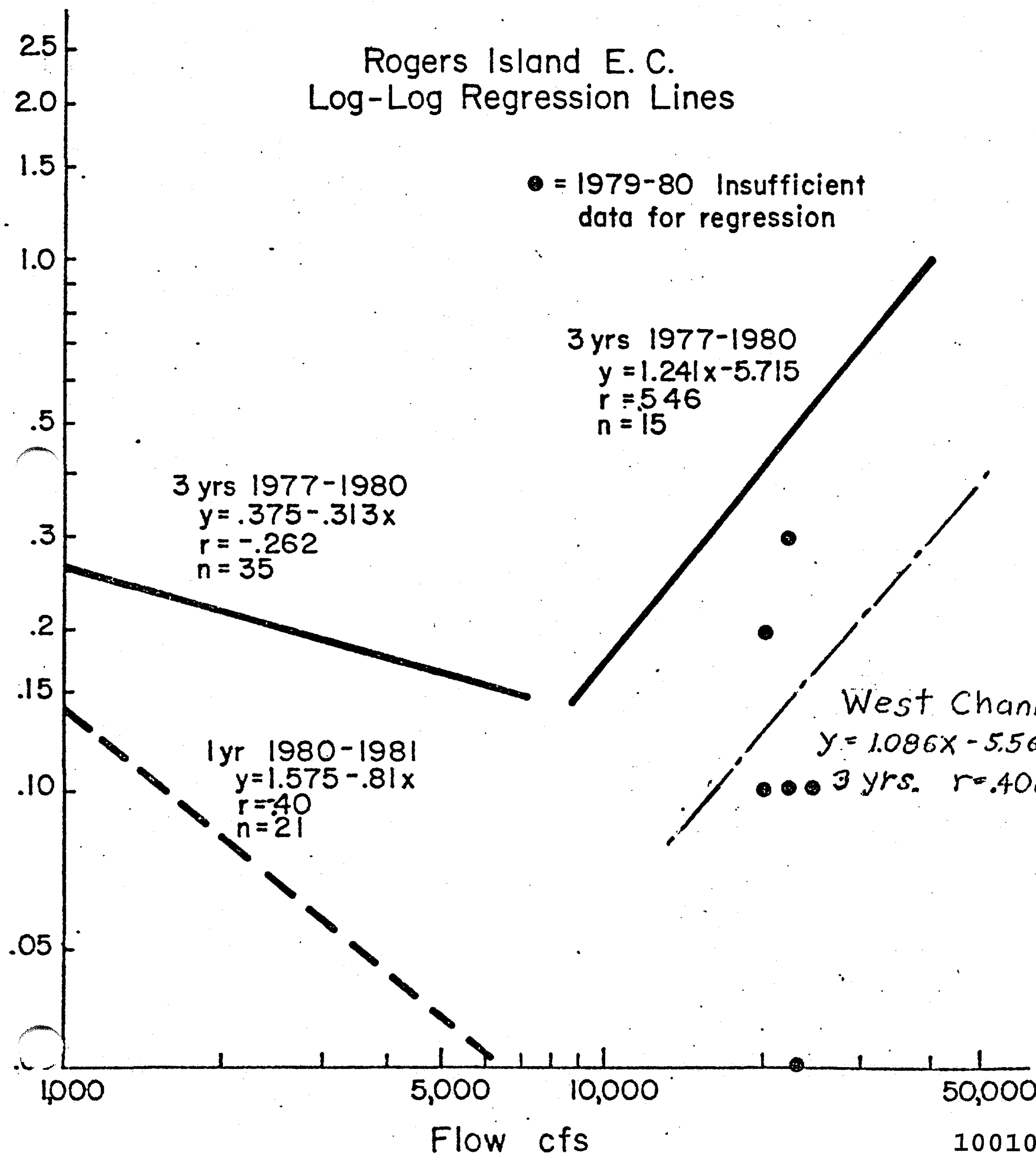

X–SECTION 1
DYE CONCENTRATION (ppb)
100
200
20
40
60
DISTANCE (feet)


X–SECTION 2
DYE CONCENTRATION (ppb)
20
40
60
80
40
80
120
160
DISTANCE (feet)

100105


ROGERS ISLAND (CANAL)
DYE CONCENTRATION (ppb)
10
8
6
4
2
40
80
120
160
200
240
DISTANCE (feet)

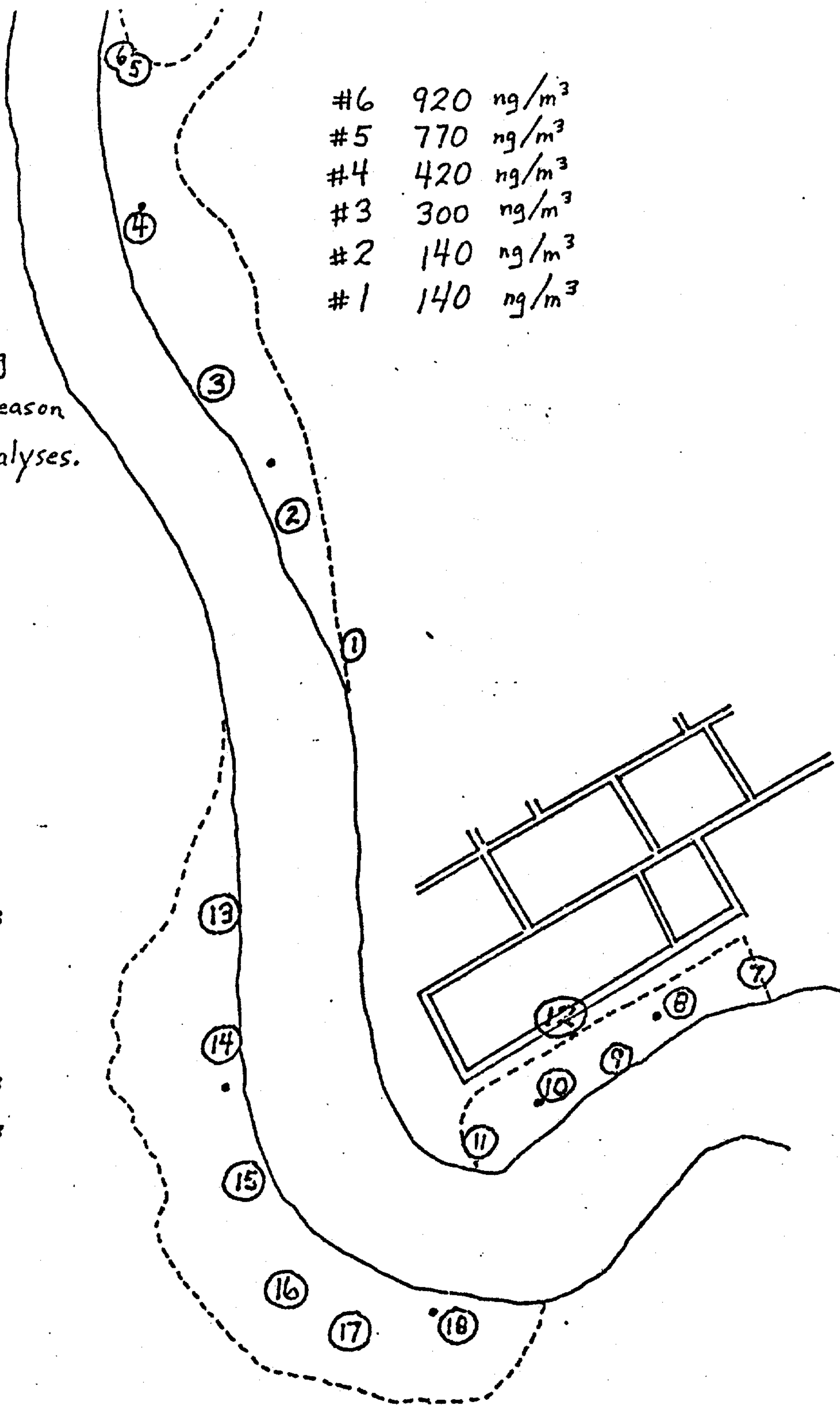

ROGERS ISLAND (RIVER)
DYE CONCENTRATION (ppb)
10
8
6
4
40
80
120
160
200
240
280
DISTANCE (feet)



Rogers Island E. C.
Log-Log Regression Lines
● = 1979-80 Insufficient data for regression
3 yrs 1977-1980
y = 1.241x-5.715
r = .546
n = 15
3 yrs 1977-1980
y = .375-.313x
r = -.262
n = 35
1yr 1980-1981
y = 1.575-.81x
r = .40
n = 21
West Channel
y = 1.086x - 5.567
3 yrs. r = .408
2.5
2.0
1.5
1.0
.5
.3
.2
.15
.10
.05
1,000
5,000
10,000
50,000
Flow cfs

100107

Calculated air concentrations of PCBs during 1981 growing season based on foliar analyses.



#6 920 ng/m³
#5 770 ng/m³
#4 420 ng/m³
#3 300 ng/m³
#2 140 ng/m³
#1 140 ng/m³

#13 120 ng/m³
#14 90 ng/m³
#15 70 ng/m³
#16 150 ng/m³
#17 1400 ng/m³
#18 20 ng/m³

#7 250 ng/m³
#8 590 ng/m³
#9 410 ng/m³
#10 130 ng/m³
#11 110 ng/m³

100108

12 (on residential street) 50 ng/m³

Map based on NYDEC aerial photo # 805-17-3
Nov. 2 1976