RETURN TO 1998 ROD AR INDEX

Superfund Records Center
SITE: NEWBEDFORD
BREAK: 5.3
OTHER: 46654

SDMS DocID 46654

ATTACHMENT C

Evaporation of PCBs from proposed CDFs at New Bedford Harbor

Date: July 10, 1992

From: Danny D. Reible, PhD, PE and K.T. Valsaraj, PhD
2112 Oak Cliff Dr, Baton Rouge, LA 70810

To: Weldon Bosworth
Balsam Environmental Consultants

Subject: Evaporation of PCBs from proposed CDFs at New Bedford Harbor

Evaporative losses of PCBs after placement in proposed confined diposal facilities (CDFs) in New Bedford Harbor were estimated. Estimates were made for 3 conditions,

1. Water ponded in CDF with vapor emissions from dissolved PCBs in the water,
2. Exposed dredged material in the CDF with direct evaporation, and,
3. Dredged material in the CDF capped with clean sediment with vapor emissions by diffusion through the cap.

Models used to estimate emissions were identical to models reported by Thibodeaux (Miscellaneous Paper EL-89-3, USACE-WES, Vicksburg, MS, 39181, 1989). Physical and chemical property data for the sediment contained within the proposed dredging and disposal plan were taken from Valsaraj and Reible (A Theoretical Evaluation of the Effects of Dredging on PCB Emissions from New Bedford Harbor Sediment, Report to Balsam Environmental Consultants, September, 1991) and Thibodeaux et al. (A Theoretical Evaluation of the Effectiveness of Capping PCB Contaminated New Bedford Harbor Sediment, Report to LSU Hazardous Waste Research Center, Novemeber, 1990). The average Aroclor-1242 concentration in the contaminated sediment to be placed in the CDF was estimated to be 687 mg/kg which corresponds to a saturated water concentration of 0.087 mg/L assuming a sediment-water partition coefficient of 7920. The average Aroclor-1254 concentration in the contaminated sediment to be placed in the CDF was estimated to be 446 mg/kg. Water in contact with this sediment would be limited to the salt water solubility of Aroclor-1254 of about 0.012 mg/L. Elutriate tests reported by Thibodeaux (1989) indicated that estimated suspended solids concentrations in the CDFs would be about 490 mg/L suggesting equilibrium dissolved Aroclor-1242 and Aroclor-1254 concentrations in the ponded CDF water of about 0.069 mg/L and 0.012 mg/L, respectively.

The proposed CDFs in the Upper Estuary of New Bedford Harbor have a total capacity of 434,000 cu. yds. of dredged material. Assuming a fill depth of 8 feet (USACE, New Bedford Harbor Superfund Pilot Study, Interim Report, 1989), this requires a total

surface area of about 136,000 m^2. The largest of the CDFs which might be in use at any one time has a capacity of 270,000 cu. yds., for a surface area of 84,700 m^2. The ponded CDF emissions were assumed to occur from this CDF during filling. The exposed dredged material and capped dredged material scenarios were assumed to apply to the entire CDF area.

Ponded CDF Scenario

The ponded CDF scenario is appropriate for the CDF filling operation. The suspended sediment concentration in the CDF waters was assumed to be 490 mg/L. The equilibrium water concentrations for Aroclor 1242 and 1254 would then be 0.069 mg/L and 0.012 mg/L, respectively. Assuming a water-side mass transfer coefficient of 7 cm/hr (Thibodeaux, 1989) and the 84,700 m^2 surface area of the largest CDF, this corresponds to an Aroclor 1242 emission rate of 409 g/hr and an Aroclor 1254 emission rate of 71 g/hr for a total PCB emission rate of 480 g/hr. It should be noted that the New Bedford Harbor Pilot Study (USACE, 1989) observed total PCB concentrations of approximately 1 μg/L (0.001 mg/L) in CDF effluent and 8 μg/L (0.008 mg/L) in modified elutriate tests which are designed to indicate CDF effluent concentrations. If these concentrations were present in the CDF ponded water, estimated evaporation rates would be about 6 and 47 g/hr, respectively. The sediment used in the pilot study, however, was less contaminated than the average sediment expected to be deposited in the CDF. In addition, effluent concentrations would normally be expected to be lower than water concentrations within the CDF due to evaporation and sorption. The actual CDF water concentrations and the evaporation rate are likely to be between the pilot study measurements and the theoretical upper-bound estimated above.

Exposed Dredged Material Scenario

The ponded CDF scenario would not be appropriate after filling of the CDF. The CDF is designed to allow release of excess waters leaving the dredged material exposed. Without a water covering, PCB evaporation will tend to increase and initially is controlled by air-side resistances. Within a short time, however, the evaporation rate slows as a result of mass transfer resistances in the sediment. Estimates of evaporation rates for this scenario were made based on the physical and chemical properties of the sediments and chemical as given by Thibodeaux (1989) except as noted above. After 100 hours, the release rate of Aroclor 1242 from the CDFs is of the order of 172 g/hr. After 100 days, the release rate is about 37 g/hr. The combined Aroclor 1242 and 1254 release rate would be about 216 g/hr after 100 hours and about 46 g/hr after 100 days. In both cases the entire area of all CDFs are assumed to be exposed dredged material (136,000 m^2). At long times, the evaporation rate depends inversely on the square root of time. Thus a further reduction in the emission rate by a factor of two would require 4 times as long (i.e. after 400 days the total emission rate would be approximately 23 g/hr). At short times, the

estimated evaporation rate would be significantly higher but dredged material would not be exposed simultaneously in all CDFs.

Capped Dredged Material Scenario

Evaporation during the exposed dredged material scenario can be significantly reduced by placement of a clean sediment cap on top. Using a 16.5 cm cap with the same physical properties as the underlying contaminated sediment, as described by Thibodeaux (1989), the steady state emission rate of PCB vapors would be 0.87 g/hr of Aroclor 1242 and 0.16 g/hr of Aroclor 1254. The total emission rate of about 1.03 g/hr is about 0.2% of the expected emission in the ponded CDF scenario.

Summary and Conclusions

Evaporative emissions of PCBs from CDFs in New Bedford Harbor can pose a significant problem if ponded water were allowed to equilibrate with the contaminated sediment. Evaporation rates from the CDF under such conditions can exceed emissions occurring during the dredging operation. Hydraulic dredging, which tends to generate large amounts of water intimately mixed with the contaminated dredged material, tends to maximize evaporation in the CDF. Removal of the water and placement of a clean sediment cap over the contaminated dredged material, however, can reduce the PCB evaporation rates significantly. A summary of the evaporative emissions of PCBs under various scenarios can be found in Table 1.

Table 1

Estimated Evaporative Emissions from CDF Scenarios

Scenario	PCB Evaporation Rate g/hr		
	A-1242	A-1254	Total
Ponded Water Theoretical Equilibrium	409	71	480
Ponded Water Pilot Study Mod. Elutriate			47
Exposed Sediment- 100 Days	37	9	46
Capped Sediment	0.87	0.16	1.03

ATTACHMENT D

Review of EPA (1992): Addendum Proposed Plan. EPA proposes expanded cleanup to address contamination in parts of Upper Buzzards Bay, New Bedford Superfund Site

REVIEW OF EPA (1992): ADDENDUM PROPOSED PLAN. EPA PROPOSES EXPANDED CLEANUP TO ADDRESS CONTAMINATION IN PARTS OF UPPER BUZZARDS BAY, NEW BEDFORD HARBOR SUPERFUND SITE.

BACKGROUND

In May 1992, EPA released an addendum to its remediation plan for New Bedford Harbor. This plan was drawn largely from the Draft Final Supplemental Feasibility Study prepared by Ebasco Services, Inc. (1992). The Draft Final Supplemental Feasibility Study, in turn, relied heavily on an evaluation provided by NOAA.

The history is as follows: After evaluating a number of alternatives using Battelle's (1990) modeling effort, EPA proposed to remediate the Acushnet Estuary and lower harbor areas of New Bedford Harbor to 50 ppm PCB. In response, NOAA recommended extending remediation efforts to include upper Buzzards Bay, specifically to remediate three areas of elevated PCB concentration to 10 ppm. The background of NOAAs rationale and arguments are contained in two documents: (1) a letter from K. Finklestein (NOAA) to M. Sanderson (EPA) dated 30 October 1990 (Finklestein 1990); and (2) a document dated 31 January 1991 in which NOAA compares remedial alternatives recommended by the Natural Resources Trustees for upper Buzzards Bay (Finklestein 1991).

NOAA's synthesis statement on the matter is contained in a document, "Evaluation of Effectiveness: Relative Exposure Model", dated 22 April 1992, submitted to G. Garman, Remediation Project Manager, EPA Region 1 (NOAA 1992). This summary document argues in favor of extending the New Bedford Harbor remediation effort to upper Buzzards Bay, with a target clean-up level of 10 ppm PCB for three areas of elevated PCB concentration. The conclusions of NOAA's (1992) "Evaluation of Effectiveness" were subsequently incorporated into Ebasco's (1992) Draft Final Supplemental Feasibility Study (SFS) Evaluation and EPA's (1992) Addendum for New Bedford Harbor.

NOAA's objective in the "Evaluation of Effectiveness" is to evaluate the benefits of cleaning up hot spots in upper Buzzards Bay to 10 ppm PCB. NOAA argues that, although average PCB concentrations in biota from the upper bay may be below the FDA action level of 2 ppm, individual organisms can have high levels and thus constitute a risk to human health. NOAA's relative exposure model defines the study areas; uses area-weighted sediment PCB concentrations to estimate relative overall exposure to organisms residing in the contaminated areas; estimates changes in average sediment PCB concentration that would result from remedial action; relates this to relative change in exposure to the biota; and extrapolates the results to estimate the magnitude of residual human risk.

Because the rationale and conclusions of NOAA's "Evaluation of Effectiveness" permeate EPA's addendum plan, the assumptions underlying this document are subjected to careful scrutiny

below.

ASSUMPTIONS:

NOAA's "Evaluation of Effectiveness" makes the following assumptions:

1. PCB levels in the biota are directly related to sediment PCB concentrations. This assumption has two corollaries: (a) exposure can be estimated directly using dry weight sediment concentrations; and (b) exposure is related to the time spent in contaminated areas without reference to the exposure pathway. An unstated corollary to this assumption is that the target biota are distributed homogeneously within the area of concern.

2. The sediments of upper Buzzards Bay are the predominant source of PCB to the resident biota. A corollary of this assumption is that significant flux of PCB from the inner harbor to upper Buzzards Bay will not occur after remediation of the harbor.

3. The available sediment PCB data accurately represent the present distribution patterns of PCB in upper Buzzards Bay.

These assumptions are examined below. Additionally, the question of biota body burdens relative to FDA and alleged risk-based limits (SFS, Ebasco 1992) are addressed.

SPATIOTEMPORAL DISTRIBUTIONS OF BIOTA

Distributions of the target biota in space and time are relevant to NOAA's assumption that the organisms are distributed homogeneously within the area of concern. Any evidence that the organisms aggregate or migrate violates this assumption.

NOAA's relative exposure model uses area-weighted sediment PCB concentrations to estimate relative esposure of the biota in upper Buzzards Bay to PCB, assuming that the target biota move randomly within the area of concern. However, NOAA also argues that the concerse applies: because fish aggregate at waste water treatment plant outfalls, they are likely to increase their exposure to PCB in upper Buzzards Bay. This is interpreted as further evidence supporting remediation of the upper bay.

FISH AGGREGATION AT OUTFALL AREAS:

NOAA asserts that fish, including the target species, winter flounder, aggregate at waste water treatment plant outfalls, including the municipal outfalls located in areas of elevated PCB

concentrations in upper Buzzards Bay. Such aggregation, if it occurs, would serve to increase flounder exposure to PCB, thereby increasing their body burden of toxicant.

The assertion that fish aggregate at outfalls appears to come from NOAA's erroneous citation of a paper by Young et al. (1991) to this effect. The study cited by NOAA concerns the use of Dover sole, *Microstomus pacificus*, as a bioindicator of pesticide pollution in the Southern California Bight. The study does not concern, nor does it even mention, fish aggregation phenomena. EPA then cites NOAA to the effect that fish aggregate at outfalls.

After a thorough search of the published literature, SEA was unable to find any evidence that winter flounder, or any fish for that matter, aggregate at wastewater treatment plant outfalls. No data specifically for the Buzzards Bay outfalls have been published in the primary (i.e. refereed) literature.

WINTER FLOUNDER LIFE HISTORY AND MIGRATION:

Phenotypic analyses indicate that winter flounder from separate estuaries do not constitute separate genetic populations. However, distinct subpopulations exist north of Cape Cod, south of Cape Cod, and off Martha's Vineyard (Pierce and Howe 1977). Winter flounder from Buzzards Bay and the New Bedford Harbor area are part of the "south of Cape Cod" subpopulation.

Adult females of the winter flounder, *Pseudopleuronectes americanus*, spawn in shallow inshore areas between November and May, when water temperature is at its annual minimum. They produce eggs which are demersal and adhesive. Hence, the eggs remain localized in spawning areas. Larvae are non-buoyant, leading a mixed planktonic-benthic existence. They drift in the plankton for approximately 7 weeks prior to metamorphosis, at which time they assume a benthic existence. Juvenile fish spend their first two years in or near their shallow natal waters. In estuarine environments, the juvenile forms move gradually seaward as they grow larger. Adult fish are strictly demersal and do not school. Some stocks do, however, perform seasonal migrations (Gray 1990).

Winter flounder stocks located north of Cape Cod move only locally in inshore waters. In contrast, stocks south of Cape Cod, including those located in Buzzards Bay, perform seasonal migrations (Howe and Coats 1975). Water temperature is the most important factor affecting the seasonal distribution of adult winter flounder, with fish moving offshore to cooler water (< 15 °C) during summer (Buckley 1989). Howe and Coats (1975) reported that the majority of winter flounder tagged in upper Buzzards Bay moved north with season, into Cape Cod Bay via the Cape Cod Canal. A small fraction moved south. In contrast, most winter flounder tagged in lower Buzzards Bay tended to move to the southeast, some as far as Nantucket Shoals. A small fraction moved north. The average distance travelled from release sites appears to be related to the proximity of suitable seabed temperature. Distances travelled by winter flounder released in both upper and lower Buzzards Bay are on the order of 10 to 100 kilometers (Howe and Coats 1975).

On the basis of spawning patterns and seasonal temperatures, adult flounder (i.e. greater than age 3) spend about 50% of each year inshore and 50% offshore. Juvenile flounder remain in nearshore waters for approximately the first two years of life. After reaching sexual maturity (year 3), they adopt the adult pattern of seasonal migration.

LOBSTER LIFE HISTORY AND MIGRATION:

The American lobster, *Homarus americanus*, is a benthic species having a planktonic larval life history stage. The preferred habitat of adult lobster is hard-bottom substratum. Below, the term "lobster" refers to post-larval, fully metamorphosed life history stages.

Stock identification studies indicate that inshore and offshore lobster populations are genetically separate (Tracey et al. 1975; Saila and Flowers 1969), although seasonal intermixing of the populations does occur during periods of molting and mating activities. SEA was unable to locate published studies concerning lobster migrations in New Bedford Harbor and Buzzards Bay. However, the phenomenon has been well studied in adjacent waters of coastal Rhode Island (Fogarty et al. 1980). Lobsters from offshore (i.e. outer continental shelf) stocks migrate on the order of 20 to 100 km (e.g. Cooper and Uzmann 1971; Fogarty et al. 1980; Campbell and Stasko 1985; Campbell 1989). Lobsters from inshore populations move considerably shorter distances, on the order of 5 to 10 km. Movements in offshore and nearshore environments are the same for both sexes and all age classes (Fogarty et al. 1980).

Lobster in upper Buzzards Bay are clearly members of the less migratory inshore stock. However, the magnitude of the distance they are able to move, on the order of 10 km, is sufficient for them to transit between upper Buzzards Bay and inner New Bedford Harbor as well as between upper Buzzards Bay and lower Buzzards Bay.

Bottom line: Assumption 1 is violated. Both winter flounder and lobster are highly motile species. While the magnitude of winter flounder migration is small compared to the global and basin-scale movements of anadromous fishes, adult winter flounder from upper Buzzards Bay clearly spend a significant fraction of their life history outside of the PCB-contaminated area. The lobster population of upper Buzzards Bay, while somewhat more restricted in range than winter flounder, has the potential to move into more contaminated areas (the inner harbor) or less contaminated areas (the lower bay).

PCB FLUX THROUGH HURRICANE BARRIER FOLLOWING REMEDIATION

NOAA posits that, following remediation of the inner harbor to 50 ppm PCB, only a small amount of contaminant relative to PCB levels already present in the bay will pass through the hurricane barrier into upper Buzzards Bay (Finklestein 1990; 1991). Hence, cleanup efforts north of the hurricane barrier will not affect the concentration of PCB in bay sediments or biota.

On this basis, NOAA argues that the major source of PCB contamination in the upper bay is PCB presently located in the upper bay sediments.

Comparison of Battelle's (1990) model results of PCB flux through the hurriciane barrier with calculated fluxes from sediments in upper Buzzards Bay shows this assumption to be false. In fact, mass flux of PCB through the hurricane barrier under the 50 ppm remediation scenario (43.8 kg/y) is approximately equal to the mass flux of PCB from sediments remediated to 10 ppm in the upper bay (40 kg/y) (Table 1). The calculation is done as follows:

Thibodeaux (1989) gives a mean PCB flux of 3.4 mg/cm^2 at site FX in New Bedford Harbor where the surface sediment concentration of PCB was 1600 ppm. Assuming that flux scales linearly with surface PCB concentration, fluxes for various surface PCB concentrations were calculated. The annual mass flux was calculated by applying this estimate to a 50 acre area having a surface PCB concentration of 10 ppm.

Table 1. Comparison of annual mass flux of PCB through the hurricane barrier (Battelle 1990) and annual mass flux of PCB from sediments having various surface sediment concentrations of PCB.

FLUX THROUGH HURRICANE BARRIER

	Mass flux (kg/y)
No action scenario, Year 0	109.5
50 ppm scenario, Year 0	43.8

FLUX FROM SEDIMENTS

Surface PCB (ppm)	Flux (mg/cm^2/y)	Mass flux (kg/y)
100	0.21	420
50	0.0425	90
10	0.02	40
1	0.002	4

Bottom line: Assumption 2 is violated. Under EPA's preferred remediation scenario for the inner harbor, PCB flux to upper Buzzards Bay through the hurricane barrier is approximately equal to PCB flux from the sediments of upper Buzzards Bay. Hence, the bay sediments are not the primary source of PCB contamination for the biota.

DISTRIBUTION OF PCB IN UPPER BUZZARD'S BAY

Historically, 9 areas of elevated PCB concentration were noted in upper Buzzards Bay (Ebasco, 1992: Appendix B) (Figure 1). Only three of these areas are presently targeted for remediation by EPA (Figure 2). As will be shown below, the data used to define these three areas are extremely limited. There is thus a high degree of uncertainty regarding the areas and volumes of sediment targeted for remediation. Further, the effects of two major storms during 1991, Hurricane Bob and the Halloween storm, are unknown. Both storms were of sufficient magnitude to move sediment in the area.

Data contoured are those provided in Appendix A of EBASCO (1992) (Table A-1; Appendix I of this report). The method of analysis was to use the commercial contouring package SURFER. Data were input into SURFER as three columns of data: X-distance (feet), Y-distance (feet), and PCB concentration (ppm). Limits for the gridding were 759000-767000 for X-distance and 223500-228000 for Y-distance with a grid resolution of ca. 100 feet. The kriging method, using only the data within the defined limits, was used to grid the randomly located input data. The resulting grid was then plotted using TOPO to produce the attached graphs. Two contour levels were specified: 10 and 50 ppm. SURFER's utility program was then used to calculate the area of the regions having sediment PCB concentrations exceeding 10 ppm.

In terms of the three areas (A,B and C) targeted for remediation, NOAA's contouring procedures appear to be arbitrary. To evaluate NOAA's contouring results, SEA initially used an objective method to contour upper Buzzards Bay PCB concentrations. A truly objective method defines contour levels solely on the basis of mathematical properties of the data distribution, with no human interpretation (the area A contours demarked by solid lines in Figure 3). Because there are no data points contained within the large bulge to the east in area A (Figure 3), SEA performed additional contouring, described below. We define this approach as semi-objective.

The total planar area (ie. area A+B1+B2) for the three areas shown on Figure 3 which exceed 10 ppm is 85 acres. This is double EPA's estimate for areas A (7 acres) and B (35 acres) combined of 42 acres. To compare results for the areas individually, the one large PCB value of 81 ppm which creates area A was deleted from the data set and the data recontoured. Figure 4 shows the contours which result; B1 and B2 combined represent 30.6 acres. This compares reasonably well with the single B area of 35 acres calculated by EPA. The difference is caused

by the inclusion of relatively low PCB sediments that occur between the two hotspots of the B region. Given the relatively sparse number of sampling sites the higher acreage proposed for remediation by EPA seems justified.

The above results were used to calculate an estimated acreage of area A in Figure 3 of 54.4 acres. This figure is considerably larger than the acreage proposed for remediation by EPA. The difference is due primarily to the complete lack of data to the east of the hotspot in area A. Consequently, the gradient from high PCB concentrations at the hotspot to low background concentrations at locations further to the east is ill-defined. The objective analysis indicates that the 10 ppm contour level may be much further to the east than EPA proposes. If one assumes that the PCB concentration gradient from the A hotspot decreases similarly in all directions, one might suppose that the actual acreage having > 10 ppm PCB in area A is like that shown as a dotted line on Figure 3. We estimate that the hotspot area A as defined by the dotted line is ca. one-third that of area estimated by objective analysis. Consequently, the portion of area A having > 10 ppm PCB would be estimated to be ca. 18 acres.

Thus, a <u>semi-objective</u> contour analysis of the recent PCB data suggests that the remediation acreage is ca. 18 acres for area A and ca. 30.6 acres (possibly 35 acres) for area B. The total remediation area for areas A and B combined is then 48.7-53 acres.

For area C near the 60 inch outfall, EBASCO (1992) shows a remediation area of ca. 17 acres, which includes the only three data values (6.1, 28.5, and 135.3 ppm PCB) which were available in the GZA/Battelle data set. SEA determined the locations of those three stations and the proposed remediation area by digitizing their positions from the map shown as Figure 2-3 of EBASCO (1992). That data and the proposed remediation area are shown in Figure 5. Also shown are the positions and PCB concentrations of four surface sediment (0-6 inch layer) samples provided to us by Balsam Environmental Consultants, Inc. (1990). The locations and PCB concentrations of those samples, labeled TPO samples, are tabulated in Table A-2 of Appendix I. The addition of the Balsam samples to Figure 5 suggests that the proposed remediation area for > 10 ppm PCB sediment concentrations in the vicinity of the 60 inch outfall is not large enough to encompass all of the region having sediment PCB concentrations exceeding 10 ppm.

Bottom line: Assumption 3 is violated. Sampling is obviously insufficient to determine the size of contaminated zones. We do not know where the PCB is located in upper Buzzards Bay and we do not know how much of it there is. Consequently, the size of the areas to be remediated are not known, nor are the volumes of contaminated sediment to be removed or capped.

Overall, the number and distribution of samples available for describing the distribution of PCB's in surface sediments is inadequate for determining the size of the proposed remediation areas. EBASCO (1992) shows three regions (A,B, and C) proposed for remediation. The data are not sufficient to delimit the sizes of regions A and C, and are only slightly better for delimited the areal extent of region B.

BIOTA BODY BURDENS OF PCB

FDA LIMIT:

As of 1986, winter flounder collected from upper Buzzards Bay were under the FDA limit of 2 ppm for PCB (Table 2). According to Battelle's (1990) model results, under the no-action scenario, PBC concentrations in flounder would remain about the same, but still be under the FDA limit, after 10 years (Table 3). Using Battelle's (1990) 50 ppm model scenario, flounder PCB concentrations would decrease even further below the FDA limit after 10 years (Table 3).

As of 1986, lobster collected from upper Buzzards Bay were under the FDA limit of 2 ppm for PCB (Table 2). According to Battelle's (1990) model results, under the no-action scenario, PBC concentrations in lobster would remain about the same, but still be under the FDA limit, after 10 years (Table 3). Using Battelle's (1990) 50 ppm model scenario, lobster PCB concentrations would decrease even further below the FDA limit after 10 years (Table 3).

RISK-BASED LIMIT:

The SFS (Ebasco 1992) focuses on 0.2 ppm PCB as the target cleanup level for human health for the ingestion of biota. Neither flounder nor lobster would achieve this limit after 10 years of Battelle's no-action scenario, but both species would approach the limit after 10 years of Battelle's 50 ppm scenario (Table 3).

Table 2. Measured body burdens of PCB in winter flounder and lobster from upper Buzzards Bay. Data collected in 1985-1986 (Schwartz 1988).

	(ppm)
Flounder	0.45 ± 0.05
Lobster	0.96 ± 0.11

Bottom line: Schwartz's (1986) data on PCB body burdens of lobster and winter flounder collected from upper Buzzards Bay are the most recent available to us. It is likely that biota body burdens have decreased further during the intervening five years. The target biota of upper Buzzards Bay are presently within the FDA limits in the absence of remediation.

Table 3. Predicted biota body burdens of PCB after 10 years. From Battelle (1990) model results for model box 5, upper Buzzards Bay (Battelle 1990). Edible to whole body ratios: 0.18 flounder; 1.35 lobster.

	No Action Scenario		50 ppm Scenario	
	whole body (ppm)	edible tissue (ppm)	whole body (ppm)	edible tissue (ppm)
Phytoplankton	0.9		0.3	
Polychaetes	4.1		1.5	
Hard clams	0.3		0.1	
Mussels	0.9		0.3	
Crabs	1.1		0.4	
Winter flounder	2.2-3.5	0.4-0.63	0.8-1.3	0.14-0.23
Lobster	0.6	0.81	0.2	0.27

SUMMARY

- NOAA's model assumptions are invalid. Hence, NOAA's model results are incorrect. NOAA presents no basis for an accurate or realistic assessment of remedial alternatives.

- The present distribution of PCB in upper Buzzards Bay is unknown. The area is badly undersampled. Errors in estimates of surface areas, sediment volumes, etc. are undoubtedly extremely large (factor of 2 or more). This is particularly the case at the Fort Rodman outfall site.

- Selection of a preferred remediation plan for upper Buzzards Bay is premature. No tradeoff analysis of remedial scenarios should be done until a thorough PCB sediment survey is done.

BIBLIOGRAPHY

Battelle 1990. Modeling of the transport, distribution, and fate of PCBs and heavy metals in the Acushnet River/New Bedford Harbor/Buzzards Bay System. Contract No. 4236-MOD-0019 to Ebasco Services, Inc.

Buckley, J. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic). Winter flounder. U.S. Fish and Wildlife Service. Biological Report 82(11.87).

Campbell, A. and A.B. Stasko 1985. Movements of tagged American lobsters, *Homarus americanus* off southwestern Nova Scotia. Can. J. Fish. Aquat. Sci. 42: 229-238.

Campbell, A. 1989. Dispersal of American lobsters, *Homarus americanus*, tagged off southwestern Nova Scotia. Can. J. Fish. Aquat. Sci. 46: 1842-1844.

Cooper,R.A. and J.R. Uzmann 1971. Migrations and growth of deep-sea lobsters, *Homarus americanus*. Science 171: 288-290.

Ebasco 1992. Draft final supplemental feasibility study evaluation for upper Buzzards Bay, New Bedford Harbor, RI/FS, New Bedford, Massachusetts. Contract No. 69-W9=0034.

EPA 1992. Addendum proposed plan. EPA proposes expanded cleanup to address contamination in parts of upper Buzzards Bay, New Bedford Harbor superfund site.

Finklestein, K. 1990. Letter to Mary Sanderson, EPA, on Draft Final Feasibility Study for the Estuary and Lower Harbor/Bay, New Bedford Harbor Superfund site.

Finklestein, K. 1991. Analysis and comparison of remedial alternative recommended by natural resource trustees for the upper Buzzards Bay section of the New Bedford Superfund site.

Fogarty, M.J., D.W. Borden and H.J. Russell 1980. Movements of tagged american lobster, *Homarus americanus*, off Rhode Island. Fish. Bull. 78: 771-780.

Gray, C.L. 1990. Winter flounder *Pseudopleuronectes americanus*. Species Profile. Rhode Island Department of Environmental Management.

Howe, A.B. and P.G. Coats 1975. Winter flounder movements, growth, and mortality off Massachusetts. Trans. Am. Fish. Soc. 164: 13-29.

NOAA 1992. Evaluation of effectiveness: relative exposure model. Report to Gayle Garman,

EPA.

Pierce, D.E. and A.B. Howe 1977. A further study on winter flounder group identification off Massachusetts. Trans. Am. Fish. Soc. 106: 131-139.

Saila, S.G. and J.M. Flowers 1968. Movement and behavior of berried female lobsters displaced from offshore areas to Narragansett Bay, Rhode Island. J. Conseil. 31: 342-351.

Schwartz, J.P. 1988. Distribution and concentration of polychlorinated biphenyls in lobster, winter flounder, and quahogs from Buzzards Bay, Masachusetts. Report for EPA Buzzards Bay Program. Grant no. CX 812852-01.

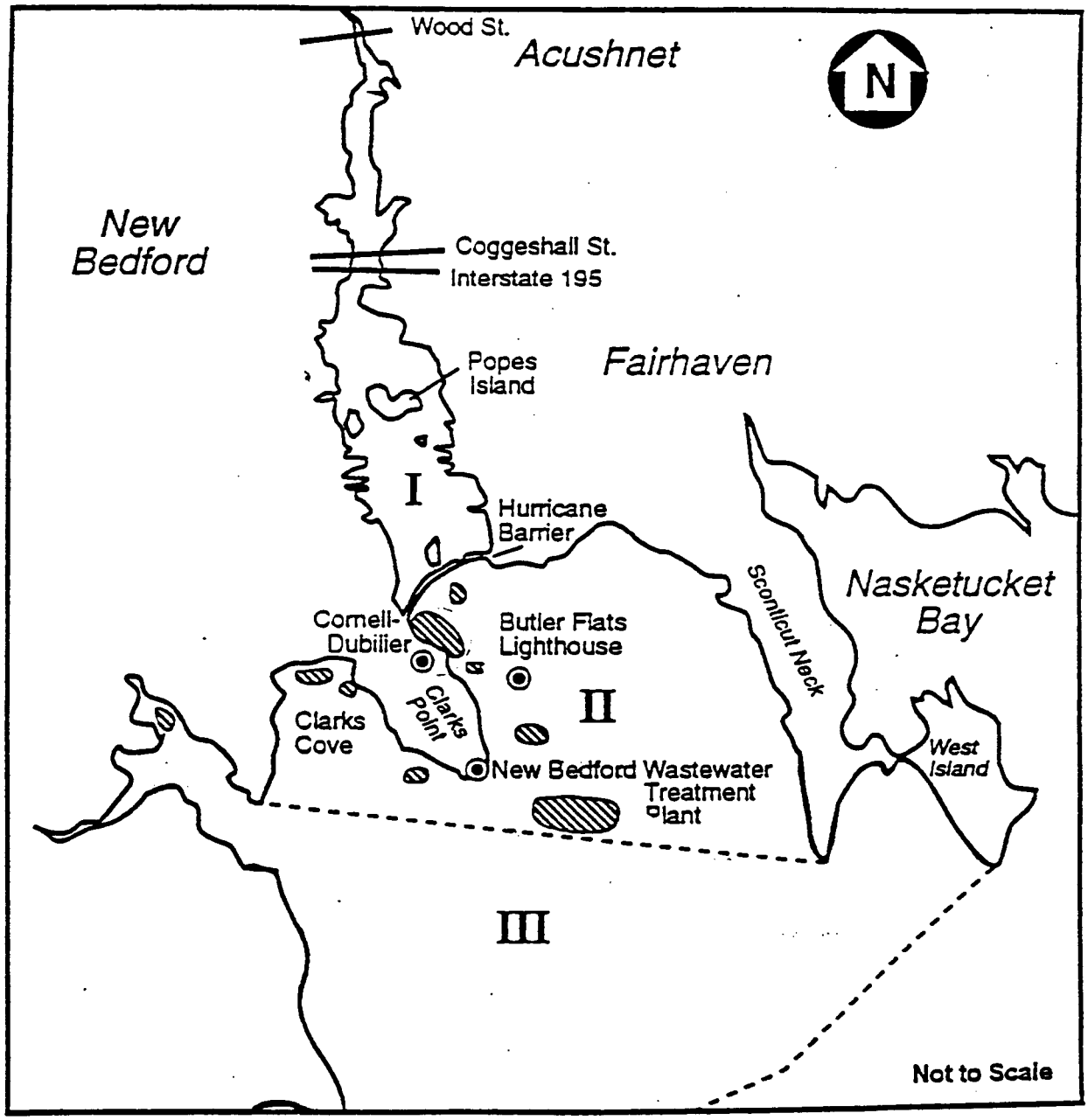
Thibodeaux 1989. A theoretical evaluation of the effectiveness of capping PCB contaminated New Bedfor Harbor sediments. Report forr Balsam Environmental Consultants, Inc. Balsam Project 6692.01.

Tracey, M.L. et al. 1975. Biochemical genetics of lobsters: genetic variation and the structure of american lobster (*Homarus americanus*) populations. J. Fish. Res. Board. Canada 32: 2091-2101.

Young, D.R., A.J. Mearns and R.W. Gossett 1991. Bioaccumulation of p,p'-DDE and PCB 1254 by a flatfish bioindicator from highly contaminated marine sediments of southern California. pp. 159-169 in: R.A. Baker (ed.). *Organic Substances and sediments in water.* Vol. 3. Lweis Publications, Chelsea, MI.

Figure 1. Areas potentially exceeding 10 ppm in upper Buzzard's Bay. From EPA (1992).

Areas potentially exceeding 10 ppm in Upper Buzzards Bay

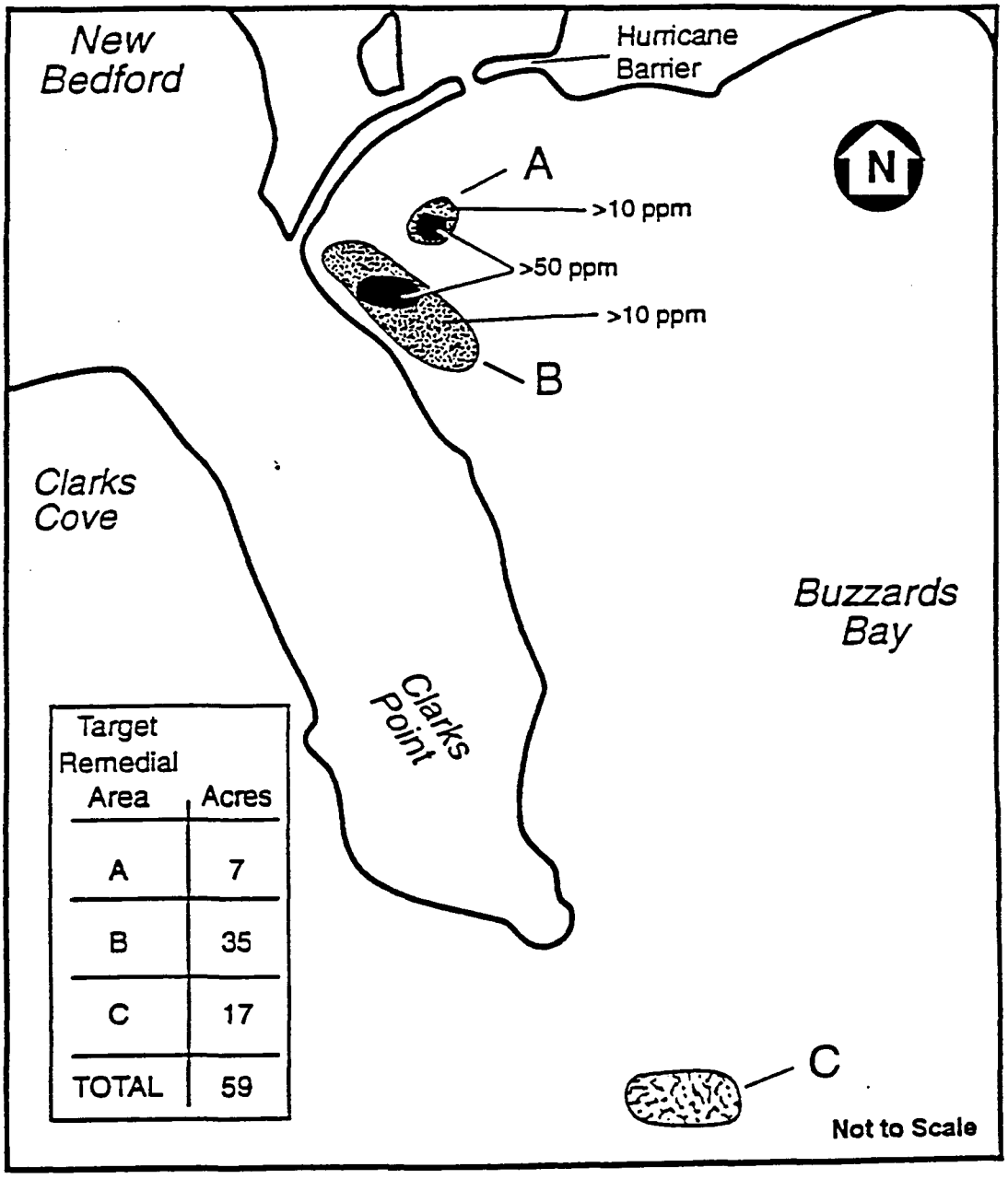


Legend

Areas potentially >10 ppm

Figure 2. EPA's Preferred remedial alternative for upper Buzzard's Bay. From EPA (1992).

Preferred Alternative (Bay-4)



Target Remedial Area	Acres
A	7
B	35
C	17
TOTAL	59

Legend

Proposed Dredging Areas

Proposed Capping Area

Figure 3. SEA's contours of areas A, B1 and B2. Axes are given in feet in order to be consistent with the format of the raw data. The uppermost left axis point corresponds to 41.6254 °N lat; 70.9179 °W long. The lowermost right axis point corresponds to 41.6119 °N lat; 70.8885 °W long.

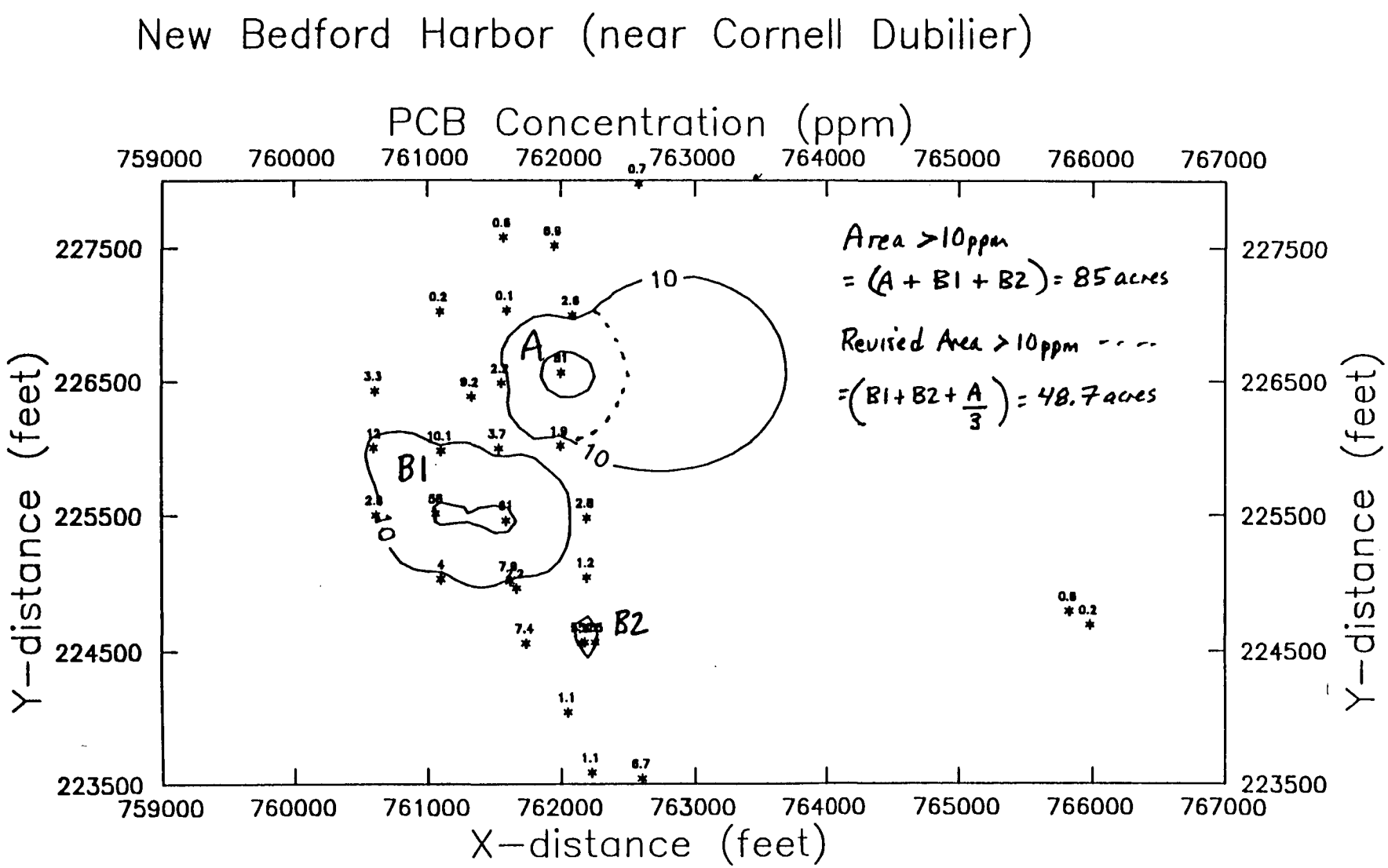


Figure 4. SEA's contours of areas B1 and B2. Coordinates as in Figure 3.

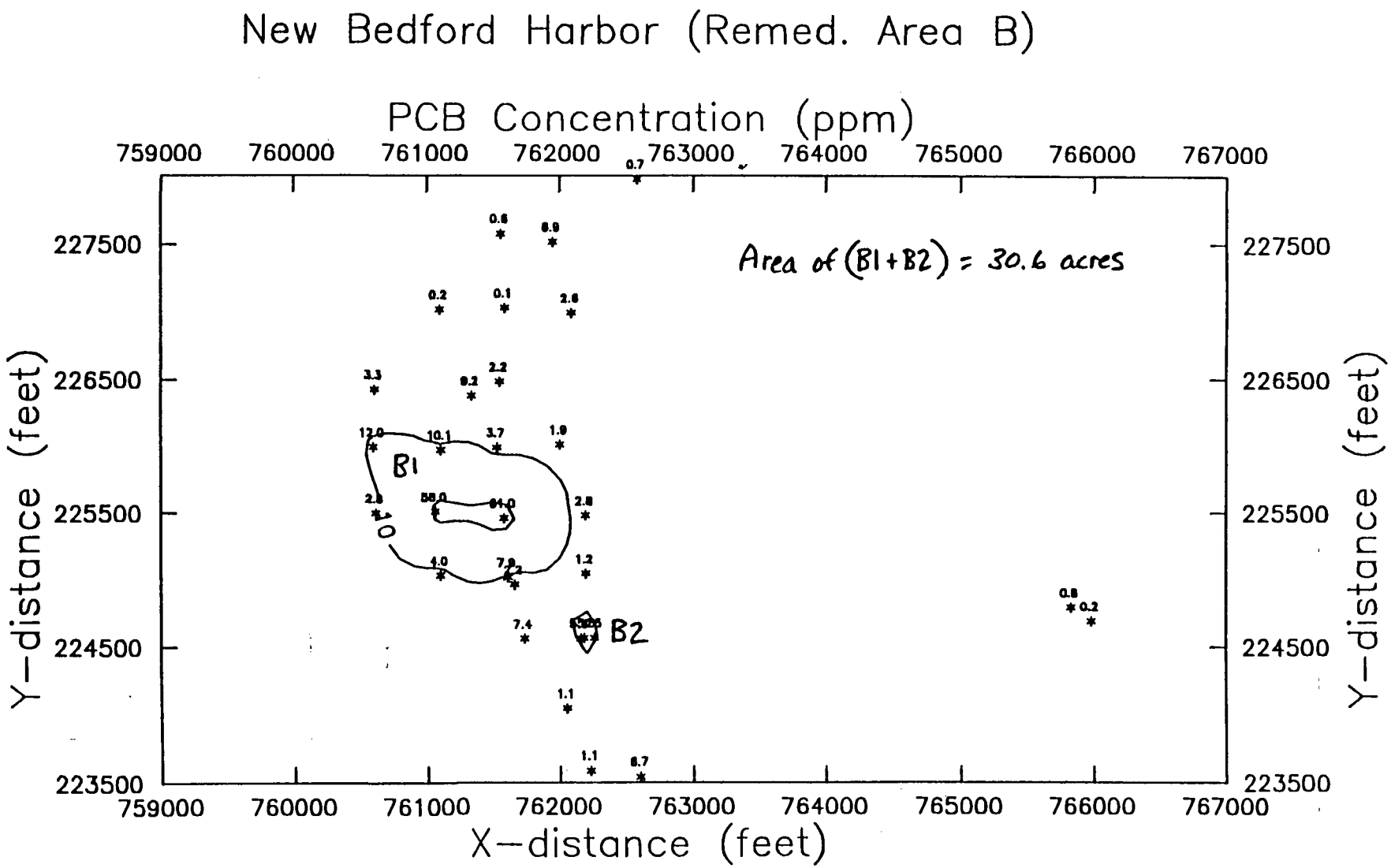
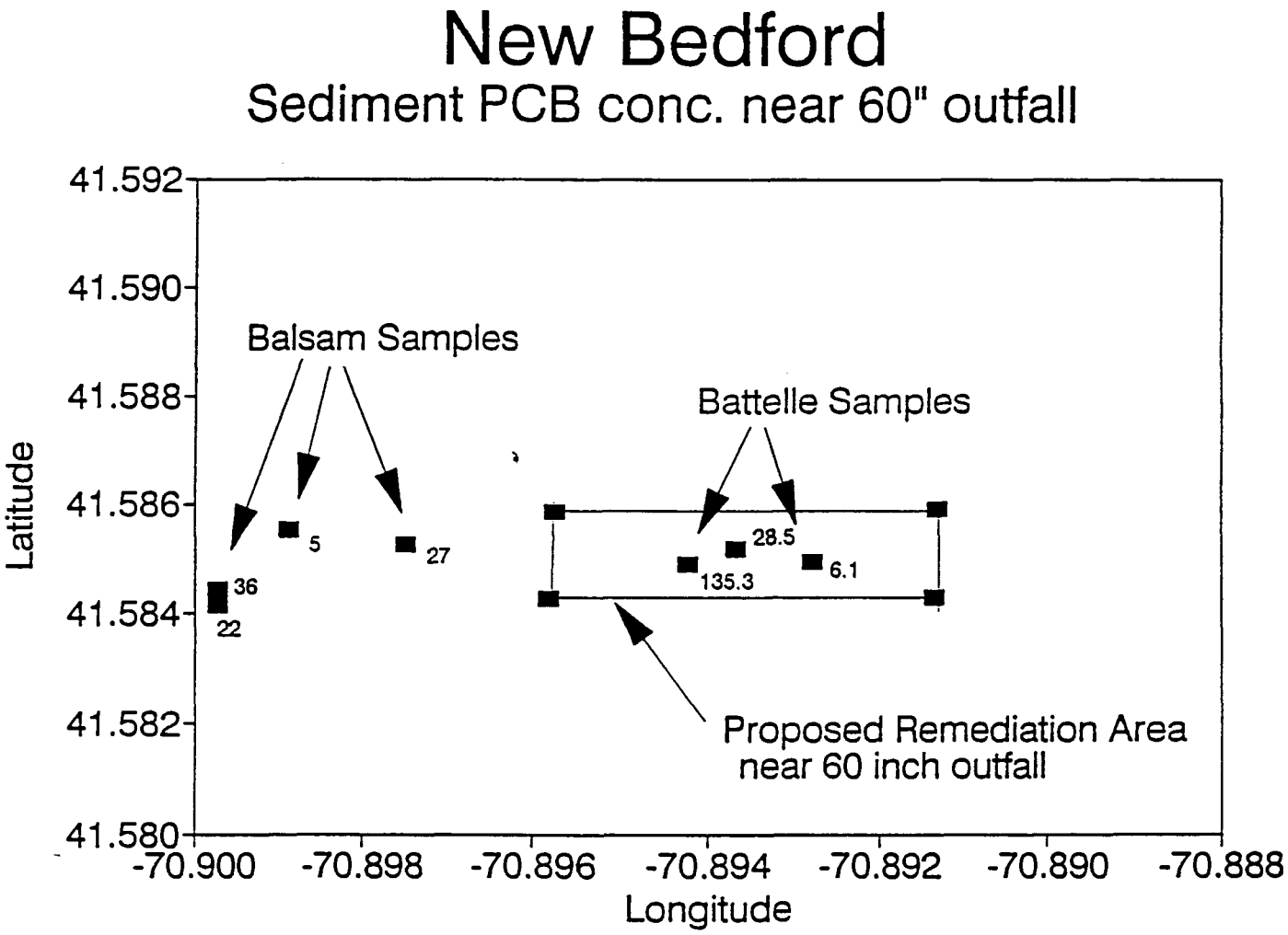


Figure 5. Area C. Locations of Battelle and Balsam sediment PCB samples.



APPENDIX I.

Data contoured are those provided in Appendix A of the EBASCO report (Table 1 of this report). The method of analysis was to use the commercial contouring package SURFER. Data were input into SURFER as three columns of data: X-distance (feet), Y-distance (feet), and PCB concentration (ppm). Limits for the gridding were 759000-767000 for X-distance and 223500-228000 for Y-distance with a grid resolution of ca. 100 feet. The kriging method, using only the data within the defined limits, was used to grid the randomly located input data. The resulting grid was then plotted using TOPO to produce the attached graphs. Two contour levels were specified: 10 and 50 ppm. SURFER's utility program was then used to calculate the area of the regions having sediment PCB concentrations exceeding 10 ppm.

Table A-1.

Sediment PCB data from the Battelle and GZA Sampling Programs as reported in:
Appendix A. of:

ARCS I Work Assignment Number 012-1L43, EPA Contract Number 68-W9-0034
EBASCO Services Incorporated
Draft final supplemental feasibility study evaluation for upper Buzzards Bay
New Bedford Harbor RI/FS New Bedford, Massachusetts, May 1992.

SEA FIL PCB62592.WQ1

Samplin Program	Sample Numbe	X(ft)	Y(ft)	PCB (ppm)	Fishing Closure Area	Target Remedial Area	Decimal Longitude	Decimal Latitude
GZA-86	6240	761948.7	227515.0	6.9	II	Background	-70.9070	41.6230
GZA-86	6243	760614.4	225499.5	2.8	II	Background	-70.9120	41.6175
GZA-86	6246	761616.4	225019.7	7.9	II	Area B	-70.9083	41.6163
GZA-86	6259	760608.3	226426.9	3.3	II	Background	-70.9120	41.6201
GZA-86	6264	762001.6	226562.7	81.0	II	N/A	-70.9068	41.6204
GZA-86	6267	761062.9	225509.8	58.0	II	N/A	-70.9104	41.6176
GZA-86	6268	761587.4	225461.4	61.0	II	N/A	-70.9085	41.6174
GZA-86	6269	761099.7	225033.5	4.0	II	Background	-70.9103	41.6163
GZA-86	6277	762155.3	224561.5	1.9	II	Area B	-70.9064	41.6149
GZA-86	6286	762582.8	227977.2	0.7	II	Background	-70.9047	41.6242
GZA-86	6299	761567.9	227577.2	0.6	II	Background	-70.9084	41.6232
GZA-86	6300	761097.4	227020.0	0.2	II	Background	-70.9102	41.6217
GZA-86	6301	761594.3	227032.9	0.1	II	Background	-70.9084	41.6217
GZA-86	6302	760596.6	225998.0	12.0	II	Area B	-70.9121	41.6190
GZA-86	6303	761536.6	225993.5	3.7	II	Background	-70.9086	41.6189
GZA-86	6304	761999.7	226013.8	1.9	II	Background	-70.9069	41.6189
GZA-86	6305	762190.7	225479.7	2.8	II	Background	-70.9062	41.6175
GZA-86	6306	762190.9	225046.9	1.2	II	Area B	-70.9062	41.6163
GZA-86	6307	761734.8	224561.2	7.4	II	Background	-70.9079	41.6150
GZA-86	6308	762053.6	224040.7	1.1	II	Background	-70.9068	41.6136
GZA-86	6309	762226.5	223586.9	1.1	II	Background	-70.9062	41.6123
GZA-86	6310	762603.5	223541.4	6.7	II	Background	-70.9048	41.6121
GZA-86	6311	762717.5	223062.2	1.0	II	Background	-70.9044	41.6109
GZA-86	6312	762231.0	223096.0	5.7	II	Background	-70.9025	41.6109
GZA-86	6314	763683.3	222602.7	7.2	II	Background	-70.9009	41.6095
GZA-86	6315	763346.9	222130.8	5.6	II	Background	-70.9021	41.6082
GZA-86	6316	763816.4	222142.5	2.9	II	Background	-70.9004	41.6083
GZA-86	6317	763463.6	221696.0	3.9	II	Background	-70.9017	41.6070
GZA-86	6318	763299.7	221088.3	0.3	II	Background	-70.9023	41.6053
GZA-86	6319	763761.3	221118.8	0.5	II	Background	-70.9007	41.6054
GZA-86	AF274	762085.8	226994.8	2.6	II	Background	-70.9065	41.6216
GZA-86	AF212	761557.6	226485.1	2.2	II	Background	-70.9085	41.6202
GZA-86	AF213	761330.4	226382.3	9.2	II	Background	-70.9094	41.6199
GZA-86	AF214	761105.4	225975.8	10.1	II	Area B	-70.9101	41.6189
GZA-86	AF279	763719.1	221540.3	2.2	II	Background	-70.9008	41.6066
GZA-86	AF275	761664.1	224967.3	2.2	II	Area B	-70.9083	41.6161
GZA-86	AE537	763006.1	228013.9	ND	II	Background		
GZA-86	AE541	762841.1	227607.4	ND	II	Background		
GZA-86	AE225	763873.2	221237.7	ND	II	Background		

Duxbury	11	762178.6	224566.0	55.3	II	Area B	-70.9060	41.6152
Duxbury	12	769681.0	227048.7	1.0	II	Background		
Duxbury	14	766915.7	220753.0	4.8	II	Background	-70.8890	41.6043
Duxbury	15	768846.5	216414.3	0.3	II	Background		
Duxbury	16	765749.7	213760.3	28.5	II	Area C	-70.8937	41.5852
Duxbury	17	758598.6	214824.1	1.4	II	Background	-70.9203	41.5882
Duxbury	18	771794.4	208236.9	0.2	II	Background		
Duxbury	19	758002.3	201863.7	0.2	III	Background		
Duxbury	21	783270.1	208627.8	0.0	III	N/A		
Duxbury	22	781526.3	188470.9	0.0	N/A	N/A		
Duxbury	23	754681.3	186658.2	0.0	N/A	N/A		
Duxbury	24	764554.5	178425.5	0.0	N/A	N/A		
Duxbury	25	770709.9	169359.6	0.0	N/A	N/A		
Duxbury	12	765975.9	224693.9	0.2	II	Background	-70.8922	41.6152
Duxbury	16	765598.5	213658.0	135.3	II	Area C	-70.8942	41.5849
Duxbury	18	771717.6	208337.5	0.6	III	Background		
Duxbury	21	783345.3	208729.6	0.0	N/A	N/A		
Duxbury	24	768062.9	177438.2	0.1	N/A	N/A		
Duxbury	11	762254.6	224566.5	0.5	II	Area B	-70.9060	41.6150
Duxbury	18	771718.4	208236.3	0.6	III	Background		
Duxbury	21	783347.7	208426.0	0.0	N/A	N/A		
Duxbury	24	765177.0	176506.6	0.0	N/A	N/A		
Duxbury	12	765823.3	224794.0	0.8	II	Background	-70.8928	41.6155
Duxbury	16	765978.4	213660.7	6.1	II	Area C	-70.8928	41.5850
Duxbury	18	772100.7	207935.4	0.5	III	Background		
Duxbury	21	783802.9	208530.8	0.4	N/A	N/A		
Duxbury	24	767683.1	177334.3	0.0	N/A	N/A		

Table A-2.

Sediment PCB data from Balsam Environmental Consultants, Inc.
Reference: FAX dated 6/28/92 (18:28) to Dian Gifford (SEA) from Weldon Bosworth (Balsam) and FAX dated 7/1/92 to Dian Gifford (SEA) from Weldon Bosworth (Balsam)
SEA FILE: PCB62592.WQ1

Sampling Program	Sample #	PCB(ppm	Fishing Closure Area	Target Remedial Area	Decimal Longitude	Decimal Latitude
Balsam	TPO-1	36.0	II		-70.8997	41.5844
Balsam	TPO-3	5.0	II		-70.8989	41.5856
Balsam	TPO-4	22.0	II		-70.8997	41.5842
Balsam	TPO-5	27.0	II		-70.8975	41.5853

5.3.18

~~Attach E~~

Attachment E

In separate binders

ATTACHMENT F-1

Comments on Proposed Rule to Promulgate Numeric Sediment Cleanup Criteria

March 2, 1992

BY HAND DELIVERY

Ms. Margaret Stasikowski
Director
Health and Ecological Criteria Division (WH-586)
Office of Water
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Re: Proposed Rule to Promulgate Numeric Sediment Cleanup Criteria for Priority Toxic Pollutants In Sediment

Dear Ms. Stasikowski:

The Environmental Protection Agency (EPA) is proposing to issue national numeric sediment cleanup "guidance" for priority toxic pollutants in sediment. Although polychlorinated biphenyls (PCBs) are not expected to be among the first five chemicals for which such guidance is issued, the Polychlorinated Biphenyl Panel of the Chemical Manufacturers Association (CMA), the National Electrical Manufacturers Association (NEMA) and the Utility Solid Waste Activities Group (USWAG) (collectively, the PCB Consensus Group) is concerned that the methodology is likely to be adopted and eventually used to derive a PCB sediment cleanup level. The PCB Consensus Group has for many years worked with EPA to develop objective standards and practical guidance for the proper management of PCBs. We, therefore, submit these comments on the generic method.

As explained more fully in the attachment, we strongly urge EPA not to develop a numerical cleanup guidance for contaminated sediment at this time. The method currently under consideration to assess the potential human health and environmental impacts from contaminated sediment, the equilibrium partitioning method, is scientifically flawed, unsupported by field studies, fails to take into account the nature of the water body, and inevitably will be used inappropriately as a standard. These flaws are evident from an examination of the comments on this method from EPA, other Federal Agencies, the Science Advisory Board, and independent scientists in the field.

As a result of the lack of scientific support for this method, the cost of such cleanups would be substantial with no significant public health or environmental benefit. Thus, use of the equilibrium partitioning coefficient method would be contrary to the Administrator's directive to enhance the use of science in EPA decisionmaking and would exacerbate the misallocation of resources.

The PCB Consensus Group is willing to provide assistance in evaluating alternative approaches to the problem of contaminated sediment.

Sincerely,

Gordon D. Strickland

Gordon D. Strickland,
Vice President
Technical Services
Chemical Manufacturers Association

John F. McKenzie /pof

John F. McKenzie
Chairman, USWAG PCB Committee
Utility Solid Waste Activities Group

Douglas Bannerman, Ph.D.

Douglas Bannerman, Ph.D.
National Electrical Manufacturers Association

cc: Tony W. Baney
David Kling
OPTS Docket Office (No. 66009)

The Environmental Protection Agency ("EPA") has completed the first five sediment criteria documents and will provide notice of a public comment period shortly.[1] The Polychlorinated Biphenyl Panel of the Chemical Manufacturers Association (CMA), the National Electrical Manufacturers Association (NEMA) and the Utility Solid Waste Activities Group (USWAG) (collectively, the PCB Consensus Group) strongly urges EPA not to issue regulations, standards, or guidance setting sediment cleanup levels pursuant to any statute, particularly PCB sediment cleanup levels. The method proposed to set these numerical sediment cleanup levels, the equilibrium partitioning coefficient method, is unsupported by the scientific evidence and fails to take into account actual exposures and risks. EPA should establish cleanup levels on a case-by-case basis.

A. There Are No Uniformly Applicable Scientifically Valid Methods At This Time For Setting Cleanup Levels In Sediment; Therefore, EPA Should Not Establish Sediment Cleanup Standards or Criteria

There is no legally applicable action level for contaminated sediment in any Federal regulations. EPA will issue non-enforceable advisory levels that States may use in developing enforceable sediment standards. These standards will be derived using the equilibrium partitioning coefficient.[2] The Agency has already issued guidance using the equilibrium partitioning method to assess the impact of PCB contaminated sediment at Superfund sites.[3]

Conceptually, the equilibrium partitioning theory estimates the sediment concentration necessary to ensure that the concentration of a chemical in interstitial water (i.e., the water present in between sediment particles in a water body) does not exceed EPA's non-enforceable chronic water quality criterion. Sediment concentrations derived by the equilibrium partitioning method are a function of the ability of the chemical to adsorb to

---

1. Sediment Criteria Documents, 4 Contaminated Sediments News 1-2 (EPA-823-N-92-001, Feb. 1992).

2. Id.; see also Science Advisory Board, EPA, Report of The Sediment Criteria Subcommittee of The Ecological Processes and Effects Committee: Evaluation of the Equilibrium Partitioning (EqP) Approach for Assessing Sediment Quality (Feb. 1990) ("SAB Report"); EPA, Technical Support Document For Water Quality-based Toxics Control (EPA/505/2-90/001, 1991).

3. Guidance on Remedial Actions For Superfund Sites With PCB Contamination 36 (OSWER Dir. No. 9355.4-01, Aug. 1990) ("Superfund PCB Cleanup Guidance") (which recommends using the equilibrium partitioning method for screening purposes).

sediment, the amount of organic carbon in the sediment, and the environmental criterion that EPA is using as an end point (i.e., the chronic water quality criterion).[4]

For example, based on this methodology, a concentration of environmental concern for PCBs in sediment with an organic carbon content of 10%, is 1.9 ppm (with a potential range of 0.4 ppm and 9.9 ppm).[5] The concentration of concern drops to 0.2 ppm (with a potential range of 0.04 ppm to 1.0 ppm) if the organic carbon content is 1%.[6] The lower end of this range of concentrations, however, is below generally achievable detection limits and may be below ambient levels in some geographical areas.

B. The Equilibrium Partitioning Method Is Scientifically Flawed

The National Research Council Committee on Contaminated Marine Sediment found that there is no scientific, accepted technique for setting sediment cleanup levels.[7] Similarly, EPA's own Science Advisory Board recommended against use of the equilibrium partitioning method to derive a uniform national standard.[8]

The scientific flaws in the equilibrium partitioning method include, inter alia: (1) reliance on the doubtful assumption that the water/sediment/fish ecosystem is in equilibrium; (2) failure to use toxicity data from actual sediment of interest; (3) high levels of uncertainty in predicting PCB water concentrations from PCB sediment

---

4. E.g., the chronic water quality criterion for PCB (0.014 ug/L) is based on the lowest levels that result in adverse health effects in mink. Superfund PCB Cleanup Guidance, supra note 3, at 35.

5. Id. at 36.

6. Id.

7. Committee on Contaminated Marine Sediments, National Research Council, Contaminated Marine Sediments - Assessment and Remediation 3 (1989) ("NRC Sediment Report"); see also a list of classification methods and their advantages and disadvantages. Id. at 7-9.

8. SAB Report, supra note 2, at 1.

concentrations; (4) the lack of field validation of the method; (5) the invalid assumption that the water concentration above the sediment (i.e., the water concentration to which bottom feeders are exposed) is the same as the interstitial water concentration; (6) the doubtful assumption that water column organisms and benthic organisms have similar sensitivities; and (7) failure to define the limitations of the methodology, particularly those related to its unreliability for sediment with low organic carbon content.[9]

Other problems apply specifically to PCBs. For example, EPA's existing use of the equilibrium partitioning coefficient relies on a single partitioning coefficient and toxicity factor even though both partitioning factors and toxicity factors vary substantially for different PCB congeners.

Additionally, the equilibrium partitioning method does not account for the nature of the water body, as with EPA's approach to other cleanup levels. Just as soil cleanup levels take into account whether a property is subject to future residential or industrial use, sediment criteria should take into account whether the water body is: (1) essentially a drainage ditch on industrial property; (2) in a highly commercialized and/or industrialized area; (3) in an area where there are no mink, the sensitive species used as the endpoint for the PCB water quality criterion; or (4) located in a pristine environment. It would be arbitrary, ineffective, extremely costly, and inconsistent with other Superfund policies to attempt to clean up every body of water to the same level.

Each of the scientific uncertainties associated with the equilibrium partitioning method is substantial.[10] The combined impact of these uncertainties is overwhelming. It is

---

9. NRC Sediment Report, supra note 7, at 9; Rodricks, Determining Compliance With PCB Standards, 9 Risk Analysis 275 (1989); the technical comments sent to Christopher Zarba of EPA's Office of Water concerning EPA's proposal to use the equilibrium partitioning method to promulgate sediment criteria (The number of documents are too numerous to cite individually, but are incorporated by reference) ("Comments on Equilibrium Partitioning Method").

10. For example, according to EPA's Superfund PCB Cleanup Guidance, the sediment value varies by a factor of 25 based on differing experimental partition coefficients. Superfund PCB Cleanup Guidance, supra note 3, at 36.

particularly telling that several offices within EPA,[11] other Federal agencies,[12] and other independent experts[13] have severely criticized or rejected the equilibrium partitioning method. Thus, sediment cleanup levels derived using this method would be scientifically inaccurate, unduly stringent, infeasible to meet, and incorrectly applied to widely differing situations.

---

11. E.g., Memorandum from M. Sprenger, Environmental Response Branch, EPA, to C. Zarba, Office of Water, EPA, Re: Pre-Draft Sediment Quality Criteria For Endrin - for the Protection of the Presence of Benthic Organisms (June 5, 1991) in Comments on Equilibrium Partitioning Method, supra note 9 ("These discrepancies ... give rise to serious doubts as to whether or not the SQC [sediment quality criteria] as currently developed should be proposed." Id. at 1).

12. E.g., Letter from P. Landrum, National Oceanic and Atmospheric Administration ("NOAA"), to C. Zarba, EPA (May 31, 1991) ("I remain concerned that this criteria generation is proceeding faster than the development of data to provide suitable validation of the method." Id. at 5); Letter from T. O'Connor, Manager of the National Status and Trends Program, NOAA, to C. Zarba, EPA (June 6, 1991) ("I sincerely hope, however, that EPA is not considering early adoption of the tentative SQC's. Their physical-chemical assumptions are contradictory and fragile." Id. at 5); and Letter from J. Elmore, Chief, Operations, Construction and Readiness Division, Directorate of Civil Works, U.S. Army Corps of Engineers, to C. Voigt, EPA (1991) (no specific date discernible) ("The COE is not supportive of the use of numerical chemical specific sediment criteria (SQC) in the evaluation of dredged material. The COE feel that it is likely that once SQC are available they will be rigidly applied by regulatory agencies and that there would be little or no flexibility to consider all pertinent factors and disposal options when handling contaminated sediments." Id. at 1 of attachment) in Comments on Equilibrium Partitioning Method, supra note 9.

13. Letter from P. T. Carver and V. Bierman, Co-Chairmen of the Water Pollution Control Federation's Sediment Work Group, to C. Zarba, EPA (June 7, 1991) (communicating individual comments of members) in Comments on Equilibrium Partitioning Method, supra note 9. Many respected associations, such as the American Petroleum Institute also filed critical comments on the equilibrium partitioning method.

C. EPA Superfund Guidance Recognizes That The Equilibrium Partitioning Method Is Not Reliable Enough To Use For Deriving Cleanup Levels

It is significant that Superfund PCB guidance does not recommend that values derived by the equilibrium partitioning method be used as sediment cleanup levels, i.e., levels which trigger remedial action if exceeded. Rather, the numerical values derived by this method are used as screening levels. If the concentration of PCBs is below the screening level, then no action is necessary.

Remedial action is not necessarily triggered, however, if the concentrations of PCBs in sediment exceed these values. Instead, EPA's Superfund guidance indicates that "chemical monitoring of indigenous benthic and water column species should be instituted to determine if prey species of wildlife or marketable benthic or water column species contain unacceptable concentrations of PCBs."[14] Only if this environmental monitoring indicates a significant environmental impact is remedial action considered.[15] Even then, Superfund guidance requires a balancing of several factors before deciding that a remedial action is appropriate.

The PCB Consensus Group agrees with EPA's Superfund office that the existing scientific data are not sufficient to justify using the equilibrium partitioning method to set cleanup levels. Even a nonbinding guidance, however, presents concerns. Experience with EPA's water quality criteria, EPA Superfund guidance, the PCB new spill cleanup policy, and other guidance demonstrate that the distinction between guidance and binding regulation is often ignored in implementing these programs.[16]

---

14. Superfund PCB Cleanup Guidance, supra note 3, at 36.

15. "If chemical monitoring of biota fails to indicate . . . [impairment], the need for extensive remediation based on exceedence of . . . [sediment quality criteria] should be questioned." Id. The nature of the water body and the type of land use in the area must be taken into account in determining whether and what type of remedy is appropriate.

16. See, e.g., Committee on Ground Water Modeling Assessment, Ground Water Models: Scientific and Regulatory Applications 212-215 (1990) (criticizing the frequent misuse of models, particularly the selection of overly simplistic models for site-

(continued...)

The cost of applying these criteria as rigid cleanup goals would be astronomical and no significant public health or environmental benefits would be achieved.[17] In effect, use of this method to set rigid cleanup levels would protect the most sensitive benthic organisms (with an ample margin of safety) in drainage ditches, regardless of cost.

In sum, EPA should not include a numerical cleanup criterion for PCB contaminated sediment in its regulations or guidance. If a scientifically appropriate method is developed, it must be systematically validated prior to promulgation with field data from actual sites to determine if its predictions are accurate.

---

16. (...continued)
specific problems); McLouth Steel Prods. Corp. v. Thomas, 838 F.2d 1317, 1320 (D.C. Cir. 1988) (holding that EPA erred in treating guidance as a de facto rule).

17. The National Academy of Sciences urged that the reduction of sediment remedies be cost-beneficial. NRC Sediment Report, supra note 7, at 3.

ATTACHMENT F-2

FOIA Correspondence

FOLEY, HOAG & ELIOT

ONE POST OFFICE SQUARE
BOSTON, MASSACHUSETTS 02109
TELEPHONE (617) 482-1390
CABLE ADDRESS "FOLEYHOAG"
TELECOPIER (617) 482-7347
TELEX 940993

IN WASHINGTON D.C.
1615 L STREET, N.W.
WASHINGTON D.C. 20036
TELEPHONE (202) 775-0500

REBECCA L. BRYANT

July 31, 1989

BY HAND

Charles C. Bering, Esquire
Assistant Regional Counsel
EPA-Region I
JFK Federal Building
Boston, Massachusetts 02203-2211

Re: FOI Request No. 1-FOI-769-89

Dear Mr. Bering:

This letter confirms our telephone conversation of July 26, 1989 in which you stated that you would authorize Evo Cunha at the Records Center to allow our access to the site file for the New Bedford Harbor. We thank you for your promptness in responding to my July 26 letter regarding this matter. I have scheduled with Mr. Cunha an appointment for Wednesday, August 3, 1989, to begin our review of the documents in the site file.

Due to the voluminous nature of the file, I have, as you suggested, identified several categories of documents from the "Region I Superfund NPL and Removal Site File Structure" which we do not need to review at this time. We may need to review some or all of the documents included in these categories in the future, and I will contact you to arrange for their review if needed. The following are categories of documents which we will not review at this time:

1.0 Pre-remedial
  Subcategories 1.13-1.18
2.0 Removal Response
  All subcategories
8.0 Site closeout
  All subcategories
10.0 Enforcement
  Subcategory 10.9

11.0 Potentially Responsible Party (PRB)
Subcategories 11.2-11.16
12.0 Cost Recovery
Subcategories 12.1-12.7 and
Subcategories 12.11-12.15
15.0 Freedom of Information Act (FOIA) Management
All subcategories
16.0 Natural Resource Trustee
Subcategories 16.4-16.5
17.0 Site Management Records
Subcategories 17.3-17.9
18.0 Initial Remedial Measure (IRM Records)
Subcategories 18.5-18.9

If we are able to identify other categories of documents which we do not need to review at this time, we will inform Mr. Cunha at the time of our review. Please do not hesitate to call if you have any questions.

Sincerely,

Rebecca L. Bryant

rlb/je

NUTTER, McCLENNEN & FISH

ONE INTERNATIONAL PLACE
BOSTON, MASSACHUSETTS 02110-2699

TELEPHONE: 617 439-2000 FACSIMILE: 617 973-9748

DIRECT DIAL NUMBER:

(617)439-2212

June 29, 1992
11478-122

BY HAND

Gayle Garman
Remedial Project Manager
U. S. Environmental Protection Agency, Region I
Waste Management Division (HRM-CAN3)
JFK Federal Building
Boston, MA 02203

Re: New Bedford Harbor Superfund Site:
Freedom of Information Act Request

Dear Ms. Garman:

Pursuant to the Freedom of Information Act ("FOIA"), 5 U. S. C. § 552, and on behalf of AVX Corporation, I request copies of any and all documents concerning the sampling data referenced or contained in the following two studies:

(1) PCB concentrations in fish and sediment summarized in a January 6, 1992 memorandum to you from Paul Craffey, DEP (see attached).

(2) Distribution of PCB in lobster and winter flounder conducted by Swartz in 1992 and referred to in the Draft Final Supplemental Feasibility Study Evaluation for Upper Buzzards Bay on page 2-18 (see attached).

In addition, we request any and all documents concerning any other sampling and/or field data of whatever type or nature, which the governments have collected since March 1990 concerning the New Bedford Harbor Superfund Site and/or which has not previously been made available to AVX as a defendant in the related litigation.

Our request includes, without limitation, the complete quality assurance/quality control materials. At a minimum, this should include all sampling protocols, field logs, chain of custody documents, laboratory notebooks, calibration data, chromatograms and data validation reports. The enumeration of these items is not intended to exclude any other documentary material consisting of, evidencing or referring to the requested information.

Experience has shown that in order to determine the validity of data of the type requested, it is imperative to have all of the backup documentation. For this reason, in addition to providing us with these studies, please include them in the Administrative Record. The National Contingency Plan regulations specifically recognize the importance of including factual information, data, and factual analysis, including, but not limited to, sampling data, control and quality assurance documentation, and chain of custody forms -- in short the materials we request -- in the Administrative Record. Failure to follow the NCP regulations and include the above requested information in the Administrative Record compromises AVX's ability to defend its interests. We will consider EPA's failure to include the material a substantial violation of AVX's rights, particularly in the event litigation is ever reopened.

As provided under FOIA, please reply to this request within ten (10) working days.

Thank you for your assistance.

Very truly yours,

Mary Ryan

Mary K. Ryan

MKR:jnh
0949c
cc: Weldon Bosworth

bcc: Joan Prager
Sean Roche

ARCS I WORK ASSIGNMENT NUMBER 012-1L43
EPA CONTRACT NUMBER 68-W9-0034
EBASCO SERVICES INCORPORATED

DRAFT FINAL
SUPPLEMENTAL FEASIBILITY STUDY EVALUATION FOR UPPER BUZZARDS BAY NEW BEDFORD HARBOR RI/FS NEW BEDFORD, MASSACHUSETTS

MAY, 1992

NOTICE

The information in this document has been funded by the United States Environmental Protection Agency (EPA) under ARCS I Contract No. 68-W9-0034 to Ebasco Services Incorporated (Ebasco). This document is a draft and has not been formally released by either Ebasco or the EPA. As a draft, this document should not be cited or quoted, and is being circulated only for comment.

kg to 100 kg per year. It should, however, be noted that on a mass basis the amount of PCBs being transported through the Hurricane Barrier (yearly) is relatively small compared to the mass of PCBs already present in the sediments and surface waters of the Upper Bay.

2.2.2.2 Surface Water Metals Concentrations

This section presents surface water data for three of the more prevalent trace metals in Upper Buzzards Bay; cadmium, copper and lead. The data appears to indicate the surface water concentrations for each of the three metals are relatively similar throughout most of Fishing Closure Zones II and III (Figure 2-8). The only exception is a station near the entrance of the Hurricane Barrier which would suggest upstream sources. This hypothesis is plausible given the higher sediment metals concentrations and the industrial discharge locations north of the Hurricane Barrier.

Seaward of the Upper Bay region, the metals concentrations appear to be lower, but not markedly, suggesting that perhaps surface water metals contamination extends further into the central regions of the Bay. Unfortunately, no surface water data was presented in the City of New Bedford's Facility Plan for the Outfall area. Based on the sediment data, it is reasonable to assume that metals may be higher than some of the other surrounding stations.

The chronic AWQC values for cadmium, copper and lead are 9.9 ppb, 2.9 ppb and 5.6 ppb, respectively. Based on a review of the available data presented in Figure 2-8, none of the criteria are exceeded. However, the chronic criterion for copper is close to being exceeded at the entrance to the Hurricane Barrier.

2.2.3 Distribution of PCB in Biota

Both lobster and flounder are important commercial and recreational resources to the Upper Bay. However, exceedances of the FDA tolerance level of 5 ppm prompted the Massachusetts DPH to establish fishing closure areas in the New Bedford Harbor and Upper Buzzards Bay in 1979. This was due to the potential health risks associated with the consumption of the PCB contaminated fish and shellfish. This closure has meant the loss of over 17,000 acres of Buzzards Bay for lobstering. Of this area, approximately 5,000 acres are also closed to fishing for bottom feeding fish including flounder.

This section presents PCB data for two representative species of the Upper Bay; lobster, *Homarus americanus*, and winter flounder, *Pseudopleuronectes americanus*. The data for this assessment are from the Battelle Sampling Program (Hillman et al., 1987), studies conducted by the Massachusetts Division of Marine Fisheries (DMF)

for EPA's Buzzard Bay Program (Schwartz, 1988) and unpublished data from the state (Schwartz, 1992).

2.2.3.1 Distribution of PCB in Lobster

Although the major PCB inputs to the Lower Harbor and Upper Bay have been eliminated (local use was discontinued in 1978), there has not been a dramatic drop in the body burdens for biota. This is demonstrated by the lack of a definitive trend in edible tissue PCB concentrations for lobster from Fishing Closure Area III (Figure 2-9). Although the average concentration of 4.1 ppm for the years 1980 through 1985 has dropped to 2.9 ppm for the years 1986 through 1990, this change is insignificant relative to the spatial and temporal variabilities exhibited by the data. For example, data collected by Massachusetts Department of Environmental Protection (MADEP) during the spring of 1989 for two stations in Area III include an average edible tissue PCB concentration of 2.01 ppm at one location and a concentration of 4.19 ppm from another. Data from the same two stations six months later were 2.13 ppm and 1.74 ppm respectively. Lobster data from the Battelle Program for Fishing Closure Areas II and III are 2.3 ppm and 1.4 ppm, respectively. These values were calculated using the average edible tissue PCB concentration for the edible muscle tissue and hepatopancreas (tomalley), and the mean weight for each, as presented in Pruell et al, 1988.

In his study of lobsters from Area III, Pruell reported the mean weights of the edible muscle and tomalley as 156 g and 14.4 g, respectively. This calculation was done to provide (1) an estimate of the risk assuming an individual would eat both the muscle tissue and the tomalley and (2) to facilitate a comparison to other data for lobster PCB concentrations analyzed using the FDA sample preparation procedures which combine the tomalley with the muscle tissue. Although the Battelle results would suggest the average edible tissue (i.e., muscle plus tomalley) concentrations in Closure Area III are below 2 ppm, the variability demonstrated by the state's data indicates that this may or may not be the case, and in fact, the state's data does demonstrate exceedances in this Area.

The variability associated with the lobster data is probably indicative of the lobsters lifecycle and seasonal habits. Larval lobsters settling out in Buzzards Bay tend to stay within close proximity of the place of settlement for the first three years. Between the fourth and sixth years, these lobsters will tend to remain in the general vicinity of settlement, but they begin to move about in order to forage. Typically by the sixth year lobsters reach sexual maturity and for the first time as seasonal waters warm, they will migrate into deeper cooler waters of Buzzards Bay, or beyond. In these offshore locations, the New

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

MEMORANDUM

TO: Gayle Garman, U.S. EPA

FROM: Paul Craffey, DEP

DATE: January 6, 1992

SUBJECT: New Bedford Area PCB Data

Enclosed is some PCB data on bird, fish, and sediment analysis. A summary of the fish (Atlantic Silversides) and sediment samples (Tables 1 and 3) is as follows.

	AVERAGE PCB CONCENTRATIONS (PPM)	
LOCATION	Fish	Sediment
Marion	0.35	0.0077
Ft Phoenix Beach	4.7	0.012
Near Medeiros Bus	56	2.3

See map for Fairhaven locations. Date sampled - July 26, 1990.

The Common Tern liver PCB concentrations (Tables 4 and 5A) ranged 3.9 ppm to 1,900 ppm. The Roseate Tern liver PCB concentrations (Tables 5 and 5A) ranged 0.11 ppm to 10 ppm. Additional fish data is shown on Table 2.

If you have any questions concerning this information, please contact me at (617) 292-5591.

One Winter Street • Boston, Massachusetts 02108 • FAX (617) 556-1049 • Telephone (617) 292-5500

Table 1. Data Summary for Whole Fish Composite Samples.

Atlantic Silversides

Lab Number	Sample Location	PCB Concentration in parts per million		% Distribution by Level of Chlorination 1	2	3	4	5	6	7	8
119180	Marion	0.45			0	6	18	40	31	3	1
119181	Marion	0.45		3	0	2	16	42	33	4	0
119182	Marion	0.25		5	1	3	12	38	36	4	1
119183	Marion	0.28	Average 0.36		0	2	11	39	39	4	1
119184	New Bedford Outer	4.6			0	16	24	37	24	2	0
119185	New Bedford Outer	4.3			1	17	23	37	20	2	0
119186	New Bedford Outer	6.1			0	11	21	41	25	2	0
119187	New Bedford Outer	3.7	Average 4.7		0	16	24	38	22	2	0
119188	New Bedford Inner	63			3	33	30	25	8	1	0
119189	New Bedford Inner	75			3	35	29	24	8	1	0
119190	New Bedford Inner	43			2	30	30	28	9	1	0
119191	New Bedford Inner	41			2	32	29	24	8	1	0
			Average 56								

90102D190CT90

Locations Marion - Sippian Harbor
New Bedford Outer - Fort Phoenix Beach, Fairhaven
New Bedford Inner - Near Medeiros Bus, Fairhaven

Table 2. Data Summary for Regurgitated Fish Samples from Bird Island, Marion, Massachusetts.

Lab Number	Sample Type	PCB Concentration in parts per million	% Distribution by Level of Chlorination							
			1	2	3	4	5	6	7	8
119207	American Sand Lance (SL-90-01)	0.15	27	3	11	14	23	17	2	0
119208	Bay Anchovy (BA-90-01)	0.13	3	4	17	22	32	21	3	1

Table 3. Data Summary for Sediment Samples.

Lab Number	Sample Location	PCB Concentration in parts per million	% Distribution by Level of Chlorination							
			1	2	3	4	5	6	7	8
119209	Marion (SED1)	0.0077	40	3	36*	6	10	4	0	0
119210	New Bedford Outer (SED2)	0.012	8	8	13	18	20	12	2	0
119211	New Bedford Inner (SED3)	2.3		3	22	30	32	14	1	0

* This higher value may be the result of interference.

Table 4. Data Summary Of Tern Liver Samples.

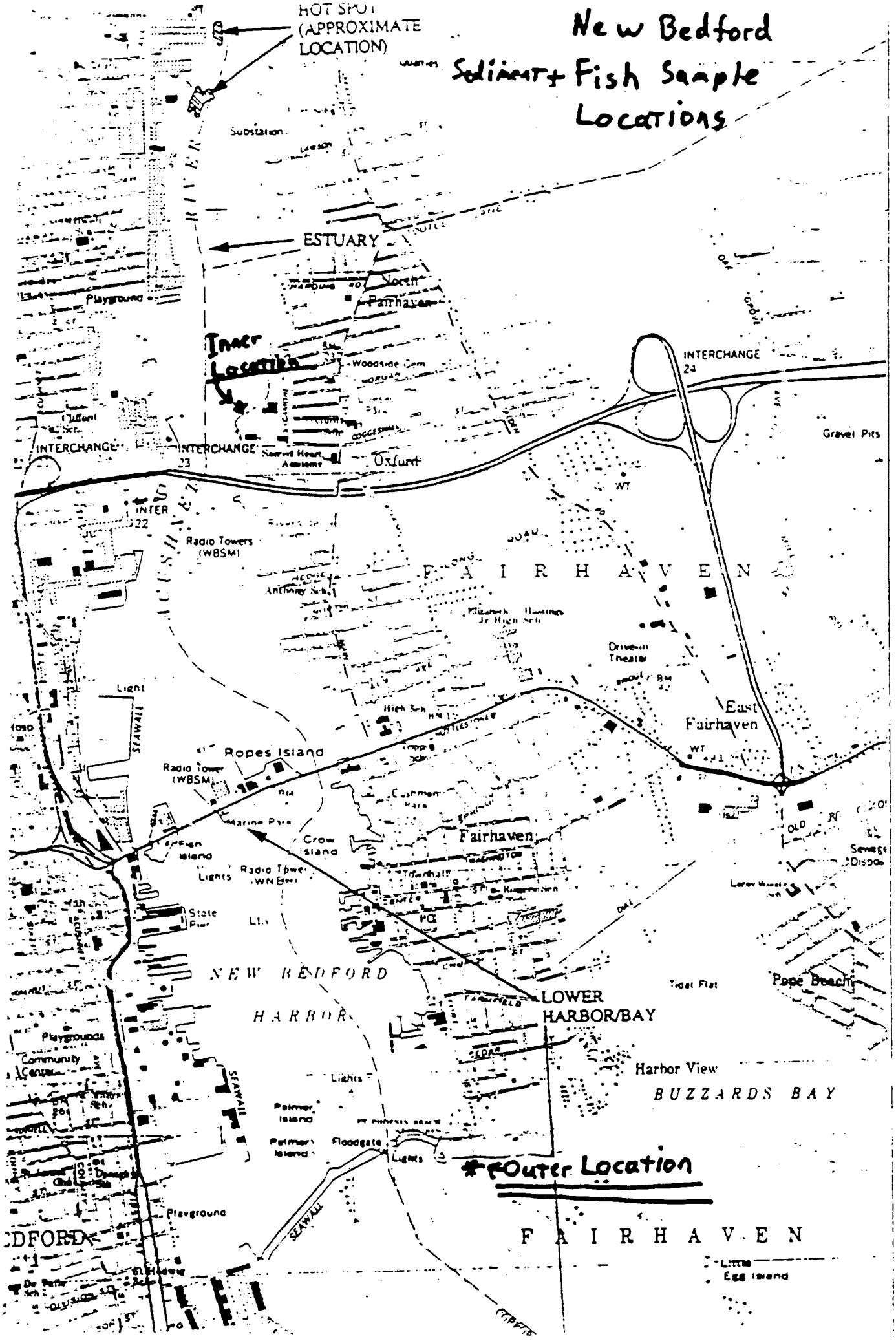
Lab Number	Tern Species	General Conditions Reported at Collection	Liver PCB Concentration in parts per million	% Distribution by Level of Chlorination						
				2	3	4	5	6	7	8
119192	Common (A89-08-22-063	Alive, Unable to fly, Tremors	1600.	0	29	29	28	13	1	0
119193	Common (A89-08-21-105)	Alive, Unable to fly, Tremors	1900.	1	31	28	29	13	1	0
119194	Roseate (NIS-RT-L1)	Unknown	10.	1	2	8	28	53	10	3
119195	Roseate	Unknown	3.5	1	23	23	24	23	1	0

Table 5. Data Summary for Liver Dissected From Whole Bird Samples.

Lab Number	Tern Species	General Conditions Reported at Collection	Liver PCB Concentration in parts per million	% Distribution by Level of Chlorination 1	2	3	4	5	6	7	8
119196	Roseate	RT-90-01 Band # 892-31563 Found Dead	0.14	14	0	1	9	13	41	15	5
119197	Roseate	RT-90-02 Unbanded, Unable to fly, Occasional Tremors	0.11	19	0	5	15	15	40	8	7
119198	Roseate	RT-90-03 Unbanded, Found dead, No signs of convulsions	0.15		0	4	11	23	48	10	4
119199	Roseate	RT-90-04 Unbanded, Found dead, No signs of convulsions	0.91	4	1	34	30	26	12	3	0
119200	Roseate	RT-90-05 Unbanded, Found dead, No signs of convulsions	0.16		0	5	15	23	43	9	3
119201	Roseate	RT-90-06 Unbanded, Found dead, Lying upside down	0.44	1	4	9	8	25	41	11	7

Table 5A. Data Summary for Liver Dissected From Whole Bird Samples.

Lab Number	Tern Species	General Conditions Reported at Collection	Liver PCB Concentration in parts per million	% Distribution by Level of Chlorination 2	3	4	5	6	7	8
119202	Common	CT-90-01 Banded # 1103-64169 Unable to fly, Enlarged gall bladder	520	0	25	29	29	16	2	0
119203	Common	CT-90-02 Unbanded, Found dead, Neck twisted, Body contorted	5.7	0	3	8	26	51	9	3
119204	Common	CT-90-03 Unbanded, Found dead, Neck twisted, Wings contorted, Toes curled	10	0	6	10	28	48	10	3
119205	Common	CT-90-04 Unbanded, Found weak, Intermittent tremors	840	0	23	31	30	14	1	0
119206	Common	CT-90-05 Unbanded, Found dead, Neck twisted, Wings partly extended, Belly soiled with green algae	3.9	0	4	12	31	41	10	3


New Bedford
Sediment + Fish Sample
Locations
HOT SPOT
(APPROXIMATE
LOCATION)
ESTUARY
Inner Location
INTERCHANGE
24
INTERCHANGE
23
INTERCHANGE
22
Gravel Pits
Radio Towers
(WBSM)
FAIRHAVEN
Drive-in
Theater
East
Fairhaven
Ropes Island
Radio Tower
(WBSM)
Crow
Island
Fairhaven
Lights
State
Pier
NEW BEDFORD
HARBOR
LOWER
HARBOR/BAY
Tidal Flat
Pope Beach
Harbor View
BUZZARDS BAY
Palmer
Island
Floodgate
Lights
*Outer Location
FAIRHAVEN
Little
Egg Island
Playgrounds
Community
Center
Playground
SEAWALL

I.C.T. NISBET & Co.

TERN AND FISH SPECIMENS FOR DISPATCH TO AQUATEC, 2 AUG. 1990

Specimen no.	Species	Location	Date	Notes
NISBET-CT-90-01	Common Tern	Bird Ls., MA	05-23-90	Band no. 1103-64469. 9 years old (banded as a chick, Plymouth Beach, 1981). Found unable to fly. Autopsied by Dr. Tremblay. Path. specimens retained by Nisbet & Co. Enlarged gall bladder. No subcutaneous fat.
CT-90-02	Common Tern	Bird Ls.	05-23-90	Unbanded. Found dead. Neck twisted, body contorted. Autopsied by Dr. Tremblay. No gross lesions. No subcutaneous fat
CT-90-03	Common Tern	Bird Ls.	05-24-90	Unbanded. Found dead. Neck twisted, wings contorted, toes curled
CT-90-04	Common Tern	Bird Ls.	05-26-90	Unbanded. Found weak on 25 May. Intermittent tremors. Died on 26th
[illegible]90-05	Common Tern	Bird Ls.	06-26-90	Unbanded. Found dead. Neck twisted, wings partly extended legs turned to right. Belly soiled with green algae
RT-90-01	Roseate Tern	Bird Ls.	05-23-90	Band no. 892-31523 (banded in NY, 1986). Found dead. Autopsied by Dr. Tremblay. Tan spots on liver. Some subq. fat. Path specimens sent to NEWC (accession no. A90-06-04-01)
RT-90-02	Roseate Tern	Bird Ls.	05-26-90	Unbanded. Found unable to fly 25 May. Occasional tremors. Died early on 26 May
RT-90-03	Roseate Tern	Bird Ls.	06-02-90	Unbanded. Found dead. No signs of convulsions.
RT-90-04	Roseate Tern	Bird Ls.	06-03-90	Unbanded. Found dead. No signs of convulsions.
[illegible]90-05	Roseate Tern	Bird Ls.	06-08-90	Unbanded. Found dead. No signs of convulsions. Blood dripped from bill when handled.
RT-90-06	Roseate Tern	Bird Ls.	06-12-90	Unbanded. Found dead. Lying upside down.

Sample No.	Species	Location	Date	Notes
NISBET-				
SL-90-01	Amer. Sand Lance	Bird Is.	07-20-90	9 samples of 1-3 fish each. Regurgitated by 9 different Roseate Terns when handled for banding. Each sample wrapped individually in aluminum foil and frozen. May need to be pooled into 1 or 2 composites for analysis
BA-90-01	Bay Anchovy (or similar fish)	Bird Is.	07-17-90	4 samples of 1-2 fish each. Regurgitated by 4 different Roseate Terns when handled for banding. Each sample wrapped individually in aluminum foil and frozen. May need to be pooled for analysis. [Note. Anchovy spp. are difficult to identify to species when heads are missing, as in these cases. 2 whole fish collected at the same time have been sent to Dr. D. Heinemann for identification]

NUTTER, McCLENNEN & FISH

ONE INTERNATIONAL PLACE
BOSTON, MASSACHUSETTS 02110-2699

TELEPHONE: 617 439-2000 FACSIMILE: 617 973-9748

DIRECT DIAL NUMBER:
(617)439-2212

July 2, 1992
11478-122

Gayle Garman
Remedial Project Manager
U.S. Environmental Protection Agency, Region I
Waste Management Division (HRM-CAN 3)
J.F.K. Federal Building
Boston, MA 02203

Re: New Bedford Harbor Superfund Site:
Administrative Record

Dear Ms. Garman:

1. After review of the various indices of the Administrative Record for what is now called the Estuary/Lower Harbor Bay Operable Unit, I have realized that none of the extensive expert and technical data collected by AVX and submitted as part of its litigation pleadings has been included in the record to date. We believe that these pleadings should be included in the Administrative Record.

In the litigation related to the New Bedford Harbor Superfund Site, AVX was ordered to file all expert and technical data which it wished to rely upon at trial in pleadings which are referred to as requests for admissions ("RFAs"). This procedure applied to all parties. The filings by both the plaintiff governments and the defendants were extensive. Because of the timing of our filing (June 1990), the vast majority of the RFAs filed by AVX consist of a detailed analysis by AVX's expert consultants of the exact same data, technical information, and technical reports which form the basis for the Draft Final Feasibility Study Of Remedial Alternatives For The Estuary And Lower Harbor/Bay which was released to the public in August of the same year. Thus, the subject matters of AVX's June 1990 RFAs and the Draft Feasibility Study are largely co-extensive.

For that reason, we request the inclusion of these materials in the Administrative Record. We believe this is appropriate because the regulations governing the compilation of an Administrative Record make clear that the Administrative Record is broadly to include all material relevant to the selection of the final remedy. The extensive technical and comprehensive nature of these pleadings make them precisely the type of document which should form the basis of the agency's final decision. More to the point, AVX's detailed consideration, response, and comments with respect to many of the studies upon which the Agency's proposed plans for the Estuary/Lower Harbor and Bay are based is contained in these pleadings and attachment. As a single example only, the transport studies relied upon by Ebasco Services Inc. in §2.4.1.5 of the Draft Final Feasibility Study referenced above are exhaustively reviewed in AVX's RFAs. It would be an exercise in futility to try to reframe AVX's detailed critique into another format. Failure to include these pleadings in the Administrative Record would be inconsistent with applicable law and regulations, would severely compromise AVX's ability to defend its interests, and would substantially violate AVX's rights.

There is a practical issue which I think it would be advisable for us to discuss. We have the option of submitting copies of these voluminous pleadings into the Administrative Record as part of AVX's July 13 submittal. However, I believe that all of the data has also been microfiched by the Department of Justice and/or EPA. I suggest that it would be more convenient for EPA to incorporate our documents in that form. I would appreciate it if you could call me by noon on Wednesday, July 8 so that I can make timely arrangements for copying if it is necessary for AVX to resubmit all of this material.

2. I would also appreciate hearing from you whether the extensive sampling data which was produced by the governments in the winter and spring of 1990 is included in the Administrative Record. I did not find this data in the indices.

3. Finally, my paralegal was told this afternoon at the Administrative Record Depository that the Site file was not a public record and that access could only be granted through your office. We have previously had access to the Site file for the First Operable Unit and we would like to have the opportunity to review the Site file for the Second Operable Unit early next week. Please call me at your earliest convenience on this matter.

Please include this letter in the Administrative Record. Thank you for your assistance and cooperation.

Very truly yours,

Mary Ryan

Mary K. Ryan

MKR/smd:4181e
~~Enclosures~~
cc: Mark Lowe, Esq.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

July 8, 1992

Ms. Mary K. Ryan
Nutter, McClennen & Fish
One International Place
Boston, Massachusetts 02110-2699

Dear Ms. Ryan:

This letter is to confirm the content of a telephone conversation we had yesterday, July 7, 1992, regarding your letter of June 29, 1992. In your letter you requested copies of "any and all documents concerning the sampling data" for two documents referenced in the Supplemental Feasibility Study for the Buzzards Bay portion of the New Bedford Harbor Superfund Site.

The first document you referenced is a memorandum to me from Paul Craffey of Massachusetts DEP dated January 6, 1992, reporting analyses for PCB concentrations in sediment and fish at three locations. The memorandum is in the Administrative Record as supplied to us by DEP. All of the analytical data that accompanied the memorandum also is in the Administrative Record as an attachment to the memorandum.

The second document you request is unpublished data on PCB concentrations in lobster that was developed by Mr. Jack Schwartz of the Massachusetts Department of Marine Fisheries which was referenced on page 2-18 of the Supplemental Feasibility Study. I will supply that information to you within the week.

Please note that these data sets were not collected by EPA and were not acquired specifically for the New Bedford Harbor Superfund site investigation. Neither were these data sets acquired for purposes of litigation. However, EPA has taken this data into consideration in developing the proposed remedial alternatives for the New Bedford Harbor site. We consider the data to be of sufficient quality for this purpose.

In response to your request for any data collected "by the governments" since March, 1990, I can only assure you that EPA has not collected any data specifically for the New Bedford Harbor site since March, 1990, except for the data which is already in the Administrative Record.

Unfortunately, because your letter was addressed to me, it was unopened during my week's absence from the office. You can avoid

PRINTED ON RECYCLED PAPER

this inconvenience in the future by sending your request directly to our Freedom of Information Act specialist, Ms. Evelyn Sullivan at the above address. In order to expedite routing of your request to Evelyn, include the mail code "RPM" after J.F.K. Federal Building on the envelope.

Please let me know if I can be of any further assistance.

Sincerely,

Gayle Garman

Gayle Garman
Remedial Project Manager

cc: Mark Lowe, ORC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

July 9, 1992

VIA FAX

RECEIVED
JUL 13 1992
M.K.R.

Ms. Mary K. Ryan, Esq.
Nutter, McClennen & Fish
One International Place
Boston, Massachusetts 02110-2699

Re: New Bedford Harbor Superfund Site
Administrative Record

Dear Ms. Ryan:

This letter is in response to your letter to Gayle Garman dated July 2, 1992, concerning the contents of the New Bedford Harbor Administrative Record, and summarizes our telephone conversation Wednesday of this week. In your letter you request that "the extensive expert and technical data collected by AVX and submitted as part of its litigation pleadings... should be included in the Administrative Record." EPA has, to date, placed into the Administrative Record all of the reports submitted to it by AVX's consultants, including the voluminous reports submitted in 1989 and 1990 regarding the Hot Spot Operable Unit. To the extent that further reports have been developed, EPA welcomes your submission of them. Of course, EPA also welcomes your submission of comments on the alternatives under consideration, and intends to respond as appropriate to all significant comments submitted by AVX and other members of the public.

The Request for Admissions, the "pleadings", you seek to have included in the Administrative Record are litigation documents, produced under the unique circumstances and court orders in United States, et al. v. AVX Corporation et al. Civil Action No. 83-3882-Y. Under the National Contingency Plan, 40 CFR Part 300.810, documents which ought to be included in the Administrative Record are those documents that may form a basis for the selection of a response action. EPA is not required to include documents which do not form a basis for the selection of a response action. The documents which you seek to add to the Administrative Record contain the thousands of factual assertions which you would have attempted to prove at a trial where the liability of AVX for response costs and natural resource damages was the key issue. These documents simply cannot be accurately characterized as documents that may form the basis for a response action. Facts that would tend to establish that AVX is not liable for response costs or natural resource damages are distinguishable from facts that may form the basis for the selection of a response action.

SAVE IT!

PRINTED ON RECYCLED PAPER

EPA disagrees with your characterization that failure to include AVX's requests for admission in the Administrative Record would substantially violate AVX's rights. Under section 113(k)(2) of CERCLA the public is to be afforded the opportunity to participate in the creation of the Administrative Record. However, the right to participation in the formation of the Administrative Record does not mean that EPA is bound to place into the record each and every document that a member of the public feels should be included. Moreover, EPA believes that AVX has been afforded the fullest opportunities to participate in the development of the Administrative Record. AVX's participation opportunities include a separate public meeting in 1990 at which AVX was allowed to present its own alternative for remediation.

Turning finally to the last two items raised in your letter, please be advised that EPA believes that summaries of the extensive sampling data which was produced by the governments in the winter and spring of 1990 are presently included in the Administrative Record. If you have information regarding particular sets of data which you believe are not covered, please bring this to our attention and we will attempt to rectify the situation as appropriate.

With regard to your having access to the site file, please be advised that under EPA's current policy the public is not allowed access to site files. This policy is necessary to ensure the confidentiality of certain information contained in the file which is subject to privileges such as the attorney client or deliberative process privileges or is protected as confidential business information. While access to nonprivileged nonconfidential documents in the site file may have been granted in circumstances in the past, EPA must, in this instance, follow its current policy. EPA will endeavor to provide you with any documents contained in the site file pursuant to an appropriate request under the Freedom of Information Act, and provided that the documents sought under the request are releasable in accordance with the statute.

Sincerely,

Mark A. Lowe

Mark A. Lowe
Assistant Regional Counsel

cc: Gayle Garman

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

July 9, 1992

VIA FAX

RECEIVED
JUL 13 1992
M.K.R.

Ms. Mary K. Ryan, Esq.
Nutter, McClennen & Fish
One International Place
Boston, Massachusetts 02110-2699

Re: New Bedford Harbor Superfund Site
Administrative Record

Dear Ms. Ryan:

This letter is in response to your letter to Gayle Garman dated July 2, 1992, concerning the contents of the New Bedford Harbor Administrative Record, and summarizes our telephone conversation Wednesday of this week. In your letter you request that "the extensive expert and technical data collected by AVX and submitted as part of its litigation pleadings... should be included in the Administrative Record." EPA has, to date, placed into the Administrative Record all of the reports submitted to it by AVX's consultants, including the voluminous reports submitted in 1989 and 1990 regarding the Hot Spot Operable Unit. To the extent that further reports have been developed, EPA welcomes your submission of them. Of course, EPA also welcomes your submission of comments on the alternatives under consideration, and intends to respond as appropriate to all significant comments submitted by AVX and other members of the public.

The Request for Admissions, the "pleadings", you seek to have included in the Administrative Record are litigation documents, produced under the unique circumstances and court orders in United States, et al. v. AVX Corporation et al. Civil Action No. 83-3882-Y. Under the National Contingency Plan, 40 CFR Part 300.810, documents which ought to be included in the Administrative Record are those documents that may form a basis for the selection of a response action. EPA is not required to include documents which do not form a basis for the selection of a response action. The documents which you seek to add to the Administrative Record contain the thousands of factual assertions which you would have attempted to prove at a trial where the liability of AVX for response costs and natural resource damages was the key issue. These documents simply cannot be accurately characterized as documents that may form the basis for a response action. Facts that would tend to establish that AVX is not liable for response costs or natural resource damages are distinguishable from facts that may form the basis for the selection of a response action.

SAVE IT!

PRINTED ON RECYCLED PAPER

EPA disagrees with your characterization that failure to include AVX's requests for admission in the Administrative Record would substantially violate AVX's rights. Under section 113(k)(2) of CERCLA the public is to be afforded the opportunity to participate in the creation of the Administrative Record. However, the right to participation in the formation of the Administrative Record does not mean that EPA is bound to place into the record each and every document that a member of the public feels should be included. Moreover, EPA believes that AVX has been afforded the fullest opportunities to participate in the development of the Administrative Record. AVX's participation opportunities include a separate public meeting in 1990 at which AVX was allowed to present its own alternative for remediation.

Turning finally to the last two items raised in your letter, please be advised that EPA believes that summaries of the extensive sampling data which was produced by the governments in the winter and spring of 1990 are presently included in the Administrative Record. If you have information regarding particular sets of data which you believe are not covered, please bring this to our attention and we will attempt to rectify the situation as appropriate.

With regard to your having access to the site file, please be advised that under EPA's current policy the public is not allowed access to site files. This policy is necessary to ensure the confidentiality of certain information contained in the file which is subject to privileges such as the attorney client or deliberative process privileges or is protected as confidential business information. While access to nonprivileged nonconfidential documents in the site file may have been granted in circumstances in the past, EPA must, in this instance, follow its current policy. EPA will endeavor to provide you with any documents contained in the site file pursuant to an appropriate request under the Freedom of Information Act, and provided that the documents sought under the request are releasable in accordance with the statute.

Sincerely,

Mark A. Lowe

Mark A. Lowe
Assistant Regional Counsel

cc: Gayle Garman

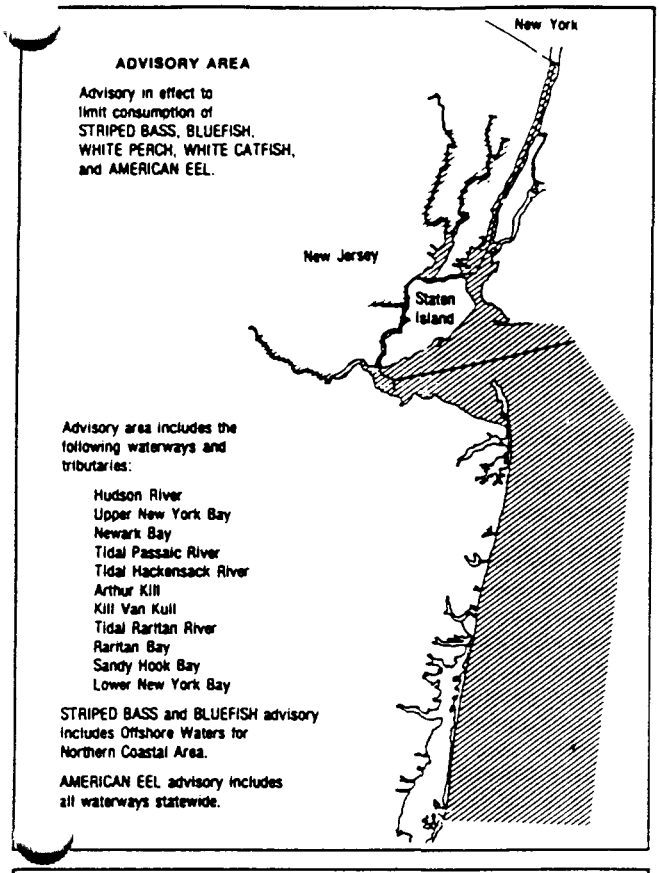
ATTACHMENT F-3

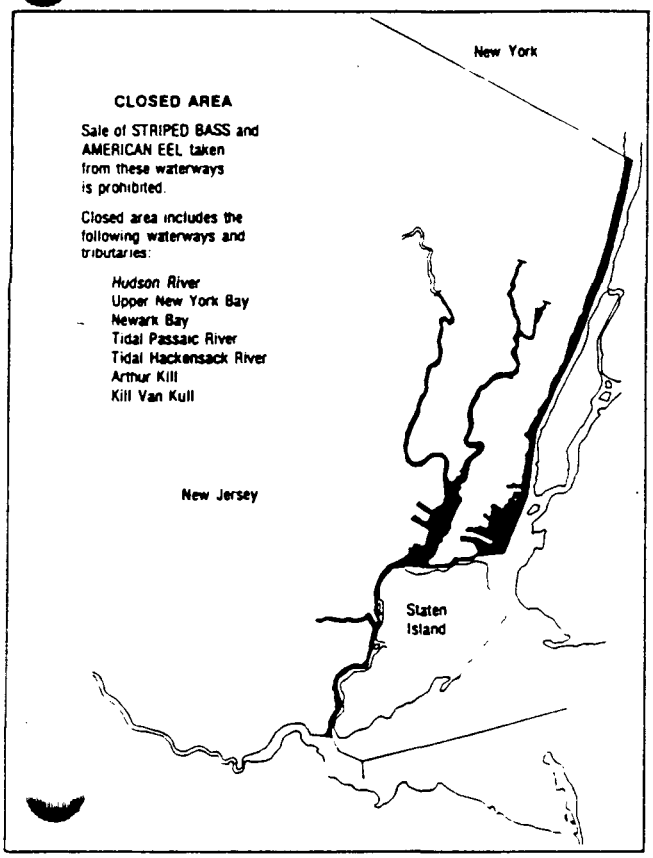
N.J.A.C. 7:15-18A

COPY

Fishing Guidelines for New Jersey Waters

By Bruce Ruppel, Office of Science and Research





How to Reduce Exposure to PCB Contaminated Fish

Introduction

Since the late 1960's there has been an increasing awareness of polychlorinated biphenyls (PCB) compounds impacting upon aquatic life throughout the nation's waterways. The development of sensitive analytical techniques has provided detection of these contaminants in fish tissue at extremely low concentrations. Recently several incidents have illustrated the potential health hazard and economic loss that can be attributed to such contamination. Several states have issued health advisories to limit consumption of certain species and prohibited the sale of others in an effort to reduce human exposure to these contaminants. Protection of human health is a vital part of the state government function and it is through the release of specific information concerning these contaminants that the public can make informed decisions.

PCBs and their Distribution

Polychlorinated biphenyls (PCBs) are a group of synthetic compounds with worldwide distribution. The commercial production began in 1929 and since that time over a billion tonnes have been manufactured. Their unique characteristics of thermal and chemical stability and dielectric properties make them ideally suited for such industrial applications as heat transfer systems, hydraulic fluids and electrical components.

There have been some 210 different types of PCBs developed under a variety of trade names. In the U.S. 12 different types of PCBs called *Aroclors* have been produced, between 1957 and 1971.

PCBs range in consistency from straw-colored oily liquids to whitish, waxy powders. Their value for industrial application depends upon their chemical inertness, resistance to oxidation, and their insulating properties and low water solubility.

The most common uses of PCBs have been in the manufacture of electrical capacitors and transformers, such as those in television sets, air conditioners, and for public utility companies. But there are many other uses including plasticizers in paints, surface coatings, inks, adhesives, fillers for casting waxes, dye carriers in carbonless copy paper, extenders in pesticides, and dust control agents in road construction.

In 1976 the Toxic Substances Control Act (TSCA) gave EPA broad powers to prohibit the production within the U.S. and regulate the disposal and use of in service PCBs. It is estimated that only 4% of over one billion pounds of PCBs purchased by U.S. industries has been degraded or incinerated leaving a significant quantity in service or in landfills or otherwise uncontrolled within the environment.

Released into the environment through spills, effluent discharges, incineration, or through the disposal of end use products in dumps and landfills, PCBs are considered to be a long term problem. A General Electric transformer manufacturing plant, had until recently discharged tons of PCB contaminated wastes into the Hudson River upstream near Troy, New York. It has been estimated that between 32-54 metric tons of PCB contaminated sediments will be transported into the Hudson River *estuary* during the next 20 years if no remedial action is taken. It is likely that the ultimate reservoirs of PCBs will remain the sediments of rivers and estuaries, where their impact upon aquatic organisms can be significant.

PCBs are stable in the environment degrading slowly over a period of decades, and once released are readily absorbed by all or-

Continued on page 2

ganisms through the food chain. These compounds accumulate in the fat tissues of all organisms, and continue to increase over time, even if exposure levels are low.

Health Effects

Several adverse health effects have been identified with PCB contamination including liver damage, reproduction disorders, skin lesions and cancer.

A well documented accidental PCB exposure occurred in Yusho, Japan in 1968. Over 1200 people developed a wide range of health effects after ingestion of rice oil contaminated with PCBs from a leaking heat transfer system. Observed symptoms of what was called "Yusho Disease" were nervous system disorders, reproductive difficulties, chloracne (skin rashes), swollen joints, gum discoloration, eye discharges and lethargy. As a result in 1972 the Japanese government banned the import and production of PCBs.

PCBs are not easily metabolized in the body and have been shown to cross the placental barrier and also may be excreted in breast milk of nursing mothers. They can enter the body by various means, including inhalation, absorption and ingestion. Recently the Food and Drug Administration has determined that the major source of PCB exposure is through food ingestion, with fish being the singly most important dietary contributor. Fish can accumulate PCBs to more than 100,000 times the present level in water. In Japan 80% of the weekly intake of PCBs was from fish. In the U.S. a 1971-1975 survey of all food items showed a decrease in PCB levels except fish. With todays emphasis on utilizing all high protein food sources it is important to protect the consuming public from potential exposure to toxic contaminants.

PCB In Fish

Since 1976 the Office of Cancer and Toxic Substances and Division of Fish, Game and Wildlife within the DEP along with the Department of Health have been conducting a comprehensive survey into polychlorinated biphenyl (PCB) contamination of finfish and shellfish throughout the state. Since that time the "PCB Project" has caught and analyzed fish annually. In addition to PCBs, organochlorine pesticides such as Chlordane and DDT are also measured and these results will be released in followup reports.

The project was designed with three main objectives: 1.) to determine the degree to which aquatic organisms are contaminated; 2.) to determine how PCB

Continued on page 4

Departmental Action Concerning PCBs in Fish

In accordance with Federal and State statutes, New Jersey is required to take action based upon this data. The Department of Environmental Protection realizes the importance of commercial and recreational fisheries to the economy and enjoyment of the citizens of the state. Furthermore, the Department understands the broad range public health threat associated with the contamination of fisheries. Human health remains extremely sensitive to aquatic releases of toxic chemicals. Therefore the Department finds that an important peril of serious public health problem exists due to PCB contamination in certain species of finfish in particular areas of the state's waters necessitating the following adopted emergency new rule and concurrent proposal: N.J.A.C. 7:15-18A *Fisheries Closures and Advisories for Striped Bass, American Eel, Bluefish, White Perch and White Catfish taken from the Northeast Region of the State.* (See Maps)

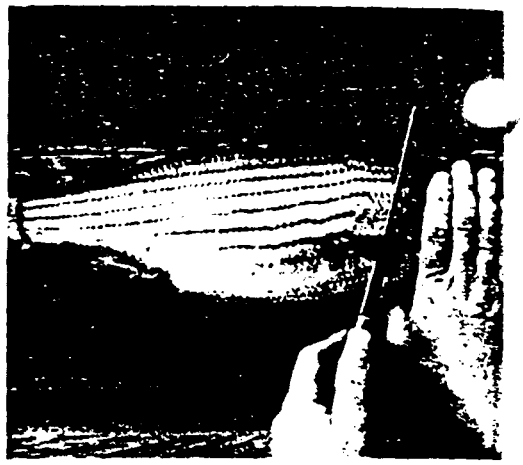
STRIPED BASS and AMERICAN EEL

Prohibition of the sale of *Striped Bass,* (Morone saxatilis) and *American Eel* (Anguilla rostrata) taken from the Hudson River, upper New York Bay, Newark Bay, Lower Passaic River, Lower Hackensack River, Arthur Kill, and Kill Van Kull. Also an advisory to "limit consumption" of Striped Bass taken from the "Northeast Region" and offshore state waters in the northern coastal area of the state, and an advisory to limit consumption of American Eel statewide, especially from the Northeast Region.

BLUEFISH

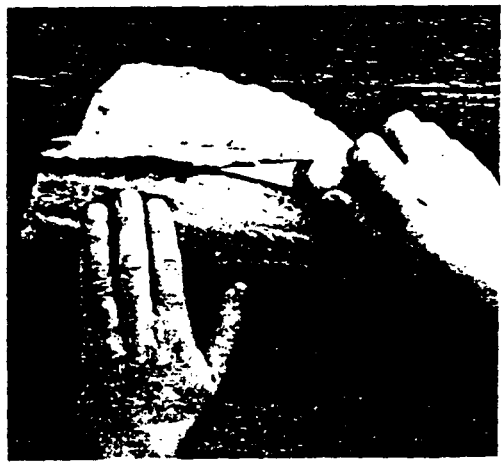
An advisory to limit consumption of *Bluefish* (Pomatomus saltatrix) taken from the Northeast Region, including the

How to Fillet and Skin a Fish to Reduce Toxic Contaminants



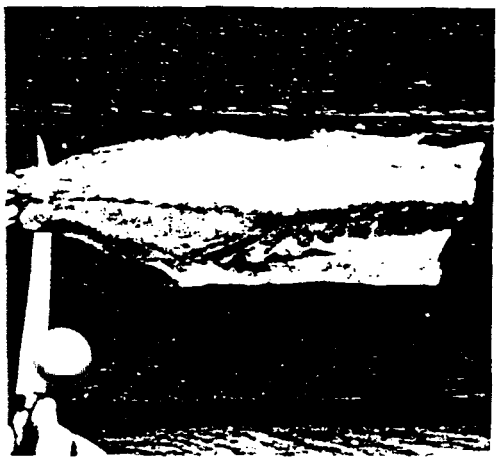
1. LIFT the pectoral fin. Angle the knife towards the back of the head and cut to the backbone.

2. TURN the blade parallel to the backbone. Cut towards tail with a sawing motion. Cut fillet off.

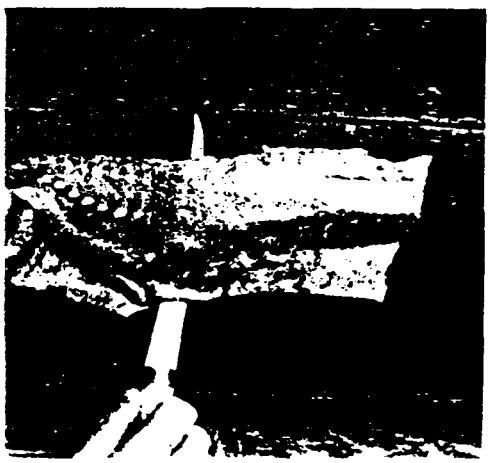


3. REMOVE the rib bones by sliding blade along the ribs. Turn fish over and remove second fillet.

4. CUT off the strip of fatty belly fish. Discard guts and belly.



5. SKIN the fillet by cutting into the tail flesh to the skin. Turn the blade parallel to the skin.



6. PULL the skin firmly while moving the knife in a sawing action between the skin and the flesh. Remove dark meat (lateral line) section prior to cooking.

PHOTOS BY CY DeCOSSE, INC MINNEAPOLIS MN

offshore state water, in northern coastal area of the state. The advisory has primary relevance to Bluefish exceeding *24 inches in length or six pounds in weight.*

WHITE PERCH and WHITE CATFISH

An advisory to limit consumption of *White Perch* (Morone american) and *White Catfish* (Ictalurus catus) taken from the Northeast Region.

Precautions

Limited consumption for purposes of this emergency rule means that in order to reduce exposure to and accumulation of PCBs, **persons of *high risk* such as pregnant women, nursing mothers, women of child bearing age and young children, should not eat *any fish* taken from the regions designated and all others should consume not *more than one meal per week*** of such fish. The term *"Northeast Region"* has been defined for the purpose of this emergency rule as that region encompassing the New Jersey portion of Sandy Hook and Raritan Bays; the tidal portion of the Raritan River upstream to the Route 1 Bridge in New Brunswick; the Arthur Kill and Newark Bay; the Passaic River up to Dundee Dam; the Hackensack River up to Oradell Dam; the Kill Van Kull and Upper New York Bay; and the Hudson River up to the New Jersey-New York border; approximately four miles above Alpine, New Jersey.

Due to the limited amount of data available especially on the larger, legal-sized Atlantic Sturgeon no advisory or fishing closure has been developed. Continued sampling of this species will provide a more comprehensive data base and better management tool for the future.

By this action the Department recognizes certain impacts both social and economic. **It is felt that by compliance with this rule the bioaccumulation of PCBs in the fish consuming public of the State will be substantially decreased, thereby reducing the risk of cancer and other serious health problems, and that the negative economic impact (upon commercial and recreational fishing) will be offset by the overall public health benefit.**

Fish Preparation and Cooking to Reduce PCBs

By following the outlined advisories concerning species and their geographic locations it is possible to avoid exposure to PCB contaminated fish. To reduce PCB levels in fish from questionable water quality that you wish to eat follow these suggestions.

Cleaning Method
(Refer to Filleting Technique photographs.)

- Remove only fillet sections for eating.
- Trim away the belly flap, back strap, skin and lateral line. These areas have the highest fat content and highest contaminant levels.
- For Bluefish consume only smaller fish under 6 pounds or 24 inches in length.

Cooking Method

- Methods that allow the removal of fats from the fish sample generally will remove contaminants as well. These include broiling on an elevated rack, boiling in water, and canning fish without skins. In all cases do not use the liquid that contains the oils and fats as a food item. In addition coatings which hold in oil or fats should also be avoided.

References

For more information on environmental contaminants contact:

New Jersey Department of
Environmental Protection
Office of Science and Research
Information Resource Center
190 West State Street
CN-402
Trenton, New Jersey 08625
609-984-2249
Tuesday-Friday
9:30 am-4:00 pm

PUBLIC ACCESS BROCHURE

The NJO July/August issue will feature a full-color center spread snapout titled, *Public Access to the New Jersey Shore 1983.*

Everything you wanted to know about our Jersey shore resorts including transportation, directions, parking, facilities, costs, activities, telephone numbers, beach fees, and a map. Don't miss it!

Continued from page 2

levels in fish vary with geography; and finally, 3.) to assess the suitability of the fish for human consumption.

The study shows that 75 percent of the finfish and 50 percent of the shellfish had *detectable levels* of PCBs in their edible flesh. Of that only 2.4 percent of the finfish and none of the shellfish had levels exceeding the *5.0 parts per million (ppm)* "action level" established for adulterated or contaminated food items by the Food and Drug Administration. In 1977, based upon declining incidences and new toxicity data, the FDA proposed that the PCB tolerances should be lowered to *2.0 ppm*. The decision is still pending.

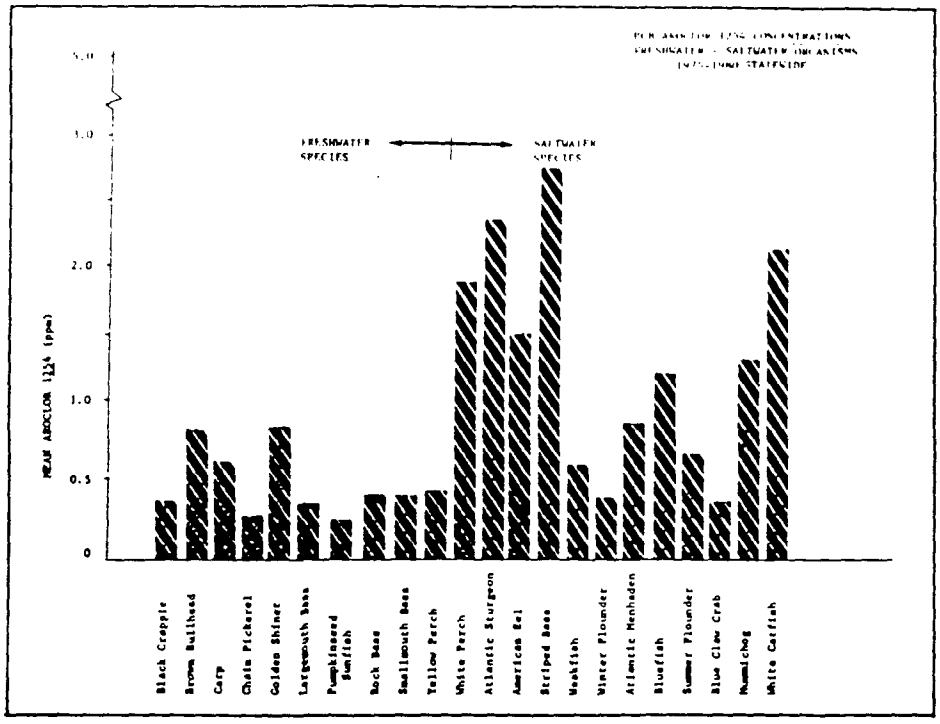
A total of 11.1% of the finfish exceeded the *proposed* level and none of the shellfish had contaminant concentrations greater than the proposed 2.0 ppm action level. The data also show that those fish which are highly contaminated **represent only a few species from the heavily urbanized, northeastern corner of the state, within the Hudson-Newark-Raritan Bay Complex.** Even though levels have declined the Hudson River still appears to be the most severely contaminated drainage within the state's water.

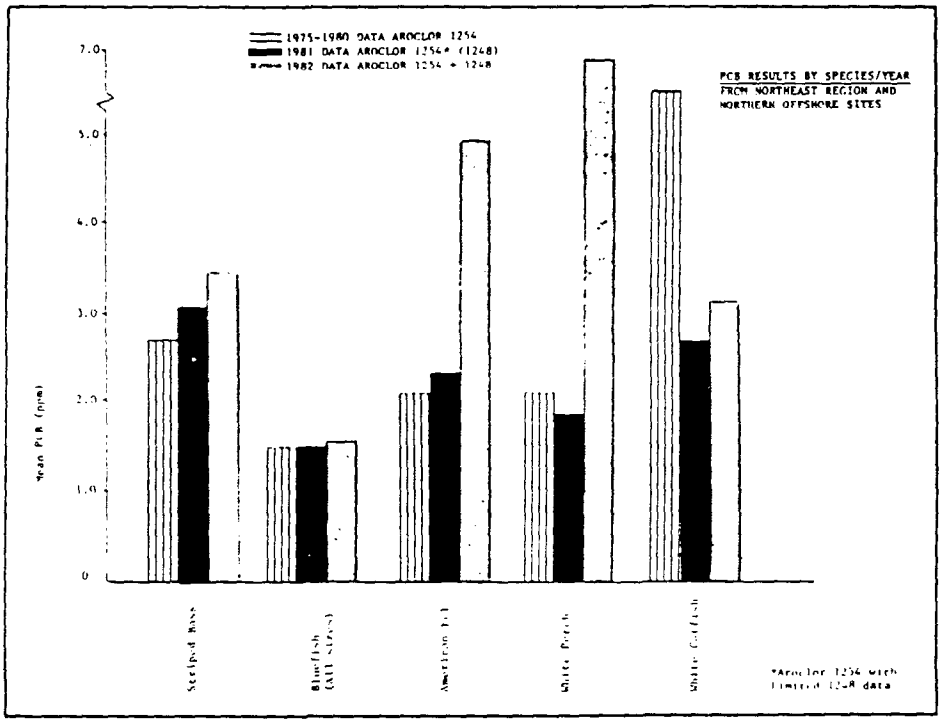
The study examined samples of over 50 different species of aquatic organisms from both fresh and saltwater habitats, representing several major trophic classifications. Only six species of fish exhibited elevated levels of PCB concentrations. The euryhaline species, White Catfish *(Ictalurus catus)*, White Perch *(Morone americana)*, and American Eel *(Anguilla rostrata)* and the saltwater species including Striped Bass *(Morone saxatilis)*, Bluefish *(Pomatomus saltatrix)*, and Atlantic Sturgeon *(Acipenser oxyrhynchus)*. All species, except Atlantic Sturgeon, represent recreational and/or commercial interests within the State. Species like Bluefish that are highly migratory may well have interstate health risk implications as well. Research into this concept is currently underway.

The tendencies of PCBs to concentrate in fatty tissues has been demonstrated as a prime correlation factor for bioaccumulation in fish as the results show those species with high lipid (fat) content also show elevated PCB concentrations. The data also indicates that in Bluefish the larger, older and more lipid fish had higher levels than the smaller juvenile or young of the year size. This differential uptake may be due to changes in feeding habits or geographic-migratory contamination source.

It is known that lipid storage differs within species. Pelagic fish (e.g. Bluefish) use muscle tissue for storing lipids much more often than benthic species (e.g. flatfish) which may use liver and/or bone marrow. This may explain why the mid-water esturine fish had elevated levels and why the Flatfish (Fluke or Flounder), which lie on the bottom in close proximity to contaminated sediments, had low levels of PCBs.

An important observation, concerning PCBs association with the lipid rich tissues, is that human consumption exposure to these substances can be reduced in a number of ways, such as fat-trimming while filleting the fish and altering cooking techniques so as to allow fat to run-off from the food tissue. It has been shown that removal of the fat-rich *belly flap, skin,* and *lateral line* of a fish, as well as broiling, rather than frying, can reduce the exposure to PCBs from a contaminated fish by up to 50%.





ATTACHMENT F-4

TPO Data
(Chromatograms submitted under separate cover from laboratory)

D R A F T

NEW BEDFORD HARBOR
WASTEWATER TREATMENT PLANT OUTFALL
OUTER HARBOR SEDIMENT
SAMPLING PROGRAM
MARCH 1990 SAMPLING PROTOCOL

Prepared for:

Nutter, McClennen & Fish
One International Place
Boston, Massachusetts 02110-2699

Prepared by:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.
59 Stiles Road
Salem, New Hampshire 03079

March 9, 1990
Balsam Project 6292.08:3334

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1
2.0	SAMPLE COLLECTION	2
3.0	SAMPLE HANDLING AND TRANSPORT	3
4.0	QUALITY ASSURANCE/QUALITY CONTROL	7
5.0	HEALTH AND SAFETY PROTOCOL	8

Exhibits

FIGURE 1. WASTEWATER TREATMENT PLANT OUTFALL SAMPLING AREA - APPROXIMATE LOCATION

NEW BEDFORD HARBOR
WASTEWATER TREATMENT PLANT OUTFALL
OUTER HARBOR SEDIMENT
SAMPLING PROGRAM
MARCH 1990 SAMPLING PROTOCOL

1.0 INTRODUCTION

In support of work currently being performed for Nutter, McClennen & Fish to evaluate conditions and environmental mechanisms existing at the New Bedford Harbor Superfund site, Balsam Environmental Consultants, Inc. (Balsam) has designed a sampling program to collect selected data to address questions associated with current assessment and remedial option activities. This wastewater treatment plant outfall sediment sampling program was designed to provide additional sediment quality data that would permit better definition of the vertical distribution of polychlorinated biphenyls (PCBs) in New Bedford Harbor area sediment.

The sampling program discussed here will be performed outside of New Bedford Harbor in a area which will be termed the Outer Harbor. This sampling program will involve the collection of sediment samples for PCB analyses. These programs were designed to provide additional sediment quality data to better permit definition of the presence and vertical distribution of PCBs in Outer Harbor sediment. The Outer Harbor area that will be sampled is the New Bedford wastewater treatment plant discharge off Clarks Point.

To establish standard sampling practices prior to initiation of this sampling effort, sampling protocol have been developed for this sampling program. These protocol are presented in the remainder of this document.

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

2.0 SAMPLE COLLECTION

Sediment core samples will be obtained to provide data for the assessment of the occurrence of PCBs in the sediment column of the Outer Harbor sediment. A general protocol has been developed for the collection of these sediment samples.

For Outer Harbor sampling, it is expected that a vibratory corer sampling device will be used to sample sediment. However, depending upon field conditions, a gravity core sampler or similar device may be used. After the sampler has been advanced to a minimum of 18 inches or refusal, whichever occurs first, the sampler will be slowly withdrawn from the sediments and retrieved on board the sampling vessel. Following retrieval of a sediment sample, the sample will be extruded into a core cradle. Subsamples from the core sample will then be collected, composited and placed into appropriate pre-cleaned containers that will be placed in a cooler with ice to maintain samples near 4 degrees Centigrade.

Collection of sediment samples will be performed from a boat equipped to conduct aquatic sediment sampling. This vessel will be equipped with all necessary equipment required for collection of sediment samples, pumps and apparatus to be used during equipment decontamination, appropriate safety gear for over-water sampling efforts, and electronic navigational equipment to permit accurate determination of sampling locations. Sample recovery and sampler advancement, where possible, will be measured to quantify the amount of sample recovered as compared to the depth to which the sampler was advanced.

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

3.0 SAMPLE HANDLING AND TRANSPORT

This protocol describes methods for handling samples in the field and sample transport to laboratories for analyses. Sample handling protocol will be initiated immediately after the retrieval of sediment samples on board the sampling vessel.

Outer Harbor sampling will involve collection of up to five core samples at the New Bedford wastewater treatment plant outfall. The general location of this area is shown on Figure 1. Bathymetry will be performed prior to initiating sampling activities to attempt to locate the position of silt deposits. Subbottom profiling may also be performed in conjunction with bathymetry to provide further information describing the Outer Harbor bottom strata profile. This information will be used together with available charts to select sampling locations.

It is proposed that five stations will be sampled. We will attempt to locate the five sampling stations within depositional areas at the wastewater treatment plant outfall. Some sampling stations will attempt to be collected directly downstream of the discharge and some from what is believed to be the boundary of these depositional areas. The location of these stations are preliminary and may be modified based upon further field evaluation of the nature of the wastewater treatment plant discharge area and deposition associated with this discharge.

Upon retrieval of a sediment sample from the Outer Harbor, the sampling device will be brought on board the vessel in a manner to minimize the loss of sediment from the open end of the sampler. Once the sampling device is brought on board the vessel, it will be secured to perform sample extrusion and the base of the core tube sampler will be capped to prevent loss of sediment from the open end of the sampler. After capping the base of the sampler, the

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

sample tube will be washed with sea water to remove sediments adhering to the outside of the sample tube. This washing process will also allow easier handling of the sample and minimize potential sample cross contamination. The portion of the vibracore tube which contains the sample will be disconnected from the sampling device to perform sample extraction. The sample will be extruded from the tube into a pre-cleaned core cradle in such a manner to promote sample integrity. The core cradles have been designed to hold the extruded sediment sample and allow sampler access to the sediment material.

Following extrusion of the sediment sample into the cradle, the sample will be segregated into three 6-inch intervals. These intervals are proposed to be from 0 to 6 inches, 6 to 12 inches and 12 to 18 inches starting from the sediment surface. However, based upon the visual characteristic of the core sample, the number of intervals or interval spacing may vary. The exterior portion of each sample segment will then be removed to minimize potential cross contamination resulting from sample smearing against the interior tube wall. The interior of each sample segment will then be transferred to a pre-cleaned container to allow thorough homogenization of the sample. Following homogenization, the sample will then be transferred to a pre-cleaned glass sample container provided by the analytical laboratory. The sample container will then be labeled according to prescribed protocol and prepared for shipment to the analytical laboratory. Samples will be stored on ice and maintained near 4 degrees Centigrade prior to and during transportation to American Analytical Laboratories, Inc. Samples collected from the wastewater treatment plant outfall will be designated TPO. These designations will be followed by a number denoting the core sample station and a letter that will denote the sample depth (e.g., TPO-2b).

All sampling equipment will be decontaminated prior to collection of each sample using the following protocol. Equipment will be rinsed with sea water to wet equipment surfaces, followed by thorough scrubbing with a trisodium phosphate (TSP) and potable water solution. Equipment will then be rinsed with sea

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

water to remove the TSP solution. In addition to cleaning sampling equipment utilized during this sampling program, all personnel involved in the collection or handling of samples will be required to wash their gloves prior to handling of each sample.

Visual characterization of samples to describe sediment stratigraphy will also be performed. Samples will be visually classified by Balsam personnel with classifications being recorded in a sampling field book. The visual classification process will include a description of the sediment density, particle size, particle nature, sediment color, and observable changes in strata. The presence of anthropogenic remnants will also be noted.

A uniform and comprehensive sample designation and management protocol has been developed for all samples which are to be processed by the analytical laboratories. To assist in keeping a record of sampling activities, a sampling log will be maintained and document, on a daily basis, the personnel involved in sampling activities, weather, general sampling activities, and a detailed description of samples collected each working day. In addition to a sampling log, sample chain-of-custody will be maintained from the time of sample collection through sample shipment to the analytical laboratory.

Immediately following completion of sample preparation, each sample will be labeled. Sample labeling will include assigning each sample a unique designation number including the project location (NHB), sample location and station (e.g., TPO-2), sample type and sample depth, as appropriate. In addition, sample collection time will also be noted on the sample label.

Samples which are to be shipped to an outside analytical laboratory will be packaged in reinforced coolers. American Analytical Laboratories, Inc. of Cleveland Tennessee has been selected as the analytical laboratory. As previously discussed, samples will be shipped on ice to maintain these samples

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

near 4 degrees Centigrade. At the time of sample shipment, Balsam personnel will transfer chain-of-custody to the receiving agent, place the completed chain-of-custody form in the shipping container, and seal the shipping container. Sample shipment will be conducted by overnight courier.

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

4.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) considerations have been incorporated throughout the development of this sampling program. Examples of QA/QC considerations included in the program are sample tracking and chain-of-custody documentation, as well as equipment decontamination procedures, discussed later in this document.

In addition to sampling protocol QA/QC efforts, further QA/QC efforts will be undertaken to evaluate performance of outside analytical laboratories. The analytical laboratory selected for sample analysis under this sampling program has been evaluated in terms of its current QA/QC practices. The laboratory selected to conduct PCB analyses on sediment samples has implemented pre-established QA/QC protocol including the analysis of blank samples, duplicate samples, spiked samples, and reference material samples.

To further address analytical laboratory accuracy and precision, Balsam has elected to submit additional samples to the analytical laboratory conducting PCB analyses. These additional samples will include field blank samples consisting of distilled water, trip and equipment blank samples, and blind duplicate sediment samples to allow assessment of analytical precision and reproducibility. Approximately 15 percent of all samples submitted to the analytical laboratory selected to perform PCB analyses on sediment samples will consist of QA/QC samples.

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

5.0 HEALTH AND SAFETY PROTOCOL

Health and safety protocol have been developed based upon the reported presence of anthropogenic compounds in New Bedford Harbor sediments. Widely varying concentrations of Aroclors 1016, 1242 and 1254, as well as varying concentrations of numerous heavy metals, including copper, zinc, nickel, lead, chromium and mercury, and polycyclic aromatic hydrocarbons (PAHs) have been reported present in the sediment; low concentrations of other EPA Hazardous Substance List organic compounds have also been reported present in New Bedford Harbor sediments.

Based upon an evaluation of the types and concentrations of compounds present in New Bedford Harbor water and sediments, the primary routes of exposure are expected to be direct contact and ingestion. A review of the physical properties of compounds present in New Bedford Harbor media in combination with consideration of the concentrations of those compounds present does not indicate inhalation of vapors or contaminated airborne particles to be a significant exposure pathway.

Based upon this expected exposure assessment, a modified EPA Level C health and safety protocol was selected for the conduct of this sampling program. This level of protection must be maintained by all personnel directly involved with sample collection. Protective equipment to be worn by sampling personnel is as follows:

- **Outer Garment**. To provide protection against direct contact with contaminated sediments, rubber rainsuits will be worn by all sampling personnel. Rainsuits have been selected for use as compared to disposable coveralls due to their durability and superior ability to shed water and soil. A disposable inner Tyvek suit will also be worn beneath

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

the rainsuit to provide additional protection during personnel decontamination and disrobing.

- **Gloves.** Nitrile gloves will be worn by personnel involved with the collection and retrieval of sediment samples. Thin-layer surgical gloves may be worn by personnel documenting sediment sample collection or visually characterizing sediment samples.

- **Boots.** Neoprene rubber boots will be worn by all sampling personnel.

- **Eye Protection.** Goggles or approved safety glasses shall be worn by all personnel involved in the collection and handling of sediment samples.

- **Respiratory Protection.** Dust masks shall be used by all personnel involved in the collection or processing of sediment samples. The sole purpose of dust mask use during this project is to prevent accidental ingestion of harbor sediments.

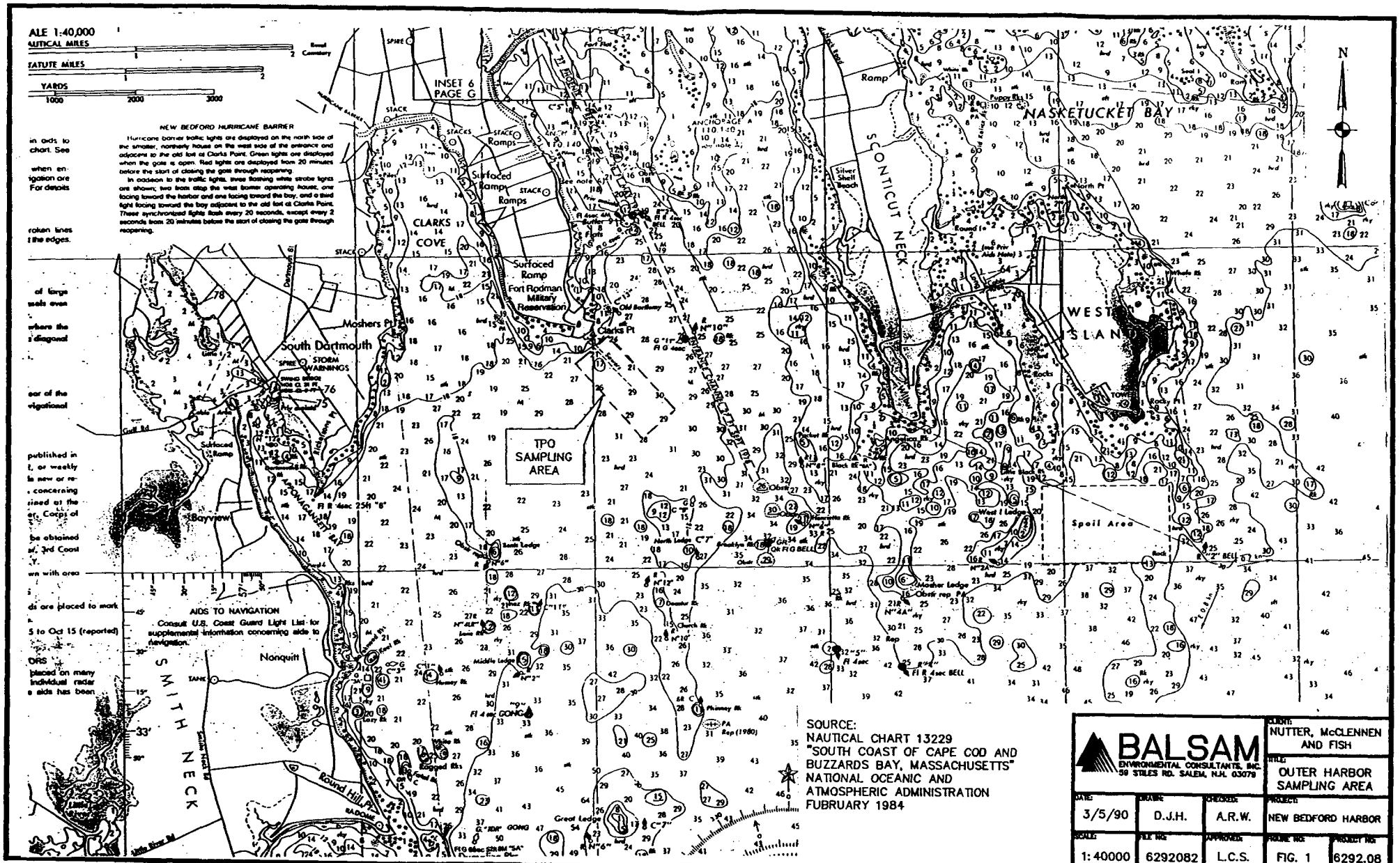
In addition to the use of protective clothing to maintain the health and safety of sampling personnel, rules have been developed regarding sampling personnel conduct for the period of this program. Eating, drinking, smoking, or chewing of tobacco or gum is prohibited during sample collection or processing activities. Restricted activities presented above may be performed only in designated areas after appropriate personnel decontamination has been performed. Food intended to be consumed on board will be maintained in a designated clean area to prevent accidental contamination.

Running, jumping or horse play will not be allowed by any sampling personnel during sampling or sample processing activities. Personal flotation devices will be assigned to each sampling team member and will be utilized by that member during sampling efforts.

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -

At the completion of a work day, each sampling team member will undertake thorough cleaning of reusable safety equipment and disposal of expendable safety equipment. Following this decontamination procedure, the individual will shower as soon as possible after returning to shore as a further precautionary measure.

- ATTORNEY WORK PRODUCT/PRIVILEGED AND CONFIDENTIAL -



SOURCE:
NAUTICAL CHART 13229
"SOUTH COAST OF CAPE COD AND BUZZARDS BAY, MASSACHUSETTS"
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
FUBRUARY 1984

BALSAM ENVIRONMENTAL CONSULTANTS, INC. 59 STILES RD. SALEM, N.H. 03079			CLIENT: NUTTER, McCLENNEN AND FISH
			TITLE: OUTER HARBOR SAMPLING AREA
DATE: 3/5/90	DRAWN: D.J.H.	CHECKED: A.R.W.	PROJECT: NEW BEDFORD HARBOR
SCALE: 1:40000	FILE NO.: 6292082	APPROVED: L.C.S.	FIGURE NO.: FIG. 1
			PROJECT NO.: 6292.08

American Analytical Laboratories, Inc.
1550 37th Street, N.E. P.O. Box 3898 Cleveland, Tennessee 37320-3898 (615) 476-7766

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental
Consultants, Inc.
59 Stiles Road
Salem NH 03079

Lab Reference # 2533/2547
Report Date: 04/07/1990
Sample Received: 03/15/1990 & 3/17/1990
Sample Matrix: SEDIMENT

Authorized Release of Data:
Maurice Smith
Maurice Smith, Ph.D.
Senior Chemist

ND = Not Detected = < 1 ppm
PCB results expressed as mg/kg (ppm)

Laboratory Sample ID	Customer Sample ID	Percent Moisture	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2547-115	NBH-DSD-1A	21.11	ND	2	2
2547-116	NBH-DSD-1B	24.80	ND	ND	ND
2547-117	NBH-DSD-1C	21.46	ND	ND	ND
2547-132	NBH-DSD-1D	25.42	ND	ND	ND
2547-118	NBH-DSD-2A	16.02	ND	ND	ND
2547-119	NBH-DSD-2B	15.49	ND	ND	ND
2547-120	NBH-DSD-2C	16.04	ND	ND	ND
2547-130	NBH-DSD-2D	21.31	ND	ND	ND
2547-121	NBH-DSD-3A	15.36	ND	ND	ND
2547-122	NBH-DSD-3B	18.70	ND	ND	ND
2547-123	NBH-DSD-3C	19.58	ND	ND	ND
2547-124	NBH-DSD-4A	17.79	ND	ND	ND
2547-125	NBH-DSD-4B	18.37	ND	ND	ND
2547-126	NBH-DSD-4C	24.55	ND	ND	ND
2547-127	NBH-DSD-5A	14.70	ND	ND	ND
2547-128	NBH-DSD-5B	12.66	ND	ND	ND
2547-129	NBH-DSD-5C	11.53	ND	ND	ND
2533-101	NBH-STL-1A	70.07	246	157	403
2533-102	NBH-STL-1B	70.80	248	140	388
2533-103	NBH-STL-1C	72.25	314	138	452
2533-104	NBH-STL-1D	72.19	375	143	518
2533-105	NBH-STL-1E	69.11	313	122	435

Quality Assurance Manager: _____
William M. Seymour

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental

Lab Reference # 2533/2547
Sample Received: 03/15/1990 & 3/17/1990
Report Date: 04/07/1990
Sample Matrix: Sediment

ND = Not Detected = < 1 ppm
PCB results expressed as mg/kg (ppm)

Laboratory Sample ID	Customer Sample ID	Percent Moisture	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2533-106	NBH-STL-1F	66.90	420	142	562
2533-107	NBH-STL-1G	66.10	989	264	1253
2533-108	NBH-STL-1H	66.62	662	202	864
2533-109	NBH-STL-1I	66.57	1887	438	2325
2533-110	NBN-STL-1J	70.12	3994	647	4641
2533-111	NBH-STL-1K	71.70	4671	809	5480
2533-112	NBH-STL-1L	66.81	1760	1432	3192
2533-113	NBH-STL-1M	70.13	1993	1788	3781
2533-114	NBH-STL-1N	71.79	253	519	772
2533-115	NBH-STL-1O	62.28	59	69	128
2533-116	NBH-STL-1P	57.16	11	7	18
2533-117	NBH-STL-1Q	57.61	10	4	14
2533-118	NBH-STL-1R	61.10	ND	ND	ND
2533-119	NBH-STL-1S	57.96	ND	ND	ND
2533-120	NBH-STL-1T	56.63	ND	ND	ND
2533-121	NBH-STL-1U	55.40	ND	ND	ND
2533-122	NBH-STL-1V	65.65	195	96	291
2533-123	NBH-STL-2A	77.89	141	75	216
2533-124	NBH-STL-2B	61.36	101	52	153
2533-125	NBH-STL-2C	73.19	327	122	449
2533-126	NBH-STL-2D	71.15	575	165	740
2533-127	NBH-STL-2E	68.87	1152	292	1444
2533-128	NBH-STL-2F	67.39	1469	359	1828
2533-129	NBH-STL-2G	68.74	2474	616	3090
2533-130	NBH-STL-2H	69.31	2322	898	3220
2533-131	NBH-STL-2I	72.21	1252	705	1957
2533-132	NBH-STL-2J	88.63	1875	1454	3329
2533-133	NBH-STL-2K	70.33	211	514	725
2533-134	NBH-STL-2L	60.36	117	173	290
2533-135	NBH-STL-2M	54.82	33	31	64
2533-136	NBH-STL-2N	54.14	20	13	33
2533-137	NBH-STL-2O	54.68	4	2	6

Quality Assurance Manager: _____
William M. Seymour

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental

Lab Reference # 2533/2547
Sample Received: 03/15/1990 & 3/17/1990
Report Date: 04/07/1990
Sample Matrix: Sediment

ND = Not Detected = < 1 ppm
PCB results expressed as mg/kg (ppm)

Laboratory Sample ID	Customer Sample ID	Percent Moisture	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2533-138	NBH-STL-2P	57.35	8	3	11
2533-139	NBH-STL-2Q	53.59	8	3	11
2533-140	NBH-STL-2R	55.77	ND	ND	ND
2533-141	NBH-STL-2S	52.52	ND	ND	ND
2533-142	NBH-STL-2T	52.52	ND	ND	ND
2533-143	NBH-STL-2U	61.83	32	121	153
2533-144	NBH-STL-3A	68.20	32	32	64
2533-145	NBH-STL-3B	66.14	ND	ND	ND
2533-146	NBH-STL-3C	66.15	ND	ND	ND
2533-147	NBH-STL-3D	66.23	ND	ND	ND
2533-148	NBH-STL-3E	79.13	80	72	152
2533-149	NBH-STL-3F	68.31	34	43	77
2533-150	NBH-STL-3G	67.76	314	92	406
2533-151	NBH-STL-3H	68.88	172	127	299
2533-152	NBH-STL-3I	66.75	147	112	259
2533-153	NBH-STL-3J	65.41	192	64	256
2533-154	NBH-STL-3K	66.51	125	107	232
2533-155	NBH-STL-3L	67.45	2253	1397	3650
2533-156	NBH-STL-3M	68.72	4913	1400	6313
2533-157	NBH-STL-3N	69.12	562	128	690
2533-158	NBH-STL-3O	64.06	45	37	82
2533-159	NBH-STL-3P	45.96	393	109	502
2533-160	NBH-STL-3Q	46.27	15	19	34
2533-161	NBH-STL-3R	45.78	2	1	3
2533-162	NBH-STL-3S	50.21	ND	ND	ND
2533-163	NBH-STL-3T	52.33	ND	ND	ND
2533-164	NBH-STL-3U	42.59	ND	ND	ND
2533-165	NBH-STL-4A	44.29	3	4	7
2533-166	NBH-STL-4B	37.17	8	9	17
2533-167	NBH-STL-4C	39.22	12	13	25
2533-168	NBH-STL-4D	35.11	7	8	15

Quality Assurance Manager: _____
William M. Seymour

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental

Lab Reference # 2533/2547
Sample Received: 03/15/1990 & 3/17/1990
Report Date: 04/07/1990
Sample Matrix: Sediment

ND = Not Detected = < 1 ppm
PCB results expressed as mg/kg (ppm)

Laboratory Sample ID	Customer Sample ID	Percent Moisture	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2533-169	NBH-STL-4E	35.25	19	18	37
2533-170	NBH-STL-4F	41.77	12	13	25
2533-171	NBH-STL-4G	34.11	17	16	33
2533-172	NBH-STL-4H	34.92	16	16	32
2533-173	NBH-STL-4I	37.54	10	10	20
2533-174	NBH-STL-4J	42.54	1	1	2
2533-175	NBH-STL-4K	34.38	ND	ND	ND
2533-176	NBH-STL-4L	38.15	ND	ND	ND
2533-177	NBH-STL-4M	39.24	ND	ND	ND
2533-178	NBH-STL-4N	35.86	ND	ND	ND
2533-179	NBH-STL-4O	37.87	ND	ND	ND
2533-180	NBH-STL-4P	37.78	ND	ND	ND
2533-181	NBH-STL-4Q	38.32	ND	ND	ND
2533-182	NBH-STL-4R	30.56	ND	ND	ND
2533-183	NBH-STL-4S	95.00	ND	ND	ND
2533-184	NBH-STL-4T	30.77	ND	ND	ND
2533-185	NBH-STL-4U	39.75	6	5	12
2533-186	NBH-STL-4V	40.59	1	1	2
2547-103	NBH-TPO-1A	51.56	ND	36	36
2547-104	NBH-TPO-1B	45.10	ND	17	17
2547-105	NBH-TPO-1C	46.18	ND	1	1
2547-106	NBH-TPO-2A	22.63	ND	ND	ND
2547-107	NBH-TPO-2B	22.86	ND	ND	ND
2547-108	NBH-TPO-2C	21.32	ND	ND	ND
2547-109	NBH-TPO-3A	56.07	ND	5	5
2547-110	NBH-TPO-3B	53.77	ND	10	10
2547-111	NBH-TPO-3C	51.43	ND	ND	ND
2547-112	NBH-TPO-4A	57.85	ND	22	22
2547-113	NBH-TPO-4B	58.33	ND	1	1

Quality Assurance Manager: _____
William M. Seymour

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental

Lab Reference # 2533/2547
Sample Received: 03/15/1990 & 3/17/1990
Report Date: 04/07/1990
Sample Matrix: Sediment

ND = Not Detected = < 1 ppm
PCB results expressed as mg/kg (ppm)

Laboratory Sample ID	Customer Sample ID	Percent Moisture	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2547-114	NBH-TPO-4C	54.96	ND	ND	ND
2547-131	NBH-TPO-4D	55.60	ND	2	2
2547-133	NBH-TPO-5A	54.52	14	13	27
2547-134	NBH-TPO-5B	30.37	8	5	13
2547-135	NBH-TPO-5C	23.64	ND	ND	ND
2533-188	NBH-QC-2	11.22	ND	ND	ND

Quality Assurance Manager: _____
William M. Seymour

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental

Lab Reference # 2533/2547
Sample Received: 03/15/1990 & 3/17/1990
Report Date: 04/07/1990
Sample Matrix: Water

ND = Not Detected = < 1 ppb
PCB results expressed as µg/L (ppb)

Laboratory Sample ID	Customer Sample ID	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2533-187	NBH-QC-1	ND	ND	ND
2533-189	NBH-QC-3	ND	ND	ND
2533-190	NBH-QC-4	ND	ND	ND
2533-191	NBH-QC-5	ND	ND	ND
2533-192	NBH-QC-6	103	88	191
2547-101	NBH-QC-1	ND	ND	ND
2547-102	NBH-QC-2	ND	ND	ND

Quality Assurance Manager: _____
William M. Seymour

CHAIN-OF-CUSTODY RECORD

BALSAM
ENVIRONMENTAL CONSULTANTS, INC.
86 STILES RD.
SALEM N.H. 03079

PROJECT NAME: New Bedford Harbor

PROJECT ADDRESS: New Bedford Massachusetts

PROJECT NO.: 6292 08

SAMPLERS (SIGNATURES): Ron Coleman, Allen Walk

I.D. NUMBER	SAMPLING LOCATION	DATE	TIME	SAMPLE TYPE: SOIL	WATER	OIL	AIR	BULK	NO. OF CONTAINERS	ANALYSES	COMMENTS
3	NBH-TPO-1 a	3/14/90	2:50 pm	X					1	PCBs	Shipped on ice
4	NBH-TPO-1 b	3/14/90	↓	↓					1	↓	
5	NBH-TPO-1 c	3/14/90	↓						1		
6	NBH-TPO-2 a	3/15/90	2:32 pm						1		
7	NBH-TPO-2 b	↓	↓						1		
8	NBH-TPO-2 c	↓	↓						1		
9	NBH-TPO-3 a	3/16/90	8:54 am						1		
10	NBH-TPO-3 b	↓	↓						1		
11	NBH-TPO-3 c	↓	↓						1		
12	NBH-TPO-4 a	3/16/90	9:28 am						1		
13	NBH-TPO-4 b	↓	↓						1		
14	NBH-TPO-4 c	↓	↓	↓					1	↓	
	~~NBH-TPO-~~ (Rev)			↓					↓	↓	
	~~NBH-TPO-~~ (Rev)			↓					↓	↓	
	~~NBH-TPO-~~ (Rev)			↓	(Rev)				↓ (Rev)	↓ (Rev)	

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
Allen R. Walk	3/16/90	6:15 pm	Maria Smith	3-17-90	10:30
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
RELINQUISHED BY:	DATE:	TIME:	RECEIVED FOR LABORATORY BY:	DATE:	TIME:
			Maria Smith	3-17-90	10:30

METHOD OF SHIPMENT: Federal Express

AIRBILL (OR SHIPPING INVOICE) NUMBER: 3934476073 (Rev) 2" 2

CHAIN-OF-CUSTODY RECORD

BALSAM
ENVIRONMENTAL CONSULTANTS, INC.
59 STILES RD.
SALEM N.H. 03079

PROJECT NAME: New Bedford Harbor

PROJECT ADDRESS: New Bedford, Massachusetts

PROJECT NO.: 0292.05

SAMPLERS (SIGNATURES): Tom Coleman, [illegible]

I.D. NUMBER	SAMPLING LOCATION	DATE	TIME	SAMPLE TYPE: SOIL	WATER	OIL	AIR	BULK	NO. OF CONTAINERS	ANALYSES	COMMENTS
	NBH-~~QC~~ QC-1	3/14/90	1:15pm	X	X				1	PCBs	Shipped on ice
	NBH-QC-2	3/14/90	1:15pm		X				1	PCBs	
	* Sample has NBH-OH-QC1										
	NBH-OH-QC2										

MBS 3-19-90 @ Login

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
[illegible]	3/14/90	6:15pm	Maurice Smith	3-17-90	10:30am
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
RELINQUISHED BY:	DATE:	TIME:	RECEIVED FOR LABORATORY BY:	DATE:	TIME:
			Maurice Smith	10-17-90	10:30am

METHOD OF SHIPMENT: Federal Express

AIRBILL (OR SHIPPING INVOICE) NUMBER: 3936476073 (Rev) 2nd of 2

CHAIN—OF—CUSTODY RECORD

BALSAM ENVIRONMENTAL CONSULTANTS, INC.
50 STILES RD.
SALEM N.H., 03079

PROJECT NAME: New Bedford Harbor

PROJECT ADDRESS: New Bedford, Massachusetts

PROJECT NO.: 6292.05

SAMPLERS (SIGNATURES): [signature] [signature]

I.D. NUMBER	SAMPLING LOCATION	DATE	TIME	SAMPLE TYPE: SOIL	WATER	OIL	AIR	BULK	NO. OF CONTAINERS	ANALYSES	COMMENTS
27	NBH-DSD-5a	3/15/90	12:57pm	X					1	PCBs	Shipped on ice
28	NBH-DSD-5b	3/15/90	12:57pm	↓					1	↓	
29	NBH-DSD-5c	3/15/90	12:57pm	↓					1	↓	
	~~TPO~~ FRD										
30	NBH-TPO-2d	3/15/90	2:32pm	↓					1	↓	
31	NBH-TPO-4d	3/16/90	8:54am	↓					1	↓	
32	NBH-DSD-1d	3/15/90	8:22am	↓					1	↓	
33	NBH-TPO-5A	Samples not on original chain of Custody									
34	NBH-TPO-5B	entered by MBS 3-19-90 @ Login time									
35	NBH-TPO-5C										

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
[signature]	3/16/90	6:40 pm			
RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:	DATE:	TIME:
RELINQUISHED BY:	DATE:	TIME:	RECEIVED FOR LABORATORY BY:	DATE:	TIME:
			Marina Smith	3-17-90	10 30 am

METHOD OF SHIPMENT: Federal Express

AIRBILL (OR SHIPPING INVOICE) NUMBER: 3936476073

DAILY FIELD REPORT

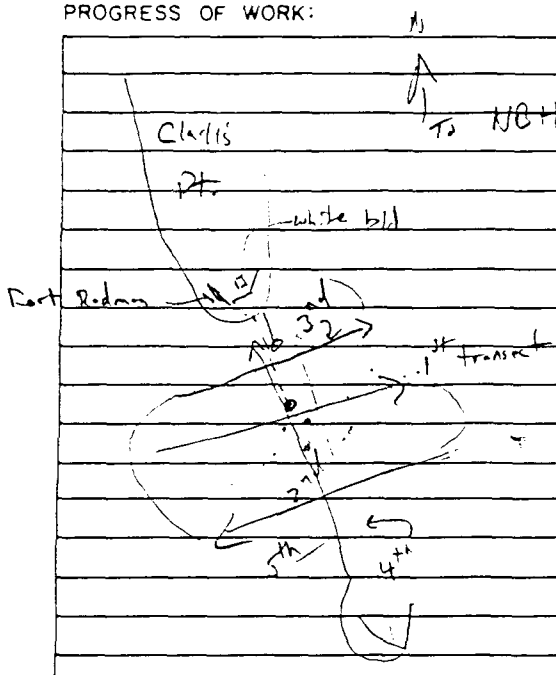
PROJECT _____ PROJECT NO. C292.08

CONTRACTOR _____ REPORT NO. _____

BALSAM PERSONNEL _____ PAGE 3 OF 5

WEATHER _____ DATE 3/14/90

PROGRESS OF WORK:



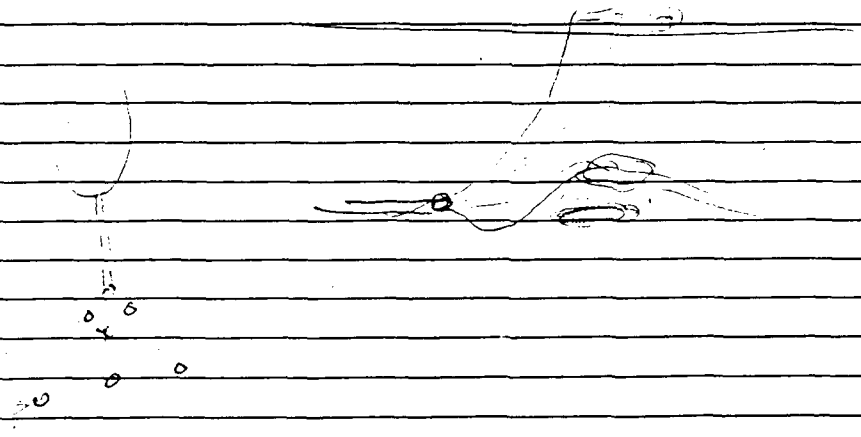
OSI

non-I	1
rung	= 2
	3
	4
	5

offset to pipe length - east side
tried to follow plume centerline

area on bathymetric printout.

District mound was observed directly over the discharge plume. Top of mound was ~ 20' deep. Surrounding water depth was about 55' ~~higher~~ lower (~25-26' deep) than mound. Mound was about 5.5' high.



INSPECTOR:

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

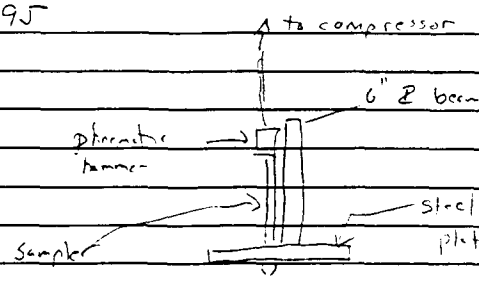
PROJECT NVB4 PROJECT NO. 6292.08
CONTRACTOR NMF REPORT NO.
BALSAM PERSONNEL AAW, DAC PAGE 4 OF 5
WEATHER Ptly Sunny, ~55°F DATE 3/14/90

PROGRESS OF WORK: Set up Vibracore for 1st sample – TPO-1

→ TPO-1 ~ 50' south of visible plume Time 2:50pm
(Core 1)

Water depth = 22 feet

Loran C 25561.20 before & after
43994.95



Penetration = 5
recovery = 3.4' – 1st section
0.9' – 2nd section
4.3

TPO-1 retrieved @ 1530 – 1st core

Sample core was capped and placed on ice in cooler.

TPO-2 ~ 30' north of visible plume Time: 4:00pm
(Core 2)

Water depth = 23 feet

Loran C : 14199.34 Lat 41° 35 05
25561.08 Long 70° 53 34

Aborted, Lost bow anchor at 415 while lowering vibracore. Near end of day, OSI chose to hold in. Majority of todays proposed work completed.

INSPECTOR:

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

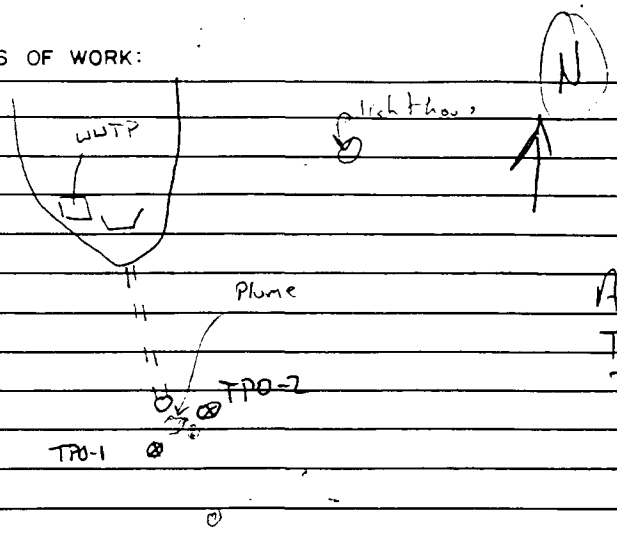
PROJECT _____ PROJECT NO. 6292.08

CONTRACTOR _____ REPORT NO. _____

BALSAM PERSONNEL _____ PAGE 5 OF 5

WEATHER _____ DATE 3/14/90

PROGRESS OF WORK:



Approximate locations of TPO-1 and attempt at TPO-2.

Left site and headed for port. Arrived at dock ~ 4:40 pm and unload bulk of our gear. ARW & DAC left ~~ARW~~ dock and travelled to Federal Express in Taunton, MA to ship sectioned samples to analytical labs. Samples had been locked in van in coolers with ice.

INSPECTOR: ARW

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

PROJECT _____ PROJECT NO. 6292.08
CONTRACTOR _____ REPORT NO. _____
BALSAM PERSONNEL _____ PAGE 4 OF 5
WEATHER _____ DATE 3/15/70

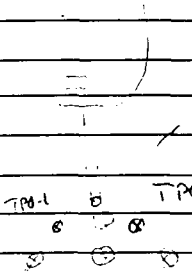
PROGRESS OF WORK:

DSD-4 was cored over ~~the~~ (AND) assumed bedrock. Mike (driller) noted this when advancing core. Refusal was encountered.

Note: Fog cleared and wind picked up, and was increasing after ~10:30 AM. Seas increasing to 2' freq.

1:30 pm DSD sampling completed. Moved to TPO site.

2:25 pm Set up on TPO-2 site. This is about 50' east of visible plume from WWTP discharge



P/12	Location Designation	Time	Water Depth (ft)	Lat (N)	Long (W)	TDs (ppm)
5.4/1.9	TPO-2	2:32.37	25	4135.07	7053.52	~~14232.77~~ (AND) 25560.6
						14199.2
						43994.6
						60212.4

Penetration = 5.4'
Recovery = ~~3.4~~ (AND) 1.9

INSPECTOR:

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

PROJECT _____ PROJECT NO. 6292.08
CONTRACTOR _____ REPORT NO. _____
BALSAM PERSONNEL _____ PAGE 5 OF 5
WEATHER _____ DATE 3/15/90

PROGRESS OF WORK:

3:10 pm Finished collection of TPO-2. Motored over plume discharge and observed depth gauge. The mound observed the previous day was observed just down stream from the plume

with bathymetry and subbottom profile transect

Completed days activities and motored to port. Arrived at dock about 3:50pm. Unloaded gear and placed coolers with samples and ice in van.

Departed S.Z. — 4:10 pm

INSPECTOR: ARJ

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

Dave Cohen - Typed up charts
AAL - Sat. delivery

203 [illegible] Dave [illegible]
[illegible] AAL
615/476-[illegible]

DAILY FIELD REPORT

PROJECT New Bedford Harbor
CONTRACTOR NM&F
BALSAM PERSONNEL DAC ARW
WEATHER Fog ~50°F calm

PROJECT NO. 6292.08
REPORT NO.
PAGE 1 OF 6
DATE 3/16/90

PROGRESS OF WORK:

OSI: John Sullivan, Mike Engels
boat captain Bob Elenieffsky

Met at boat at 7:00 Am. Left dock at ~7:30 on transit to TPO location John and I picked (ARW) candidate sampling stations.

→ Run 8 13 37.05

TDs 14199.5, 25560.7 43994.6 60191.6
Lat, long 41 35.04 N 70 53 54 W

The above location appears to be centerline of plume discharge. Will adjust it according to visual identification of plume

P/R (ft)	Location Designation	Time	Water Depth (ft)	Lat (N)	Long (W)	TDs Lower
		845		← data	cable	knocked out ← false reading (ARW)
~~6/~~	~~TPO-3~~	~~08 21 13~~	~~27~~	~~41 35.11~~	~~70 53.55~~	~~14199.4 25561.2~~ ~~43995.1 60202.0~~
6/4.1	TPO-3	08:54.23	27	41 35.08	7053.56	14199.5 25561.1 43995.1 60223.2
6.5/5.1	TPO-4	0928.03	28	41 35.03	7053.59	14199.7 25561.2 43994.6 60233.4
	Plume	812.53		41 35.10	70 53 58	14199.5 43995.0
		821.03		41 35.12	7053.55	14199.3 43995.1 25561.2 60202.0

INSPECTOR:

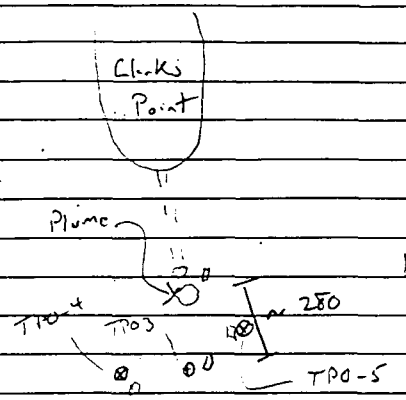
REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

PROJECT _____ PROJECT NO. 6292.08
CONTRACTOR _____ REPORT NO. _____
BALSAM PERSONNEL _____ PAGE 2 OF 6
WEATHER _____ DATE 3/16/90

PROGRESS OF WORK:



TPO-3 was located approximately 250 feet from plume estimated to be the centerline of plume. We were fogged in and could not see shore during set up on TPO-3. The plume buoy = 0 and buoy markers placed from previous day were used to locate TPO-3. Buoys were placed at every sampling point.

A southeasterly wind moved the boat west so we were about 120 feet west of TPO-4. We set up to sample here

~10 AM TPO-4 sample collected and brought on board boat. Top 18" cut off, as with all cores, capped and placed on ice in cooler. Pulled anchor and motored to TPO-5 site.

P/R	Location Designation	Time	Water Depth (ft)	Lat (N)	Long (W)	TDs	
4.5/2.6	TPO-5	10:32.03	29	4135.07	7053.51	14199.1 43994.7	25560.6 60221.5
4/14/90 5/4.3	TPO-1	14:35 - on site (2:50pm) - time of sample	22	41 35.04	70 53.59	14199.8 43994.8	25560.2 60191.7

From J. Sullivan's note

INSPECTOR:

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

PROJECT _____ PROJECT NO. 6292.08
CONTRACTOR _____ REPORT NO. _____
BALSAM PERSONNEL _____ PAGE 3 OF 6
WEATHER _____ DATE 3/16/90

PROGRESS OF WORK:

11:05 AM Finished collection of samples. Clean up with salt water. Collected bouys and returned to harbor where collected core samples will be extruded characterized, sectioned, ~~and~~ contained and placed on ice.

Sample Designation	Date	Time	
TPO - 1	3/14/90	2:50 pm	
TPO - 2	3/15/90	2:32 pm	Dup
TPO - 3	3/16/90	8:54	
TPO - 4	3/16/90	9:28	Dup
TPO - 5	3/16/90	10:32	
DSD - 1	3/15/90	8:22	
DSD - 2		9:24	
DSD - 3		10:38	Dup
DSD - 4		11:51	
DSD - 5		12:59	

1 pm On dock and prepared to section and contain samples.

Sample Description (Top - bottom)

DSD - 5 0-12" Dark grey F M SAND. Little cobble (granite) and gravel
12-18" Same as 0-12" throughout 18" (ADW) Trace silt at bottom and returning to F Sand. Shells in 0-12" zone - some large.

INSPECTOR:

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

Core barrel ID = 7cm or 2.8"

PROJECT _____ PROJECT NO. 0292.08

CONTRACTOR _____ REPORT NO. _____

BALSAM PERSONNEL _____ PAGE 5 OF 6

WEATHER _____ DATE 3/16/90

PROGRESS OF WORK:

	Sampl.		Description (Top - Bottom)
Dup	TPO-5	0-6"	Black SILT, trace F SAND, Odor. 0-3" loose. Few shells
TB-2		6-12	Dark Grey SILT, Little Fine Sand Shell Fragments. Odor
TB-4		12-18	Dark Grey F SAND, some Silt. Few shell Fragments
	TPO-4	0-6	Black SILT, ~~Black~~ trace F SAND Odor, rootlets. Apparent oil sheen
	Duplicate TPO-4-b = TPO-4-d	6-12	Same as 0-6
		12-18	Same as 0-6
	TPO-3	0-6	Black SILT, trace Silt. Trace Shell Fragments rootlets. Odor
		6-12	Same as 0-6. ~~at~~ Piece of Wood & Oil sheen at 9"
		12-18	Same as 0-6
	TPO-2	0-6	Dark Grey Fine SAND, some Silt
	Duplicate TPO2-a = TPO2-d		trace gravel, cobbles. Odor
		6-12	Dark Grey Fine SAND, some Silt
			trace gravel. Shell hash. Odor
		12-18	Dark Grey F SAND, Little Silt.
			Odor shell hash
	TPO-1	0-6	~~Dark~~ Black SILT, little F Sand.
			Organics/rootlets odor
		6-12	Same as 0-6. Leafs present. odor
		12-18	Same as 0-6. Oil sheen
			Note: A Corn Kernel at 13" was observed.

INSPECTOR:

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

DAILY FIELD REPORT

PROJECT _____ PROJECT NO. 6292.0F

CONTRACTOR _____ REPORT NO. _____

BALSAM PERSONNEL _____ PAGE 6 OF 6

WEATHER _____ DATE 3/16/98

PROGRESS OF WORK:

3:45 Completed Sectioning of samples Clean Up and leave dock Gear and Coolers with Samples placed in van.

Stopped at Federal Express in Wilmington MA on way to Salem, NH where samples were left for shipment to analytical laboratory.

INSPECTOR: ARW

REVIEWED BY:

BALSAM ENVIRONMENTAL CONSULTANTS, INC.

American Analytical Laboratories, Inc.

1550 - 37th Street, N.E. • P.O. Box 3898 • Cleveland, TN 37320-3898 • (615) 476-7766, Fax (615) 476-9217

July 13, 1992

Gayle Garman
Remedial Project Manager
U.S. Environmental Protection Agency, Region I
Waste Management Division (HRM-CAN 3)
J.F.K. Federal Building
Boston, MA 02203

Re: New Bedford Harbor Superfund Site:
AVX Corporation's Administrative Record Comments

Dear Ms. Garman:

At the request of Balsam Environmental Consultants, Inc., I am forwarding directly to you chromatograms for sample analyses conducted by American Analytical for Balsam in March 1990. Balsam has advised me that these chromatograms are submitted in connection with Attachment F.4 of the AVX comments.

If you have any questions concerning this matter, please contact Weldon Bosworth at Balsam Environmental Consultants.

Sincerely,

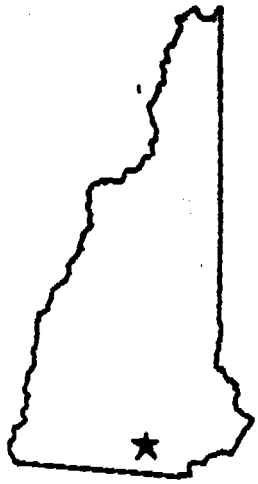
Cynthia Holtsclaw

Cynthia Holtsclaw
Client Services Representative

JUL- 9-92 THU 10:28

BALSAM
ENVIRONMENTAL CONSULTANTS, INC.

5 INDUSTRIAL WAY, SALEM, NH 03079
(603) 893-0616
TELECOPY NO: (603) 893-6240



FAX TRANSMITTAL

DATE: 7/9/92

OF PAGES 2
(INCLUDING THIS PAGE)

TIME: 10:30

PROJECT: 6465 T1

TO: Maurice Smith (615) 476-9217
NAME FAX NUMBER
American Analytical
COMPANY

FROM: WELDON BISHOPETTI

COMMENTS: Please send chromatograms for attached samples to Mary Ryan as discussed

PLEASE CONTACT US IMMEDIATELY IF ALL THE PAGES ARE NOT RECEIVED

THANK YOU

forms/fasmh

FAX
615 476 9217

LABORATORY REPORT

Attn: Mr. Alan Walker
Balsam Environmental

Lab Reference # 2533/2547
Sample Received: 03/15/1990 & 3/17/1990
Report Date: 04/07/1990
Sample Matrix: Sediment

"A" = 0-6"
"B" = 6"-12"
"C" = 12"-18"

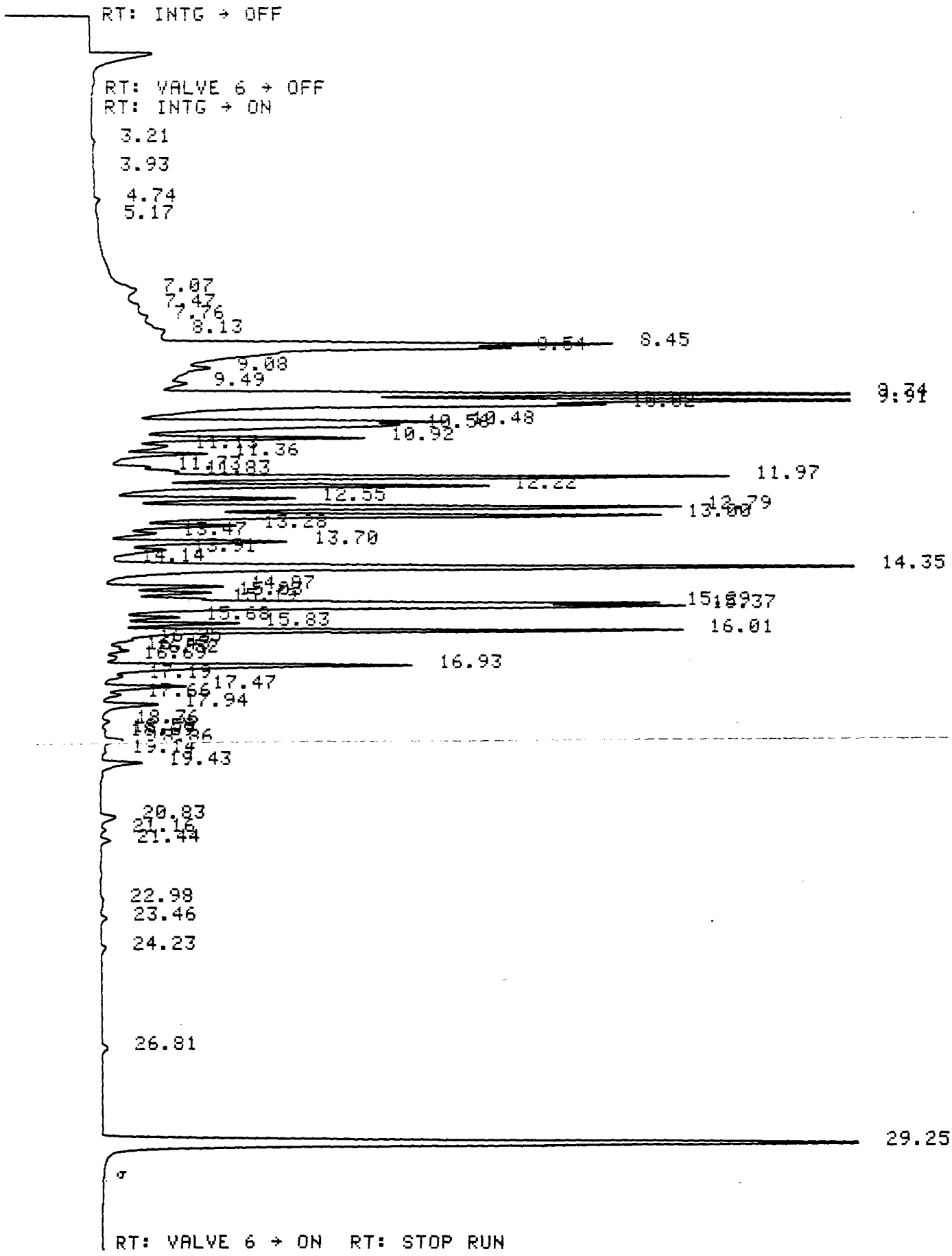
ND = Not Detected = < 1 ppm
PCB results expressed as mg/kg. (ppm)

Laboratory Sample ID	Customer Sample ID	Percent Moisture	Aroclor 1016/1242	Aroclor 1254	Total Aroclor
2547-114	NBH-TPO-4C	54.96	ND	ND	ND
2547-131	NBH-TPO-4D	55.60	ND	2	2
2547-133	NBH-TPO-5A	54.52	14	13	27
2547-134	NBH-TPO-5B	30.37	8	5	13
2547-135	NBH-TPO-5C	23.64	ND	ND	ND
2533-188	NBH-QC-2	11.22	ND	ND	ND
2547-103	NBH-TPO-1A	51.56	ND	36	36
2547-104	NBH-TPO-1B	45.10	ND	17	17
2547-105	NBH-TPO-1C	46.18	ND	1	1
2547-106	NBH-TPO-2A	22.63	ND	ND	ND
2547-107	NBH-TPO-2B	22.86	ND	ND	ND
2547-108	NBH-TPO-2C	21.32	ND	ND	ND
2547-109	NBH-TPO-3A	56.07	ND	5	5
2547-110	NBH-TPO-3B	53.77	ND	10	10
2547-111	NBH-TPO-3C	51.43	ND	ND	ND
2547-112	NBH-TPO-4A	57.85	ND	22	22
2547-113	NBH-TPO-4B	58.33	ND	1	1

-163

	[illegible]	VV	0.000
24.22	1020.12	BV	0.000
26.00	1390.40	VB	0.000
29.26	179662.00	BB	0.000

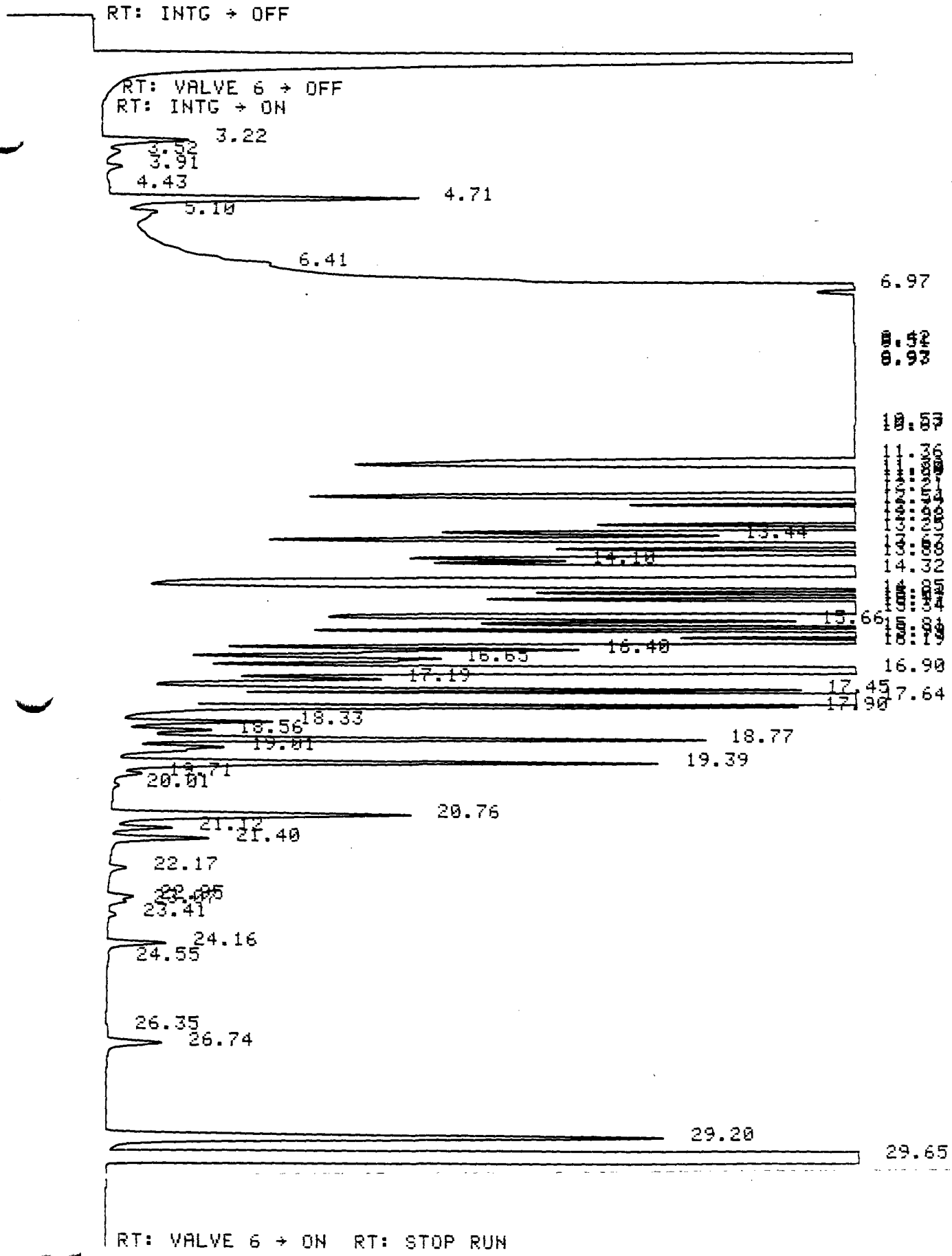
TOTAL AREA = 1001090.00
MULTIPLIER = 0



SUPELCO, Bellefonte, PA Cat. No. 2-2887 (pad); Cat. No. 2-2888 (box of 10 pads)

049

-104



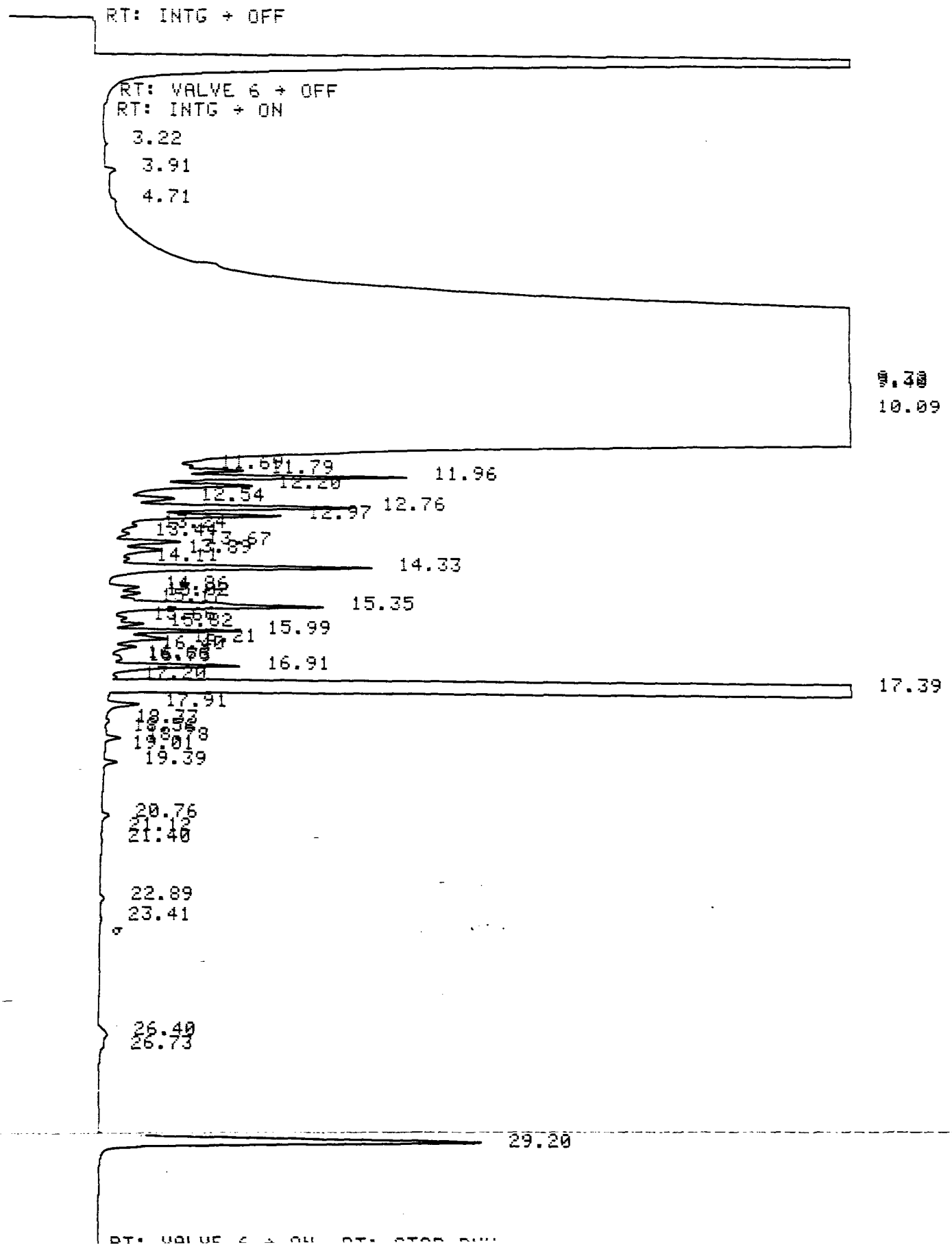
P] 5880A SAMPLER INJECTION @ 23:28 MAR 26, 1990
SAMPLE # : ID CODE :
11 2547-104
THOD ABORTED
EA %

250 ml / 1 ml

24.33	642.58	C	VB	0.000
26.35	1263.41	C	BV	0.000
26.74	9334.18	C	VB	0.000
29.20	101893.00	C	PV	0.000
29.65	4823330.00	C	VB	0.000

-105

TOTAL AREA = 76472400.00
MULTIPLIER = 0



SUPELCO, Bellefonte, PA Cat. No. 2-2887 (pad); Cat. No. 2-2888 (box of 10 pads)

-106

RT: INTG → OFF

RT: VALVE 6 → OFF
RT: INTG → ON

3.91
4.48
4.96

6.02
6.39

7.06

8.12
8.96

9.51
10.91

11.35

12.20
12.53

13.25
13.89

14.34

15.30

16.92
17.45
17.93

19.40

22.88
23.41

26.74

29.18

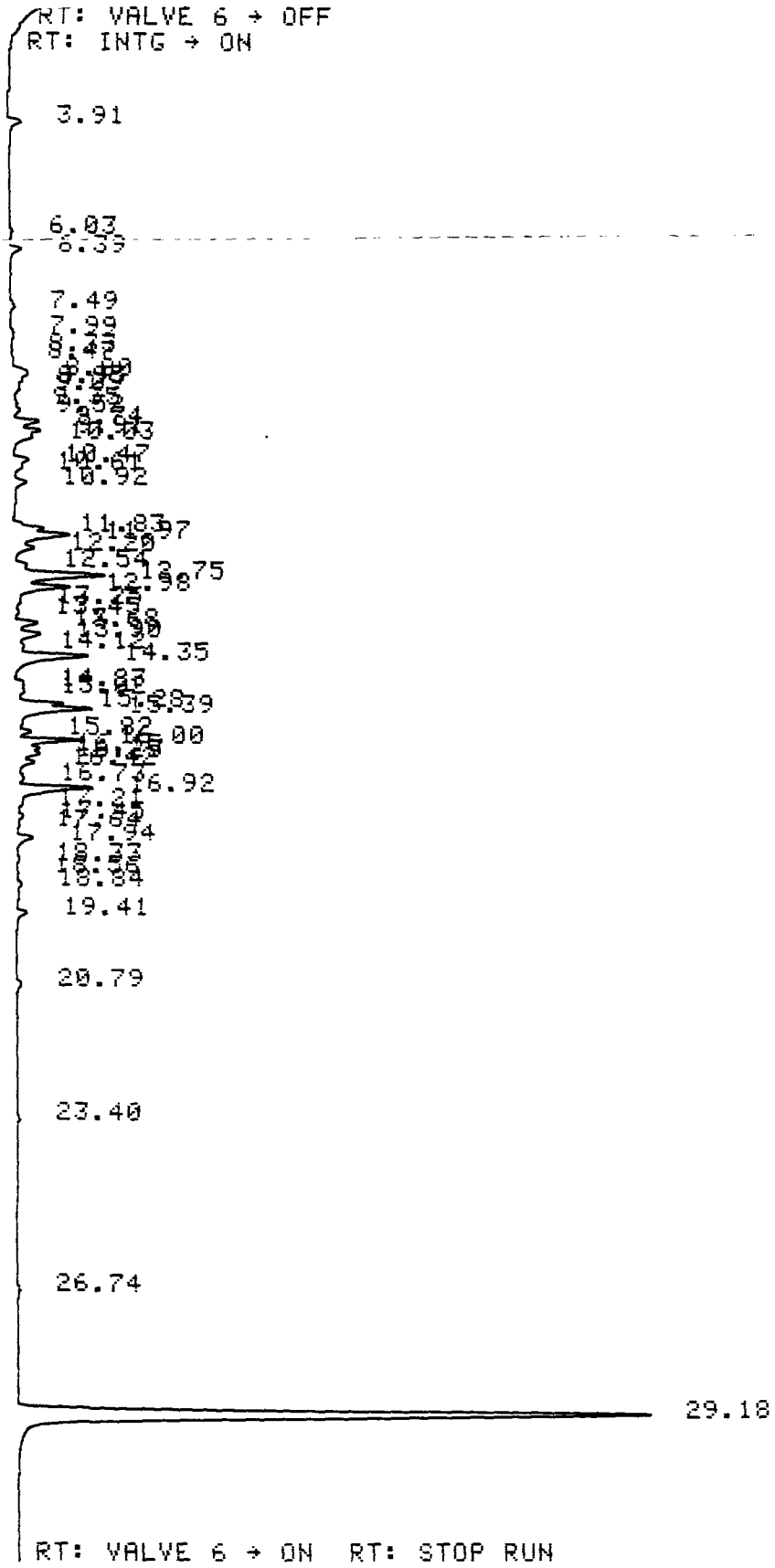
RT: VALVE 6 → ON RT: STOP RUN

hp 5880A SAMPLER INJECTION @ 00:52 MAR 27, 1990
SAMPLE # : ID CODE : 2547-106
13
METHOD ABORTED 250 ml / 1 ml
AREA %

RT	AREA	TYPE	AREA %

-107

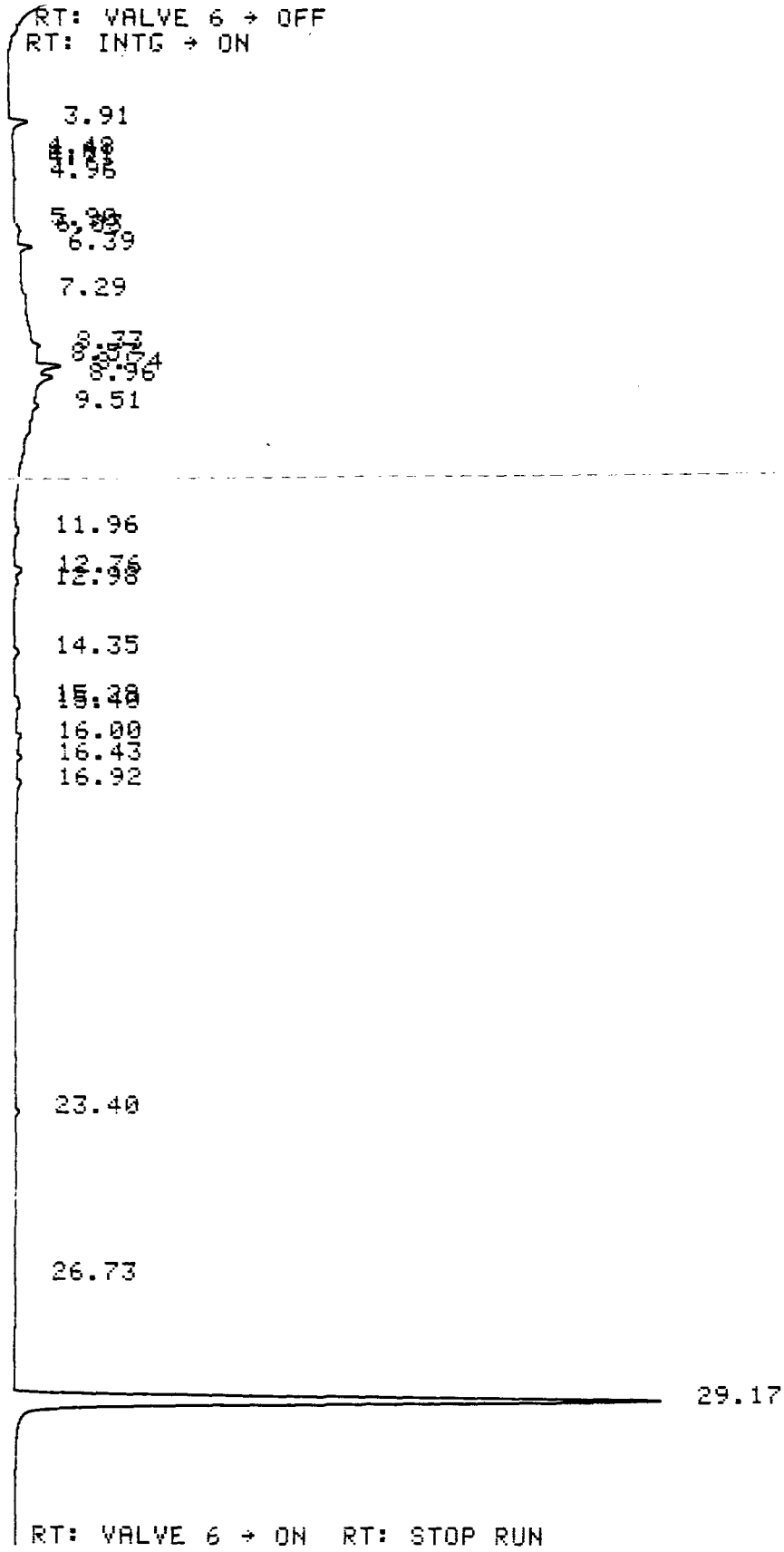
142



[hp] 5880A SAMPLER INJECTION @ 01:35 MAR 27, 1990
SAMPLE # : ID CODE : 2547-107
14
METHOD ABORTED
AREA % 250 ml / 1 ml

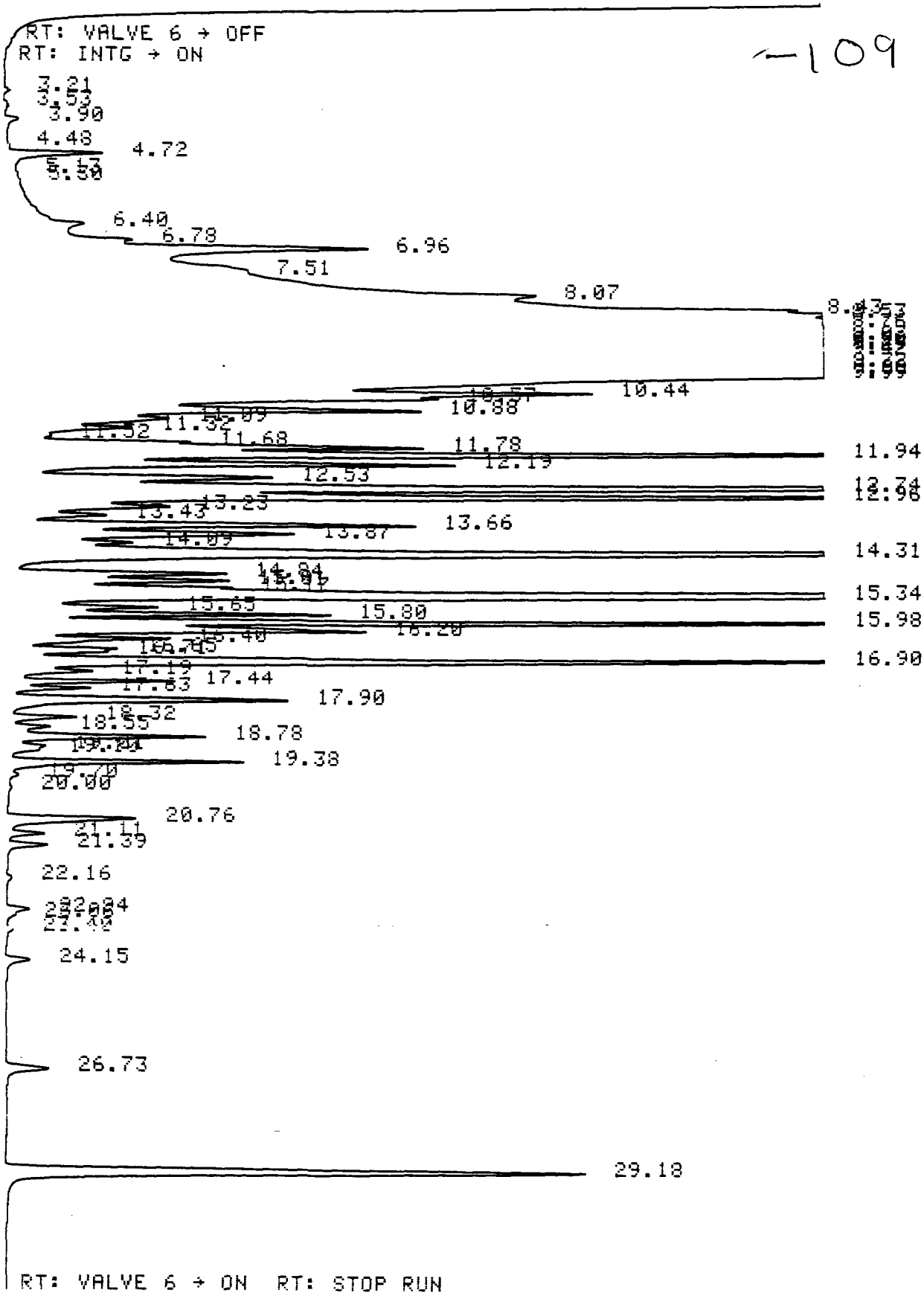
RT	AREA	TYPE	AREA %
3.91	1733.84	BV	0.000
6.03	591.75	VV	0.000
[illegible]	1257.70	VV	0.000

-108



[hp] 5880A SAMPLER INJECTION @ 02:17 MAR 27, 1990
SAMPLE # : 15 ID CODE : 2547-108
METHOD ABORTED 250 ml/1ml
AREA %

RT	AREA	TYPE	AREA %
3.91	2142.52	BV	0.000
4.48	137.81	VV	0.000
4.61	106.25	VV	0.000



[hp] 5880A SAMPLER INJECTION @ 03:42 MAR 27, 1990

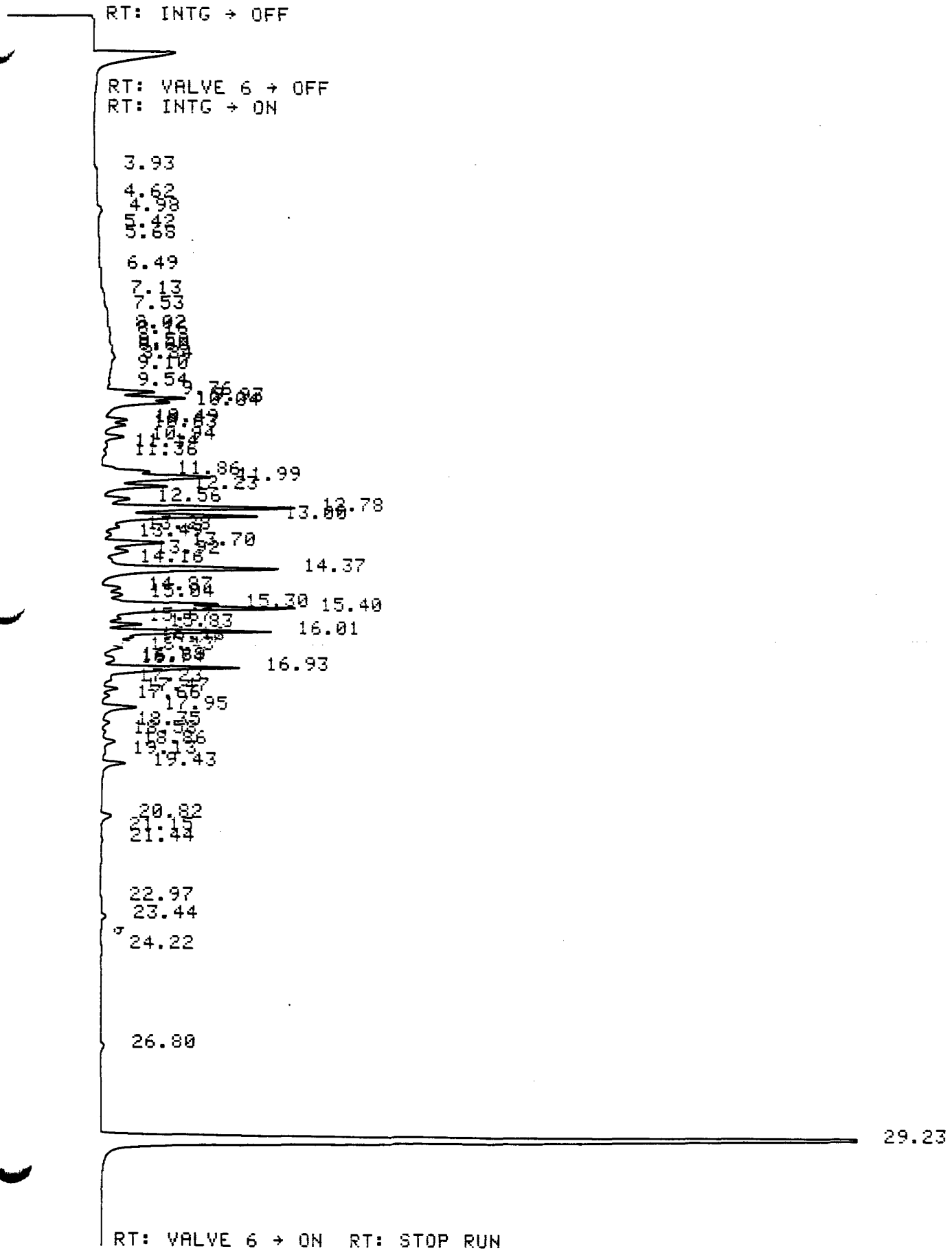
SAMPLE # : 17 ID CODE : 2547-109

METHOD ABORTED

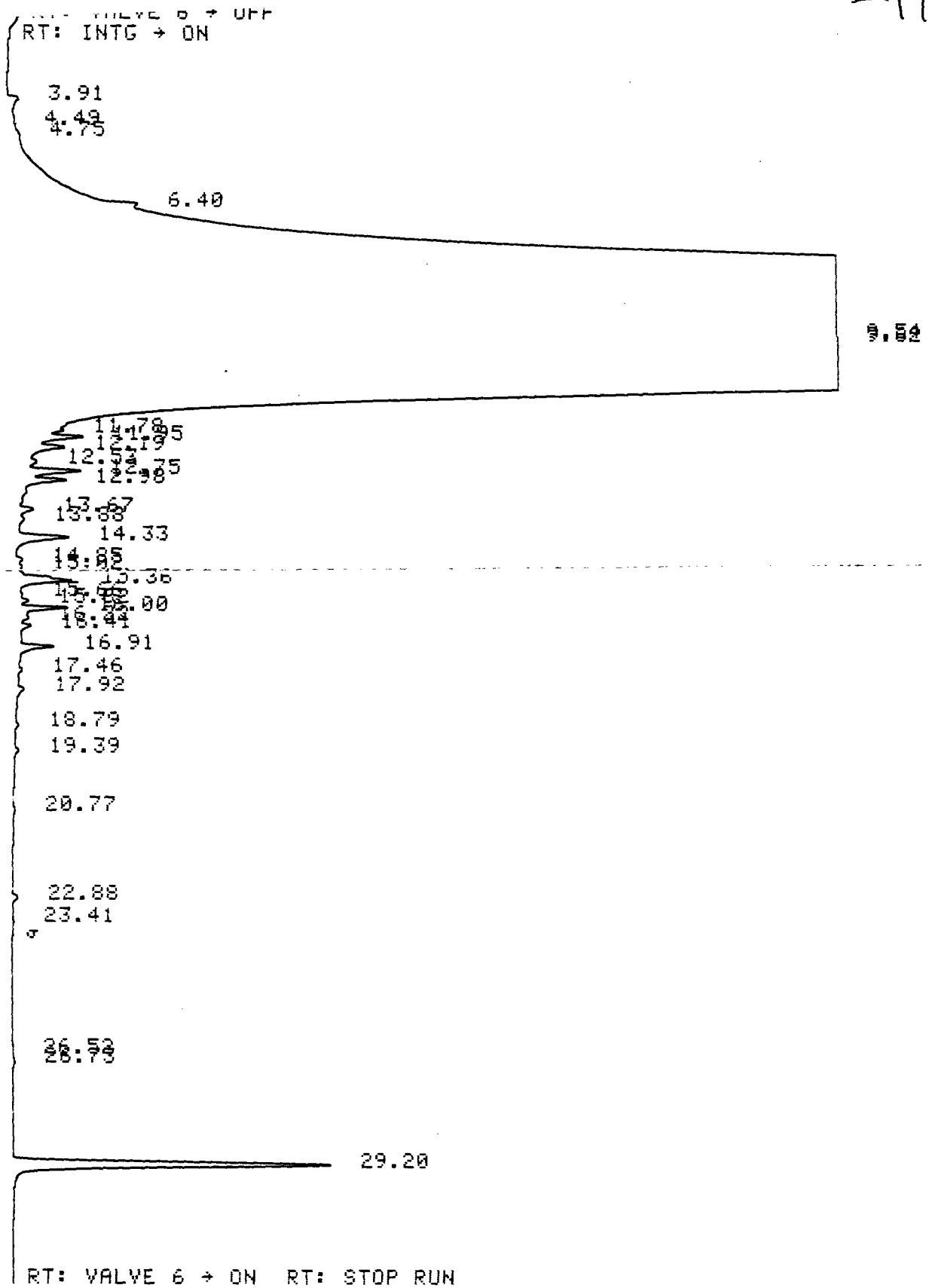
AREA % 250 ml/1ml

RT	AREA	TYPE	AREA %
~~3.21~~	~~729.40~~	~~BP~~	~~0.000~~
3.53	1114.59	PV	0.000

TOTAL AREA = 293622.00
MULTIPLIER = 0



[hp] 5880A SAMPLER INJECTION @ 01:50 MAR 25, 1990
SAMPLE # : ID CODE :



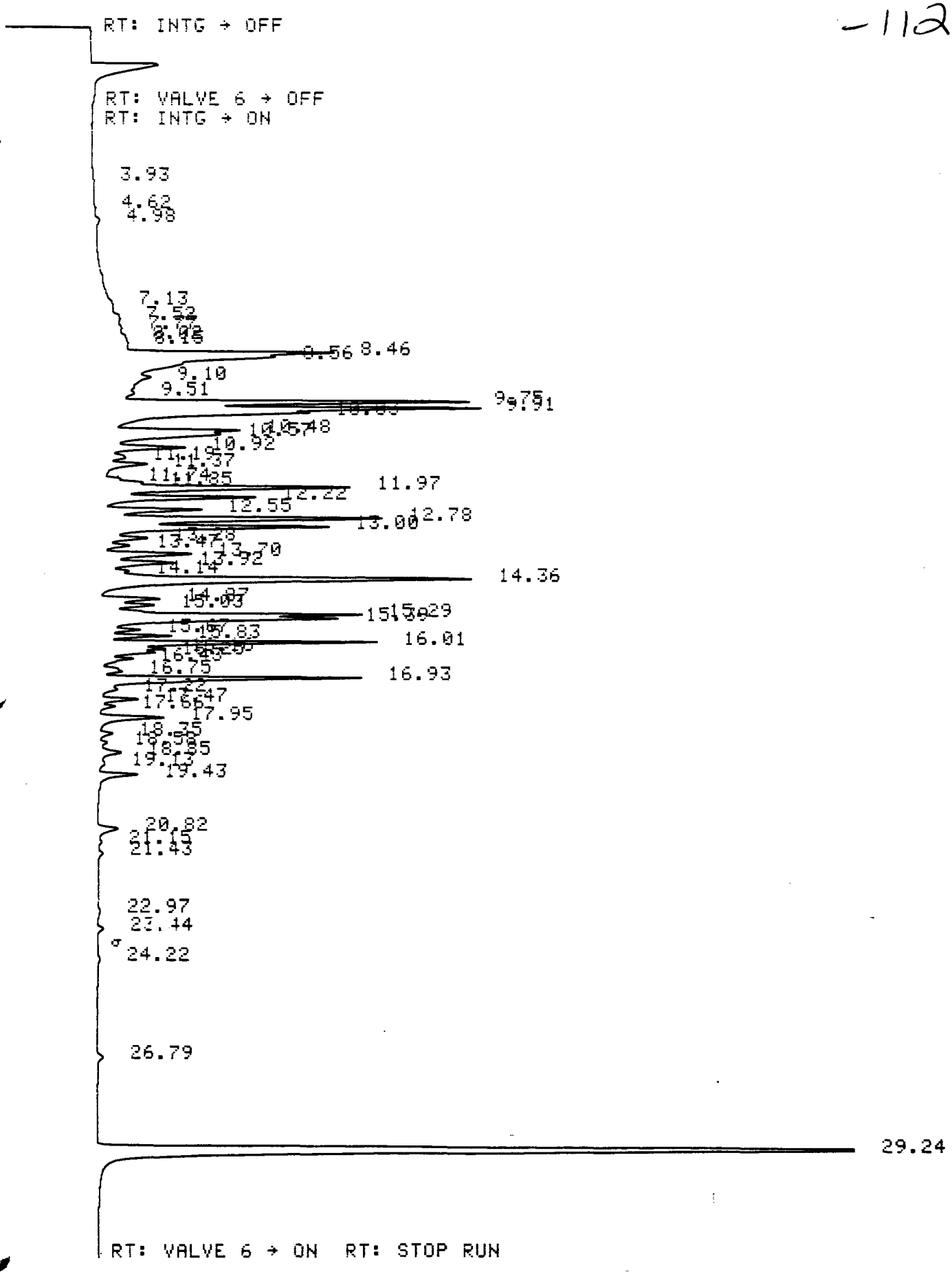
[hp] 5880A SAMPLER INJECTION @ 04:24 MAR 27, 1990
SAMPLE # : 18 ID CODE : 2547-111

METHOD ABORTED 250 ml/1 ml
AREA %

RT	AREA	TYPE	AREA %
3.91	2090.27	BV	0.000
4.49	1886.26	VV	0.000
4.75	3116.04	VV	0.000

MULTIPLIER = 0

-112



[hp] 5880A SAMPLER INJECTION @ 03:57 MAR 25, 1990
SAMPLE # : ID CODE :
30
METHOD ABORTED

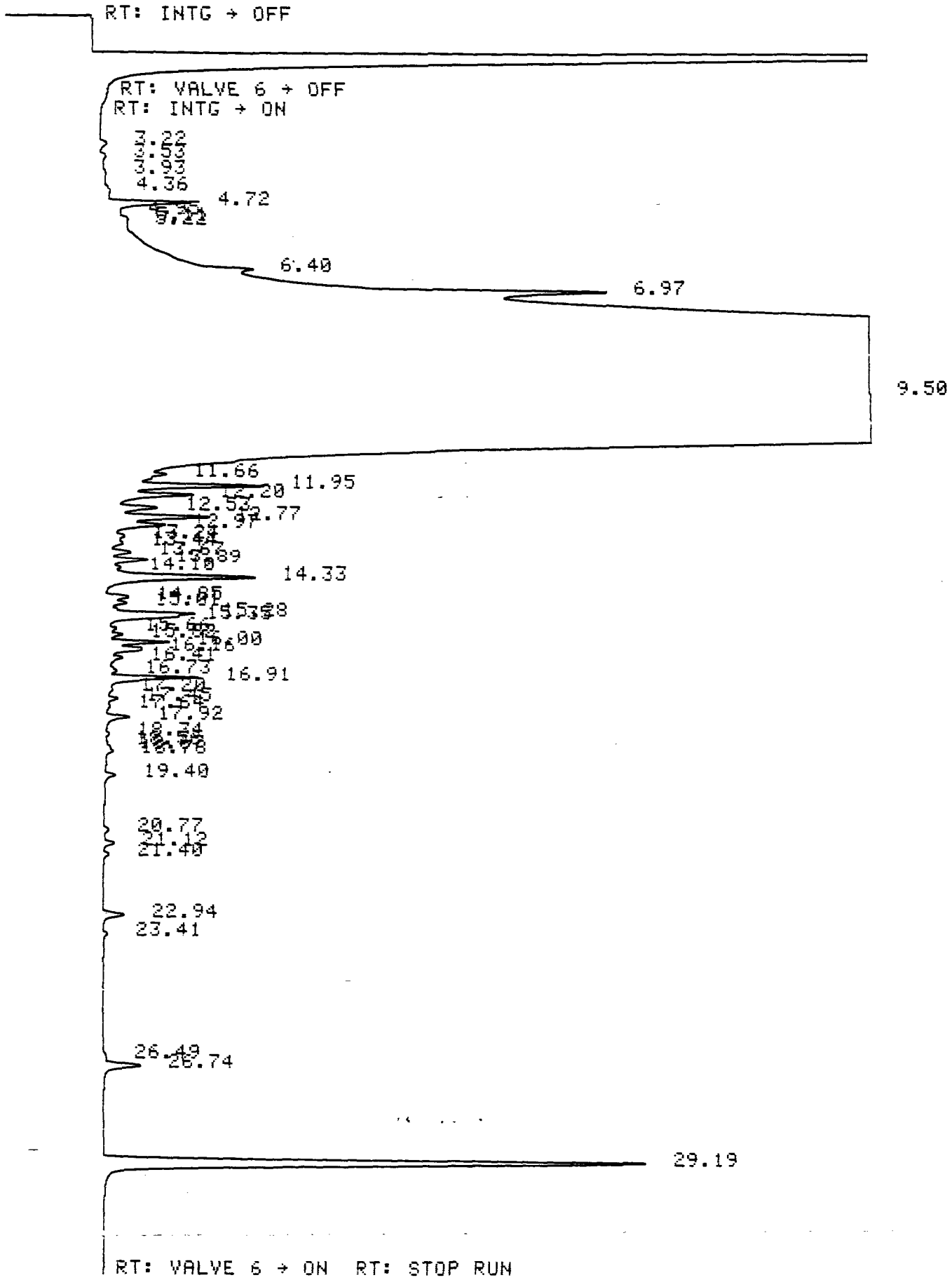
AREA %

METHOD [illegible]

SUPELCO, Bellefonte, PA Cat. No. 2-2887 (hard); Cat. No. 2-2888 (box of 10 pads)

TOTAL AREA = 16408000.00
MULTIPLIER = 0

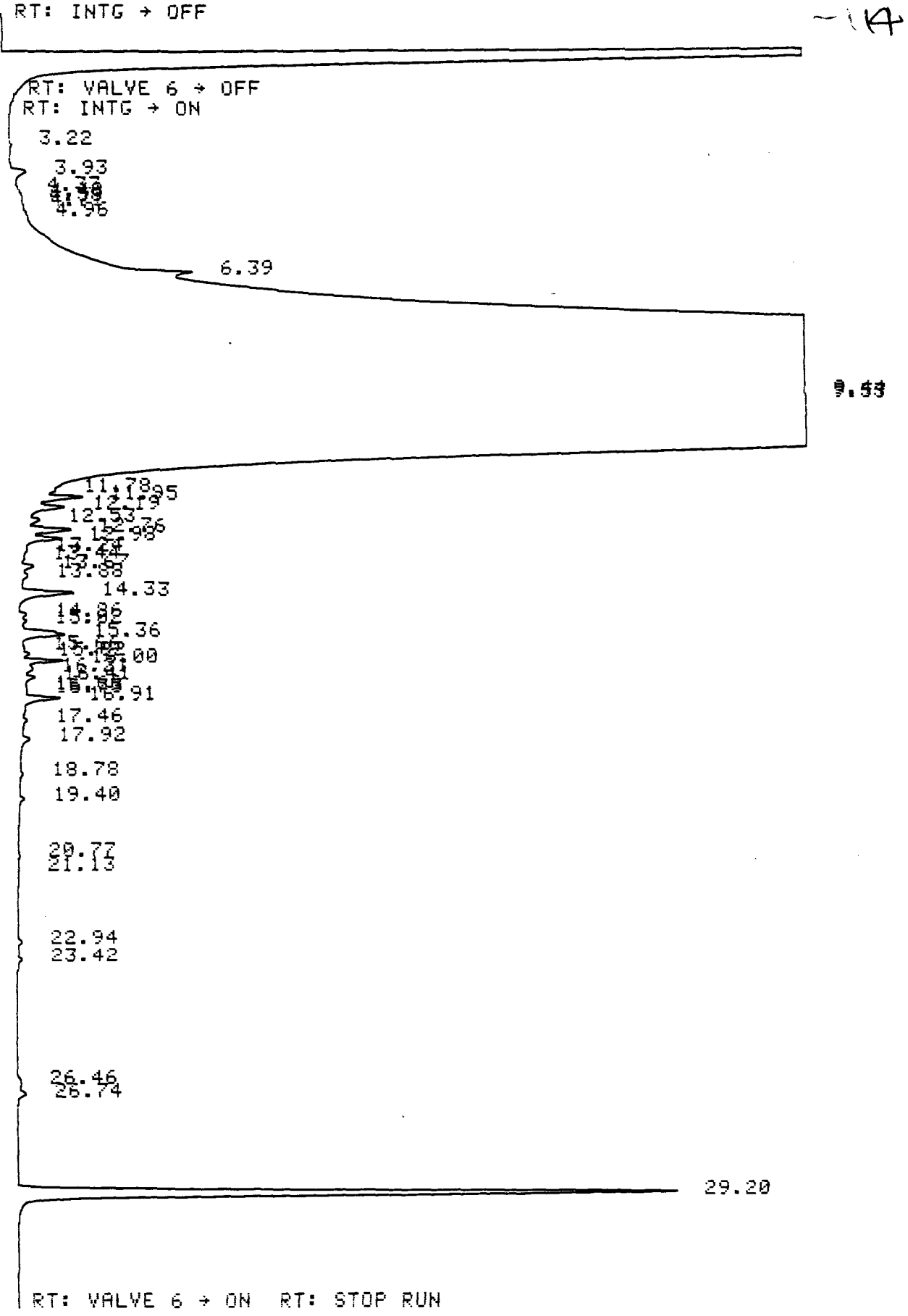
~113



[hp] 5880A SAMPLER INJECTION @ 05:06 MAR 27, 1990
SAMPLE # : 19 ID CODE : 2547-113

METHOD ABORTED

2547/1ml



HP 5880A SAMPLER INJECTION @ 05:49 MAR 27, 1990

SAMPLE # : ID CODE : 2547-114 250 ml/1ml

20

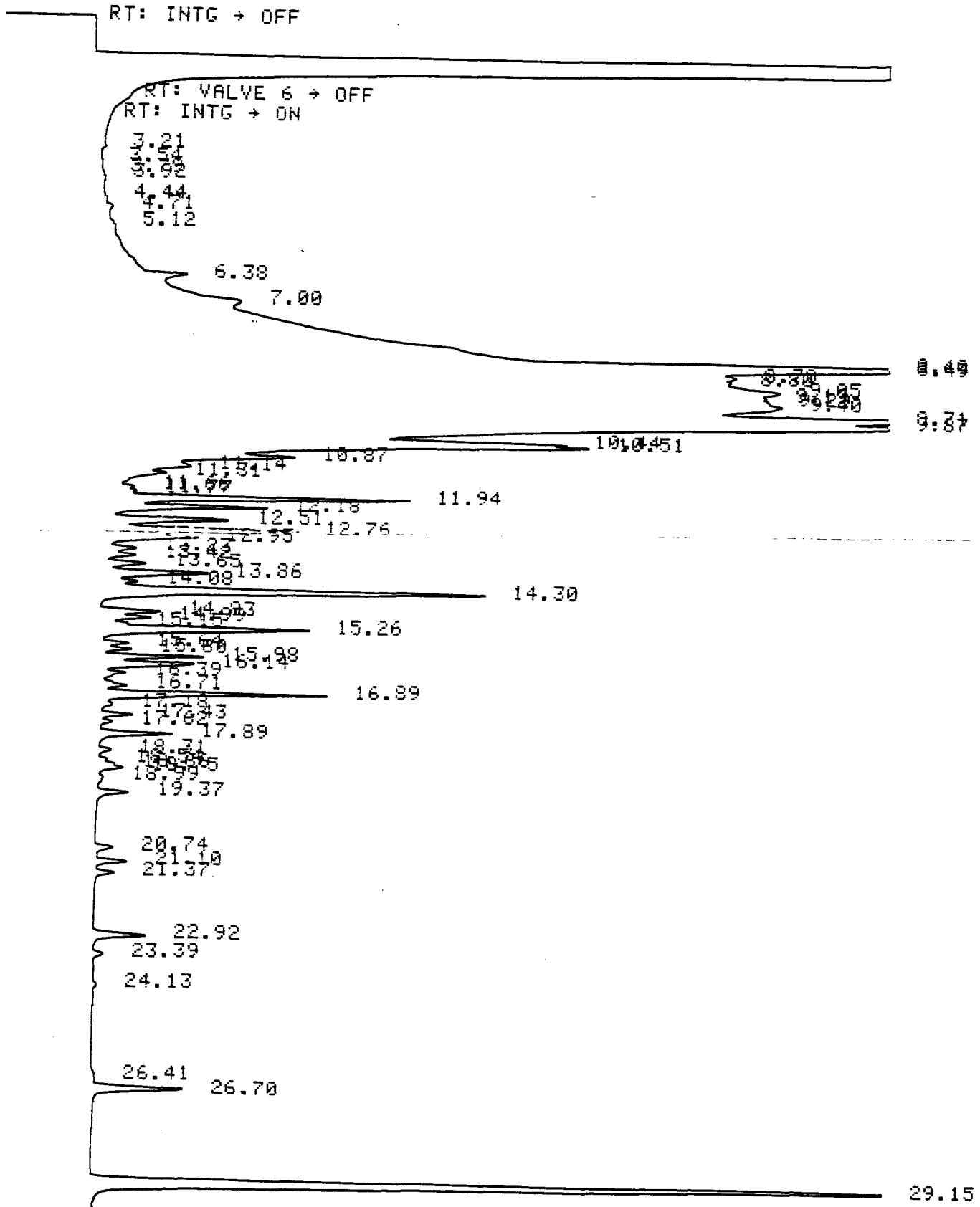
METHOD ABORTED

AREA %

RT	AREA	TYPE	AREA %

TOTAL AREA = 235438.00
MULTIPLIER = 0

-131



[illegible] SAMPLE INJECTION @ 03:23 MAR 28, 1990
SAMPLE [illegible] 2547-131
METHOD ABORTED

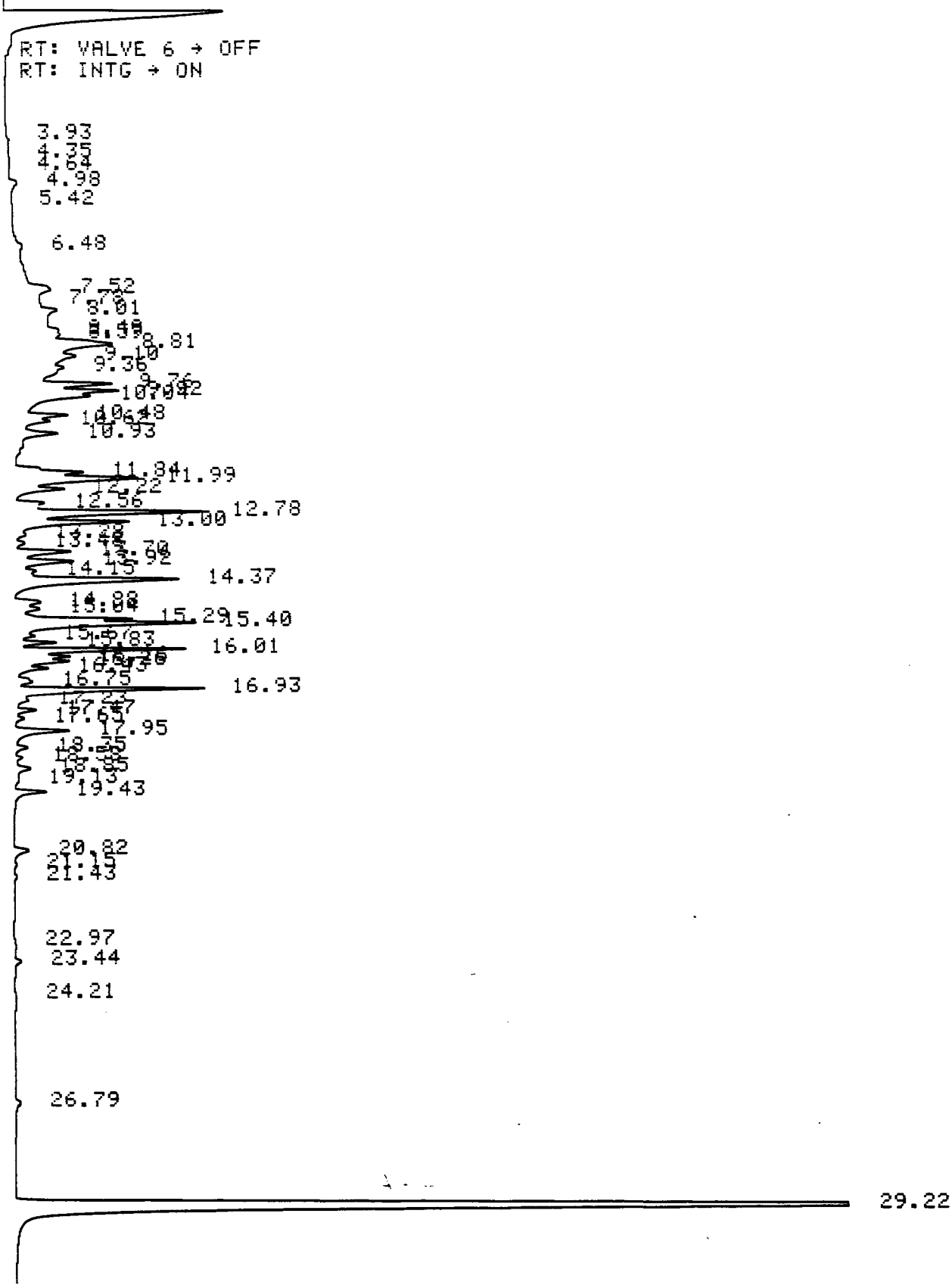
RT	AREA	TYPE	AREA %
22.98	158.74	BB	0.000
23.45	934.11	BP	0.000
26.81	576.11	BB	0.000
29.23	148797.00	BH	0.000

-133

TOTAL AREA = 150465.00
MULTIPLIER = 0

RT: INTG → OFF

RT: VALVE 6 → OFF
RT: INTG → ON

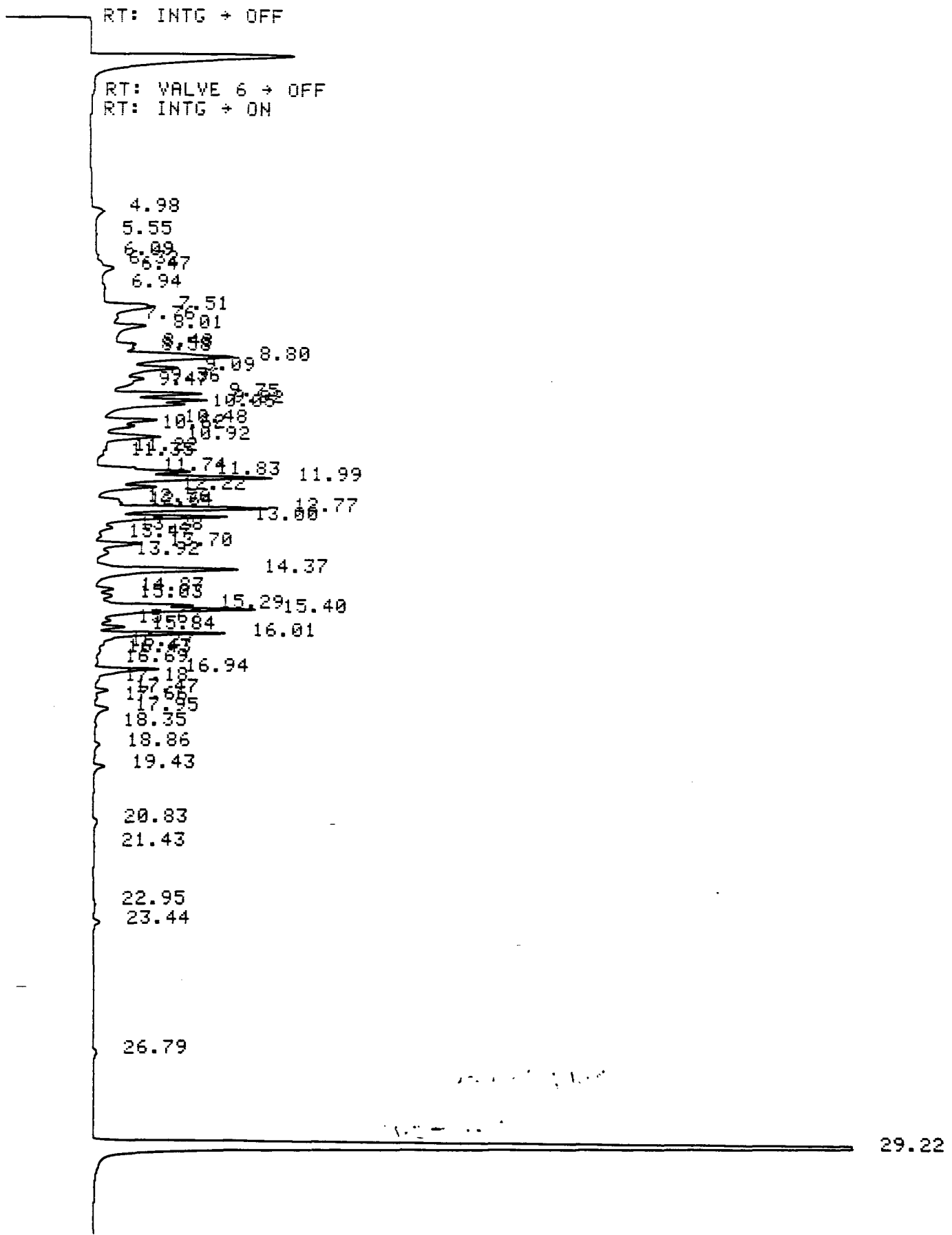


SUPELCO Bellefonte, PA Cat No. 2-2887 (pad); Cat No. 2-2888 (box of 10 pads)

-134

22.97	644.10	VV	0.000
23.44	1388.58	VV	0.000
24.21	649.73	VV	0.000
26.79	1142.01	VV	0.000
29.22	186901.00	PB	0.000

TOTAL AREA = 681959.00
MULTIPLIER = 0

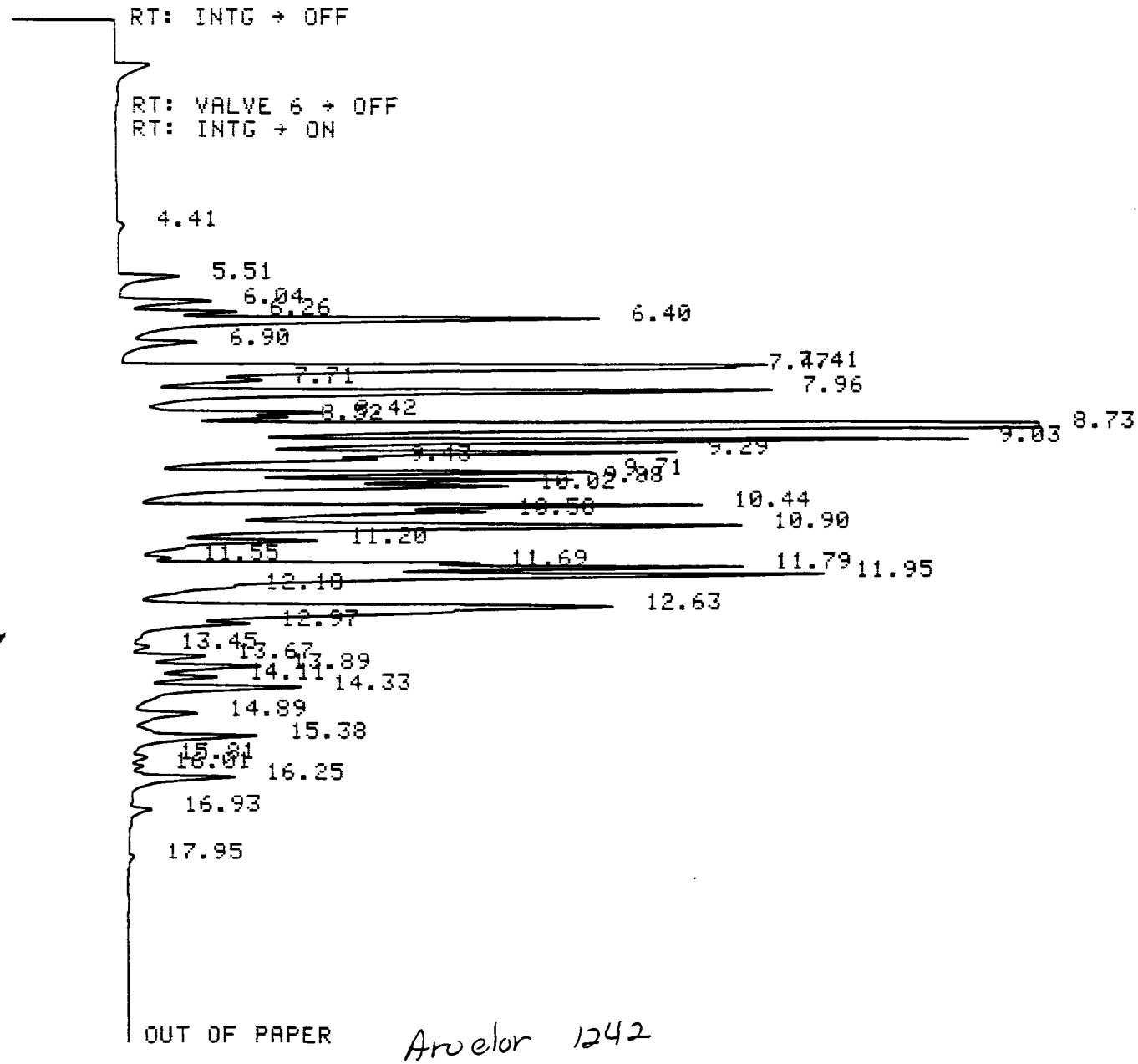


SUPELCO, Bellefonte, PA Cat. No. 2-2887 (pad); Cat. No. 2-2888 (box of 10 pads)

19.39	951.45	VV	0.000
20.77	395.91	BV	0.000
23.40	728.35	BP	0.000
26.73	530.93	BB	0.000
29.17	126330.00	BB	0.000

-135

TOTAL AREA = 240906.00
MULTIPLIER = 0



Aroelor 1242

10 ng/ul

SUPELCO, Bellefonte, PA Cat. No. 2-2887 (pad); Cat. No. 2-2888 (box of 10 pads)

ATTACHMENT F-5

Expert affidavits on the effect of
Hurricane Carol on transport and circulation

SERVICE DATE: 9/25/90 MOTION NO.: LU-16
SIGNATURE OF OPPOSITION DATE: 10/9/90
COUNSEL: Mary Ryan DELIVERED TO COURT: _____
NO OPPOSITION: _____ SUPPLEMENTAL DATA: _____

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

MOTION NUMBER LU-16

LUMBERMENS MUTUAL CASUALTY COMPANY,	CIVIL ACTION NO. 84-2043-Y
Plaintiff,	(New Bedford Harbor Cases) (Consolidated Civil Action No. 83-3882-Y)
v.	
AVX CORPORATION,	(BBO #268440) (BBO #435860) (BBO #549958)
Defendant.	

APPENDIX OF EXHIBITS TO
AVX'S STATEMENT OF MATERIAL FACTS IN
OPPOSITION TO MOTION OF LUMBERMENS MUTUAL CASUALTY COMPANY FOR
PARTIAL SUMMARY JUDGMENT REGARDING THE POLLUTION EXCLUSION

VOLUME III OF III

Respectfully submitted,

AVX CORPORATION

By its attorneys,

Mary K. Ryan

Brian T. Kenner
Mary K. Ryan
Henry J. King, Jr.
NUTTER, McCLENNEN & FISH
One International Place
Boston, Massachusetts 02110-2699
(617) 439-2000

Dated: October 9, 1990

EXHIBITS

Table of Contents

TAB	
A.	Charles Bariteau
B.	William Kameron's Diary
C.	Myron Owen's "Hurricane" Book
D.	Pereria, Richard
E.	Employee Statements
F.	U.S. Army Corp of Engineers Map
G.	Goddu, Norman
H.	George, Frederick
I.	Muscarella, Joseph
J.	Devlin, Robert
K.	Redfearn, John
L.	Monteiro, Adolph
M.	Alfredo, Richard
N.	Pequita, Ernest
O.	Fuller, Donald
P.	Gelinas, Edmund
Q.	Goddu, Kenneth
R.	Hutzler, John
S.	Souza, Arnold
T.	Warwick, William
U.	Bosworth, Robert Louis
V.	Okren, Robert

EXHIBITS

Table of Contents - Continued

TAB	
W.	Hallet, Carl
X.	Clark, Ulrick
Y.	Hickey, Edmund V.
Z.	Kramer, Paul
AA.	Perry, Paul
BB.	Anthony, Adam
CC.	Almeida, Evelyn
DD.	Oliver, Ernest
EE.	Babineau, Albert
FF.	Malita, Borsilaw
GG.	Niles, Irving
HH.	Cornell, Charles
II.	Kalstein, Abe
JJ.	Bosworth, Weldon S. (Affidavit)
KK.	Sarapas, Leonard C. (Affidavit)
LL.	Bohlen, Walter F. (Affidavit)
MM.	Thibodeaux, Louis J. (Affidavit)
BV.	Belleville's Statement Of Material Facts In Opposition To LU-15

MOTION NO: LU-16

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

LUMBERMENS MUTUAL CASUALTY COMPANY, Plaintiff, v. AVX CORPORATION, Defendant.	CIVIL ACTION NO. 84-2043-Y (New Bedford Harbor Cases) (Consolidated Civil Action No.83-3882-Y)

AFFIDAVIT OF WELDON S. BOSWORTH, Ph.D.

I, Weldon S. Bosworth, do hereby depose and state as follows:

1. I am a marine ecologist with a Ph.D. in zoology from Oregon State University. I am presently President of Balsam Environmental Consultants, Inc. of Salem, New Hampshire ("Balsam"). I have over twenty years of experience and training in the design, implementation and evaluation of studies dealing with environmental impact in the marine and estuarine environment. A true and accurate copy of my resume is attached as Exhibit 1.

2. I am familiar with the New Bedford Harbor Superfund Site as a result of independent evaluation of a number of environmental issues related to the site. These include evaluation of environmental impacts of various remedial alternatives (both those developed by EPA and by Balsam) and the fate and transport of PCBs in the estuarine and marine environment of New Bedford Harbor. I have also evaluated the potential effects of PCBs in marine and estuarine organisms, including the potential for bioaccumulation and bioconcentration of PCBs and potential for toxic effects.

3. In connection with preparation of this affidavit, I have reviewed the affidavits submitted by Dr. Louis J. Thibodeaux, Dr. Walter F. Bohlen, and Mr. Leonard C. Sarapas, as well as the following evidentiary materials: the diary of William Kameron, plant foreman for the Aerovox Corporation in 1954; the book published by Aerovox Corporation concerning Hurricane Carol; the deposition testimony of Normal Goddu and Charles Bariteau; and the Statement of Undisputed Material Facts in Support of Plaintiff Lumbermens Mutual Casualty Company's Motion for Partial Summary Judgment Regarding the Pollution Exclusion.

4. I was retained as a consultant for AVX Corporation in connection with litigation instituted by the United States of America and the Commonwealth of Massachusetts entitled United States, et al v. AVX Corporation, et al. in 1984. As a result

of my work for AVX, I am familiar with the expert theories and contentions presented by the government plaintiffs in that litigation.

5. Government allegations of natural resource injury in New Bedford include assertions that PCBs are present in New Bedford Harbor at levels in excess of the following regulatory criteria: FDA tolerances for PCBs in marine species; ambient water criteria for PCBs in the marine environment; and regulations concerning disposal of dredge spoils. In addition to the impacts claimed from these exceedences on both marine life and human use of the harbor, the governments have also alleged natural resource injury to tern populations in the area of New Bedford Harbor and Buzzards Bay.

6. The government lawsuit also sought recovery of costs incurred to date in studying PCB contamination in New Bedford Harbor, estimated at approximately $30 million, and cleanup costs it is anticipated will be incurred in the future. In particular, the United States Environmental Protection Agency ("EPA") has already decided upon site remediation which calls for dredging approximately 10,000 cubic yards of PCB-contaminated sediment above a 4000 ppm action level from within a so-called "hot spot" and then treating, incinerating and storing the residue. The estimated cost for this remedial action is approximately $15 million. (Hot Spot Record of Decision, April 1990.) In addition to the action plan set forth in its Hot Spot Record of Decision, EPA is studying plans

to remediate other sediments in the estuary and harbor where concentrations of PCBs exceed either 10 or 50 ppm as a target concentration level. Estimates of the cost of such response actions range from $7 million to $646 million as reprinted in the government's Draft Final Feasibility Study of Remedial Alternatives for the Estuary and Lower Harbor/Bay, August 1990.

7. The upper reach of New Bedford Harbor is referred to as the Upper Acushnet River Estuary or Upper Estuary. PCBs have been deposited in the estuarine sediments throughout New Bedford Harbor and the Upper Estuary. Both numerous EPA studies and a study performed by Dr. Thibodeaux report that PCBs in these sediments can be transported by several physical, chemical and biological processes from the sediment of the harbor and Upper Estuary into the overlying water, and thereby are dispersed throughout other areas of the Upper Estuary and harbor, either in solubilized form or adsorbed to fine particles of matter.

8. PCBs transported by these overlying waters are lipophilic (meaning they exhibit a tendency to adsorb to fat) and, therefore, tend to accumulate in the fatty tissue of marine organisms. As a result, marine organisms exposed to solubilized and particle-borne PCBs or to PCBs in the sediment may accumulate PCBs to levels that typically equal or exceed concentrations found in their environment. The phenomenom of accumulating PCB concentrations to levels higher than the ambient environment of the organism is known as bioconcentration.

9. Dr. David Hansen, a government expert in the Superfund litigation, has reported that organisms exposed to PCBs in the environment can bioconcentrate to levels up to 100,000 to 1,000,000 times that of their ambient environment, i.e., that marine organisms in an environment of only 10 parts per trillion of PCB found in the water column may bioconcentrate PCB in their bodies to a level of 1 to 10 parts per million.

10. Given this bioaccumulation phenomenom, it is clear that marine organisms in New Bedford Harbor can potentially bioaccumulate PCBs in their body tissues to levels that exceed the Federal Drug Administration (FDA) temporary tolerance limit of 2 parts per million -- the level above which fish and shellfish cannot lawfully be sold in interstate commerce because they are presumed unsafe to eat.

11. Government samples taken in New Bedford Harbor have reported levels in many organisms that exceed 2 parts per million. Bioaccumulation has also been reported by the government or its contractors in various terrestrial or avian species which participate in the marine food chain (e.g., terns, ducks, geese, rodents and terrestrial carnivores). As a result of the evidence developed at the New Bedford Harbor Superfund Site, large areas of the harbor have been closed since 1979 to commercial and recreational fishing for species believed likely to contain PCB body burdens greater than 2 ppm. It is my opinion that bioaccumulation processes have

occurred in New Bedford Harbor in the past as well. The releases from the 1954 hurricane, as described by Drs. Thibodeaux and Bohlen, would have resulted in substantial bioaccumulation of PCBs released by the hurricane from that point forward.

12. PCB present in the sediment and waters of the estuary result in concentrations that exceed several federal and state water quality criteria, e.g., the criteria for acute and chronic exposure of marine organisms to PCB in the marine environment, as well as the water quality criterion for human ingestion of contaminated water or contaminated aquatic organisms. These criteria have been asserted by the government to be applicable to the waters of New Bedford Harbor.

13. Published EPA studies addressing ecological risk indicate concerns that PCB concentrations in all areas of the Upper Estuary are sufficiently elevated to result in a significant likelihood of chronic effects to indigenous biota. (Ebasco, Draft Final Baseline Ecological Risk Assessment, New Bedford Harbor Site Feasibility Study, April 1990.) In fact, EPA contends that the PCB concentration in the harbor sediments and porewater is highly toxic to at least some members of all major taxonomic groups living in or ingesting sediment and that in all probability such sediment PCB levels are toxic to marine fish. EPA further contends that collected data indicate that PCBs have accumulated in the reproductive organs of some species to levels demonstrated to have caused harm to reproduction.

14. The government has also alleged that the presence of PCBs in sediments at concentrations reported by EPA to be greater than or equal to 1 ppm and greater than or equal to 50 ppm will result in additional restrictions and conditions being imposed on dredging activities under federal and state regulations.

15. The government also alleges that the presence of PCBs in the New Bedford Harbor environment at levels in excess of regulatory criteria have led to lost use by humans of the lobster fishery, and of losses to recreational fishing, to beach use, and to general environmental amenities of New Bedford Harbor, from at least December 1980.

16. Assuming PCBs entered the estuarine environment during Hurricane Carol in 1954 in the quantities and in the manner described in the Affidavits of Louis J. Thibodeaux and Walter F. Bohlen, such PCBs have been transported throughout the estuary and deposited at the time of the hurricane and thereafter, in estuarine and harbor sediments. (PCBs released as a result of Hurricane Carol, and the emergency response thereto, are referred to herein as "Hurricane PCBs.") Over time, Hurricane PCBs initially deposited in estuarine sediments have been acted upon by physical, chemical, and biological processes leading to wide dispersal and continued releases into the marine environment. Through these processes substantial Hurricane PCBs likely have continued to be made available to

and bioaccumulated by marine and estuarine organisms, leading to conditions which the government contends may be chronically toxic to these organisms.

17. Since marine organisms process PCBs without regard to their origin, Hurricane PCBs deposited into the sediments in 1954 and released each and every year thereafter (including from 1973 through the present) contribute substantially to the body burden of organisms resulting from the molecules of PCBs bioaccumulated by such organisms and, in turn, contribute to the any potential injuries alleged by the government. Thus, organisms of any species recruited to the New Bedford Harbor estuary and surrounding waters at any time between 1954 and the present (including from 1973) would have been exposed to, and would have bioaccumulated, PCB molecules that either were in the sediment or released from the sediment to overlying estuary waters, including Hurricane PCBs. Hurricane PCBs bioaccumulated in the bodies of these marine species are indistinguishable from PCB from any other potential source.

18. Many organisms, e.g., lobster, shellfish, and fish with life expectancies of 5 to 20 years and living in 1980 (and thus the subject of the governments' natural resources claims), were likely exposed to and bioaccummulated substantial quantities of Hurricane PCBs released from the sediment into the water column during years from 1973 through the present.

19. In sum, based on the information presented in the Affidavits of Drs. Thibodeaux and Bohlen, it is my opinion that Hurricane PCBs, since their initial release in 1954 and continuing until today have substantially contributed to the presence of PCBs in New Bedford Harbor sediments and surface water, and consequently also to the PCB body burdens of endemic marine organisms which allegedly exceed various state and federal criteria.

20. Likewise, PCBs in the sediments of New Bedford Harbor at any level above 1 part per million that lead to special conditions for handling of the dredge spoils likely contain substantial Hurricane PCBs.

21. Government claims for natural resource damages which are premised on adverse public reaction to the reported presence of PCBs in New Bedford Harbor biota, sediments or water that purportedly diminished the human use value of the Harbor are likewise based in part on the impact of Hurricane PCBs on the system today.

Signed under the penalties of perjury this 9th day of October, 1990.

Weldon S. Bosworth

3273e

RESUME

WELDON S. BOSWORTH, PH.D.
President/Principal
Senior Consultant - Environmental Impact Analysis

EDUCATION:

Ph.D., Oregon State University, 1976. Marine Ecology
M.S., University of New Hampshire, 1969. Zoology
B.A., University of New Hampshire, 1964. Zoology
MBA Studies, Rivier College (30% Completed)

PROFESSIONAL HISTORY:

1985-Present	Balsam Environmental Consultants, Inc., President
1981-1985	Normandeau Associates, Inc., President
1979-1981	Normandeau Associates, Inc., Executive Vice President
1976-1979	Normandeau Associates, Inc., Vice President, Operations
1972-1976	Normandeau Associates, Inc., Project Manager
1969-1972	Oregon State University, Teaching Assistant
1967-1969	University of New Hampshire, Research Assistant
1964-1967	U. S. Army, Commissioned Officer

REPRESENTATIVE EXPERIENCE:

Dr. Bosworth has twenty years of consulting experience specifically related to evaluating the environmental impact of siting and operation of major facilities. He has also directed studies of contaminant fate and effects in marine and aquatic environments. He has negotiated work scopes of environmental studies with state and federal regulatory agencies and provided expert testimony on environmental impact at over a dozen regulatory hearings at state and federal levels. As an expert in environmental management, Dr. Bosworth has contributed to numerous national publications and has been a presenter at regional and national conferences.

NEW BEDFORD HARBOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY AND REMEDIATION DESIGN; 1986-Present; Principal Scientist. Performed independent evaluation of feasibility study performed by the U. S. Environmental Protection Agency on behalf of AVX Corporation and completed independent assessments of environmental and transport issues related to natural resource damage and remediation of New Bedford Harbor. Also developed recommendations to address potential adverse impacts of PCB and heavy metal contamination in the harbor.

NEW HAMPSHIRE PORT AUTHORITY EXPANDED FACILITIES; 1989-Present; Project Manager. Evaluated environmental impact of various project alternatives on marine and wetland communities in the Piscataqua River.

ASBESTOS MANAGEMENT PROGRAM, STATE OF MAINE, DIVISION OF SAFETY AND ENVIRONMENTAL SERVICES; 1986-Present; Officer-In-Charge. Coordinated project teams which provided various services including survey of and remediation design for asbestos in state facilities and public schools in the State of Maine. Developed computerized database management system for real time management and archiving of asbestos survey and abatement information on all facilities.

SEABROOK (NH) ENVIRONMENTAL STUDIES; 1971-1980; Project Manager. Managed large multi-year, multi-discipline baseline study in coastal waters of New Hampshire for proposed nuclear generating station. Designed, developed and evaluated sampling program for all biological communities including benthic, fisheries and planktonic; collaborated on design of physical oceanographic studies. Supervised installation and maintenance of over 40 in-situ instruments in nearshore ocean environment. Negotiated work scope with state and federal regulatory agencies; provided expert testimony on environmental impact at over a dozen regulatory hearings at the state and federal levels.

LAKE ONTARIO SHORELINE PROTECTION STUDY FOR THE U. S. ARMY CORPS OF ENGINEERS; 1980-1981; Project Manager. Evaluated impacts of water level changes on shoreline and shoreline structures.

NEW ENGLAND DIVISION, U. S. ARMY CORPS OF ENGINEERS, BASIC ORDERING AGREEMENT; 1978-1980; Officer-In-Charge. Coordinated logistics, provided financial management and report review for several projects at various New England harbors to provide information on the impacts of dredging and spoil disposal.

CONTINENTAL OFF-SHORE STRATIGRAPHIC TEST (COST) WELL SITE SURVEYS; GEORGES BANK, BALTIMORE CANYON, GEORGIA EMBAYMENT; 1975-1977; Officer-In-Charge. Coordinated logistics, provided financial management and report review for physical and biological studies of OCS test site prior to leasing of offshore areas for exploratory drilling.

BIG RIVER RESERVOIR ENVIRONMENTAL STUDIES. U. S. ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION; 1978-1980; Officer-In-Charge. Reviewed and edited technical report for impact assessment of a proposed water supply reservoir. Studies included fisheries, wildlife and wetland communities. A wildlife habitat mitigation plan was developed to increase carrying capacity in unaffected areas.

PORTSMOUTH NAVAL SHIPYARD DREDGING EIS FOR U. S. NAVY, NORTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND; Officer-In-Charge. Subcontracted through Parsons Brinckerhoff, 1976-1978. Helped coordinate logistics, reviewed work plan and reviewed and edited technical reports for development of a candidate EIS for a proposed dredging program at the Portsmouth Naval Shipyard in Kittery, Maine. The study involved dredging impacts as well as evaluation and selection of both offshore and upland spoil disposal sites.

WEST BRANCH PENOBSCOT RIVER HYDROELECTRIC DEVELOPMENT FOR GREAT NORTHERN PAPER COMPANY, 1981-1983; Officer-In-Charge. Collaborated in developing work scope, and reviewed and approved study plans and technical reports for studies of water quality, benthos, and aquatic and terrestrial habitats for FERC Exhibit E for proposed "Big A" hydroelectric facility. Particular attention was focused on using Habitat Evaluation Procedures (HEP) for developing mitigation plans.

HUDSON RIVER BATHYMETRIC AND SEDIMENT SAMPLING FOR PCB SURVEY, NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION, 1976-1977; Officer-In-Charge. Coordinated logistics, provided financial management and review of deliverables for a study which involved aerial photography, photogrammetric mapping, collection of 700 grab and 200 core samples, and analyses of grab samples for grain size and volatile organics.

EPA 301h WAIVER APPLICATION, PEAKS ISLAND, ME; 1979, Officer-In-Charge. Developed sampling plan, coordinated logistics and reviewed technical results for EPA 301h waiver application. Study involved physical oceanographic, marine biological and water quality analysis.

EXPERT TESTIMONY:

Testified before U. S. House of Representatives Subcommittee on Investigations and Review regarding the Federal Water Pollution Control Act (PL 92-500). April 1977.

Lead expert witness on environmental impacts of Seabrook Station at over a dozen State and Federal (U. S. EPA 316(a) and (b)) and NRC Atomic Safety and Licensing Board regulatory hearings.

SPECIAL TRAINING:

Strategic Management Seminars. SRI International. 1981-1982.

Certified SCUBA Diver since 1959. Designed, managed and participated in several scientific diving studies on both the eastern and western U. S. coasts.

OTHER PROFESSIONAL ACTIVITIES:

Member, Marine Studies Curriculum Advisory Committee, Southern Maine Vocational Technical Institute, 1979-1983.

Invited member to NOAA North and Mid-Atlantic Region Conference on Marine Pollution Studies, 1980.

Executive Board Member, New England Estuarine Research Society, 1976-1980.

Participated in OCEANLAB (undersea laboratory) workshop sponsored by New England Marine Advisory Service, 1976.

PUBLICATIONS AND PRESENTATIONS:

Bosworth, W. S. and L. J. Thibodeaux, 1989. Bioturbation: A Facilitator of Contaminant Transport in Bed Sediments. Presented to American Society of Chemical Engineers, Session No. 120, Annual Meeting.

Grabe, S. A., J. W. Shipman, and W. S. Bosworth, 1983. New Hampshire Lobster Larvae Studies. IN: Michael J. Fogarty (Ed), Distribution and Relative Abundance of American Lobster, Homarus americanus, larvae: New England Investiagtions during 1974-1979, p.63-64. NOAA Tech Rep. NMFS SSRF-775.

Bosworth, W. S., J. Germano, D. J. Hartzband, A. J. McCusker and D. C. Rhoads, 1980. Use of Benthic Sediment Profile Photography in Dredging Impact Analysis and Monitoring. IN: Proceedings of the Ninth World Dredging Conference (WODCON IX), 29-31 October 1980, Vancouver, B.C., Canada.

Mattice, J. S. and W. S. Bosworth, 1979. A Modified Venturi Suction Sampler for Collecting Corbicula. Progressive Fish Culturist 41(3):121-123.

Bosworth, W. S., 1976. The Biology of the Genus Eohaustorius (Amphipoda: Haustoridae) on the Oregon Coast. Ph.D. Dissertation. Oregon State University. 200 pp.

Bosworth, W. S., 1973. Three New Species of Eohaustorius (Amphipoda: Gammaridea) from the Oregon Coast. Crustaceana 25(7):253-260.

Authored and/or contributed to over fifty technical reports on various aspects of marine and aquatic communities.

MOTION NO: LU-16

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

LUMBERMENS MUTUAL CASUALTY COMPANY, Plaintiff, v. AVX CORPORATION, Defendant.	CIVIL ACTION NO. 84-2043-Y (New Bedford Harbor Cases) (Consolidated Civil Action No. 83-3882-Y)

AFFIDAVIT OF LEONARD C. SARAPAS

I, Leonard C. Sarapas, do hereby depose and state as follows:

1. I am employed as Vice President, Engineering by Balsam Environmental Consultants, Inc. ("Balsam"). I obtained a B.S. in civil engineering from the University of Kansas in 1976 and an M.S. in environmental/civil engineering from the University of Kansas in 1982. I have been a licensed professional engineer since 1983 and am registered to practice in over 10 states. I have been directly involved in the national Superfund program since inception of the program in 1980; my responsibilities have included involvement in three contracts to EPA as well as undertaking an RI/FS for a potentially responsible party group. A true and accurate copy of my resume is attached as Exhibit 1 to this affidavit.

2. I am familiar with the New Bedford Harbor Superfund Site as a result of independent evaluation of a number of environmental issues related to the site, including general site conditions, the horizontal and vertical distribution of PCBs, and various remedial alternatives proposed for site. I was Project Manager for the development of a remedial proposal for New Bedford Harbor which Balsam developed on behalf of AVX Corporation. A report on that proposal, entitled "A Remedial Action Program, New Bedford Harbor Superfund Site," October 16, 1989, was submitted to the EPA Administrative Record for the Superfund Site.

3. In connection with the preparation of this affidavit, I have reviewed the affidavits of Dr. Louis J. Thibodeaux, Dr. Walter F. Bohlen , and Dr. Weldon S. Bosworth.

4. It is my opinion that the release of PCBs caused by the 1954 hurricane, and their subsequent deposition in New Bedford Harbor sediments created an ongoing presence of PCBs in the sediments and waters of New Bedford Harbor that would have, taken alone, resulted in a regulatory remedial response comparable to that undertaken by the government at this site today. Based upon the opinions of Dr. Thibodeaux and Dr. Bohlen, areas of high PCB concentrations would have been created by the 1954 hurricane similar to those found today. PCB transport in the system, the dynamics of PCB movement within sediments, and the responses of marine organisms for

example, would all have been comparable had nothing but the Hurricane-related PCB release occurred. Hurricane PCBs would still have been deposited within the sediments as in fact happened and would have been acted upon by the same physical, chemical, and biological mechanisms as have been described for PCBs currently seen in New Bedford Harbor. Accordingly, the concerns and responses mandated by public policy and regulations would have involved the same criteria and issues considered in response to the situation now found.

Signed under the penalties of perjury this 9th day of October, 1990.

Leonard C. Sarapas

79151

RESUME

LEONARD C. SARAPAS, P. E.
Vice President, Engineering

EDUCATION:

M.S., University of Kansas, 1983. Civil/Environmental Engineering
B.S., University of Kansas, 1976. Civil Engineering

PROFESSIONAL CERTIFICATION:

Registered Professional Engineer: Connecticut, Delaware, Kansas, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Vermont

PROFESSIONAL HISTORY:

1986-Present	Balsam Environmental Consultants, Inc., Vice President, Engineering
1984-1986	Normandeau Associates, Inc., Manager, Waste Management Engineering
1980-1984	Woodward-Clyde Consultants, Manager, Waste Management Services
1977-1980	Black & Veatch Consulting Engineers, Project Engineer

REPRESENTATIVE EXPERIENCE:

Mr. Sarapas has been directly and actively involved in the waste management field for over ten years. He has been personally involved in the Superfund and RCRA programs since their inception in 1980. His experience base includes the investigation and assessment of industrial facilities and abandoned waste disposal sites across the United States involving widely varying geologic and hydrologic conditions. At many of these sites, Mr. Sarapas has also developed and/or implemented remedial programs to address identified site contamination.

MOTTOLO SUPERFUND SITE REMEDIAL INVESTIGATION/FEASIBILITY STUDY; 1985-Present; Project Manager. Initial stages of this project involved review and critique of site investigations performed by EPA and New Hampshire regulatory agencies, as well as a buried drum

exhumation/remedial program. Based upon this review, provided expert testimony in behalf of PRP in litigation involving recovery of remedial costs. Subsequent to that time, a full Superfund RI/FS was initiated including the use of geophysics and remote sensing techniques and the installation of an extensive ground water monitoring network for unconsolidated and consolidated deposits. The FS included development of a state-of-the-science contaminated soils leachability protocol to more effectively evaluate remedial alternatives.

NEW BEDFORD HARBOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY AND REMEDIATION DESIGN; 1984-Present; Project Manager. Performed independent evaluation of RI/FS performed by EPA on behalf of AVX Corporation and completed independent engineering assessments of environmental, geotechnical and transport issues related to natural resource damage and remediation of New Bedford Harbor. Also developed a cost-effective remedial measures program to address potential adverse impacts of PCB and heavy metal contamination in the harbor involving in-situ containment and biological degradation.

AMOCO SUGAR CREEK REFINERY RCRA COMPLIANCE; 1980-1984; Project Manager. Provided RCRA and CERCLA regulatory compliance and planning to Amoco including development and implementation of a ground water monitoring program, development of closure plans and certification of closure, assessment of property and presentation of findings, and development of a conceptual design for an on-site landfill.

CLEAN HARBORS, INC. FACILITY ASSESSMENT AND REMEDIAL DESIGN; 1985-Present; Project Manager. Performed hydrogeologic and contaminant 21E/HSWA assessments at two of Clean Harbors, Inc. RCRA TSD facilities, including evaluation of contaminant migration in consolidated and unconsolidated formations underlying facilities. Based upon investigation findings, developed and implemented an agency approved remedial program including source removal and source isolation.

U. S. EPA INTERIM SUPERFUND PROGRAM, ZONE 3; 1981-1983; Assistant Project Manager. Managed remedial investigations, feasibility studies and remedial programs for Superfund sites in Missouri, Texas, Iowa and Washington. Developed site investigation and remedial work plans, safety and sampling documents, and engineering evaluation reports.

SAVAGE WELL, MILFORD, NH, SUPERFUND SITE; 1984-1986; Project Manager. Performed assessment of ground and surface water quality and identification of contamination source areas related to prior discharge of

volatile organic compounds. Using these data, developed conceptual remediation programs including an on-site contaminated soils treatment program and an air stripping treatment system for ground water remediation.

EASTERN MISSOURI TCDD (DIOXIN) SITES; 1982-1984; Project Manager. Managed remedial investigations at eastern Missouri dioxin sites and performed feasibility studies and conceptual design of remedial programs at seven sites. Completed the conceptual design for a 1,000,000-cubic yard regional landfill to hold dioxin wastes.

LINCOLN MILL ASBESTOS REMEDIATION, LINCOLN, NH; 1985-1986; Project Manager. Developed a program to identify, quantify and segregate asbestos wastes and construction debris present at the former Lincoln paper mill. Based on this assessment, a site remediation program was prepared and implemented, including siting and permitting of three on-site landfills, an air quality monitoring program to document effectiveness of remediation, and a contaminated materials transport and disposal program.

CLOSURE OF BROWNING-FERRIS INDUSTRIES, INC. HAZARDOUS WASTE LANDFILL; 1984; Project Engineer. Designed ground water drainage trench for remediation and closure of a hazardous waste landfill. Assisted in design of landfill cap and ground water monitoring system.

WASTE MANAGEMENT PLAN FOR KANSAS CITY POWER & LIGHT WASTE DISPOSAL AREA; 1980-1981; Project Engineer. Developed cost-reducing closure techniques, ground water monitoring program, waste handling program and permit for a 600-acre coal burning waste disposal site.

RCRA PART B PERMIT APPLICATION FOR CARGILL HAZARDOUS WASTE INCINERATOR AND STORAGE FACILITY; 1983; Senior Consultant. Developed strategy and permit application for Cargill chemical manufacturing hazardous waste incinerator and storage facilities located in southern California.

SOUTHERN NEW HAMPSHIRE MILLYARD FACILITIES REMEDIAL PROGRAM; 1985-1986; Project Manager. Conducted an environmental evaluation of a former tannery/millyard facility to assess feasibility of building renovation. Designed and implemented a facility remedial program including asbestos removal, extensive surface cleaning, decommissioning of underground storage tanks, waste removal, and environmental monitoring. Following program completion, verification sampling was performed to

document effectiveness of remedial measures and permit initiation of building renovation.

INVESTIGATION AND REMEDIATION OF THOMPSON-HAYWARD CHEMICAL COMPANY PESTICIDE FACILITY; 1983-1984; Project Manager. Determined extent and level of pesticide, dioxin and other organic compound contamination at this active facility, previously used for pesticide formulation. Developed program for remediation of facility to allow continued use of site.

SPECIAL TRAINING:

Professional Liability: A Loss Prevention Course; National Society of Professional Engineers; 1988.

Assessment of Contaminant Migration in Saturated Materials; Dr. John Cherry, Distinguished Lecturer Series; 1986.

Hazardous Waste Management Practice Health and Safety Training (40 hours); Woodward-Clyde Consultants; 1984 (Served as Regional WCC Health and Safety Officer).

Chemodynamics - Environmental Fate of Chemical Compounds in Air, Water and Soil; University of Missouri; 1982.

Geotechnical and Geohydrological Aspects of Hazardous Waste Containment; Woodward-Clyde Consultants; 1982.

PROFESSIONAL AFFILIATIONS:

American Society of Civil Engineers
National Water Well Association
Tau Beta Pi
Chi Epsilon

PUBLICATIONS AND PRESENTATIONS:

"HSWA Corrective Action" Executive Enterprises Seminars (Instructor), Atlanta, GA; Chigaco, IL; and Washington, D.C.; Winter 1990.

"HSWA Corrective Action: Status Report for EPA Regions 1, 2 and 3," Seventh Annual Hazardous Materials Management Conference, June 1989.

"Site Investigation Sampling Guidelines to Protect Sampling Data Defensibility and Admissability," Massachusetts ~~Contingency~~ Continuing Legal Education, October 1988.

"Case Study of Natural Resource Damage Assessment Litigation at New Bedford Harbor, Massachusetts," First Annual Hazardous Materials Management Conference/Central, March 1988.

"A Practical Approach to Corrective Action Implementation Under the 1984 Hazardous and Solid Waste Amendments," Fifth Annual Hazardous Materials Management Conference, June 1987.

"*Guidance Document for Cleanup of Surface Tank and Drum Sites*," coauthored with Jeffrey Cassis, U. S. EPA, August 1984.

"The Potential Impact from Land Application of Waste Water Treatment Plant Sludge on Ground and Surface Water Quality and Soil Characteristics," coauthored with Dr. J. D. Campbell, Kansas Water Pollution Control Association, May 1981.

MOTION NO: LU-16

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

LUMBERMENS MUTUAL CASUALTY COMPANY, Plaintiff, v. AVX CORPORATION, Defendant.	CIVIL ACTION NO. 84-2043-Y (New Bedford Harbor Cases) (Consolidated Civil Action No.83-3882-Y)

AFFIDAVIT OF WALTER F. BOHLEN

I, Walter F. Bohlen do hereby depose and state as follows:

1. I hold a Ph.D. in physical oceanography and have concentrated my research efforts in the field of estuarine and coastal circulaton and sediment transport. I am an Associate Professor in the Department of Marine Sciences at the University of Connecticut. A true and accurate copy of my resume is attached as Exhibit 1 to this affidavit.

2. I am familiar with New Bedford Harbor and adjoining Buzzards Bay having personally made observations of suspended sediment concentrations, deposited sediment distributions, and system hydrodynamics and reviewed numberous reports dealing with circulation, sediment transport, and the hydrographic

character of the New Bedford Harbor/Acushnet River estuarine system including those by Teeter (1988) and ASA (1986, 1987, 1990). I use the term New Bedford Harbor to refer to areas north of the Hurricane Dike and the term Upper Estuary to refer to areas north of the Coggeshall Street Bridge.

3. In connection with preparation of this affidavit, I have reviewed the following evidentiary materials: the Affidavits of Dr. Louis J. Thibodeaux, Dr. Weldon S. Bosworth and Mr. Leonard C. Sarapas; the diary of William Kameron, plant foreman for the Aerovox Corporation in 1954; the book published by Aerovox Corporation concerning Hurricane Carol; the deposition testimony of Norman Goddu and Charles Bariteau; and the Statement of Undisputed Material Facts In Support of Plaintiff Lumbermens Mutual Casualty Company's Motion for Partial Summary Judgment Regarding the Pollution Exclusion.

4. The sediments of the Upper Estuary are primarily fine grained cohesive materials which display a marked variation in bulk density over the vertical. The low density, high water content sediment layers forming the sediment water interface in the Upper Estuary display low shear strengths and are easily displaced by ambient tidal currents and/or surface wave associated velocities. Regular tidal resuspension of the near surface sediment layers results in persistent suspended material transport throughout the Upper Estuary and much of the adjoining harbor. The rate and distance of transport is dependent upon the prevailing oceanographic and meteorological

conditions, as well as the basin morphology of the estuary. As a result the sediment transport system can be expected to display significant spatial and temporal variability.

5. In addition to sediment resuspended from the sediment-water interface additional materials are introduced into the New Bedford Harbor system by streamflows entering from the Acushnet River, overland drainage from bordering shorelines and tidal transport of sediments inshore from adjoining Buzzards Bay. The resulting mass of material is distributed throughout New Bedford Harbor (which I define to be the geographical area north of the hurricane dike) and estuary by the local circulation system.

defined

6. The hydrophobic nature of PCBs favors adsorbtion of these materials by fine grained organic and inorganic particulates in the receiving water body. Within New Bedford Harbor such particulate materials are typically found both in suspension and along the near-surface of the sediment-water interface.

7. Following adsorbtion, subsequent PCB transport is governed by the same range of factors affecting suspended material transport including tidal currents, gravitational circulation, wind-driven flows and mass settling. As in the case of suspended material transport, this combination of factors is expected to favor significant spatial and temporal variability in PCB mass transport.

8. On August 31, 1954, Hurricane Carol passed to the west of New Bedford along a track that took it from Old Saybrook, Connecticut, near the mouth of the Connecticut River, around 0900 EST, northeast to Worcester, Massachusetts at noon and then on through central New Hampshire to southern Quebec, Canada by 1930. This timing made passage approximately conincident with the predicted time of high water at New Bedford. As a result water levels in excess of 10 feet above high water were produced in New Bedford resulting in significant low land flooding. Peak winds during the period were from the south and southeast with speeds approaching 80 mph. Maximum winds in the region of 120 mph were recorded at Block Island, Rhode Island. Although tidal levels were not monitored at New Bedford, tidal data from Newport, Rhode Island show the hurricane-associated storm surge to be quite discrete in time and short-lived, with tidal heights approaching pre-storm levels within six hours of storm passage. This appears to be the result of the rapid speed of advance of the storm (40 mph).

9. Assuming that there was a significant release of Aroclor from the Aerovox plant as a result of Hurricane Carol, this mass of oil was carried to the estuary where it was distributed under the combined effects of streamflows and tidal currents.

10. This rapid introduction of a significant volume of PCB, and the relatively small mass of sediment available within the upper estuary for adsorbtive purposes, resulted initially in a large volume of liquid PCB resident along the sediment-water interface. This mass of non-aqueous phase liquids (NAPLs) would tend to displace the near-surface interstitial waters of the sediment column and/or be transported horizontally by the near-bottom velocity field. Based on anticipated velocities, substantial volumes of NAPL remained in the Upper Estuary resulting in a high concentration zone or "hot spot".

11. Subsequent introduction of sediment as part of the persistent tidal transport system resulted in the adsorbtion and transport of PCB from this region to adjoining areas of the harbor/estuary. The routes and rates of this transport are expected to vary significantly with time as a function of available transport energy and associated sediment supply.

12. Subsequent movements of sediment from adjoining areas of the harbor/estuary to and through the region of the "hot spot" as part of the persistent tidal transport system, resulted in the continuing adsorbtion and transport of PCB from the "hot spot" to adjoining areas of the harbor/estuary.

13. In addition to the persistent tidal transport, short-term storm events can produce major disruptions of the

sediment-water interface, including in areas of high concentrations, resulting in the transport of masses of sediment with PCB concentrations, thereby spreading contamination.

14. The potential for significant storm-associated transport in an estuarine system varies as a function of sediment characteristics, basin morphology and available transport energies. The relatively sheltered form of New Bedford Harbor and the fine-grained cohesive nature of the sediments serve to limit the range of storm conditions able to effect significant transport.

15. Transport energies in the New Bedford Harbor system can increase significantly during the passage of episodic high energy storm events due primarily to associated wind stress effects. Rainfall and subsequent streamflows generally represent secondary factors.

16. Storm-induced winds can modify mean current velocities and produce moderate to high energy surface wind waves. Subsequent interactions between wind wave velocities and the ambient tidal flows can significantly increase boundary shear stress, favoring increased suspension of materials from the sediment-water interface.

17. Interactions are expected to be most pronounced during storms dominated by winds from the northerly or southerly quadrants with speeds in excess of 25 mph.

18. Review of meteorological data for the New Bedford area indicate that during the period 1948-1986 storms sufficient to produce increases in boundary shear stress favoring increased erosion of the sediment-water interface in excess of that produced by the average tidal flows occurred at a minimum of once each year.

Signed under the penalties of perjury this 9th day of October, 1990.

Walter F. Bohlen

Walter F. Bohlen

79421

EXHIBIT 1

Biography, Bibliography, and Professional Summary

of

Walter F. Bohlen, Associate Professor of Marine Science
Department of Marine Science
The University of Connecticut
Avery Point, Groton, Connecticut 06340
(203) 446-1020 x 256

Birthdate: 6/21/38

Home: 1 Scott Lane
Mystic, CT 06355
(203) 536-1908

Education:	B.S. 1960	University of Notre Dame
	Ph.D. 1969	Massachusetts Institute of Technology and Woods Hole Oceanographic Institution
Experience:	1960-62	U. S. Navy - Engineering Officer
	1962-63	Research Assistant, Woods Hole Oceanographic Institution
	1963-64	Staff Engineer, Robert Taggart, Inc.
	1964-65	Research Assistant, Woods Hole Oceanographic Institution
	1965-69	Research Assistant, Massachusetts Institute of Technology
	1969-77	Assistant Professor, University of Connecticut
	1977-78	Visiting Investigator, Woods Hole Oceanographic Institution
	1980-	Associate Professor, University of Connecticut

Professional Societies: Member of Marine Technology Society; Society of Sigma Xi; American Geophysical Union

Honors or Distinctions: WHOI Fellowship 1967-68; Member, Research/Planning Advisory Committee of the New England River Basins Commission; American Geophysical Union Visiting Scientist Lecturer 1970-73; Invited lecturer 3rd Annual Ocean Disposal Conference, U. S. Army Corps of Engineers, West Boothbay Harbor, Maine; Invited lecturer 4th Annual Ocean Disposal Conference, Boston, Mass.; Associate Editor, Estuaries, 1979; Member, NAS/NRC Committee on National Dredging Issues, 1983- .

Field of Specialization: Physical Oceanography

Research Interests: Fluid Mechanics, Turbulence, Sediment Transport Processes, Coastal Buoy Systems, Instrument Design

Publications:

Bohlen, W. F. 1964. The search for materials data. Geo-Marine Technology, 1:36-38.

Bohlen, W. F. 1965. Data center for hydro-wire experience. Geo-Marine Technology, 1:18-23.

Bohlen, W. F. 1971. On the measurement of turbulence in estuaries. Proc. of 1971 IEEE Int'l. Conf., Engineering in the Ocean Environment. Sept. 1971, San Diego, CA, pp. 238-242.

Bohlen, W. F. 1974. Continuous monitoring systems in Long Island Sound: description and evaluation. Proc. of IEEE Int'l. Conf. on Engineering in the Ocean Environment. Halifax, Nova Scotia, Aug. 1975, Vol. 2:61-69.

Bohlen, W. F. 1975. Suspended material concentrations and transport in eastern Long Island Sound. J. Geophys. Res. (Oceans and Atmospheres), 80(36): 5089-5100.

Bohlen, W. F. 1977. Shear stress and sediment transport in unsteady turbulent flows. In: Estuarine Processes, Vol. II. M. Wiley, Editor, Academic Press: 109-123.

Bohlen, W. F., Cundy, D. F. and J. M. Tramontano. 1978. Suspended material distributions in the wake of estuarine channel dredging operations. Estuarine and Coastal Marine Science, 9, 699-711.

Bohlen, W. F. 1979. Factors governing the distribution of dredge-resuspended sediments. Proc. of the 16th Coastal Engineering Conf., Amer. Soc. of Civ. Eng., N.Y., N.Y.: 2001-2017.

Cundy, D. F. and W. F. Bohlen. 1979. A numerical simulation of the dispersion of sediments suspended by estuarine dredging operation. In: "Wetland and Estuarine Processes." Plenum Press, pp. 339-353.

Bohlen, W. F. 1980. A comparison between dredge-induced resuspension of sediments and that produced by naturally occurring storm events. Proc. of the 17th Coastal Engineering Conf., Amer. Soc. of Civ. Eng., N.Y., N.Y.: 1700-1707.

Tramontano, J. M. and W. F. Bohlen. 1982. The nutrient and trace metal geochemistry of a dredge plume. Estuarine, Coastal and Shelf Science. 18:385-401.

Bohlen, W. F. 1982. In situ monitoring of sediment resuspension in the vicinity of active dredge spoils disposal areas. Proc. of Oceans '82 MTS/IEEE Conf.: 1028-1033.

Welsh, B. L., Whitlatch, R. B. and W. F. Bohlen. 1982. Relationship between physical characteristics and organic carbon sources as a basis for comparing estuaries in southern New England. Estuarine Comparisons. (V. Kennedy, ed.) Academic Press, p. 53-67.

Tolmazin, D., Bohlen, W. F. and M. Fecher. 1983. Variability of currents and horizontal eddy coefficients in eastern Long Island Sound. Continental Shelf Res., 2(1): 35-48.

Bohlen, W. F. 1984. Evaluations of the factors governing the mobility of dredged materials placed at open water disposal sites. Proc. of 10th/U. S./Japan experts meeting on the management of bottom sediments containing toxic substances. Kyoto, Japan, November 1984. (In Press)

Published Abstracts:

Bohlen, W. F. 1970. Experimental studies of turbulence in liquid-solid flows. (Abstract) E⊕S Trans. of Amer. Geophys. Un., 51(4): 279.

Bohlen, W. F. 1971. Some observations of suspended material transport near the mouth of the Connecticut River. (Abstract) Proc. 2nd Coastal and Shallow Water Res. Conf., Oct. 1971, Newark, Del., 261.

Bohlen, W. F. 1972, Turbidity measurements in estuaries. (Abstract) E⊕S Trans. Amer. Geophys. Un., 53(4):421.

Bohlen, W.F. 1973. Suspended material concentrations in eastern Long Island Sound. (Abstract) E⊕S Trans. of Amer. Geophys. Un., 54(4):259.

Bohlen, W. F. and M. M. Smith. 1974. The effects of storms on suspended material concentrations in eastern Long Island Sound. (Abstract) E⊕S Trans. Amer. Geophys. Un., 55(4):280.

Leonard, J. E., Bohlen, W. F. and H. Wright. 1975. Nearshore and offshore current monitoring systems: a review. (Abstract) Abstracts with Programs, Vol. 7(1), Tenth Annual Meeting, Northeast Section, The Geological Society of America, pp. 88.

Bohlen, W. F. and J. M. Tramontano. 1976. The influence of dredging operations on suspended material characteristics in an estuary. (Abstract) E⊕S Trans. of Amer. Geophy. Un. 57(4):268.

Bohlen, W. F. 1978. The response of the suspended material field in eastern Long Island Sound to selected storm events. (Abstract) Abstracts with Programs, Vol. 10(2), 13th Annual Meeting, Northeast Section, The Geological Society of America, pp. 33.

Bohlen, W. F. 1979. Observations of storm-induced sediment resuspension in eastern Long Island Sound. E⊕S Trans. Amer. Geophys. Un., 60(18):285.

Bohlen, W. F. 1979. Some observations concerning the cross-shelf flux of fine-grained suspended sediments along the coast of southern New England. (Abstract) Proc. of the 5th Estuarine Research Conference.

Bohlen, W. F., 1980. Storm-induced variations in suspended material concentrations in coastal waters. (Abstract) 26th International Geological Congress, Paris, France. Published Abstracts, pp. 438.

Bohlen, W. F. 1982. Storms and sediment resuspension in eastern Long Island Sound. (Abstract) EOS Trans. of Amer. Geophys. Un., 63(3):73.

Aubrey, D. G., Miller, M. C., Bohlen, W. F. and R. F. Morton. 1982. Seasonal patterns of beach change along the U. S. coastlines. (Abstract) EOS Trans. of Amer. Geophys. Un., 63(45):988.

Bohlen, W. F., and K. B. Winnick. 1983. Time series observations of near bottom suspended matter concentrations in an estuary. EOS. Trans. Amer. Geophys. Un. 64(52): 1042.

Bohlen, W. F. 1985. On the temporal variability of suspended material concentrations in estuaries. Estuaries 8(2b):113A

Boon, J. D., Bohlen, W. F., Winnick, K. B. and R. L. Lukens 1985. Measurements of near bottom sediment resuspension in lower Chesapeake Bay. Atlantic Estuarine Research Soc. Spring Mtg. April, 1985 Gloucester Point, Va.

Bohlen, W.F. and K.B. Winnick. 1985. Apparent non-linearities in the magnitude of storm induced sediment resuspension in estuaries. EOS Trans. of Amer. Geophys. Un. 66(51):1260.

Bohlen, W.F., D.C. Rhoads, P. McCall and R.W. Morton. 1986. The impact of Hurricane Gloria on dredged material disposal sites in Long Island Sound. Proc. 6th International Ocean Disposal Symposium. 21-25 April, 1986. Asilomar, CA. p. 184.

Reports:

Bohlen, W. F. 1969. Hot wire studies of turbulence in open channel flows transporting neutrally buoyant particles. Experimental Sedimentology Lab. Report No. 69-1, Mass. Inst. of Technology, Cambridge, MA, 120 p.

Bohlen, W. F. 1971. Experimental studies of turbulence in liquid-solid flows. Final Report to Research Foundation, The University of Connecticut, Storrs, CT, 34 p.

Bohlen, W. F. and J. D. Devine. 1972. Bibliography on the disposal of dredge spoils in coastal waters. Prepared for the U. S. Army Corps of Engineers, 64 p.

Bohlen, W. F. 1971. Hydrographic Data Report: Connecticut River entrance, October 6, 1971. Prepared for the U. S. Geological Survey, Hartford, CT, 12 p.

Bohlen, W. F. 1973. An investigation of suspended material transport in eastern Long Island Sound. University of Connecticut Marine Sciences Institute Annual Report of Office of Sea Grant Programs, National Oceanic and Atmospheric Admin., Rockville, MD, Appendix E, 29 p.

Bohlen, W. F. 1973. A water quality survey of the sewage treatment plant discharge areas adjoining Stonington, Connecticut: The Mystic River Estuary. Prepared for the Town of Stonington, Stonington, CT, 37 p.

Bohlen, W. F. and J. M. Tramontano. 1974. Oceanographic factors relating to the disposal of dredged materials in Long Island Sound. Physical and chemical characteristics of the waters adjacent to the New Haven dredge spoils disposal site: Data Report 1972-73. Prepared for the New England Div., U. S. Army Corps. of Eng., 44 p. and Appendix.

Bohlen, W. F. and J. M. Tramontano. 1974. Oceanographic factors relating to the disposal of dredge materials in Long Island Sound. Physical and chemical characteristics of the waters adjacent to the New Haven dredge spoils disposal site: Data Report 1973-74. Prepared for the New England Div., U. S. Army Corps. of Eng., 34 p. and Appendix.

Bohlen, W. F. 1974. An investigation of suspended material concentrations in eastern Long Island Sound. University of Connecticut Marine Sciences Institute Final Report to Office of Sea Grant Programs, National Oceanic and Atmospheric Admin., Rockville, MD, pp. 100-131.

Bohlen, W. F., Nalwalk, A. J. and H. R. Robinson. 1974. A photographic study of the bottom conditions characteristic of the New Haven dredge spoils disposal site, 1972-1974. Prepared for the New England Div., U. S. Army Corps of Eng., 33 p.

Bohlen, W. F. and J. M. Tramontano. 1976. An examination of the impact of dredging on suspended material transport in the lower Thames River estuary. Prepared for the National Oceanic and Atmospheric Admin., MAFC, Sandy Hook, NJ.

Bohlen, W. F. and D. F. Cundy. 1978. Observations of the suspended material field and local hydraulic characteristics in the vicinity of Pawson Marsh, Branford, Connecticut: June 1975-October 1975. Prepared for the U. S. Army Corps of Eng., Waterways Exp. Station, Vicksburg, Miss. Marine Sciences Institute, University of Connecticut, Groton, CT

Bohlen, W. F., Cundy, D. F. and J. M. Tramontano. 1980. An investigation of the impact of dredging on suspended material transport within the Thames River estuary. Prepared for the U. S. Navy, Naval Facilities Engineering Command, Philadelphia, PA, 41 pps. + Tables.

Bohlen, W. F. and J. A. Hamilton. 1980. An investigation of storm-induced sediment resuspension in the vicinity of the New London dredge spoils disposal area: instrumentation and preliminary results - 1980. Prepared for Science Applications Inc., Newport, RI, 50 pps.

Bohlen, W.F. and K. B. Winnick. 1983. A survey of surface waves in Long Island Sound. Prepared for State of Connecticut Department of Environmental Protection. 6 pps + App.

Morton, R. W., Bohlen, W. F., and D. G. Aubrey. 1983. Beach changes at Milford and Fairfield beaches, Connecticut, 1962-1971. U.S. Army Corps of Engineers. Misc. Paper CERC-83-5. Coastal Engineering Research Center, Vicksburg, Miss. 41 pps + App.

Bohlen, W. F. and K. B. Winnick 1984. Observations of near-bottom suspended material concentrations at the FVP site Central Long Island Sound dredge spoils disposal area: Pre-disposal conditions, August 16, 1982 - April 8, 1983. Prepared for Science Applications Inc., Newport, Rhode Island. 25 pps + Figs. and App.

Bohlen, W. F. and K. B. Winnick 1984. Observations of near-bottom suspended material concentrations at the FVP site Central Long Island Sound dredge spoils disposal area: Immediate pre-disposal, disposal, and immediate post disposal period. Prepared for Science Applications Inc., Newport, Rhode Island. 17 pps + Figs. and App.

Bohlen, W. F. and K. B. Winnick 1985. An evaluation of the effects of the storm of March 29, 1984 on sediment resuspension in central Long Island Sound. Prepared for Science Applications International Corporation, Newport, Rhode Island.

Welsh, B. L., Bohlen, W. F. and J. D. Buck 1985. An investigation of impacts produced by settling basin discharges on the Copps Brook/Quiambog Cove System. Prepared for the Connecticut-American Water Company, Greenwich, CT. 26 pps + App.

Bohlen, W.F. and K.B. Winnick. 1985. Time series observations of near-bottom suspended material concentrations in the vicinity of the Boston Foul Ground Dredged material Disposal Area: July 2, 1985 - August 6, 1985. Prepared for Science Applications International Corp., Newport, RI. 6 pps. and Figs.

Bohlen, W.F. and K.B. Winnick. 1985. An evaluation of the effects of the storm of March 29, 1984 on sediment resuspension in central Long Island Sound. Prepared for Science Applications International Corporation, Newport, RI. 13 pps. and Figs.

Welsh, B.L., W.F. Bohlen and J.D. Buck. 1985. An investigation of impacts produced by settling basin discharges from the Connecticut American Water Treatment Facility within Copps Brook and adjoining Quiambog Cove, Stonington CT. Prepared for the Connecticut American Water Co., Marlton, NJ. 29 pps and App.

Bohlen, W.F. 1985. Investigation of sediment transport associated with dredging and the disposal of dredged materials: A discussion of standard procedures. Prepared for Science Applications International Corporation, Newport, RI. 13 pps

Bohlen, W.F. and K.B. Winnick. 1986. DAISY Deployment Report: Central Long Island Sound. August 12-15, 1986. Prepared for U. S. Environmental Protection Agency. Environmental Research Lab., Narragansett, RI. 12 pps.

Pritchard, D.W., W.F. Bohlen and H. Carter. 1986. Report of the Long Island Sound Modeling Workshop. 27-28 January, 1986. Stony Brook, NY. Prepared for the U. S. Environmental Protection Agency. 29 pps. and App.

Bohlen, W.F. and K.B. Winnick. 1986. Time series observations of the near-bottom suspended material field adjacent to the field verification site: Central Long Island Sound Disposal Area. Prepared for the U. S. Environmental Protection Agency, Environmental Research Laboratory, Narragansett, RI.

Bohlen, W.F. 1986. Observations of the effect of Hurricane Gloria on the suspended material field in eastern Long Island Sound. Prepared for Science Applications International Corporation, Newport, RI. 17 pps. and Figs.

Consulting Reports:

McDonald, M., Rabideau, R. and W. F. Bohlen. 1973. A field study of the geology and hydrography of the Mumford Cove area. Tech. Rpt. No. U440-72-143. General Dynamics Corp., Electric Boat Div., 64 pps.

Bohlen, W. F. and G. A. Gilmore. 1973. Oil spill control on the lower Mississippi River. Prepared for the American Petroleum Inst., Washington, D.C., Project OSR-3, 63 pp. and Appendix.

Bohlen, W. F. 1973. The hydrographic characteristics of Trading Cove, mixing and dispersion. Prepared for United Nuclear Corporation, 28 pps.

Bohlen, W. F. 1974. The dispersion characteristics of mycelium. Prepared for Pfizer Inc., 23 pps.

Bohlen, W. F. 1974. A water quality survey of the sewage treatment plant discharge areas adjoining Stonington, Connecticut: 1973-74. Prepared for the Town of Stonington, Stonington, CT, 50 pps.

Bohlen, W. F. 1974. The sediment transport regime within Rotten Bayou and the Jourdan River. Prepared for Environmental Devices Corp., 8 pps.

Bohlen, W. F. 1975. Laboratory investigations of the physical transport characteristics of shad roe. Prepared for Normandeau Associates, Bedford, New Hampshire, 30 pps. and Appendix.

Bohlen, W. F. 1975. An investigation of sediment transport in South Cove, Old Saybrook, Connecticut. Prepared for the Waterfront Advisory Comm., Old Saybrook, CT, 20 pps. and Appendix.

Bohlen, W. F. 1976. An investigation of the sediment transport system and its relationship to PCB transfers within the upper Hudson River. Prepared for Lawler, Matusky and Skelly Engineers, Tappan, NY, 15 pps.

Bohlen, W. F. 1977. The influence of channel modifications in Lewis Gut on the stability of Long Beach, Stratford, Connecticut. Prepared for the Town of Stratford, Stratford, CT, 33 pps and Appendix.

Bohlen, W. F. 1978. On the response of the Revere Beach shorefront to the storm of February 6-7, 1978. Prepared for the Metropolitan District Commission, Commonwealth of Massachusetts, 14 pps.

Bohlen, W. F. 1978. An investigation of beachfront erosion: governing factors and recommended solutions. Revere Beach Master Plan: Oceanographic Studies. Prepared for Carl R. Johnson and Assoc., Inc., and the Metropolitan District Commission, Commonwealth of Massachusetts, 50 pps. and Appendix.

Bohlen, W. F. 1980. An investigation of shorefront erosion: Lynn Beach, Massachusetts. Prepared for the Metropolitan District Commission, Commonwealth of Massachusetts, 30 pps. and Appendix and Illustrations.

Bohlen, W. F. 1981. An evaluation of the causes of shorefront erosion: Castle Island, Boston, Massachusetts. Prepared for Fay, Spofford and Thorndike, Inc., Boston, MA, 33 pps. and Illustrations.

Bohlen, W. F. and R. B. Whitlatch. 1981. An evaluation of selected geological and biological characteristics of the area adjacent to Stratford marina, Stratford, Connecticut. Prepared for Environmental Design Assoc., New Canaan, CT, 55 pps. and Appendix.

Bohlen, W. F. 1981. An analysis of environmental impacts associated with beach restoration: Lynn Beach, Massachusetts. Prepared for the Metropolitan District Commission, 79 pps. and Appendix.

Morton, R. W., Bohlen, W. F., Aubrey, D. G. and M. R. Miller. 1981. Beach changes at Misquamicut Beach, Rhode Island, 1962-1973. Prepared for the U. S. Army Coastal Engineering Research Center, 63 pps. and Appendix.

Morton, R. W., Bohlen, W. F. and D. G. Aubrey. 1982. Beach changes at Jones Beach, Long Island, N.Y. 1962-1974. Prepared for U. S. Army Coastal Engineering Research Center. 2 Vols. + Apps.

Bohlen, W. F. and L. E. Johnson. 1983. Clinton Harbor, Connecticut: wave energy analysis and sediment transport study. Prepared for U. S. Army Corps of Engineers, New England Division, Waltham, Mass. 75 pps.

Bohlen, W. F. 1983. An evaluation of beachfront impacts associated with reconstruction of a stone groin: Lindemann Property, Greenwich, Connecticut. Prepared for Keith E. Simpson Associates, New Canaan, Conn. 14 pps + Figs.

Bohlen, W. F. 1983. Dredging and sedimentation control in selected coastal embayments: Waterford, Conn: Prepared for Town of Waterford Flood and Erosion Control Board. Waterford, Conn. 49 pps + Figs.

Bohlen. W. F. 1984. An evaluation of the surface wave climate near the entrance to the Harbor of Mamaroneck. New York: Western Long Island Sound. Prepared for Coastal Environmental Associates, Gloucester Point Virginia. 13 pps + Figs.

Bohlen, W. F. 1984. An investigation of the influence of a fixed stone seawall/jetty on local shoreline processes: W. B. Porter property, Compo Mill Beach, Westport, Connecticut. Prepared for Environmental Design Associates, P.C., Wilton, Connecticut. 30 pps + Figs.

Bohlen, W. F. 1985. An evaluation of the suitability of Oyster River sands as renourishment material for Woodmont Beach, Milford, Connecticut. Prepared for Milford Engineering Associates, Milford, Connecticut. 5 pps + Plates.

Bohlen, W. F. 1985. An assessment of effects associated with shoreline construction: Lunghino Property, Saugatuck Shores, Westport, Connecticut. Prepared for Donald F. Lunghino, Westport, Connecticut 21 pps. and Figs.

Book Reviews

Bohlen, W. F., 1983. The Ocean Basin and Margins. Vol. 3: The Indian Ocean. A. E. M. Narin and F. G. Shehli (eds.). Estuaries 6(4).

MOTION NO: LU-16

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

LUMBERMENS MUTUAL CASUALTY COMPANY, Plaintiff, v. AVX CORPORATION, Defendant.	CIVIL ACTION NO. 84-2043-Y (New Bedford Harbor Cases) (Consolidated Civil Action No.83-3882-Y)

AFFIDAVIT OF LOUIS J. THIBODEAUX, PH. D

I, Louis J. Thibodeaux, do hereby depose and state as follows:

1. I am a Professor of Chemical Engineering and Director of the Hazardous Waste Research Center at Louisiana State University. I have over twenty-five years experience in environmental chemodynamics, which is the study of the fate and transport of chemicals in the natural environment. A true and accurate copy of my resume is attached as Exhibit 1.

2. In connection with preparation of this affidavit, I have reviewed the following evidentiary materials: the Affidavits of Dr. Walter F. Bohlen, Dr. Weldon S. Bosworth and Mr. Leonard C. Sarapas; the diary of William Kameron, plant

foreman for the Aerovox Corporation in 1954; the book published by Aerovox Corporation concerning Hurricane Carol; the deposition testimony of Norman Goddu and Charles Bariteau; and the Statement of Undisputed Material Facts In Support of Plaintiff Lumbermens Mutual Casualty Company's Motion for Partial Summary Judgment Regarding the Pollution Exclusion.

3. I am familiar with the New Bedford Harbor Superfund site as a result of independent evaluation of a number of environmental issues related to the site. My work concerning New Bedford Harbor was undertaken both at the request of AVX Corporation ("AVX") and at the request of the United States Army Corps of Engineers, Waterways Experiment Station. Vicksburg, MS. For AVX Corporation, I conducted a study of the effectiveness of capping of contaminated bed sediment in the Upper Estuary of New Bedford as a mechanism to retard the movement of PCB from the sediment to the water column, as more fully described in a study entitled, "A Theoretical Evaluation of the Effectiveness of Capping PCB Contaminated New Bedford Harbor Bed Sediment," October 9, 1989, which was submitted to the United States Environmental Protection Agency on October 16, 1989 as part of the Administrative Record for the New Bedford Harbor Superfund Site. My work for the Army Corps is reported in two documents entitled "Theoretical Models for Evaluation of Volatile Emissions to Air During Dredged Material Disposal with Applications to New Bedford Harbor,

Massachusetts," Miscellaneous Paper EL-89-3, US Army Engineer Waterways Experiment Station, Vicksburg, MS (1989), and "Theoretical Models for Volatile Emissions from Dredged Material - Comparison of Predicted and Laboratory Measurements for New Bedford Harbor Sediment" (1989).

4. In order to determine the effectiveness of capping, it was first necessary to consider the rate at which PCBs fluxed (or moved) from the sediment bed to the overlying waters under present conditions. The most important transport mechanisms known to be operative in bed sediment were reviewed for significance with respect to the New Bedford Harbor PCB contamination problem. Four were identified for consideration: absorption/desorption of PCBs between solids and porewater (the water between grains of material within the sediment bed); molecular diffusion within porewater; sediment deposition; and bioturbation. The following is a brief description of each of these processes.

Desorption: At this time PCB molecules are sorbed primarily onto the silt, clay and natural organic matter fraction of the bed sediment in New Bedford Harbor. The molecules must physically detach from this sorbent material before they enter the adjacent porewater. This is the desorption process, after which the molecule is considered to be "in solution."

Diffusion: Molecular diffusion is a process by which molecules move from regions of high concentration to low concentration through random molecular motions. The process occurs readily in porewater between the sediment particles. PCB molecules are transported by this process within and between adjacent pores. Transport of PCBs molecules by molecular diffusion can occur in any direction.

Bioturbation: Sediment processing by animals residing in the upper layers occurs as a result of burrowing, ingestion/defecation, tube-building and biodeposition. Taken together, these processes are termed bioturbation. The net result is the physical vertical and horizontal movement of sediment particles and porewater. PCB molecules either on the particles or in the pore spaces are likewise translocated in the bioturbation.

Particle Deposition: The Upper Estuary of New Bedford Harbor is a net depositional environment (Summerhayes, et al.,"Fine-Grained Sediment and Industrial Waste Distribution and Dispersal in New Bedford Harbor and Western Buzzards Bay, MA," Woods Hole Oceanographic Institution, WHOI-76-115, August 1977). Particles enter by the water route under the Coggeshall Street Bridge and settle from the water column onto the bed sediment surface. Over time this results in sediment buildup and a net accretion.

5. These processes taken together result in the transport of PCBs from the sediment to the overlying water in the Upper Estuary of New Bedford Harbor. PCB molecules desorbed from sediment particles or absorbed onto particles are transported by a combination of molecular diffusion and bioturbation. This brings the PCBs to the sediment-water interface. From here additional desorption and diffusion occurs and molecules in solution move through the benthic boundary layer, entering the overlying water.

i.e. sediments are sources —

6. Thin layer sediment samples obtained from cores at two sites in the Upper Estuary were studied to better understand the in-bed transport processes, which are dominant in controlling the rate of PCB release to the water column. These data, along with other information from the site, suggested that the transport of Aroclors 1242 and 1254 within the top 6-10 cm of the sediment is occurring primarily due to bioturbation processes. Deep within the sediment, molecular diffusion appeared to be the dominant process.

7. Three different models were developed as part of the capping effectiveness study to estimate the average annual PCB flux rate. The range of coincidence of predictions based on these models suggest that the most probable PCB flux rate from Upper Estuary sediments is 500 to 6000 kg/y (or 1100 to 13,200 lbs).

8. These flux calculations reflect average annual PCB flux in 1988, the year in which the thin-layer sampling data was collected, but the basic processes of molecular diffusion and bioturbation would be the same historically once PCBs discharges commenced. Assuming that the use and discharge of PCB commenced effectively in 1947, as alleged by the governments, the sediments would have begun to receive these inputs at that time. An active bioturbation zone (approximately 10 cm) resulted in the inputs being incorporated down to this level. Simultaneously, molecular diffusion commenced to transport the PCBs throughout and below the 10 cm level, and the process has continued to this day.

9. As a result of the combined effect of in-bed sediment transport processes, PCB flux in every year from 1973 to the present is likely to contain a significant amount of PCB molecules that were deposited in the sediment bed prior to 1973 from the Aerovox Corporation plant, including most particularly discharges and releases caused by Hurricane Carol in 1954.

10. Assuming there was a significant loss of Aroclor product as a result of Hurricane Carol, beginning with releases during the height of the storm surge on Tuesday, August 31, 1954 and continuing until mid-day on Wednesday, September 1, 1954 when major pumping operations were substantially concluded, it is my opinion that a substantial quantity of the Aroclor released would have been deposited in the sediments of

the upper estuary, taking into account likely current velocities, calculations for bed sheer stress, the density of PCBs and the sediment characteristics of New Bedford Harbor.

11. The PCB mass deposited into the sediment bed from Hurricane Carol ("the Hurricane PCBs") would likely then have covered an area roughly the size of the area of highest PCB concentrations currently found in the Upper Estuary included within EPA's definition of the "Hot Spot." Since PCB flux is dependent on concentration as well as area, the contribution of Hurricane PCBs to areas of high concentration means they have substantially contributed to PCB flux over time. The governments allege that the Hot Spot and other areas of high concentration in the Upper Estuary act as a continuing source of contamination for the remainder of the Estuary and Lower Harbor/Bay areas. It is, therefore, my opinion that the PCBs which Hurricane Carol caused to be released from the Aerovox Corporation facility likely were and continue to be responsible for the high areas of concentration which are the subject of EPA's April 1990 Hot Spot Record of Decision and of EPA's August 1990 Remedial Investigation and Feasibility Study for the Estuary, Lower Harbor and Bay. Figures prepared for use in my study showing reported concentrations in the Upper Estuary are attached as Exhibits 2, 3, 4, and 5.

12. It is further my opinion that the PCBs which have fluxed over time from the sediment bed into overlying waters

and which have been subject to transport throughout the estuary and harbor have included a substantial amount of Hurricane PCBs. As a result, Hurricane PCBs have been in the past and remain today likely sources of PCBs transported into other areas of the estuary and lower harbor with every tidal cycle. The government alleges that PCBs released from the upper estuary are also transported into Buzzards Bay. If that were correct, Hurricane PCBs likely contributed to that phenomenon as well.

13. It is also my opinion that, beginning with their initial deposition in 1954, Hurricane PCBs have continued to migrate vertically downward into sediment to reach previously uncontaminated depths, by virtue of the process of molecular diffusion referred to above. This process is a continual one and would have occurred in each year from 1954 to and including the present.

Signed under the penalties of perjury this 9th day of October, 1990.

Louis J. Thibodeaux

3270c

EXHIBIT 1

RESUME

(Revised October 24, 1989)

Louis Joseph Thibodeaux
Professor of Chemical Engineering
Director of Hazardous Waste Research Center
Louisiana State University
Baton Rouge, LA 70803
Phone: (504) 388-1426 & 388-6770

PERSONAL DATA

Date of birth: November 13, 1939
Place of birth: Church Point, Louisiana
Home address: 3449 Tezcucco Drive, Baton Rouge, LA 70820
Wife: Elwana Joyce Lasiter
Place of birth: Wewoka, Oklahoma
Children: Jason Scott born August 8, 1961
Michelle Renee born Apri. 21, 1964
Hobbies: sailing, history, travel, cajun music
Social Security No.: 437-60-2801

EDUCATION

Ph.D., Chemical Engineering, Louisiana State University, 1968
M.S., Chemical Engineering, Louisiana State University, 1966
B.S., Petroleum-Chemical Engineering, Louisiana State University, 1962 (five year course equivalent to separate degrees in each discipline).

PROFESSIONAL EXPERIENCE

Academic

Director of U.S. EPA Center of Excellence in Hazardous Waste Research, Louisiana State University; August 1984 to present
Professor of Chemical Engineering, Louisiana State University, August 1984 to present
Professor of Chemical Engineering, University of Arkansas; July 1977 to August 1984
Visiting Professor of Chemical Engineering, University of Exeter, Exeter, England; January to June 1983
Associate Professor of Chemical Engineering, University of Arkansas; July 1972 to July 1977
Visiting Professor of Chemical Engineering, Oregon State University; August 1974 to Junary 1975
Assistant Professor, Chemical Engineering, University of Arkansas; January 1968 to July 1972
Assistant Professor, Civil Engineering (Environmental), University of Arkansas; Summer 1969, 1971
Research Assistant, National Council for Air and Stream Improvement, Division Engineering Research; Louisiana State University, Baton Rouge; June 1965 to February 1968
Research Assistant, Institute of Saline Studies, Division Engineering Research; Louisiana State University, Baton Rouge; September 1964 to June 1965.

Thibodeaux, L.J., and H.D. Scott, Chapter 4, Air/Soil Exchange Coefficients, in Environmental Exposure from Chemicals, Volume I, W. Brock Neely and G.E. Blau, Editors, CRC Press, Inc., Boca Raton, FL (1985).

Thibodeaux, L.J., C. Springer and S. Chatrathi, Chapter 17, Simulation Study of the Volatilization of Polychlorinated Biphenyls from Landfill Disposal Sites, in Environmental and Solid Waste, C.W. Francis and S.I. Auerbach, Editors, Butterworth Publishers, Woburn, MA (1983).

Thibodeaux, L.J., Chapter 5, Offsite Transport of 2,3,7,8-Tetrachlorodibenzo-p-dioxin from a Production Disposal Facility, in Chlorinated Dioxins and Dibenzofurans in the Total Environment, G. Choudhary, L.H. Keith and C. Rappe, Editors, Butterworth Publishers, Woburn, MA (1983).

Thibodeaux, L.J., L.K. Chang, D.J. Lewis, "Dissolution Rates of Organic Contaminants Located at the Sediment Interface of Rivers Streams, and Tidal Zones," Chapter 16 in Contaminants and Sediments, Vol. 1, R.A. Baker, Ed., Ann Arbor Science, Michigan, (1980).

Thibodeaux, L.J., "Transport of Pesticides and Related Chemicals Across to the Air-Water Interface", in Forecasting of Pesticides Behavior in the Environment, V.M. Voloschuk and V.A. Borzilov, Editors, Leningrad Gidrometeoizdat, USSR (1984).

Journal Articles (Refereed)

Formica, S.J., J.A. Baron, L.J. Thibodeaux and K.T. Valsaraj; "PCB Transport into Lake Sediments. Conceptual Model and Laboratory Simulation", Environ. Sci. Technol., Vol. 22, No. 10 (1988) p. 1435-1440.

Singh, V.P., D. Reible and L.J. Thibodeaux, "Mathematical Modeling of Fine Sediment Transport", Hydrology Jo. of IAH, Vol. XI, No. 4, Oct.-Dec. 1988, p. 1 to 23.

Valsaraj, K.T. and L.J. Thibodeaux, "Relationships Between Octanol-Water and Micelle-Water Partition Constants for Hydrophobic Compounds of Environmental Interest", Water Research, 23(2), 183-189 (1989).

Thibodeaux, L.J., C. Springer, G. Hildebrand and K.T. Valsaraj, "Mathematical Models for Chemical Emissions from Landfills", Jour. Haz. Mat., 19 (1988), 101-118.

Valsaraj, K.T. and L.J. Thibodeaux, "Equilibrium Adsorption of Chemical Vapors on Surface Soils, Landfills and Landfarms - A Review", Jour. Haz. Mat., 19 (1988), 79-99.

Thoma, G.J. and L.J. Thibodeaux and C. Springer; "The Effectiveness of Polyvinyl-Chloride An Organic As Vapor Barrier", Haz. Waste and

Haz. Mat., Vol. 6, No. 1, (1989) p. 1-16.

Poe, S.H., K.T. Valsaraj, L.J. Thibodeaux and C. Springer, "Equilibrium Vapor Phase Adsorption of Volatile Organic Chemicals on Dry Soil", Jour. Haz. Mat., 19 (1988), 17-32.

Valsaraj, K.T., A.J. Gupta, L.J. Thibodeaux and D.P. Harrison, "Partitioning of Chloromethanes Between Aqueous and Surfacant Micellar Phases", Water Research, 22 (1988), 1173-1183.

Velaga, A., J.S. Cho, L.J. Thibodeaux, K.T. Valsaraj, R.B. Eldridge and D. Moncada, "Packed Criss-Cross Tower Efficiencies for Methanol-Water Separations: Experimental and Calculated Values Using Countercurrent Flow Correlations", Ind. Eng. Chem. Res., 1988, 27, 1481-1487.

Thibodeaux, L.J. and J.D. Boyle, "Bedford-Generated Convective Transport in Bottom Sediment", Nature, Vol. 325, No. 6102, pp. 341-343, 22 Jan. 1987.

Thomas, J., L.J. Thibodeaux, A. Ramenofsky, S. Field, B.J. Miller and A. Whitmer, "The Long-Term Migration of Metals from Archaeological Contexts: Implications for Movement of Hazardous Waste Constituents", Environmental Science and Technology, Vol. 22, No. 5, 1988, p. 480-487.

Savant, A.S., D.D. Reible and L.J. Thibodeaux, "Convective Transport Within Stable River Sediments", Water Resources Research, Vol. 23, No. 9, pp. 1763-1768, Sept. 1987.

Springer, C., K.T. Valsaraj and L.J. Thibodeaux, "In-Situ Methods to Control Emissions from Surface Impoundments and Landfills", Jour. APCA, 36 (12), 1371-1374 (1986).

Springer, C., K.T. Valsaraj and L.J. Thibodeaux, "The Use of Floating Oil Covers to Control Volatile Chemical Emissions from Surface Impoundments: Laboratory Investigations", Hazardous Waste & Hazardous Materials, Vol. 2, No. 4, (1985), pp. 487-501.

Lunney, P.D., C. Springer and L.J. Thibodeaux, "Liquid-Phase Mass Transfer Coefficients for Surface Impoundments," Environmental Progress, Vol. 4, No. 3, Aug. 1985, p. 203.

Thibodeaux, L.J., and D. Lipsky, "A Fate and Transport Model for 2, 3, 7, 8 - Tetrachlorodibenzo-p-dioxin in Fly Ash on Soil and Urban Surfaces", Hazardous Waste and Hazardous Materials, Vol. 2, No. 2, 1985.

Thibodeaux, L.J., C. Springer and R.S. Parker, "Design for Control of Volatile Chemical Emissions from Surface Impoundments", Hazardous Waste and Hazardous Materials, Vol. 2, No. 1, 1985.

Thibodeaux, L.J., D.G. Parker and H. Heck, "Chemical Emissions from Surface Impoundments", Environmental Progress, Vol. 3, No. 2, May 1984, p. 73.

Hwang, S., and L.J. Thibodeaux, "Measuring Volatile Chemical Emission Rates from Large Waste Disposal Facilities", Environmental Progress, Vol. 2, No. 2, May 1983, p. 81.

Thibodeaux, L.J., and B. Becker, "Chemical Transport Rates Near the Sediment in Wastewater Impoundments", Environmental Progress, Vol. 1, No. 4, Nov. 1982, p. 296.

Thibodeaux, L.J., and P.S. Christy, "Spill of Soluble, High Density, Immiscible Chemicals in Rivers", Environmental Progess, Vol. 1, No. 2, May 1982, p. 12.

Thibodeaux, L.J., and S. Hwang, "A Model for Volatile Chemical Emissions to Air from Landfarming of Oily Waste", Environmental Progress, Vol. 1, No. 1, Feb. 1982, p. 42.

Thibodeaux, L.J., C. Springer and L.M. Riley, "Models of Mechanisms for the Vapor Phase Emission of Hazardous Chemicals from Landfills", Journal Hazardous Materials, 7 (1982), 63-74.

Thibodeaux, L.J., "Estimating the Air Emissions of Chemicals from Landfills", Jo. Haz. Materials, 4 (1981), 235-244.

Thibodeaux, L.J., "Fluid Dynamic Observations on a Packed Crossflow Cascade at High Loadings", Ind. Eng. Chem. Process Des. Dev., (1980) Vol. 19, 33-40.

Thibodeaux, L.J., K. Pittaway, "Measurements of the Oxygen Desorption Rate in a Single Stage Crossflow Packed Tower", Ind. Eng. Chem. Process Res. Dev.", (1980), Vol. 19, p. 40-46.

Thibodeaux, L.J., and J.D. Millican, "Quantity and Relative Desorption Rates of Air-Strippable Organics in Industrial Waste-Water", Env. Sci. Tech., Vol. 11, No. 9, (September 1977), p. 879.

Thibodeaux, L.J., "Mechanisms and Idealized Dissolution Modes for High Density (p 1), Immiscible Chemicals Spilled in Flowing Water", AIChE Jo., Vol. 23, Nov. 4, (July 1977), p. 544-553.

Thibodeaux, L.J., D.R. Daner, A. Kimura, J.D. Millican and R.J. Parikh, "Mass Transfer Units in Single and Multiple Stage Packed Bed, Cross-Flow Devices", Ind. Eng. Chem. Process Design and Development, Vol. 16, No. 3, (1977), p. 325.

Thibodeaux, L.J. and C.K. Chen, "A Fickian Analysis of Lake Sediment Upsurge", Water Resources Bulletin, Vol. 12, No. 2, April 1976.

Thibodeaux, L.J., "Semi-Infinite Solid Model for Prediction of Temperature in Deep Reservoirs and Lakes", Water Resources Bulletin, Vol. 11, No. 3, June 1975.

Thibodeaux, L.J., "Continuous Crosscurrent Mass Transfer in Towers", Chemical Engineering, Vol. 75, No. 12, June 1969, pp. 165-170.

Thibodeaux, L.J., and P.W. Murrill, "Comparing Packed and Plat Columns", Chemical Engineering, July 18, 1966.

1.C. Other Publications

Proceedings (Manuscript Published)

Segesta, R. and L.J. Thibodeaux, "On-Going Research Activities at L.S.U. Hazardous Waste Research Center", Proceedings 6th Nat. Conf. on Haz. Waste and Haz. Mtls., April 12-14, New Orleans, LA, p. 617-619.

Hedden, T, C. Springer and L.J. Thibodeaux, "Volatile Chemical Mass Transfer to Air From Warm Water in the Absence of Wind", Proceeding (microfiche) AIChE Spring Meeting, Houston, TX, April 2-6, 1989.

Locicero, L., K.T. Valsaraj, D.P. Harrison, L.J. Thibodeaux and D. Wood, "Air Stripping of Volatile Hydrophobics Using Packed Crisscross Flow Cascades", Proceedings (microfiche) AIChE Spring Meeting, Houston, TX, April 2-6, 1989.

Thibodeaux, L.J., "The Environmental Chemodynamic Concepts of Equilibrium and Diffusion Applied to Leaching of Waste Forms", Proceeding Waste Management Technology Center Workshop on Leaching Tests, H.W. Godbee, Editor, Oak Ridge Operations Office, TN, July 21-24, 1987.

Thibodeaux, L.J., G.J. Thoma and C.S. Springer, "The Effectiveness of Poly (vinyl chloride) As a Vapor Barrier for Use in Hazardous Waste Landfills", Proceedings 3rd International Symposium on Operating European Hazardous Waste Management Facilities, Odensa Denmark, Sept. 16-19, 1986.

Thibodeaux, L.J. C. Springer and G. Hildebrand, "Transport of Chemical Vapors Through Soil - A Landfill Cover Simulation Experiment", (Microfiche copy) Proceedings 1986 Summer National American Institute Chemical Engineers, Aug. 24-27, 1986, Boston, MA.

Springer, C., K.T. Valsaraj and L.J. Thibodeaux, "Emissions of Volatile Organics Chemicals from Landfills and Waste Piles", Manuscript #209, 7th Annual Mtg., Soc. Env. Toxicology and Chemistry, Alexandria, VA, Nov. 2-5, 1986.

Hayshi, Y., E. Hirai and L.J. Thibodeaux, "The Characteristics of a Crossflow Cascade Operation in Packed Towers", Proceedings World Congress III in Chem. Eng., Sept. 21-25 (1986), Tokyo, Japan.

C. Springer, K.T. Valsaraj and L.J. Thibodeaux, "Laboratory Investigations of In-situ Emission Control Methods for Surface Impoundments", Manuscript No. 85-70.2, Proceedings 78th Annual Air Pollution Control Association Mtg., Detroit, 1985.

Valsaraj, K.T., C. Springer, T.N. Nguyen and L.J. Thibodeaux, "Investigation of Floating Immiscible Liquids to Control Volatile Organic Emissions from Surface Impoundments", Proc. of Eleventh Annual EPA Research Symp., EPA 600/9-85/013, April (1985) pp. 142-152.

Savant, S.A., D.D. Reible, G.S. Gipson, J.D. Boyle and L.J. Thibodeaux, "An Investigation of the Significance of Convective Transport in River Sediments", to be published in the Proceedings of the 21th Hanford Life Sciences Symposium, Health and Environmental Research on Complex Organic Mixtures, Seattle, WA, 1985.

Thibodeaux, L.J., R.S. Parker and C. Springer, "Design for Control of Volatile Chemical Emissions from Surface Impoundments", Proceedings 2nd International Symposium on Emerging Hazardous Waste Management Technologies, Odense, Denmark, September 11-16, 1984.

Thibodeaux, L.J., "Chemodynamics of Hazardous Waste Treatment - The Volatile Organic Emission Problem", Proceedings of the Corn Refiners Association Scientific Conference, St. Charles, Illinois, June 26-28, 1984.

Springer, C., L.J. Thibodeaux and T. Hedden, "Thermal Effects on the Emission of Volatile Organic Chemicals from Surface Waste-Water Impoundments in the Absence of Wind: Laboratory Measurements", Paper No. 84-3.4, Proceedings Air Pollution Control Association Conference, San Francisco, CA, June 1984.

Hildebrand, G., C. Springer and L.J. Thibodeaux, "A Pilot Scale Study of Volatile Organic Chemicals from Landfills", Proceedings 77 Annual Meeting of the Air Pollution Control Association, San Francisco, CA, June 24-29, 1984.

Carvanos, J., G.H. Sewell, T. Shen and L.J. Thibodeaux, "Validation of Mathematical Models Predicting the Airborne Chemical Emission Rates from Saturated Soils", Paper No. 85-73.4, Proceedings 78th Air Pollution Control Association Conference, Detroit, June 16-21, 1985.

Springer C., K.T. Valsaraj and L.J. Thibodeaux, "Laboratory Investigations of In-situ Emission Control Methods for Surface Impoundments", Proceedings 78th Air Pollution Control Association, Detroit, MI, 1985.

Thibodeaux, L.J., C. Springer and R.S. Parker, "Volatile Organic Emissions Reductions from Surface Impoundments by the Use of Wind Fences and Wind Barriers", Proceedings 11th Annual EPA Research Symposium, Cinn., OH, April, 1985.

Thibodeaux, L.J., C. Springer, and G. Hildebrand, "Air Emissions of Volatile Organic Chemicals from Landfills - A Pilot-Scale Study", Proceedings 10th Annual Research Symposium, USEPA, Ft. Mitchell, KY, April 2-5, 1984.

Springer, C., L.J. Thibodeaux, P.D. Lunney and R.S. Parker, "Secondary Emissions from Hazardous Waste Disposal Lagoons: Field Measurements", Proceedings 9th Annual Research Symposium, USEPA, Ft. Mitchell, KY, May 2-4, 1983.

Thibodeaux, L.J., C. Springer, P. Lunney, S.C. James and T.T. Shen, "Air Emissions Monitoring of Hazardous Waste Sites", Proceedings National Conference on Management of Uncontrolled Hazardous Waste Sites, Hazardous Materials Control Research Institute, Silver Spring, Maryland, 1982, p. 70-75.

Thibodeaux, L.J., C. Springer, T. Hedden and P. Lunney, "Chemical Volatilization Mechanisms from Surface Impoundments in the Absence of Wind", Proceedings of 8th Annual EPA Research Symposium, U.S. Env. Protection Agency, Cincinnatti, OH, (March 8-10, 1982).

Thibodeauxk, L.J., "Transport of Pesticides and Related Chemicals Across Air-Water Interfaces", Predicting of Pesticide Behavior in the Environment, Proceedings of USA-USSR Symposium, October 1981, Yerevan, USSR, EPA-600/9-84-026 Env. Res. Lab., U.S. EPA, Athens, Georgia, Dec., 1984.

Thibodeaux, L.J., D.G. Parker, H. Heck and R. Dickerson, "Quantifying Organic Emission Rate from Surface Impoundments with Micrometeorlogical and Concentrations Profile Measurements", Paper No. 127e, AIChE microfiche preprint in the Engineering Societies Library, United Engineering Center, 345 East 47th Street, New York, New Orleans Ann. Mtg. (Nov. 8-12, 1981).

Thibodeaux, L.J., R. Merill and D. Wolbach, "Pentachlorophenol and Naphthalene, Emissions to Air During Therman Evaporation of Wastewater", paper No. 1196 AIChE microfiche preprint in the Engineering Societies Library, United Engineering Center, 345 East 47th Street, New York, New Orleans Ann. Mtg. (Nov. 8-12, 1981).

Springer, C.S., and L.J. Thibodeaux, "Mechanisms and Models for Predicting the Desorption of Volatile Chemicals from Wastewater", Proceedings 7th Annual Symposium, U.S. Env. Protection Agency, MERL, Cincinnati, OH, (March 1981), p. 85-90.

Thibodeaux, L.J., and D. Moncada, "Performance Comparison of A Crossflow Cascade and A Conventional Countercurrent Operation in Packed Towers", Paper 21st AIChE microfiche preprint in the Engineering Societies Library, United Engineering Center, 345 East 47th Street, New York, Chicago Ann. Mtg. (Nov. 16-20, 1980).

Thibodeaux, L.J., and P.S. Christy, "The Spill of Sinker Chemicals - Laboratory Simulations", Proceedings of the 1980 Conference on Control of Hazardous Materials Spills, (May 13-15, 1980), Louisville, KY p. 369-374.

Thibodeaux, L.J., and D.G. Parker, "Emission of Volatile Chemicals from Wastewater Plants", Special Report, National Council Air Stream Improvement, for Proceedings 1979 So. Regional Mtg., (June 6-7, 1979), New Orleans, LA.

Thibodeaux, L.J., L.K. Chang, J.K. Harris, D.J. Lewis and M.W. Mourot, "Laboratory Results on the Spill of Soluble, High Density Chemicals on Water", Proceedings 4th Joint Conference on Sensing Environmental Pollutants, Washington, D.C. (1978), p. 511-514.

Thibodeaux, L.J., and D.G. Parker, "Desorption Limits of Selected Gases and Liquids from Aerated Basins", AIChE Symp. Series 156, Vol. 72, 1976.

Thibodeaux, L.J., "Air-Stripping of Organics from Wastewater: A Compendium", AIChE Proceedings of 2nd National Conference on Complete Water Reuse, May 5-8, 1975, Chicago, IL, p. 358.

Thibodeaux, L.J., and N.J. Carter, "Coliform Emissions from Air/Water Contractors: A Preliminary Attempt to Establish Maximum Concentrations", AIChE Symp. Series 137, Vol. 70, 1974.

Thibodeaux, L.J., B. Kirsch and D.T. Mitchell, "Methodology of a Regional Industrial Waste-Water Audit", Proceedings of 28th Annual Purdue Industrial Waste Conference, West Lafayette, IN, May 1-3, 1973.

Thibodeaux, L.J., "Measurement of the Relative Volatilization Rates of the Waste-Miscible Fractions in an Aqueous Effluent", AIChE Symposium Series (WATER-1971), 68, 124, p. 169 (1972).

Thibodeaux, L.J., D.R. Smith and H.R. Berger, "Water Renovation Possibilities in the Pulp and Paper Industry", Chemical Engineering Progress Symposium Series 90 (AIChE), Vol. 64, 1968, pp. 178-186.

Reports, Bulletins and Other Prepared Documents

Thibodeaux, L.J., "Theoretical Models for Evaluation of Volatile Emissions to Air During Dredged Materials Disposal with Applications to New Bedford Harbor, Mass.", Miscellaneous Paper EL-89-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS (1989).

Thibodeaux, L.J., and E. Novotny, "Transport of Oil and Nutrients in Course, Steep Beaches", in Proceedings on Beach and Nearshore Workshop for Prince William Sound Bioremediation Project, Editor S.C. McCutchen, Env. Research Lab., EPA, Athens, GA, 1989.

Harrison, D.P., K.T. Valsaraj and L.J. Thibodeaux, "Single Cell and Cascade Crossflow Packed Towers for Air Stripping of Volatile Organics from Groundwater", Final Report, Proj. No. FO-8635-C0159, Air Force Engineering and Services Ctr., Tyndall AFB, Florida, 1989.

Segesta, R., and L.J. Thibodeaux, "The Hazardous Waste Research Center at Louisiana State University", Env. Prog., Vol. 6, No. 1, Feb. 1987, p. 57-61.

Springer, C., K.T. Valsaraj, and L.J. Thibodeaux, "In-situ Methods to Control Emissions from Surface Impoundments and Landfills", U.S. EPA No. EPA/600/2-85/124, October (1985). NTIS No. PB86-121365.

Springer, C., P.D. Lunney, K.T. Valsaraj, and L.J. Thibodeaux, "Emission of Hazardous Chemicals from Surface and Near Surface Impoundments to Air", Final Report, Project No. 808161-02, U.S. EPA, Solids and Hazardous Waste Research Division, Cinn., OH, Feb., 1986.

Dean, J.D., D.F. Atwood, A.S. Dorigan, F.R. Groves, L.J. Thibodeaux, P.S.C. Rao and J.R. Withey, "Exposure Assessment Invoving Mixtures of Environmental Pollutant", Final Report to the U.S. EPA on Contract #68-03-3116.

Thibodeaux, L.J. and D. Wolf, "Impact of High Chemical Contaminant Concentrations on Terrestrial and Aquatic Exosystems: A State-of-the-Art Review", USEPA, Athens Environmental Research Lab., Athens, GA (1983).

Thibodeaux, L.J., D.G. Parker, and H. Heck, "Measurement of Volatile Chemical Emissions from Wastewater Basins", Final Report, U.S. Environmental Protection Agency, IREL, Cincinnati, OH, January, 1982, p. 79.

Thibodeaux, L.J., "Spill of Soluble, High Density, Immiscible Chemicals in Water", DOT/RSPA/DPB-50/78/25, U.S. Department of Transportation, Office of University Research, Washington, D.C. (1978).

Thibodeaux, L.J., "The Quantity of High Volatile Constituents in Industrial Wastewater", Final Technical Letter Report for National Science Foundation, NSF-ENG 74-17316, Washington, D.C., July 1977, p. 6.

Thibodeaux, L.J., "An Aqueous Environmental Simulation Model for Mid-South Lakes and Reservoirs", Water Resources Research Center Pub. No. 41, University of Arkansas, Fayetteville, Arkansas (1976).

Thibodeaux, L.J., "A Test Method of Volatile Component Stripping of Wastewater", Report EPA-660/2-74-044, U.S. Environmental Protection Agency, Washington, D.C. (1974).

Thibodeaux, L.J., "Industrial Wastewater Survey-Northwest Arkansas Water Quality Management Study", Report No. NWARPC/UA-1, Northwest Arkansas Reg. Plan. Comm. Springdale, AR (1972).

Thibodeaux, L.J., "Preliminary Report on National Rejectors Industrial Wastewater Treatment Facilities and Practices", National Rejectors, Inc., Hot Springs, Arkansas (August 1971).

Thibodeaux, L.J., "Natchez Mill Wastewater Improvement Studies", Final Report, International Paper Company, Natchez Mississippi (September 1970).

Thibodeaux, L.J., and R.L. Wright, "Deionization of Paper Industry Wastewater by Ion Exchange", Special Report, Nat. Council Air Stream Imp., 103 Park Ave., New York, New York (May 1970).

Thibodeaux, L.J., and H.F. Berger, "Laboratory and Pilot Plant Studies on Water Reclamation", Tech. Bul. No. 203, Nat. Council Air Stream Imp., 103 Park Ave., New York, NY (July 1967).

Thibodeaux, L.J., "Improvement Study of Scotts Bluff Plant Effluent", Final Report, Naugatuck Chemical Co., Baton Rouge, LA (1964).

2. Items Accepted for Publications

Thibodeaux, L.J., "Theoretical Chemodynamic Models for Predicting Volatile Emissions to Air from Dredged Material Disposal", Intermedia Pollutant Transport: Modeling and Field Measurements, Editors D.T. Allen and I.R. Kaplan, Plenum Pub., N.Y. (scheduled for 1989).

Baron, J.A., L.J. Thibodeaux, D. Reible, C. Henry and P. Templet, "A Laboratory Simulation of Selected Natural Recovery Processes in Contaminated Marine Sediments", Estuaries (accepted 1989).

Valsaraj, K.T., and L.J. Thibodeaux, "Equilibrium Adsorption of Chemicals on Dry Soils: Model Predictions vs Experimental Data", in Fate of Chemicals in the Environment, J.R. Schnoor, Editor, John Wiley and Sons, NY (to be published in 1989).

Wood, D., L. Locicero, K.T. Valsaraj, D.P. Harrison and L.J. Thibodeaux, "Air Stripping of Volatile Organics from Groundwater Using Packed Crisscrossflow Cascade", Environmental Progress (accepted 1989).

Valsaraj, K.T., and L.J. Thibodeaux, "On the Estimation of Micelle-Water Partition Constants for Solutes from Their Octanol-Water Partition Constants, Normal Boiling Points, Aqueous Solubilities, Bond and Group Contribution Schemes", Separation Science and Technology, (accepted 1989).

Valsaraj, K.T., and L.J. Thibodeaux, "Solvent Sublation - A Non-Foaming Adsorptive Bubble Process for Separation of Waste Streams", Proceedings on Advances in Coal and Mineral Processing, S. Chandler, Editor (in press).

Thibodeaux, L.J., K.T. Valsaraj and D.D. Reible, "Chemodynamic Models for Transport of Chemicals From Bed Sediments", Chapter ? in Handbook of Environmental Chemistry, Vol. 2, O. Hutzinger, Editor (in press).

Koulermos, A.C., K.T. Valsaraj, D.D. Reible and L.J. Thibodeaux, "The Effect of Porewater Colloids on the Transport of Hydrophobic Compounds from Bed Sediments", Chapter ? in Organic Substances and Sediments in Water, S. Boyd and C.T. Chiou, Editors, Lewis Publishers, MI (accepted).

3. Artistic or other Creative Contributions

- Sigma Xi White Paper. In 1976-77 the University of Arkansas was in the midst of a transition from a mainly teachers college type role to a research institution also. As Chapter President myself and Dr. Les Simms of Chemistry Department co-authored a white paper report for the University President on the subject of research and its role in a university setting. The document was critical in voicing the support of those faculty members with a strong research bent in a system where teaching was king.

- Inaugral lectural on the occasion of appointment as Professor of Chemical Engineering, title: "Offensive Environmental Chemical Engineering", LSU, Baton Rouge, Dec. 6, 1985 (11 pages).

- Editorial contributions
  Technical: "Offensive Environmental Chemical Engineering", Environmental Progress, Vol. 5, No. 3, Nov. 1986, p. N2-N3.
  Newspaper: Letter on air toxics in Your Views, Morning Advocate, September 27, 1987.
  Guest Columnist, "I am, therefore I polute", Morning Advocate, July 23, 1989.

4. Participation at Professional Meetings

Thibodeaux, L.J., "Physical and Chemical Methods of Kraft Mill Wastewater Treatment", Seminar given to Department of Bio-Environmental Engineering, University of Florida, Gainesville, FL, August 1967.

Thibodeaux, L.J., "Water Pollution Prevention and Treatment", Interdisciplinary Toxicology Seminar, University of Arkansas Animal Science Center, Fayetteville, Arkansas, June 1969.

Thibodeaux, L.J., "Use of Chemical Engineering Design Procedures in Wastewater Treatment", Georgia WPCA Annual Conference, Savannah, Georgia, Sept. 20-23, 1970.

Thibodeaux, L.J., R.B. Estridge and B.G. Turner, "Measurement of the Relative Volatilization Rates of the Water-Miscible Fractions in a Aqueous Effluent", 69th National AIChE Meeting, Cincinnati, OH, May 16-19, 1971.

Thibodeaux, L.J., R.B. Estridge and B.G. Turner, "Simultaneous Biochemical Oxidation, Stripping and Cooling of Kraft Mill Wastewater", 73rd National AIChE Meeting, Minneapolis, MN, August 1972.

Thibodeaux, L.J., "Review of Biotreating Processes for Wastewater", 26th Annual Meeting, Bartlesville Section AIChE, Bartlesville, OK, March 25, 1972.

Thibodeaux, L.J., and N.J. Carter, "Coliform Emissions from Air/Water Contractors: A Preliminary Attempt to Establish Maximum Concentrations", AIChE Meeting, New York, NY, Fall 1972.

Thibodeaux, L.J., B. Kirsch, and D. Mitchell, "Methodology of a Regional Wastewater Audit", 28th Annual Purdue Industrial Waste Conference, West Lafayette, INdiana, May 1-3, 1973.

Thibodeaux, L.J., and D.G. Parker, "Desorption Limits of Selected Industrial Gases and Liquids from Aerated Basins," 76th National AIChE Meeting, Tulsa, OK, March 10-13, 1974.

Thibodeaux, L.J., and J.R. Jones, "A Test Method for Volatile Component Stripping of Wastewater", National AIChE Meeting, Salt Lake City, UT, Fall 1974.

Thibodeaux, L.J., "Air Stripping of Organics from Wastewater-A Compendium", 2nd National Conference on Water Reuse, Chicago, IL, May 5-8, 1975.

Thibodeaux, L.J., "Interphase Transport in the Natural Environment," AIChE Mid-Michigan Section, Midland Michigan, February 18, 1976.

Thibodeaux, L.J., and J.D. Millican, "Quantity and Relative Desorption Rates of the Air-Strippable Organics in Industrial Wastewater", ACS 172nd Meeting, San Francisco, California, August 29-September 3, 1976.

Spill of Sinker Chemicals in Flowing Water, March 12, 1977, Oklahoma Amer. Inst. Chemical Engr., Bartlesville, OK.

Mechanisms and Idealized Dissolution Modes for High Density (p 1), Immiscible Chemicals Spilled in Flowing Water, March 23, 1977, 83rd National AIChE, Houston, TX.

Laboratory Results on the Spill of Soluble, High Density Chemicals in Water, Nov. 6-11, 1977, 4th Joint Conf. Sensing Environmental Pollution, New Orleans, LA.

Laboratory Observation of the Spill of Heavy Liquids (p 1) in Water Dec. 5-7, 1977, 33rd S.W. Amer. Chem. Soc., Little Rock, AR.

Fluid Dynamics of a Packed, Crossflow Cascade at High Loadings, February 26-March 1, 1978, 84th National AIChE, Atlanta, GA.

Fluid Dynamics and Oxygen Desorption Rates in a Crossflow Packed Column, March 22, 1978, Arkansas Section AIChE, Little Rock, AR.

Spill of Soluble, High Density Immiscible Chemicals on Water, June 6, 1978, Department of Transportation, U.S. Coast Guard, Washington, D.C.

Measurement of the Oxygen Desorption Rate in a Single Stage Crossflow Packed Tower, September 10-15, 1978, Amer. Chem. Soc., Miami, FL.

Dissolution Rates of Organic Contaminants Located at the Sediment Interface Rivers, Streams, and Tidal Zones, April 6-13, 1979, Amer. Chem. Soc., Honolulu, HI.

Review of Crossflow Mass-Transfer, May 10, 1979, Norton Chemical Col., Cleveland, OH.

Dissolution Processes in an Unstratified Lake, May 14-15, 1979, Amer. Water Resources Association, Arkadelphia, AR.

Emission of Volatile Organic Carbon and Reduced Sulfur Compounds from Wastewater Treatment Plants, June 6-7, 1979, National Council Air Stream Improvement So. Reg. Mtg., New Orleans, LA.

Sediment/Chemical Dissolution Processes in an Unstratified Lake, Sept. 17, 1979, UA ChE, Fayetteville, AR.

Measurement of Volatile Chemical Emissions from Wastewater Basins, Oct. 29-30, 1979, U.S. Environmental Protection Agency, Industrial Research Environmental Lab., Cincinnati, OH.

Estimating the Air Emissions of Chemicals from Hazardous Waste Landfills, November 25-29, 1979, Annual Mtg. AIChE, San Francisco, CA.

A Review of Crossflow Mass-Transfer, February 29, 1980, Department of Chemical Engineering, University-Missouri, Rolla, MO.

The Spill of Sinker Chemicals-Laboratory Simulations, May 13-15, 1980 Hazardous Spills Conference, Louisville, KY.

An Aerodynamic - Hydrodynamic Interaction Model of the Bottom Water Mass-Transfer Coefficient in Lakes and Similar Waterbodies, Aug. 24-29, 1980, Amer. Chem. Soc., Las Vegas, NV.

Chemodynamics - What we know and what we don't know, Sept. 22, 1980 UA ChE, Fayetteville, AR.

Spill of Soluble, High Density Immiscible Chemicals on Water, Oct. 2, 1980, Department of Transportation, U.S. Coast Guard, Washington, D.C.

Performance Comparison of A Crossflow Cascade and a Conventional Countercurrent Operation in Packed Towers, Nov. 16-20, 1980, Annual Mtg., AIChE, Chicago, IL (Delivered by D. Moncada).

Quantifying Organic Emission Rates from Surface Impoundments with Micrometeorlogical and Concentration Profile Measurements, Jan. 7, 1981, U.S. Environmental Protection Agency, RTP, Durham, NC.

Chemodynamics - What we know and what we don't know, March 5, 1981, Dept. of Chemical Engineering, OK State University, Stillwater, OK.

Models of Mechanisms for Hazardous Chemical Emissions from Landfills, March 29-April 3, 1981, Amer. Chem. Soc., Atlanta, GA.

Chemodynamics - What we know and what we don't know, April 29, 1981, Rensleaar Poly. Institute, Troy, NY.

Chemodynamics - What we know and what we don't know, May 19, 1982, Dow Chemical, Freeport, TX.

Chemodynamics - What we know and whate we don't know, June 10, 1981, Department of Chemical Engineering, Tech. High School, Zurich, Switzerland.

Gas-Side Mass Transfer Coefficient and Interfacial Phenomena of Flat-Bladed Surface Agitators, Oct. 4-9, 1981, Second World Congress Chem. Engr. Montreal, Canada (delivered by James Reinhardt).

Gas Crossflow Distillation in Packed Towers, Oct. 4-9, 1981, Second World Congress Chem. Engr., Montreal, Canada (delivered by Bruce Eldridge).

Transport of Pesticides and Related Chemicals Across Air-Water Interfaces, Oct. 17-31, 1981 US-USSR Symposium on Transport of Pesticides in the Environment, Yerevan, Armenia SSR.

Spill of Soluble, High Density, Immiscible Chemicals in Rivers, Nov. 8-11, 1981, Ann. Mtg. AIChE, New Orleans (delivered by Pattie S. Christy).

Pentachlorophenol and Naphthalene Emissions to Air During Thermal Evaporation of Wastewater, Nov. 8-11, 1981, Ann. Mtg. AIChE, New Orleans, LA.

A Model for Volatile Chemical Emissions to Air from Landfarming of Oily Waste, Nov. 8-11, 1981, Ann. Mtg. AIChE, New Orleans, LA.

Quantifying Organic Emission Rate from Surface Impoundment with Micrometeorological and Concentration Profile Measurements, Nov. 8-11, 1981, Ann. Mtg., AIChE, New Orleans, LA.

A Simulation Study of the Volatilization of Polychlorinated Biphenyls from Landfill Disposal Sites, October 4-8, 1981, 4th Annual Oak Ridge National Laboratory Life Sciences Symposium on Environmental and Solid Waste, Oak Ridge, TN (delivered by C. Springer).

Mechanisms and Models for Predicting the Desorption of Volatile Chemicals from Wastewater, 7th Annual Research Symposium, U.S. Envir. Protection Agency, March 16-18, 1981, Philadlephia, PA (delivered by C. Springer).

Chemical Volatilization Mechanisms from Surface Impoundments in the Absence of Wind, March 8-10, 1982, 8th Annual Research Symposium U.S. Environmental Protection Agency, Cincinnati, OH.

Measurement of Volatile Chemical Emissions from Aerated Stabilization Basins, National Conference on Environmental Engineering, Env. Engr. Div. ASCE, Atlanta, GA, July 1981 (presented by H. Heck).

Thibodeaux, L.J., and C. Springer, presented "Identification of Volatilization Mechanisms" at EPA Research Symposium in Cincinnati, OH (Feb., 1982).

Thibodeaux, L.J., "Off-Site Transport of 2,3,7,8-Tetrachloro-dibenzo-p-dioxin from a Production Disposal Facility" was presented at the American Chemical Society Meeting at Kansas City (Sept. 1982).

Thibodeaux, L.J., and C. Springer, "Air Emission Monitoring of Hazardous Waste Sites" at the National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D.C. (Nov. 1982).

Thibodeaux, L.J., "Chemodynamics at Environmental Interfaces-the Mass Transport Aspects", Monsanto Company Technical Community, St. Louis, MO, Nov. 8, 1982.

Thibodeaux, L.J., "Chemicals in the Environmental", University de Santiago, Santiago de Compostela, Spain, April 19, 1983.

Thibodeaux, L.J., "Hazardous Chemicals in the Environment: Mass Transfer Aspects", University of Exeter, Exeter, England, April 29, 1983.

Thibodeaux, L.J., "Chemical Engineering Research in Hazardous Waste", 7th Anniversary Symp. Arkansas Chemical Industry, Little Rock, AR, Oct. 27-28, 1983.

Thibodeaux, L.J. and C. Springer, "Monitoring and Modelling of Chemical Vapor Emissions from Industrial Hazardous Waste Sites", Third International Symposium on Industrial and Hazardous Waste, June 24-27, 1985, Alexandria, Egypt.

Groves, F.R., D.D. Reible and L.J. Thibodeaux, "Estimation of Physical and Chemical Properties of Waste Organic Mixtures Associated with Land Pollution", American Chemical Society, Miami, FL, April, 1985.

Boyle, J.D., T. Sheppard, R.J. Case, A. Koulermos and L.J. Thibodeaux, "Transfer of Solutes between Water Flowing Above and Through Permeable Riverbeds", American Chemical Society, Miami, FL, April, 1985.

Thibodeaux, L.J., "Volatile Emissions from Toxic and Hazardous Waste", Institute for Environmental Studies, University of Toronto, Toronto, Canada, January 17, 1985.

Thibodeaux, L.J., "The Chemodynamics of Hazardous Chemicals in the Natural Environment-Mass Transport Aspects", Department of Chemical Engineering, University of Toronto, Toronto, Canada, January 17, 1985.

Thibodeaux, L.J., "Estimating and Controlling VOC Emissions from Land Disposal and Treatment Operations", Environmental Design Symposium, Baton Rouge Section, American Institute Chemical Engineers, B.R., November 20, 1985.

Thibodeaux, L.J., "Sources and Initiating Mechanisms for Chemical Contamination of Groundwater", Seminar-Grounded Water Contamination in Louisiana - Issues and Answers, Baton Rouge, February 27, 1986.

Thibodeaux, L.J., "Volatile Chemical Emissions from Toxic and Hazardous Waste in Land Disposal and Treatment Operations - A Review of Selected Literature", Second Annual Conference Current Topics in Hazardous Waste Control, Georgia Tech. Research Institute, Atlanta, February 6-8, 1985.

Thibodeaux, L.J., "Volatile Organic Chemicals from Land Disposal of Waste - Mechanism Emissions and Control Strategies", Feature Paper III, Technology Transfer Conference No. 6, Ministry of Environment, Ontario, Toronto, Canada, December 11-12, 1985.

Thibodeaux, L.J., "Treatment of Hazardous Waste from Chemical Plants and Refineries", Chemical Processing Table Top Show and Seminar, Baton Rouge, LA, September 25, 1985.

Thibodeaux, L.J., "Chemodynamics in the Natural Environment: The Mass-Transport of Chemicals at the Sediment/Water Interface", U.S. EPA, Athens Environmental Research Laboratory, Athens, GA, January 9, 1986.

Savant, S.A., D.D. Reible and L.J. Thibodeaux, "Modeling Convective Transport in River Sediments", to be presented at the National Meeting of the American Chemical Society, Anaheim, CA, September 1986.

Groves, F.R., D.D. Reible and L.J. Thibodeaux, "Estimation of Physical and Chemical Properties of Waste Organic Mixtures Associated with Land Pollution", presented at the National Meeting of the ACS, Miami, FL, May, 1985.

Thibodeaux, L.J., "Sources and Initiating Mechanisms for Chemical Contamination of Groundwater", Groundwater Contamination Issues in Louisiana, Feb. 27, 1986, Baton Rouge, LA.

Thibodeaux, L.J., "Chemodynamics in the Natural Environment: Mass-Transfer of Chemicals at the Sediment/Water Interface", Tulane University, New Orleans, LA, February, 1987.

Baron, J.A., D.D. Reible and L.J. Thibodeaux, "The Natural Recovery Processes of Marine Sediment Contaminated During Offshore Drilling Activities", Presentation 61, Env. Chem. 194th Amer. Chem. Soc. Nat. Mtg., N.O. Aug. 30 - Sept. 4, 1987.

Valsaraj, K.T. and L.J. Thibodeaux, "Equilibrium Adsorption of Chemical Vapors onto Surface Soils: Model Predictions and Experimental Data", USA/USSR Symp. on the "Fate and Transport of Pesticides and Chemicals in the Environment" at Univ. Iowa, Iowa City, Oct. 12-16, 1987.

Thibodeaux, L.J., and K.T. Valsaraj, "The Role of Physical Adsorption in Determining the Equilibrium Vapor Pressure of Volatile Organic Chemicals Above Landfills, Landfarms and Surface Soils", Presentation to Society for Env. Tox. and Chemistry, Penscola, FL, Nov. 9-12, 1987.

Thibodeaux, L.J., "Chemical Transport Across the Mud-Water Interface", N.O. Section AIChE, N.O., Jan. 12, 1988.

Thibodeaux, L.J., "Overview of Research at the Hazardous Waste Research Center at LSU", 1987 Conf. on Haz. Waste Res., Kansas State University, Manhattan, KS, May 20, 1987.

Thibodeaux, L.J., "Chemical Transport Processes Across the Mud-Water Interface of Natural Aquatic Environments", Invited Seminar, Vanderbilt University, Nashville, TN, February 20, 1989.

Thibodeaux, L.J., "Theoretical Chemodynamic Models for Predicting Volatile Emissions to Air from Dredged Material Disposal", Workshop on Intermedia Transport of Pollutants: Modeling and Field Measurements, Los Angeles, August 23-26, 1989.

Thibodeaux, L.J., "Chemical Transport Processes Across the Mud-Water Interface of Natural Aquatic Environments", Presentation before the Environmental Service and Technology Chapter of the Technical Community of Monsanto, St. Louis, MO, May 15, 1987.

Thibodeaux, L.J., "Chemical Transport Across the Mud-Water Interface: Is this Chemical Engineering?", Univ. of Kentucky, Lexington, KY, April 15, 1988.

5. Other Scholarly or Creative Activities and Contributions to Profession

Continuation Education Courses

- Chemodynamics, Transport and Fate of Chemicals in the Environment. After the appearance of the textbook Chemodynamics and starting in 1981 a CE course based on the material has had a continuous record of presentations to date as follows:

  - American Institute of Chemical Engineers, National Headquarters, N.Y. arranged 20 presentation in conjunction with national meetings in the USA.

  - University of Missouri, Columbia, Engineering Extension Center has arranged 8 presentations in midwestern states.

  - University of Arkansas and LSU Continuation Education Departments has had 3 arranged presentations.

  - U.S. Environmental Protection Agency, Cincinnati Laboratory has requested and arranged 2 in-house presentations.

- Environmental Chemical Engineering courses. Prior to the appearance of Chemo. I participated in four environmental engineering short courses on topics ranging from wastewater treatment to air pollution control. These courses were in the years 1969, 1971, 1979 and 1981. A once offered chemodynamic related course was offered by the American Petroleum Institute Specialty Conference in 1985.

Professional Organization Memberships

- American Institute Chemical Engineers, Environmental Division:
  Past Chairman, 1987
  Chairman, 1986
  First Vice Chairman, 1985
  Second Vice Chairman, 1984 (elected)
  Treasurer, 1982-83 (elected)
  Secretary, 1981 (elected)
- American Water Resources Association, Arkansas Section
  President, 1975 (elected)
  Meeting Program Chair, 1972-74.
- Sigma Xi, Hon. Res. Society, Univ. of Arkansas Chapter
  President, 1977 (elected)

- Session Chair (by invitation)
  American Institute of Chemical Engineers, National Chair at annual meetings 1974, 1983 to 1985, 1989.
  American Chemical Society, National Chair at annual meetings 1976, 1985 and 1987.

Professional Engineer Registrations
State of Louisiana No. 11762
State of Arkansas No. 4114

Invited Activities

- American Institute Chemical Engineers, National Speakers Bureau Tours. Commencing in 1987
  I was invited to be a part of this tour:
  - New Orleans Section 1987
  - Southwest Louisiana Section 1989
- Local Section, AIChE
  - Barthesville, OK 1972
  - Mid-Michigan 1976
  - Barthesville, OK 1977
  - Central Arkansas, AR 1978
  - El Dorado, AR 1988
  - Baton Rouge 1989
- Industrial Laboratories
  - Norton Chemical, Akron, OH 1979
  - Dow Chemical, Freeport, TX 1982
  - Monsanto Company, St. Louis, MO 1982
  - U.S. EPA Environmental Laboratory, Athens, GA 1986
  - Monsanto Company, St. Louis, MO 1987
  - Battelle Northwest Laboratory, Richland, WA 1989
- Universities
  - University of Florida, Gainesville 1967
  - University of Arkansas, Fayetteville, 1969, 1979, 1980
  - University of Missouri, Rolla 1980
  - Oklahoma State University, Stillwater 1981
  - Renssalaer Polytechnic Institute, Troy 1981
  - Technical High School, Zurich 1981
  - University Exeter, Exeter 1983
  - University Toronto, Toronto 1985
  - University of Akron, Akron 1985
  - Tulane University, New Orleans 1987
  - University of Kentucky, Lexington 1988
  - University of Illinois, Urbana-Champaign 1989
- Lecture tour Peoples Republic of China, Dec. 1987
  University of Petroleum, Beijing: Three lectures, two days on environmental chemodynamics.
  Jinghan Petroleum Institute, Jingling: Nine lectures, 5 days on env. chemo.
- Delegation member. U.S. Environmental Protection Agency, USA/USSR Agreement of Corporation in Field of Environmental Protection, Project 02.03-31 on "Forms and Mechanisms by which Pesticides and Chemicals are Transported in Soil, Water, and Biota", part of Nixon-Breshnev accords of 1972.

  - Symposium, "Prediction of Pesticide Behavior in the Environment", Oct. 21-27, 1981, Yerevan, Armenia USSR.

  - Symposium, "The Fate of Pesticides and Chemicals in the Environment", Oct. 4-18, 1987, University of Iowa.

  - Exchange, Dr. D. Reible 1988 to Institute of Experimental Meterology, Obninsk, USSR

  - Exchange Dr. Novitskiy 1989 to LSU

Reviews, Workshops, Study Panels, etc.

- National Science Foundation Project "Council on Environmental Quality Conference on Long-Term Environmental Reseach and Development", Expert panel member Geochemical and Hydrologic Processes and their Protection, May 1984, Washington, D.C.
- National Academy of Sciences. Member of review panel on Dioxin Guidelines, Washington, D.C., Nov. 1988.
- National Academy of Sciences. Invited workshop participant, Marine Board study on Contaminated Marine Sediments - Assessment and Remediation, Tampa, FL, May 1988.
- National Academy of Sciences/EPA Study on Disposal of Hazardous-Industrial Waste, member of AIChE committee, March - October 1980.
- U.S. Environmental Protection Agency, panel member: Major Technical Issues Relating to the Land Disposal of Hazardous Waste, Arlington, VA, May 1981.
- U.S. Environmental Protection Agency, workshop member: Determining the Field Applicability of Environmental Assessment Methods", Washington, D.C., March 1982.
- U.S. Environmental Protection Agency, workshop member, "Level I and II Exposure Assessment, Washington, D.C. April 1982, Atlanta, GA, April 1982.
- U.S. Environmental Protection Agency, reviewer: Technology Development Applications Branch, Pesticides Exposure Assessment, Environmental Research Laboratory, Athens, GA, Feb. 1983.
- U.S. Environmental Protection Agency, Peer review panel member: "Dioxin Documents to Assess the Health Risk to Air and Water Media", Cinn., OH, July 1983.
- U.S. Environmental Protection Agency, Peer review panel: Proposals for Office of Exploratory Research, Chemistry and Physics, Chicago, IL, Oct. 1985.
- U.S. Environmental Protection Agency, Peer review panel member: Hazardous Substance Research Center Superfund Program Competition, Arlington, VA, Aug. 1988.
- U.S. Army Corp of Engineers, Workshop member: Development of Leaching Test, Baton Rouge, LA, June 1988.

Advisory Committees

- State of Arkansas, Hazardous Waste Technical Advisory Committee, Member: Appointed by Hon. W. Clinton, Governor (Dec. 1979 - Dec. 1981).
- Louisiana State University, Scientific Advisory Committee member, Hazardous Waste Research Center, Baton Rouge, 1982-83.
- State of Louisiana, Department of Environmental Quality Hazardous Waste Advisory Board: Appointed by Hon. Edwin Edward, Governor (1985-1990).

Editorial Boards

- Journal of Hazardous Materials, G.F. Bennett, Editor, Elsevier Science Publishers, Netherlands
- Hazardous Waste and Hazardous Materials, Norman Beecher, Mary Ann Liebert, Publisher, NY.
- American Environmental Laboratory, Brian Howard, Editor, International Scientific Communications, Publishers, Shelton, CT.

- Journal of Toxicological and Environmental Chemistry, O. Hutzinger, Editor, Gordon and Breach Science Publishers, Ltd, London, GB.

Visiting Scholars

- Professor Yoshishi Hayashi, Department of Chemical Engineering, Kanazawa University, Japan. Visiting professor sabbatical leave to University of Arkansas on joint crossflow mass transfer research, 1979-1980.
- Professor Dr. rer. nat. H.-G. Schecker, Department of Chemical Engineering, Universitat Dortmund, Dortmund W. Germany to University of Arkansas 1983. Visiting Professor in Environmental Chemodynamic Research Laboratory.
- Professor X-Q Wang, Environmental Engineering Labortory Director, University of Petroleum, Beijing, China to LSU. Visiting Professor in Environmental Chemodynamics Laboratory 1989-1990.

6. Awards, Lectureships or Prizes

- Distinguished Award in Teaching and Research, University of Arkansas, Presented by Blue key Arksansas Alumni Association, Inc., 1982 (Plaque and $1,000).
- Outstanding Researcher in Chemical Engineering, College of Engineering, University of Arkansas, 1982 ($1,000).
- Award of Excellence in education, research and service to students, Halliburton Education Foundation, 1982.
- Awarded Off-Campus Duty Assignment for Sabbatical leave to Oregon State University, 1974.
- Awarded Off-Campus Duty Assignment for Sabbatical leave to University of Exeter, Exeter, England, 1983.

7. Grants and Contracts*

Title: Northwest Arkansas Water Quality Management Study-Industrial Wastewater Survey
Agency: U.S. EPA
Period of Support: 1970-72
Total Dollars: $30,000

Title: A Test Method of Volatile Component Stripping of Wastewater in Cooling Towers
Agency: U.S. EPA
Period of Support: 1972-73
Annual Dollars: $38,538
Total Dollars: $38,538

Title: The Quantity of Highly Volatile Constituents in Industrial Wastewaters
Agency: National Science Foundation
Period of Support: 1975-76
Annual Dollars: $24,185
Total Dollars: $24,185

*Does not include Grants and Contracts recieved as Director of Hazardous Waste Research Center.

Title: An Aqueous Environmental Simulation Model for Mid-South Lakes and Reservoirs
Agency: U.S. Dept. Interior
Period of Support: 1973-76
Annual Dollars: $7,079
Total Dollars: $21,237

Title: Spill of Soluble High Density, Immiscible Chemicals on Water
Agency: USCG, DOT
Period of Support and Annual Dollars: 1977 - $48,520
1978 - $46,654, 1979 - $10,642
Total Dollars: $105,816

Title: Measurement of Volatile Chemical Emissions from Wastewater Basins
Agency: U.S. EPA
Period of Support: 1977, 1978, 1979, (extension)
Total Dollars: $127,782

Title: Emission of Hazardous Chemicals from Surface and Near Surface Impoundments into Air
Agency: U.S. EPA
Period of Support and Annual Dollars: 1980-81 $156,872
1981-82 $148,457 1982-83 $154,238
Total Dollars: $459,567

Title: Investigation of Volatile Orgranic Chemical Emission Control Methods from Hazardous Waste Disposal Operations
Agency: U.S. EPA
Period of Support: 1983-85
Total Dollars: $262,888

Title: An Experimental Study of the Short Range Air Dispersion of Toxics from Area Sources
Agency: U.S. EPA Office of Exposure Assessment
Period of Support: 1986
Total Dollars: $75,000

Title: Single Cell and Cascade Crossflow Packed Towes for Air-Stripping of Volatile Organics - Phase I
Agency: U.S. Air Force
Period of Support: April 1986 - October 1987
Total Dollars: $164,947

Title: Laboratory Investigation of the Natural Recovery Processes of Marine Sediment Contaminated During Offshore Drilling Activities
Agency: LSU Center for Energy Studies
Period of Support: August 1986 - July 1987
Total Dollars: $21,023

Title: Single Cell Cascade Crossflow Packed Towers for Air-Stripping of Volatile Organics - Phase II
Agency: U.S. Air Force
Period of Support: Feb. 1988 - May 1989
Total Dollars: $177,747

Title: Solvent Sublation for Removal of Low Solubility Hydrophobic Compounds from Aqueous Systems
Agency: National Science Foundation (NSF)
Period of Support: May 1989-1991
Total Dollars: $127,076

Title: Single Cell Cascade Crossflow Packed Towers for Air-Stripping of Volatile Organics - III (IPA Assignment Agreement)
Agency: U.S. Air Force
Period of Support: October 1989 to September 1990
Total Dollars: $60,026.42

8. Theses/Dissertations Directed

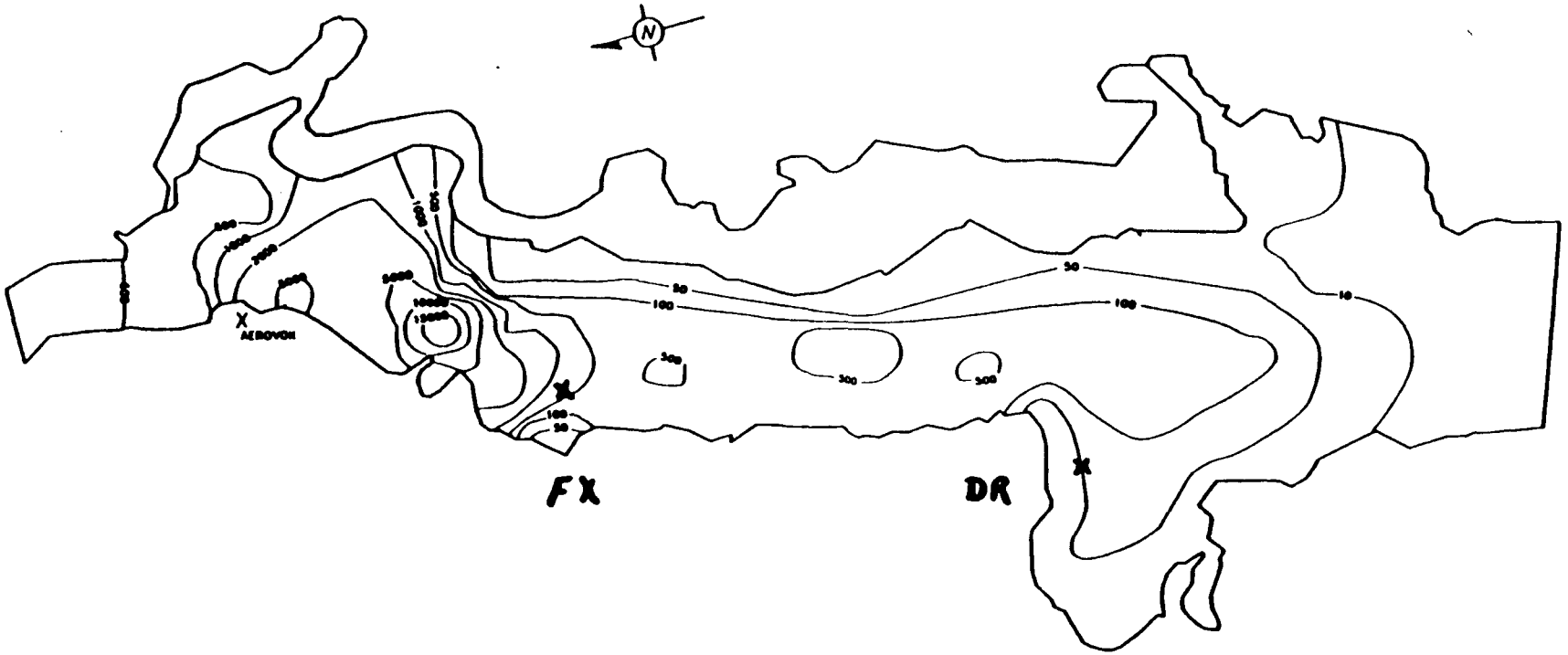
M.S. Theses, University of Arkansas and LSU combined:
36 completed, 1 active.

Ph.D. Dissertations, University of Arkansas and LSU combined:
3 completed, 1 active.

9. Major Areas of Research Interest

Chemical Separation - Developed Crossflow Cascade Contacting Device.

Environmental Chemodynamics - Developing the definition of this new field of environmental engineering/chemistry research.



LEGEND.

500 = A1016/1242 CONCENTRATION ISOPLETH (PPM)

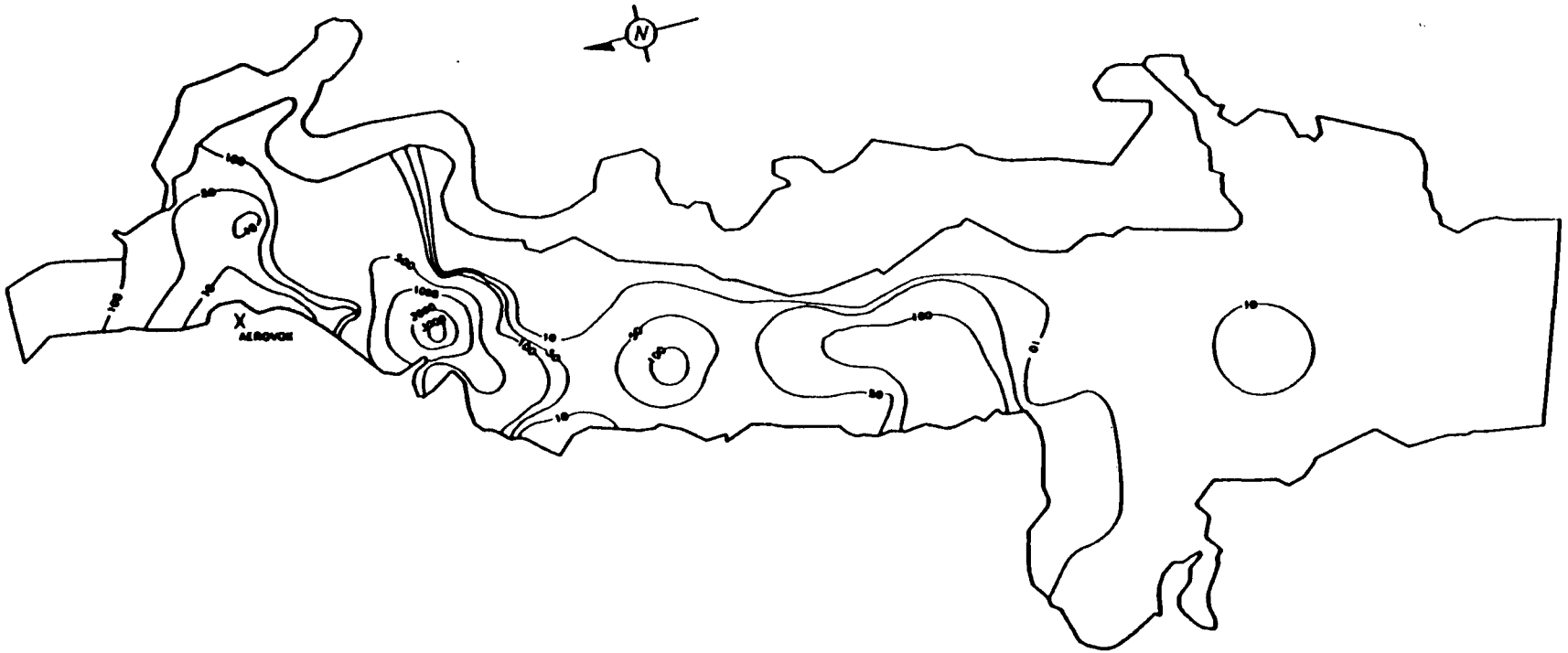
NOTES.

1) ISOPLETHS DEVELOPED USING KRIGING & DATA FROM UNITED STATES ARMY CORPS OF ENGINEERS (AUGUST-OCTOBER, 1985) AND BATTELLE/NUS (JUNE, 1985)

DRAFT

Figure 1

BALSAM ENVIRONMENTAL CONSULTANTS, INC. 20 STILES RD. SALEM, N.H. 03079			MUTTER, MCLENNEN AND FISH
			ISOPLETHS FOR A1016/1242 CONCENTRATIONS 0-12" INTERVAL
	D.J.P.	E.S.W.	NEW BEDFORD HARBOR
	0007wo23	L.C.S.	



LEGEND:

100 = A1248 CONCENTRATION ISOPLETH (PPM)

DRAFT

Figure 2

NOTES:

1) ISOPLETHS DEVELOPED USING KRIGING & DATA FROM UNITED STATES ARMY CORPS OF ENGINEERS (AUGUST-OCTOBER, 1985) AND BATTELLE/RMS (JUNE, 1985)

BALSAM ENVIRONMENTAL CONSULTANTS, INC. 50 STATE RD. SALEM, N.H. 03079			HUTTER, MCCLENNEN AND FISH
			ISOPLETHS FOR A1248 CONCENTRATIONS 0-12' INTERVAL
	D.J.P.	E.S.W.	NEW BEDFORD HARBOR
[redacted]	6003-24	L.C.S.	

EXHIBIT 3

LEGEND:

100 - A1254 CONCENTRATION ISOPLETH (PPM)

DRAFT

Figure 3

NOTES:

1) ISOPLETHS DEVELOPED USING KRIGING & DATA FROM UNITED STATES ARMY CORPS OF ENGINEERS (AUGUST–OCTOBER, 1988) AND BATTELLE/NUS (JUNE, 1988)

BALSAM ENVIRONMENTAL CONSULTANTS, INC. 30 STILES RD. SALEM, N.H. 03079			MUTRIE, MOLEDMEN AND FITH
			ISOPLETHS FOR A1254 CONCENTRATIONS 0–12" INTERVAL
	B.J.P.	E.S.W.	NEW BEDFORD HARBOR
		L.C.S.	

EXHIBIT 4

LEGEND:

— 100 — = TOTAL PCB CONCENTRATION ISOPLETH (PPM)

DRAFT

Figure 4

NOTES:

1) ISOPLETHS DEVELOPED USING KRIGING & DATA FROM UNITED STATES ARMY CORPS OF ENGINEERS (AUGUST-OCTOBER, 1985) AND BATTELLE/NUS (JUNE, 1986)

BALSAM ENVIRONMENTAL CONSULTANTS, INC. 50 STILES RD. SALEM, N.H. 03079			WATER, SEDIMENT AND FISH
			TOTAL PCB CONCENTRATIONS 6" - 12" INTERVAL
	D.J.P.	E.S.W.	NEW BEDFORD HARBOR
		L.C.S.	

EXHIBIT 5

ATTACHMENT F-6

Region I Superfund NPL and Removal Site File Structure

EPA Region I Records Center 7/11/89

Region I Superfund NPL and Removal Site File Structure

1.0 Pre-Remedial

- 1.1 CERCLIS Site Discovery
- 1.2 Preliminary Assessment
- 1.3 Site Inspection
- 1.4 Records Related to CERCLIS
- 1.5 Correspondence Related to CERCLIS
- 1.6 Hazard Ranking System (HRS)
- 1.7 Correspondence Related to Proposal of a Site to the NPL
- 1.8 Responses to Comments on the Proposal
- 1.9 Comments and Responses to Comments
- 1.10 HRS Narrative Summary
- 1.11 Quality Assurance (QA) Signed HRS Package
- 1.12 Hazard Ranking Package
- 1.13 FIT Related Correspondence
- 1.14 FIT Contract
- 1.15 FIT Performance Evaluation
- 1.16 FIT Vouchers
- 1.17 FIT Progress Reports
- 1.18 FIT Technical Direction Documents (TDDs) and Associated Records

2.0 Removal Response

- 2.1 Correspondence
- 2.2 Removal Response Reports
- 2.3 Sampling and Analysis Data
- 2.4 Pollution Reports (POLREPs)
- 2.5 On-Scene Coordinator Reports
- 2.6 Work Plans and Progress Reports
- 2.7 Cost Reports and Invoices
- 2.8 Scopes of Work
- 2.9 Action Memoranda
- 2.10 Interagency Agreements (IAGs)
- 2.11 Applicable or Relevant and Appropriate Requirements (ARARs)
- 2.12 On-Site Registers and Logs
- 2.13 Daily Work Reports
- 2.14 Daily Financial Reports
- 2.15 Removal Response Subcontractor Documents
- 2.16 Delivery Orders/Purchase Orders
- 2.17 CERCLIS Removal Site Records

3.0 Remedial Investigation (RI)

- 3.1 Correspondence
- 3.2 Sampling and Analysis Data
- 3.3 Scopes of Work
- 3.4 Interim Deliverables
- 3.5 Applicable or Relevant and Appropriate Requirements (ARARs)
- 3.6 Remedial Investigation (RI) Reports
- 3.7 Work Plans and Progress Reports
- 3.8 Cost Reports and Invoices
- 3.9 Health Assessments
- 3.10 Endangerment Assessments
- 3.11 Interagency Agreements (IAGs)
- 3.12 Action Memoranda

4.0 Feasibility Study (FS)

- 4.1 Correspondence
- 4.2 Sampling and Analysis Data
- 4.3 Scopes of Work
- 4.4 Interim Deliverables
- 4.5 Applicable or Relevant and Appropriate Requirements (ARARs)
- 4.6 Feasibility Study (FS) Reports
- 4.7 Work Plans and Progress Reports
- 4.8 Cost Reports and Invoices
- 4.9 Proposed Plans for Selected Remedial Action
- 4.10 Interagency Agreements (IAGs)

5.0 Record of Decision (ROD)

- 5.1 Correspondence
- 5.2 Applicable or Relevant and Appropriate Requirements (ARARs)
- 5.3 Responsiveness Summaries
- 5.4 Record of Decision (ROD)
- 5.5 Work Plans and Progress Reports
- 5.6 Cost Reports and Invoices
- 5.7 Interagency Agreements (IAGs)
- 5.8 ROD Briefing Documents
- 5.9 Scopes of Work

6.0 Remedial Design (RD)

- 6.1 Correspondence
- 6.2 Sampling and Analysis Data
- 6.3 Applicable or Relevant and Appropriate Requirements (ARARs)
- 6.4 Remedial Design Documents
- 6.5 Interagency Agreements (IAGs)
- 6.6 Work Plans and Progress Reports
- 6.7 Cost Reports and Invoices
- 6.8 Scopes of Work

7.0 Remedial Action (RA)

- 7.1 Correspondence
- 7.2 Sampling and Analysis Data
- 7.3 Scopes of Work
- 7.4 Applicable or Relevant and Appropriate Requirements (ARARs)
- 7.5 Remedial Action Documents
- 7.6 Work Plans and Progress Reports
- 7.7 Cost Reports and Invoices
- 7.8 Interagency Agreements (IAGs)

8.0 Site Closeout

- 8.1 Correspondence
- 8.2 Deletion from National Priorities List
- 8.3 Operations and Maintenance
- 8.4 Long Term Response
- 8.5 Contractor Work Plans and Progress Reports
- 8.6 Cost Reports and Invoices

9.0 State Coordination

- 9.1 Correspondence
- 9.2 Cooperative Agreements
- 9.3 EPA/State Contracts
- 9.4 Status of State Assurances
- 9.5 Quarterly Progress Reports
- 9.6 Quarterly Financial Reports
- 9.7 Letters of Credit
- 9.8 State Contractor Documents

10.0 Enforcement

- 10.1 Correspondence
- 10.2 Department of Justice (DOJ) - Referral Documents
- 10.3 State and Local Enforcement Records
- 10.4 Interviews, Depositions, and Affidavits
- 10.5 General Negotiations
- 10.6 PRP-Specific Negotiations
- 10.7 EPA Administrative Orders
- 10.8 EPA Consent Decrees
- 10.9 Pleadings -- Directly Related to Trial
- 10.10 Trial Documents
- 10.11 PRP Enforcement Work Plans
- 10.12 Litigation Support Documents
- 10.13 Scopes of Work
- 10.14 Work Plans and Progress Reports
- 10.15 Cost Reports and Invoices

11.0 Potentially Responsible Party (PRP)

- 11.1 PRP Lists
- 11.2 Contractor-Related Correspondence
- 11.3 Contractor Work Plans and Progress Reports
- 11.4 Cost Reports and Invoices
- 11.5 Site Level - General Correspondence
- 11.6 Site Level - Evidence - Government Agency Documents
- 11.7 PRP Steering Committee Documents
- 11.8 Site-Specific Contractor Deliverables
- 11.9 PRP-Specific Correspondence
- 11.10 PRP-Specific Evidence - Government Agency Documents
- 11.11 PRP-Specific Evidence
- 11.12 PRP Related Documents
- 11.13 Financial Status Documents
- 11.14 Title Searches
- 11.15 Non-Binding Allocation of Responsibility (NBAR)
- 11.16 Scopes of Work

12.0 Cost Recovery

- 12.1 Correspondence
- 12.2 Software Package for Unique Reports (SPUR Reports)
- 12.3 Cost Summaries
- 12.4 Travel Vouchers
- 12.5 Timesheets
- 12.6 Agency Indirect Costs
- 12.7 Miscellaneous Procurement Expenses
- 12.8 Interagency Agreements (IAGs)
- 12.9 State Cooperative Agreements
- 12.10 State Contracts
- 12.11 Contractor Deliverables
- 12.12 Contractor Work Plans and Progress Reports
- 12.13 Cost Reports and Invoices
- 12.14 Cost Recovery Documentation Checklists
- 12.15 Contractor Cost Information

13.0 Community Relations

- 13.1 Correspondence
- 13.2 Community Relations Plans
- 13.3 News Clippings/Press Releases
- 13.4 Public Meetings
- 13.5 Fact Sheets
- 13.6 Mailing Lists
- 13.7 Technical Assistance Grants
- 13.8 Scopes of Work
- 13.9 Work Plans and Progress Reports
- 13.10 Cost Reports and Invoices

14.0 Congressional Relations

- 14.1 Correspondence
- 14.2 Transcripts
- 14.3 Testimonies
- 14.4 Published Hearing Records

15.0 Freedom of Information Act (FOIA) Management

- 15.1 Correspondence
- 15.2 Requests
- 15.3 Responses

16.0 Natural Resource Trustee

- 16.1 Correspondence
- 16.2 Interagency Agreements/Memoranda of Understanding
- 16.3 Natural Resource Trustee Release
- 16.4 Trustee Notification Form and Selection Guide
- 16.5 Technical Issue Papers

17.0 Site Management Records

- 17.1 Correspondence
- 17.2 Access Records
- 17.3 Site Security Records
- 17.4 Site Photographs/Maps
- 17.5 Site Descriptions/Chronologies
- 17.6 Site Management Plans
- 17.7 Reference Documents
- 17.8 State and Local Technical Records
- 17.9 Site Safety Plans

18.0 Initial Remedial Measure (IRM) Records

- 18.1 Correspondence
- 18.2 Sampling and Analysis Data
- 18.3 Scopes of Work
- 18.4 Initial Remedial Measure (IRM) Reports
- 18.5 Work Plans and Progress Reports
- 18.6 Cost Reports and Invoices
- 18.7 Operations and Maintenance Records
- 18.8 Action Memoranda
- 18.9 Interagency Agreements (IAGs)

19.0 Resource Conservation and Recovery Act (RCRA) Records

- 19.1 Correspondence
- 19.2 Notification Form – Part A
- 19.3 Notification Form – Part B
- 19.4 RCRA Facility Inspection Reports
- 19.5 RCRA Enforcement Action Records
- 19.6 Notifications of Hazardous Waste Activity

ATTACHMENT F-7

Excerpt from Court Transcript of February 7, 1990

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

UNITED STATES OF AMERICA, Plaintiff v. AVX, INC., ET AL, Defendants.	CIVIL ACTION Nos. 83-3882-Y, 83-3899-Y and 84-2044-Y
COMMONWEALTH OF MASSACHUSETTS, Plaintiff v. AVX, INC., ET AL, Defendants.	

PRETRIAL CONFERENCE
BEFORE: The Honorable William G. Young,
District Judge

Post Office and Courthouse
Boston, Massachusetts 02109

February 7, 1990

1 the extent that none are proved, no quantification can
2 follow.
3 And not only a cataloguing of the variety of
4 impacts, but a basis for the extent temporally of the
5 impact so that a second jury can quantity it. And I want
6 to explain that because I think it needs explanation and
7 I think that was implicit and indeed is required by my
8 prior rulings and so that must be proved in these next
9 twelve weeks.
10 Now then, with respect the following motions, the
11 Court deals first with United States 31. United States
12 31 is allowed. Specifically, the following exhibits
13 marked in this hearing, because they've been narrowed
14 somewhat by a submission that I required, Docket Number
15 1594, are ruled to be authentic pursuant to Federal Rules
16 of Evidence 9024. They are Exhibits B and Exhibits J
17 through B O inclusive. So docket Number 1523, motion
18 U. S. 31 allowed.
19 The Court turns to motion U. S. 30. The motion
20 seeking to have the Court rule that the same exhibits,
21 Exhibits B and Exhibits J through B O inclusive, are
22 admissible in evidence, and I'll make my ruling only as
23 to those that in 1594 you spelled out you want admitted.
24 And to use the government, the Court makes the following
25 ruling with respect to the admissibility of certain

1 exhibits under 803(8)(C): The governments' in that
2 respect is allowed with the following exceptions: So
3 much of Exhibit P as is set forth on Enclosure 1; so much
4 of Exhibit R as is set forth on Enclosure 1; and Exhibit
5 B O are excluded.
6 Now, that will be in the court notes, refer to the
7 transcript with respect to the reasoning being the Court
8 goes on to explicate or I'll go on and explicate my
9 reasoning now.
10 The first two exhibits of course are the Coast
11 Guard studies about which I've heard a gread deal. And
12 I've reflected a long time on the meaning of the word
13 "trustworthiness." And having referred or having
14 reviewed my -- the affidavits that were filed, reflected
15 on the credibility of the live witnesses that appeared
16 before the Court, I cannot say that if the word
17 "trustworthiness," in 803(8)(C) is to be equated with
18 credibility or believability, that this data is not
19 trustworthy. But I don't think that's the only meaning
20 of the word.
21 In context where the result is a listing of what
22 purports to be a specific quantification of PCBs, I
23 simply don't think that the listing that I've been given
24 on Exhibits P and R and their respective enclosure,
25 Enclosures 1, is of the same level of quantifiable

1 determination as certain of the other studies, the Webb &
2 McCall study, which is mechanistic, the sum of the peaks
3 valleys. And I think importing to these two documents
4 something of the nature of the balancing that goes on
5 under Federal Rule of Evidence 403, I simply can't say --
6 I think it's misleading to a jury with these listings
7 which are judgemental opinion of the results of three
8 different types of gas chromatography, an opinion that
9 varies from exhibit or from site or test to test, I
10 simply don't think that the rule warrants going that far.
11 And under 803(8)(C), I exclude those specific
12 pages of those specific documents. The exclusion, of
13 course, is without prejudice to calling before the jury
14 the same or other witnesses that were called before the
15 Court and laying the foundation to put that data before
16 the jury.
17 So that's the ruling. The documents I have
18 ordered admitted in evidence will tomorrow be numbered by
19 the clerk, starting with the Number 1. They are all
20 admitted. The reason I excluded B O about which I didn't
21 hear very much on the record, but I've looked at all
22 these exhibits, is that B O appears to be an affidavit in
23 an administrative proceeding. And my problem with that
24 is not its trustworthiness, but I simply don't think that
25 factual reports designed for an administrative

ATTACHMENT F-8

Public Health and Environmental Risk Assesment
for the New Bedford Harbor Superfund Site

Public Health and Environmental Risk Assessment for the New Bedford Harbor Superfund Site

Elizabeth A. Ryan
Michael J. Donato
Susan L. Santos
Janet A. Burris
E.C. Jordan Co.
Wakefield, Massachusetts

ABSTRACT

A complete public health and environmental risk assessment was prepared as part of the RI/FS being conducted for the New Bedford Harbor Superfund site. This site posed some unique risk assessment challenges due to its size and the nature, level, and extent of contamination. The extensive data base generated for the project was used in this risk assessment to provide the most site-specific evaluation possible of the baseline exposures and risks to public health and aquatic organisms in the New Bedford Harbor.

The public health risk assessment divided the site into three areas based on location and level of contamination. The land usage within each area was determined to identify specific locations where exposure to contaminated media was considered likely. The significant routes of exposure were determined to be: (1) direct contact with and ingestion of contaminated sediments; (2) ingestion of contaminated biota; and (3) inhalation of air-borne contaminants. Using the Hydrodynamic-Sediment Transport model, location-specific exposure concentrations were used to estimate human exposure dose levels. Numerous risk scenarios were developed to reflect the varied exposure conditions that exist at this site. The body dose levels were evaluated using the most appropriate route-specific dose-response information. In addition, contaminant-specific dermal absorption factors were derived to assess direct contact exposure to sediments. The carcinogenic and noncarcinogenic risks from acute, chronic, and lifetime exposure to Polychlorinated biphenyls (PCBs) and three metals (cadmium, copper, and lead) were evaluated for the significant routes of exposure.

The ecological exposure and risk evaluation assessed the impacts of PCB and heavy metal exposure on aquatic organisms. Direct contact exposure to the water column and sediments were evaluated, and a food chain was constructed to demonstrate the potential for biomagnification of contaminants throughout the New Bedford Harbor ecosystem. Ongoing studies by the EPA Narragansett Laboratory and the U.S. Army Corps of Engineers (U.S. ACE), as part of the Pilot Study for this site, provided site-specific toxicity data which were used to evaluate potential risks associated with exposure to contaminated sediments.

In addition to the standard comparisons between observed water concentrations of contaminants and Ambient Water Quality Criteria (AWQC), Toxicity Quotients (TQs) also were used to evaluate potential risk to aquatic organisms via direct contact with water-borne contaminants. The TQ approach provided a more accurate means for assessing the potential toxicity of PCBs to the different lifestages of various aquatic organisms. The overall risk to the ecosystem was evaluated by assessing overall ecosystem integrity and stability. In addition, the assessment examined the failure of adult fish to spawn as one of the possible causes of reduced fish populations.

This paper presents the methodologies used to assess exposure and risk for this Superfund site and describes how this information was used to assist in determining site cleanup objectives.

INTRODUCTION

The New Bedford Harbor Superfund site, as listed on the NPL, includes the upper estuary of the Acushnet River, New Bedford Harbor, and portions of Buzzards Bay. This area is located between the City of New Bedford on the west and the towns of Fairhaven and Acushnet on the east at the head of Buzzards Bay, Massachusetts. Between 1974 and July 1982, several environmental studies were conducted to assess the magnitude and extent of PCB and heavy metal contamination in New Bedford Harbor. Testing revealed that PCBs had

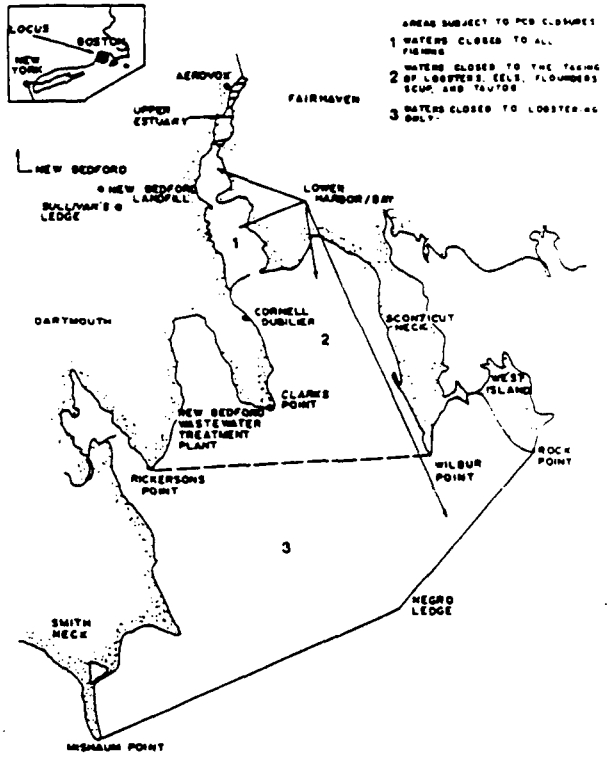


Figure 1
Fishing Closure Areas
New Bedford, Massachusetts

been discharged into the surface water of the Acushnet River, causing high PCB concentrations in sediment, water, fish, and shellfish. The sediments in the northern portion of the Acushnet River (upper estuary) had PCB concentrations ranging from a few ppm to over 100,000 ppm and heavy metals ranging from a few ppm to over 5,000 ppm. Concentrations of PCBs in the surface water of the Acushnet River were also found to be high and, in some areas, in excess of the AWQC for PCBs. Concentrations of PCBs in locally caught fish and shellfish were found to exceed the Food and Drug Administration (FDA) tolerance level of 2 ppm set for PCBs (previously 5 ppm).

To reduce the potential for human exposure to PCBs, the Massachusetts Department of Public Health (MDPH) closed New Bedford Harbor to fishing. Three closure areas were established on Sept. 25, 1979. Area 1 (New Bedford Harbor) was closed to the taking of all finfish, shellfish, and lobster. Area 2 (Hurricane Barrier to a line extending from Ricketson Point to Wilbur Point) was closed to the taking of lobster and bottom-feeding fish (i.e., eels, scup, flounder, and tautog). Area 3 (Area 2 out to a line from Mishaum Point, Negro Ledge, and Rock Point) was closed to the taking of lobster (Fig. 1). These areas remain closed at the time this report was written.

In 1984, the U.S. EPA conducted an FS of the highly contaminated mud flats and sediments in the upper estuary of the Acushnet River, and presented five clean-up options for this area. The U.S. EPA received extensive comments on these options from other federal, state, and local officials, PRPs, and the public. Many of these comments expressed concern regarding the proposed dredging techniques, potential impacts of dredging on the harbor, and the potential release of leachate from the proposed unlined disposal sites.

In responding to these comments, the U.S. EPA decided it was necessary to conduct additional studies before choosing a final cleanup alternative for the upper estuary. Concurrent with these studies, the U.S. EPA is evaluating the extent of PCB and other contamination throughout the overall harbor and bay, and developing cleanup options for these areas as well. As part of this effort, a risk assessment, which serves to establish the existence of actual a public health and the environment and to est these risks, is being developed. This risk a sampling data contained in the New Bedfor various site investigation reports. Inform tion Bedford Health Effects Study and ong tu Study and Wetlands Assessment being du used.

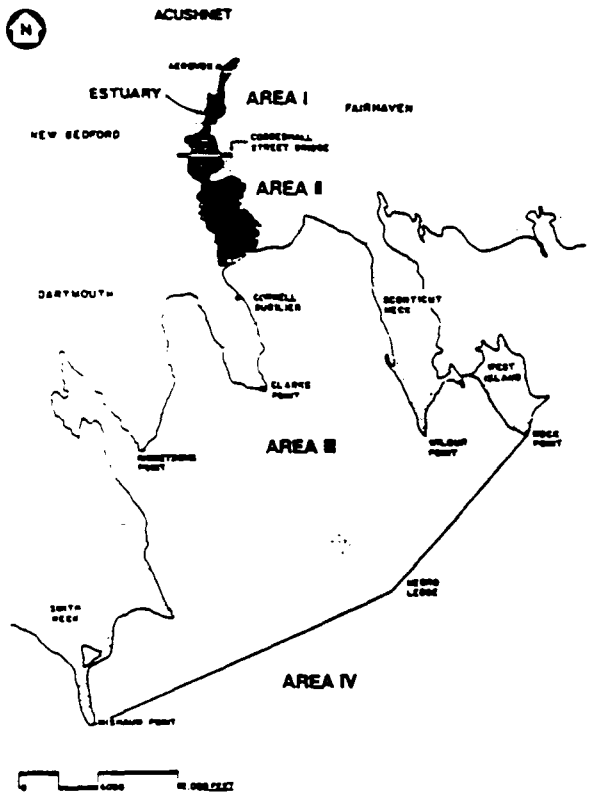


Figure 2
Areas Used to Assess Exposure to Water and Sediments
New Bedford, Massachusetts

Description of the Site

The Acushnet River estuary, part of the drainage area, is one of a series of estuari southern coast of Massachusetts. The mouth o tidal estuary forming New Bedford Harbor, di western side of Buzzards Bay.[1]

For this risk assessment, the Acushnet Riv area was subdivided into three areas to asse exposure. The subdivision, which was based nant concentrations detected in the water an areas, separates areas of high contamination areas of relatively low contamination (south of These areas are depicted in Figure 2 and are d

- Area I: The area between the Wood Stree bridges
- Area II: The area between the Hurri Coggeshall Street Bridge
- Area III: The area south of the Hurricane

Another subdivision of the Acushnet Rive area was used to assess exposure through the biota. This subdivision was established to be rent modeling. These areas are depicted in Fig

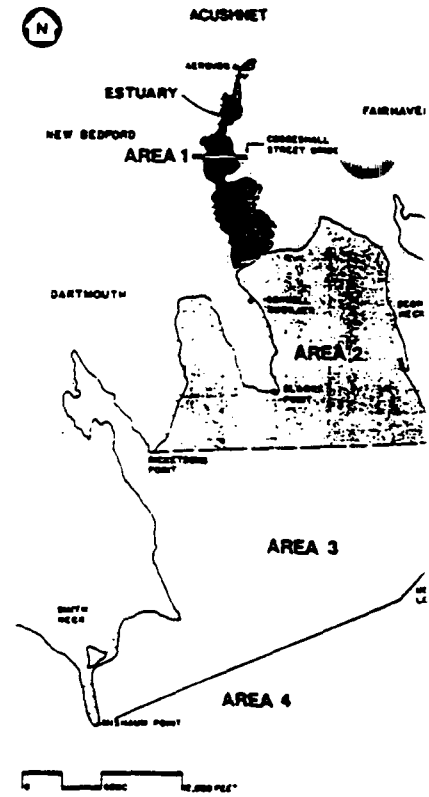


Figure 3
Areas Used to Assess Exposure t
New Bedford, Massachusett

In summary, exposure to sediments wat three areas referred to by Roman als

exposure through the ingestion of aquatic biota was assessed for the four areas referred to by Arabic numerals (1, 2, 3, and 4).

CONTAMINANTS MEASURED AT THE SITE

The U.S. EPA and its contractors measured over 29,000 contaminant parameters in sediment, water, and biota samples taken at the site. The chemical analysis of these samples revealed the presence of elevated levels of volatile, semi-volatile, and inorganic constituents. Using the sediment data for this site, E.C. Jordan Co. (Jordan) defined the extent of organic contamination (i.e., location and frequency of detection) and determined the potential for exposure to these compounds based on predicted human activities and environmental conditions. Most organic compounds detected in sediments were colocated with PCBs and occurred at concentrations less than or equal to the observed PCB concentrations. The relative toxicity of these compounds, with respect to the toxicity of PCBs, indicated that the risk from contaminant exposure will be attributable to the PCB contamination.[2] Based in part on this review, PCBs were chosen as the major contaminant of concern. To provide indicator compounds for the inorganic constituents, three heavy metals also were selected: cadmium, copper, and lead.

An extensive data base containing contaminant concentrations for all media throughout Acushnet River and Buzzards Bay was developed and used in this risk assessment to provide exposure concentrations for various receptor locations within the New Bedford Harbor area. The majority of sample analyses in this data base were obtained between 1981 and 1986 and, therefore, were considered to provide an accurate description of the present extent and level of PCB and metal contamination.

PUBLIC HEALTH RISK CHARACTERIZATION

The public health risk evaluation, developed using guidance published by EPA, consists of three sections: an Exposure Assessment, a Toxicity Evaluation, and a Risk Characterization.[3,4] The following sections summarize the results.

Toxicity Evaluation

PCBs, cadmium, copper, and lead all have been shown to cause adverse public health effects from chronic and/or acute exposures via the oral, dermal, and inhalation routes of exposure. However, the nature and severity of these adverse effects vary for each compound as well as route of exposure. As part of the toxicity evaluation, a dose-response assessment was performed to provide route-specific information on the potency of individual chemicals. Included in this assessment were the pertinent standards, criteria, advisories, and guidelines developed to protect public health.

Exposure Assessment

The exposure assessment was performed to identify potential receptors (i.e., individuals or populations) and describe the mechanisms by which persons may be exposed to contaminants at the New Bedford Harbor site. This assessment was based on land use and demographic information for this area and assumptions regarding the frequency and duration of activities likely to result in contaminant exposure. The demographic, land use, and exposure information used to complete this section included the Greater New Bedford Health Effects Study, the Federal Census, the "Land Use and Point Source Inventory, New Bedford, Massachusetts and the "New Bedford Harbor Site Visit; Summary Report".[5,6,7,8]

This subsection describes human exposure in quantitative terms which reflect the behavioral patterns and the physical and chemical conditions at the site.

Jordan's analyses[2] of the demographic and land-use information, as well as activity and behavior patterns, indicate that exposure to contaminants in the New Bedford Harbor area could occur through dermal contact with sediments, ingestion of water and biota, and/or inhalation of air-borne contaminants. A quantitative screening analysis of these exposure pathways was performed; the following pathways were considered significant:

- Ingestion of aquatic biota
- Direct contact with sediments
- Ingestion of sediments
- Inhalation of airborne contaminants

These exposure pathways, which accounted for over 99% of the potential contaminant exposures within the New Bedford area, were the focus of the risk assessment. Exposure to contaminants from direct contact with and/or ingestion of surface water was not considered because the PCB water concentrations where exposures would likely occur are not considered harmful to public health.

Exposure scenarios were developed to provide quantitative estimates of the potential exposure dose received via the principal exposure pathways. These scenarios were based on a variety of exposure conditions, including exposure to both the mean and maximum contaminant levels detected in the various media at specific locations, and under acute, chronic, and lifetime exposure durations (Fig. 4). These scenarios, which are the basis of all subsequent risk estimates generated and evaluated in this report, are summarized below in the following sections.

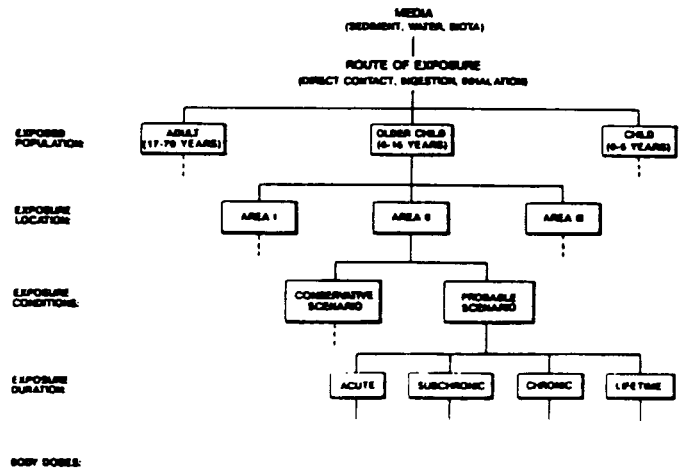


Figure 4
Flow Chart of Exposure Scenarios Evaluated
New Bedford, Massachusetts

Exposure Via Direct Contact with Sediments

The land use and activity analysis indicates that persons of all ages may contact contaminated sediments during recreational activities such as swimming, wading, and shellfishing. Therefore, contaminant exposure was evaluated for specific locations that support recreational activities within the New Bedford Harbor area. These areas include Popes Island, Marsh Island, Palmer Island (Area II), the Fort Rodman and Fort Phoenix state beaches, and the mud flat areas in the upper estuary (Area I) (Fig. 5).

Direct contact exposure was evaluated using both the mean and maximum contaminant concentrations detected in shoreline sediments. The frequency of contact was estimated between 20 and 100 times per year (corresponding to 1 and 5 days/wk during summer months).

EXPOSURE VIA INGESTION OF SEDIMENTS

These scenarios parallel the exposure scenarios used to evaluate direct contact exposure; however, they were only evaluated for children. It was assumed that a child ingests 0.5 g of sediment per visit. The mean and maximum contaminant concentrations detected in shoreline sediments were used to evaluate exposure.

Exposure Via Ingestion of Fish

Exposure to contaminants through the ingestion of aquatic biota is considered a primary route of exposure at New Bedford Harbor because, in general, it has been noted that seafood consumption is a

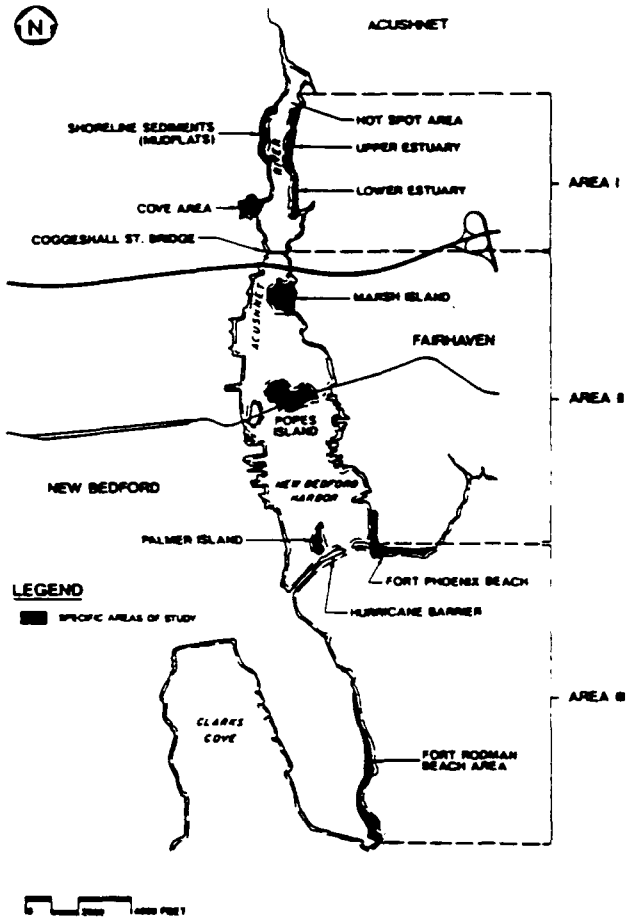


Figure 5
Exposure Locations Used to
Assess Direct Contact to Sediments
New Bedford, Massachusetts

primary source of PCB exposure in the U.S.[9]

Exposure frequencies of one fish meal per day, one fish meal per week, and one fish meal per month were evaluated. This range reflects reasonable exposure frequencies for both tourists (short-term exposure) and residents (chronic and lifetime exposure). The amount of seafood ingested per meal was considered to be a standard 8-oz (227 g) portion. Both the mean and maximum contaminant concentrations detected in the edible portion of fish and shellfish were used to assess exposure (when available).

EXPOSURE VIA INHALATION OF AIRBORNE CONTAMINANTS

Limited air monitoring data were available for the New Bedford Harbor area to develop exposure scenarios. However, to provide some indication of the potential exposure, the data collected in 1985 were used to represent possible PCB exposure concentrations.

Inhalation rates of 5, 20, and 20 m^3/day were assumed for children, older children, and adults, respectively.[3] Daily exposure frequencies with exposure occurring 8 and 24 hr/day were assumed.

RISK CHARACTERIZATION

In the risk characterization section, the potential non-carcinogenic and carcinogenic risks associated with contaminant exposure at the New Bedford Harbor site were evaluated. The estimated body dose levels of PCBs and metals developed for each exposure scenario were evaluated using the appropriate health-based standards and criteria information obtained from the dose-response assessment.

Carcinogenic risk estimates were calcula
potency factor of the chemical by the est
product of these two values is an estimate of
cancer risk, which is defined as the exc
individual will develop cancer over a ie.

The method used to estimate car eni
EPA's linearized, multistage model of carc
This model assumes that no threshold val
exposure to a carcinogen can be considered
fore, any positive dose is assumed to result in
individual's lifetime risk of developing cancer
nogenic risk estimates generally appear in
example, a 2×10^{-6} incremental risk level im
probability of manifesting cancer is two in on

EPA guidance states that the total target
individual resulting from exposure at a Superf
10^{-4} to 10^{-7}.[3] Therefore, remedial alternative
reduce the total potential carcinogenic risks t
this range.

The non-carcinogenic risk estimates were
the exposure dose for each contaminant to the
based standard or criteria value. The ratio of
levels to these standards or criteria values i
Generally, if the risk ratio is less than 1, the p
is anticipated to be without lifetime risks
exceeds 1, the estimated average daily dose ex
safe; therefore, the exposure could potentially
effects. Results of the risk characterization are
in the following sections.

Direct Contact Exposure to Sediments

The non-carcinogenic risk estimates assoc
PCBs, cadmium, copper, and lead were bel
present a risk to public health. These include
acute (or once-in-a-lifetime) exposure to sedir

The carcinogenic risks associated h su
lifetime exposure to shoreline sedir in
exceeded the target range of 10^{-4} to Th
based on exposure scenarios for children, old
Methods to reduce these risks will be evaluate

Exposure to sediments from Areas II and
locations where exposure was considered
locations were identified based on known re
land uses in the two areas.

Exposure to sediments from the Popes Islan
in excess lifetime carcinogenic risks that fell
10^{-4} to 10^{-7} Methods to reduce these risks to
range will be evaluated in the FS. The car
based on exposure at other locations in Area
and Marsh Island), and all locations in Area II
Phoenix state beaches), were not considered
risk.

Ingestion of Sediments

The non-carcinogenic risks associated wi
cadmium, copper, and lead through the inge
ments were not considered to present a risk to

The carcinogenic risks associated with ex
sediments in Area I were within or exceeded t
10^{-7}. Therefore, methods to reduce these risks
FS. The carcinogenic risks associated with the
from the Fort Rodman and Fort Phoenix
considered significant.

Ingestion of Aquatic Biota

The non-carcinogenic risk estimates assoc
PCBs and lead through the ingestion of aquat
considered protective of public healt
to these compounds exceeded 1 und

including subchronic and chronic exposures. Acute exposure (e.g., one 400-g fish meal) was not considered to present a risk to public health.

The carcinogenic risks associated with the ingestion of aquatic biota contaminated with PCBs were within or exceeded the target range of 10^{-6} to 10^{-7}. These included risks associated with daily, weekly, and monthly ingestion frequencies over a chronic exposure duration.

Inhalation of Air-borne Contaminants

Limited air data were available to assess risk from this route of exposure. Lifetime exposure to the assumed "background" concentration of 10 ng/m^3 PCBs for the New Bedford Harbor area presents incremental carcinogenic risks in the 10^{-6} range. These risk estimates were based on conservative exposure conditions. This route of exposure will be re-evaluated once additional air data become available.

Air exposures to other contaminants are not at levels associated with adverse health effects.

ECOLOGICAL RISK CHARACTERIZATION

The ecological risk assessment for the New Bedford Harbor site examined the potential risks to aquatic biota from exposure to PCBs, cadmium, copper, and lead. This evaluation consisted of three sections: an Exposure Assessment, an Ecotoxicity Assessment, and a Risk Assessment. These sections are summarized in the following sections.

Exposure Assessment

The exposure assessment identified 33 aquatic species common to New Bedford Harbor in order to represent potential receptors and to describe contaminant exposure at this site. The 33 species represented five different classes of organisms, including each major trophic level. Exposure to PCBs, cadmium, copper, and lead was evaluated for these species, for direct contact exposure to water-borne and sediment-bound contaminants, and for ingestion of contaminated biota. In addition, a food web was constructed to illustrate the interdependence of aquatic organisms and the potential risk to the ecosystem as a whole when individual components are potentially affected by PCBs and metals.

Ecotoxicity Assessment

The ecotoxicity assessment provided information regarding the effects associated with exposure to PCBs, cadmium, copper, and lead. The available toxicological information shows that these compounds elicit adverse effects to aquatic organisms from acute and chronic exposure.

Comparisons between these toxicity values and contaminant concentrations detected in sediment, water, and biota were made to evaluate the potential ecological risk. Site-specific toxicity data were used when available. In addition, the U.S. EPA AWQC were used to evaluate potential risks from direct contact exposure to waterborne contaminants.

RISK CHARACTERIZATION

The risk evaluation consisted of comparing environmental contaminant concentrations to appropriate toxicity values to estimate the potential risks to aquatic organisms at New Bedford Harbor. These risks are summarized by medium in the following sections.

Water

Metal concentrations in water were compared to the appropriate AWQC to determine potential risks to aquatic organisms. Mean contaminant concentrations were compared to chronic AWQC, and maximum contaminant concentrations were compared to acute AWQC. The results of these comparisons indicated a risk to biota in Areas I and II, and possibly Area III, due to exposure to copper. Copper concentrations in these areas exceeded levels considered protective of aquatic life and its uses. Cadmium and lead concentrations were below their respective AWQC in all areas (i.e., maximum concentrations were below chronic criteria). Although reported concentrations of lead and cadmium are below applicable criteria, they may contribute to toxicity as a result of additive or synergistic effects.

Because the AWQC for PCBs are based on the uptake and retention of PCBs by aquatic organisms rather than ecotoxicity data, potential risks to aquatic organisms from PCB exposure were estimated using benchmark concentrations. The mean dissolved PCB concentration in each area was compared to species-specific ecotoxicity data. This comparison, referred to as the toxicity quotient analyses in the risk assessment, indicates that PCB concentrations in Areas I and II exceed levels shown to elicit toxic effects to aquatic organisms. As such, exposure to the surface water in these areas represents a potential risk to aquatic organisms. Few or no adverse effects were indicated for Area III, and no adverse effects are expected outside of Area III due to PCB exposure in the water column.

Sediments

Sediments from Areas I and II were found to be toxic to exposed test organisms (in particular, amphipods and sheepshead minnows), indicating the potential for adverse effects to organisms in these areas. High mortality rates were observed in amphipods exposed to sediments obtained from Areas I and II. In the same study, sheepshead minnows experienced significant mortality and reduced reproductive capacity when exposed to sediments from Area I and significantly reduced reproductive capacity when exposed to sediments from Area II. However, no significant adverse effects were observed with sheepshead minnows or amphiphods exposed to New Bedford Harbor sediments collected near the Hurricane Barrier (southernmost end of Area II).

Biota

Body burdens of PCBs detected in winter flounder from the New Bedford Harbor area were above levels shown to elicit toxic effects. The mean whole-body PCB concentrations for the winter flounder in all areas were greater than tissue levels found to impair reproduction in two phylogenetically similar species (i.e., Starry and Baltic flounder). Another study found that PCB-contaminated winter flounder eggs from New Bedford Harbor produced larvae that were smaller in both size and weight when compared to larvae from less contaminated sites. In addition, reproductive effort in PCB-contaminated mussels from New Bedford Harbor was lower than that of mussels from less contaminated areas. No toxicity data were available to make comparisons between body burden levels and toxicity for other species.

Because of the limited amount of data on the effects of metal accumulation, it is difficult to determine potential risks to New Bedford biota from metal exposure.

Ecosystem

Evaluations made in this risk assessment suggest that the functioning of the New Bedford Harbor ecosystem may be impaired due to the presence of PCBs and metals. Levels of these contaminants found in New Bedford Harbor could potentially cause mortality, decreased reproduction, and other toxicological effects to resident biota in the estuary. As a result of the interdependence of organisms within aquatic food chains, it is possible that effects to individual organisms and populations could be deleterious to the ecosystem as a whole.

CONCLUSIONS

The methodology for the public health and ecological risk assessment has been described for the New Bedford Harbor Superfund site in New Bedford, Massachusetts. The risk assessment was prepared using guidance from the EPA. This risk assessment revealed that both the public health and the environment may be at risk from contaminant exposure at the New Bedford Harbor site. Based on results of this risk assessment, the response objectives for the New Bedford Harbor FS should seek the following:

- PCB and lead concentrations in biota to levels considered protective of public health and/or aquatic life and their uses;

- Total PCB sediment concentrations in Area I to levels considered protective of public health and/or aquatic life, and total PCB sediment concentrations in Area II to levels considered protective of aquatic life and their uses;
- Water-column PCB concentrations in Areas I and II to levels protective of aquatic life and their uses;
- Water-column copper concentrations in Areas I and II to levels protective of aquatic life and their uses.

REFERENCES

1. Sanford Ecological Services, Inc., *New Bedford Harbor Superfund Project Wetland Assessment*, prepared for U.S. Army Corps of Engineers New England Division, April 1988.
2. E.C. Jordan Co., *Selection of Additional Contaminants of Concern for Inclusion in the Risk Assessment and Feasibility Study*, prepared for Ebasco Services, Incorporated, July 1987.
3. U.S. EPA, *Superfund Public Health Evaluation Manual*, Office of Emergency and Remedial Response, Washington D.C., October 1986.
4. U.S. EPA, *Superfund Exposure Assessment Manual*, Office of Remedial Response, Washington D.C., pre-publication edition, April 1988.
5. Massachusetts Department of Public Health, *The Greater New Bedford PCB Health Effect Study 1984-1987, Executive Summary*, Boston, Massachusetts, 1987.
6. U.S. Department of Commerce, *General Population Characteristics*, M sachusetts Bureau of the Census, PC80-1-B23, 1980.
7. U.S. EPA, *Land Use and Point Source Inventory, New Bedford, Massachusetts*, Environmental Monitoring Systems Laboratory, Las Vegas, NV, 1982.
8. GCA Technology Division, *New Bedford Harbor Site Visit, Task 2, Summary Report*, prepared for Planning Research Corporation, 1986.
9. Agency for Toxic Substances and Disease Registry (ATSDR), *Public Review Draft: Toxicological Profile for Selected PCBs*, 1987.
10. Hansen, D.J., "Preliminary Data Report, New Bedford Harbor Project", Unpublished Report, EPA Narragansett Laboratory, RI, 1986.
11. Black, D.E., Phelps, D.K., and R.L. Lopan, "The Effects of Inherited Contamination on Egg and Larval Winter Flounder", Unpublished Manuscript, 1986.
12. Capuzzo, J.M., "PCBs in Buzzards Bay: Effects on Energetics and Reproductive Cycles of Bivalve Molluscs", Unpublished Report, Woods Hole Oceanographic Institute, Woods Hole, MA, 1986.

ATTACHMENT G

Resumes

Harold Parker Batchelder

132 Beach Road
Jamestown, RI 02835
Business : (401) 792-6869
Home : (401) 423-3735

DOB : 14 December 1955
SSN : 019-46-8034
Citizenship : USA
Omnet Telemail : H.BATCHELDER

Education

B.S.	(Biology) Dept. of Biological Sciences, University of Maine	1977
M.S.	(Oceanography) School of Oceanography, Oregon State University	1980
Ph.D.	(Oceanography) College of Oceanography, Oregon State University	1986

Professional Experience

Teaching and Research Assistant, Oregon State University	1977-1980
Zooplankton Taxonomist Consultant, self employed	1980-1981
Research Technician, Oregon State University	1980-1981
Research Assistant, Oregon State University	1981-1986
Post-doctoral Fellow, University of Rhode Island	1986-1988
Research Associate IV, University of Rhode Island	1988-1989
Assistant Marine Scientist, University of Rhode Island	1989-present

Responsibilities of these positions included conducting independent scientific investigation, supervision of technicians, maintenance and upkeep of a scientific laboratory, statistical evaluation, preparation, writing, presentation, and publication of scientific results, development of numerical models of ecological processes, and proposal writing.

Funded Research

ONR. Principal Investigator, "Assessment of zooplankton-derived bioluminescence in the northern North Atlantic using numerical population dynamical models" (Funded for 1988-1990, Dr. Elijah Swift, Co-Investigator).

ONR. Principal Investigator, "Assessment of zooplankton-derived bioluminescence in the northern North Atlantic Ocean: refinement, testing, and validation of numerical models of population dynamics" (Funded for 1990-1991).

ONR. Co-Principal Investigator, "Quantitative zooplankton sampling during the 1990 and 1991 cruises to the ML-ML sampling site in the North Atlantic. (Funded for 1990-1991, Dr. Elijah Swift, Principal Investigator).

Honors and Grants Awarded

Lenore Bayley Memorial Graduate Fellowship (Oregon State University, 1984, Awarded alternate years to outstanding graduate student at the university)

Professional Societies

American Society of Limnology and Oceanography
The Crustacean Society
The Oceanography Society

Research Interests

Zooplankton ecology. Role of the physical environment in determining the distribution, abundance and behavior of zooplankton, and the adaptations of organisms to their environment. Trophodynamics and population ecology of marine copepods. Model descriptions of population dynamics of marine crustaceans. Role of bioenergetics and individual variability (feeding history, acclimation, energy reserves) in determining behavior, growth, development, and reproduction of crustacean zooplankton in marine and freshwater habitats. Use of acoustics to estimate biomass and monitor vertical migratory behavior of zooplankton.

Practical Research Experience

Numerical modelling of zooplankton population dynamics
Experimental studies of feeding, growth, and respiration of zooplankton (copepods)
Experimental studies and population estimation surveys of benthic intertidal organisms
Experience with a diverse suite of oceanographic instrumentation (CTD, Rosettes, MOCNESS plankton samplers, fluorometers, spectral irradiance sensors)
Pascal, BASIC, and Fortran computer languages
Design and maintenance of laboratory database systems for management of scientific data
Proposal preparation

Cruise Participation

1980	*CCGS Quadra*; *CCGS Vancouver*	3-seven week cruises--subarctic Pacific
1982	*RV Parizeau*; *CFAV Enceavor*	2-twelve day cruises--subarctic Pacific
1983	*RV Sacajawea*	11-one day cruises--Oregon coast waters
1984	*RV Wecoma*	2-thirty day cruises--subarctic Pacific
	RV Barnes	several short cruises--Dabob Bay, WA
1986	*USNS Bartlett*	10 day cruise--Gulf Stream, Slope water
	RV Cape Hatteras	14 day cruise--Sargasso Sea, Gulf Stream
1987	*RV Oceanus*	2-eight day cruises--Sargasso Sea
	RV Endeavor	2-fifteen day cruises--Sargasso Sea
1988	*USNS Bartlett*	22 day cruise--Sargasso Sea, Gulf Stream
	USNS Bartlett	20 day cruise--Scotland, Iceland Region
1989	*RV Cape Hatteras*	8 day cruise--Gulf of Maine
1990	*RV Endeavor*	8 day cruise--Gulf of Maine
1991	*RV Endeavor*	25 day cruise--North Atlantic

Papers, abstracts presented at professional meetings

Batchelder, H.P. Seasonal abundance, vertical distribution, and life history of *Metridia pacifica* (Calanoida: Copepoda) in the oceanic subarctic Pacific. Summer 1984 ASLO, Vancouver, BC.

Batchelder, H. P. Ingestion and respiration rates of *Metridia pacifica*: experimental and modeling results. Winter 1986 AGU-Ocean Sciences Meeting, New Orleans.

Batchelder, H. P. and E. Swift. Near-surface planktonic bioluminescence during summer 1986 in the western North Atlantic. Winter 1986 AGU-ASLO, San Francisco.

Batchelder, H. P., J. Van Keuren, and E. Swift. Planktonic bioluminescence distribution and intensity in the northwestern Atlantic during May and August 1987. Winter 1988 AGU-Ocean Sciences Meeting, New Orleans.

Van Keuren, J., E. Swift, H. Batchelder, and W. Biggley. Twilight and moonlight measurements in the northwest Atlantic during May and August 1987. Winter 1988 AGU-Ocean Sciences Meeting, New Orleans.

Swift, E., J. Van Keuren, H. P. Batchelder, C. R. Booth, and C. P. Li. A moored instrument system to measure stimulated and natural bioluminescence. Ocean Optics IX, SPIE, Orlando, FL, April 1988.

Batchelder, H. P. Zooplankton population structure and dynamics. Invited presentation. Deep sea observatories: a workshop to assess near-term opportunities and long-range goals. David Taylor Research Center, Bethesda, MD. November 1989.

Swift, E., J. Van Keuren, H. P. Batchelder, and D. Butler. The rest of the story...late summer and early fall in the North Atlantic at the ML-ML station. Winter 1990 AGU-Ocean Sciences Meeting, New Orleans.

Batchelder, H. P., E. Swift, and J. Van Keuren. Diel bioluminescence patterns in the Sargasso Sea. Winter 1990 AGU-Ocean Sciences Meeting, New Orleans.

Batchelder, H. P. Population dynamics of marine copepods using individual-based bioenergetics models. Workshop on populations, communities and ecosystems: an individual perspective. Knoxville, TN. May 1990.

Publications

Batchelder, H. P. and J. J. Gonor. 1981. Population characteristics of the intertidal green sea anemone, *Anthopleura xanthogrammica* on the Oregon coast. Estuarine, Coastal and Shelf Science, 13, 235-245.

Miller, C.B., B.W. Frost, H.P. Batchelder, M.J. Clemons, and R.E. Conway. 1984. Life histories of large, grazing copepods in a subarctic ocean gyre: *Neocalanus plumchrus*, *Neocalanus cristatus*, and *Eucalanus bungii* in the northeast Pacific. Progress in Oceanography, 13, 201-243.

Brodeur, R. D., D. M. Gadomski, W. G. Pearcy, H. P. Batchelder, and C. B. Miller. 1985. Abundance and distribution of ichthyoplankton in the upwelling zone off Oregon during anomalous El Niño conditions. Estuarine, Coastal and Shelf Science, 21, 365-378.

Miller, C. B., H. P. Batchelder, R. D. Brodeur, and W. G. Pearcy. 1985. Response of the zooplankton and ichthyoplankton off Oregon to the El Niño event of 1983. pp. 185-187 in *El Niño North - Niño Effects in the Eastern Subarctic Pacific Ocean*. W. S. Wooster and D. L. Fluharty, Eds., Washington Sea Grant Program, U. Washington, Seattle.

Batchelder, H. P. 1985. Seasonal abundance, vertical distribution and life history of *Metridia pacifica* (Copepoda: Calanoida) in the oceanic subarctic Pacific. Deep-Sea Research, 32, 949-964.

Batchelder, H. P. 1986. A staining technique for determining copepod gonad maturation: application to *Metridia pacifica* from the northeast Pacific Ocean. Journal of Crustacean Biology, 6, 227-231.

Batchelder, H. P. 1987. Phytoplankton balance in the oceanic subarctic Pacific: the grazing impact of *Metridia pacifica*. Marine Ecology-Progress Series, 34, 213-225.

Swift, E., J. Van Keuren, H. P. Batchelder, C. R. Booth, and C. P. Li. 1988. A moored instrument to measure stimulated and natural oceanic bioluminescence. Ocean Optics IX, Marvin A. Blizard, Editor, Proc. SPIE 925, pp. 76-86.

Batchelder, H. P. and E. Swift. 1988. Bioluminescent potential and variability in some Sargasso Sea planktonic halocyprid ostracods. Journal of Crustacean Biology, 8, 520-523.

Batchelder, H. P. and E. Swift. 1989. Estimated near-surface mesoplanktonic bioluminescence in the western North Atlantic during July 1986. Limnology and Oceanography, 34, 113-128.

Batchelder, H. P. and C. B. Miller. 1989. Life history and population dynamics of *Metridia pacifica*: results from simulation modeling. Ecological Modelling, 48, 113-136.

Batchelder, H. P., E. Swift, and J. R. Van Keuren. 1990. Pattern of planktonic bioluminescence in the northern Sargasso Sea: seasonal and vertical distribution. Marine Biology, 104, 153-164.

Manuscripts in preparation

Batchelder, H. P. and E. Swift. Pattern of planktonic bioluminescence in the northwestern Atlantic: comparisons of the Gulf Stream North Wall and the northern Sargasso Sea in May and August 1987.

Batchelder, H. P., E. Swift, and J. R. Van Keuren. Pattern of planktonic bioluminescence in the northern Sargasso Sea: diel patterns.

Van Keuren, J. R., E. Swift, and H. P. Batchelder. Comparison between observed movement of a 150 kHz acoustic scattering layer and light intensity at depth during twilight and moonlight conditions.

References Available upon request.

RESUME

WELDON S. BOSWORTH, PH.D.
Chief Executive Officer/Principal
Senior Consultant - Environmental Impact Analysis

EDUCATION:

Ph.D., Oregon State University, 1976. Marine Ecology
M.S., University of New Hampshire, 1969. Zoology
B.A., University of New Hampshire, 1964. Zoology
MBA Studies, Rivier College (30% Completed)

PROFESSIONAL HISTORY:

1985-Present	Balsam Environmental Consultants, Inc. Chief Executive Officer/Principal
1981-1985	Normandeau Associates, Inc., President
1972-1981	Normandeau Associates, Inc., Executive Vice President; Vice President, Operations; Project Manager
1969-1972	Oregon State University, Teaching Assistant
1967-1969	University of New Hampshire, Research Assistant
1964-1967	U. S. Army, Commissioned Officer

REPRESENTATIVE EXPERIENCE:

Dr. Bosworth has twenty years of consulting experience specifically related to evaluating the environmental impact of siting and operation of major facilities. He has also directed studies of contaminant fate and effects in marine and aquatic environments. He has negotiated work scopes of environmental studies with state and federal regulatory agencies and provided expert testimony on environmental impact at over a dozen regulatory hearings at state and federal levels. As an expert in environmental impact evaluation, Dr. Bosworth has contributed to numerous national publications and has been a presenter at regional and national conferences.

SOUTHERN CALIFORNIA BIGHT/NATURAL RESOURCES DAMAGES ASSESSMENT; 1991; Principal Scientist. Provided litigation support and expert opinion for confidential client on issues related to fate, transport and ecological effects of DDT associated with the sediment bed on the Palos Verdes Shelf.

NEW BEDFORD HARBOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY AND REMEDIATION DESIGN; 1986-Present; Principal Scientist. Performed independent evaluation of feasibility study performed by the U. S. Environmental Protection Agency on behalf of AVX Corporation and completed independent assessments of environmental and transport issues related to natural resource damage and remediation of New Bedford Harbor. Also developed recommendations to address potential adverse impacts of PCB and heavy metal contamination in the estuarine sediments of the Harbor.

NEW HAMPSHIRE PORT AUTHORITY EXPANDED FACILITIES; 1989-Present; Project Manager. Evaluated environmental impact of various project alternatives for 10-acre port facility expansion on marine and wetland communities in the Piscataqua River. Developed mitigation plans for saltmarsh and eelgrass communities.

ASBESTOS MANAGEMENT PROGRAM, STATE OF MAINE, DIVISION OF SAFETY AND ENVIRONMENTAL SERVICES; 1986-Present; Officer-In-Charge. Coordinated project teams which provided various services including survey of and remediation design for asbestos in state facilities and public schools in the State of Maine. Developed computerized database management system for real time management and archiving of asbestos survey and abatement information on all facilities.

SEABROOK (NH) ENVIRONMENTAL STUDIES; 1971-1980; Project Manager. Managed large multi-year, multi-discipline baseline study in coastal waters of New Hampshire for proposed nuclear generating station. Designed, developed and evaluated sampling program for all biological communities including benthic, fisheries and planktonic; collaborated on design of physical oceanographic studies. Supervised installation and maintenance of over 40 in-situ instruments in nearshore ocean environment. Negotiated work scope with state and federal regulatory agencies; provided expert testimony on environmental impact at over a dozen regulatory hearings at the state and federal levels.

LAKE ONTARIO SHORELINE PROTECTION STUDY FOR THE U. S. ARMY CORPS OF ENGINEERS; 1980-1981; Project Manager. Evaluated impacts of water level changes on shoreline and shoreline structures.

NEW ENGLAND DIVISION, U. S. ARMY CORPS OF ENGINEERS, BASIC ORDERING AGREEMENT; 1978-1980; Officer-In-Charge. Coordinated logistics, provided financial management and report review for several

projects at various New England harbors to provide information on the impacts of dredging and spoil disposal.

CONTINENTAL OFF-SHORE STRATIGRAPHIC TEST (COST) WELL SITE SURVEYS; GEORGES BANK, BALTIMORE CANYON, GEORGIA EMBAYMENT; 1975-1977; Officer-In-Charge. Coordinated logistics, provided financial management and report review for physical and biological studies of OCS test site prior to leasing of offshore areas for exploratory drilling.

BIG RIVER RESERVOIR ENVIRONMENTAL STUDIES. U. S. ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION; 1978-1980; Officer-In-Charge. Reviewed and edited technical report for impact assessment of a proposed water supply reservoir. Studies included fisheries, wildlife and wetland communities. A wildlife habitat mitigation plan was developed to increase carrying capacity in unaffected areas.

PORTSMOUTH NAVAL SHIPYARD DREDGING EIS FOR U. S. NAVY, NORTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND; Officer-In-Charge. Subcontracted through Parsons Brinckerhoff, 1976-1978. Helped coordinate logistics, reviewed work plan and reviewed and edited technical reports for development of a candidate EIS for a proposed dredging program at the Portsmouth Naval Shipyard in Kittery, Maine. The study involved dredging impacts as well as evaluation and selection of both offshore and upland spoil disposal sites.

WEST BRANCH PENOBSCOT RIVER HYDROELECTRIC DEVELOPMENT FOR GREAT NORTHERN PAPER COMPANY, 1981-1983; Officer-In-Charge. Collaborated in developing work scope, and reviewed and approved study plans and technical reports for studies of water quality, benthos, and aquatic and terrestrial habitats for FERC Exhibit E for proposed "Big A" hydroelectric facility. Particular attention was focused on using Habitat Evaluation Procedures (HEP) for developing mitigation plans.

HUDSON RIVER BATHYMETRIC AND SEDIMENT SAMPLING FOR PCB SURVEY, NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION, 1976-1977; Officer-In-Charge. Coordinated logistics, provided financial management and review of deliverables for a study which involved aerial photography, photogrammetric mapping, collection of 700 grab and 200 core samples, and analyses of grab samples for grain size and volatile organics.

Executive Board Member, New England Estuarine Research Society, 1976-1980.

Participated in OCEANLAB (undersea laboratory) workshop sponsored by New England Marine Advisory Service, 1976.

PUBLICATIONS AND PRESENTATIONS:

Bosworth, W. S. and L. J. Thibodeaux. 1990. Bioturbation: A Facilitator of Contaminant Transport in Bed Sediment. Environmental Progress. 9(4):210-217.

Thibodeaux, L. J., D. D. Reible, W. S. Bosworth, L. C. Sarapas. 1990. A Theoretical Evaluation of the Effectiveness of Capping PCB-Contaminated New Bedford Harbor Bed Sediment. Louisiana State University Research Center Report. 180 pp.

Bosworth, W. S. and L. J. Thibodeaux, 1989. Bioturbation: A Facilitator of Contaminant Transport in Bed Sediment. Presented to American Society of Chemical Engineers, Session No. 120. Annual Meeting.

Grabe, S. A., J. W. Shipman, and W. S. Bosworth, 1983. New Hampshire Lobster Larvae Studies. IN: Michael J. Fogarty (Ed), Distribution and Relative Abundance of American Lobster, Homarus americanus, larvae: New England Investigations during 1974-1979. p.63-64. NOAA Tech Rep. NMFS SSRF-775.

Bosworth, W. S., J. Germano, D. J. Hartzband, A. J. McCusker and D. C. Rhoads, 1980. Use of Benthic Sediment Profile Photography in Dredging Impact Analysis and Monitoring. IN: Proceedings of the Ninth World Dredging Conference (WODCON IX), 29-31 October 1980, Vancouver, B.C., Canada.

Mattice, J. S. and W. S. Bosworth, 1979. A Modified Venturi Suction Sampler for Collecting Corbicula. Progressive Fish Culturist. 41(3):121-123.

Bosworth, W. S., 1976. The Biology of the Genus Eohaustorius (Amphipoda: Haustoridae) on the Oregon Coast. Ph.D. Dissertation. Oregon State University. 200 pp.

Bosworth, W. S., 1973. Three New Species of Eohaustorius (Amphipoda: Gammaridea) from the Oregon Coast. Crustaceana. 25(7):253-260.

Authored and/or contributed to over fifty technical reports on various aspects of marine and aquatic communities.

EPA 301h WAIVER APPLICATION, PEAKS ISLAND, ME; 1979, Officer-In-Charge. Developed sampling plan, coordinated logistics and reviewed technical results for EPA 301h waiver application. Study involved physical oceanographic, marine biological and water quality analysis.

EXPERT TESTIMONY:

Testified before U. S. House of Representatives Subcommittee on Investigations and Review regarding the Federal Water Pollution Control Act (PL 92-500). April 1977.

Lead expert witness on environmental impacts of Seabrook Station at over a dozen State and Federal (U. S. EPA 316(a) and (b)) and NRC Atomic Safety and Licensing Board regulatory hearings.

Provided expert opinion at deposition and public forum on issues related to remedial alternatives at New Bedford Harbor.

Provided expert testimony on issues related to fate, transport and ecological effects of DDT in Southern California Bight.

SPECIAL TRAINING:

Strategic Management Seminars. SRI International. 1981-1982.

Certified SCUBA Diver since 1959. Designed, managed and participated in several scientific diving studies on both the eastern and western U. S. coasts.

PROFESSIONAL ACTIVITIES:

Member, Scientific Advisory Committee of the Hazardous Substance Research Center/South and Southwest. The dominant research theme is hazardous substance within contaminated bed sediments and dredged materials.

Member, Marine Studies Curriculum Advisory Committee, Southern Maine Vocational Technical Institute, 1979-1983.

Invited member to NOAA North and Mid-Atlantic Region Conference on Marine Pollution Studies, 1980.

CURRICULUM VITA

DIAN J. GIFFORD

Graduate School of Oceanography
University of Rhode Island
Narragansett, R.I. 02882-1197

(401) 792-6690 Office
(401) 295-1671 Home

EDUCATION:

DEGREE	CONFERRING INSTITUTION	FIELD	DATE
A.B., *cum laude*	University of Massachusetts	Biology	1973
M.Sc.	Dalhousie University	Ecology	1979
Ph.D.	Dalhousie Univeristy	Oceanography	1986

PROFESSIONAL HISTORY:

1973-1975 Research Assistant (Invertebrate vision), University of Massachusetts.
1975-1976 Research Assistant (Aquatic community ecology), Dalhousie University.
1976 Research Diver, Discovery Bay Marine Laboratory
1976 Research Assistant (Electron microscopy), Dalhousie University.
1977 Biologist, MacLaren Plansearch Co., Dartmouth, Nova Scotia.
1980-1985 Technical Editor, Commercial Fisheries Management Associates, Halifax, Nova Scotia
1985-1986 Postdoctoral Fellow, Dalhousie University.
1986 Visiting Scientist, University of Rhode Island.
1986-1988 Postdoctoral Research Scientist, Louisiana Universities Marine Consortium.
1989– Assistant Marine Scientist, University of Rhode Island.

HONORS AND AWARDS:

Dean's List, University of Massachusetts, 1969-1973
A.B., *cum laude* and with Honors in Biology, 1973
Dalhousie Graduate Fellowship in Biology, 1976-1977; 1977-1978.
Dalhousie Graduate Fellowship in Oceanography, 1978-1979; 1979-1980; 1980-1981; 1981-1982; 1981-1983.
Delegate, NATO Advanced Study Institute on Planktonic Protozoa, Villefranche-sur-Mer, France, 1981
ASLO Student Travel Grant, 1983
AGU Travel Grant for Young Scientists, 1988
Delegate, NATO Advanced Study Institute on the Role of Protozoa in Marine Processes, Plymouth, U.K.

MEMBERSHIP IN PROFESSIONAL SOCIETIES:

American Society of Limnology and Oceanography; American Geophysical Union; Oceanography Society; Marine Biological Association; American Association for the Advancement of Science

OTHER PROFESSIONAL ACTIVITIES:

Review manuscripts for Marine Biology and Marine Ecology Progress Series. Review proposals for the National Science Foundation.

CURRENT RESEARCH INTERESTS:

Biological Oceanography. Microzooplankton ecology, with emphasis on feeding and bioenergetics of planktonic Protozoa. Trophic ecology of the microbial loop in pelagic ecosystems. Laboratory culture methods for planktonic ciliates.

RESEARCH SUPPORT:

ONR Sub-contract. Microzooplankton abundance and biomass in the BIOWATT Study area. $5,000, with E. Swift and J. Marra. 1986.

NSF OCE 86-13892 Grazing by the large copepods *Neocalanus plumchrus* and *N. cristatus* on phytoplankton and microheterotrophs in the Subarctic Pacific Ocean, $288,000, Co-investigator with M.J. Dagg. 1986-1989.

ONR Sub-contract. Microzooplankton abundance and biomass in the BIOWATT study area. $3,000, with E. Swift and J. Marra. 1987.

NOAA. Coupling of primary and secondary production in the water column of upper Narragansett Bay: control by microzooplankton, with E.G. Durbin and A.G. Durbin, $99,500. Pending..

ONR. Functional roles of nano- and microzooplankton in the high latitude North Atlantic, with E. Swift, $250,000. Pending.

NSF. Global temperature increase: impacts on the ecology of temperate coastal waters (Land-Margin Ecosystem Research Initiative), with C. A. Oviatt, et al. $1,500,000. Pending.

PUBLICATIONS DURING THE PAST FIVE YEARS:

Gifford, D.J. 1985. The impact of grazing by marine planktonic oligotrichs (Ciliophora, Oligotrichida) in laboratory culture and in the Northwest Arm of Halifax Harbour. Ph.D. Thesis, Dalhousie University.

Gifford, D.J. 1985. Laboratory culture of marine planktonic oligotrichs (Ciliophora, Oligotrichida). Marine Ecology Progress Series 23: 257-267.

Gifford, D.J. 1988. The impact of grazing by planktonic ciliates in the Northwest Arm of Halifax Harbour. Marine Ecology progress Series 47: 249-258.

Gifford, D.J. and M.J. Dagg. 1988. Feeding of the estuarine copepod *Acartia tonsa* Dana: Carnivory versus herbivory in natural microplankton assemblages. Bulletin of Marine Science 43: 458–468.

Gifford, D.J. and M.J. Dagg. 1989. The microzooplankton-mesozooplankton link: consumption of protozoa by the calanoid copepods *Acartia tonsa* Dana and *Neocalanus plumchrus* Murukawa. Marine Microbial Food Webs. Accepted.

Gifford, D.J. Impact of grazing on a declinging spring bloom in the southern Gulf of Maine. Marine Ecology Progress Series. Accepted.

MANUSCRIPTS SUBMITTED:

Gifford, D.J. Rates of grazing and growth in the planktonic ciliates *Strombidinopsis* cf. *acuminatum* and Strombidium sp. in laboratory culture. Journal of Experimental Marine Biology and Ecology.

MANUSCRIPTS IN PREPARATION:

Gifford, D.J. Quantitative fixation of marine planktonic ciliates: a comparison of methods. Applied and Environmental Microbiology.

Gifford, D.J. and M.J. Dagg. Consumption of planktonic Protozoa by *Neocalanus* spp. in the subarctic North Pacific Ocean. Deep-Sea Research.

Gifford, D.J. and M.J. Dagg. Omnivory in the diet of *Acartia tonsa* Dana: The nutritional role of microzooplankton in the inshore Gulf of Mexico. Marine Biology.

Gifford, D.J., E. Swift and J. Marra. Microzooplankton at the BIOWATT study site, 1987: distribution, abundance and biomass in relation to hydrography, chlorophyll and nutrients. BIOWATT News.

PAPERS PRESENTED DURING THE PAST FIVE YEARS:

Techniques for the laboratory culture of planktonic ciliates. American Society of Limnology and Oceanography, Vancouver. 1985.

Grazing impact of microzooplankton field assemblages. American Geophysical Union, San Francisco. 1985.

The grazing impact of marine planktonic oligotrichs in the Northwest Arm of Halifax Harbour. American Geophysical Union, New Orleans. 1986.

Microzooplankton biomass and vertical distribution in the oligotrophic North Pacific: PRPOOS, 1985. American Society of Limnology and Oceanography, Narragansett. 1986, with E. Swift and L.W. Haas.

Grazing on Natural microplankton assemblages by the Copepod *Acartia tonsa* Dana. American Geophysical Union, San Francisco, 1986, with M.J. Dagg.

Feeding behavior of the estuarine copepod *Acartia tonsa* Dana: Carnivory vs. herbivory in natural microplankton assemblages. Zooplankton Behavior Symposium, Savannah. 1987, with M.J. Dagg.

Consumption of microzooplankton by *Neocalanus* spp. in the subarctic North Pacific Ocean. American Geophysical Union, New Orleans, 1988.

The microzooplankton-mesozooplankton link: consumption of Protozoa by the calanoid copepods *Acartia tonsa* Dana and Neocalanus plumchrus Murukawa. NATO Advanced Study Institute on The Role of Protozoa in Marine Processes. Plymouth, U.K., 1988.

Impact of grazing by natural microzooplankton assemblages. Joint Oceanographic Assembly, Acapulco, Mexico, 1988.

Impact of grazing by microzooplankton on a decling spring bloom in the southern Gulf of Maine. American Geophysical Union, San Francisco, 1988.

Ingestion by *Calanus finmarchicus* during a declining spring bloom in the Gulf of Maine. American Geophysical Union, San Francisco 1988, with E.G. Durbin and A.G. Durbin.

CURRICULUM VITAE April 1992

NAME: DANNY DAVID REIBLE, Ph.D., P.E. ASSOCIATE PROFESSOR

ADDRESS: Department of Chemical Engineering
Louisiana State University
Baton Rouge, Louisiana 70803
Phone: (504) 388-3070 Home Phone: (504) 769-8215

PERSONAL: Date of Birth: December 21, 1954 at Rantoul, Illinois
Marital Status: Married with 2 children
Social Security Number: 221-38-7724

EDUCATION:

Ph.D. Chemical Engineering, June 1982 (M.S. June 1979)
California Institute of Technology, Pasadena, California
Advisor: F.H. Shair
Thesis: Pollutant Transport in Complex Atmospheric Flows

B.S. Chemical Engineering with highest honors, May 1977
Lamar University, Beaumont, Texas

PROFESSIONAL EXPERIENCE:

1/91 - 6/91 Senior Visitor, Cambridge University, UK
Department of Applied Math and Theoretical Physics
6/90 - 9/90 Summer Faculty Researcher, Army Research Office
COE Waterways Experiment Station, Vicksburg, MS
6/87 - 9/87 AAAS Environmental Science & Engineering Fellow
Environmental Processes & Effects Research, US EPA
10/81 - Department of Chemical Engineering, LSU
Director of Graduate Instruction (1/87 to present)
Professor (to be effective 8/92)
Associate Professor (8/86 to present)
Assistant Professor (10/81 to 8/86)

HONORS AND AWARDS:

1987 American Association for the Advancement of Science
Environmental Science and Engineering Fellow
1986 New Engineering Educator Excellence Award
American Society for Engineering Education
1986 Outstanding Research Accomplishments in the Natural and
Physical Sciences by Non-Tenured Faculty
LSU Phi Kappa Phi
1985 Ralph R. Teetor Educational Award from the
Society of Automotive Engineers

Publications and Professional Actvities

of

Danny David Reible

I. PUBLICATIONS

A. Refereed Publications

Book Chapters

Reible, D.D., K.T. Valsraj and L.J. Thibodeaux, "Chemodynamic Models for Transport of Contaminants from Sediment Beds", invited book chapter for Handbook of Environmental Chemistry, O.Hutzinger, Ed., Springer-Verlag, Heidelberg (1991)

Thoma, G.J., A.C. Koulermos, K.T. Valsaraj, D.D. Reible and L.J. Thibodeaux, "The Effects of Pore Water Colloids on the Transport of Hydrophobic Organic Compounds from Bed Sediments," Chapter 13 in Organic Substances in Soils and Sediments, R.A. Baker, ed., Lewis Publishers (1991)

Reible, D.D. and T.H. Illangasekare, "Subsurface Processes of Non-Aqueous Phase Liquids,"in Intermedia Pollutant Transport: Modeling and Field Measurements, D.Allen, Y. Cohen and I. Kaplan, Ed., Plenum Press (1989).

Savant, S.A., D.D. Reible, G.S. Gipson, J.D. Boyle and L.J. Thibodeaux, "An Investigation of the Significance of Convective Transport in River Sediments", Health and Environmental Research on Complex Organic Mixtures, Gray, R.H, E.K. Chess, P.J. Mellinger, R.G. Riley and D.L. Springer, eds. DOE Symposium Series, Vol. 62 (1987)

Thibodeaux, L.J., D.D. Reible and C.S. Fang, "Transport of Chemical Contaminants in the Marine Environment Originating from Offshore Drilling Bottom Deposits - A Vignette Model", published in Pollutants in a Multimedia Environment , Yoram Cohen, Ed., Plenum Press (1986)

Gipson, G.S. and D.D. Reible, "A Hybrid Boundary Element- Perturbation Technique for Forced Oscillations of Membrane Structures," in Recent Applications in Computational Mathematics, D.L. Karabalis, ed., ASCE, New York (1986)

Reible, D.D., P.Yonts and F.H. Shair, "The Effect of the Return of Exhausted Building Air on Indoor Air Quality", Indoor Air Quality in Cold Climates: Hazards and Abatement Measures, D.S. Walkinshaw and J. A. Frazier, ed. (1986)

Refereed Journal Publications

Novitsky, M., D.D. Reible and B.M. Corripio, "Modeling the Dynamics of the Land-Sea Breeze Circulation for Air Quality Modeling", Boundary Layer Meteorology, 59, 163-175 (1992)

Rhee, S.W., D.D. Reible and W.D. Constant, "Simulation of the Effects of Shale Heterogeneities on Effective Permeability in Deep Well Injection Disposal Systems", Fluid/Particle Separations Journal (1992).

Wang, X.Q., L.J. Thibodeaux, K.T. Valsaraj and D.D. Reible, "The Efficiency of Capping Contaminated Sediments in Situ. I. Lab-scale Experiments of Diffusion/Adsorption in the Capping Layer," Environmental Science and Technology, 25 (9) 1578-1584 (1991)

Thibodeaux, L.J, K.C. Nadler, K.T. Valsaraj and D.D. Reible, "The Effect of Moisture on Volatile Organic Chemical Vapor-to-Particle Partitioning with Atmospheric Aerosols - Competitive Adsorption Theory Predictions," Atmospheric Environment, 25A (8) 1649-1656 (1991)

King, J.A. and D.D. Reible, "Laminar Natural Convection Heat Transfer from Inclined Surfaces," International Journal of Heat and Mass Transfer, 34 (7), 1901-1904 (1991)

Reible, D.D., T.H. Illangasekare, D.V. Doshi and M.E. Malhiet, "Infiltration of Immiscible Contaminants in the Unsaturated Zone", Ground Water 685-692, August-September (1990)

Chitgopekar, N.P., D.D. Reible and L.J. Thibodeaux, "A Model for Describing Short Range Dispersion near Area Sources of Toxics", Journal of the Air and Waste Management Association, 40 (8) 1121-1128 (1990)

Baron, J.A., L.J. Thibodeaux, C.B. Henry, D.D. Reible and P.H. Templet, "A Laboratory Simulation of Selected Natural Recovery Processes of Contaminated Marine Sediment", Estuaries, 13 (1) 81-88 (1990)

Reible, D.D., M.E. Malhiet, T.H. Illangasekare, "Modeling Gasoline Fate and Transport in the Unsaturated Zone", Journal of Hazardous Materials, 22 359-376 (1989)

G.S. Gipson, D.D. Reible and S.A. Savant, "Boundary Elements and Perturbation Theory for Certain Classes of Hyperbolic and Parabolic Problems", Engineering Analysis, 5 (3) 133 (1988)

Savant, S.A., D.D. Reible, J.C. Ortiz and G.S. Gipson, "A Direct Method for Equipotential and Streamline Tracing in the Boundary Element Method", Engineering Analysis, 5 (3) 155 (1988)

Willms, R.S., D.M. Wetzel, D.D. Reible and D.P. Harrison, "Aqueous Phase Oxidation: The Effect of Soil on Oxidation Kinetics", Hazardous Waste and Hazardous Materials, 5 (1) 65-71 (1988)

Singh, V.P., D.D. Reible and L.J. Thibodeaux, "Mathematical Modeling of Fine Sediment Transport", Hydrology Journal of IAH, XI (4) 1-23 (1988)

Savant, S.A., D.D. Reible and L.J. Thibodeaux, "Modeling Convective Transport in Stable River Sediments", Water Resources Research, 23, 9 (1987)

Reible, D.D., F.H. Shair, R.J. Cayer and D.W. Nelson "The Transport and Dispersion of Airborne Contaminants in Boundary Layers over the Ocean and an Isolated Island Cape", Boundary Layer Meteorology, 39 , 93-102 (1987)

Marsden, A.R., D.D. Reible and M.Y. Frenklach, "Increasing the Computational Feasibility of Urban Air Quality Models that Employ Complex Chemical Mechanisms", Journal of the Air Pollution Control Assoc., 37 (4) 370-376 (1987)

Willms, R.S., A.M. Balinsky, D.D. Reible, D.M. Wetzel and D.P. Harrison, "Aqueous Phase Oxidation: Rate Enhancement Studies", I&EC Research, 26 , 606-612 (1987)

King, J.A., D.D. Reible and F.H. Shair, "The Influence of Atmospheric Stability on Pollutant Transport by Slope Winds", Atmospheric Environment, 21 (1) 53-60 (1987)

Willms, R.S., A.M. Balinsky, D.D. Reible, D.M. Wetzel and D.P. Harrison, "Aqueous Phase Oxidation: The Intrinsic Kinetics of Single Organic Compounds", I&EC Research, 26 ,148-154 (1986)

Willms, S., A. Martin, D. Reible, D. Wetzel and D. Harrison "Analysis of High Pressure, Multiphase, Batch Reactor Data", AIChE Environmental Progress, 4 (2) 131-135 (1985)

Reible, D.D. "Gas Transport Through Polyethylene Membranes", R&D Note, AIChE Journal, 30 (3) 492-494 (1984)

Reible, D.D. "Atmospheric Dispersion of Vapors - Are Molecular Properties Important?, A Reply", Referred Technical Comment, Science, 224, 905-906 (1984)

Reible, D.D., F.H. Shair and R. Aris, "A Two-Layer Model of the Atmosphere Indicating the Effects of Mixing Between the Surface Layer and the Air Aloft", Atmospheric Environment, 17, 25-33 (1983)

Reible, D.D., P.J. Sackinger and F.H. Shair "Uncertainties Associated with the Estimation of Mass Balances and Gaussian Parameters from Atmospheric Tracer Studies," Journal of the Air Pollution Control Association, 32 (7) 720-724 (1982)

Reible, D.D. and F.H. Shair "A Technique for Investigating Gaseous Diffusion in Porous Media," Journal of Soil Science, 33 (2) 165-174 (1982)

Reible, D.D., J.R. Ouimette and F.H. Shair "Atmospheric Transport of Visibility Degrading Pollutants into the California Mojave Desert," Atmospheric Environment, 16 (3) 599-613 (1982)

Reible, D.D., F.H. Shair and E. Kauper "Plume Dispersion and Bifurcation in Directional Shear Flows in Complex Terrain," Atmospheric Environment, 15 (7) 1165-1172 (1981)

B. Other Publications

Illangasekare, T.H., D. Znidarcic, M. Al-Sheridda and D.D.

Reible, "Multiphase Flow in Porous Media," in the Proceedings of International Centrifuge Conference, H.Y. Ko and F.G. McLain, Ed. (1991).

Rhee, S.W., D.D. Reible and W.D. Constant, "Simulation of the Effects of Shale Heterogeneities on Effective Permeability in Deep Well Injection Disposal Systems, presented at the Fall Meeting of the American Filtration Society, October, 1990, Baton Rouge, LA.

Illangasekare, T.H., E.J. Armbruster, D.Yates, D.Szlag, D.D. Reible, D.V. Doshi and J.L. Smith, "Transport and Entrapment of Nonaqueous Phase Waste Products in Heterogeneous Media," Proceedings of the 4th Symposium of the Hazardous Waste Research Center, Louisiana State Univ., Baton Rouge, LA, October, 1990.

Rhee, S., D.D. Reible and W.D. Constant, "Stochastic Modeling of Vertical Movement of Hazardous Waste in Deep Well Disposal Systems," Proceedings of the 11th Korea Symposium on Science and Technology, Seoul, Korea, June 1990.

Illangasekare, T.H., E.J. Armbruster, D. Yates, D.Szlag and D.D. Reible, "Effect of Heterogeneity on Transport and Entrapment of Nonaqueous Phase Waste Products in Aquifers," Proceedings of the 3rd Symposium on Hazardous Substances, Kansas State University, Manhattan, KS, 1990.

Rhee, S., D.D. Reible and W.D. Constant, "Modeling of Confining Layer Integrity in Deep Well Disposal Systems," in the Proceedings of the 1st Annual Meeting of the American Filtration Society, October, 1989, Houston, TX.

Reible, D.D. and T.H. Illangasekare, "Transport of Lighter than Water Nonaqueous Phase Liquids in and above Water Table Aquifers: Experiments, Modeling and Parameter Estimation", Proceedings of the Third Annual Symposium on Hazardous Waste Research, Baton Rouge, LA, October 18-19,1989.

Rhee, S., D.D. Reible and W.D. Constant, "Modeling of Confining Layer Integrity in Deep Well Injection Systems", Proceedings of the First Annual Meeting of the American Filtration Society, Houston, TX, October, 1989

Reible, D.D. and T.H. Illangasekare, "Modeling Transport of Multiphase Subsurface Contaminants", Proceedings of the Second Annual Symposium on Hazardous Waste Research, Baton Rouge, LA, October 25-26, 1988.

Reible, D.D. and T.H. Illangasekare, "Two Dimensional Transport of Concentrated Organic Waste in Ground Water", published in the Proceedings of the International Conference on Groundwater Contamination: Use of Models in Decision Making, Amsterdam, October, 1987, International Groundwater Modeling Center, Martinus Nijhoff.

Chitgopekar, N.P., D.D. Reible and L.J. Thibodeaux, "A Model for describing Short Range Dispersion near Area Sources of Toxics", Proceedings of the LSU HWRC Symposium on Hazardous Waste Research, Baton Rouge, LA, October 20-21, 1987.

Reible, D.D., and T.H. Illangasekare, "Modeling Transport of Multiphase Subsurface Contaminants", Proceedings of the LSU HWRC Symposium on Hazardous Waste Research, Baton Rouge, LA, October

20-21, 1987.

Illangasekare, T.H. and D.D. Reible, "Study of Concentrated Organics in the Unsaturated Zone", published in the Proceedings of the Second International Conference on New Frontiers in Hazardous Waste Management, Pittsburgh, PA, August 1987.

Reible, D.D., "Subsurface Contamination by Multiphase Processes: Research and Policy Implications for the EPA", AAAS Environmental Science and Engineering Fellows Program Report, EPA, Washington, D.C., August 1987.

Illangasekare, T.H., P. Brody and D.D. Reible, "A Study of Two-dimensional Transport of Concentrated Organics in Saturated and Unsaturated Soils", Proceedings, AGU Front Range Branch Hydrology Days, Ed. H.J. Morel-Seytoux (1987)

Reible, D.D. "The Boundary Element Method and Applications "Economic Methods for Multipollutant Analysis and Evaluation", AIChE Journal, 33 (1) 172 (1987)

Reible, D.D. and T.H. Illangasekare, "Development and Experimental Verification of a Model for Transport and Entrapment of Concentrated Organics in the Unsaturated Zone", published in Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, NWWA (1986)

Reible, D.D. and K.B. Garg, "Characterization of the Transport and Dispersion of Stack Gases from a Coal-Fired Power Plant," Final Report to the Gulf States Utilities Co., Beaumont, Texas, February 1986

Reible, D.D. and K.B. Garg, "Characterization of the Transport and Dispersion of Stack Gases from a Coal-Fired Power Plant," Final Report to the LSU Center for Energy Studies, Baton Rouge, LA, September, 1985.

Dean, J.D., D.F. Atwood, A.S. Dorigan, F.R. Groves, D.D. Reible, L.J. Thibodeaux, P.S.C. Rao, and J.R. Withey, "Exposure Assessment involving Mixtures of Environmental Pollutant" Final Report to the USEPA on Contract No. 68-03-3116 December 1984.

Reible, D.D., D.M. Wetzel, R.S. Willms, A.K. Martin and D.P. Harrison, "Soil Detoxification using Modified Wet-Air Oxidation", Final Report to USEPA on Contract No. 68-03-3014, July, 1984.

Wetzel, D.M. and D.D. Reible, "Alternative methods for the destruction of hazardous wastes", Final Report to the LSU Hazardous Waste Research Center, January 1983.

Reible, D.D. and D.M. Wetzel "A Literature Survey of Three Selected Hazardous Waste Destruction Techniques," Proceedings of the Ninth Annual Research Symposium on Land Disposal of Hazardous Waste, US EPA, Municipal Environmental Research Laboratory, Cincinnati, Ohio 45268, 408-414 (1983)

Reible,D.D., F.H. Shair, T.B. Smith and D.E. Lehrman, "A Study of the Origin and Fate of Air Pollutants in California's Sacramento Valley", Final Report to the California Air Resources Board, December 1981.

Reible,D.D., F.H. Shair, T.B. Smith and D.E. Lehrman, "The Origin

and Fate of Airborne Pollutants within the San Joaquin Valley", Final Report to the California Air Resources Board, June 1981.

Reible,D.D., F.H. Shair, T.B. Smith and D.E. Lehrman, "A Study of Transport into, within and out of Coastal Areas of Southern Santa Barbara County and Ventura County", Final Report to the Ventura Air Pollution Control District, June 1981.

II. ITEMS NOT YET PUBLISHED

Refereed Publications - Accepted

Savant-Malhiet, S.A. and D.D. Reible, "Comparison of Physical Transport Processes in River Sediments," accepted for publication Journal of Environmental Engineering.

Doshi,D.V., D.D. Reible and T.H. Illangasekare, "The Influence of Mass Transfer Limitations on the Effectiveness of In-Situ Contaminant Extraction," accepted for publication in Journal of Hazardous Materials.

Reible, D.D., F.J. Perrett, R.McIlhenny, " Modeling the Fountain Flow Effect in Reaction Injection Molding", in press, Polymer Engineering and Science.

Reible, D.D. and F.H. Shair, "The Transport and Dispersion of Airborne Contaminants in the Santa Barbara Channel of Southern California", accepted for publication, Atmospheric Environment

Refereed Publications - In Review

Reible, D.D., J.E. Simpson and P.F. Linden, "The Sea Breeze and Gravity Current Frontogenesis," submitted to the Quarterly Journal of the Royal Meteorological Society

Valsaraj, K.T., G.J. Thoma, D.D. Reible and L.J. Thibodeaux, "On the Enrichment of Hydrophobic Organic Compounds in Fog Droplets," submitted to Atmospheric Environment

III. ARTISTIC OR OTHER CREATIVE PUBLICATIONS

Not Applicable

IV. PARTICIPATION AT PROFESSIONAL MEETINGS

A. Presentations

(In addition to those presentations listed in Proceedings in I.C.)

Lo, Y.W., Reible, D.D. and Collier, J.R., "3-D Transient Computer Simulation of Flow, Reaction and Heat Transfer in Reaction Injection Molding," presented at the Annual Meeting of the AIChE, Los Angeles, CA, November, 1991.

Corripio, B., Reible, D.D., "Laboratory Model of Pollutant Transport in a Land-Sea Breeze Circulation System," presented at the Summer National Meeting of the AIChE, Pittsburgh, PA, August, 1991.

Powers, G.W., J.R. Collier and D.D. Reible, "Solution Casting of Polymer Films", presented at the 42nd Southeast/46th Southwest Combined Regional Meeting of the American Chemical Society, New

Orleans, LA, Dec. 5-7-, 1990.

Lo, Y.W., J.R. Collier and D.D. Reible, "Reaction Injection Mold Filling", presented at the 42nd Southeast/46th Southwest Combined Regional Meeting of the American Chemical Society, New Orleans, LA, Dec. 5-7-, 1990.

Doshi, D.V., J.L. Smith, J.H., D.D. Reible, and T.H. Illangasekare, "Numerical and Laboratory Modeling of the Behavior of Nonaqueous Phase Liquids in Heterogeneous Media," presented at the 1990 Summer National Meeting of the AIChE, San Diego, CA.

Illangaskare, T.H., E.J. Armbruster and D.D. Reible, "Experimental Study of Effect of Heterogeneities on Transport and Entrapment of Nonaqueous Phase Liquids," presented at the Spring Meeting of the American Geophysical Union, Baltimore, MD, May, 1990.

Reible, D.D., "Subsurface Processes: Implications for In-Situ Remediation," presented at the 1990 Ground Water Symposium, Baton Rouge, LA.

Thoma, G., Koulermos, A.C., K.T. Valsaraj, D.D. Reible and L.J. Thibodeaux, "The Effects of Porewater Colloids on the Transport of Hydrophobic Compounds from Bed Sediments," presented at the ACS Symposium on Soils and Sediments, April, 1990, Boston, MA.

Thibodeaux, L.J., K.C. Nadler, K.T. Valsaraj and D.D. Reible, "The Effect of Moisture on Volatile Organic Chemical Vapor-to-Particle Partitioning with Atmospheric Aerosols - Competitive Adsorption Theory Predictions," invited paper at the Symposium on Environmental Chemistry in honor of Philip W. West, 45th Southwest Regional Meeting of the American Chemical Society, Baton Rouge, LA, December 6-8, 1989.

Chitgopekar, N.P., D.D. Reible and L.J. Thibodeaux, "Modeling Short Range Dispersion near Area Sources of Non-Buoyant Toxics", presented at the Annual Meeting of the AIChE, San Francisco, CA, November 1989.

Reible, D.D., D.V. Doshi and T.H. Illangasekare, "Mass Transfer Limited Partitioning from Nonaqueous Phase Liquids in Soils," presented at the Annual Meeting of the AIChE, San Francisco, CA, November, 1989.

Koulermos, A.C., K.T. Valsaraj, L.J. Thibodeaux and D.D. Reible, "The Influence of Natural Colloids on the Transport and Fate of Organic Pollutants in Aquatic Systems," presented at the SETAC 10th Annual Meeting, November, 1989, Toronto, CA.

Thibodeaux, L.J. and D.D. Reible, "Estimates of PCB Fluxes from Contaminated Sediments before and after Capping with Clean Sediment," presented at the SETAC 10th Annual Meeting, November, 1989, Toronto, CA.

Malhiet, S. A. and D.D. Reible, "Comparison of Physical Transport Processes in River Sediments," presented at the SETAC 10th Annual Meeting, November, 1989, Toronto, CA.

Koulermos, A.C., L.J. Thibodeaux, K.T. Valsaraj and D.D. Reible, "Do Colloids have Significant Chemical Transport Properties in Bed Sediments," presented at the 1989 conference on Great Lakes

Research, Madison, WI, May 1989.

Baron, J.A., L.J. Thibodeaux, K.T. Valsaraj and D.D. Reible, "Transport of Hydrophobic Chemicals into and out of Bed Sediments- Laboratory Simulations," presented at the 1989 conference on Great Lakes Research, Madison, WI, May, 1989.

Znidarcic, D., T.H. Illangasekare and D.D. Reible, "Flow Pump Testing of Two-Phase Flow: Parameter Estimation," presented at the AIChE National Meeting in Houston, TX, April, 1989.

Reible, D.D. and T.H. Illangasekare, "The Role of Residual Water in the Mobility of a Non-Aqueous Phase in the Unsaturated Zone," presented at the AIChE National Meeting in Houston, TX, April, 1989.

Perrett, F.J., D.D. Reible and R.A. McIlhenny, "Computer Simulation for Design of Reaction Injection Molds", presented at the AIChE Annual Meeting in Washington, D.C., November, 1988.

Reible, D.D., L.J. Thibodeaux and J.A. Baron, "Simultaneous Desorption and Diffusion of Napthalene and Dichlorobenzene from Bed Sediment", presented at the Second Annual Symposium on Hazardous Waste Research, Baton Rouge, LA, October 25-26, 1988.

Reible, D.D. and T.H. Illangasekare, "Modeling Transport of Multiphase Subsurface Contaminants", presented at the 3rd International Conference on Environmental Contamination, 26-29 September 1988, Venice, Italy

Reible, D.D., "Subsurface Processes of Non-Aqueous Phase Contaminants", Invited presentation at Intermedia Pollutant Transport: Modeling and Field Measurements, Santa Monica, Ca, August 23-26, 1988.

Reible, D.D., T.H. Illangasekare and M. Malhiet, "Gasoline Movement in the Subsurface", presented at the AIChE Summer National Meeting in Denver, CO, August 21-24, 1988.

Reible, D.D., "The Hazardous Waste Research Center at Louisiana State University- Multiphase Subsurface Research", 14th Annual EPA Research Symposium on Land Disposal, Remedial Action, Incineration and Treatment of Hazardous Waste, Cincinnati, OH, May 9-11, 1988.

Reible, D.D., "Multiphase Flow and Ground-Water Contamination", 2nvited seminar, USGS, Reston, VA, July 1987.

Baron, J.A., D.D. Reible and L.J. Thibodeaux, "The Natural Recovery Processes of Marine Sediment Contaminated during Offshore Drilling Activities", presented at the Annual Meeting of ACS, New Orleans, LA., August 1987.

Reible, D.D., "Perspectives on Computer-Aided Classroom Instruction in Modeling of Chemical Engineering Systems", presented at the ASEE Gulf-Southwest Section Annual Conference, Lake Charles, LA, March 26-27, 1987.

King, J.A. and D.D. Reible, "Laboratory simulation of pollutant transport by buoyancy driven slope flows", presented at the Annual Meeting of the AIChE, Miami, FL, November, 1986.

Gipson, G.S. and D.D. Reible, "A Hybrid Boundary Element- Perturbation Technique for Forced Oscillations of Membrane Structures," presented at National Meeting of the American Society of Civil Engineers, New Orleans, LA, September, 1986.

Savant, S.A., D.D. Reible and L.J. Thibodeaux, "Modeling Convective Transport in River Sediments," presented at the National Meeting of the American Chemical Society, Anaheim, CA, September, 1986.

Willms, R.S., D.D. Reible, D.M. Wetzel and D.P. Harrison, "Aqueous Phase Oxidation of Dilute Organic Contaminants", presented at the Summer National Meeting of the AIChE, Boston, MA, August, 1986

Marsden, A.R., D.D. Reible and M.Y. Frenklach, "Aspects of Modeling Atmospheric Transport with Reaction", presented at the Summer National Meeting of the AIChE, Boston, MA, August, 1986

Reible, D.D. and K.B. Garg, "Regional Scale Transport of Acid Rain Precursors from a Coal-Fired Power Plant: Enhanced Transport by a Nocturnal jet," presented at the Annual Meeting of the Air Pollution Control Association, Minneapolis, MN, June, 1986

King, J.A. and D.D. Reible, "Transport via Buoyancy Driven Slope Winds - A Comparison of Field and Laboratory Experiments", presented at the Spring National Meeting of the AIChE, New Orleans, LA, March, 1986

Reible, D.D., "A Chemical Engineering Departmental System (The LSU Experience)," presented at the IBM Conference on Chemical Engineering Futures 1986, Baton Rouge, LA, February, 1986.

Thibodeaux, L.J., D.D. Reible and C.S. Fang, "Transport of Chemical Contaminants in the Marine Environment Originating from Offshore Drilling Bottom Deposits - A Vignette Model", presented at National Center for Intermedia Transport Research Symposium, Los Angeles, CA, January, 1986

Groves, F.R., D.D. Reible and L.J. Thibodeaux, "Estimation of Physical and Chemical Properties of Waste Organic Mixtures Associated with Land Pollution", presented at the National Meeting of the ACS, Miami, FL, May, 1985

Reible, D.D., P. Yonts and F.H. Shair, "The Effect of the Return of Exhausted Building Air on Indoor Air Quality", presented at the APCA International Specialty Conference on Indoor Air Quality in Cold Climates: Hazards and Abatement Measures, April 29 - May 1, 1985, Ottawa, Ontario, Canada

Willms, R.S., D.D. Reible, A.M. Balinsky, D.M. Wetzel and D.P. Harrison, "Analysis of High-Pressure, Multiphase, Batch Reactor Data", presented at the 1984 Summer National Meeting of AIChE, Philadelphia, Pennsylvania, August 1984

Reible, D.D. "Applications of Mass Balances and Residence Time Distribution Analyses to Environmental Pollutants and Tracers", presented at the Diamond Jubilee Meeting of the AIChE, Washington, D.C., November, 1983.

Reible, D.D. and F.H. Shair "Multi-day Pollutant Carryover in Spatially or Temporally Varying Wind Fields," presented at the

1982 Summer National Meeting of the AIChE, Cleveland, Ohio, August 1982

Pande, N., M.Miller, D.D. Reible and F.H. Shair, "Modeling the Impact of Chemical Spills in Fume Hoods upon the Air Quality Indoors," presented at the International Symposium on Indoor Air Pollution, Health, and Energy Conservation, Amherst, Massachusetts, October 1981

Reible, D.D., "The Transport and Dispersion of Airborne Contaminants in the Santa Barbara Channel of Southern California," presented before the Southern California Chapter of the APCA, Los Angeles, California, July 1981.

B. Chairman of Sessions

Meeting Program Chairman, San Diego AIChE Summer National Meeting, August, 1990. The most successful AIChE Summer Meeting ever with more than 2700 people attending a technical program of 100 sessions focused on the environment, energy and safety.

Vice-Chairman of Symposium on Soils and Sediments, AIChE Annual Meeting, November, 1989, San Francisco, CA

Chairman of Symposium on Non-Aqueous Phase Liquids in Soils, AIChE Spring National Meeting, April, 1989, Houston, TX.

Chairman of symposium on Chemical Engineering Fundamentals Applied to the Environment, AIChE Spring National Meeting March 1986, New Orleans, LA.

Chairman of symposium on Chemical Engineering Fundamentals Applied to the Environment, AIChE Summer National Meeting, August 1986, Boston, MA.

Chairman of symposium on Liquid Phase Oxidation of Wastewaters, AIChE Summer National Meeting, August, 1986, Boston, MA.

V. OTHER SCHOLARLY OR CREATIVE ACTIVITIES

A. Consulting

Consultant on estimating equilibrium properties of environmental pollutant mixtures for Anderson-Nichols, Co.

Consultant on gasoline movement from leaking underground storage tanks for Camp, Dresser and McKee, Inc., PEI and the EPA.

Panel reviewer of EPA programs on leaking underground storage tanks and screening models for oily wastes applied to landfills.

Consultant on groundwater remediation plans for BASF Corporation

Consultant and expert witness on groundwater contamination for Sundstrand Corporation and for potentially responsible parties to the Combustion, Inc. and Cleve Reber Sites, LA.

Consultant on oily wastes in surface waters for Aqua-Terra Corp. and the EPA.

Consultant on oily discharges from landfills for Aqua-Terra, Inc. and the US Environmental Protection Agency.

Consultant and peer reviewer on in-situ vacuum extraction of mixed wastes at Idaho National Engineering Laboratory for the Department of Energy and their contractor EG&G

Consultant on soil fumigants for the Chemical Manufacturer's Assoc.

B. Short Courses

Chemodynamics, December 6-7, 1982, LSU (with Dr. T. Marrero, U of Missouri, and Dr. L. Thibodeaux, U of Arkansas)

Hazardous Waste- Movement of Chemicals in Air, Water and Soil, June 11-12, 1985 and March 18-19, 1986, LSU (with Dr. T. Marrero, U of Missouri and Dr. L. Thibodeaux, LSU)

Transport and Fate of Chemicals in the Environment, AIChE Continuing Education Course, Taught 3-4 times per year (with L. Thibodeaux and J. Clarke)

C. Professional Affiliations

Alpha Chi Sigma - Chemistry Fraternity American Chemical Society American Institute of Chemical Engineers American Geophysical Union American Society for Engineering Education

D. Other Society and Professional Activities

Reviews of papers for Chemical Engineering Communications, AIChE Journal, Journal of Environmental Quality, Boundary Layer Meteorology, the Soil Science Journal of America, American Chemical Society, Environmental Science and Technology, International Journal of Heat and Mass Transfer and the American Society of Mechanical Engineers, books for the AIChE Journal, reports for the U.S. Department of Interior and the US Environmental Protection Agency and proposals to the Environmental Protection Agency, National Science Foundation, New Mexico Water Resources Institute and the LSU Center for Energy Studies

Faculty Advisor and Founder, LSU Chapter of Omega Chi Epsilon

President, LSU Zenith Users Group (1984-1989)

Treasurer, Baton Rouge Section of the American Institute of Chemical Engineers (AIChE) (1985)

Member, Executive Committee of the Baton Rouge Chapter of the AIChE (1986)

Faculty Advisor, LSU student chapter of AIChE (1984-1987)
LSU student chapter of Omega Chi Epsilon (1987-)

First Vice-Chair of the Executive Committee for AIChE Programming (EBPC)

Member, AIChE EBPC Committee on Inter-Society Relations

VI. AWARDS, LECTURESHIPS OR PRIZES

A. Awards

1985 Ralph R. Teetor Educational Award of the Society of Automotive

Engineers

Registered Professional Engineer in Louisiana (April, 1985)

1986 LSU Phi Kappa Phi Award for Outstanding Research Accomplishments in the Natural and Physical Sciences by Non-tenured Faculty

1986 American Society for Engineering Education New Engineering Educator Excellence Award

1987 American Association for the Advancement of Science Environmental Science and Engineering Fellow

Army Research Office Summer Faculty Researcher, 1990

Invited Senior Visitor, Department of Applied Mathematics and Theoretical Physics, Cambridge University, UK, Spring 1991

B. Lectureships

Reible, D.D., "Migration and Fate of Nonaqueous Phase Liquids in the Subsurface, " invited lecture presented at Cambridge University, Heriot-Watt University and the University of Exeter, UK, March-May, 1991.

Reible, D.D., "Contaminant Transport in River and Estuarine Sediments," invited lecture presented at Swansea University, UK, February, 1991.

Reible, D.D., "Current Environmental Contaminant Fate and Transport Research", invited series of lectures at the Institute for Experimental Meteorology, Obninsk, USSR, October 8-22, 1988.

Reible, D.D., "The State of the Student, or Who are These Students Anyway", invited presentation to national meeting of Union Carbide University Representatives, New Orleans, LA, September 23, 1988.

Reible, D.D., "Subsurface Contamination by Multiphase Processes: Research and Policy Implications for the EPA", AAAS Environmental Science and Engineering Fellow Seminar, EPA, Washington, D.C., August 1987.

Reible, D.D., "Multiphase Flow and Ground-Water Contamination", invited seminar, USGS, Reston, VA, July 1987.

Reible, D.D. "Contaminant Transport in Soils and Sediment", Invited Seminar, Shell Development Corporation, Houston,TX, March, 1987.

Reible, D.D. "The Boundary Element Method and Applications to Environmental Transport", Invited Seminar, University of Florida, Gainsville, FL, February, 1987.

Reible, D.D. "The Boundary Element Method and Applications to Environmental Transport", Invited Seminar, Rice University, Houston, TX, November 1986.

Reible, D.D., "Modeling Convective Transport in River Sediments," University of Houston, Houston, Texas, February, 1986.

Reible, D.D., "Characterization of the Transport and Dispersion

of Pollutants from a Coal-Fired Power Plant in Louisiana", Southern University, Baton Rouge, Louisiana, April 1985.

C. Honorary Societies

Omega Chi Epsilon - Chemical Engineering Phi Kappa Phi - Multidisciplinary Sigma Pi Sigma - Physics Sigma Xi - Research Tau Beta Pi - Engineering

VII. GRANTS AND CONTRACTS

A. Funded

Reible, D.D., Evaluation of Contaminant Losses from Components of Remediation Alternatives for Contaminated Sediment, US Army Corps of Engineers, 12/91 - 9/92, $31,000

Reible, D.D., K.T. Valsaraj, L.J. Thibodeaux and T.E. Myers, An Investigation Chemical Transport from Contaminated Sediment through Porous Containment Structures, EPA through LSU Hazardous Substances Research Center (HSRC), 2/1/92-2/1/93, $86,000

Reible, D.D., K.T. Valsaraj, L.J. Thibodeaux and J.W. Fleeger, Pollutant Fluxes to Aquatic Systems via Coupled Biological and Physicochemical Bed Sediment Processes, LSU HSRC, 2/1/92-2/1/93, $82,600

Thibodeaux, L.J., D.D. Reible and K.T. Valsaraj, Transport processes through interfaces, membranes and porous media ,NSF/LASER-EPScOR, 1/1/92-1/1/96, $450,000

Tittlebaum, M., D.D. Reible and R. Thompson (LaTech) Evaluation of Potential Hazard Exposure Resulting from DOE Waste Treatment and Disposal at RES, US Department of Energy, 8/91-1/92, $167,001

Reible, D.D., Evaluation of Contaminant Losses from Components of Remediation Alternatives for Contaminated Sediment, Batelle/Army Research Office, 1/91-6/92, $30,000

Thibodeau, L.J., D.D. Reible, K.T. Valsaraj and X.Q. Wang, Experimental studies on the efficiency of capping contaminated bed sediment in-situ, LSU Hazardous Waste Research Center (HWRC), 1/11/90-1/10/93, $145,000

Reible, D.D. and T. Illangasekare, Transport of concentrated organics in the unsaturated and saturated zones below spill and dump sites, EPA and LSU HWRC, 1/86-1/93, $354,000, $20,000 direct EPA

Constant, W.D., D.D. Reible, W. Bernard and S. Field, Evaluation of the mechanisms and rate of transport in deep-well injection strata, Underground Injection Practices Council and LA Chemical Assoc., 4/1/89-8/15/91, $75,000

McIlhenny, R.C. and D.D. Reible, Optimized computer-aided design for reaction-injection molding, LA Educational Quality Support Fund (LEQSF),7/1/87-12/30/90, $280,000

Collier, J.R., D.D. Reible and F.C. Knopf, Advanced materials characterization, manufacturing and processing, LEQSF, 7/1/89-6/30/90, $285,000

Reible, D.D., J.R. Collier and D.Nikitopoulos, Image analysis system, ARCO Chemical Company Foundation, 1/1/90-7/1/90, $20,000

Reible, D.D. and L.J. Thibodeaux, An experimental study for short range air dispersion of toxics from area sources, EPA and LSU HWRC, 1/1/86-1/1/89, $122,000, $75,000 EPA direct

Thibodeaux, L.J. and D.D. Reible, Laboratory investigation of the natural recovery processes of marine sediment contaminated during offshore drilling activities, LSU Center for Energy Studies (CES), 8/1/86-7/1/87, $21,203

Reible, D.D., Characterization of the transport and dispersion of the stack gases from the Lake Charles coal-fired power plant of Gulf States Utilities, Gulf States Utilities and LSU CES, 7/1/83-1/1/86, $62,000

Pending:

Reible, D.D., Gravity current mixing and frontogenesis, LEQSF, 7/1/92-6/30/95, $336,989

Reible, D.D., J.R. Collier and R.C. McIlhenny, Production of thick parts during molding of reaction injection molding, LEQSF, 7/1/92-6/30/95, $347,079

VIII. THESES/DISSERTATIONS DIRECTED

Master of Science in Chemical Engineering
Served as Advisor - 13 (6 in Progress, 1 as co-advisor)
Served as Committee Member - 8

Doctor of Philosophy
Served as Advisor - 8 (6 in Progress, 3 as co-advisor)
Served as Committee Member - 9

CURT D. ROSE

EDUCATION

Ph.D., Aquatic Ecology, North Carolina State University at Raleigh, 1966.
B.A., Zoology, University of Maine at Orono, 1960.

EXPERIENCE

Dr. Rose is an aquatic ecologist with experience in marine, estuarine, and freshwater systems. His major area of expertise is the evaluation of biological hazard associated with the discharge of wastes to aquatic environments. He has conducted such evaluations in Canada, Europe, the Republic of Korea, and the Republic of China (Taiwan), as well as in the United States, for a variety of wastes -- including drilling fluids, produced waters, dredged materials, sewage sludge, coal ash, and acid-iron wastes. Dr. Rose is also an applied statistician, and has authored sampling procedures for EPA's Office of Solid Wastes (Test Methods for Evaluating Solid Waste, second edition). Dr. Rose has taught general and advanced courses in biology at several universities in Louisiana and Maryland.

EMPLOYMENT

CDR Environmental Specialists, Incorporated (1988-present): President and Chief Scientist. Representative scientific projects are:

"Remedial Investigation/Feasibility Study (RI/FS) for Onondaga Lake, New York" (For Allied-Signal). Scientific Advisor. Investigation performed in response to Consent Order from State of New York. Emphasis directed towards comprehensive evaluation of environmental impacts of mercury, calcite, ionic materials, and various organic chemicals on biota of lake system. Study performed in 1990 - 1995.

"Aquatic Risk Assessment for Nine Mile Creek, New York" (For Allied-Signal). Program Director and Chief Scientist. Literature-, laboratory-, and field-based assessment of environmental effects of ionic and other discharges to lower reach of creek. Study performed in 1989 - 1991.

"Toxicological Assessment of Effluent Discharged from Ballast Water Treatment Plant, Valdez, Alaska" (For Alyeska Pipeline Services Company). Program Director and Chief Scientist. Acute and partial-chronic toxicity tests with various aquatic species, with emphasis on derivation of application factor for effluent; also, development of toxicological testing program in response to NPDES permit for effluent. Study performed in 1989-1991.

"Aquatic Hazard Evaluation for PCBs and Mercury in Langley Pond, South Carolina" (For Eder Associates). Chief Consultant. Field- and laboratory-based assessment of environmental fate and effects of PCBs and mercury in Langley Pond. Assessment performed in response to Consent Order from State of South Carolina. Emphasis directed towards body burdens of inorganic and methyl mercury in fishes. Study performed in 1989 - 1990.

"Aquatic Risk Assessment for PCBs at a Superfund Site -- New Bedford Harbor, Massachusetts" (For Nutter, McClennen & Fish; Attorneys). Program Director and Chief Scientist. Literature-, field-, and laboratory-based evaluation of environmental fate and effects of PCBs in inner and outer New Bedford Harbor. Study performed in 1989 - 1990.

"Aquatic Risk Assessment for PCBs at a Superfund Site -- New Bedford Harbor, Massachusetts" (For Ropes and Gray; Attorneys). Program Director and Chief Scientist. Literature-, field-, and laboratory-based evaluation of environmental fate and effects of PCBs in inner and outer New Bedford Harbor. Study performed in 1989 - 1990.

"Bioassessment of a Superfund Site -- the Maryland Sand, Gravel, and Stone Site" (For Clean Sites, Inc.). Program Director and Chief Scientist. Comprehensive field and laboratory bioassessment in Region III, EPA, that included wetland identification and delineation, benthos and fish survey, chemical analyses, and aquatic-toxicity tests. Study performed in 1988 - 1989.

"Evaluation of Environmental Effects Associated with Discharge of Industrial Waste at the New York Bight Acid Waste Disposal Site as Compared to Effects of Feasible Land-Based Alternatives" (For Allied-Signal, Inc.). Program Director and Chief Scientist. Literature, field, and laboratory study in support of application for an ocean dumping permit in Region II, EPA. Study performed in 1988 - 1989.

"Mathematical Modeling and Dye Verification Study for Industrial Effluent Discharged to Newark Bay" (For Allied-Signal, Inc.). Program Director and Chief Scientist. Modeling and dye verification study in response to NPDES permit conditions established by State of New Jersey. Study performed in 1988.

"NPDES Biomonitoring Program for Sewage Sludge Discharged from MWRA's Treatment Plants at Deer Island and Nut Island to Boston Harbor" (For Enseco, Inc.). Technical Consultant. Evaluation of sewage effluents for chemical characteristics and aquatic toxicity. Also, assessment of potential of chemical constituents of effluents to bioaccumulate (trayed mussel study). Investigation performed in 1987-1988.

"Physical, Chemical, and Biological Oceanographic Monitoring Program at the Acid Waste Disposal Site in New York Bight" (For Enseco, Inc.). Program Director and Chief Scientist. Continuation of ten-year field program (1979-1988) to evaluate fate and effects of acid waste disposal.

Enseco, Inc. (1977-1988): Senior Scientific Specialist, Enseco. Previous positions at Enseco included: President, ERCO Division of Enseco (1980-1984); Senior Corporate Vice President, Enseco (1985-1987); Member, Board of Directors, Enseco (1984-1986); Member, Board of Directors, Enseco Investments (1984-1988). Representative scientific projects are:

"NPDES Biomonitoring Program for Sewage Sludge Discharged from MWRA's Treatment Plants at Deer Island and Nut Island to Boston Harbor" (For Massachusetts Water Resources Authority). Program Director and Chief Scientist. Assessment of sewage effluents for chemical characteristics and aquatic toxicity. Also, evaluation of potential chemical constituents of effluents to bioaccumulate (trayed mussel study). Investigation performed in 1987-1988.

"Environmental Assessment of Fly-Ash Disposal off the Coast of Taiwan, Republic of China" (For Taiwan Power Company). Program Manager and Chief Scientist. Comprehensive aquatic hazard evaluation that included both laboratory investigations (e.g., chemical analyses, aquatic-toxicity analyses, environmental fate studies employing physical models) and field investigations (e.g., plume studies, side-scan-sonar studies, underwater-television studies). Study performed in 1987-1988.

"Environmental Assessment of Various Alternatives for Disposing of Acid-Iron Waste in the Sea of Japan" (For E.I. Du Pont De Nemours & Company). Program Manager and Chief Scientist. Literature and field evaluation of two alternatives: discharge of unaltered liquid waste off the coast of the Republic of Korea and solidification of waste into monoliths to be employed in construction of artificial fishing reefs. Study performed in 1987-1988.

"Preparation of Ocean-Dumping Permit (Subparts B, C, D, and E Demonstrations) for By-product Hydrochloric Acid Discharged at Acid Waste Disposal Site in New York Bight" (For Allied-Signal). Program Manager and Chief Scientist. Literature- and laboratory-based ecological/economic evaluation presented to Region II, EPA. Studies performed in 1976, 1979, 1982, 1985, and 1988.

"Physical,, Chemical, and Biological Monitoring Program at the Acid Waste Disposal Site in New York Bight" (For Allied-Signal). Program Manager and Chief Scientist. Ten-year field program (1979-1988) to evaluate fate and effects of acid-waste disposal.

"Physical, Chemical, and Biological Monitoring Program at Deepwater Dumpsite 106" (For E.I. Du Pont De Nemours & Company). Program Manager and Chief Scientist. Five-year field program (1984-1988) to evaluate fate and effects of acid-iron waste disposal.

"Ecological Evaluation of Proposed Oceanic Discharge of Dredged Material from Numerous Locations in New England" (For New England Division, Corps of Engineers). Program Manager and Chief Scientist. Laboratory-based aquatic-toxicity and bioaccumulation analyses. Study performed in 1982-1988.

"Environmental Assessment of an Active Oil Field in the Northwestern Gulf of Mexico - Fish and Crustacean Bioassays" (For National Marine Fisheries Service). Program Manager and Chief Scientist. Laboratory- and field-based aquatic toxicity investigation. Study performed in 1977.

"Evaluation of Environmental Suitability of Two Potential Disposal Sites off the Coast of Taiwan to Receive Acid-Iron Waste" (For E.I. Du Pont De Nemours & Company). Program Manager and Chief Scientist. Literature study designed to facilitate selection of appropriate disposal site by the Taiwan Environmental Protection Agency. Study performed in 1987.

"Preparation of Ocean-Dumping Permit (Subparts B, C, D, and E Demonstrations) for Sewage Sludge Discharged at Deepwater Dumpsite 106" (For Massachusetts Water Resource Authority). Program Manager and Chief Scientist. Literature- and laboratory-based ecological/economic evaluation presented to Regions I and II, EPA. Study performed in 1985.

"Processing of Drilling Fluids for Environmental Testing" (For American Petroleum Institute). Program Manager and Chief Scientist. Laboratory-based evaluation of toxicological, chemical, and microbiological deterioration of drilling fluids under various storage conditions. Study performed in 1985.

"Testing of Drilling Fluids for Acute Toxicity" (For American Petroleum Institute). Program Manager and Chief Scientist. Development and validation of 17 critical testing protocols and interpretive techniques employed in evaluating drilling fluids for acute toxicity. Study performed in 1985.

"Aquatic Hazard Associated with Disposal of Acid-Iron Waste in the North Sea" (For Kronos Titan-GmbH). Program Manager and Chief Scientist. Results presented in form of expert testimony at The Hague, Netherlands. Study performed in 1982.

"Interpretation of the 1977 Ocean Dumping Regulations and Associated EPA/COE Guidelines" (For New England Division, Corps of Engineers). Program Manager and Chief Scientist. Interpretation of statistical procedures employed in ecological evaluations of dredged material. Study performed in 1982.

"Preparation of Ocean-Dumping Permit (Subparts B, C, D, and E Demonstrations) for Coal Ash Discharged at Deepwater Dumpsite 106" (For Con Edison of New York). Program Manager and Chief Scientist. Literature- and laboratory- and field-based ecological/economic evaluation presented to Region II, EPA. Study performed in 1981.

"Aquatic Hazard Evaluations for Acid-Iron Wastewaters Discharged from Two Titanium-Dioxide Manufacturing Plants to the St. Lawrence River, Quebec Province, Canada" (For Canadian Titanium Pigments, Ltd. and Tioxide Canada, Inc.). Program Manager and Chief Scientist. Chemical analyses of wastewater plumes, aquatic toxicity testing of wastewaters with freshwater animals, and field bioaccumulation studies. Study performed in 1980.

"Aquatic Hazard Evaluations for Ammonia-Containing Wastewater Discharged to the Missouri River from a Plant in La Platte, Nebraska" (For Allied-Signal). Project Manager and Chief Scientist. Field and modeling studies of wastewater plume. Study performed in 1979.

"Preparation of Ocean-Dumping Permit (Subparts B, C, D, and E Demonstrations) for Acid-Iron Waste Discharged at Acid Waste Disposal Site in New York Bight" (For NL Industries). Program Manager and Chief Scientist. Literature- and laboratory-based ecological/economic evaluation presented to Region II, EPA. Study performed in 1978.

"Technical and Environmental Assessment of Coal Cleaning -- Health and Ecological Effects Tests" (For Versar Corporation). Program Manager and Chief Scientist. Laboratory-based evaluation of toxicity of chemical substances to aquatic organisms and mammals. Study performed in 1978.

"Preparation of Ocean Dumping Permit (Subparts B, C, D, and E Demonstrations) for Acid-Iron Waste Discharged at Acid Waste Disposal Site in New York Bight" (For Gulf & Western). Program Manager and Chief Scientist. Literature- and laboratory-based ecological/economic evaluation presented to Region II, EPA. Study performed in 1977.

EG&G Environmental Consultants (1974-1977): Director of Biological Sciences Group

University of Maryland, Chesapeake Biological Laboratory (1971-1974): Research Associate Professor

Nicholls State University (1966-1971): Associate Professor of Marine Sciences

Southeastern Louisiana State University (1963-1966): Assistant Professor of Biology

EXPERT TESTIMONY

Environmental conditions in Onondaga Lake system, New York. Series of meetings in Syracuse and Albany, New York, with representatives of New York State Department of Environmental Conservation (NYDEC). 1990.

Environmental effects of PCBs and other chemical constituents in New Bedford Harbor, Massachusetts. Deposition taken in Boston by U. S. Department of Justice. August 16, 1990.

Aquatic hazard associated with disposal of fly ash off the coast of Taiwan and criteria for selection of optimal disposal sites (For Taiwan Power Company). Meeting attended by representatives of Taiwan Environmental Protection Agency. Taipei, Taiwan (Republic of China). 1987.

Ecological effects associated with ocean dumping of acid-iron wastes and environmentally appropriate disposal sites offshore of Taiwan (For E.I. Du Pont De Nemours & Company). Meeting attended by representatives of Taiwan's academic community. Taipei, Taiwan (Republic of China). 1987.

Environmental impacts of discharged acid-iron wastes and environmentally suitable disposal sites offshore of the Republic of Korea in the Sea of Japan (For E.I. Du Pont De Nemours & Company). Meeting attended by representatives of Korea's academic community and environmental agencies. Edge Moor, Delaware. 1987.

Acute toxicity and aquatic hazard related to discharge of produced waters in Santa Barbara Channel, California (For California Offshore Operators' Ad Hoc Committee). EPA, Region IX, workshop. Santa Barbara, California. 1984.

Potential ecological effects associated with runoff of herbicides to two Massachusetts streams (For American Railroad Association). Hearing before Massachusetts Department of Environmental Quality Engineering. Boston and Worcester, Massachusetts. 1984.

Relative environmental impacts of disposing of ferric chloride waste by ocean-based versus land-based alternatives (For E.I. Du Pont De Nemours & Company). EPA, Region III, hearing. Dover, Delaware. 1984.

Acute toxicity and aquatic hazard related to discharge of produced waters to offshore southern California waters (For California Offshore Operators' Ad Hoc Committee). EPA, Region IX hearing. Santa Barbara, California. 1983.

Aquatic hazard associated with disposal of acid-iron waste in the North Sea (For Kronos Titan-GmbH). The Hague, Netherlands. 1982.

Review of environmentally related testimony of Greenpeace (For NL Industries). EPA, Region II, hearing. New York, New York. 1982.

Acute toxicity and hazard associated with materials discharged from petroleum platforms located off the southern California coast (For Offshore Operations' Ad Hoc Committee). EPA Region IX, hearing. Santa Barbara, California. 1981.

Aquatic hazard evaluations of wastes proposed for discharge during exploratory drilling in the vicinity of the Flower Garden Banks (For Offshore Operators' Ad Hoc Committee). EPA Region VI, hearing. New Orleans, Louisiana.

Ocean dumping of wastes. EPA, Region II, hearing. New York, New York. 1978.

Aquatic hazard evaluations. EPA, Region III, hearing. Philadelphia, Pennsylvania. 1977.

Aquatic hazard evaluations. Virginia Water Control Board and Department of Health. Richmond, Virginia. 1977.

Aquatic hazard evaluations. Virginia Water Control Board and Department of Health. Richmond, Virginia. 1976.

Ocean dumping of wastes. EPA, Region II, hearing. New York, New York. 1976.

Aquatic ecology. LaFourche District Court, Thibodaux, Louisiana. 1972.

Aquatic ecology. Terrebonne District Court, Houma, Louisiana. 1971.

PROFESSIONAL AFFILIATIONS AND ACTIVITIES

American Association for the Advancement of Science

Member, Panel on "Ocean Pollution Research Development and Monitoring -- North and Mid-Atlantic Regions, " NOAA, Durham, New Hampshire. 1980.

Member, Panel on "Sources" Workshop on the Carrying Capacity of U.S. Coastal Waters. NOAA, Crystal Mountain, Washington. 1979.

Member, Board of Directors, World Mariculture Society. 1971-1972.

Chairman of the Program Committee, Second Annual Meeting of the World Mariculture Society. Galveston, Texas. 1971.

Moderator of Pond Management Workshop at First Annual Meeting of the World Mariculture Society. Baton Rouge, Louisiana. 1970.

PUBLICATIONS, PRESENTATIONS, AND REPORTS (Not including reports pertaining to previously identified representative scientific projects)

Ward, T., Rose, C., and Boeri, R. "Influence of Ferric-hydroxide Floc on the Acute Toxicity of Acid-Iron Waste to Marine Organisms." Presented at meeting of Society for Environmental Toxicology and Chemistry. 1985.

Rose, C.D., Ward, T.J., and DePass, V. "Ecological Assessment for Coal Ash Dumped at Deepwater Dumpsite 106." Chapter 16: Wastes in the Ocean (1985): 389-422. (Duedall, I.W., Kester, D.R., and Park, P.K., eds.). John Wiley & Sons, Inc.

Rose, C.D. "Meaningful Measures of Marine Pollution Effects -- An Overview." Presented at the Pensacola Beach Workshop (NOAA-sponsored). April 26-29, 1982.

Rose, C.D., and Ward, T.J. 1980. "Acute Toxicity and Aquatic Hazard Associated with Discharged Formation Water." Presented at Expochem '80, October 6-9, 1980, Houston, Texas (published in Environmental Effects of Offshore Oil Production; New York: Plenum, 1981.)

Rose, C.D., and Ward, T.J. "Principles of Aquatic Hazard Evaluation as Applied to Ocean-Disposed Wastes." Presented at the American Society for Testing and Materials (ASTM) Symposium on Aquatic Toxicology, Chicago, Illinois, 1979 (published in 1981 as ASTM STP 737: 138-158).

Rose, C.D. , and Heath, E. "Viability of American Oyster, Crassostrea virginica, Spermatozoa Exposed to Stress." Ches. Sci. 1(4) (1978): 245-251.

Rose, C.D., Williams, W.G., Hollister, T., and Parrish, P. "Method for Determining Acute Toxicity of an Acid Waste and Limiting Permissible Concentration at Boundaries of an Oceanic Mixing Zone." Env. Sci. Tech. 11(4) (1977): 367-371.

Rose, C.D. "Aquatic Hazard Evaluations for Oximes Wastewater Associated with the Specialty Oximes Plant in Hopewell, Virginia." For Allied Chemical Corporation. 1977.

Rose, C.D. "Documentation of Current Methods of Assessing Impacts of Power Plants on Populations of Fishes and Shellfishes." For National Power Plant Team, U.S. Fish and Wildlife Service. 1977.

Rose, C.D., and Menzie, C. "316-a Demonstration for Brunner Island Steam Electric Plant -- Unit Nos. 1-3." For Pennsylvania Power and Light Company. 1977.

Rose, C.D. "Compliance with Ocean Dumping Final Regulations and Criteria of Proposed Discharges from Exploratory Drilling Rigs on the Mid-Atlantic Outer Continental Shelf." For Shell Oil Company and a consortium of other petroleum companies. 1977.

Mainville, C.R., and Rose, C.D. "Some Environmental Effects of an Oil Spill in the Schuylkill River." Presented at the American Society of Limnology and Oceanography, Halifax, Nova Scotia. 1975.

Rose, C.D. and Harris, A. "Extensive Culture of Penaeid Shrimp in Louisiana Salt-Marsh Impoundments." Trans. Amer. Fish. Soc. 104(2) (1975): 296-307.

Rose, C.D. "Evaluation of Environmental Impacts and Relative Costs of Current Practice and Alternatives of Disposing of By-Product Hydrochloric Acid Produced at Elizabeth, New Jersey, Works of Allied Chemical Corporation." For Allied Chemical Corporation, 1975.

Rose, C.D. "Petroleum in the Estuary." Special Report No. 5, Natural Resources Institute, Center for Environmental and Estuarine Studies, University of Maryland. 1974.

Rose, C.D., and Hassler, W.W. "Food Habits and Sex Ratios of Dolphin, Coryphaena hippurus, in the Western Atlantic Ocean off Hatteras, North Carolina." Trans. Amer. Fish Soc. 103 (1) (1974): 94-100.

Rose, C.D. "Evaluation of Potential Sites for Maryland's Production Shellfish Hatchery." For the State of Maryland. 1974.

Rose, C.D. "Effect of Dredging on Survival of the American Oyster (Crassostrea virginica) in a Coastal Bayou." Ches. Sci. 14(2) (1973): 135-138.

Rose, C.D. "Oyster Hatchery to be Built on Choptank River." Comm. Fish. News 6(4) (1973): 3.

Rose, C.D. "Salinity at Solomons and Horn Point, Maryland, with Emphasis on Salinity Patterns Considered Important to Successful Operations of Production and Research Shellfish Hatcheries." For the University of Maryland. 1973.

Rose, C.D. "Bacteria Counts (Including Coliform and Fecal Coliform) Taken at Pier and Shellfish Hatchery of Chesapeake Biological Laboratory and at Horn Point during 31 July - 5 September 1973." For the University of Maryland. 1973.

Rose, C.D. "The Basis of Effective Expert Testimony." Journal of the Louisiana Bar Association 20(1) (1972): 17-20.

Rose, C.D. "Extensive Culture of Penaeid Shrimp in Salt-Marsh Impoundments." Presented at the Atlantic Estuarine Research Society. April 1972.

Rose, C.D. "Shrimp Aquaculture in Louisiana Salt-Marsh Impoundments." Presented at the 100th Annual Meeting of American Fisheries Society, New York, New York. 1970.

Rose, C.D. "Shrimp Farming in Louisiana." Presented at the Organizational Meeting of the World Mariculture Society. Grand Terre Island, Louisiana. 1970.

Harris, A.H., and Rose, C.D. "Penaeid Shrimp Production in a Managed, Unfed, Natural Pond in South Louisiana." Asso. Southeastern Bio. Bull. 17(2) (1970): 46.

Rose, C.D., and Hassler, W.W. "Application of Survey Techniques to the Dolphin, Coryphaena hippurus, Fishery of North Carolina." Trans. Amer. Fish. Soc. 98(1) (1969): 94-103.

Rose, C.D., and Harris, A. "Pugheadedness in the Spotted Sea Trout, Cynoscion nebulosus." Quart. J. Flor. Acad. Sci. 31(4) (1968): 268-270.

Harris, A.H., and Rose, C.D. "Shrimp Predation by the Sea Catfish, Galeichthys felis." Trans. Amer. Fish. Soc. 97(4) (1968): 503-504.

Rose, C.D., and Hassler, W.W. "Age and Growth of the Dolphin, Coryphaena hippurus (Linnaeus) in North Carolina Waters." Trans. Amer. Fish. Soc. 97(3) (1968): 271-276.

Rose, C.D., and Hassler, W.W. "Occurrence of the Pompano Dolphin, Coryphaena equiselis (Linnaeus) in North Carolina Waters." Journal of the Elisha Mitchell Scientific Society 84(2) (1968).

RESUME

LEONARD C. SARAPAS, P.E., P.H.
Vice President, Engineering

EDUCATION:

M.S., University of Kansas, 1983. Civil/Environmental Engineering
B.S., University of Kansas, 1976. Civil Engineering

PROFESSIONAL CERTIFICATION:

Registered Professional Engineer: Connecticut, Delaware, Kansas, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Vermont

Certified Professional Hydrologist, Ground Water; American Institute of Hydrology

PROFESSIONAL HISTORY:

1986-Present	Balsam Environmental Consultants, Inc., Vice President, Engineering
1984-1986	Normandeau Associates, Inc., Manager, Waste Management Engineering
1980-1984	Woodward-Clyde Consultants, Manager, Waste Management Services
1977-1980	Black & Veatch Consulting Engineers, Project Engineer

REPRESENTATIVE EXPERIENCE:

Mr. Sarapas has been directly and actively involved in the waste management field for over fourteen years. He has been personally involved in the Superfund and RCRA programs since their inception in 1980. His experience base includes the investigation and assessment of industrial facilities and abandoned waste disposal sites across the United States involving widely varying geologic and hydrologic conditions. At many of these sites, Mr. Sarapas has also developed remedial designs and/or implemented remedial programs to address identified site contamination.

MOTTOLO SUPERFUND SITE REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI / FS); 1985-Present; Project Manager. Initial stages of this project involved review and critique of site investigations performed by EPA and New Hampshire regulatory agencies, as well as a buried drum exhumation/remedial program. Based upon this review, Mr. Sarapas provided expert testimony on behalf of PRP in litigation involving recovery of remedial costs. Subsequent to that time, a full Superfund RI/FS was performed which included the use of geophysics and remote sensing techniques and the installation of an extensive ground water monitoring network for unconsolidated and consolidated deposits. The FS included development of a state-of-the-science protocol to determine leachability of contaminated soil and to more effectively evaluate remedial alternatives. Based on the results of the RI/FS, the EPA selected the remedial alternative recommended by Balsam which included site dewatering, in situ soils treatment and ground water treatment through material attenuation.

NEW BEDFORD HARBOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY AND REMEDIATION DESIGN; 1984-Present; Project Manager. Performed independent evaluation of RI/FS performed by EPA on behalf of AVX Corporation (AVX) and completed independent engineering assessments of environmental, geotechnical and transport issues related to natural resource damage and remediation of New Bedford Harbor. Also developed a cost-effective remedial measures program to address potential adverse impacts of PCB and heavy metal contamination in the harbor involving in-situ containment and biological degradation. Based on this work, AVX and EPA reached a favorable settlement with EPA using much of the design work performed under Mr. Sarapas's direction in the development of their site-wide alternative.

HAMPDEN COLOR & CHEMICAL, SPRINGFIELD, MASSACHUSETTS; SITE CHARACTERIZATION AND REMEDIAL ACTION ASSESSMENT, MASSACHUSETTS CONTINGENCY PLAN; 1989-PRESENT. Principal-In-Charge. Responsible for directing the overall design of the hydrogeologic investigation for this RCRA licensed hazardous waste storage and reclamation facility. The investigation included an assessment of VOC contamination in the vadose and saturated zones due to at least two known accidental releases of 500-700 and 600 gallons of 1,1,1-trichloroethene, respectively. Investigatory techniques used to characterize the site included monitoring well installation, soil borings, slug tests, the collection and interpretation of ground water potentiometric data and aquifer hydraulic parameters, and the interpretation of water quality data and contaminant fate and transport. Using site investigation data, a risk assessment was performed and a remedial interim measure was designed for the site

including hydraulic control, ground water extraction treatment, and in-situ soil treatment.

AMOCO SUGAR CREEK REFINERY RCRA COMPLIANCE; 1980-1984; Project Manager. Provided RCRA and CERCLA regulatory compliance and planning to Amoco including development and implementation of a ground water monitoring program, development of closure plans and certification of closure, assessment of property and presentation of findings, and development of a conceptual design for an on-site landfill.

CLEAN HARBORS, INC., FACILITY ASSESSMENT AND REMEDIAL DESIGN; 1985-Present; Principal-In-Charge. Performed hydrogeologic, contaminant and remedial alternative 21E/HSWA assessments at two of Clean Harbors, Inc.'s RCRA TSD facilities, including evaluation of contaminant migration in consolidated and unconsolidated formations underlying facilities. Based upon investigation findings, developed and implemented an agency approved remedial program including source removal and source isolation at one facility and oversaw design of an interim corrective measure involving site dewatering, ground water extraction and treatment and in-situ soil treatment at the other facility.

U. S. EPA INTERIM SUPERFUND PROGRAM, ZONE 3; 1981-1983; Assistant Project Manager. Managed remedial investigations, feasibility studies and remedial programs for Superfund sites in Missouri, Texas, Iowa and Washington. Developed site investigation and remedial work plans, safety and sampling documents, and engineering evaluation reports.

SAVAGE WELL, MILFORD, NH, SUPERFUND SITE; 1984-1986; Project Manager. Performed assessment of ground water and surface water quality and identified contamination source areas related to prior discharge of volatile organic compounds. Using these data, developed conceptual remediation programs including an on-site contaminated soils treatment program and an air stripping treatment system for ground water remediation.

EASTERN MISSOURI TCDD (DIOXIN) SITES; 1982-1984; Project Manager. Managed remedial investigations at eastern Missouri dioxin sites and performed feasibility studies and conceptual design of remedial programs at seven sites. Completed the conceptual design for a 1,000,000-cubic yard regional landfill to hold dioxin wastes.

LINCOLN MILL ASBESTOS REMEDIATION, LINCOLN, NH; 1985-1986; Project Manager. Developed a program to identify, quantify and segregate

asbestos wastes and construction debris present at the former Lincoln paper mill. Based on this assessment, a site remediation program was prepared and implemented that included siting and permitting of three on-site landfills, an air quality monitoring program to document effectiveness of remediation, and a contaminated materials transport and disposal program.

CLOSURE OF BROWNING-FERRIS INDUSTRIES, INC. HAZARDOUS WASTE LANDFILL; 1984; Project Engineer. Designed ground water drainage trench for remediation and closure of a hazardous waste landfill. Assisted in design of landfill cap and ground water monitoring system.

WASTE MANAGEMENT PLAN FOR KANSAS CITY POWER & LIGHT WASTE DISPOSAL AREA; 1980-1981; Project Engineer. Developed cost-reducing closure techniques, ground water monitoring program, waste handling program and permit for a 600-acre coal burning waste disposal site.

RCRA PART B PERMIT APPLICATION FOR CARGILL HAZARDOUS WASTE INCINERATOR AND STORAGE FACILITY; 1983; Senior Consultant. Developed strategy and permit application for Cargill chemical manufacturing hazardous waste incinerator and storage facilities located in southern California.

SOUTHERN NEW HAMPSHIRE MILLYARD FACILITIES REMEDIAL PROGRAM; 1985-1986; Project Manager. Conducted an environmental evaluation of a former tannery/millyard facility to assess feasibility of building renovation. Designed and implemented a facility remedial program including asbestos removal, extensive surface cleaning, decommissioning of underground storage tanks, waste removal, and environmental monitoring. Following program completion, verification sampling was performed to document effectiveness of remedial measures and permit initiation of building renovation.

INVESTIGATION AND REMEDIATION OF THOMPSON-HAYWARD CHEMICAL COMPANY PESTICIDE FACILITY; 1983-1984; Project Manager. Determined extent and level of pesticide, dioxin and other organic compound contamination at this active facility previously used for pesticide formulation. Developed program for remediation of facility to allow continued use of site.

SPECIAL TRAINING:

Professional Liability: A Loss Prevention Course; National Society of Professional Engineers; 1988.

Assessment of Contaminant Migration in Saturated Materials; Dr. John Cherry, Distinguished Lecturer Series; 1986.

Hazardous Waste Management Practice Health and Safety Training (40 hours); Woodward-Clyde Consultants; 1984 (Served as Regional Health and Safety Officer).

Chemodynamics - Environmental Fate of Chemical Compounds in Air, Water and Soil; University of Missouri; 1982.

Geotechnical and Geohydrological Aspects of Hazardous Waste Containment; Woodward-Clyde Consultants; 1982.

PROFESSIONAL AFFILIATIONS:

American Institute of Hydrology
American Society of Civil Engineers
National Ground Water Association
Tau Beta Pi
Chi Epsilon

PUBLICATIONS AND PRESENTATIONS:

"Effective Use of Experts in Environmental Litigations," Massachusetts Continuing Legal Education, Inc., February 1991.

"A Theoretical Evaluation of the Effectiveness of Capping PCB-Contaminated New Bedford Harbor Bed Sediment," Thibodeaux, L.J., D.D. Reible, W.S. Bosworth, L.C. Sarapas, Louisiana State University Research Center Report, 1990, 180 pp.

"HSWA Corrective Action" Executive Enterprises Seminars (Instructor), Atlanta, GA; Chicago, IL; and Washington, D.C.; Winter 1990.

"HSWA Corrective Action: Status Report for EPA Regions 1, 2 and 3," Seventh Annual Hazardous Materials Management Conference, June 1989.

"Site Investigation Sampling Guidelines to Protect Sampling Data Defensibility and Admissability," Massachusetts Continuing Legal Education, Inc., October 1988.

"Case Study of Natural Resource Damage Assessment Litigation at New Bedford Harbor, Massachusetts," First Annual Hazardous Materials Management Conference/Central, March 1988.

"A Practical Approach to Corrective Action Implementation Under the 1984 Hazardous and Solid Waste Amendments," Fifth Annual Hazardous Materials Management Conference, June 1987.

"Guidance Document for Cleanup of Surface Tank and Drum Sites," coauthored with Jeffrey Cassis, U. S. EPA, August 1984.

"The Potential Impact from Land Application of Waste Water Treatment Plant Sludge on Ground and Surface Water Quality and Soil Characteristics," coauthored with Dr. J. D. Campbell, Kansas Water Pollution Control Association, May 1981.

MALCOLM L. SPAULDING Ocean Engineer

EDUCATION

Ph.D. Engineering and Applied Mechanics, University of Rhode Island, 1972
M.S. Mechanical Engineering, Massachusetts Institute of Technology, 1970
B.S. Mechanical Engineering and Applied Mechanics, University of Rhode Island, 1969

QUALIFICATIONS

Dr. Malcolm L. Spaulding is an ocean engineer specializing in numerical modeling of nearshore and coastal processes of estuarine, coastal and continental shelf regions to include hydrodynamics, waves, sediment transport and pollutant transport, fate, and effect. In addition he has been active in computational fluid dynamics investigating a wide range of geophysical and engineering flow problems. Dr. Spaulding has 15 years of experience in teaching, research, and project management. He has maintained an active research program and managed several projects with budgets in excess of a half million dollars. He has contributed over 100 publications to the literature over 30 of which are refereed.

EXPERTISE

- Project and program management
- Ocean Engineering
- Coastal Engineering
- Coastal Physical Oceanography
- Numerical modeling of estuarine, coastal and shelf processes
  - Hydrodynamics
  - Pollutant transport and fate
  - Water quality
  - Waves
  - Sediment transport
- Numerical finite element and finite difference methods
- Coordinate generation
- Physical oceanographic data collection and measurement programs
- Modeling impacts of pollutant effects on marine resources
- Oil and hazardous material fate and impact modeling
- Computational fluid dynamics
- Hydrodynamics

HONORS AND AWARDS

- National Aeronautics and Space Administration, American Society of Engineering Education (NASA/ASEE), Research Fellowship in Environmental Modeling, Langley Research Center, Hampton, Virginia, Summers 1974, 1975

- Environmental Research Fellowship at Oak Ridge National Laboratory, Oak Ridge, Tennessee, June 1978
- Council for International Exchange of Fulbright-Hayes Lectureship at the Leningrad Shipbuilding Institute, Leningrad, USSR, February - May, 1977
- Senior Scientist Visiting Fellowship, Continental Shelf Institute (IKU), Trondheim, Norway, 1982-1983
- Visiting Senior Scientist, Proudman Oceanographic Laboratory, Bidston Observatory, Merseyside, England, 1989
- Member National Research Council Physical Oceanography Panel to Review the Minerals Management Service Environmental Studies Program, 1987-1990
- Member Mumford Cove Restoration Committee. Appointed by U.S. District Court Connecticut Division to oversee restoration of cove water quality
- Member, NOAA Center for Ocean Analysis and Prediction (COAP) review panel 1990-92
- Presented the 49th Coast Guard Academy Lecture of the Newcomen Society of the United States, November 2, 1990
- Member National Research Council, Marine Board Committee to Review the Federal Government's Interagency Oil Pollution Research and Development Plan mandated by the Oil Pollution Act of 1990. January 23-24, 1991.
- Listed in Who's Who in the East
- Listed in Who's Who in Technology
- Listed in American Men and Women of Science
- Listed in American Men and Women in Frontier Sciences
- Pi Tau Sigma
- Tau Beta Pi
- Phi Kappa Phi
- Sigma Xi

PROFESSIONAL MEMBERSHIPS

- American Association for the Advancement of Science
- American Society of Mechanical Engineers
- American Society of Civil Engineers
- American Geophysical Union
- Marine Technology Society
- National Research Council, Marine Board's Committee on Oil Spill Research & Development, Commission on Engineering & Technical Systems
- Registered Professional Engineer, State of Rhode Island, 1974, Number 3539
- Rhode Island Society of Professional Engineering

EXPERIENCE

Spaulding Environmental Associates, Inc, (SEA), President, 1991 to present:

- Management of corporation
- Project management in areas of marine environmental assessments

- Provides engineering and marine science services to government and private clients. Primary focuses are in numerical modeling of physical, chemical and biological processes in marine environments. Environmental impact assessment and data analysis and management are also areas of specialty.

Project Manager for numerous research programs funded by federal and state government and private clients. Representative examples include:

- Assessing the impacts of oil spills on a commercial fishery
- Circulation and pollutant transport dynamics in Narragansett Bay.
- Ocean circulation and oil trajectory modeling for Alaskan coastal waters.
- A model to predict the distribution of selected water quality indicators.
- Hydrodynamic services.

Department of Ocean Engineering, University of Rhode Island

Acting Chair	1990
Professor	1983 to present
Associate Professor	1977-1983
Assistant Professor	1973-1977

- Teaching and research in the areas of numerical modeling of coastal processes and computational fluid mechanics.

PUBLICATIONS (1981-present)

Jayko, K., M.L. Spaulding, E. Howlett, W. Knauss, T. Isaji, E.L. Anderson, R. Goodman and B. McKenzie, 1991. A personal computer based oil spill response model for the Canadian Beaufort Sea.

Mendelsohn, D.L., E.L. Anderson, M.L. Spaulding and R.H. Goodman, 1991. A mesoscale meteorological model hindcast of the Exxon Valdez oil spill.

Spaulding, M.L., E.L. Anderson, T. Isaji and E. Howlett, 1991. Simulation of the oil trajectory and fate in the Arabian Gulf from the Mina Al Ahmadi Spill.

Spaulding, M.L. and K. Jayko, 1991. Estimating the search area of the New England Airlines crash site off Block Island, Marine Technology Society Journal, September 1990 (in press).

Spaulding, M.L., A. Odulo and S. Feng, 1991. Vertical dispersion of oil due to breaking waves.

Swanson, J.C., M. Spaulding, J-P. Mathisen and O^H/ystein O. Jenssen, 1991. A three dimensional boundary fitted coordinate hydrodynamic model, Part I: development and testing.

Anderson, E.L., E. Howlett, W. Knauss, D.P. French, M.L. Spaulding, M. Reed, S. Puckett, T. Isaji and D. Mendelsohn, 1990. The Alyeska tactical oilspill model. Mar. Tech. Soc. Journal, Vol 24, No. 4, p. 33-39.

Jordan, S.A. and M.L. Spaulding, 1990. FLAGG-A fast algorithm for grid generation. Journal of Computational Physics (in review).

National Research Council, 1990. Assessment of the U.S. outer Continental Shelf environmental studies program, I. Physical oceanography prepared by physical oceanography panel committee to review the outer Continental Shelf environmental studies program, Board on Environmental Studies and Toxicology, Commission on Geosciences, Environment and Resources, National Academy Press, Washington, DC, p. 149 (panel member).

National Research Council, 1990. Georges Bank: Environmental information for OCS Lease Sale 96. Prepared by Committee to review the outer Continental Shelf environmental studies program. Commission on GeoSciences, Environment and Resources, National Academy Press, Washington, DC (panel member) (in press).

Spaulding, M.L., (editor) 1990. Estuarine and coastal modeling. Proceedings of an American Society of Civil Engineers (ASCE) Specialty Conference, November 15-17, 1989, Newport, RI.

Spaulding, M.L., 1990. Inlet hydrodynamics (Chapter 5) in coastal lagoon management: A case study in science and public policy that worked. Oxford University Press, New York, New York (in press).

Venkat, N.K. and M. Spaulding, 1990. Numerical simulation of unsteady laminar flow over vibrating bodies (Planar Flow), Journal of Ship Research, (in press).

National Research Council, 1989. The adequacy of environmental information for outer Continental Shelf oil and gas decisions Florida and California. Prepared by committee to review the outer Continental Shelf Environmental Studies Program. National Academy Press (member of Physical Oceanography Panel).

Spaulding, M., K. Jayko and W. Knauss, 1989. Hindcast of medical waste trajectories in southern New England waters. Journal of the New England Water Pollution Control Association, Vol. 23, No. 2, November 1989. Published by New England Water Pollution Control Association, Boston, MA.

Spaulding, M.L., 1988. A state-of-the-art review of oil spill trajectory and fate modelling. Oil and Chemical Pollution, Vol 4:39-55.

Wang, X.M. and M.L. Spaulding, 1988. A two dimensional potential flow model of the wave field generated by a semi-submerged body in heaving motion. Journal of Ship Research, Vol. 32, No. 2, p. 83-91.

Gordon, R. and M.L. Spaulding, 1987. Numerical simulations of the tidal and wind driven circulation in Narragansett Bay. Estuarine, Coastal and Shelf Science, p. 611-636.

Isaji, T. and M.L. Spaulding, 1987. A numerical simulation model of the M2 and K1 tide in the northwest Gulf of Alaska. Journal of Physical Oceanography, Vol. 17, No. 5, p. 698-704.

Spaulding, M.L., T. Isaji, D. Mendelsohn and A.C. Turner, 1987. Numerical simulation of wind driven flow through Bering Strait. Journal of Physical Oceanography, Vol. 17, No. 10, p. 1799-1816.

Spaulding, M.L. and T. Isaji, 1986. A three dimensional continental shelf hydrodynamics model including wave current interaction, 18th International Liege Colloquium on Ocean Hydrodynamics, Three-Dimensional Models of Marine Estuarine Dynamics. University of Liege, Belgium, 5-9 May.

Isaji, T., M.L. Spaulding and J. Stace, 1985. Tidal exchange between a coastal lagoon and offshore waters. Estuaries (8)2B, pp. 203-216.

Spaulding, M.L., T. Isaji and M. Reed, 1985. A pollutant transport model system for Alaskan Seas, physics based environmental modelling of material release and waste disposal. in: Estuarine, Bays and Open Coasts, ASCE, New York, N.Y.

Spaulding, M.L., M. Reed, E. Anderson, T. Isaji, J.C. Swanson, S. Saila, E. Lorda and H. Walker, 1985. Oil spill fishery impact assessment model: Sensitivity to spill location and timing. Estuarine, Coastal and Shelf Science 20, pp. 41-53.

Isaji, T. and M.L. Spaulding, 1984. A model of the tidally induced residual flow in the Georges Bank-Gulf of Maine area. Journal of Physical Oceanography, June.

Reed, M., and M.L. Spaulding, 1984. Response of Georges Bank cod to periodic and nonperiodic oil spill events. Environmental Management, 8(l), pp. 67-74.

Reed, M., M.L. Spaulding, T. Isaji and J. Rosen, 1984. Modelling the long term fate and effects of anthropogenic pollutants on the North American Continental Shelf, ICES. Symposium on Contaminant Fluxes Through the Coastal Zone. Paper No. 14. Nantes, France, May 14-16.

Reed, M., M.L. Spaulding, S.B. Saila, E. Lorda and H.A. Walker, 1984. Oil spill fishery impact assessment modeling: The recruitment problem. Estuarine, Coastal and Shelf Science, 19:591-610.

Spaulding, M.L., 1984. A vertically averaged circulation model using boundary fitted coordinates. Journal of Physical Oceanography, May, pp. 973-982.

Spaulding, M.L. and D. Pavish, 1984. A three dimensional numerical model of particulate transport for coastal waters. Continental Shelf Research, Vol. 3, No. 1, pp. 55-67.

Spaulding, M.L. and C. Beauchamp, 1983. Modeling tidal circulation in coastal seas. ASCE Journal of Hydraulics, Vol. 109, No. 1, pp. 116-132, January.

Spaulding, M.L., S.B. Saila, E. Lorda, H.A. Walker, E.L. Anderson and J.C. Swanson, 1983. Oil spill fishery interaction modeling: Application to selected Georges Bank fish species. Estuarine, Coastal and Shelf Science, Vol. 16, pp. 511-541.

Hurlbut, S., M.L. Spaulding and F.M. White, 1982. Numerical solution for laminar flow about a cylinder oscillating in a uniform stream. ASCE Journal of Fluids Engineering, June.

Robertson, R. and M.L. Spaulding, 1982. A three dimensional numerical dispersion model for acid iron waste disposal. Wastes in the Ocean, Volume 5, Deep Sea Disposal D. Kester et al. (id) John Wiley and Sons. pp. 125-145.

Spaulding, M.L. and R. Gordon, 1982. A nested numerical tidal model of the southern New England bight. Journal of Ocean Engineering, Vol. 9, No. 2, pp. 107-126.

Spaulding, M.L., K. Jayko and E. Anderson, 1982. Hindcast of the Argo Merchant spill using the URI oil spill fates model. Journal of Ocean Engineering, 9(5), pp. 455-482.

Anderson, E.L. and M.L. Spaulding, 1981. Application of an oil spill fates model to environmental management on Georges Bank. Journal of the Environmental Professional, Special Issue on Toxic and Hazardous Substances, Science, Technology and Public Policy, Vol. 3, No. 1/2, pp. 119-132.

Reed, M., M.L. Spaulding and P. Cornillon, 1981. A fishery-oil spill interaction model: Simulated consequences of a blowout, pp. 99-114 in K.B. Haley (ed.) Operations Research in Fisheries, Plenum Press, NY, 490 pp.

PUBLICATIONS (Refereed)

Spaulding, M.L. and M. Reed (guest editors), 1990. Oil Spill Legislation and Management Issues, Marine Technology Society Journal, Vol 24, No. 4, December 1990.

TECHNICAL REPORTS

Spaulding, M.L., F. White, 1990. Circulation dynamics in Mt. Hope Bay and the lower Taunton River, Narragansett Bay Project, Environmental Protection Agency. Coastal and Estuarine Studies, Vol. 38, R.T. Cheng (Ed.), Springer-Verlag New York, Inc., 1990.

Spaulding, M.L., E. Anderson, K. Jayko, T. Isaji, C. Turner and D. Mendelsohn, 1988. ASA oilspill model user's manual. Report to NOAA/OCSEAP.

Spaulding, M.L., T. Isaji, K. Jayko, and C. Turner, 1988. Ocean circulation and oil spill trajectory simulations for Alaskan waters: Spill trajectory simulations for Alaskan waters: Spill trajectory simulations for Navarin Basin oil and gas lease sale number 107. Report to NOAA/OCSEAP, Anchorage, Alaska.

Spaulding, M.L., T. Isaji, K. Jayko, C. Turner and D. Mendelsohn, 1988. Ocean circulation and oil spill trajectory simulations for Alaskan waters: Spill trajectory simulations for St. Georges basin oil and gas lease sale number 101. Report to NOAA/OCSEAP, Anchorage, Alaska.

Spaulding, M.L., K. Jayko and T. Isaji, 1988. Sensitivity of Bering sea oil spill trajectory predictions to environmental data. Report to NOAA/OCSEAP, Anchorage, Alaska.

Reed, M., K. Jayko, A. Bowles, E. Anderson, S. Leatherwood and M.L. Spaulding, 1987. Computer simulation of the probability that endangered whales will interact with oil spills. OCS Study 86-0044, Minerals Management Service, Anchorage, Alaska.

Turner, C. and M.L. Spaulding, 1987. Influence of wind record length on oil spill trajectory calculation. Report to NOAA/OCSEAP, Anchorage, Alaska.

Spaulding, J.L., T. Isaji, E. Anderson, C. Turner, K. Jayko and M. Reed, 1986. Ocean circulation and oil spill trajectory simulations for Alaskan waters: Spill trajectory simulations for Shumagin oil and gas lease sale number 86. Report to NOAA/OCSEAP, Anchorage, Alaska.

Spaulding, M.L., T. Isaji, D. Mendelsohn and C. Turner, 1986. Numerical simulation of wind and ice transport through the Bering Strait. Report to NOAA/OCSEAP, Anchorage, Alaska.

Spaulding, M.L. and T. Isaji, 1985. Design flow conditions near bottom: Coupling of a continental shelf hydrodynamics model to a bottom boundary layer model Volume I - theoretical development and applications. Volume II - User's Manual. Final Report to the American Gas Association, Pipeline Research Committee, Arlington, VA. April.

Isaji, T., M.L. Spaulding and M. Reed, 1983. A numerical modeling characterization of the annual three dimensional circulation on Georges Bank - Gulf of Maine region. Applied Science Associates, Inc. Narragansett, R.I.

Reed, M., T. Isaji, E. Anderson, J.C. Swanson and M.L. Spaulding, 1983. Characteristic wind, hydrodynamics, and oil spill analyses for Georges Bank and the Gulf of Maine. Phase II Report to U.S. Department of State, Canadian Maritime Boundary Dispute Task Force, 401 C Street NW, Washington, D.C.

Swanson, J.C. and M.L. Spaulding, 1983. A two dimensional estuarine numerical water quality model: Application to the Providence River, Appendix B in Water Quality Benefits of proposed CSO Control Projects for Providence, Rhode Island. Prepared for EPA Region I under Contract 68-04-1009.

Isaji, T., M.L. Spaulding and J.C. Swanson, 1982. A three dimensional hydrodynamic model of wind and tidally-induced flows on Georges Bank, Appendix A in EG&G, 1982. Interpretation of the physical oceanography of Georges Bank. Prepared for U.S. Dept. of the Interior, Bureau of Land Management, Final Report, Contract AA851-CT1-39, 47. p.

Reed, M., M.L. Spaulding, E. Anderson and E. Lorda, 1982. Oil spill-fishery impact assessment on Georges Bank: Effects of spill timing and spill site location. Special report, prepared by Applied Science Associates, Inc. for the U.S. Dept. of the Interior, Bureau of Land Management, June.

Spaulding, M.L., S. Saila, M. Reed, J.C. Swanson, T. Isaji, E. Anderson, E. Lorda, V. Pigoga, K. Marti, J. Hoenig, H. Walker, F. White, R. Glazman and K. Jayko, 1982. Assessing the impact of oil spills on a commercial fishery - OCS lease sale no. 52, First Interim Report, July 1981; Second Interim Report, February 1982; Third Interim Report, July 1982; Final Report,

November 1982, prepared for U.S. Department of Interior, Bureau of Land Management New York OCS Office. Contract No. AA851-CTO-75. NTIS No. PB83-149104.

REVIEWS

Spaulding, M.L., 1987. Review of Environmental Hydraulics: Stratified Flows, by Flemming Bo Pederson, Lecture Notes on Coastal and Estuarine Studies Vol. 18, Springer-Verlag, for Marine Technology Society Journal.

Spaulding, M.L., 1986. Review of Lecture Notes on Coastal and Estuarine Studies, Volume 12: Offshore and coastal studies (ed. P.P.G. Dyke at al.) in The Quarterly Review of Biology, March.

CONFERENCE PROCEEDINGS

Spaulding, M.L., 1991. Ecological response modeling: A review, Proceedings of Environment North Sea (ENS) Conference: State of the Art Environmental Modeling Session Seminar on Measuring and Monitoring Technology, August 26-30, 1991, Stavanger, Norway.

Spaulding, M.L., E. Howlett, K. Jayko, E. Anderson, and T. Isaji, Applied Science Associates, Inc., 1991. A shell approach to modeling oil spill trajectory and fate and Research and Reserve operations. Second (2nd) International Conference on Estuarine and Coastal Modeling, Forecasting Models, November 13-15, Tampa, Florida.

Anderson, E., E. Howlett, W. Knauss, D. French, M. Spaulding, M. Reed, S. Puckett, T. Isaji, and D. Mendelsohn, 1990. The Alyeska tactical oil spill model. Proceedings of Conference: Oil Spills: Management and Legislative Implications, May 15-18, 1990, Newport, RI, Published by Am. Soc. of Civil Engineers, NY, NY, pp. 215-231.

Spaulding, M.L. (editor), 1990. Estuarine and coastal modeling. Proceedings of an American Society of Civil Engineers (ASCE) Specialty Conference, November 15-17, 1989, Newport, R.I.

Spaulding, M.L. and M. Reed, 1990, (editors). Oil spills: Legislative and management implications. Proceedings of an American Society of Civil Engineers (ASCE) Conference, May 15-18, 1990, Newport, RI, 570 pp.

Swanson, J.C. and M.L. Spaulding, 1990. Marine boat carrying capacity: An assessment and comparison of methodologies. National Marine Research Conference, January 12-14, 1990, Tampa, Florida.

Spaulding, M.L., W. Huang and D. Mendelsohn, 1989. Application of a boundary fitted coordinate hydrodynamic model. ASCE Specialty Conference, Estuarine and Coastal Modeling, Proceedings of the Conference, 15-17 November 1989, Newport, R.I.

Spaulding, M.L., T. Isaji, K. Jayko, E.L. Anderson, A.C. Turner and D. Mendelsohn, 1989. An oil spill model system for arctic waters. Oil Spill Conference, EPA-USCG-API, San Antonio, Texas, February.

Spaulding, M.L., K. Jayko and W. Knauss, 1989. Hindcast of medical waste trajectories in southern New England waters. In: Proceedings of Floatable Wastes in the Ocean. Social, Economic and Public Health Implications, Marine Sciences Research Center, State University of N.Y., Stony Brook, N.Y. March 21-22, 1989.

Spaulding, M.L. and S.J. Liang, 1989. Boundary fitted estuarine water quality model. ASCE Specialty Conference, Estuarine and Coastal Modeling, 15-17 November 1989, Newport, R.I.

Gundlach, E., M.L. Spaulding, and M. Murday, 1989. Erosion along the western Niger River Delta, Nigeria, Coastal Zone 89. The Sixth Symposium on Coastal and Ocean Management, July 11-14, 1989, Charlestown, South Carolina.

Jordan, S., and M.L. Spaulding, 1988. A numerical technique for predicting recirculation in a fully submerged hull cavity. Symposium on Hydrodynamic Performance Enhancement for Marine Applications. October 31-November 1, 1988, Newport, R.I.

Gundlach, E.R., M. Reed and M.L. Spaulding, 1987. Quantification of oil deposition and removal rates for a shoreline/oil spill interaction model. In: Proc. 1986 Arctic Marine Oil Program (AMOP), Edmondton, Canada; Publ. by Environment Canada, Ottawa, pp. 65-76.

Gundlach, E.R., M. Reed and M.L. Spaulding, 1987. Development of a coastal oil spill model. In: Coastal Zone 1987, The Fifth Symposium on Coastal and Ocean Management, Seattle, Washington.

Gundlach, E., M. Reed and M.L. Spaulding, 1987. A computer simulation model depicting oil impact and removal within coastal environments. Fate and Effects of Oil in the Marine Ecosystems (eds. J. Kniper and W.J. Van Den Brink) Marinus Nijhoff Publishers.

Mathison, J.P., O. Jenssen, M.L. Spaulding and J.C. Swanson, 1987. A three dimensional numerical model for ocean currents where the horizontal grid spacing is varied using boundary fitted coordinates, modelling the offshore environment. Society of Underwater Technology, London, England 1-2 April.

Reed, M., A.C. Turner, M.L. Spaulding and D. Dorson, 1987. Evaluation of surface drifters for satellite tracking of oil in the sea. Tenth Annual Arctic and Marine Program (AMOP) Conference, Edmonton, Canada, June 9-11, p. 267-290.

Reed, M., A.C. Turner, J.L. Spaulding, D. Dorson and O^H/. Johansen, 1987. Evaluation of surface drifters for satellite tracking of oil spills for the sea surface. OCEANS 87, September 3-8 October, Halifax, Nova Scotia, Canada.

Spaulding, M.L., 1987. Ocean circulation and oil spill trajectory for Alaskan coastal waters. MMS Alaska OCS Region - Arctic Information Transfer Meeting, November 17-20, 1987, Anchorage Hilton Hotel, Anchorage, Alaska.

Spaulding, M.L., 1987. Circulation dynamics of Narragansett Bay, in NOAA Estuary of the Month Seminar Series No. 1 Narragansett Bay: Issues, Resources, Status and Management. NOAA Estuarine Programs Office Seminar held January 28, 1985, Washington, D.C.

Spaulding, M.L., E. Anderson, T. Isaji, E. Gundlach and M. Murday, 1987. Application of an oil spill trajectory model to Nigerian coastal waters. 1987 Seminar on the Petroleum Industry and the Nigerian Environment, Ouerri, Bendel State, Nigeria.

Reed, M., M.L. Spaulding, E.R. Gundlach, T.W. Kana and S.J. Siah, 1986. Formulation of a shoreline/oil spill interaction model. Proc. 1986 Arctic Marine Oil Program (AMOP), Edmondton, Canada, Ottawa, Ontario, pp. 77-101.

Reed, M., M.L. Spaulding, E. Gundlach, T. Kana and J. Siah, 1986. Formulation of shoreline-oil spill interaction model. Proceedings of the 9th Annual Arctic and Marine Oil Spill Program, Edmonton, Canada, June 10-12.

Spaulding, M.L., 1986. A state-of-the-art review of oil spill trajectory and fate modelling, international services on chemical and natural dispersion of oil on the sea. Mullerhotel, Hemidal, Norway, 10-12 November.

Reed, M., A.E. Bowles, E.L. Anderson, S. Leatherwood, M.L. Spaulding, K. Jayko, H.E. Winn and J. Geraci, 1984. Feasibility of dynamic models of the interactions of potential oil spills with bowhead and gray whales in the Bering, Chukchi, and Beaufort Seas. Phase I Report to U.S. Department of Interior, Minerals Management Service, Anchorage, AL. Contract No. 14-12-0001-30076.

Reed, M., V.J. Bierman, Jr., E. Anderson, T. Isaji, M.L. Spaulding and J.C. Swanson, 1983. A proposed ocean disposal site designation protocol: Document overview and workshop summary. Proceedings of Ocean Waste Management Symposium, NOAA/NOS/OAD, May 2-6, W. Alton Jones Campus, The University of Rhode Island.

Reed, M. and M.L. Spaulding, 1982. Oil spill fishery impact assessment modeling: Application for Coastal State Use. OCEANS 82, Washington, D.C., September.

Reed, M., M.L. Spaulding, E. Lorda and H. Walker, 1982. Oil spill - fishery impact assessment modeling: The fisheries recruitment problem, American Society of Engineering Educators, Georges Bank: Hydrocarbon exploration and development. A technological conference, Nantucket Island, Massachusetts, April 27-30.

Spaulding, M.L., M. Reed, S. Saila, E. Lorda and H. Walker, 1982. Oil spill - fishery impact assessment modeling: Application to a Georges Bank, invited paper NOAA/EDIS Marine Ecosystem Modeling Workshop, Frederick, Maryland, April 2-6, pp. 101-130

Spaulding, M.L. and T. Isaji, 1981. A simplified model for assessing the impact of breachway modifications on coastal pond circulation and flushing dynamics. Proceedings of OCEANS 81, Boston, Mass., September. pp. 824-828.

01-27-91

KALLIAT T. VALSARAJ

Business Address

Dept. of Chemical Engineering
Louisiana State Univ.
Baton Rouge, LA 70803
(504) 388-6522

Hazardous Waste Research Center
Louisiana State Univ.
Baton Rouge, LA 70803
(504) 388-6770

Home Address

2023 General Beauregard Ave.
Baton Rouge, LA 70810
(504) 766-7262

SOCIAL SECURITY NUMBER:

414 33 9060

DATE OF BIRTH:

October 2, 1957

CITIZENSHIP :

India
U.S. Permanent Resident
(ARC No: A24 411 092)

MARITAL STATUS:

Married; one daughter (born 3/1/92)

EDUCATION:

VANDERBILT UNIVERSITY, Nashville, TN, 1980-1983
Ph. D. in Chemistry with Chemical Engineering as Minor

INDIAN INSTITUTE OF TECHNOLOGY, Madras, 1978-1980
M. Sc. in Chemistry (First Class)

UNIVERSITY OF CALICUT, Calicut, India, 1975-1978
B. Sc. in Chemistry (First Class, III Rank)

EXPERIENCE:

Assistant Professor (Research), Department of Chemical Engineering, Louisiana State University, August 1991 -*.

Affiliate Member, Graduate Faculty, Department of Chemical Engineering, Louisiana State University, February 1990 - present.

Senior Research Associate, LSU-EPA Hazardous Waste Research Center, Louisiana State University, August 1986 - present.

Affiliate Member, Graduate Faculty, College of Engineering, University of Arkansas, April 1984 - July 1986.

Research Associate, Department of Chemical Engineering, University of Arkansas, October 1983 - July 1986.

Director of Analytical Laboratory, Trace Contaminants Section, Engineering Experiment Station, University of Arkansas, October 1983- July 1986.

Research Assistant, Department of Chemistry, Vanderbilt University, 1981-1983.

Graduate Teaching Assistant, Department of Chemistry, Vanderbilt University, 1980-1981.

MAJOR AREAS OF RESEARCH INTEREST:

Surface Chemistry,
Environmental Chemistry and Engineering,
Wastewater Treatment,
Hazardous Waste Treatment,
Electrochemistry,
Environmental Analytical Chemistry.

PROFESSIONAL AFFILIATIONS:

American Chemical Society
Indian Chemical Society
American Institute of Chemical Engineers

OTHER SCHOLARLY ACTIVITIES:

<u>(a) Teaching Experience:</u>

1. Developed and taught a graduate level course on interfacial phenomena in the departments of Chemical Engineering at the University of Arkansas and Louisiana State University and an undergraduate level course in transport phenomena in the department of Chemical Engineering at LSU.

   At the University of Arkansas:
   CHEG 5883 *Special Topics in Chemical Engineering (Interfacial Phenomena)*- Graduate Level.
   At the Louisiana State University:
   CHE 7536 *Advanced Mass Transfer (Interfacial Transport Phenomena)*- Graduate Level.
   CHE 4102 *Transport Phenomena (Heat and Mass)*-

Undergraduate Senior Level.

2. Taught undergraduate laboratories in General, Organic and Physical Chemistry in the Department of Chemistry, Vanderbilt University.

3. Co-directed thesis and dissertation research for 3 M.S. students and 1 Ph.D. student at the University of Arkansas. Co-directed thesis and dissertation research for 2 M.S. students and 1 Ph.D. student at Louisiana State University.

4. At LSU service on committees: Member of the Examination Committee for 4 Ph.D. students and 2 M.S. students in the Departments of Chemistry, Chemical Engineering and Civil Engineering.

(b) Technical Reviewer for Papers and Proposals:

Journal of Indian Chemical Society (paper)
Journal of Hazardous Materials (paper)
U.S. Geological Survey (proposal)
National Science Foundation (proposal)
U.S. Environmental Protection Agency (report)
Water Research (paper)
Environmental Science and Technology (paper)
Environmental Progress (book)

Member - NSF workshop panel for recommendations on Future Research Directions in Dilute Separations Technology held at University of Cincinnati, Ohio on June 22-25, 1991.

(c) Consulting Activities:

Balsam Environmental Consultants, Salem, NH.

Part of a team of experts from the College of Engineering, Louisiana State University for the oversight of the remediation of a Superfund site (Petroprocessors Inc. site) in North Baton Rouge, LA.

AWARDS AND HONORS:

1. Vanderbilt University Research Assistantship, 1980-83.
2. Government of India Merit Scholarship, 1978-80.
3. University of Calicut Merit Scholarship, 1975-78.
4. Third rank (out of 30,000 students) in Bachelor of Science examination at the University of Calicut, 1978.
5. Post Doctoral Fellowship, University of Arkansas, 1984-86.
6. Placed First in the District for the Secondary School Leaving Certificate Examination out of more than 30,000 students, 1972.
7. Placed First in the College for Pre Degree Examination 1975.

PUBLICATIONS:

Refereed Book Chapters:

1. Solvent Sublation-A Non-Foaming Adsorptive Bubble Process for Separation of Waste Streams,
K.T. Valsaraj and L.J. Thibodeaux
In Advances in Coal and Mineral Processing Using Flotation, Society of Mining Engineers, Littleton, Co., S. Chander and R.R, Klimpel (Eds.) Chapter 28, pages 255-265, (1989).

2. Chemodynamic Models for Transport of Chemicals from Bed Sediments, D. D. Reible, K.T. Valsaraj and L.J. Thibodeaux, Chapter 3 in Handbook of Environmental Chemistry, Vol. 2 Part F, Reactions and Processes, O. Hutzinger (Ed.), Springer Verlag GmbH, Germany,1991; pages 185-228.

3. The Effects of Porewater Colloids on the Transport of Hydrophobic Compounds from Bed Sediments,
G.J. Thoma, A.C. Koulermos, K.T. Valsaraj, D.D. Reible and L.J. Thibodeaux,
Chapter 13 in "Organic Substances and Sediments in Water", Vol. 1, Humics and Soils, R. A. Baker (Ed.),Lewis Publishers, MI, pages 231-250, (1991).

4. Equilibrium Adsorption of Chemical Vapors onto Surface Soils: Model Predictions Versus Experimental Data.
K. T. Valsaraj and L. J. Thibodeaux.
Chapter 10 in In Fate of Pesticides and Chemicals in the Environment, Environmental Science and Technology: A Wiley Interscience Series of Texts and Monographs, J. L. Schnoor (Ed.) John Wiley & Sons, NY, pages 155-174, (1992).

   Simultaneously published in Russian as Proceedings of the Soviet-American Symposium held at Iowa City, October 1987 on Fate of Pesticides and Chemicals in the Environment , M A Novitsky (editor), Leningrad Gidrometeoizdat (1991).

5. Continuous non-foaming adsorptive bubble separation processes for the removal of hydrophobic organic compounds from the aqueous phase.
K. T. Valsaraj, X. Y. Lu and L. J. Thibodeaux,
Chapter in ACS Symposium Series (Separations Science in Environmental Chemistry, G. F. Vandegrift, D. T. Reed and I. R. Tasker (editors), ACS Books Department, Washington, D. C. (1992) - in press.

6. Air-Water Transfer: The Role of Partitioning, D. McKay, W.Y. Shiu, K.T. Valsaraj and L.J. Thibodeaux, In "Air-water Mass Transfer" John Gulliver (editor), Second International Symposium on Gas Transfer at Water Surfaces, US Army Waterways Experiment Station/ ASCE, Minneapolis, MN (1990).

7. Removal of organics from water by non-foaming flotation., K. T. Valsaraj, in "Flotation- Science and Engineering", K A Matis (editor), Marcel Dekker, New York, NY (1992).

Refereed Journal Articles:

1. Influence of Bromide, Chloride and Thiourea Additions on the Reduction of Pb(II) from Molten Calcium Nitrate at the Mercury Electrode.
R. Narayan and K.T. Valsaraj
Electrochimica Acta, 27, 153-158 (1982).

2. Removal of Refractory Organics by Aeration III. A Fast Algorithm for Modeling Solvent Sublation Columns.
D.J. Wilson and K.T. Valsaraj
Separation Science and Technology, 17, 1387-1396 (1982).

3. Removal of Refractory Organics by Aeration IV. Solvent Sublation of Chlorinated Organics an Nitrophenols.
K.T. Valsaraj and D.J. Wilson
Colloids and Surfaces, 8, 203-224 (1983).

4. Removal of Refractory Organics by Aeration V. Solvent Sublation of Polynuclear Aromatic Hydrocarbons.
S-D Huang, K.T. Valsaraj and D.J. Wilson
Separation Science and Technology, 18, 941-968 (1983).

5. Studies in Aeration I. Determination of Henry's Constants and Adsorption Isotherm Parameters at Air-Water Interfaces for Hydrophobic Chlorinated Compounds from Solvent Sublation Experiments.
K.T. Valsaraj
Journal of Indian Chemical Society, 62, 476-480 (1985).

6. The Use of Floating Oil Covers to Control Volatile Chemical Emissions from Surface Impoundments: Laboratory Investigations.
C. Springer, K.T. Valsaraj and L.J. Thibodeaux
Hazardous Waste and Hazardous Materials, 2(4), 487-501 (1985).

7. Solvent Sublation for the Removal of Hydrophobic Chlorinated Compounds from Aqueous Solutions.
K.T. Valsaraj, J.L. Porter, E.K. Liljenfeldt and C. Springer.
Water Research, 29(9), 1161-1174 (1986).

8. Removal of Pentachlorophenol from Aqueous Acidic Solutions by Solvent Extraction and Solvent Sublation.
K.T. Valsaraj and C. Springer.
Separation Science and Technology,21(8), 789-807 (1986).

9. Comparison of Co-Solvent Effects on Solvent Sublation and Bubble Aeration of Hydrophobic Organics from Aqueous

Solutions.
K.T. Valsaraj
Journal of Indian Chemical Society, 63, 1010-1012 (1986).

10. In-Situ Methods to Control Emissions from Surface Impoundments and Landfills
C. Springer, K.T. Valsaraj and L.J. Thibodeaux
Journal of the Air Pollution Control Association, 36(12), 1371-1374 (1986).

11. Solvent Sublation for the Removal of Hydrophobic Taste and Odor Causing Organics from Aqueous Solutions.
K.T. Valsaraj and C. Springer
Journal of the Indian Chemical Society, 65, 369-376 (1988)

12. Equilibrium Vapor Phase Adsorption of Volatile Organic Chemicals on Dry Soils.
S.H. Poe, K.T. Valsaraj, L.J. Thibodeaux and C. Springer.
Journal of Hazardous Materials, 19, 17-32 (1988).

13. Packed Criss-Cross Flow Tower Efficiencies for Methanol-Water Separations: Experimental and Calculated Values Using Countercurrent Flow Correlations.
A. Velaga, J.S. Cho, L.J. Thibodeaux, K.T. Valsaraj, R.B. Eldridge and D. Moncada
Industrial Engineering Chemistry Research, 27, 1481-1487 (1988).

14. Partitioning of Chloromethanes Between Aqueous and Surfactant Micellar Phases.
K.T. Valsaraj, A. Gupta, L.J. Thibodeaux and D.P. Harrison,
Water Research, 22,(9) 1173-1184 (1988).

15. On the Physico-Chemical Aspects of Partitioning of Hydrophobic Non-Polar Organics at the Air-Water Interface.
K.T. Valsaraj,
Chemosphere, 17(5), 875-887 (1988).

16. PCB Transport into Lake Sediments- A conceptual Model and Laboratory Simulations,
S. Formica, J. Baron, L.J. Thibodeaux and K.T. Valsaraj,
Environmental Science and Technology, 22(12), 1435-1440 (1988).

17. Equilibrium Adsorption of Chemical Vapors on Surface Soils, Landfills and Landfarms - A Review,
K.T. Valsaraj and L.J. Thibodeaux
Journal of Hazardous Materials, 19, 79-100 (1988).

18. Mathematical Models for Chemical Emissions from Landfills,
L.J. Thibodeaux, C. Springer, G. Hildebrand and K.T. Valsaraj,
Journal of Hazardous Materials, 19, 101-118 (1988).

19. Binding Constants for Non-Polar Hydrophobics at the Air-Water Interface: Comparison Between Experimental and Predicted Values.
K.T. Valsaraj
Chemosphere, 17(10) 2049-2053 (1988)

20. Relationships Between Octanol-Water and Micelle-Water Partition Constants for Hydrophobic Compounds of Environmental Interest,
K.T. Valsaraj and L.J. Thibodeaux,
Water Research 23(2), 183-189 (1989)

21. Partitioning of Hydrophobic Nonpolar Volatile Organics Between the Aqueous and Surfactant Aggregate Phases on Alumina,
K.T. Valsaraj
Separation Science and Technology, 24(14), 1191-1205 (1989).

22. Air Stripping of Volatile Hydrophobic Compounds Using Packed Crisscrossflow Cascades,
D. Wood, L. Locicero, K.T. Valsaraj, D.P. Harrison and L.J. Thibodeaux
Environmental Progress, 9(1), 24-29 (1990).

23. On the Estimations of Micelle-Water Partition Constants for Solutes From Their Octanol-Water Partition Constants, Normal Boiling Points, Aqueous Solubilities, Bond and Group Contribution Schemes,
K.T. Valsaraj and L.J. Thibodeaux
Separation Science and Technology, 25, 369-395 (1990).

24. Studies in Batch and Continuous Solvent Sublation, I. A. Complete Model and Mechanisms of Sublation of Neutral and Ionic Species from Aqueous Solutions,
K.T. Valsaraj and L.J. Thibodeaux
Separation Science and Technology, 26, 37-58 (1991).

25. Studies in Batch and Continuous Solvent Sublation II. Countercurrent Continuous Solvent Sublation of Neutral and Ionic Species from Aqueous Solutions.
K.T. Valsaraj and L.J. Thibodeaux
Separation Science and Technology, 26, 367-380 (1991) .

26. Studies in Batch and Continuous Solvent Sublation III, Solubility of Pentachlorophenol in Alcohol-Water Mixtures and Its Effects on Solvent Sublation.
K.T. Valsaraj, L.J. Thibodeaux and X. Y. Lu
Separation Science and Technology , 26, 529-538 (1991).

27. Studies in Batch and Continuous Solvent Sublation IV. Continuous Countercurrent Solvent Sublation and Bubble Fractionation of Hydrophobic Compounds from Aqueous Solutions.
X.Y. Lu, K.T. Valsaraj and L.J. Thibodeaux

Separation Science and Technology , 26, 977-989 (1991).

28. The Effect of Moisture on Volatile Organic Chemical Gas-to-Particle Partitioning with Atmospheric Aerosols - Competitive Adsorption Theory Predictions.
L.J. Thibodeaux, K.C. Nadler, K.T. Valsaraj and D.D. Reible.
Atmospheric Environment, 25, 1649-1656 (1991).

29. The efficiency of capping contaminated bed sediments in-situ I. Adsorption/desorption in the capping layer.
X.Q. Wang, L.J. Thibodeaux, K.T. Valsaraj and D.D. Reible.
Environmental Science and Technology, 25, 1578-1584 (1991).

30. Continuous countercurrent solvent sublation for the removal of hydrophobic organics from aqueous solutions.
K.T. Valsaraj, X.Y. Lu and L. J. Thibodeaux.
Water Research ,25, 1061-1072 (1991).

31. Non-foaming adsorptive bubble separation processes.
K.T. Valsaraj, G.J. Thoma, L.J. Thibodeaux and D.J. Wilson.
Separations Technology ,1, 234-244 (1991).

32. Separation of organic dyes from wastewater using colloidal gas aphrons.
D. Roy, K. T. Valsaraj and S. A. Kottai,
Separation Science and Technology, 27, 573-588 (1992).

33. Treatability of water-based drilling fluids using colloidal gas aphrons.
D. Roy, K. T. Valsaraj and V. J. Amedee.
Fluid/Particle Separations Journal, 5, 31-36 (1992).

34. Separation of hydrophobic organic compounds from wastewater using surfactant aggregates on alumina particles.
K T Valsaraj.
Water Science and Technology, 26(5), 1213-1220 (1992).

35. Adsorption of trace hydrophobic organics on surfactant-coated alumina.
K. T. Valsaraj.
Separation Science and Technology, 27, 1633-1642 (1992).

36. Transport of chemical vapors through soil - A landfill cover simulation experiment.
G. J. Thoma, G. Hildebrand, K. T. Valsaraj, L. J. Thibodeaux and C. Springer.
Journal of Hazardous Materials (in press).

37. A mathematical model for sediment and chemical transport in agricultural watersheds.
V. P. Singh, S. N. Prasad and K. T. Valsaraj.
Hydrology Journal of IAH (in press).

38. On the enrichment of hydrophobic organic compounds in fog droplets.
K. T. Valsaraj, G. J. Thoma, D. D. Reible and L. J. Thibodeaux.
Atmospheric Environment (under review).

39. Cascade cross-flow air stripping of moderately volatile organics at high air-to-water ratios.
E. Mertooetomo, K T Valsaraj, D M Wetzel and D P Harrison.
Water Research (under review).

40. Comparison of soil washing using conventional surfactant solutions and colloidal gas aphron suspensions.
D. Roy, K. T. Valsaraj and A. Tamayo.
Separation Science and Technology, 27, 1555-1568 (1992).

41. A study of the size and stability of colloidal gas aphrons using a particle size analyser.
P. Chapalker, K. T. Valsaraj and D. Roy.
Separation Science and Technology (under review).

Refereed Bulletins,Proceedings,Reports etc.:

(a) Proceedings:

1. Investigation of Floating Immiscible Liquids to Control VOC Emissions from Surface Impoundments.
K.T. Valsaraj, C. Springer, T. Nguyen and L.J. Thibodeaux.
Proceedings of the Eleventh Annual EPA Research Symposium, EPA 600/9-85/013, April (1985), page 145-152.

2. Laboratory Investigations of In-Situ Emission Control Methods for Surface Impoundments.
C. Springer, K.T. Valsaraj and L.J. Thibodeaux.
Proceedings of the 78th Annual Air Pollution Control Association Meeting, Paper No: 85-70.2, June (1985).

(b) Refereed Research Reports (Published Monographs):

1. "Emission of Hazardous Chemicals from Surface and Near Surface Impoundments to Air" Part A- Surface Impoundments.
C. Springer, P.D. Lunney, K.T. Valsaraj an L.J. Thibodeaux.
Final Report to the U.S. EPA under Grant No:CR-808161-02, February (1986), 98 pages.

2. "Emission of Hazardous Chemicals from Surface and Near Surface Impoundments to Air" Part B- Landfills.
C. Springer, P.D. Lunney, K.T. Valsaraj and L.J. Thibodeaux.
Final Report to the U.S. EPA under Grant No: CR-808161-02, February (1986), 71 pages.

3. "In-situ Methods to Control Emissions from Surface

Impoundments and Landfills."
C. Springer, K.T. Valsaraj and L.J. Thibodeaux
Final Report to U.S. EPA, EPA/600/2-85, October (1985), NTIS No. PB 86-121365.

4. Laboratory Studies of Packed Crossflow Cascades for Air Stripping of Volatile Organics from Groundwater.
D.P. Harrison, K.T. Valsaraj and L.J. Thibodeaux.
Final Report to Air Force Engineering and Services Center, Tyndall Air Force Base, FL. Report No: ESL-TR-89-55, September (1989), 152 pages.

5. A theoretical evaluation of the effects of dredging on PCB emissions from New Bedford harbor sediment.
K T Valsaraj and D D Reible.
Final Report to Balsam Environmental Consultants, Inc., Salem, NH, September (1991). 33 pages.

(c) Research Reports (Non-refereed):

1. "Pollution Abatement and Demilitarization for the Pine Buff Arsenal White Phosphorous and Red Phosphorous Munitions: Survey of Materials and Handling and Disposal Options."
C. Springer and K.T. Valsaraj
Report submitted to the Technical Support Division, Pine Bluff Arsenal, Arkansas, U. S, Army, April (1986), 27 pages.

2. Strengthening the Basic Research Capabilities of the LSU EPA Center of Excellence Hazardous Waste Research Center Analytical Laboratory.
L.J. Thibodeaux, R. Segesta and K.T. Valsaraj
Final report to the LA State Board of Regents on project No:LEQSF-ENH-ENGR-5, Baton Rouge, LA September (1988).

3. Solvent sublation (floto-extraction) for the removal of low solubility hydrophobic organic compounds from aqueous systems.
L J Thibodeaux and K T Valsaraj.
Final report to the National Science Foundation on Grant No: BCS 8822835, January (1992).

PATENTS:

1. Cascade Crossflow Tower (AF Inv. 19691)
L J Thibodeaux, D P Harrison and K T Valsaraj
Pending U. S. Patent Application through the Secretary of the Air Force (submitted - January, 1991).

PARTICIPATION AT PROFESSIONAL MEETINGS:

(a) Papers Presented in Symposia(*Denotes invited presentations)

1. Removal of Chlorinated Organics from Aqueous Systems.

K.T. Valsaraj and D.J. Wilson.
Paper presented at the 91st meeting of the Tennessee Academy of Sciences held at the Austin Peay State University, Clarksville, TN, November 20, 1981.
Abstract in the Journal of Tenn. Acad. of Sci., 57,42(9182).

2. Removal of Organics from Water by Solvent Sublation.
D.J. Wilson, K.T. Valsaraj and J.L. Womack
Paper presented at the 56th Colloid and Surface Chemistry held at the Virginia Polytechnic Institute and State University, Blacksburg, VA, June 13-16, 1982. (Abstract No: 204)

3. Solvent Sublation of Chlorinated Organics and Nitrophenols
K.T. Valsaraj and D.J. Wilson
Paper presented at the 35th Southeastern Regional ACS Meeting held at Birmingham, AL, November 3-5, 1982

4. Solvent Sublation of p-dichlorobenzene
C. Schneider, J.L. Womack, K.T. Valsaraj and D.J. Wilson
Paper presented at the 92nd meeting of the Tennessee Academy of Sciences held at the University of Tennessee, Martin, TN, November 19, 1982.

5. Theoretical Simulation of the Process Control Operations on a Solvent Sublation Pilot Plant.
K.T. Valsaraj and D.J. Wilson
Paper presented at the 93rd meeting of the Tennessee Academy of Sciences held at the Volunteer State Community College, Gallatin, TN, November 18, 1983.

6. Removal of Naphthalene and Phenanthrene from Water by Solvent Sublation.
S-D Huang, K.T. Valsaraj and D.J. Wilson
Paper presented at the 93rd meeting of the Tennessee Academy of Sciences held at the Volunteer State Community College, Gallatin, TN, November 18, 1983.

7. *Solvent Sublation of Refractory Organics
K.T. Valsaraj
Invited lecture to the Department of Chemical Engineering University of Arkansas, Fayetteville, AR, January 30, 1984.

8. Investigation of Floating Immiscible Liquids to Control VOC Emissions from Surface Impoundments.
K.T. Valsaraj, C. Springer, T. Nguyen and L.J. Thibodeaux.
Paper presented at the 11th Annual EPA Research Symposium held in Cincinnati, OH on April 29 - May 1, 1985.

9. Laboratory Investigations of In-situ Control Methods for Surface Impoundments.
C. Springer, K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the 1985 Annual Meeting of the Air

Pollution Control Association held in Detroit, Michigan, June 19-21, 1985.

10. (*)Comparison of Aeration and Solvent Sublation of Chlorobenzenes.
K.T. Valsaraj
Paper presented at the ACS Joint Southeast/Southwest Regional Meeting (Symposium on Hazardous Waste: Storage, Monitoring and Reuse) held in Memphis, TN, October 9-11, 1985.

11. (*)Emissions of Volatile Organic Chemicals from Landfills and Wastepiles.
C. Springer, K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the Seventh Annual Meeting of the Society for Environmental Toxicology and Chemistry. Theme session "Sources and Fate of Trace Organics in the Atmosphere" held in Alexandria, VA, November 2-5, 1986.

12. (*)Removal of Trace Organics from Aqueous Solutions by Aeration and Solvent Sublation.
K.T. Valsaraj
Invited lecture to the Hazardous Waste Research Center. Louisiana State University, Baton Rouge, LA, May 5, 1986.

13. Diffused Aeration and Solvent Sublation for the Removal of Volatile Organics from Aqueous Systems.
K.T. Valsaraj and L.J. Thibodeaux
Paper presented before the Division of Environmental Chemistry, National ACS Meeting in New Orleans, LA, August 30 - September 4, 1987, Div. Env. Chem. ACS - Preprint Abs., 27,(2), 220-222 (1987).

14. Equilibrium Vapor Phase Adsorption of Volatile Organic Chemicals by Dry Soils.
S.H. Poe, K.T. Valsaraj and L.J. Thibodeaux
Paper presented before the Division of Environmental Chemistry, National ACS Meeting in New Orleans, LA, August 30 - September 4, 1987. Div. Env. Chem. ACS - Preprint Abs., 27, 223-225 (1987).

15. Comparison of Experimental and Calculated Stage Efficiencies in a Packed Cross-Flow Cascade for Methanol-Water Separations.
K.T. Valsaraj, A. Velaga, J.S. Cho and L.J. Thibodeaux.
Paper presented before the Industrial Engineering Chemistry Division, ACS National Meeting in New Orleans, LA, August 30 - September 4, 1987.

16. Role of Physical Adsorption in Determining the Vapor Pressure of Volatile Organic Above Landfills, Landfarms and Surface Soils.
K.T. Valsaraj and L.J. Thibodeaux

Paper presented to the Eight Annual Meeting of the Society of Environmental Toxicology and Chemistry held at Pensacola, FL, November 9-12, 1987.

17. (*)Equilibrium Adsorption of Chemical Vapors onto Surface Soils: Model Prediction and Experimental Data.
K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the EPA sponsored USA-USSR Symposium on the Fate of Pesticides and Chemicals in the Environment held at the University of Iowa, Iowa City on October 12-16, 1987.

18. (*)On the Physico-Chemical Aspects of Partitioning of Hydrophobic Non-Polar Organics at Air-Water and Solid-Water Interfaces.
K.T. Valsaraj
Paper presented at the 43rd Southwest ACS Regional Meeting (Symposium on Environmental Science & Technology) held at Little Rock, Arkansas, December, 2-4, 1987.

19. Cascade Crossflow Air Stripping of Volatile Organic Compounds from Groundwater.
L.J. Thibodeaux, D.P. Harrison and K.T. Valsaraj
Paper presented at the First Annual Hazardous Waste Research Symposium organized by the LSU Hazardous Waste Research Center at Louisiana State University, Baton Rouge, LA, October 20-21, 1987.

20. Air Stripping of Volatile Organics from Groundwater Using Packed Crisscrossflow Cascades.
L. Locicero, D. Wood, K.T. Valsaraj, L.J. Thibodeaux and D.P. Harrison.
Paper presented at the 1989 AIChE Spring National Meeting in Houston, TX, April 26-29, 1989.

21. Estimation of Interfacial Areas in Packed Crisscrossflow Distillation Columns.
A. Velaga, K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the 1989 AIChE Spring National Meeting in Houston, TX, April 26-29, 1989.

22. Efficiencies of Volatile Organic Air Stripping in a Packed Crossflow Cascade.
L.J. Thibodeaux, K.T. Valsaraj and D.P. Harrison
Paper presented at the Second Annual Symposium on Hazardous Waste Research Sponsored by the LSU EPA Center of Excellence Hazardous Waste Research Center, Baton Rouge, LA, October 25-26, 1988.

23. (*)Air Stripping of Volatile Organics from Groundwater Using Packed Crisscross Flow Cascades.
F.D. Wood, L. Locicero, K.T. Valsaraj, D.P. Harrison and L.J. Thibodeaux,

Paper presented at the 196th ACS National Meeting held in Dallas, TX, April 9-14, 1989.

24. (*)Transport of Hydrophobic Chemicals Into and Out of Bed Sediments - Laboratory Simulations.
J.A. Baron, L.J. Thibodeaux, K. T. Valsaraj and D.D. Reible,
Paper presented at the 32nd Annual Meeting of the International Association of Great Lakes Research (IAGLR) held at the University of Wisconsin, Madison, WI, May 30 - June 2, 1989.

25. (*)Do Colloids Have Significant Chemical Transport Properties in Bed Sediments?
A.C. Koulermos, L.J. Thibodeaux, K.T. Valsaraj, and D.D. Reible.
Paper presented at the 32 nd Annual Meeting of IAGLR held at University of Wisconsin, Madison, WI, May 30 - June 2, 1989.

26. Influence of Natural Colloids on the Transport and Fate of Organic Pollutants in Aquatic Systems.
A.C. Koulermos, L.J. Thibodeaux, K.T. Valsaraj, and D.D. Reible.
Paper presented at the 10th Annual Meeting of SETAC, October 29 - November 2, 1989.

27. Continuous Countercurrent Solvent Sublation of Hydrophobic Compounds from Aqueous Solutions.
X.Y. Lu, K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the 200th National ACS Meeting in Washington, D.C., August 26-31, 1990.

28. (*)The Effects of Porewater Colloids on the Transport of Hydrophobic Compounds from Bed Sediments.
G.J. Thoma, A.C. Koulermos, K.T. Valsaraj, D.D. Reible and L.J. Thibodeaux
Paper presented at the Symposium on "Organic Substances and Sediments in Water" at the National ACS Meeting in Boston, MA, April, 1990.

29. Solvent Sublation - An Adsorptive Bubble Process for the Removal of Hydrophobic Compounds from Aqueous Solution.
K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the Second Annual HWRC Research Symposium at LSU, Baton Rouge, LA, October, 1989.

30. (*)The Effect of Moisture on Volatile Organic Chemical Vapor-to-Particle Partitioning with Atmospheric Aerosols - Competitive Adsorption Theory Predictions.
L.J. Thibodeaux, K. Nadler, K.T. Valsaraj and D.D. Reible
Paper presented at the Symposium on Environmental Chemistry in honor of Philip W. West, 45th Southwest Regional ACS Meeting, Baton Rouge, LA, December 6-8, 1989.

31. Theory of In-Situ Capping of Contaminated Sediments.
L.J. Thibodeaux, D.D. Reible, K.T. Valsaraj and X. Wang.
Paper presented at the Second Annual HWRC Symposium, Louisiana State University, Baton Rouge, LA, October, 1989.

32. Air Stripping of VOCs from Groundwater Using Crisscross Flow Cascades.
D.P. Harrison ,K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the Second Annual HWRC Research Symposium, Louisiana State University, Baton Rouge, LA, October, 1989.

33. (*)Solvent Sublation - A Non Foaming Adsorptive Bubble Process for the Separation of Waste Streams.
K.T. Valsaraj and L.J. Thibodeaux
Presented at the Engineering Foundation Conference on Advances in Flotation for Coal and Mineral Processing held at Sheration Palm Coast Resort, Florida, December 3-8, 1989.

34. (*) Air-Water Transfer: Role of Partitioning.
D. McKay, W.Y. Shiu, K.T. Valsaraj and L.J. Thibodeaux
Paper presented at the Second International Conference on Gas Transfer at Water Surfaces held at the University of Minnesota, Minneapolis, MN, September 10-11, 1990.

35. In-Situ Capping of Contaminated Bed Sediments In-Situ.
X.Q. Wang, L.J. Thibodeaux, K.T. Valsaraj and D.D. Reible.
Paper presented at Third Annual Symposium of the Hazardous Waste Research Center, LSU, Baton Rouge, October 22, 1990.

36. Continuous non-foaming adsorptive bubble separation processes for the removal of hydrophobic organics from the aqueous phase.
K. T. Valsaraj, X. Y. Lu and L. J. Thibodeaux.
Paper presented at the symposium on Separations Science in Environmental Chemistry, ACS National meeting, Atlanta, GA, April 14- 19, 1991.

37. Criss-cross flow stripping of volatile organics from wastewater.
D. P. Harrison, D. M. Wetzel, K. T. Valsaraj and E. Mertooetomo.
Paper for the symposium on Separations in Wastewater Cleanup, AIChE national meeting, Pittsburgh, PA, August, 18-21, 1991.

38. (*) Non-foaming adsorptive bubble processes for wastewater treatment.
K. T. Valsaraj and L. J. Thibodeaux.
Invited paper for the national meeting of the American Society of Mining Engineers, Phoenix, AZ, February 24 - 27, 1992.

39. (*) Quantitative release rates of bed sediment contaminants.
L. J. Thibodeaux, D. D. Reible and K. T. Valsaraj.

Paper presented at the Contaminated Sediment Assessment Methods Workshop held at the Village of Galilee, Narangansett, RI, May 6-8, 1991.

40. (*) Comparison of physical transport processes in noncohesive river sediments.
D. D. Reible, S. A. Savant-Mahliet, K. T. Valsaraj, L. J. Thibodeaux and G. J. Thoma.
Paper presented at the 1991 National Conference on Hydraulic Engineering Special Session on "Transport Processes at the Interface of Water Column and Bottom Sediment" sponsored by the American Society of Civil Engineers, held in Nashville, TN from July 29 to August 2, 1991.

41. Separation of hydrophobic organic compounds from wastewater using surfactant aggregates on alumina particles.
K T Valsaraj.
Paper for the conference entitled "Water Quality International'92", the 16 th Biennial International Conference of the International Association for Water Pollution Research and Control, Washington, DC, May 24-30, 1992.

42. The effectiveness of in-situ capping of contaminated sediments: A Feasibility Study.
G Thoma, K T Valsaraj, D D Reible, L J Thibodeaux and W Bosworth.
Paper No: 18a at the 1992 Spring National Meeting of the American Institute of Chemical Engineers, New Orleans, LA, March 29 - April 2, 1992.

43. Cascade cross flow stripping for groundwater purification.
D P Harrison, D M Wetzel, K T Valsaraj, E Mertooetomo and S Verma.
Paper No. 83a for the Symposium on Separation of Contaminants from Soil and Groundwater, Summer National AIChE meeting to be held in Minneapolis, MN, August 9-12, 1992.

44. Bench scale testing of capping as an in-situ remediation alternative for contaminated sediments.
G Thoma, D D Reible, K T Valsaraj and L J Thibodeaux.
Paper No. 51g for the Symposium on Remediation of Contaminated Sediments, Summer National AIChE meeting to be held in Minneapolis, MN, August 9-12, 1992.

GRANTS AND CONTRACTS:

(a) FEDERAL:

1. Title: "Solvent Sublation for the Removal of Low Solubility Hydrophobics from Aqueous Solutions"
P.Is: K.T. Valsaraj and L.J. Thibodeaux
Agency: National Science Foundation (NSF)

Period: 1989-91
Amount: $127,076
Status: Funded

2. Title: "Crossflow Air Stripping of Moderately Volatile Organics".
P.Is: K.T. Valsaraj
Agency: Air Force Engineering and Services Center Tyndall Air Force Base, FL
Period: 1989-91 (through IPA)
Amount: $46,136
Status: Funded

3. Title: "In-situ Capping of Contaminated Bed Sediments"
P.Is: L.J. Thibodeaux, D.D. Reible and K.T. Valsaraj
Agency: EPA through LSU Hazardous Waste Research Center
Period: 1990-91
Amount: $43,367
Status: Funded

4. Title: "Experimental Studies on the Efficiency of Capping Contaminated Bed Sediments In-Situ"
P.Is: L.J. Thibodeaux, D.D. Reible, K.T. Valsaraj and J.W. Fleeger
Agency: EPA through LSU-HWRC
Period: 1991-92
Amount: $62,562
Status: Funded

5. Title: "Colloid Enhanced Transport from Unconsolidated Media"
P.Is: L.J. Thibodeaux, K.T. Valsaraj and D.D. Reible
Agency: National Science Foundation-LaSER/EPSCoR Program
Period: 1992-95
Amount: $516,987
Status: Funded

5. Title: "Pollutant fluxes to aquatic systems via coupled biological and physicochemical bed-sediment processes"
P.I.s: D D Reible, L J Thibodeaux, K T Valsaraj and J Fleeger
Agency: U.S. Environmental Protection Agency through the LSU/EPA Hazardous Substances Research Center (S&SW).
Period: 1991-92
Amount: $103,951
Status: Funded.

6. Title: "An investigation of chemical transport from contaminated sediment through porous containment structures"
P.I.s: D D Reible, L J Thibodeaux, K T Valsaraj and T Myers
Agency: U.S. Environmental Protection Agency through the LSU/EPA Hazardous Substances Research Center (S&SW).
Period: 1991-92

Amount: $108,039
Status: Funded.

7. Title: "Development of Procedures for the Selection and Design of a Cap for In-situ Treatment of Contaminated Sediments"
P.Is: D. D. Reible, L. J. Thibodeaux and K. T. Valsaraj
Agency: U S Environmental Protection Agency
Period: 1992-94
Amount: $186,709
Status: Submitted.

8. Title: Development and testing of a physical-chemical model for determining sediment and chemical inputs into aquatic environments.
P.I.s: V. P. Singh, K. T. Valsaraj and S. N. Prasad
Agency: U S Environmental Protection Agency
Period: 8/01/92 - 7/31/95
Amount: $349,100
Status: Submitted.

9. Title: Extraction of solutes from dilute aqueous streams using gas and liquid microdispersions.
P.Is: K. T. Valsaraj and D. Roy
Agency: U S Environmental Protection Agency
Period: 10/1/92 - 9/30/95
Amount: $282,999
Status: Submitted.

(b) STATE AND OTHER AGENCIES:

1. Title: "Development of Microbial Gas Aphrons for In-Situ Decontamination of Hazardous Waste Sites".
P.Is: D. Roy, K.T. Valsaraj and D.D. Adrian
Agency: LEQSF Subprogram B (8g grant)
Period: 1989-92
Amount: $258,500
Status: Funded

2. Title: "Strengthening the Basic Research Capabilities of the Hazardous Waste Research Center"
P.I.s: L.J. Thibodeaux, K.T. Valsaraj and R. Segesta
Agency: LEQSF Equipment Enhancement Grant (8g grant)
Period: 1987-88
Amount: $95,000
Status: Funded

3. Title: "Performance Verification of a Packed Crossflow Cascade for Air Stripping Volatiles from Groundwater"
P.Is: D.P. Harrison, D.M. Wetzel and K.T. Valsaraj
Agency: LEQSF Subprogram B (8g grant)
Period: 7/91-7/93.
Amount: $166,908

Status: Funded

4. Title: "In-situ soil washing using surfactants and colloidal gas aphrons to enhance pump and treat remediation"
   P.Is: D. Roy, K. T. Valsaraj and W. D. Constant
   Agency: LSU/EPA Hazardous Waste Research Center.
   Period: 6/91-9/91
   Amount: $31,980
   Status: Funded

5. Title: "Surface and Flow Characterisation Equipment"
   P.Is: J R Collier, R D Wesson, K T Valsaraj, P S Russo and W H Daly
   Agency: LEQSF Equipment Enhancement Grant
   Period: 1 year starting 6/1/92
   Amount: $ 144,000
   Status: Funded.

6. Title: "Enhancement of the Subsurface Environmental Research Lab."
   P.Is: D Roy, D D Adrian, V P Singh, W D Constant and K T Valsaraj
   Agency: LEQSF Equipment Enhancement Grant
   Period: 6/1/92 - 5/31/93
   Amount: $100,000
   Status: Funded

7. Title: "Pilot studies on the application of colloidal gas aphrons for in-situ remediation of hazardous waste sites"
   P.Is: D Roy, K T Valsaraj and D D Adrian
   Agency: LEQSF Industrial Ties Program
   Period: 6/1/92-5/31/93
   Amount: $25,000
   Status: Funded.