New Bedford

215069

Total Environmental Restoration Contract

New England Division

USACE Contract No. DACW33-94-D-0002

FOSTER WHEELER ENVIRONMENTAL CORPORATION

USACE CONTRACT NO. DACW33-94-D-0002
DELIVERY ORDER NO. 017
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

DRAFT FINAL
DEVELOPMENT OF PCB AIR ACTION LEVELS FOR THE PROTECTION OF THE PUBLIC
NEW BEDFORD HARBOR SUPERFUND SITE
New Bedford Harbor, Massachusetts

December 2001

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

2001-017-0427
12/12/01

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LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
CDF	Combined Disposal Facility
EPC	Exposure Point Concentration
ISC3	Industrial Source Complex Model, Version 3
HPG	Horizontal Profiling Grab Bucket
MADEP	Massachusetts Department of Environmental Protection
MAOL	Most Appropriate Occupational Limit
NBH	New Bedford Harbor
NIOSH	National Institute for Occupational Safety and Health
NTEL	Non-Threshold Effect Exposure Limit
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl Compounds
PDFT	Pre-Design Field Test
SPU	Slurry Processing Unit
TEL	Threshold Effects Exposure Limit
TERC	Total Environmental Restoration Contract
TEUF	Threshold Effects Uncertainty Factor
USEPA	United States Environmental Protection Agency
WES	Waterways Experiment Station
WHO	World Health Organization

1.0 EXECUTIVE SUMMARY

The remediation of the sediments at New Bedford Harbor is currently planned to involve the dredging and excavation of sediments that are contaminated with Polychlorinated Biphenyls (PCBs). These sediments will be removed from their current location, transported to on-shore treatment and processing facilities, Harbor-side Confined Disposal Facilities (CDFs), or off-site disposal facilities. These operations will disturb contaminated sediments and expose them to the open air for varying periods of time. In the process, vapor phase PCBs could be released into the atmosphere where they could, to varying degrees, impact neighboring communities. This increase in emissions, however, will be short-lived and occur primarily during certain phases of the clean-up operation. Currently, the release of PCBs into the air at the site is uncontrolled and the emissions are increased at times by natural forces (e.g., wind and water effects from storms and tides) and man's activities (e.g., boating and other Harbor commerce and recreation). Until the Harbor is cleaned-up, PCB emissions from the contaminated sediments (including exposed mudflats, beach areas, and the surface water) will lead to continued public exposure at roughly current levels. Although it has the short-term potential for increases in airborne PCB concentrations if properly managed the clean-up will lead to a far greater benefit in terms of reduced, long-term releases and public exposure. The sooner the clean-up is accomplished, the more the long-term public exposure to PCBs will be reduced relative to the current levels.

This document summarizes work that was performed to address the potential impact on the public health of the community due to the incremental amount of volatile PCBs that may be released during remediation. This effort was undertaken to provide a sound foundation for managing the clean-up operation such that the long-term benefits of the remediation activities (in terms of reduced public exposure) far outweigh any short duration impacts, and to ensure that any remediation-related impacts are minimized and controlled to acceptable health-based levels. Two goals were accomplished through this work:

- Assessment of the potential for health impacts associated with emissions of volatile PCBs during the remediation of the contaminated Harbor sediments.
- Development of a cumulative exposure budgeting program that, when implemented, will ensure the protection of public health.

There were several distinct sequential and parallel efforts undertaken over a period of months to accomplish these goals. These steps are fully described in this document, and briefly described below.

The first step in assessing potential health impacts and developing the cumulative exposure budget plan was the development of allowable ambient limits for potentially impacted segments of the public. Allowable ambient limits are defined as risk-based exposure point concentrations of a contaminant in the ambient air that a person could be exposed to without adverse effects. For this project, allowable ambient limits for PCBs were calculated for two types of public receptors: (1) a child and adult resident and (2) an adult non-remediation worker at a commercial or industrial facility. The limits were developed using State and Federal guidance and using input regarding exposure scenarios and target risk goals from both the USACE and USEPA. The development of these limits is presented in Section 3.0 of this document. These allowable ambient limits were also used to develop a cumulative exposure budget for the protection of potentially exposed populations for a baseline remediation scenario.

The next step in this assessment was the estimation of the potential emission of volatile PCBs from the baseline remediation operations (i.e., dredging and CDF filling). The magnitude and distribution of air emissions from the project is largely dependent upon the remediation plan. The plan for remediating the Harbor has undergone several modifications during the course of this study, and continues to do so. At the time that the emissions modeling was completed, the baseline remediation plan included the following principal elements:

- Dredging of contaminated sediments from the Harbor over a 5 or 10 year period starting in the north and working to the south;
- Hydraulic transport of wet sediment to two CDFs (C and D);
- Storage and settling of the sediment in the CDFs (C and D);
- Decanting and treating water from the CDFs; and
- Capping the remaining sediments in the CDFs.

This document presents a study that assesses impacts from a baseline remediation scenario that includes these principal elements. A screening level assessment of impacts from the storage of dewatered sediments in CDFs was also performed and is presented in this report. This analysis, summarized as a technical memorandum (see Appendix L), was submitted separately.

There are several potential sources of air emissions from these remediation activities. The most significant sources of emissions are from storage of sediment (wet or dry) in the CDFs or emissions from dredging contaminated sediments from the Harbor. Potential emissions from these sources were estimated using theoretical models and refined using flux box test results and other field measurements. The estimation of potential emissions from these sources is fully described in Section 4.0 of this document. These PCB emissions estimates were used in conjunction with air dispersion modeling to estimate annual-average concentrations at specified locations around the site for comparison to allowable ambient limits for the baseline remediation scenario. Emissions estimates also were developed to account for changes in physical parameters such as sediment concentration, temperature and windspeed as the remediation activities progressed through the Harbor.

The third step in this assessment was the modeling of atmospheric dispersion of potential PCB emissions. Natural attenuation of the airborne PCB concentrations resulting from the operations will occur as a result of dispersion. This dispersion was evaluated using the ISC computer model with site-specific meteorology. The modeling provided a prediction of annual average PCB concentrations at potential exposure locations around the site and in the community. Ambient air impacts at any location depend on temporal operational parameters of the dredges and the CDFs and other natural factors which effect dispersion. For this reason, worst-case source characteristics were defined in consideration of the remediation options being considered at the time of the study. These source configurations modeled provided an upper-bound estimate of ambient PCB concentrations for the baseline scenario. The results of this modeling effort were used to predict ambient air concentrations of total PCBs to compare to risk-based exposure levels and to develop dispersion factors that were used in the development of the cumulative exposure budgeting plan. The air dispersion modeling work is presented in Section 5.0 of this document. The results of the dispersion modeling show that the maximum predicted ambient PCB concentrations were less than the risk-based allowable ambient limits at the potential exposure locations. As such, adverse health effects to the public are not anticipated due to the proposed remediation of the Harbor.

The potential health risks associated with inhalation of airborne PCBs were evaluated in the development of the allowable ambient limits. The relationship between the remediation activities and projected ambient airborne concentrations at the targeted receptor locations was established with the emissions and air dispersion modeling. The final step was developing a program that will ensure that exposures to airborne PCBs are maintained below appropriate health-based levels. Because the inhalation of PCBs is principally a health concern due to long term or chronic exposure, the allowable ambient limits are exposure point concentrations that should not be exceeded for extended periods. Short-term concentration limits (i.e., hourly or daily) typically associated with contaminants exhibiting acute health effects have not been defined and published for PCBs. Consequently, exposure to PCBs is best tracked, for purposes of protecting the public, against a calculated baseline exposure budget. This baseline exposure profile is based upon the allowable ambient limits, reduced to account for current pre-remediation background levels, and the site-specific dispersion patterns for the volatile PCBs in the vicinity of the emission sources. A sensitivity analysis was conducted to identify which factors have a relatively major or minor effect on the character of the budget. The factors exhibiting a relatively minor influence were conservatively set and then eliminated as explicit variables, simplifying the remaining budget. The development of the cumulative exposure budgets is presented in Section 6.0.

During remediation, ambient air sampling data will be collected and evaluated to ensure that the cumulative exposure to the most sensitive public receptor remains below these baseline exposure levels. A Draft Final Implementation Plan (see Appendix M) has been developed to define how to put the ambient air management program into practice, including how to: locate monitoring stations; collect air samples; evaluate the data obtained from the laboratory analysis of the samples; track cumulative exposures; manage and publish information; and make decisions regarding what responses are appropriate to reduce emissions and exposure.

The Draft Final Implementation Plan defines the principal aspects of the air monitoring that will be performed. The monitoring will be designed to ensure that actual exposures are at or below the acceptable long term exposure budget and thus that no adverse impacts to human health will be generated by the harbor clean-up. Regular monitoring will be performed to evaluate concentration trends over time. The Implementation Plan will dovetail with a Sampling and Analysis Plan that defines the sampling frequency, required turnaround time, analytical methods, and required QA/QC to be performed as part of the ambient air monitoring effort. Finally, the Draft Final Implementation Plan identifies "triggers" or conditions that indicate that follow-up analysis of projected emission sources and their potential impact on exposures to the public is warranted. A graded scale of priority is defined to facilitate matching a response to the severity of the potential consequences of the triggering condition.

Several changes to the planned approach for remediation of the contaminated sediments at NBH have been proposed since the scoping and performance of this study. The most significant of these changes included first the reduction from 4 CDFs to 2 CDFs, and then the proposal to dewater the sediment prior to disposal in a CDF or disposal off-site. While this assessment was based the original clean-up plan which did not include sediment dewatering, most of the information obtained from this study (including the exposure budgeting process) can be directly applied to these alternative clean-up approaches. These alternative scenarios and their relationship to this assessment is discussed further in Section 7.0, Conclusions.

2.0 INTRODUCTION

2.1 Project Description

The remediation at New Bedford Harbor (NBH) is currently planned to involve the dredging and excavation of sediments that are contaminated with Polychlorinated Biphenyls (PCBs) from their current location. PCB emissions from these sediments, along with emissions from sources at other contaminated sites in the immediate vicinity of the Harbor, are currently contributing to localized elevated levels of volatile PCBs in the ambient air. The annual average background levels at New Bedford Harbor ranged from 2 ng/m^3 to 80 ng/m^3 at various locations bordering the Harbor during the Ambient Air Sampling and Analysis Study conducted in 1999. These background concentrations are somewhat higher than the annual average PCB background concentrations published for the overall U.S. by the U.S. EPA (3.8 to 5 ng/m^3). The ongoing emissions and resulting background ambient air concentrations fluctuate noticeably by season and are affected by temperature, tides, and weather conditions. While ambient air concentrations may be increased for a relatively short time during the clean-up effort in some areas nearest the Harbor, the characteristically higher background levels can only be reduced to an acceptable level relative to long-term exposure to the public by the completion of the remediation activities. The ambient air public protection program is being designed to manage and limit the shorter-term exposures to airborne PCBs during the clean-up effort (i.e., during sediment dredging, handling, treatment and disposal activities) while the long-term benefits of the remediation and significantly lower PCB background ambient air concentrations are achieved. The sooner the clean-up is accomplished, the more the long-term public exposure to PCBs will be reduced relative to the current levels.

Several remediation alternatives have been discussed and are being considered for disposal of the dredged sediments including storage and disposal of wet sediments in Confined Disposal Facilities (CDFs), dewatering prior to storage and disposal, and off-site disposal. These alternatives will disturb contaminated sediments directly or indirectly and expose these sediments to the open air for varying periods of time. Vapor phase PCBs could then be released into the atmosphere where they could impact the neighboring community. Residents and commercial workers closest to the Harbor have the highest potential for being impacted because natural attenuation of the airborne PCB concentrations resulting from dispersion will increase as the distance from the source(s) increases.

Dredging of contaminated sediments will likely increase ambient PCB concentrations by some amount for a short period of time, but will also lead to significantly lower ambient levels over the long term. Air action levels were developed to define the upper ambient air concentration limits that would pose an acceptable/minimal risk to the most sensitive receptors while allowing the remediation project to go forward. These air action levels are based on risk-based allowable ambient limits, the atmospheric dispersion and attenuation characteristics of the NBH remediation site, and the locations of the most potentially exposed or sensitive public receptors.

Data was collected in a baseline ambient air monitoring program that was used to calculate the current pre-remediation air concentrations in the nearby residential and commercial areas around the Harbor. These air concentrations are influenced by factors such as the exposed sediment in tidal areas, wind direction, season of the year, and the amount of solar radiation. This data also established the nature of the PCB contamination in the air and the distribution of the various homologues or homologues/congeners in the air samples. The collected data indicates that a large portion of the PCBs detected in the air samples is comprised of chlorinated biphenyls with four or less chlorines.

Once developed, the air action levels were incorporated into a long-term process and procedure for monitoring the ambient air conditions. This program will help to ensure that all necessary engineering controls and work practices will be employed to maintain airborne PCB concentrations below risk-based limits. The risk associated with inhalation of PCBs is one from long term or chronic exposure and therefore, the process for monitoring and evaluating the effectiveness of the current controls is geared toward maintenance of the annual mean exposure below the air action levels. This process has been incorporated into a cumulative exposure budgeting program.

Remediation decisions will continue to be made as part of design and planning efforts. These decisions include the selection of dredging equipment, the scale of dredging operations, the temporal staging of dredging and CDF filling activities, and a number of additional factors that will also have an effect on PCB emissions and, consequently, ambient air concentrations in the area of the Harbor. The plan for remediating the Harbor has undergone several modifications during the course of preparing this assessment, and continues to do so. At the time the emissions modeling was completed, the baseline remediation scenario included the following principal elements:

- Dredging of contaminated sediments from the Harbor over a 5 or 10 year period starting in the north and working to the south;
- Hydraulic transport of wet sediment to CDFs C and D;
- Storage and settling of the sediment in CDFs C and D;
- Decanting and treating water from the CDFs; and
- Capping the remaining sediments in the CDFs.

Development of an emissions estimation methodology allows for an evaluation of the relative amount of PCB emissions expected to be generated by various operational alternatives and physical parameters (i.e., windspeed, temperature, etc.). Understanding the impact of spatial and temporal distributions of PCB emissions on ambient air quality in public areas allows for more informed decisions to be made and public protectiveness to be confidently demonstrated.

2.2 Document Organization

This document presents work that was performed to address the potential impact of volatile PCBs released during remediation on the public health of the community. Two goals were accomplished through this work:

- Assessment of the potential for health impacts associated with emissions of volatile PCB during the remediation of the contaminated Harbor sediments.
- Development of an exposure budgeting program that, when implemented, will ensure the protection of public health over the duration of the remediation.

There were several distinct sequential and parallel efforts undertaken over a period of months to accomplish these goals. These steps are fully described in this document. Section 3.0 describes the development of risk-based allowable ambient limits. Section 4.0 presents the modeling used to estimate emissions of volatile PCBs from the proposed remediation activities. Section 5.0 summarizes the atmospheric dispersion modeling used to estimate annual average ambient concentrations of PCBs and dispersion factors for the exposure budgeting program. The development of the exposure budgeting program and the proposed approach for its implementation is presented in Section 6.0. The conclusions and recommendations for this assessment are summarized in Section 7.0.

3.0 DEVELOPMENT OF ALLOWABLE AMBIENT LIMITS FOR AIRBORNE PCB'S

3.1 Introduction

This section presents work performed under Task Order No. 17, Task 2, Subtask 2. This subtask provided for the development of acceptable exposure point concentrations for targeted public receptors. The allowable concentrations have been calculated for two types of public receptors: (1) a child and adult resident and (2) an adult non-remediation worker at a commercial or industrial facility. This section describes the methodology used to develop the Allowable Ambient Limits, and presents the results of the calculations. The Allowable Ambient Limits are then used to develop a cumulative exposure budget as described in Section 6.0 of this document.

The MADEP maintains a list of Allowable Ambient Limits for over 100 chemicals, including a value for PCBs. The currently published value for PCBs is a recommended annual average concentration of 0.0005 ug/m^3 (0.5 ng/m^3) and a 24-hour average Threshold Effects Exposure Limit of 0.003 ug/m^3 (3 ng/m^3) (MADEP ORS & DAQC, 1995). These values were last reviewed by MADEP prior to the publication of the current list in December of 1995. This Allowable Ambient Limit value of 0.5 ng/m^3 was based primarily on the toxicological characteristics of Aroclor 1260, and the extrapolation of observed health effects resulting from the oral exposure of rats to PCBs to the potential effects due to the long-term inhalation of PCBs by members of the public (MADEP, 2001). Direct exposure route-to-route extrapolation (i.e., oral-to-inhalation) was assumed. The MADEP value was back-calculated so as not to exceed a target carcinogenic risk level of $1\text{x}10^{-5}$. The 1990 MADEP annual average Allowable Ambient Limit of 0.0005 ug/m^3 was revised downward from the previously published 1985 value of 0.001 ug/m^3 (1.0 ng/m^3) (MADEP, Volume II, 1990).

The annual average background levels at New Bedford Harbor ranged from 2 ng/m^3 to 80 ng/m^3 at various locations bordering the Harbor during the Ambient Air Sampling and Analysis Study in 1999. These concentrations exceed the current annual average Allowable Ambient Limit value of 0.5 ng/m^3. The current MADEP Allowable Ambient Limit for PCBs also is lower than the annual average ambient PCB concentration published for the overall U.S. by the U.S. EPA of 5 ng/m^3 (See Appendix H and Figure H-1 for more details). As discussed in Section 2.1, elevated background levels around the Harbor are strongly influenced by the continuing sources of PCB emissions from the contaminated areas of the Harbor and from other identified sources in the immediate area. The ongoing emissions fluctuate noticeably by season and are affected by temperature and weather factors. It is the presence of these elevated ambient PCB concentrations and the potential for exposure that they create that was one of the primary justifications for the current clean-up effort.

The ambient air public protection program for the New Bedford Harbor remediation project will be built upon a large body of information, including aspects of exposure conditions and toxicological dose-response of people to PCBs inhalation. This particular information also is central to the development of the MADEP Allowable Ambient Limits. To the extent possible, the development of this ambient air public protection program should be as site-specific as possible and incorporate the latest in risk assessment and exposure analysis data and procedures for PCBs. It was noted that the 1985 MADEP Allowable Ambient Limit for PCBs was revised in 1990, but stayed the same from 1990 to December of 1995 (when they were last reviewed). In September of 1996, U.S. EPA published new comprehensive guidance, "PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures" (USEPA, 1996). As the 1990 and 1995 Allowable Ambient Limits for PCBs were driven by the assessment of potential carcinogenic health effects, it was unclear how this new guidance would affect the Allowable Ambient Limit value calculated using the MADEP methodology. The U.S. EPA guidance recommended an alternative approach to selecting a carcinogenic potency factor for PCBs based on the particular exposure route being assessed (i.e., not direct route-to-route extrapolation in all cases), and basing more toxicological decision-making on the distribution of individual congeners and homologue groups in the exposure medium. In addition, the ambient air public protection program for the New Bedford Harbor remediation project is designed to look specifically at a set of different "public receptors" – child residents, adult residents, and adult commercial workers. These different receptors possess different exposure characteristics relative to the input parameters to the MADEP methodology (e.g., exposure duration, exposure frequency, and body weight). Because of these exposure differences, and the release of the 1996 PCB risk assessment guidance since the MADEP Allowable Ambient Limit for PCBs was last reviewed, the project elected to recalculate the Allowable Ambient Limits for PCBs using the MADEP methodology and the most updated and site-specific information available.

3.2 Description of Methodology

Allowable Ambient Limits are typically defined as risk-based exposure point concentrations (EPCs) of a contaminant in the ambient air that a person could be exposed to without adverse effects given their projected activities. Deriving an Allowable Ambient Limit according to the procedures published in the Massachusetts Department of Environmental Protection (MADEP), The Chemical Health Effects Assessment Methodology and the Method to Derive Allowable Ambient Limits (May 1990), is a three phase procedure. The first phase is completing a threshold effects evaluation. A threshold effect is one for which a threshold, or dose below which the adverse effect has not been observed, is indicated or assumed to exist. These effects may include a broad range of acute and chronic effects, such as allergic reactions, kidney or liver damage, or effects on the central nervous system. The result of conducting a threshold effects evaluation is the identification of an appropriate Threshold Effects Exposure Limit (TEL). The second phase of the overall Allowable Ambient Limit procedure is the non-threshold effects evaluation. Non-threshold effects are effects for which there is no conclusive or compelling evidence that a threshold exists. Carcinogenicity and mutagenicity are considered non-threshold effects. The result of conducting a non-threshold effects evaluation is the identification of an appropriate Non-Threshold Effect Exposure Limit (NTEL). The third and last phase of the procedure is selecting the Allowable Ambient Limit by choosing the lower of the TEL and NTEL values identified during the first and second phases. These three phases of the overall evaluation are presented in Sections 3.4.1 through 3.4.3, respectively.

As presented above, an Allowable Ambient Limit is an exposure point concentration that refers to a risk-based allowable ambient airborne contaminant concentration at a point of potential public exposure. The Allowable Ambient Limits derived in this section will be used in Section 6.0 of this document to develop a cumulative exposure budget which use risk-based "Air Action Level" concentrations. Air Action Levels are related to the allowable ambient air concentrations at proposed air monitoring stations located near the source of emissions. These proposed air monitoring stations do not necessarily represent points of potential public exposure. These Air Action Levels reflect both the allowable risk-based EPCs relative to potential public receptors (potentially exposed individuals) and the projected atmospheric dispersion that would result in the decrease of ambient airborne contaminant levels between the near-source monitoring stations and the locations where the public may potentially be exposed. The development of cumulative exposure budgets based on Air Action Levels is fully described in Section 6.0 of this document. It is important to note that the Ambient Allowable Limit and the Air Action Levels are typically not the same concentration. The Allowable Ambient Limits represent concentrations at potential points of public exposure while the Air Action Levels represent concentrations at proposed monitoring points around the emitting source.

Since the publishing of the cited 1990 MADEP guidance, aspects of the Allowable Ambient Limit development process relating to evaluation of threshold effects have been criticized. Specifically, the adjustment of occupationally-based limits to develop EPCs to protect a child and adult resident and an adult commercial worker has come to be viewed with increased reservation by USEPA Region I. As the analysis presented in this report results in the Non-Threshold Effect Exposure Limit being more stringent than the Threshold Effect Limit for the potentially exposed target receptors for each land use (i.e., either a child resident or an adult commercial worker). The calculated Threshold Effect Limits were not used or relied upon in any subsequent efforts toward public protection. As such, any criticisms of the threshold effect evaluation and adjustment process have not impacted the Allowable Ambient Limits recommended for use at NBH and are not further discussed. However, the application of this process and its results are presented in Section 3.3 below.

3.3 Threshold Effects Evaluation

A threshold effects evaluation was completed as the first phase in deriving the Allowable Ambient Limits, resulting in the identification of a TEL for Polychlorinated Biphenyl (PCB) compounds. This evaluation began with selecting the "Most Appropriate Occupational Limit" (MAOL). This value is an occupational limit that provides protection against the greatest number of health effects. Selection of the MAOL is based on comparisons of the toxicity data and occupational limits developed by the National Institute for Occupational Safety and Health (NIOSH), the American Conference of Governmental Industrial Hygienists (ACGIH), and the Occupational Safety and Health Administration (OSHA). Selection of the MAOL, in the case of potential mixtures of PCBs, starts with an identification of the nature and composition of the PCBs present in the air at the likely points of public exposure. Having identified the type(s) of PCBs present, if one occupational limit is higher than another for the given airborne contaminant and the health effects are reported at or below the higher limit, the lower limit should be chosen as the MAOL. The selection process involves the following criteria, in order of priority:

1. The degree of protection afforded by the occupational limit;
2. Relevance of the occupational limit to documented health effects;
3. Adequacy and comprehensiveness of the toxicity data;
4. Limitations in the occupational level, as reported by the occupational sources themselves;
5. The importance (severity) of the health effects accounted for;
6. How recently reviewed and toxicologically current the occupational limit is; and
7. The relevance of the limit to long-term chronic effects.

When specific, reported, threshold limits are associated with a given occupational limit, choosing the MAOL is straightforward, using Criteria 1, 2, and 3 above. When the decision cannot be related to specific effects levels, Criteria 4 and 5 are used and the overall hazard is considered. When the occupational limits do not differ numerically, Criteria 6 and 7 are used to choose between the alternatives.

Occupational limits represent time-weighted average concentrations of airborne substances to which a worker can be exposed during a work period, under specific conditions, throughout a working lifetime. Time-weighted average concentrations are the average respirable concentrations that could be present over the specified monitoring period or duration while still maintaining protectiveness. NIOSH uses a 10-hour workday and 40-hour workweek and averaging time, while OSHA and ACGIH use 8-hour workdays and 40-hour workweek and averaging time. These limits represent permissible exposure levels for healthy adult workers in controlled settings. They allow for certain periods of recovery or rest where exposure is assumed to be zero. OSHA and ACGIH allow for a recovery period of 16 hours between daily activities and 64 hours on the weekend. NIOSH allows 14 hours between workdays and 86 hours on the weekend. Workers are assumed to be between 18 and 65 years of age and to represent a relatively healthier subset of the general population.

After selecting the MAOL, this value is then adjusted to provide protection for the general public against acute and chronic health effects in a manner that accounts for:

1. Differences between workplace and environmental exposures;
2. Physiological differences between adults and children;
3. Differences in sensitivity between healthy workers and the general population;
4. Any limitations or inadequacies in the toxicological studies used to set the MAOL; and
5. Any threshold effects not accounted for in the MAOL on a case-by-case basis.

The process of adjusting the MAOL is performed in a sequential, step-wise fashion. Details of each step are summarized below in Sections 3.3.1 through 3.3.7 below, with calculations specific to each receptor (i.e., adult vs. child; worker vs. resident) presented in Section 3.3.8.

3.3.1 Step 1: Extrapolate from Occupational Exposure to Environmental Exposure

To begin the adjustment of the MAOL, differences between workplace and environmental exposures need to be addressed. A normal workweek of 40 hours is used for occupational exposure, which accounts for periods of rest of 14 to16 hours per day and two days per week. Since public exposure to ambient levels of airborne PCBs may be continuous, the occupational value is extrapolated to a continuous exposure of 168 hours per week (24 hours/day x 7 days/week) for residential or general population exposure scenarios. The resulting exposure adjustment factor that would be applied to the MAOL for a 7-day continuous exposure is:

$$\frac{\textit{Public Exposure Period}}{\textit{Occupational Exposure Period}} = \frac{168\ \textit{hours / week}}{40\ \textit{hours / week}} = 4.2 \qquad \text{Equation (3-1)}$$

The MAOL is divided by this adjustment factor to ensure that the total dose to a member of the public within the respective time frames will never exceed that allowed for workers over a shorter period of time. This adjustment factor is only applied for the adult and child resident exposure scenarios for NBH, since the commercial worker's exposure is based on the standard 40-hour occupational workweek duration.

3.3.2 Step 2: Extrapolate from Adult to Child

The second step in adjusting the MAOL is to account for the physiological differences between adults and children, since the MAOL is based on an adult worker. This adjustment is important because children may be particularly susceptible to air pollution due to their relative ventilation (breathing) rates per unit of body weight. Children may also be relatively more susceptible to inhaled air contaminants due to immature enzyme detoxification systems, immature immune systems, relatively higher absorption rates, relatively lower excretion rates, and the potential for increased cellular proliferation in children. The following adjustment factor is used to extrapolate from adult to child exposures in consideration of the differences in their breathing rates and body weights:

$$\frac{\textit{Normalized Child Ventilation Rate}}{\textit{Normalized Adult Ventilation Rate}} = \frac{[10\,m^3/24\,hours]}{20\,kg} x \frac{70\,kg}{[20\,m^3/24\,hours]} = 1.75 \qquad \text{Equation (3-2)}$$

where:

$10\ m^3/24$ hours = average child ventilation (inhaled) volume per 24 hour day
20 kg = average body weight of a 6 year old child

$20\ m^3/24$ hours = average adult ventilation (inhaled) volume per 24 hour day
70 kg = average body weight of an adult male

The MAOL is divided by this adjustment factor for the child resident exposure scenario, since the other two target receptors are adults.

3.3.3 Step 3: Divide MAOL by Both Adjustment Factors

The MAOL for PCBs is then adjusted by dividing it by the appropriate combination of adjustment factors calculated in Steps 1 and 2, calculating an Adjusted MAOL. Using the results of Steps 1 and 2, the following adjustment is made to account for a healthy child who may be continuously exposed to ambient levels of PCBs:

$$Adjusted\,MAOL = \frac{MAOL}{4.2 * 1.75} = \frac{MAOL}{7.35}$$

Equation (3-3a) Child Resident

For the adult resident, only the extrapolation from occupational exposure to continuous environmental exposure is required. This adjustment factor becomes:

$$Adjusted\,MAOL = \frac{MAOL}{4.2}$$

Equation (3-3b) Adult Resident

The MAOL is not adjusted for the commercial worker public exposure scenario since adult occupational exposure is assumed for the MAOL.

3.3.4 Step 4: Account for High-Risk Groups (Sensitive Subpopulations)

The previous adjustments accounted for time (exposure duration) and physiological differences between children or adults in the public and adult workers, effectively equating the body weight-normalized inhalation doses for the three possible receptors. This step provides protection for high-risk groups, such as the elderly, the chronically ill, and the hypersensitive. High-risk groups include those people who would experience adverse health effects due to the inhalation of PCBs at significantly lower levels or to a much greater degree than the general population. To provide protection for these high-risk groups in the public, an uncertainty factor of 10 is applied to the previously adjusted MAOL from Step 3 and a Sensitivity Adjusted MAOL is calculated. On the basis of data available from studies on the variability of human populations, an uncertainty factor of at least 10 is supported by most investigators and is used by the MADEP to account for sensitive individuals within the general population. The adjustment to account for sensitive populations for the child and adult residents is as follows:

$$Sensitivity\,Adjusted\,MAOL = \frac{Adjusted\,MAOL}{10}$$

Equation (3-4) Child and Adult Resident

Since this adjustment accounts for the potentially more sensitive general population, rather than the relatively healthier occupational population, it should only be applied for the adult and child resident exposure scenarios. No adjustment is required for the commercial worker.

3.3.5 Step 5: Uncertainty Factor for Inadequate Toxicity Data

This step provides an opportunity to account for any unknown effects, due to gaps or inadequacies in the toxicological database for threshold effects used to set the MAOL, resulting in a Toxicity Adjusted MAOL. A crucial consideration is the type and amount of data used as the basis for the original MAOL. The following types of data are considered inadequate by the MADEP for determining long term exposure levels for the general public:

- Exposure: When the data used to derive the MAOL are limited to acute or high-level exposures and no low-level or chronic exposure data exists.
- Data: When no human toxicity data exist and the MAOL is only based on extrapolation from animal data.
- Effects: When the MAOL is set on the basis of acute or subacute effects only and no data exist for chronic effects for humans or animals.

The approach used by USEPA to address the evaluation of toxicological data (e.g., in the development of Reference Doses or Reference Concentrations) involves applying uncertainty factors in multiples of 10 (although values less than 10 are sometimes used) for each of the following limitations associated with the study or resulting toxicological data:

- Principal study was based on subchronic and not chronic exposure;
- Lack of interspecies variability; and
- Principal studies identified a Lowest Observed Adverse Effect Level (LOAEL) but not a No Observed Adverse Effects Level (NOAEL).

In applying the USEPA approach, an uncertainty factor of 10 could be given for each of the above mentioned limitations, resulting in a total uncertainty factor of 1,000 being applied to experimental intake rates when there is a lack of both human and chronic data, and a NOAEL has not been identified (USEPA, 1989).

In using occupational data, the limits are based on both human and animal data where available and are derived specifically for repeated human exposures. An uncertainty factor of 10, in contrast to an additional USEPA-style multi-component adjustment factor, is applied to the sensitivity adjusted MAOL, for all three receptors:

$$Toxicity\ Adjusted\ MAOL = \frac{Sensitivity\ Adjusted\ MAOL}{10}$$

Equation (3-5) Child and Adult Resident

By applying these adjustment factors and the uncertainty factor, adequate protection of the public is assumed for these threshold effects addressed by the original occupational limit. The degree of protection given to the workers by the occupational limit is projected to be extended to the general public, including those more susceptible to adverse threshold health effects.

3.3.6 Step 6: Selection of a Threshold Effects Uncertainty Factor

After adjusting the MAOL to account for inadequacies in toxicological data, sensitive populations, and occupational and public exposure differences, the MAOL may still be judged to be inadequate from the perspective of protecting the public. This may occur when there are known threshold effects that have not been accounted for in the MAOL itself (e.g., teratogenicity). An additional factor, the threshold effects uncertainty factor (TEUF), should then be applied to the MAOL for a further reduction in accordance with the MADEP methodology.

The TEUF accounts for specific toxic effects that were not explicitly considered in the development of the MAOL. For example if reproductive or developmental health effects are noted by health effects assessments, and these effects were not incorporated or considered in the MAOL established by NIOSH, ACGIH, or OSHA, the TEUF is applied to account for these effects.

The basis of selecting the TEUF depends on the score for the health effect category associated with the chemical. In order to score the health effect category, a Severity Factor is chosen (see the matrix below (MADEP, 1990)). This factor is then correlated to a score of "A", "B", "C" or "D". The Severity Factor is based on the acute and chronic effects documented in the MAOL (and is given a value of 1, 2, or 3) representing the severity of those effects. Carcinogenicity, mutagenicity, and developmental and reproductive toxicity are not considered in the Severity Factor since they are accounted for in a separate adjustment. The Severity Factor score is assigned as follows:

1. Mild or transient irritant effects (e.g., runny nose, eye irritation, headache, and coughing).
2. Moderate to severe irritant effects; mild to moderate transient systemic effects; or effects generally considered to be reversible (e.g., bronchitis, anoxia, incoordination, fatigue, and dizziness).
3. Irreversible pulmonary effects; serious systemic effects; chronic or persistent effects; cumulative effects, or effects involving multiple sites or organ systems (e.g., emphysema).

After choosing the appropriate Severity Factor, the score for the health effects category is determined using the matrix presented in Table 3-1 (which has been extracted from the cited guidance document).

Table 3-1
Scoring Matrix for Acute and Chronic Toxicity

Original (Unadjusted) MAOL (mg/m^3)	Severity Factor		
	3	2	1
≤ 0.25	A	B	C
0.25 – 1	B	B	C
2 – 5	B	C	D
>5	C	D	E

Source: MADEP, 1990, Table II-3

Since health effects are basically descriptive and the scores represent a ranking with respect to a degree of hazard, the TEUF has a direct relationship to the estimated hazard. Situations with higher scores ("A" or "B") are assigned a TEUF of 10, while situations with lower scores ("C", "D", or "E") are assigned a TEUF of 5. A factor could also be applied for acute and for chronic toxicity, if they were not accounted for in the original MAOL. This uncertainty factor can only be applied once, for developmental and reproductive toxicity <u>or</u> for acute and chronic toxicity.

3.3.7 Step 7: Threshold Effects Exposure Limit

A Threshold Effects Exposure Limit (TEL) is derived by dividing the Toxicity Adjusted MAOL by an appropriate TEUF and a relative source contribution factor of 20% (ambient air is assumed to represent 20% of the total exposure to PCBs, consistent with default MADEP assumptions (MADEP, 1990)):

$$\frac{\textit{Threshold Effects}}{\textit{Exposure Limit}} = \frac{\textit{Toxicity Adjusted MAOL}}{\textit{TEUF} * 0.20} = \frac{\textit{Toxicity Adjusted MAOL}}{(5\,\textit{or}\,10) * (0.20)} \qquad \text{Equation (3-6)}$$

3.3.8 Calculating the Threshold Effects Exposure Limits for the Target Receptors

As discussed earlier in Section 3.3, the selection of the MAOL is critical to the identification of an appropriate Allowable Ambient Limit. The MAOL selected for the PCBs at New Bedford Harbor is the OSHA PEL TWA and ACGIH TLV value for Aroclor 1242 (OSHA, 2001). Aroclor 1242 was judged to represent the airborne PCBs at NBH because its distribution of homologue groups is most consistent with the distribution of homologue groups measured in the baseline air data at New Bedford Harbor (see Table 3-2). The baseline air data closely matched the Aroclor 1242 homologue pattern, with slightly less of the tri- and tetrachlorinated homologues and correspondingly more of the lighter dichlorinated compounds. The OSHA PEL TWA for chlorobiphenyl (Aroclor 1242) is 1.0 mg/m^3 (NOTE: There are no established occupational limits for Aroclor 1016).

Table 3-2
Distribution of the Homologue Groups Sampled During the Baseline Ambient Air Sampling and Analysis Study in 1999

Homologues	**Measured Four-Season Ranges (Min - Max) (Wt. %)** [1]	**Calculated Four-Season Averages (All Stations) (Wt. %)** [1]	**Aroclor 1016 (Wt. %)** [2]	**Aroclor 1242 (Wt. %)** [2]	**Aroclor 1248 (Wt. %)** [2]	**Aroclor 1254 (Wt. %)** [2]	**Aroclor 1260 (Wt. %)** [2]
Mono	0.29 – 3.13	1.54	**2.00**	**1.00**	0.00	0.00	0.00
Di	19.16 – 44.40	29.95	**19.00**	**13.00**	**1.00**	0.00	0.00
Tri	26.41 – 40.41	31.17	**57.00**	**45.00**	**21.00**	**1.00**	0.00
Tetra	19.91 – 34.02	27.69	**22.00**	**31.00**	**49.00**	**15.00**	0.00
Penta	4.78 – 22.09	7.91	0.00	**10.00**	**27.00**	**53.00**	**12.00**
Hexa	0.99 – 2.27	1.59	0.00	0.00	**2.00**	**26.00**	**42.00**
Hepta	0.04 – 0.19	0.12	0.00	0.00	0.00	**4.00**	**38.00**
Octa	0.01 – 0.12	0.02	0.00	0.00	0.00	0.00	**7.00**
Nona	0.002 – 0.04	0.01	0.00	0.00	0.00	0.00	**1.00**
Deca	0.002 – 0.17	0.02	0.00	0.00	0.00	0.00	0.00
TOTAL		100.02	100.00	100.00	100.00	99.00	100.00
Total Homologues with > 4 Chlorines		9.67	0.00	10.00	29.00	83.00	100.00

Notes:

[1] Based on the analysis of all 79 ambient air samples taken from June 1999 to August 1999.

[2] Typical Aroclor distributions presented in PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures, EPA/600/P-96/001F, September 1996, Table 1-1.

A Severity Factor of 3 was chosen based on the health effects found in the Integrated Risk Information System (IRIS) and the On-line NIOSH Pocket Guide. The target organs specified for Aroclor 1242 were the skin, eyes, liver, and reproductive system. On the USEPA website (www.epa.gov/opptintr/pcb/effects), noncancer health effects were found to include effects on the immune system, reproductive system, nervous system, and endocrine system, along with dermal, ocular, and liver effects. These effects are assigned a severity of "3" since there are multiple sites or organ systems involved. As presented in the severity matrix (Table 3-1), a Severity Factor of 3 and an MAOL of 1.0 mg/m^3 result in an assigned score of "B". This correlates to a TEUF of 10 by the criteria previously mentioned.

The derivation of the threshold effect-based Allowable Ambient Limits for a child resident, an adult resident, and a commercial worker in the general public are presented below.

3.3.8.1 Child Resident

To calculate the TEL for a child resident based on the steps outlined above, the following adjustments are made to the MAOL:

- Divide MAOL by both Adjustment Factors using Equation (3-3a) [Steps 1, 2, and 3]:

$$Adjusted\ MAOL = \frac{MAOL}{4.2 * 1.75} = \frac{1.0\,mg/m^3}{7.35} = 0.136\,mg/m^3$$

- Account for High Risk Groups using Equation (3-4) [Step 4]:

$$Sensitivity\ Adjusted\ MAOL = \frac{0.136\,mg/m^3}{10} = 0.0136\,mg/m^3$$

- Apply the Uncertainty Factor for Inadequate Toxicity Data using Equation (3-5) [Step 5]:

$$Toxicity\ Adjusted\ MAOL = \frac{0.0136\,mg/m^3}{10} = 0.00136\,mg/m^3$$

- Apply the Threshold Effects Uncertainty Factor (TEUF) and relative source contribution factor using Equation (3-6) [Steps 6 and 7]:

$$\begin{matrix} Threshold\ Effects \\ Exposure\ Limit \end{matrix} = \frac{Toxicity\ Adjusted\ MAOL}{(TEUF) * (0.20)} = \frac{0.00136\,mg/m^3}{(10) * (0.20)} = 0.000680\,mg/m^3 = 680\,ng/m^3$$

3.3.8.2 Adult Resident

To calculate the TEL for an adult resident based on the steps outlined above, the following adjustments are made to the MAOL:

- Divide MAOL by the continuous exposure adjustment factor using Equation (3-3b) [Steps 1 and 3]:

$$Adjusted\ MAOL = \frac{MAOL}{4.2} = \frac{1.0\,mg/m^3}{4.2} = 0.238\,mg/m^3$$

- Account for High Risk Groups using Equation (3-4) [Step 4]:

$$Sensitivity\ Adjusted\ MAOL = \frac{0.238\,mg/m^3}{10} = 0.0238\,mg/m^3$$

- Apply the Uncertainty Factor for Inadequate Toxicity Data using Equation (3-5) [Step 5]:

$$Toxicity\ Adjusted\ MAOL = \frac{0.0238\,mg/m^3}{10} = 0.00238\,mg/m^3$$

- Apply the Threshold Effects Uncertainty Factor (TEUF) and relative source contribution factor using Equation (3-6) [Steps 6 and 7]:

$$\frac{Threshold\ Effects}{Exposure\ Limit} = \frac{Toxicity\ Adjusted\ MAOL}{(TEUF)*(0.20)} = \frac{0.00238\,mg/m^3}{10*0.20} = 0.00119\,mg/m^3 = 1{,}190\,ng/m^3$$

3.3.8.3 Commercial Worker

To calculate the TEL for a commercial worker based on the steps outlined above, the following adjustments are made to the MAOL:

- The adjustments in Steps 1-4 do not pertain to the commercial worker because this receptor is an adult in an occupational exposure setting.

- Apply the Uncertainty Factor for Inadequate Toxicity Data using Equation (3-5) [Step 5]:

$$Toxicity\ Adjustment\ MAOL = \frac{MAOL}{10} = \frac{1.0\,mg/m^3}{10} 0.1\,mg/m^3$$

- Apply the Threshold Effects Uncertainty Factor (TEUF) and the relative source contribution factor using Equation (3-6) [Steps 6 and 7]:

$$\frac{Threshold\ Effects}{Exposure\ Limit} = \frac{Toxicity\ Adjusted\ MAOL}{(TEUF)*(0.20)} = \frac{0.1\,mg/m^3}{(10)*(0.20)} = 0.05\,mg/m^3 = 50{,}000\,ng/m^3$$

3.3.8.4 Threshold Effects Exposure Limit Summary

The TELs calculated for the three target public receptors at NBH are summarized in Table 3-3. As can be seen, the calculated TELs represent overall adjustment factors of 1470, 840, and 20 for the child resident, adult resident, and the commercial worker, respectively, relative to the original MAOL.

Table 3-3
Summary of the Threshold Effect Exposure Limit Development Process for the Three Target Receptors at New Bedford Harbor

	Original MAOL (ng/m^3)	Adjusted MAOL (ng/m^3)	Sensitivity Adjusted MAOL (ng/m^3)	Toxicity Adjusted MAOL (ng/m^3)	Threshold Effect Exposure Limit (ng/m^3)	Overall Adjustment Factor (1)
Child Resident	1,000,000	136,000	13,600	1,360	680	1,470
Adult Resident	1,000,000	238,000	23,800	2,380	1,190	840
Commercial Worker	1,000,000	NA	NA	100,000	50,000	20

Notes: NA = Not Applicable
(1) Overall Adjustment Factor = (Original MAOL) / (Threshold Effect Exposure Limit)

3.4 Non-Threshold Effects Evaluation

As described earlier in Section 1.0, the second phase of the Allowable Ambient Limit derivation procedure is the non-threshold effects evaluation. Non-threshold effects are effects for which there is no conclusive or compelling evidence of a minimum intake or dose of the contaminant that is not associated with an adverse health effect. In this case, the non-threshold effect of primary interest for PCBs is carcinogenicity.

The product of the non-threshold effects evaluation is the Non-threshold Effect Exposure Limit (NTEL). There are two separate procedures that may be applied for this evaluation. The availability of quantitative data on cancer potency determines which procedure is to be used. The two alternative procedures for calculating the NTEL are as follows:

1. When sufficient valid data on cancer potency are available to calculate unit risk, the derived NTEL is based on quantitative cancer risk estimates.
2. When quantitative data is not available, an alternative approach is used to calculate the NTEL. This approach incorporates uncertainty factors to estimate the potential risks due to non-threshold effects.

Since there are sufficient data on cancer potency for PCBs at the New Bedford Harbor Superfund Site, the first procedure was applied. This cancer potency data was obtained from the USEPA's Integrated Risk Information System (IRIS) and is discussed in the 1996 guidance entitled "PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures" (EPA/600/P-96/001F, USEPA, National Center for Environmental Research, ORD, September 1996).

An NTEL was calculated for each of the same three target public receptors for whom a TEL was calculated: child resident, adult resident and commercial worker. Since PCBs are the chemicals of concern for this Site, NTELs were developed for total PCBs and four individual dioxin-like congeners (No. 114, No. 118, No.126, and No.169 – See Table 3-4 and the accompanying discussion for the justification for focusing on these specific congeners).

Table 3-4
World Health Organization (WHO) PCB Congeners Detected in the Baseline Ambient Air Study at the New Bedford Harbor Site, 1999
(Represents the Congeners that exhibit dioxin-like effects on people)

WHO Congener Number	Average Weight Percent of Total WHO Congeners (Wt. %)	Average Weight Percent of Total PCBs Comprised of this WHO Congener (Wt. %)	Present on the USEPA Highest Toxicity and Abundance List[1]	Present on the USEPA Potential for Toxicity List[1]	World Health Organization Toxicity Equivalency Factors
118[2]	58.47	0.70	√		0.0001
105	12.44	0.20			0.0001
114[2]	7.39	0.09		√	0.0005
77	6.92	0.10	√		0.0001
170	6.32	0.09	√		No TEF
180	4.39	0.07	√		No TEF
156	1.29	0.01			0.0005
123	0.94	0.01		√	0.0001
169[2]	0.65	0.01	√		0.01
167	0.54	0.005		√	0.00001
81	0.47	0.004		√	0.0001
157	0.16	0.001		√	0.0005
126[2]	0.02	0.0002	√		0.1
189	*<0.01*	*<0.01*		√	*0.0001*
209	<0.01	<0.01			No TEF

Notes:

[1] USEPA, 1996 – Table 3-3.

[2] Indicates congeners with relatively greater toxicity that were detected in relatively greater abundance at NBH. The four highlighted (footnoted) congeners are the three congeners with the highest products of measured concentration and toxicity (TEF) and the congener with the highest toxicity (TEF). These were therefore highlighted for further consideration.

The process of evaluating the NTELs involved calculating risk-based exposure point concentrations for each target receptor for a range of potential exposure scenarios. The NTELs were calculated for the Adult Resident and Commercial Worker using the general equation below:

$$NTEL_{Adult} = \frac{TR \cdot BW \cdot AT_C \cdot CV}{EF \cdot ED \cdot IR \cdot CSF}$$

where:

NTEL = Non-threshold Effects Exposure Limit for carcinogenic effects (ng/m^3)
TR = Target Risk Level (unitless)
BW = Body Weight (kg)
AT_c = Averaging Time, Carcinogenic (days)
CV = Conversion Factor (1,000,000 ng/mg)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
IR = Inhalation Rate (m^3/day)
CSF = Cancer Slope Factor for Total PCBs or a Specific Congener ($(\text{mg/kg-day})^{-1}$)

The NTEL for the Child Resident receptor uses an age-adjusted approach when the assumed exposure duration is 10 years. Since a Child Resident was considered to be a child from 0-6 years of age, the age-adjustment accounts for 6 years as a child and 4 years as an adult. The age-adjusted equation for the NTEL for the Child Resident becomes:

$$NTEL_{Child} = \frac{\left(\dfrac{TR * AT_c * CV}{EF * CSF}\right)}{\left(\dfrac{IR_c * ED_c}{BW_c}\right) + \left(\dfrac{IR_a * ED_a}{BW_a}\right)}$$

where:

NTEL = Non-threshold Effects Exposure Limit for carcinogenic effects (ng/m^3)
TR = Target Risk Level (unitless)
BW_c = Body Weight, child (kg)
BW_a = Body Weight, adult (kg)
AT_c = Averaging Time, Carcinogenic (days)
CV = Conversion Factor (1,000,000 ng/mg)
EF = Exposure Frequency (days/year)
ED_c = Exposure Duration, child (years)
ED_a = Exposure Duration, adult (years) [Note: Assumed to be "0" if the total assumed Exposure Duration is 5 years]
IR_c = Inhalation Rate, child (m^3/day)
IR_a = Inhalation Rate, adult (m^3/day)
CSF = Cancer Slope Factor for Total PCBs or a Specific Congener ((mg/kg-day)$^{-1}$)

The previous equations calculate NTELs based on a PCB-related cancer slope factor. Three cancer slope factors for Total PCBs were evaluated (i.e., 2.0, 0.4, and 0.07 (mg/kg-day)$^{-1}$) based on the operative guidance "PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures", EPA/600/P-96/001F, USEPA, National Center for Environmental Research, ORD, September 1996. This guidance directs that the cancer slope factor for PCB mixtures be determined using the available analytical data on the nature of the PCB mixture and the nature of the exposure pathways associated with the target receptors. Both upper bound and central estimate cancer slope factors are presented in the guidance. The upper-bound cancer slope factors, being more conservative, were judged to be most appropriate for the development of NTELs for the protection of the public at NBH. Three upper-bound reference cancer slope factors are defined:

- An upper reference point of 2 (mg/kg-day)$^{-1}$ – Indicated to be appropriate for food dose exposure, sediment or soil ingestion, and dust or aerosol inhalation or early life exposures;
- A middle reference point of 0.4 (mg/kg-day)$^{-1}$ – Indicated to be appropriate for drinking water ingestion and vapor inhalation; and
- A lower reference point of 0.07 (mg/kg-day)$^{-1}$ – Indicated to be appropriate for mixtures of PCBs in which the congeners with more than four chlorines comprise less than one-half of one percent of the Total PCBs (by weight) and when there are minimal dioxin-like tumor producing and persistent congeners present.

Further discussion with the primary author of the guidance (Cogliano, 2000) indicated that the most appropriate cancer slope factor may be chosen in consideration of the distribution of homologues within the PCB mixture and its resemblance to the distributions of homologues typically associated with three specific Aroclor compounds (Aroclor 1254, Aroclor 1242, and Aroclor 1016). These three Aroclors have had the greatest toxicological evaluation and were the basis for the three quantitative reference cancer slope factors presented in the 1996 USEPA guidance. These two criteria (mixture composition and exposure pathway processes) can be seen to be partially linked in that the chemical composition of the mixture has a direct impact on the partitioning, transformation, and bioaccumulation of the PCBs. Table 2-2 showed the typical distribution of the homologues sampled during the Baseline Ambient Air Sampling and Analysis Study in 1999. The measured distribution is seen to closely match that of Aroclor 1242 (which is associated with the middle reference cancer slope factor of 0.4 $(mg/kg\text{-}day)^{-1}$), although the New Bedford Harbor mixture shows a slightly greater component of the lighter homologues giving it some of the characteristics of Aroclor 1016. The data also illustrate that the New Bedford Harbor airborne PCBs have congeners with more than four chlorines amounting to significantly more than one-half of one percent by weight (on average typically about 10% (with an individual sample range of 7%-19%). As such, the lower reference cancer slope factor (0.07 $(mg/kg\text{-}day)^{-1}$) would not be appropriate to apply. The principal exposure pathway of concern during the dredging and filling operations, the inhalation of released volatiles, also would lead to the selection of the middle reference cancer slope factor of 0.4 $(mg/kg\text{-}day)^{-1}$.

An analysis also was made of the relative presence of the various dioxin-like congeners in the Baseline Ambient Air Sampling and Analysis Study results. The detected congeners were compared to the PCB congeners of highest concern as identified in the USEPA guidance (USEPA, 1996, Table 3-3). Table 3-4 lists the PCB Congeners detected in the New Bedford Harbor samples in decreasing order of prevalence.

Table 3-4 also indicates (using a checkmark) if the detected congener was identified by the USEPA as being in the “Highest Toxicity and Abundance” or “Potential for Toxicity” categories as defined in the guidance. Although there are a number of congeners present on the USEPA’s toxicity list, only the congeners that were detected in abundance at NBH were highlighted for further consideration relative to the NBH Allowable Ambient Limit development process: Congeners Nos. 118, 114, 169, and 126. These congeners are marked with a “2” in Table 3-4. The Work Health Organization (WHO) toxicity equivalency factors (TEFs) for the detected congeners also are presented in Table 3-1. The toxicities of the congeners listed in this table are related to the chemical 2,3,7,8-tetrachlorodibenzodioxin (TCDD). A TEF is a ratio of the toxicity of the specific congener to the toxicity of 2,3,7,8-TCDD. For the individual congeners, the product of the CSF for 2,3,7,8-TCDD and the TEF for the particular congener replaces the CSF in the NTEL equation. For example, to calculate the NTEL for Congener No. 126, the CSF parameter is replaced by $CSF_{TCDD}{*}TEF_{No.\ 126}$. TEFs of 0.005, 0.0001, 0.1, and 0.01 are used for Congeners Nos. 114, 118, 126, and 169, respectively (USEPA, 1996;Vanden Berg et al, 1998). A CSF for 2,3,7,8-TCDD of 1.5 x 10^5 $(mg/kg\text{-}day)^{-1}$ was used in the NTEL calculations performed for the individual congeners (USEPA IRIS, 2000).

Three Target Risk Levels (i.e., 1 x 10^{-6}, 1 x 10^{-5}, and 1 x 10^{-4}) were evaluated as part of the NBH Allowable Ambient Limit development process consistent with the USEPA’s published target risk range. The currently anticipated project duration is between a minimum of 5 years and a reasonable maximum duration of 10 years. As such, Exposure Durations of 5 and 10 years were evaluated based on this range of projected schedules.

The calculation of the NTEL also requires the specification of a number of receptor-specific input parameters for each identified target receptor. These exposure parameters are presented in the following sections.

3.4.1 Child Resident

The exposure scenario for the Child Resident assumes that the child lives near the New Bedford Harbor for the full duration of the remediation activities. A child is defined as being between the ages of 0 and 6 years of age. The following exposure parameters were compiled for the child resident:

• Exposure Duration:	5 years (as a child) or 10 years (6 as a child plus 4 as an adult)
• Exposure Time	350 days/year (USEPA, 1991)
• Body Weight	15 kg (child) (USEPA, 1991) 70 kg (adult) (USEPA, 1991)
• Averaging Time	25,550 days (USEPA, 1991)
• Inhalation Rate	12 m^3/day (child) (USEPA, 1991)

3.4.2 Adult Resident

The exposure scenario for the Adult Resident assumes that the resident lives near the New Bedford Harbor for the duration of the remediation. The following exposure parameters were compiled for the adult resident:

• Exposure Duration:	5 years or 10 years
• Exposure Time	350 days/year (USEPA, 1991)
• Body Weight	70 kg (USEPA, 1991)
• Averaging Time	25,550 days (USEPA, 1991)
• Inhalation Rate	20 m^3/day (USEPA, 1991)

3.4.3 Commercial Worker

Many commercial facilities exist in the near vicinity of New Bedford Harbor. The exposure scenario for one of these receptors is based on working at one of these facilities for the duration of the remediation activities. The following exposure parameters were compiled for the Commercial Worker:

• Exposure Duration:	5 years or 10 years
• Exposure Time	250 days/year (USEPA, 1991)
• Body Weight	70 kg (USEPA, 1991)
• Averaging Time	25,550 days (USEPA, 1991)
• Inhalation Rate	20 m^3/day (USEPA, 1991)

3.4.4 Results of the Non-Threshold Effect Exposure Limit Calculations

The results of the NTEL calculations for each of the three receptors are found in Appendix A in Tables A-1 through A-15. The calculated NTELs for the Child Resident are presented in Table A-1 for Total PCBs, Table A-2 for Congener No. 114, Table A-3 for Congener No. 118, Table A-4 for Congener No. 126, and Table A-5 for Congener No. 169. The calculated NTELs for the Adult Resident are presented in Table A-6 for Total PCBs, Table A-7 for Congener No. 114, Table A-8 for Congener No. 118, Table A-9 Congener No. 126, and Table A-10 for Congener No. 169. The calculated NTELs for the Commercial Worker are presented in Table A-11 for Total PCBs, Table A-12 for Congener No. 114, Table A-13 for Congener No. 118, Table A-14 for Congener No. 126, and Table A-15 for Congener 169.

3.5 Selection of Allowable Ambient Limits

The final step in the derivation of an Allowable Ambient Limit is the comparison of the TEL to the NTEL, and choosing the lower value to represent the Allowable Ambient Limit for each target receptor. As there are three target receptors, the comparison and selection process was performed for each receptor. Table 3-5 presents the calculated TEL and NTEL values for Total PCBs for the child and adult residents and the commercial worker, and summarizes these comparisons. Table 3-5 shows the comparison and selection process for the Allowable Ambient Limits for a Target Risk of 1 x 10^{-5}, a CSF of 0.4 $(mg/kg\text{-}day)^{-1}$; and an Exposure Duration of 5 years. The Target Risk goal of 1 x 10^{-5} was established for this public protection program by the USEPA.

Table 3-5
New Bedford Harbor TELs, NTELs, and Allowable Ambient Limits for Total PCBs for the Child Resident, Adult Resident, and the Commercial Worker
(5 Year Exposure Duration)

Receptor	TEL (ng/m^3)	NTEL (ng/m^3)	Allowable Ambient Limit (ng/m^3)
Child Resident	680	660	660
Adult Resident	1,190	1,278	1,190
Commercial Worker	50,000	1,789	1,789

Table 3-6 shows the comparison and selection process for Allowable Ambient Limits assuming a Target Risk of 1 x 10^{-5}; a CSF of 0.4 $(mg/kg\text{-}day)^{-1}$; and an Exposure Duration of 10 years.

Table 3-6
New Bedford Harbor TELs, NTELs, and Allowable Ambient Limits for Total PCBs for the Child Resident, Adult Resident, and the Commercial Worker
(10 Year Exposure Duration)

Receptor	TEL (ng/m^3)	NTEL (ng/m^3)	Allowable Ambient Limit (ng/m^3)
Child Resident	680	409	409
Adult Resident	1,190	639	639
Commercial Worker	50,000	894	894

NTEL calculations were performed for the four highlighted congeners, as noted previously. The most recent USEPA guidance for assessing and managing PCB cancer risk directs that PCB risks should be assessed on the basis of Total PCBs (measured as either the sum of the Aroclors or the sum of the homologue groups). As such, the TEL and NTEL comparisons and Allowable Ambient Limit values presented in Tables 3-5 and 3-6 will be used as the basis for the subsequent development of cumulative exposure budgets for the protection of the public during remediation operations.

The most recent USEPA PCB risk assessment guidance also recommends that individual congener data be collected and evaluated whenever possible, as a supplement and complement to the primary focus on

Total PCBs. The available congener data for New Bedford Harbor have been critically evaluated up to this point as part of the effort to identify Allowable Ambient Limits by:

- Identifying the most toxic and prevalent congeners measured in the baseline ambient air samples at New Bedford Harbor;
- Evaluating congener distributions in the air samples to aid in selecting the most appropriate CSF for Total PCBs (to verify the exposure pathway element of this selection process); and
- Calculating NTELs for the four congeners highlighted as being most toxic and prevalent.

A further assessment of the congeners associated with the pre-remediation baseline air samples was performed relative to their possible contribution to projected carcinogenic risk. The objective of this assessment was to determine if and how to more explicitly consider the dioxin-like PCB congeners in the establishment of the allowable ambient limits to be used in the development of the program to manage volatile PCB emissions during the New Bedford Harbor clean-up operations. Table 3-4 shows the average weight percentage of the total sum of homologues represented by each of the 15 individual WHO Congeners (i.e., the congeners exhibiting a dioxin-like response relative to health effects on people). These percentages are considered to be conservative (i.e., indicating that a greater amount of each congener is likely to be present than may actually be there) as these values reflect taking one-half of the sample detection limit for each congener when the sample was reported as non-detect for that congener. While this is a justifiable and accepted approach to quantify the distribution of congeners in a mixture, it tends to be very conservative in this case. This is because the individual congener detection limits often increase by a factor of 2 or 3 in samples with elevated Total PCB levels relative to blank air samples or samples that are only lightly contaminated with PCBs (i.e., samples sometimes require laboratory dilution that results in somewhat higher sample detection limits for the least abundant [lowest concentration] congeners). As such, the relative contribution to inhalation risk associated with these congener concentrations is expected to less than that calculated using these concentrations. A calculation of the potential contribution of the dioxin-like PCB congeners to the carcinogenic risk projected for a child resident under the assumption of a 5-year project duration is presented in the supporting calculations contained in Appendix B. The analysis of the baseline air data indicated that only a maximum of 1.3% of the mass of the Total PCBs is associated with the 15 WHO Congeners (even given the conservative estimation technique employed). In addition, only 80% of this amount is associated with the 7 dioxin-like PCB congeners with the smallest published toxicity factors (TEFs ≤ 0.0001). Approximately 0.9% of the mass of the WHO Congeners (0.0117% of the mass of Total PCBs present) is indicated to be WHO Congener Nos. 169 and 126, the two individual congeners with the highest toxicity. Again, these small quantities are maximums relative to this data. For example, in the case of Congener No. 169 the tabulated average is based on only 2 actual detections over the entire year, one at each of only 2 of the 6 baseline ambient air monitoring stations. This analysis and the associated calculation of potential risk did not discount or ignore the congener concentration if a particular congener was not detected at every baseline monitoring station, or if the estimated congener concentration was based on only a few actual detections and numerous half detection limit sample concentration values.

These conservative concentrations for all the WHO congeners were then multiplied by the toxicity equivalency factor (TEF) for that PCB congener and summed to estimate a toxically equivalent (TEQ) concentration of dioxin (as referenced to the compound 2,3,7,8- tetrachlorodibenzodioxin). These calculations are illustrated in the top portion of the supporting calculation table in Appendix B. Of this total, over one third of the equivalent concentration (37%) was associated with the highly conservative Congener No. 169 concentration estimates, and a much larger percentage of the 2,3,7,8 – TCDD equivalent concentration is heavily influenced by sample-specific detection limits and detections only in a subset of the monitoring stations. Combining this concentration with the cancer slope factor for 2,3,7,8 – TCDD and the exposure assumptions for a child resident over a 5 year project duration (see the bottom portion of the Appendix B supporting calculation table) revealed that, at maximum, the small quantity of dioxin-like PCB congeners are associated with approximately the same level of potential inhalation risk as the remaining 98.7% of the airborne mass of Total PCBs (i.e., 1.55 E-08 vs. 1.50E-08 calculated risk, respectively).

This result could be interpreted as justifying that the allowable ambient limits based on Total PCBs developed thus far be reduced or divided by two for purposes of developing the cumulative exposure budgets. However, in consideration of a number of factors associated with this projection of relative contributions to inhalation risk, this further adjustment to the allowable ambient limit is not currently recommended. These factors include:

- The conservative approach of assuming half of the detection limit for congeners that are not detected in a sample, coupled with the somewhat elevated detection limits for the low concentration congener results in the more contaminated samples;
- The uncertainty as to whether the congener distribution exhibited in the data from baseline air samples is representative of the distribution that will be present in the ambient air during actual remediation operations; and
- The large sensitivity of the results to a great deal of analytical information at (or below) the limits of detection.

Other considerations are associated with the fact that additional conservative assumptions also have been made during the application of the allowable ambient limits developed in this Section in the process of developing the cumulative exposure budgets (see Section 6 of this document). Collectively, the conservative effect of these choices made at that point in the overall program development are expected to cover this possible factor of two:

- Protection of most potentially impacted individual who is assumed to remain fixed at a particular location for multiple years;
- Assumption of emission sources and distribution associated with the highest projected impacts; and
- Assumption of the modeled atmospheric dispersion behavior associated with the worst year's meteorology.

Finally, the sediment remediation clean-up goals and compliance targets have been established on the basis of Total PCBs. Until a stronger or more technically supported justification can be made to more quantitatively consider the effects of the dioxin-like PCB congeners in the air compliance program, maintaining regulatory and analytical consistency with the sediment compliance program is viewed as beneficial.

Given the uncertainties involved, however, it is recommended that congener analyses be performed on a periodic basis once remediation begins. These results can be evaluated and used to verify or adjust the congener distributions shown in Table 3-4 and reassess the contribution of any dioxin-like PCB congeners that are present, as was illustrated in the supporting calculation table in Appendix B. This reassessment also should consider the implications of the USEPA Dioxin Reassessment Study that may be published in the second half of 2001. Indications are that dioxin may be reported to be more potent in causing cancer than has been thought to be the case to date.

The results of these congener and homologue analyses will be used to define certain elements of the specifications for future air monitoring efforts. The four highlighted congeners (Nos. 114, 118, 126 and 169) are currently indicated to be the congeners of most practical interest from a public protection perspective for New Bedford Harbor. The baseline distributions of homologue groups and individual congeners will serve as the benchmark for comparison of the distributions of these same constituents in the air samples that will be collected during remediation operations. Such comparisons will be required on a periodic basis to determine if the composition (and, hence, toxicity) of the airborne PCBs has changed from the baseline, and if any adjustment of the Allowable Ambient Limits or the cumulative exposure budgets is warranted. The calculated NTELs for the four highlighted congeners also will be used to guide the selection of sampling techniques, analytical methods, and maximum detection limits for the future periodic verification monitoring.

3.6 References

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4.0 EMISSIONS MODELING

4.1 Introduction

This section presents the estimation of PCB emissions rates associated with operations associated with a baseline remediation scenario. The scope of work for this subtask involved identifying and describing the possible sources of volatile PCB emissions associated with the remediation and disposal activities and quantitatively estimating the corresponding emission rates. These quantitative estimates were important in evaluating the potential air impacts from the remediation. First, they were used in conjunction with air dispersion modeling to estimate annual-average concentrations at specified locations around the Harbor where the public lives and works (see Section 5.0). The emissions modeling also illustrated the relative contribution of each emissions source, which was used in developing a dispersion modeling strategy. Later the modeling will be used to locate the ambient air monitoring stations relative to the implementation of the exposure budgeting program. The theoretical modeling algorithms and empirical measurements were developed to allow application of these results to subsequent planning and performance assessments. These algorithms were used in a sensitivity analysis to illustrate the relative impact of different chemical and physical parameters on emissions (see Section 4.5).

4.2 Theoretical Emissions Modeling

As described previously, the remediation of New Bedford Harbor will involve the excavation and relocation of sediments that are contaminated PCBs from their current location to Harbor-side or to an off-site disposal facility. These operations will disturb contaminated sediments and enhance the release of Volatile Organic Compounds (VOCs) to the air. Please note that vapor phase PCBs are considered VOCs under state and Federal regulations. The vapor phase PCBs will be released into the atmosphere primarily in the gaseous state from water or sediment surfaces.

There are three phases of matter that are involved in emissions of VOC from PCB-contaminated waste in the harbor: air, water, and sediment. In such a system, a chemical equilibrium is established at the sediment/water interface, the sediment/air interface and the water/air interface. Theoretical models have been developed to define the equilibrium relationships between the concentration of PCBs in the individual media. For example, the theoretical model representing the equilibrium at the air/water interface uses an equation that relates the concentration of volatile PCBs in water to their concentration in air using published chemical and physical properties.

The type of chemical equilibrium that controls transport is dependent on the emission source or emission producing activity. There have been several potential sources of emissions identified for NBH:

- Dredging Operations
- Emissions During Filling of the CDF
- Ponded Sediment in the CDF
- Exposed Sediment in the CDF
- Capped CDF

Thibodeaux et al. have developed theoretical models to estimate emissions from each of these potential sources using equilibrium relationships and mass transfer correlations (Ref. 1-6). The correlations developed to model the emissions from each of these sources are presented in greater detail below. Supporting calculations for the emissions estimates are presented in Appendix B.

4.2.1 Dredging or Excavation Operations

One potential source of VOC emissions during the baseline remediation scenario is the dredging or excavation operation. During dredging or excavation, contaminated sediment is removed from various locations in and around the Harbor to be transported to a CDF. Areas to be dredged or excavated include bottom sediments, intertidal areas, beach areas. and wetlands. There are three potential sources of air emissions during dredging:

- The disturbed water surface;
- The dredge bucket; and
- The surface of the receiving vessel.

During dredging in standing water, the bottom sediments are disturbed, creating a localized plume of suspended solids in the surrounding waters. The concentration of suspended sediment can vary within the water column, depending on the type of sediment and the method of dredging. In general, there are two basic types of dredges: hydraulic and mechanical. Hydraulic dredges hydraulically remove and transport sediment in slurry form using centrifugal or other types of pumps. Mechanical dredges remove bottom sediment through the direct application of mechanical force to dislodge and capture the contaminated material. Emissions of VOCs may be enhanced by two mechanisms during dredging:

- Resuspension of sediment particles in the water column where contaminated particles are brought into the column near the air/water interface; and
- Increased turbulence at the water surface during dredging which increases the rate of transport at the air/water interface.

Hydraulic dredges often reduce the impact of these mechanisms more than mechanical dredges because mechanical dredges tend to disturb the bottom sediment more than hydraulic counterparts, thereby causing greater particle resuspension. In addition, mechanical dredges can create significant water turbulence at the point where the bucket breaks through the water surface. Please note, however, that the dredging methods being considered for use at NBH have been screened to minimize the release of VOCs. In an effort to be conservative, emissions from the dredging operations were initially modeled assuming enhanced transport from sediment resuspension and water surface turbulence.

The emission flux due to transport through the air/water interface can be represented by the following equation (Ref. 1):

$$n = K_w(C_w - C_w^*) \qquad \text{Equation (4-1)}$$

where:

n = Emissions flux (kg/m^2 hr)

K_w = Overall mass transfer coefficient (m/hr)

C_w = Equilibrium concentration of constituent in water (kg/m^3)

C_w^* = Hypothetical concentration of a constituent in water in equilibrium with the constituent in air

Please note that for equations presented in this section, the units identified for each parameter should be used in the associated equation. For purposes of this analysis, it was assumed that there is no PCB vapor over the water surface that would impede mass transfer, so that C_w^* is zero. The equilibrium concentration of volatile PCBs in water that are in equilibrium with contaminated sediment can be represented by the following equation (Ref. 1):

$$C_w = \frac{\omega \rho_s}{1 + K_d \rho_s} \qquad \text{Equation (4-2)}$$

where:

C_w = Equilibrium concentration of constituent in water (kg/m^3)

ω = PCB concentration in sediment (kg/kg)

ρ_s = Concentration of suspended solids (kg/m^3)

K_d = Sediment-water equilibrium partition coefficient (m^3/kg)

In Equation 4-1 above, K_w is the overall liquid phase mass transfer coefficient. This coefficient is often represented by a combination of gas phase and liquid phase transfer coefficients. However, for this situation and anticipated conditions, volatile PCB emissions are water-side controlled, so K_w can be represented by a correlation that does not include gas phase transfer. The overall mass transfer coefficient (K_w) can be represented by the liquid phase coefficient (k_w) using the following correlation (Ref. 1):

$$k_w = 19.6 v_x^{2.23} D_w^{\frac{2}{3}} \qquad \text{Equation (4-3)}$$

where:

k_w = Liquid phase Mass transfer coefficient (cm/hr)

v_x = Windspeed (mi/hr)

D_w = Diffusion coefficient of constituent in water (cm^2/sec)

Equations 4-1 through 4-3 were used to estimate the emission flux of volatile PCBs from the water surface of the area being dredged. As mentioned previously, mechanical dredging not only causes a resuspension of particles in the water column, but the dredge bucket going in and out of the water can create a turbulent surface. The correlation presented in Equation 4-3 is most applicable to more calm or quiescent surfaces. In order to accommodate the potential increase in emissions due to turbulence, the emissions flux estimated using Equations 4-1 through 4-3 was multiplied by the number of times the dredge bucket breaks the water per hour. The estimated emissions for total PCBs from the disturbed water surface at the dredge are presented in Table 4-1. The parameters used to generate these estimates are presented in Table 4-2.

Table 4-1
Summary of Theoretical Emissions from Sources at NBH Estimated Prior to Testing

Emission Source Associated with Baseline Remediation Scenario	Estimated Emissions Flux (kg/m^2 sec)	Assumed Area of Emissions (m^2)	Estimated Emission Rate (g/sec)
Surface Water at Dredge	2.56×10^{-10}	5.57	1.43×10^{-6}
Dredge Bucket	5.31×10^{-11}	80.4	4.27×10^{-6}
Receiving Vessel on Barge	1.49×10^{-10}	20.9	3.11×10^{-6}
Open Pipe Filling of CDF	-	-	9.89×10^{-8}
Ponded Sediments – CDF D	4.26×10^{-12}	64,750	2.76×10^{-4}
Ponded Sediments – CDF C	4.26×10^{-12}	28,330	1.21×10^{-4}
Exposed Sediments – CDF D	5.96×10^{-13}	64,750	3.86×10^{-5}
Exposed Sediments – CDF C	5.96×10^{-13}	28,330	1.69×10^{-5}
Capped Sediments – CDF D	4.61×10^{-14}	64,750	2.99×10^{-6}
Capped Sediments – CDF C	4.61×10^{-14}	28,330	1.31×10^{-6}

Table 4-2
Parameters Used to Estimate Emissions from the Surface Water at the Dredge

Parameter	Assumed Value	Units	Source
PCB concentration in sediment	4.32×10^{-4}	kg/kg	Ref. 2
Concentration of suspended solids	0.49	kg/m^3	Ref. 2
Sediment-water partition coefficient	188	m^3/kg	Ref. 2
Windspeed	8.7	mi/hr	a
Diffusion coefficient of constituent in water	4.6×10^{-6}	cm^2/hr	Ref. 1
Number of times bucket breaks water per hour	60	-	Ref. 2

a assumed windspeed based on available meteorological data for the site

As mentioned above, the transport of volatile PCBs from resuspended sediment in a water column (such as that generated by dredging) is dominated by liquid phase transport. This is not true for sediment that is being transported in the dredge bucket. In this case, the wet sediment is coming into greater contact with air, and the transport through water is minimized. Consequently, the transport in this system is dominated by the gas phase. For this reason, emissions from the dredge bucket need to be modeled using a different set of equations.

Equation 4-1 is appropriate for estimating emissions that are dominated by liquid-phase transport. However, an equation of this form can also be used to estimate emissions for gas-phase dominated transport as shown below (Ref. 1):

$$n = k_g(C_a^* - C_a) \qquad \text{Equation (4-4)}$$

where:

n = Emissions flux (kg/m^2 sec)

k_g = Gas phase mass transfer coefficient (m/sec)

C_a^* = Equilibrium concentration of constituent in air (kg/m^3)

C_a = Hypothetical concentration of a constituent in the air over wet sediment (kg/m^3)

As mentioned above, it was assumed for purposes of this analysis that there is no volatile PCB concentration over the sediment that would impede mass transfer, so that C_a is zero. The equilibrium concentration of volatile PCBs over wet sediment can be estimated using the following equation (Ref. 1):

$$C_a^* = \frac{\omega H_c}{K_d} \qquad \text{Equation (4-5)}$$

where:

C_a^* = Equilibrium concentration of constituent in air (kg/m^3)

ω = PCB concentration in sediment (kg/kg)

H_c = Henry's Law Constant (dimensionless)

K_d = Sediment-water equilibrium partition coefficient (m^3/kg)

The gas-phase mass transfer coefficient (k_g) can be estimated using the following correlation (Ref. 1):

$$\frac{k_g D}{D_a} = 2 + 0.6 \left(\frac{D v_x}{\nu}\right)^{1/2} \left(\frac{\nu}{D_a}\right)^{1/3} \qquad \text{Equation (4-6)}$$

where:

k_g = Gas-phase mass transfer coefficient (m/s)

D = Characteristic length of dredge bucket (m)

D_a = Diffusion coefficient of constituent in air (m^2/sec)

v_x = Windspeed (m/sec)

ν = Kinematic viscosity of air (m^2/sec)

Equations 4-4 through 4-6 can be used to estimate the emission flux of volatile PCBs from the surface of the dredge bucket. In an effort to be conservative, it was assumed that the entire surface of the bucket would be covered with wet sediment, and therefore represent a potential emissions source. The surface area of the bucket was estimated assuming that it was a square box with all dimensions equal to the length of the bucket. The estimated emissions for total PCBs from the dredge bucket are presented in Table 4-1. The parameters used in this estimate are presented in Table 4-3.

Table 4-3
Parameters Used to Estimate Emissions from the Dredge Bucket

Parameter	Assumed Value	Units	Source
PCB concentration in sediment	4.32×10^{-4}	kg/kg	Ref. 2
Henry's Law Constant	0.0249	-	Ref. 2
Sediment-water partition coefficient	188	m^3/kg	Ref. 2
Characteristic length of dredge bucket	3.66	m	a
Diffusion coefficient of constituent in air	3.6×10^{-6}	m^2/sec	Ref. 1
Windspeed	3.9	m/sec	b
Kinematic viscosity of air	1.5×10^{-5}	m^2/sec	Perry's Handbook

a characteristic length of bucket based on available project information
b assumed windspeed based on available meteorological data for the site

After the sediment is removed from the Harbor under the baseline remediation scenario, it will be placed in a receiving vessel or hopper on the barge before being transported to a CDF. To obtain a conservative estimate of emissions, it was assumed that this would be an open top vessel that would essentially act as a continuous source of emissions. These emissions can be estimated using Equations 4-4 and 4-5. However, the mass transfer coefficient presented in Equation 4-6 is not applicable for this source. In this case, the receiving vessel is an open top container where the surface of the sediment is below the top of the container. The gas-phase mass transfer coefficient for this configuration can be estimated using the following correlation (Ref. 1):

$$\frac{k_g D_e}{D_a} = 0.036 \left(1 - \frac{z}{D_e}\right) \left(\frac{D_e v_x}{v}\right)^{1/1.25} \left(\frac{v}{D_a}\right)^{1/3} \qquad \text{Equation (4-7)}$$

where:

k_g = Gas-phase mass transfer coefficient (m/s)

z = Depth of water surface below top of hopper (m)

D_e = Effective diameter of hopper (m)

D_a = Diffusion coefficient of constituent in air (m^2/sec)

v_x = Windspeed (m/sec)

v = Kinematic viscosity of air (m^2/sec)

Equations 4-4 through 4-5 and 4-7 were used to estimate the emission flux of volatile PCBs from the surface of the hopper on the barge. It was assumed that the hopper would be approximately 15 ft by 15 ft. The estimated emissions for total PCBs from the receiving hopper are presented in Table 4-1. The parameters used in this estimate are presented in Table 4-4.

Table 4-4
Parameters Used to Estimate Emissions from the Hopper on the Barge

Parameter	Assumed Value	Units	Source
PCB concentration in sediment	4.32×10^{-4}	kg/kg	Ref. 2
Henry's Law Constant	0.0249	-	Ref. 1
Sediment-water equilibrium partition coefficient	188	m^3/kg	Ref. 2
Depth of sediment surface below lip of hopper	1	m	a
Effective diameter of hopper	5.16	m	b
Diffusion coefficient of constituent in air	3.6×10^{-6}	m^2/sec	Ref. 1
Windspeed	3.9	m/sec	c
Kinematic viscosity of air	1.5×10^{-5}	m^2/sec	Perry's Handbook

a depth of water surface below top based on available project information
b size of receiving hopper based on available project information
c assumed windspeed based on available meteorological data for the site

4.2.2 Emissions During Filling CDF

After dredging under the baseline scenario, additional water will be added to the sediment in the receiving hopper to create a slurry that is suitable for transport. This slurry will be hydraulically transported to a CDF for storage. The inlet to the CDF can either be above (open filling) or below (submerged filling) the water level of the CDF. The discharge of slurry from an open pipe is similar to water flowing over a dam. As water flows out of the open pipe reaeration occurs, and the VOCs are partially stripped from the flow producing an additional source of emissions. In contrast, a submerged fill pipe would not be an additional source of emissions.

Emissions were conservatively estimated assuming that the inlet pipe would be above the water level during filling (open filling). The equation below can be used to estimate the emissions of volatilized PCBs from open filling:

$$E = Q\ F\ C_w \qquad \text{Equation (4-8)}$$

where:

E = Emissions rate (kg/sec)

Q = Volumetric flow rate of water (solids free) (m^3/sec)

F = Fraction of constituent volatilized across the discharge (dimensionless)

C_w = Equilibrium concentration of constituent in water (kg/m^3)

The flow rate of water through the inlet was estimated based on available site data. It was assumed that the 25 yd^3/hour of slurry with a 5% solids content would be transported to the CDF under this scenario. The equilibrium concentration of PCBs in water can be estimated using Equation 4-2. There are many empirical relationships available to estimate the fraction of a chemical volatilized from water flowing over a dam that could be used for this system. The equation below presents one of these correlations:

$$F = \frac{0.033ab\ (1+0.046(T-273))\ H_d \left(\dfrac{D_w}{D_{O_2,w}}\right)^{1/2}}{1 + 0.033ab\ (1+0.046(T-273))\ H_d \left(\dfrac{D_w}{D_{O_2,w}}\right)^{1/2}} \qquad \text{Equation (4-9)}$$

where:

F = Fraction of constituent volatilized across the discharge (dimensionless)

a = Water quality factor (1 for polluted water)

b = Spillway factor (0.6 for round broad-crested curved face spillway)

T = Temperature of water (K)

H_d = Height the water falls (m)

D_w = Diffusion coefficient of VOC constituent in water (m^2/sec)

$D_{O2,w}$ = Diffusion coefficient of oxygen in water (m^2/sec)

Emissions from open filling of the CDF were estimated using Equations 4-8 and 4-9 with Equation 4-2. The results of these calculations are presented in Table 4-1. The parameters used in these estimates are provided in Table 4-5.

Table 4-1
Parameters Used to Estimate Emissions from Open Filling of the CDF

Parameter	Assumed Value	Units	Source
Volumetric flow rate of water (solids free)	0.00065	m^3/sec	a
Water quality factor	1	-	Ref. 1
Spillway factor	0.6	-	Ref. 1
Temperature of water	288	K	b
Height the water falls	5	m	b
Diffusion coefficient of VOC constituent in water	4.6×10^{-10}	m^2/sec	Ref. 1
Diffusion coefficient of oxygen in water	2.5×10^{-9}	m^2/sec	Ref. 1
PCB concentration in sediment	4.32×10^{-4}	kg/kg	Ref. 2
Concentration of suspended solids	0.49	kg/m^3	Ref. 2
Sediment-water equilibrium partition coefficient	188	m^3/kg	Ref. 2

a estimate of slurry flow based upon available project information

b estimate based on good engineering judgement

4.2.3 Ponded Sediment

After entering the CDF under this scenario, the sediment-containing slurry will remain suspended for a period of time before the solids settle to the bottom. After settling, the sediment will be covered with a layer of water, creating “ponded sediment”. Emissions during the initial stage of filling (while sediment is resuspended) are similar to the emissions from the dredging model and can be estimated using

Equations 4-1 through 4-3. Once the sediment settles, however, the transport mechanisms change. Emissions of volatiles from the sediment bed will occur in four steps: desorption from the sediment, diffusion through the benthic boundary layer, diffusion through the water column, and volatilization through the atmospheric boundary layer. Conversely, volatilization from suspended sediment is mostly driven by desorption from the sediment and then volatilization through the atmospheric boundary layer. Volatiles from resuspended sediment do not need to diffuse through the benthic boundary layer or the water column. For this reason, emissions from ponded sediment should be less than emissions from suspended sediment after filling. It is unclear how long it would take the sediment to become ponded after being placed in the CDF. Consequently, in efforts to be conservative, emissions from the ponded sediment source were estimated using the emissions methodology for suspended sediment.

Equations 4-1 through 4-3 were used to estimate emissions from ponded sediment. In Table 4-1, it was conservatively assumed that the entire surface of both CDF C and CDF D would have ponded sediment. The assumed areas of CDF C and CDF D are 7 acres and 16 acres, respectively. Estimated emissions from ponded sediment in CDF C and CDF D are presented in Table 4-1 with assumed modeling parameters used to the generate the emissions presented in Table 4-6.

Table 4-6
Parameters Used to Estimate Emissions
from Ponded Sediment (Modeled as Suspended Sediment)

Parameter	Assumed Value	Units	Source
PCB concentration in sediment	4.32×10^{-4}	kg/kg	Ref. 2
Concentration of suspended solids	0.49	kg/m^3	Ref. 2
Sediment-water equilibrium partition coefficient	188	m^3/kg	Ref. 2
Windspeed	8.7	mi/hr	a
Diffusion coefficient of VOC constituent in water	4.6 x 10-6	cm^2/hr	Ref. 1

a assumed windspeed based on available meteorological data for the site

4.2.4 Exposed Sediment

After filling, the water may be drained or removed from the CDF exposing some sediment to the air. Wet exposed sediments are potentially a large source of volatile emissions because the water at the air/water interface is essentially saturated with the VOC. However, the magnitude of emissions will change with time as the upper layers of saturated water are quickly depleted. Evaporation from the exposed sediment will occur in a series of steps: diffusion from particle surface to pore water, diffusion through water film; desorption from water film to air boundary layer; and diffusion through air. In reality, it is likely that the sediment particle and pore water would already be in equilibrium and that the water film is very thin so these steps would provide little resistance to transport. So, the transport in this system is dominated by the sediment/air interface. After a period of time, the water and volatiles in the upper layers of the wet sediment will evaporate, and transport will become limited by diffusion through the air filled pore spaces to get to the atmosphere. At this point, the system changes from being air-side controlled to sediment-side diffusion controlled. These two phenomenon can be combined into one equation that estimates the emissions from exposed sediment as shown below (Ref 1):

$$n = \frac{\left(\frac{\omega H_c}{K_d} - C_a\right)}{\left[\left[\frac{\pi t}{D_{eff}\left(\frac{\varepsilon_a H_c + K_d \rho_b}{H_c}\right)}\right]^{\frac{1}{2}} + \frac{1}{k_{gs}}\right]} \qquad \text{Equation (4-10)}$$

where:

n = Emissions flux (kg/m^2 hr)

ω = PCB concentration in sediment (kg/kg)

H_c = Henry's Law Constant (dimensionless)

K_d = Sediment-water equilibrium partition coefficient (m^3/kg)

ε_a = Air filled porosity in the sediment (m^3/m^3)

t = Time since sediment has been exposed (hr)

D_{eff} = Effective diffusivity within the sediment pore spaces (m^2/hr)

ρ_b = Bulk density of sediment (kg/m^3)

k_{gs} = Sediment-to-air mass transfer coefficient (m/hr)

C_a = Hypothetical concentration of a constituent in the air over wet sediment

For purposes of this analysis, it was conservatively assumed that there is no volatile PCB concentration over the sediment that would impede mass transfer, so that C_a is zero. The effective diffusivity is an estimate of the diffusivity through pore spaces as opposed to through a homogeneous air layer. This diffusivity can be estimated using the following equation (Ref. 1):

$$D_{eff} \cong \frac{D_a \, \varepsilon_a^{10/3}}{\varepsilon_T^{\,2}} \qquad \text{Equation (4-11)}$$

where:

D_{eff} = Effective diffusivity within the sediment pore spaces (m^2/sec)

D_a = Diffusion coefficient of constituent in air (m^2/sec)

ε_a = Air filled porosity in the sediment (m^3/m^3)

ε_T = Total porosity of the sediment (m^3/m^3)

The sediment-to-air mass transfer coefficient (k_{gs}) can be estimated using the following equations (Ref. 1):

$$k_{gs} = 0.036 \, \mathrm{Re}^{4/5} \, Sc^{1/3} \, \frac{D_a}{L} \qquad \text{Equation (4-12)}$$

$$\mathrm{Re} = \frac{v_x L}{\nu} \qquad \text{Equation (4-13)}$$

$$Sc = \frac{\nu}{D_a}$$ Equation (4-14)

where:

k_{gs} = Sediment-to-air mass transfer coefficient (m/s)

Re = Reynolds Number (dimensionless)

Sc = Schmidt Number (dimensionless)

D_a = Diffusion coefficient of constituent in air (m^2/sec)

L = Characteristic length of exposed area (m)

v_x = Windspeed over the surface of exposed area (m/sec)

ν = Kinematic viscosity of air (m^2/sec)

Equations 4-10 through 4-14 were used to estimate emissions from exposed sediment. Emissions were estimated at the first hour of exposure (t = 1 hour). It was also assumed that the entire surface of both CDF C and CDF D would have exposed sediment producing a worst case estimate. The assumed areas of CDF C and CDF D are 7 acres and 16, acres respectively. The characteristic length of the exposed area was estimated based on the dimensions of CDF D. Estimated emissions from exposed sediment in CDF C and CDF D are presented in Table 4-1. Parameters used in these calculations are presented in Table 4-7.

Table 4-7
Parameters Used to Estimate Emissions from the Exposed Sediment

Parameter	Assumed Value	Units	Source
PCB concentration in sediment	4.32×10^{-4}	kg/kg	Ref. 2
Henry's Law Constant	0.0249	-	Ref. 1
Sediment-water equilibrium partition coefficient	188	m^3/kg	Ref. 2
Time since sediment has been exposed	1	hr	a
Bulk density of sediment	1.2×10^{-3}	kg/m^3	Ref. 2
Diffusion coefficient of constituent in air	3.6×10^{-6}	m^2/sec	Ref. 1
Air filled porosity in the sediment	0.3	m^3/m^3	Ref. 2
Total porosity of the sediment	0.7	m^3/m^3	Ref. 2
Characteristic length or fetch of exposed area	254	m	b
Windspeed	8.7	mi/hr	c
Kinematic viscosity of air	1.5×10^{-5}	m^2/sec	Perry's Handbook

a estimate based on good engineering judgement
b estimated value based on dimensions of CDF D
c assumed windspeed based on available meteorological data for the site

4.2.5 Capped Sediment

After the CDFs have been filled and curing completed, the CDFs may be capped with clean fill under the baseline scenario. This would serve to reduce emissions from the CDFs on a long term basis. Emissions from this source can be estimated using models developed for steady-state emissions from soil-covered landfills. The appropriate equation to estimate the emissions flux from this type of system is presented below:

$$n = \frac{D_{eff}}{h}\left(\frac{\omega\, H_c}{K_d} - C_a\right) \quad \text{Equation (4-15)}$$

where:

n = Emissions flux (kg/m^2 sec)

D_{eff} = Effective diffusivity within the sediment pore spaces (m^2/hr)

h = Thickness of soil cap (m)

ω = PCB concentration in sediment (kg/kg)

H_c = Henry's Law Constant (dimensionless)

K_d = Sediment-water equilibrium partition coefficient (m^3/kg)

C_a = Hypothetical concentration of a constituent in the air over wet sediment

As before, it was assumed that there is no PCB concentration over the soil cap that would impede mass transfer, so that C_a is zero. The effective diffusivity was calculated using Equation 4-11. It was also assumed that the entire surface of both CDF C and CDF D would be capped. The assumed areas of CDF C and CDF D are 7 acres and 16 acres, respectively. The estimated emissions from capped sediment are presented in Table 4-1 with supporting parameters in Table 4-8. As shown in these estimates, emissions from capped sediment are expected to be very small. However, please note that unlike the other types of emission sources described in this section, capped sediment is considered a long-term source and will occur for as long as the sediment remains in the CDF.

Table 4-8
Parameters Used to Estimate Emissions from the Capped Sediment

Parameter	Assumed Value	Units	Source
PCB concentration in sediment	4.32 x 10^{-4}	kg/kg	Ref. 2
Thickness of soil cap (m)	0.165	m	Ref. 2
Henry's Law Constant	0.0249	-	Ref. 1
Sediment-water equilibrium partition coefficient	188	m^3/kg	Ref. 2
Diffusion coefficient of constituent in air	3.6 x 10^{-6}	m^2/sec	Ref. 1
Air filled porosity in the sediment	0.3	m^3/m^3	Ref. 2
Total porosity of the sediment	0.7	m^3/m^3	Ref. 2

4.2.6 Discussion of Results

Table 4-1 summarizes the theoretical volatile PCB emission rates from potential sources associated with the NBH remediation operations. There are several comparisons and observations that can be made using these results.

First, based on these estimates, emissions from dredging appear to provide a relatively significant contribution to the total emissions from the project. There are several assumptions that have been used in the modeling that could contribute to these higher rates. The modeling assumes that the water at the dredging surface will be turbulent which would significantly increase emissions. In addition, it was assumed that wet sediment would cover the entire dredge bucket, which creates a significant emissions source. Finally, the emissions from the receiving hopper were estimated assuming that the concentration of volatile PCBs in the air space would be saturated.

The emissions from open filling of the CDF do not appear to be a significant contributor to the overall emissions from the Site. The emission correlations are considered reasonably conservative, so it is likely that this could be attributed to the flow rate assumptions. A flow rate of 25 yd^3/hr was assumed in this calculation. More recent operating data has indicated that the flow rate into a CDF could be as high as 75 yd^3/hr, which would triple the estimated emission rate. Even though the emissions from open filling are less in magnitude than the CDFs, they are a much more concentrated source. Consequently, it is a potent point source that could have strong nearby impacts. As such, open filling is not recommended for filling the CDFs.

Lastly, the theoretical emissions estimates indicate that ponded sediment produces a larger emissions flux than exposed sediment. Considering the assumed transport mechanisms, it appears that the exposed sediment should have the larger emissions flux. In addition, previous ambient air monitoring has shown higher results during periods of low-tides versus high-tides. These observations also support the concept that exposed sediment may have a larger emissions flux than ponded sediment. The anomaly in the predicted emissions could be a result of the underestimation of emissions from the exposed sediment, but without test data, it is unclear which source should have larger emissions.

It has been observed that an oil sheen sometimes develops on the surface of water as contaminated sediments are agitated or otherwise disturbed. It is not well understood why oil is generated. One theory suggests that the free-oil phase may be attached to the particles but is not released by the gentle process of settling, instead, it is only released upon agitation. Another theory suggests that once deposited, free oil may be formed on the sediment (Ref. 2).

Either way, this oil sheen floats on the water and essentially separates the air from direct contact with the water. It is unclear how this oil film would effect emissions of volatile PCBs. It could act as a barrier between the water and air, thereby impeding the volatilization of organics. However, since the oil may be in direct contact with the sediment for prolonged periods of time, it could act an organic phase reservoir for PCBs. This would likely cause an increase in emissions from a surface with an oil sheen. It is recommended that the effect and extent of oil sheens be further investigated.

4.3 Field and Laboratory Measurements

A Pre-Design Field Test (PDFT) was conducted to evaluate dredging technology for use in designing the dredge and disposal plan for the full-scale cleanup. The results of the PDFT are presented in a document entitled *Pre-Design Field Test Evaluation Report New Bedford Harbor Superfund Site* (Ref. 7). As a part of the PDFT, Radian URS was asked to take flux measurements at several potential sources of emissions. In addition, sediment samples were collected and sent to the USACE Waterways Experiment Station (WES) for additional testing. The testing locations were chosen to help evaluate the assumptions and ground truth the results of the theoretical emissions modeling. The results of the PDFT and the WES testing are fully described below.

4.3.1 Pre-Design Field Test

A Pre-Design Field Test was conducted in August 2000 for the purpose of evaluating one of the dredging approaches being considered for use during the full-scale remediation. During the PDFT, a Bean TEC environmental hydraulic excavator *Bonacavor* was used for dredging. The *Bonacavor* is a hybrid dredge with mechanical excavation and hydraulic transport. The dredging equipment used a mechanical clamshell bucket called the Horizontal Profiling Grab (HPG) bucket. The HPG bucket is designed to excavate thin layers of material with high accuracy, causing minimal spill and turbidity. This bucket is self-sealing to minimize loss of water and sediments during transfer from the Harbor.

Another key feature of the dredging system was incorporation of a "moon pool", a 30 ft by 40 ft wide cutout at the digging end of the barge where the excavation takes place. The moon pool allowed dredging to be conducted within an isolated and relatively quiescent area. An oil boom was placed at the opening to the moon pool, which is enclosed on the other three sides by barge sidewalls.

The dredge material was placed in a slurry processing unit (SPU) located on the dredge platform. The SPU system is a proprietary hydraulic slurry transport system that delivers high percent solids concentrations, by introducing controlled amounts of water to mechanically dredged material. The SPU was equipped with a process hopper that included a 6 in by 6 in grizzly screen for separation of debris. On the bottom of the hopper, two horizontal augers were used to homogenize the dredged material and prepare the slurry for transport. The SPU unit was designed to add the minimum amount of water to the slurry and still allow efficient hydraulic transport to the CDF.

The sediment slurry was hydraulically transported to a CDF for storage. The CDF was filled using a suspended pipe several meters above the water surface. It was observed that an oil sheen formed in the CDF around the inlet. Oil booms were used to contain the oil sheen within the CDF. Field operations observed that the sheen area was roughly equivalent to about 45 feet by 45 feet or approximately 2000 ft^2 (186 m^2).

The URS Corporation (URS), under contract to Foster Wheeler Environmental Corporation (Foster Wheeler), measured the emission flux of PCBs associated with dredging and sediment storage operations. The overall objective of the sampling effort was to characterize the emission flux of PCBs from the potential emissions sources associated with dredging. Flux box measurements were performed at various potential emission points as follows:

- Fresh slurry;
- Water over fresh slurry;
- Oil sheen on the CDF;
- Water near oil sheen on the CDF;
- Moon pool at the dredge; and
- Outside the silt fence at the dredge barge.

In addition, ambient air measurements were taken in the vapor space of the grizzly hopper at the dredge barge.

The testing procedures used during this study were based on the EPA User's Guide for flux chamber monitoring prepared by Radian URS (Ref. 8). The flux chamber is a vessel with a volume of 30 liters and it is filled around its rim with a tire inner tube to allow it to float on the water surface. Fresh, unexposed air was passed over the sample surface at a rate of 5 liters per minute. The tests were conducted in August when the ambient daytime temperature at the time of the tests ranged from 20 to 28 °C. The flux box was unable to be used for testing emissions from the grizzly. URS took samples of the grizzly head space air and made the assumption that the grizzly volume was purged four times per hour to determine the emission rate from the hopper. Three one-hour tests were taken for most of these source locations. The average flux test results for Total PCBs for each location are presented in Table 4-9. Please note that total PCBs were measured as total homologues. A complete description of the flux testing is presented in the URS summary report (Ref. 9), which is an eppendix to the Pre-Design Field Test report. Table 4-9 also presents the theoretical emissions estimate projections that would be most appropriate to compare for each testing location.

Table 4-9
Summary of PDFT Flux Test Results from Sources at NBH

Emission Source	Analogous Source Location	Measured Emissions Flux (ng/m^2 min)	Theoretical Emission Flux (ng/m^2 min)
Fresh Slurry	-	2,477	-
Water Over Fresh Slurry	-	2,529	-
Oil Sheen on CDF	-	2,480	-
Water near Oil Sheen on CDF	Ponded Sediments	1,355	256
Moonpool at Dredge	Water Surface at Dredge	555	15,360
Outside the Oil Boom at Dredge	Ponded Sediments	213	256
Grizzly at the Dredge Barge	Receiving Vessel on Barge	20 μg/min	8,940
Mud Flat in Harbor	Exposed Sediment	265	36

4.3.2 WES Laboratory Analysis

As previously noted, several remedial alternatives or variations are being considered for the New Bedford Harbor Superfund site. Dewatering the sediment prior to disposal is one option currently receiving further consideration. After dewatering and associated processing, the sediment would either be sent off-site for disposal, or stored on-site in a CDF.

There are several reasons why a sediment dewatering option is being considered. As discussed above for the baseline remediation scenario, the wet slurry would be pumped from the dredge into the CDFs where it would be stored and allowed to settle over a period of time. Because of the consistency of the slurry, the wet sediment would spread out and cover the entire bottom of the CDFs so that volatile PCBs would generally be emitted from the entire footprint area. Preliminary searches have identified few practical engineering or processing options for controlling the volatile emissions from wet sediment in this configuration. In addition, the storage capacity required for dewatered sediment would be less than for the wet sediment handling alternative because the wet slurry occupies a much larger volume per mass of sediment sediment stored than a dewatered sediment would occupy. Given these potential advantages, sediment dewatering is being considered and flux box testing was conducted on dewatered sediment to evaluate the effect of dewatering on emissions of volatile PCBs from the surface of the resulting sediment.

WES Laboratories conducted flux box testing on samples of PCB-contaminated sediment from New Bedford Harbor. The results of this testing are presented in a document authored by WES and included in this document as Appendix K (Ref. 10). Laboratory analyses were performed on untreated (or non-dewatered) and dewatered sediment samples. The samples were provided as the result of the bench-scale testing of three methods for dewatering which were conducted by the following vendors:

- Koester Environmental Services (Koester)
- Mineral Processing Services (MPS)
- JCI/Upcycle Associates (JCI)

Koester used a plate and frame filter press that utilized diaphrams. MPS was proposing the use of a "bladder press" that combined the technologies of a continuous belt filter press and a plate and frame press. However, for the bench-scale program, MPS used a modified diaphragm plate and filter press to simulate the results of a bladder press. The bench-scale testing for these two methods produced dewatered filter cakes with moisture contents between 34% and 39%. JCI was proposing to dewater the full-scale project with a technology that utilized a modified belt filter press to dewater the sediments. JCI did not successfully dewater sediment during the bench-scale testing, producing filter cake with a moisture content of 71.9%. However, their bench-scale tests indicated that the NBH sediment was responsive to flocculation and therefore amenable to commercial scale-up. In all three methods, polymer was added to the wet sediment prior to treatment to enhance dewatering. The bench-scale testing of these dewatering technologies is presented in the Final Technical Memorandum entitled *Feasibility Investigation of Sediment Dewatering Alternatives* (Ref 11). PCB concentrations in the tested sediment samples were not provided in the WES report.

Testing was conducted using a flux chamber designed at Louisiana State University (LSU) and constructed by WES. The two-piece anodized aluminum chamber was constructed to hold a sediment depth of 10 cm and has a surface area of 375 cm^2. Dry air was passed uniformly over the sediment surface at a rate of 1.7 liters per minute. There were 6 tests performed on New Bedford Harbor Sediment. Tests at two temperatures were performed on both the untreated and the Koester process samples. For these samples, tests were performed on sediment at room temperature and on sediment heated to 85 °F. Flux box testing for the MPS and JCI samples were performed only on sediment at room temperature.

Air was run through the chamber and through a sampling medium to collect PCBs continuously for 7 days. The sampling medium was extracted for testing at 6, 24, 48, 72 hours and 7 days after introduction of clean dry air flow through the chamber. The untreated (non-dewatered) samples showed a peak in emissions approximately 48 hours after initiation, while the dewatered samples generally showed peak fluxes earlier in the sampling timeline. The moisture contents and average and peak measured emission fluxes of total PCBs for the samples tested in the WES study are presented in Table 4-10. Please note that in this study, total PCBs were measured as Aroclor 1242.

Table 4-10
Summary of Peak Volatile PCB Emission Fluxes
Measured During WES Laboratory Testing

Sample Description	Moisture Content of Sample	Range of Measured Emission Fluxes over 7 days (ng/ m^2 min)	Number Average Emission Flux over 7 days (ng/m^2 min)	Time Into the Test when the Maximum Emission Flux was Measured
Untreated Sediment (room temp.)	61.3%	1515 – 5300	3,700	48 hours
Untreated Sediment (85 °F)	61.3%	703 – 210	460	48 hours
Koester Dewatered Sediment (room temp.)	34.4%	27,500 – 43,000	36,400	24 hours
Koester Dewatered Sediment (85 °F)	34.4%	4,083 – 5,550	4,877	72 hours
MPS Dewatered Sediment	39.1%	1,298 – 2,533	2,017	6 hours
JLS Dewatered Sediment	71.9 %[a]	1,283 – 5,433	3,717	6 hours

[a] Dewatering using the JLS method was not successful for this sample.

The measured flux time trend for the six sampling runs are presented in graphical form as Figure B-1 in Appendix B. This figure plots the measured emission fluxes as a function of time over the 7 day test runs. As shown in this figure, the measured fluxes for the dewatered Koester sample at room temperature were reported to be almost an order of magnitude higher than the measured fluxes for all other sampling runs. More specifically, the room temperature Koester sample had measured emission fluxes significantly higher than the Koester sample run at 85 °F and the MPS dewatered sample. It is unclear why there is such a difference between the emissions from these samples. The first notable difference is between the heated and the room temperature Koester samples. It was not anticipated by the investigators that the increase in temperature to 85 °F would result in significantly different emission rates. The other notable difference is that the MPS sample has significantly lower measured emission rates than the room temperature Koester sample. This again is not anticipated because the MPS and Koester samples have similar moisture contents and were produced by similar bench-scale methods (i.e., a plate and frame filter press with diaphram). For these reasons, it is difficult to confidently conclude, based upon this limited data, that dewatering the New Bedford Harbor sediment will result in a significant increase in emissions relative to the untreated sediment in the same configuration.

4.3.3 Discussion of the Measured Fluxes

There are several conclusions and observations that can be made concerning potential emission sources during dredging. One important observation during the PDFT was the presence of three distinct regions of emissions in the CDF during filling. As described previously, there was a consistent oil sheen that developed around the fill pipe to the CDF. Testing indicated that this oil sheen area exhibited an elevated emission rate. Then, around this fill area, there was the near-sheen area that also exhibited a relatively elevated emission rate, approximately one half that of the oil sheen area. The third region in the CDF was the quiescent region where the sediment was not really being effected by filling. This region would exhibit characteristics most like the ponded sediment locale described previously. It is important that all three of these regions be accommodated in the emissions modeling.

As mentioned above, the presence of an oil sheen during dredging operations was consistently observed during the PDFT. For this reason, the effect of oil sheen on emissions needs to be included in the emissions estimates. It does not appear that the oil sheen inhibits emissions. Conversely, it appears that the sheen could contribute to higher emissions. As shown in Table 4-9, the emission flux over the sheen is approximately twice as high as the flux measured near the sheen. This indicates that for sources under similar conditions, the presence of an oil sheen causes higher emissions. The PDFT results and the WES results (which are similar for wet/untreated slurry) indicate that the theoretical emissions estimates for the ponded sediments would not be appropriate for estimating emissions from recently agitated slurry. Actually, the emissions from the recently agitated wet slurry and the oil sheen appear to be very similar. This would indicate that the oil phase generated during agitation is likely the driving source for emissions under these conditions. The results of the testing can be used to develop a modeling approach that predicts emission rates from sediment slurries with an oil phase and for agitated slurries near an oil sheen.

The model for the ponded sediment can be refined using the PDFT test results to accurately represent the remainder of the CDF area (the quiescent area). The most appropriate testing locale to use to represent the quiescent area in the CDF is the area outside the oil boom by the dredge. In this area, the sediment is settled and the water surface is not subject to turbulence. One parameter in the ponded sediment model that could be refined is the equilibrium concentration of PCBs in water at the water/air interface. This is a difficult parameter to predict because it is not only dependent on the sediment/water equilibrium, but it is also dependent on the diffusion of PCBs to the surface through the water column. An appropriate value for this concentration can be determined from the PDFT results and subsequently used in the modeling.

The test results (as summarized in Table 4-9) also indicate that the contribution from dredging operations are likely overestimated in the theoretical emissions modeling. There are several factors that may have contributed to the overestimation. First, as mentioned previously, it is very difficult to predict the equilibrium concentration of PCBs at the water surface. This was likely conservatively overestimated in the theoretical modeling. Also, the modeling assumed that the dredge bucket would create a turbulent water surface. Observation at the PDFT indicated that the moon pool and the clamshell dredge bucket greatly reduced the amount of turbulence generated. The test results can be used more accurate estimate the equilibrium concentration of PCBs at the water surface.

Additionally, the emissions modeling assumed that the surface of the dredge bucket would be a significant source of emissions. The use of a clamshell dredge bucket specifically designed in part to reduce sediment disturbance and emissions essentially eliminates the significance of the dredge bucket surface as an emissions source. Observations during the PDFT support this assertion. Finally, the theoretically predicted emissions from the grizzly hopper on the barge also appear to be overestimates. This is likely due to the over estimation of the equilibrium concentration of PCBs in the air in the hopper. This concentration can be more accurately predicted using the measurements taken during the PDFT.

Lastly, it should be noted that the predicted emissions from exposed sediment was a little lower than measured emissions from the mudflats and significantly lower than the measurements from the dewatered sediment. This indicates that the algorithms for emissions from exposed sediment would need further refinement to represent the mudflat area, and that they do not accurately reflect dewatered sediment. At the time of this analysis, the baseline remediation scenario called for storage of wet slurry in the CDFs with a water layer. Also, testing and modeling have indicated that exposed and capped sediment are smaller emissions sources than wet slurry and ponded sediment. For these reasons, the final methodology presented below looks at emissions from wet slurry being stored in the CDF.

4.4 Application of PDFT and WES Results to Emissions Modeling

Observations from the PDFT indicated that there are several distinct regions of emissions present in the CDF: oil sheen region around discharge pipe; area near oil sheen; and quiescent area over remainder of CDF. Emissions from all of these potential emission regions needed to be incorporated into the emissions methodology.

As presented above, there were several additional conclusions made from the PDFT and WES testing that needed to be incorporated in the emissions modeling. First, the ponded sediment model needed to be further refined to more accurately reflect the equilibrium concentration of PCBs at the water surface. Second, the emissions algorithms for the dredge needed to be further reviewed. Lastly, emissions from an oil sheen needed to be included in the overall modeling.

The results of the PDFT and WES results were incorporated in the emission modeling algorithms to more accurately predict estimated emissions from the remediation operations as shown below.

4.4.1 Ponded Sediment – Quiescent Surface

Equations 4-1 and 4-3 can still be used to estimate emissions from ponded sediment in the CDF with a quiescent surface. However, rather than use Equation 4-2 to estimate the concentration of PCBs at the water surface, the PDFT results can be used to more accurately predict this value. It was assumed that the area outside of the silt fence would most accurately reflect the quiescent area in the CDF. The measured concentration of PCBs at the water surface at this location was 4.02 $\mu g/m^3$. Therefore, instead of using Equation 4-2, the equilibrium water concentration over ponded sediment with a quiescent surface was represented by the measured water concentration of 4.02 $\mu g/m^3$. The predicted theoretical emissions flux using this value is presented in Table 4-11. Please note that the base emissions flux for the ponded sediment will be adjusted to account for sediment concentrations. This adjustment is described in Section 4.7.

Table 4-11
Summary of Theoretical Emissions from Sources at NBH
Estimated After Pre-Design Field Test

Emission Source	Theoretical Emission Flux (ng/m^2 min)	Theoretical Emission Flux (kg/m^2 sec)
Ponded Sediment – Quiescent Surface	441	7.34×10^{-12}
Moon Pool at Dredge	1,565	2.61×10^{-11}
Grizzly Hopper	3.34×10^{-7} g/sec	20 μg/min
Oil Sheen on CDF	29,632	4.94×10^{-10}
Near Oil Sheen on CDF	16,179	2.7×10^{-10}

4.4.2 Dredging Operations

As mentioned above, the predicted emissions due to the dredging appear to be overestimated. Emissions from the water surface at the dredge or the moon pool were estimated using Equations 4-1 through 4-3 and the resulting emission flux from these equations was increased to account for enhanced turbulence. The results and observations from the PDFT indicate that the effect of enhanced turbulence does not need to be included in the emissions model for the moon pool. Similar to the ponded sediment above, the equilibrium concentration of PCBs at the water surface can be incorporated using test results. The average measured concentration of PCBs at the water surface at the moon pool was 14.3 $\mu g/m^3$. Updated emissions from the moon pool were estimated using this water surface concentration and Equations 4-1 and 4-3. The result is presented in Table 4-11.

The results of the PDFT also indicate that emissions from the grizzly hopper are not a significant source of emissions. This was not accurately reflected in the theoretical emissions modeling. Emissions from the grizzly are a function of how much PCB is saturated in the air above the sediments and the sediment throughput. In reality, the PCB concentration in air above the water would likely very seldom reach total saturation. Reaching saturation is a function of the quantity of time that the air comes in contact with the PCBs in water. Therefore, using the measured emission rate from the PDFT is the most accurate choice for this task. The emission rate of PCBs from the grizzly hopper is presented in Table 4-11.

4.4.3 Oil Sheen on CDF

As observed during the PDFT, there is a portion of the CDF around the fill pipe where there is a more turbulent regime and an oil sheen is created. This sheen will likely have the properties of an oil film or an emulsification of oil that floats on the water surface. Gas-phase resistance would limit the emissions of volatile PCBs from such an oil sheen. A model developed by the USEPA to estimate emissions from an oil film can be used to predict emissions from this film (Ref. 11). The equations used in this model are presented below.

The relationship describing the flux of a volatile constituent from a liquid surface to the air can be represented using the following equation:

$$n = K C_L \qquad \text{Equation (4-16)}$$

where:

n = Emissions flux (g/m^2 sec)

K = Overall mass transfer coefficient (m/sec)

C_L = Concentration of constituent in liquid (oil) phase (g/m^3)

Assuming that the oil film is relatively thin and that mass transfer is controlled by the gas-phase resistance, the following equation applies:

$$K = k_g \, K_{eq}$$

Equation (4-17)

where:

K = Overall Mass transfer coefficient (m/sec)

k_g = Gas-phase mass transfer coefficient (m/sec)

K_{eq} = Equilibrium partition coefficient between oil phase and gas phase (dimensionless)

K_{eq} can be estimated using Raoult's Law as shown below:

$$K_{eq} = \frac{P^{*} \rho_a \, MW_{oil}}{\rho_L \, MW_a \, P_o}$$

Equation (4-18)

where:

K_{eq} = Equilibrium partition coefficient between oil phase and gas phase (dimensionless)

P^{*} = Vapor pressure of volatile constituent (atm)

ρ_a = Density of air (g/cm^3)

MW_{oil} = Molecular weight of oil (g/gmol)

ρ_L = Density of oil (g/cm^3)

MW_a = Molecular weight of air (g/gmol)

P_o = Total pressure (1 atm)

The gas-phase mass transfer coefficient (k_g) can be estimated from the correlation of MacKay and Matasugu (Ref. 11):

$$k_G = 4.83 \times 10^{-3} \, U^{0.78} \, Sc_G^{-0.67} \, d_e^{-0.11}$$

Equation (4-19)

where:

k_g = Gas-phase mass transfer coefficient (m/sec)

U = Windspeed (m/sec)

Sc_G = Schmidt number (dimensionless)

d_e = Effective diameter of exposed surface of the oil film (m)

As mentioned previously, the area around the fill pipe with an oil sheen was observed to cover an area of approximately 45 feet by 45 feet. This area was used to determine the effective diameter for Equation 4-19 above. The Schmidt number was calculated using Equation 4-14. The concentration of PCBs in the oil phase was determined using the results from the PDFT. No testing was performed to measure the concentration of PCBs in the oil phase, but the concentration can be back-calculated using the PDFT results and Equations 4-17 through 4-19. Using this methodology, the concentration of PCBs in the oil phase was estimated to be approximately 2,230 g/m^3. Other parameters used in this calculation are presented in Table 4-12. The results of this calculation are presented in Table 4-11.

Table 4-12
Parameters Used to Estimate Emissions from the Oil Sheen

Parameter	Assumed Value	Units	Source
Concentration of constituent in liquid (oil) phase	2,230	g/m^3	a
Vapor pressure of volatile constituent	5.7 x 10^{-6}	atm	b
Density of air	1.170 x 10^{-3}	g/cm^3	Ref. 11
Molecular weight of oil	240	g/gmol	b
Molecular weight of air	28.8	g/gmol	Ref. 11
Density of oil	1.0	g/cm^3	Ref. 11
Total pressure	1	atm	Ref. 11
Windspeed	3.9	m/sec	c
Effective diameter of exposed area	13.7	m	a

a estimate based on back-calculation using other parameters
b a composite based on properties of di- and tri-homologues and correcting for temperature (300K)
c assumed windspeed based on available meteorological data for the site

As mentioned above, the sheen area was observed to cover an area of about 45 feet by 45 feet of the CDF. It was observed during field-testing that the emissions from the water near the sheen were at a reduced level relative to the area with the sheen or film, but still at a significant percentage of the sheen flux (approximately one half). This near-sheen area was roughly estimated to be a swath of 10 feet width, surrounding the sheen area. For the purposes of an emissions estimate, it is assumed that the near-sheen flux is 55% of the sheen flux as measured during the PDFT. The estimated flux for the near-sheen area is presented in Table 4-11.

4.5 Sensitivity Analysis

As was discussed previously, emission rates are sensitive to many chemical and physical parameters such as the ones listed below:

- Ambient temperature;
- Windspeed;
- Sediment/water equilibrium partition constant;
- Sediment suspended in water; and
- Diffusivity of volatile PCB in air and water.

A sensitivity analysis of these parameters can be a helpful tool in evaluating potential operating programs. The equations and methodologies presented in this section were used to evaluate the influence of many of these factors on volatile PCB emission rates at New Bedford Harbor. The sensitivity of the emissions estimates to these parameters is presented below.

Ambient Temperature

Temperature can have an effect on emissions because it has an effect on the amount of PCB dissolved in water. The higher the temperature, the more PCB will be able to be dissolved in water. The higher the quantity of PCB in water, the higher the emission rate. The Henry's Law constant is the parameter that defines the concentration of volatile PCBs in water. For example, the Henry's Law constants for Arochlor 1242 at 15 and 25 °C are shown in Table 4-13.

Table 4-13
Henry's Law Constants for Aroclors

Ambient Temperature	Henry's Law Constant
15 °C	12
25 °C	23

The annual average ambient temperature for the site is about 15 °C while the temperature during the field flux box testing was about 25 °C. Since the mass transfer coefficient is directly related to the Henry's Law constant, the reduction of the flux from test conditions to an annual averaged temperature is estimated to be 46%, or a factor of 0.54.

4.6 Windspeed

Windspeed has a significant impact on predicted emission rates. The two models used in the final emissions calculations are based on mass transfer coefficients as an exponential function of the windspeed. Average site windspeed is about 8.7 mph. The USEPA WATER8 model for an oil film is based on mass transfer resistance from diffusion of a VOC molecule through air (Ref. 11). The Valsaraj model for emission from a water covered CDF is based on a limiting diffusion resistance through water (Ref. 1). If the windspeed increases from 5 mph to 10 mph, the two models predict increases in emissions as shown in Table 4-14.

Table 4-14
Effect of Windspeed on Emissions Estimates

Model	Exponent in Mass Transfer Correlation	Predicted percent increase in emission flux
WATER8 Oil Film	0.78	71 %
Valsaraj	2.23	469%

Prorating the emission fluxes from the flux box test results in large increases in fluxes for the Valsaraj model. For this reason, caution should be used when using the Valsaraj model to predict emissions for extremely low wind velocities.

Sediment/Water Equilibrium Partition Coefficient

The sediment/water partition coefficient is a parameter used in Valsaraj correlations to calculate the equilibrium concentration of PCBs in water. The lower the partition constant, the higher the concentration of PCBs dissolved in water, and thus the higher the volatile PCB emission rate to the air. These values are mostly determined through laboratory experiments. Valsaraj (Ref. 1) provides partition coefficients for two common PCB Aroclor mixtures presented in Table 4-15.

Table 4-15
Sediment/Water Partition Coefficients for Aroclors

	Sediment/Water Equilibrium Partition Coefficient (m^3/kg)
Aroclor 1242	188
Aroclor 1254	304

As shown in Equation 4-2, the equilibrium concentration of PCBs in water is generally inversely proportional to this partition coefficient. Since Aroclor 1242, which has a lower partition coefficient, has a higher fraction of lighter PCB constituents, more PCB congeners will be dissolved in water resulting in higher predicted emissions to the air.

Conclusions

The most significant impact on emission rates according to the models presented is wind velocity since the mass transfer coefficient is an exponential function of wind velocity. Temperature has a significant impact on emissions as well, but not to the extent of the wind velocity. Emissions will also be related to the PCB content of the sludge and dependent on the distribution of low to high molecular weight congeners.

4.7 Summary of Results

This section presented a summary of the emissions that were used in the dispersion modeling analysis. However, prior to use in the dispersion modeling, the base emissions (or emissions developed up to this point) were adjusted to account for temporal and spatial considerations. These adjustments are presented below.

4.7.1 Emissions Adjustments

At time of this report, dredge and fill operations in New Bedford Harbor are expected to take place over a period of 4 years and occur through six zones which were delineated for this analysis. Maps of the zone locations are included in Appendix C. Table 4-16 is a schedule of the expected operational activities:

Table 4-16
Assumed Schedule of Dredging Operations

Year	Months	Dredge Location	Activity at CDF C	Activity at CDF D
1	3	Zone 1	Fill	None
	6	Zone 1	Cure	Fill
	3	Zone 2	Cure	Fill
2	7	Zone 2	Cure	Fill
	5	Zone 3	Cure	Fill
3	2	Zone 3	Cure	Fill
	7	Zone 4	Cure	Fill
	2	Zone 5	Cure	Fill
	1	Zone 6	Cure	Fill
4	12	None	Cure	Cure

The operational scenarios presented above were used in the dispersion modeling analysis presented in Section 5.0 of this document. There are four scenarios, one for each year of operation. Each annual scenario is made up of the combination of operations that occur in each year.

As mentioned above, the dredging operations will move through six different zones. Each zone has its own characteristic sediment PCB concentration with Zone 1 having the highest average PCB concentration in the sediments. The sediment PCB concentration by dredging zone and planned dredging volumes are provided in Table 4-17:

Table 4-17
Dredging Volumes and Average PCB Concentrations for Each Zone

	Planned Dredging Volumes (ft^3)	Average Total PCB Concentration in the Dredge Sediments (ppm)
Zone 1	3,326,002	1,031
Zone 2	3,725,048	843
Zone 3	3,169,752	256
Zone 4	2,716,418	89
Zone 5	882,772	155
Zone 6	171,472	150

As noted previously, the emissions of PCBs are directly related to the concentration of PCBs in the sediments. Since the zones that are dredged from year to year change, the average concentration of PCB stored in the CDFs will also change from year to year as shown below. The predicted concentration of PCBs in the CDFs for each year of operations is based on the dredging schedule and planned dredge volumes.

Averaged sediment PCB concentration in CDF C	1,031	ppm
CDF D gets filled in over 3 years		
Year 1: Volumetric averaged sediment PCB concentration	968	ppm
Year 2: Volumetric averaged sediment PCB concentration	732	ppm
Year 3: Volumetric averaged sediment PCB concentration	486	ppm

The emission fluxes presented in Table 4-11 were based on Zone 1 concentrations, which has the highest average PCB content. Subsequent year's emissions are based on ratios of that year's or Zone's average sediment PCB concentration to the average concentration for year 1 or Zone 1 respectively.

Finally, since PCB concerns are based on chronic health impacts rather than acute or short term impacts, annual average emissions estimates were developed. At the time of this study, the project schedule called for 16 hours/day, 6 days per week. Consequently, it was assumed that dredging operations that result in sheen and near sheen emissions occurs 16 hours/day and 6 days per week. For these locations, converting the instantaneous emissions to an annualized basis is accomplished by applying the following factor:

$$\mathit{annualizationfactor} = \frac{6*16*52}{8760} = 57\%$$

In addition, as presented above, dredging only occurs in certain zones each year. For this project, it is assumed that dredging proceeds from Zone 1 to 2 and then to 3 and so on, until Zone 6 is dredged and completed. So, for example, in year 1, dredging from Zone 1 occurs for 9 months out of the year and thus, in order to annualize emissions, the emission rates for Zone 1 were weighted by 75%. It was then assumed that Zone 2 emissions would apply for the remainder of the year.

4.7.2 Summary of Emissions for Dispersion Modeling

In summary, the approach for calculating emissions was to generate a base emission rate for total PCB homologues at 25 °C and the average wind speed of 8.7 mph. The base emission rate is based on the composition of the sediment in Zone 1 and are summarized in Table 4-11. For each year of dredging operation, the fluxes are adjusted based on the ratio of the concentration of PCBs in that zone over the PCBs concentration in Zone 1. The emissions are also adjusted for average annual temperature, for the amount of time of scheduled dredging, and for the amount of time in each zone.

Annualized PCB emissions are given in Table 4-18. These emissions fluxes and rates were used in the dispersion modeling analysis presented in Section 5.0 of this document. As shown in this table, emission fluxes and rates generally decrease from year to year primarily because of the PCB content of the sediments decrease as dredging proceeds from Zone 1 to Zone 6. The PCB concentration in CDF D decreases from approximately 1000 ppm in year 1 to about 500 ppm in year 3. The PCB flux from ponded sediment in CDF C stays the same throughout all years of curing because after it is filled, it was assumed, water stays over the dredged sediments at a constant level. Because of volatilization, the PCB content in CDF C diminishes over the 4-year period of study. However, the PCBs emitted are a very small fraction of the total quantity dredged, and thus the PCB content in CDF C does not vary significantly from year 1 to year 4 of operation.

This is shown in Table 4-19, which gives the total estimated PCB emissions over the 4-year period of study. It was estimated that about 57.4 kg of total PCBs are emitted over the 4-year period of dredging operations. Year 1 gives the highest quantity of PCB emissions, and therefore, it would be expected that this year would have the highest measured ambient air impacts. The total PCB emission was estimated to be approximately 0.0260% of the total PCB dredged. The fraction volatilized as a percentage of the cumulative quantity dredged falls each year because the dredged materials in year 3 are less contaminated with PCBs than in year 1.

Table 4-18
Emission Fluxes and Rates Used in the Modeling

	Year 1 Annual Averaged Emissions		Year 2 Annual Averaged Emissions		Year 3 Annual Averaged Emissions		Year 4 Annual Averaged Emissions	
Zone 1								
Dredging	9.2	μg/min						
Moon pool	361	ng/m2-min						
Zone 2								
Dredging	2.50	μg/min	5.84	μg/min				
Moon pool	98	ng/m2-min	230	ng/m2-min				
Zone 3								
Dredging			1.27	μg/min	0.51	μg/min		
Moon pool			49.8	ng/m2-min	20	ng/m2-min		
Zone 4								
Dredging					0.61	μg/min		
Moon pool					24.1	ng/m2-min		
Zone 5								
Dredging					0.31	μg/min		
Moon pool					12.0	ng/m2-min		
Zone 6								
Dredging					0.149	μg/min		
Moon pool					5.84	ng/m2-min		
CDFC								
sheen emissions	2,280	ng/m2-min	0	ng/m2-min	0	ng/m2-min		ng/m2-min
near sheen	1,245	ng/m2-min	0	ng/m2-min	0	ng/m2-min		ng/m2-min
ponded	238	ng/m2-min	238	ng/m2-min	238	ng/m2-min	238	ng/m2-min
CDFD								
sheen emissions	6,421	ng/m2-min	6,474	ng/m2-min	4,560	ng/m2-min		ng/m2-min
near sheen	3,506	ng/m2-min	3,535	ng/m2-min	2,490	ng/m2-min		ng/m2-min
ponded	168	ng/m2-min	169	ng/m2-min	119	ng/m2-min	119	ng/m2-min

Table 4-19
Total PCB Emission Inventory by Year in Grams

	Year 1 Total PCB Emissions	Year 2 Total PCB Emissions	Year 3 Total PCB Emissions	Year 4 Total PCB Emissions
Zone 1				
Dredging	5			
Moon pool	32			
Zone 2				
Dredging	1	3		
Moon pool	9	21		
Zone 3				
Dredging		1	0	
Moon pool		4	2	
Zone 4				
Dredging			0	
Moon pool			2	
Zone 5				
Dredging			0	
Moon pool			1	
Zone 6				
Dredging			0	
Moon pool			1	
CDFC				
sheen emissions	223	-	-	-
near sheen	134	-	-	-
ponded	6,185	6,185	6,185	6,185
CDFD				
sheen emissions	627	633	446	-
near sheen	377	380	268	-
ponded	8,581	8,651	6,094	6,094
Total PCBs, g	16,174	15,878	12,998	12,279
Total PCBs dredged, g	123,797,065	78,692,930	17,982,798	0
fraction volatilized, %	0.0131%	0.0202%	0.0723%	
Cumulative total dredged, g	123,797,065	202,489,995	220,472,793	220,472,793
fraction volatilized, %	0.0131%	0.0078%	0.0059%	0.0056%
Total volatilized/total dredged, %	0.0260%			

4.8 References

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9. "Draft Report, Flux Chamber Sampling and Analysis, Pre-Design Field Test, New Bedford Harbor Superfund Site", prepared for Foster Wheeler Environmental Corp., by Bart Eklund and Eric Anderson, URS, September 18, 2000.

10. "Laboratory Assessment of PCB Volatilization from New Bedford Harbor Sediment", Memorandum for Record, 2001

11. "Feasibility Investigation of Sediment Dewatering Alternatives, New Bedford Harbor Superfund Site, Revision 2" prepared by Foster Wheeler Environmental, May 2001.

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5.0 AIR DISPERSION MODELING

5.1 Introduction

This section presents the results of a dispersion modeling analysis of volatile PCBs with proposed remedial operations at New Bedford Harbor. The scope of work for this subtask involved estimating the anticipated dispersion of any released volatile PCBs in the area of the Harbor using computer modeling. The results of this modeling effort were used for two purposes: to predict ambient air concentrations of total PCBs to compare to risk-based exposure levels (please see Section 3.0) and to develop dispersion factors that will be used in the exposure budgeting plan (please see Section 6.0).

5.2 Description of Air Dispersion Modeling

This section describes the dispersion modeling methodology that was used to predict ambient air concentrations of volatile PCBs at commercial and residential receptors around the NBH site. The following sections describe the dispersion model, meteorology, source characterization and other parameters used to estimate ambient air concentrations.

5.2.1 Selection of Model

Potential exposures to the public may occur at commercial, residential, or recreational facilities in proximity to the Harbor. Due to its capability to simulate a wide area that encompasses multiple source and receptor locations, the USEPA Industrial Source Complex Model, Version 3 (ISC3) is well suited to the modeling needs associated with this site. The ISC3 (Version 00101) can process dispersion calculations with varied simultaneous source locations and with site-specific meteorological input data. ISC3 allows the analysis of many types of sources, including area and volume sources, and can be used to estimate dispersion and attenuation of airborne releases over both short-term (i.e., 1- to 24-hour averages) and long-term (i.e., annual average) periods. This model typically provides more accurate predictions of ambient impacts as compared to screening models.

The ISC3 model is a USEPA-recommended model that is based on an advanced steady-state Gaussian plume equation. The model calculates chemical concentrations at specific downwind locations as a function of windspeed, atmospheric stability, temperature gradient, mixing height, and downwind distance. The model also has the capability to account for plume rise, building downwash, dry deposition of particulate, receptor elevation, and simple terrain adjustment. At each receptor location, the computed concentrations are weighted and averaged according to the joint frequency of occurrence of windspeed and wind-direction categories, as classified by the Pasquill-Gifford atmospheric stability categories.

The USEPA *Guideline on Air Quality Models* suggests using the ISC3 model for sources in simple terrain, i.e. multiple sources where terrain is less than stack or source height (Ref. 1). The Guideline recommends the use of the COMPLEX-I model for areas where terrain elevation is above stack or source height. The latest version of the ISC3 model contains the algorithms for the COMPLEX-I model. The ISC3 model will automatically choose the correct algorithm based on input terrain data and source characteristics.

Two separate versions of the ISC3 model are available to estimate both long-term and short-term air dispersion. The short-term version is appropriate for calculating average concentrations using one or more individual, discrete years of pre-processed meteorological data. The long-term version is useful for simultaneously using several years of meteorological data for estimating average concentrations. For this assessment, the short-term version was chosen to estimate annual average downwind air concentrations. This was most appropriate for estimating annual average concentrations since one year meteorological data sets will be used. The parameters and inputs used to model ambient air impacts are presented in the sections below.

5.2.2 Source Characterization

Each emissions source must be represented as a point, line, volume or area source for the ISC3 model. A description of the characterization of the emissions sources for the site for use in the modeling is presented in this section.

As presented in Section 4.0 of this document, there are two main sources of emissions from the remedial activities at the site: the dredge and the CDFs. Each of these sources can then be broken down into smaller sources as shown in Table 5-1.

Table 5-1
Breakdown of Sources for Dispersion Modeling

Remedial Activity	Emission Source	Source Type
Dredge	Grizzly Hopper	Point
	Moon Pool	Area
CDF's	Sheen	Area
	Near Sheen	Area
	Ponded	Area Poly

The source types were determined based upon the physical characteristics of the source. The moon pool at the dredge and the CDF areas are all considered to produce ground-level emissions with negligible buoyancy effect dispersed over a large area. For this reason, they were represented as area or polygon area sources. The polygon area source option is useful for representing odd shaped area sources. The polygon area source may be used to specify an area source as an arbitrarily-shaped polygon of between 3 and 20 sides. This source type option gives considerable flexibility for specifying the shape of an area source. It is important to note that this type of source uses the same numerical integration algorithm for estimating impacts from area sources. The polygon area source is merely a different option for specifying the shape of the area source. Emissions from area sources are input as emissions fluxes (emissions rate per unit area) for use in the ISC3 model.

The grizzly hopper is more of a concentrated source where emissions occur from a more confined space. For this reason, the grizzly hopper was represented as a point source for use in the ISC3 model. Emissions from point sources are input as an emission rate.

Table 4-18 in Section 4.0 presents the annualized emissions estimated that were used for each of these sources.

5.2.3 Meteorological Data

A meteorological monitoring program has been established at the New Bedford Superfund Site. The meteorological tower is located adjacent to the Harbor on Sawyer Street in New Bedford, MA. The system consists of a 10-meter tower instrumented with horizontal wind speed, horizontal wind direction and ambient temperature measured at the 10-meter level; an additional level of ambient temperature, relative humidity, barometric pressure and solar radiation measured at the 2-meter level; and a precipitation gage located near ground level. In addition, the standard deviation of wind direction (sigma theta) and the difference between the 10-meter and 2- meter temperature (DeltaT) are calculated and recorded. A listing of the specific instrumentation utilized is presented in Table 5-2. The data are collected, processed and stored using a Campbell Scientific, Inc. Model CR10 Data Acquisition System (DAS). The DAS queries each sensor a minimum of once per second and uses this information to calculate averages every five minutes as well as hourly.

Table 5-2
Meteorological System Components

Parameter	Height Measured	Manufacturer	Model	Range
Horizontal Wind Speed	10-meter	Climatronics	100075	0.5 – 100 mph
Horizontal wind direction	10-meter	Climatronics	100076	0 – 360°
Sigma Theta	10-meter	Calculated Value		
Temperature	10 and 2 meter	Climatronics	100093	-25 to 125 °F
Delta Temperature	10 and 2 meter	Calculated Value		
Solar Radiation	2-meter	Matrix	NA	0- 1000 w/m^2
Relative Humidity	2-meters	Climatronics		0 – 100 %RH
Barometric Pressure	2-meter	Climatronics	NA	28 – 32 in. Hg
Precipitation	Surface	Climatronics	100097-1	NA

Based on a review of the available data, the meteorological data sets for 1996 and 1999 are the most complete and have undergone the most thorough quality control. These two years of meteorological data were therefore selected for use in the modeling analysis. Additional processing was needed to assure its reasonableness for this analysis and to transform the data into a form compatible with the ISC3 model. The 1996 and 1999 data was sent to T3 (Trinity Consultants) located in Research Triangle Park, NC for further processing into ISC3 format. As per Foster Wheeler Environmental Corporation's telephone conversation with T3, the meteorological data was processed (using PCRAMMET) and underwent QA/QC in accordance with EPA Guidelines by T3.

In 1999, Foster Wheeler took over the responsibility of auditing the meteorological station. In the process of preparing the audit reports, it was determined that the wind direction indicator was calibrated to magnetic north rather than true north. This is unusual since modeling applications use the wind directions based on true north. For the NBH site, magnetic north differs from true north by 15.5 degrees, rotated counterclockwise. For example, if the measured wind direction was 0°, the direction based on true north is 344.5°. Windroses for the 1996 and 1999 on-site meteorological data are presented in Appendix D. Please note that, consistent with the on-site meteorological station, the windroses are oriented to magnetic north.

5.2.4 Area Classification

The ISC3 model has rural and urban area classification options, which affect the dispersion coefficients (i.e., wind speed profile exponent law, dispersion rates, and mixing-height formulations) used in calculating ground-level concentrations. The criteria used to determine the selection of rural or urban coefficients are based on land use near and surrounding the source to be modeled (Ref. 2). If the land use is classified as heavy industrial, light-moderate industrial, commercial, or compact residential for more than 50 percent of the area within a 3 km radius circle centered on the source, the urban option should be selected. Otherwise, the rural option is more appropriate.

Based on the review of USGS topographic maps, the area surrounding the Harbor is a mixture of industrial, commercial and residential areas, thus it is concluded that the land use is consistent with the use of the urban rather than rural options. However, much of the dredging and filling activities take place over the water, which is consistent with rural terrain characteristics. The width of the Harbor in the dredging zones and CDFs varies from roughly 500 feet near Zone 1 to about 3500 feet near CDF D and wider at the southern extent of the Harbor. The north-south distance from the external boundaries of Zones 1-6 is about 6.5 km or 4 miles, which is almost entirely over water. This area is on the order of 5.3 square kilometers (18.7%) of the total 28.3 square kilometers, which is based on the 3-km radius. In addition, due to the irregular nature of the Harbor, mud flats line parts of the Harbor and adds to the non-urban land categorization.

As stated above, the choice of urban or rural affects the Gaussian dispersion coefficients used in the ISC3 model. Urban dispersion coefficients result in greater dispersion than rural because urban terrain features (i.e. buildings and structures) cause eddies, which in turn results in more mixing. Approximately 50% of the winds originate from the northerly and southerly directions (please see windroses in Appendix D). Since, this trajectory is mostly over water, plumes from dredging activities may be more concentrated when winds blow from these directions. A sensitivity analysis was performed to determine the magnitude of the difference in the predicted impacts between the rural and urban dispersion coefficients. Remedial activities during Year 1 (see Section 4.6.1) of operation were used in this sensitivity analysis. Maximum predicted annual concentrations (using both years of meteorological data) due to emissions from CDF C, CDF D and all sources combined are presented in Table 5-3.

Table 5-3
Comparison of Maximum Predicted Annual Average Concentrations Using Urban versus Rural Dispersion Coefficients

Source	Rural – Annual Average Concentration (ng/m^3)		Urban – Annual Average Concentration (ng/m^3)	
	1996	1999	1996	1999
CDFC	21.46	20.88	13.56	13.23
CDFD	3.10	3.02	1.09	1.12
All	21.91	21.25	13.71	13.36

As shown in Table 5-3, the predicted annual impacts using urban dispersion are lower by 36%-65%. The model does not allow the setting of different terrain coefficients for different sources. Since there are meteorological conditions that are best represented by a rural dispersion coefficient, it was decided to model impacts using rural dispersion coefficients rather than urban. This selection also enhances the inherent conservatism of the modeling analysis.

5.2.5 Receptor Locations

One master receptor grid was placed at 100-meter intervals starting at the edge of the Harbor and continuing out 2 km on either side of the Harbor. This receptor spacing was used to demonstrate the spatial distribution of concentrations.

As a subset to the master receptor gird, 46 discrete receptors were selected. These discrete receptor locations were identified based on a field reconnaissance representing the closest residential, commercial, and public exposed points at locations all around the Harbor. The choice of these discrete receptors is more fully described in Section 6.0. The 46 discrete receptors include 19 residences, 2 schools, and 25 commercial locations. In addition, four ambient air-monitoring locations on each side and at midpoint of the CDF were also selected for each of the CDFs. A graphical representation of the receptor grid and discrete receptor points are presented in Appendix E. The tabulated UTM Coordinates for the discrete receptors are also presented in Appendix E.

5.3 Application of Model

This section presents the emission source configurations and modeling options used in the air dispersion modeling analysis.

5.3.1 Modeling Scenarios

There were four annual scenarios or "snapshots" that were evaluated in the air dispersion modeling analysis. Each one represented one year of dredge and fill activities. These scenarios were presented in Section 4.0 of this document and are presented again in Table 5-4.

Table 5-4
Assumed Schedule of Dredging Operations

Year	Months	Dredge Location	Activity at CDF C	Activity at CDF D
1	3	Zone 1	Fill	None
	6	Zone 1	Cure	Fill
	3	Zone 2	Cure	Fill
2	7	Zone 2	Cure	Fill
	5	Zone 3	Cure	Fill
3	2	Zone 3	Cure	Fill
	7	Zone 4	Cure	Fill
	2	Zone 5	Cure	Fill
	1	Zone 6	Cure	Fill
4	12	None	Cure	Cure

It was considered likely that there will be two dredges operating in the same Zone at the same time during the remediation. For purposes of modeling, it was also assumed that the two dredges would be located at the same coordinate points, creating one dredge source that emits at twice the base emission rate for dredges. This is a common modeling approach when average annual impacts are being evaluated because for this averaging time, dredge locations are not as significant. A summary of the source parameters used in the modeling runs are presented in Appendix F. A graphical representation of the source locations are also provided in Appendix F.

5.3.2 Model Options

In addition to emission rates and physical emission characteristics of the source, other input data are needed to estimate the air quality impact of the facility. Specifically, model options, a receptor grid network and meteorological data are required as input to the ISC3 model. The receptor grid and meteorological data have already been addressed in previous sections. This section presents the other modeling options that were used in this analysis. The ISC3 model has numerous options to simulate different dispersion conditions for source emissions.

The USEPA has recommended that certain options be used in dispersion modeling to ensure regulatory compliance. These recommended regulatory default options, shown below, were used in the refined modeling analysis:

- Buoyancy induced dispersion (BID)- The BID directs the program to use Pasquill Stability method to parameterize the growth the spreading out of the plume as a result of thermal properties.
- Final Plume Rise- The model can include gradual plume rise (calculation of concentrations as the plume rises as a function of downwind distance) or final plume rise (the concentration at the plume's final height).
- Vertical Potential Temperature Gradients of 0.0, 0.0, 0.0, 0.0, 0.02, 0.035, for stability classes A through F, respectively- Potential temperature is the temperature a parcel of dry air would have if brought adiabatically from its initial state to a standard sea-level pressure of 1000 millibars. The change in potential temperature with height is used in modeling plume rise through a stable layer. Stability categories indicate the dispersive capacity.
- Wind Profile Exponents of 0.07, 0.07, 0.10, 0.15, 0.35, 0.55 for stability classes A through F, respectively- The wind profile exponent is the value of the exponent in a power law equation used to specify the profile of the wind with height.
- Automatic Treatment of Calms- The concentration in Gaussian plume model goes to infinity as wind speed approaches zero, therefore calm hours are excluded in ISCST3 calculations.
- Infinite Pollutant Half-Life- No degradation over time in the pollutant emitted.

Another non-regulatory option that was included is the wind rotation angle. As presented in Section 5.2.3, the on-site meteorological station is oriented toward magnetic north. ISC3 has an option that allows the user to correct the wind directions by a counterclockwise rotation angle. This option was used to adjust the meteorological data to true north. The wind rotation angle is 15.5° counterclockwise, which is entered as a positive number for a counterclockwise rotation.

5.4 Predicted Ambient Air Concentrations

ISC3 was used to predict annual average concentrations for points on the receptor grid and for discrete receptors for each year of dredging (Years 1 through 4) using both sets of meteorological data (1996 and 1999). Table 5-5 presents maximum predicted impacts for several types of discrete receptor groups including:

- Residential receptors
- Commercial receptors
- Sensitive receptors (e.g., school, hospitals, etc.)
- CDF monitoring stations

As shown in Table 5.5, the highest impacts occur near the CDFs. The next highest results occur at a commercial receptor, which is located about 150 meters west of CDF C.

Table 5-5
Maximum Predicted Annual Average Concentrations for Discrete Receptor Groups

Discrete Receptor Location	Annual Average Concentration (ng/m^3)		Year of Operation		UTM N	UTM E	Approximate Location
	1996	1999	1996	1999			
Residential Highest Impact	2.02	1.96	1	1	4,613,123	339,922	751 meters North of CDF C
Residential Second Highest Impact	1.95	1.87	2	2	4,613,123	339,922	751 meters North of CDF C
School Discrete Max Impact	0.63	0.65	1	1	4,613,123	340,944	795 meters south of CDF C
School Discrete Impact in Yr 4	0.47	0.49	4	4	4,613,123	340,944	795 meters south of CDF C
Commercial Max Impact	4.27	4.19	1	1	4,613,302	340,040	150 meters west of CDF C
Commercial Impact Yr 4	3.77	3.68	4	4	4,613,302	340,040	150 meters west of CDF C
CDF C Monitoring Station	21.91	21.21	1	1	4,613,470	340,225	East monitoring point
CDF D Monitoring Station	21.14	20.58	2	2	4,612,163	340,045	East monitoring point

Tables 5-6 and 5-7 present the maximum predicted annual average concentrations for receptors on the master receptor grid using 1996 and 1999 meteorological data, respectively. Similar to the discrete receptors, the highest impacts occur near a CDF, at the Northeast (NE) corner of CDF C.

The modeling runs were set up to provide an estimate of maximum annual average concentrations from individual source contributions, from the contribution of source groups, and from the contribution of all sources. Below is a list of the individual sources and source groups for which concentrations were predicted.

- CDF C Near Sheen (area source alone)
- CDF C Sheen (area source alone)
- CDF C Ponded (polygon area source alone)
- CDF D Near Sheen (polygon area source alone)
- CDF D Sheen (area source alone)
- CDF D Ponded (areapoly source alone)
- Dredging Zone 1 (point source alone)
- Dredging Zone 2 (point source alone)
- Moon Pool Zone 1 (area source alone)
- Moon Pool Zone 2 (area source alone)
- CDF C – total contribution from Near Sheen, Sheen, and Ponded
- CDF D – total contribution from Near Sheen, Sheen, and Ponded
- Dredge Zone 1 – total contribution from Grizzly Hopper and Moon Pool
- Dredge Zone 2 – total contribution from Grizzly Hopper and Moon Pool
- All - total source contribution from CDF C, CDF D, Grizzly Hopper and Moon Pool

Tables 5-8 and 5-9 present the maximum predicted annual average concentrations due to emissions from CDF C and CDF D individually using 1996 and 1999 meteorological data respectively. The highest predicted concentration due to emissions from CDF C occurs at the CDF C East Monitoring Station while the highest concentration due to emissions from CDF D occurs at a receptor on the master grid at a point close to the CDF D West Monitoring Station.

Tables 5-10 and 5-11 present the maximum predicted annual average concentrations with all sources contributing (CDF C, CDF D, Grizzly Hopper and the Moon Pool) using both years of meteorological data.

Maximum predicted impacts for all sources are tabulated in Appendix G. Please note that the sum of the individual impacts ***does not necessarily*** equal the maximum predicted concentrations for all of the sources combined because the maximum impact from individual sources may occur at different locations.

As shown above, this air dispersion modeling study predicts maximum annual average concentrations from a variety of sources at a variety of locations. In all cases, the maximum impacts do not exceed the risk-based ambient air concentrations developed in Section 3.0 of this document.

These modeling results will also be used to derive dispersion factors for use in the budgeting exposure plan. The derivation of these factors and a complete description of the exposure plan are presented in Section 6.0 of this document.

Table 5-6
Maximum Predicted Annual Average Concentrations at Receptors on Master Receptor Grid using 1996 On-Site Meteorological Data

	Annual Average Concentration (ng/m^3)	UTM N	UTM E	Approximate Location
Y1	18.90	4,613,560	340,214	NE Corner of CDF C
Y2	17.30	4,613,560	340,214	NE Corner of CDF C
Y3	17.16	4,613,560	340,214	NE Corner of CDF C
Y4	17.12	4,613,560	340,214	NE Corner of CDF C

Table 5-7
Maximum Predicted Annual Average Concentrations at Receptors on Master Receptor Grid using 1999 On-Site Meteorological Data

	Annual Average Concentration (ng/m^3)	UTM N	UTM E	Approximate Location
Y1	17.50	4,613,560	340,214	NE Corner of CDF C
Y2	17.04	4,611,900	339,958	SW Corner of CDF D
Y3	15.90	4,613,560	340,214	NE Corner of CDF C
Y4	15.88	4,613,560	340,214	NE Corner of CDF C

Table 5-8
Maximum Predicted Annual Average Concentrations Due to Contributions from the CDFs using 1996 On-Site Meteorological Data

	Contributing Source	Annual Average Concentration (ng/m^3)	UTM N	UTM E
Y1	CDF C	21.46	4,613,470	340,225
	CDF D	20.67	4,612,163	340,045
Y2	CDF C	18.30	4,613,470	340,225
	CDF D	20.84	4,612,163	340,045
Y3	CDF C	18.30	4,613,470	340,225
	CDF D	13.85	4,612,163	340,045
Y4	CDF C	18.30	4,613,470	340,225
	CDF D	12.36	4,612,163	340,045

Table 5-9
Maximum Predicted Annual Average Concentrations Due to Contributions from the CDFs using 1999 On-Site Meteorological Data

	Contributing Source	Annual Average Concentration (ng/m³)	UTM N	UTM E
Y1	CDF C	20.88	4,613,470	340,225
	CDF D	20.10	4,612,163	340,045
Y2	CDF C	17.61	4,613,470	340,225
	CDF D	20.32	4,612,163	340,045
Y3	CDF C	17.61	4,613,470	340,225
	CDF D	13.47	4,612,163	340,045
Y4	CDF C	17.61	4,613,470	340,225
	CDF D	12.02	4,612,163	340,045

Table 5-10
Maximum Predicted Annual Average Concentrations Due to Contributions from all Sources using 1996 On-Site Meteorological Data

	Source	Annual Average Concentration (ng/m³)	UTM N	UTM E
Y1	CDF C, CDF D and Dredging	21.91	4,613,470	340,225
Y2	CDF C, CDF D and Dredging	21.15	4,612,163	340,045
Y3	CDF C, CDF D and Dredging	18.60	4,613,470	340,225
Y4	CDF C and CDF D	18.57	4,613,470	340,225

Table 5-11
Maximum Predicted Annual Average Concentrations Due to Contributions from all Sources using 1999 On-Site Meteorological Data

	Source	Annual Average Concentration (ng/m³)	UTM N	UTM E
Y1	CDF C, CDF D and Dredging	21.25	4,613,470	340,225
Y2	CDF C, CDF D and Dredging	20.58	4,612,163	340,045
Y3	CDF C, CDF D and Dredging	17.61	4,613,470	340,225
Y4	CDF C and CDF D	17.83	4,613,470	340,225

5.5 Dewatered Sediment Screening Analysis

As previously noted, several remedial alternative variations are being considered for the New Bedford Harbor Superfund site. Dewatering the sediment prior to disposal is one option currently receiving further consideration. After dewatering and associated processing, the sediment would either be sent off-site for disposal, or stored on-site in a CDF.

There are several reasons that a sediment dewatering option is being considered. Under the baseline wet sediment remediation scenario, as discussed in Section 4.0, the wet slurry would be pumped from the dredge into the CDFs where it would be treated over a period of time. Because of the consistency of the slurry, the wet sediment would spread out and cover the entire bottom of the CDFs so that volatile PCBs would generally be emitted from the entire footprint area. Preliminary searches have identified few practical engineering or processing options for controlling the volatile emissions from wet sediment in this configuration. In addition, the storage capacity required for dewatered sediment would be less than for the wet sediment handling alternative because the wet slurry occupies a much larger volume per mass of dry sediment stored than a dewatered sediment would occupy. Vendors have estimated that dewatering will reduce the in situ sediment volume by 50%, allowing for reduced storage capacity requirements.

However, testing has indicated that dewatered sediment may produce a higher PCB emission flux per unit area than wet sediment. As presented in Section 4.3.2, testing performed by WES have shown a maximum total PCB flux of 43,000 ng/m^2/min for sediment at room temperature dewatered using the Koester method. This rate is ten times higher than the flux of total PCBs emitted from exposed wet sediment under similar conditions. However, there is more ability to define and limit the area of exposed sediment (and hence the size of the potential emission source) with dewatered sediments than with the wet sediment alternative. As mentioned above, the wet slurry would cover the entire footprint area of the CDF. The dewatered sediment, having a firmer consistency, and can be placed in the CDF in discrete vertical lifts and in particular locations within the CDF. As such, the entire area of the CDF would not necessarily be a working face with exposed fresh sediment that would be an active PCB emission source. Under this scenario, there are more practical options for controlling emissions from the dewatered sediment that has already been placed in the CDF.

The cumulative exposure budgets presented in this report were developed using detailed air dispersion modeling results from an assessment of the wet sediment scenario. However, a preliminary air dispersion screening assessment also was performed to evaluate the impact of various dewatered sediment source area sizes and orientations on potential ambient air concentrations in the areas near the CDF. Several factors can influence the ambient air concentrations that result from the storage of dewatered sediment in a CDF, including:

- The size of exposed areas (i.e., the footprint of the fresh, exposed dewatered sediment);
- The location of exposed areas within a CDF (i.e., where in the CDF the dewatered sediment is placed relative to the prevailing wind direction and the orientation of the CDF); and
- Suppression or reduction of emissions from the exposed areas using engineering controls.

The effect of each of these factors was quantitatively evaluated using the SCREEN3 model. SCREEN3 is an EPA-recommended model for estimating short-term ground-level concentrations resulting from point, area and volume emission sources. The details of this preliminary modeling study were presented in a draft memorandum to the USACE dated March 30, 2001. This memorandum, without the voluminous SCREEN3 computer outputs (that were included in the original submission to the USACE), is included as Appendix L to this document. The main conclusions from this preliminary air dispersion screening analysis of the dewatered sediment scenario were:

- Decreasing the size of the emitting area (i.e., the extent of the fresh, exposed dewatered sediment) will decrease nearby ground-level concentrations of PCBs.
- The location of the emitting area within the CDF has a significant impact on the location and magnitude of the predicted ground-level concentrations adjacent to the CDF.

- Use of an engineered emission control (like a vapor suppressing cover) would be likely to effectively reduce the magnitude of ground-level concentrations near the CDF.
- There are certain emission source area configurations (i.e., smaller emitting areas located on far (up-wind) side of CDF) for which the ground-level concentrations at receptor locations away from the CDF change relatively little with distance.

The maximum ground-level concentration predicted by this air dispersion modeling screening study is 1,140 ng/m^3 at the northern edge of the CDF. This maximum concentration was predicted assuming the entire area of a CDF (with dimensions 1,200 feet by 450 feet) would have exposed dewatered sediment that produced an emissions flux of 43,000 ng/m^2/min or 258 ng/cm^2/hr. This is the maximum measured flux from the Koester process sample at room temperature. It is important to note that SCREEN3 is a very conservative screening level dispersion model that is typically used to measure short-term concentrations (e.g., one-hour averages). Screening level applications are most appropriate for SCREEN3 because the model assumes that the wind blows in only one direction, directly at the receptor. In addition, the model chooses the wind speed and atmospheric stability class combination from a set of standard conditions that results in the highest ground-level concentration. However, despite these characteristics, the SCREEN3 model is appropriate and suitable for evaluating the relative impact of area source configurations on ambient air concentrations, which was the primary purpose of this preliminary, screening study. Should the dewatered sediment alternative be selected for application for all or part of the New Bedford Harbor cleanup effort, the atmospheric dispersion of the volatile PCB emissions from the dewatering process and dry sediment handling and disposal operations could be modeled using the ISCST3 model and assessment approach that was applied to the wet sediments as described in this report.

5.6 References

"Guideline on Air Quality Models", 40CFR51, Appendix W, 7-1-99 edition.

"Correlation of Land Use Cover with Meteorological Anomalies", A.H. Auer, Journal of Applied Meteorology 17:636-643, 1978.

6.0 CUMULATIVE EXPOSURE BUDGETS FOR PROTECTING THE PUBLIC FROM AIRBORNE PCB EMISSIONS DURING SEDIMENT REMEDIATION ACTIVITIES AT NEW BEDFORD HARBOR

6.1 Introduction

The first part of the work described in this section involved using the allowable ambient limits (Section 3.0) and the air dispersion modeling results (Section 5.0) to develop an overall ambient air management program that will protect the public from volatile PCB emissions released during Harbor remediation operations. This program involved using health-based ambient air target concentrations to develop long-term, cumulative exposure budgets. The remaining portion of this effort involved developing an Implementation Plan to guide the tracking of real-time conditions near the principal emission sources during the remediation operations. This tracking is designed to ensure that the health-based, cumulative exposure budgets continue to be met, or that emission reduction steps are taken to reduce ambient airborne PCB concentrations to levels that are protective. The description and development of the Implementation Plan is described in a separate report.

6.2 Objectives of the PCB Ambient Air Management Program

The objective of the overall PCB ambient air management program is to ensure and verify the protection of the public from volatile PCB emissions during contaminated sediment remediation operations at the Harbor. In order to meet these objectives, the ambient air management program and the cumulative exposure budgets on which it is based must be:

- protective;
- verifiable;
- technically defensible;
- logical and comprehensible; and
- implementable.

Section 6.3 through 6.9 are aimed at demonstrating that the program meets all of these objectives. The Implementation Plan discussed in Section 6.10focuses on the verifiability and implementation of the public protection program.

6.3 Overview

The relationship between the PCB emissions from the remediation operations and the projected ambient airborne concentrations at the targeted receptor locations must be understood to develop an effective ambient air management program. Remediation activities that disturb or involve the movement of contaminated sediments can liberate PCBs that are trapped within, or adhere to, the sediment. Directly or indirectly, these PCBs may ultimately become airborne. As was discussed in Section 2.0, the releases from these remedial activities (e.g., sediment dredging, transport, treatment, or disposal) are of relatively short duration, and these activities will lead to a reduction or elimination of more significant long-term releases of PCBs into the air and the exposures to the public that may result from them. Currently, the release of PCBs into the air at the site are uncontrolled and are increased at times by natural forces (e.g., wind and water effects from storms) and man's activities (e.g., boating and other Harbor commerce and recreation). Until the Harbor is cleaned-up, PCB emissions from the contaminated sediments (including exposed mudflats, beach areas, and the surface water) will lead to some level of continued public exposure. The short-term increase in airborne PCB concentrations above the currently elevated levels, if properly managed during the clean-up activities, will lead to a far greater benefit in terms of reduced, long-term releases and public exposure during natural weather events and routine Harbor activities. While not generally considered "volatile", highly contaminated sediments that exist at certain locations within the Harbor may contain enough of the lighter components of the PCBs to create airborne concentrations of possible human health concern near remediation operations. This ambient air management program, along with the parallel but independent remediation worker health and safety program, are designed to ensure that exposures to airborne PCBs are maintained below appropriate health-based levels for these two different groups of people.

The PCBs that have been found in the contaminated sediments in the Harbor occur in a range of different mixtures, containing varying amounts of the specific homologue groups (reflecting different amounts of chlorination) and individual congener compounds (reflecting how the chlorines that are present are arranged on the molecules). These various homologue groups and congeners vary significantly in their indicated toxicity to people. The effort to develop health-based Allowable Ambient Limits (see Section 3.0) addressed this reality by selecting the most appropriate toxicological factors and occupational concentration standards based on an evaluation of the distribution of the homologue groups and specific congeners measured in air samples collected during the Baseline Ambient Air Sampling and Analysis program (Final Annual Report – *Baseline Ambient Air Sampling & Analysis*, 1 June 1999 – 30 May 2000, New Bedford Harbor Superfund Site, March 2001). This evaluation is described in Section 3.0 of this report. A subsequent analysis of the distribution of the homologue groups in the ambient air samples collected during the Early Action sediment removal activities in the far upper Harbor indicated very similar homologue distributions, with a slight shift to somewhat lighter homologue groups (i.e., a shift in mass from the total tetra-chlorinated biphenyls to the total tri-chlorinated biphenyls homologue group). This shift would not change the selection of the toxicological factors used to calculate the Allowable Ambient Limits.

Volatile airborne PCBs have been shown to be a potential health concern following long-term inhalation exposure over many years (in contrast to short-term or acute exposure over hours or days). As such, ensuring protection of the public requires a focus on maintaining long-term, average exposures (as determined by long-term average ambient airborne concentrations) below levels that are established to prevent adverse health effects. Given what is known about the nature of the adverse health effects associated with inhaled PCBs, occasional short-term exposure to ambient concentrations above target levels would not be a health concern provided the long-term average exposure is maintained below the health-based target level.

6.4 Health Effects Associated with PCB Inhalation

Compiled published data on the health effects of inhaling PCBs was reviewed *(ATSDR Toxicological Profile for Polychlorinated Biphenyls Update, National Technical Information Service, September 1997).* Seven principal studies of human exposure to PCBs via inhalation define the range of health effects that have been linked to this potential exposure route. These studies are summarized in Table 6-1. Figure H-1 in Appendix H shows a plot of the findings of these studies in terms of the airborne concentrations of PCBs that were associated with adverse health effects on people and what is known about the duration of exposures of each study population. The reported studies range over orders of magnitude in airborne PCB concentrations (note the logarithmic scale of the y-axis) and a factor of 50 in exposure duration. It must be noted that the airborne PCB concentrations and/or the durations of exposure associated with these studies are generally imprecise. The imprecision and resulting ranges of values are due to the fact that the studies all evaluate past occupational exposures where the exposures were highly variable, uncontrolled, associated with changing Aroclors or mixtures of Aroclors over time, and largely undocumented. The exposure concentrations and durations had to be estimated using limited quantitative information. This

Table 6-1
Summary of Studies of Human Exposure to Inhaled PCBs and the Types of Non-Cancer Adverse Health Effects Reported

Study	Duration of Exposure (years)	Reference [1]	Exposed Population	Average Exposure Point Concentration (ng/m^3)	Types of Effects Reported
A	3.75 (ave)	Emmett et al. 1988a	Transformer Workers	10-12,000	Chest pain, loss of appetite, headaches, sleeplessness, memory loss
B	> 5	Fischbein et al. 1979; Warshaw et al. 1979	Capacitor Workers	7,000-11,000,000	Upper respiratory tract irritation, eye irritation, anorexia, weight loss, nausea, vomiting, abdominal pain, joint pain, headache, dizziness, depression, fatigue, nervousness
C	12 (ave)	Maroni et al. 1981a	Transformer Workers	48,000-275,000	Epigastric distress, epigastric pain, headache, intolerance to fatty foods
D	17 (ave)	Lawton et al. 1985a	Capacitor Workers	200,000-2,000,000	Decreased white blood cell counts, slightly increased lymphocyte monocyte and eosinophil counts
E	1.2 (ave)	Meigs et al. 1954	Transformer Workers	100,000	Mild to moderate chloracne
F	> 3	Emmett et al. 1988a; Ouw et al. 1976; Smith et al. 1982	Transformer Workers	<2,200,000	Eye irritation, tearing and burning
G	0.33-0.58	Bertazzi et al. 1987	Autoclave Operators	5,200,000-6,800,000	Chloracne

REFERENCES:

[1] Study letters correspond to plotted areas on Figure H-1 in Appendix

[2] National Technical Information Service. Toxicological Profile for Polychlorinated Biphenyls (Update). September, 1997.

- Bertazzi PA, Riboldi L, Pesatori A, et al. 1987. Cancer mortality of capacitor manufacturing workers. Am J Ind Med 11:165-176.
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Smith AB, Schloemer J, Lowry LK, et al. 1982. Metabolic and health consequences of occupational exposure to polychlorinated biphenyls. Br J Ind Med 39:361-369.

imprecision is depicted in Figure H-1 using shaded ranges for the information associated with Studies A through G. Table 6-1 indicates a range of non-cancer health effects associated with chronic inhalation exposure to PCBs, including chloracne, upper respiratory tract irritation, eye irritation, headaches and nausea.

PCBs are also classified by USEPA as a Probable Human Carcinogen (Classification B2) based on evidence of carcinogenicity in rats following extended exposures. Studies of capacitor manufacturing, transformer repair, and petrochemical workers exposed to PCBs through inhalation have not provided consistent information regarding an increase in overall mortality or in specific cancer mortality attributable to PCBs. The most often cited target organs for cancers potentially related to PCB exposures are the kidneys, liver, biliary tract, gall bladder, pancreas and rectum.

In addition to presenting the characteristic exposure concentrations and durations for the seven reported studies, a number of additional benchmark concentrations are identified to allow these values to be placed in perspective. Figure H-1 shows the set of occupational safety criteria published for PCBs using the horizontal dotted lines. The two Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration (OSHA) for PCBs with different levels of chlorination (42% and 54%, respectively) and the single Recommended Value published by the National Institute for Occupational Safety and Health (NIOSH) are shown on Figure H-1. The OSHA PEL values are representative of time-weighted average (TWA) concentrations that must not be exceeded during an 8-hour workshift during a 40-hour workweek. The OSHA PEL for 42% chlorinated PCBs was used in part of the analysis presented in Section 3.0. The NIOSH Recommended Value is representative of TWA concentrations for up to a 10-hour workday during a 40-hour workweek. Some background ambient air PCB concentrations are also are shown on Figure H-1. The published U.S. background concentration of 5 ng/m^3 is indicated, as well as the range of annual average PCB concentrations measured at various locations around the Harbor (2 to 80 ng/m^3). The last set of benchmark concentrations shown on Figure H-1 is four of the Allowable Ambient Limits calculated in Section 3.0. The Allowable Ambient Limits calculated for a child resident and an adult commercial worker assuming either a 5-year or a 10-year project duration (exposure period) are shown. These allowable ambient limits can be seen as considerably higher than the observed background levels and lower than the concentration ranges associated with adverse health effects in all the studies compiled by the Agency for Toxic Substances and Disease Registry (ATSDR) with the exception of the lower end of the imprecise concentration estimated for Study A. As such, these allowable ambient limits would appear to be protective even in light of the considerable uncertainties and imprecision involved. These allowable ambient limits are used in the development of the cumulative exposure budgets later in this Section.

6.5 Conceptual Model of Airborne PCB Impacts to the Public

Remediation activities to be performed in and around the Harbor will disturb sediments that are contaminated with PCBs. The lighter fractions of these PCBs are more prone to be released into the surrounding surface water and air. Eventually, some of these volatile PCBs can become airborne. In order to better understand how these airborne PCBs could impact the public, a conceptual model was developed which identifies possible exposure pathways that link the sources of PCB emissions with the potentially exposed members of the public. This conceptual model is graphically depicted in Appendix H, Figure H-2.

6.5.1 Emission Sources

Potential sources of volatile PCB emissions during the remediation operations include the:

- excavation and removal of the sediment from the Harbor;
- transfer of the sediment from the dredges to the onshore facilities;

- processing or pre-treatment of the sediment in the onshore facilities; and
- storage and disposal of the wet sediment in confined disposal facilities (CDFs).

6.5.2 Atmospheric Transport and Dispersion

As presented earlier in Sections 4.0 and 5.0, volatile PCBs released from these operations into the open air may be transported and dispersed by the wind to locations within the community where members of the public may be exposed to them via inhalation. The transport and dispersion were modeled as described previously using on-site meteorological data for 1996 and 1999. Both data sets were used in developing the exposure budget, with the greater air impact levels projected using either meteorological data set adopted as the basis for the exposure budgets.

6.5.3 Potential Public Receptors

The public receptors that may be exposed via this pathway include child and adult residents, and adult workers at commercial facilities located along the Harbor. Individual members of the public differ with respect to their sensitivity and susceptibility to inhaled PCBs. Individuals differ with respect to the rate at which they breathe and the amount they breathe with each breath, resulting in different intake rates due to inhalation. In general, children are somewhat more sensitive to inhaled volatile PCBs than adults due to their smaller size, differences in metabolic processes, and the extent of their bodily growth and development. Unborn fetuses and breast-fed newborns may also be somewhat more susceptible to volatile PCBs inhaled by the mother.

By explicitly recognizing and accounting for the differences among individuals in the general public, health-based target ambient air concentrations at possible exposure points in the community (away from the direct remediation area) can be calculated for any given exposure scenario and any specified target risk goal. These differences were explicitly considered in the calculation of the allowable ambient limits, the long-term average health-based target ambient PCB concentrations, that were developed and presented in Section 3.0. Allowable Ambient Limits were calculated specifically for both child and adult receptors, accounting for their respective body weights, breathing rates, and lung capacities.

A windshield survey was performed to identify or confirm the locations of residential and commercial/industrial land use in the areas bordering the Harbor. In addition, locations of potentially higher sensitivity to exposure (such as schools, hospitals, or day care facilities) were identified. The current land use all along both the western and eastern shores of the Harbor was evaluated and representative receptor locations representing potential points of exposure by individuals performing residential or commercial activities were identified. A total of 46 target receptor locations were identified in the surveyed band of land around the Harbor: 19 representative residential locations; 25 representative commercial land use locations; and 2 schools. These representative locations are shown in Appendix H, Figure H-3 with the:

- residential locations labeled as "R##";
- commercial locations labeled as "C##"; and
- locations of schools labeled as "S#".

These target receptor locations were used as discrete receptors in the air dispersion modeling (see Section 5.0) and as reference points throughout the remainder of the exposure budget development effort.

6.6 Background PCB Ambient Air Concentrations

Emissions of volatile PCBs from sediment remediation activities add to current (pre-remediation) background ambient air levels. These background levels are attributable to current conditions in the Harbor and other possible sources of PCB emissions in the vicinity. Using the results obtained during the Baseline Ambient Air Sampling and Analysis Program, annual average ambient air PCB concentrations were calculated for the period of June 1999 through May 2000 for each of the six baseline monitoring stations. The results are shown in Table 6-2.

PCB background ambient air concentrations near the Harbor vary with the seasons (due to differences in temperature and the prevailing wind direction) and with the tides (with low tides exposing more contaminated sediment). The background concentrations presented in Table 6-2 reflect the characteristic level throughout the year, averaged over these shorter run variations and cyclic oscillations. These annual average PCB concentrations were plotted on a map of the Harbor and rough contours were drawn (see Figure H-4).

Table 6-2
Annual Average PCB Background Concentrations
at the Baseline Monitoring Locations at New Bedford Harbor

Air Quality Site Number [1]	Air Quality Site Location	Annual Average PCB Background Concentration (ng/m^3)
21	CDF D Area	16.7
22	Brooklawn Park	2.3
23	Acushnet Substation	23.0
24 and 24D	Aerovox	75.0
25	Cliftex	26.1
26	Sawyer Street	56.0
28 [2]	*Early Action Area*	*21.4* [2]

Notes:

[1] See Figure 3-2, Appendix M

[2] The concentration shown for Air Quality Site 28 reflects the results of ambient air sampling in September 2000 prior to the performance of the Early Action sediment removal activity in the upper Harbor. As such, this average value is not a full year average concentration.

The allowable ambient limits (calculated in Section 3.0) for each representative target receptor reflect the total concentration to which that receptor could be exposed, regardless of the source of PCB emissions contributing to that concentration (i.e., from background or as the result of remediation activities). As such, a public protection program for the New Bedford Harbor sediment remediation effort must maintain total PCB exposure below this health-based target at a location, not just the amount projected to be present at that location as the result of the remediation operations. The map of the extrapolated and interpolated annual average background PCB concentrations presented in Figure H-4 was used to estimate the pre-remediation background concentration contributing to the PCB exposures at each target receptor location.

6.7 Cumulative Exposure Budgets

6.7.1 Description of an Exposure Budget

An exposure budget is a target ambient air concentration trend over time at a monitoring station near a major emission source that is designed to keep total public exposures to airborne PCBs below acceptable health-based target levels. Because the documented adverse health effects associated with PCB inhalation are associated with long-term or chronic exposure, the most appropriate exposure budgets for public protection from volatilized PCBs at the Harbor also relate to chronic exposure. As such, the exposure budget is referred to as a "cumulative" exposure budget because the projected exposures are tracked, summed, and managed over time as the remediation operations are performed. It must be noted, however, that the exposure budget approach will include checks and monitoring points to also ensure that elevated ambient concentrations over the short-term are limited in duration and magnitude.

Remediation operations will be limited to a specified maximum level of ambient air impact so that adverse health effects will not result. This exposure budget is based on the Allowable Ambient Limits calculated in Section 3.0 for the most sensitive or susceptible target receptor, and explicitly considers the background contribution of other sources of PCBs to the ambient airborne concentration at the point where that target receptor is located. The linkage between the airborne concentration of volatile PCBs near the major emission source and at the location of the most sensitive or susceptible public receptor was established using air dispersion modeling with site-specific meteorology as described in Section 5.0 (and confirmed through direct confirmatory monitoring).

6.7.2 Developing an Exposure Budget

Developing a cumulative exposure budget involves five sequential steps:

Step 1. Identify and locate the most potentially exposed and most sensitive subgroups of the general public.

Step 2. Determine the maximum allowable ambient air PCB concentration at potential points of public exposure that achieve health-based limits for these "target" receptors.

Step 3. Relate the ambient air concentrations at potential public exposure points to the concentrations that would be measured near the monitoring stations that would be placed near the major PCB emission sources.

Step 4. Calculate the maximum allowable concentration at the monitoring stations that protects the most sensitive target receptors (given site-specific meteorology, operational plans, and the proposed spatial configuration of the PCB emission sources).

Step 5. Use this concentration as the slope of the cumulative exposure budget line for that monitoring station.

A simple illustrative cumulative exposure budget is a straight, upward sloping line on a graph where the x-axis marks time (e.g., time of exposure or time since the beginning of dredging) and the y-axis marks cumulative exposure (measured in "concentration-days" or the multiplicative product of a health-based target PCB concentration and the period of time over which public exposure may occur). Figure I-1 in Appendix I shows an example of a cumulative exposure budget line for a hypothetical monitoring station near a major PCB emission source. The slope of the budget line is the allowable ambient PCB concentration at the monitoring station that is protective of the most sensitive target receptors.

Relative to the 5 step cumulative exposure budget development process:

- Step 1 of this process was accomplished through the performance of the windshield survey that was described above in Section 6.5.3.
- Step 2 involved the calculation of the allowable ambient limits for the target receptors. These calculations are documented in Section 3.0. Maximum allowable ambient air PCB concentrations at potential points of public exposure were calculated assuming target risk limits and the exposure patterns typical of adult and child residents and adult commercial workers.
- Step 3 was accomplished through the air dispersion modeling and the supporting source emission estimation work. These efforts are described in Sections 5.0 and 4.0, respectively.

The subsections that follow present the results of the remaining steps of this process, Steps 4 and 5, which relate to calculating the appropriate slope for the exposure budget line.

6.7.3 Establishing the Slope of the Exposure Budget Line

As was noted, the slope of the cumulative exposure budget line is the allowable ambient PCB concentration at the monitoring station that is protective of the most sensitive target receptor. The slope is quantitatively dependent on three primary factors (Allowable Ambient Limit, Annual Average Background Concentration, and Air Dispersion Factor) and a number of subfactors, as defined in the relationship below:

$$Slope = \left\langle (Allowable\ Ambient\ Limit) - (Background\ Concentration) \right\rangle x \left[Air\ Dispersion\ Factor \right]$$

This relationship for the slope highlights that the Allowable Ambient Limit is first reduced by the currently estimated Annual Average Background Concentration before the Air Dispersion Factor is applied. This is done because the health-based Allowable Ambient Limit represents the PCB concentration in the air that may be inhaled given the assumed exposure scenario, regardless of the source of the PCBs. Reducing the target concentration before applying the Air Dispersion Factor focuses the slope factor and the public protection program on the necessary constraints for the clean-up operations. It is understood that a significant contributor to the current background levels may be the contaminated mudflats that will eventually be remediated. As such, this minor adjustment is viewed as a conservative measure. This basic relationship can be expressed in terms of the individual subfactors that determine the magnitude of the primary factors:

$$Slope = \left\langle \left([TRG] x \left[\frac{AT}{DRTF} \right] x \left[\frac{BW}{BV\ x\ BR\ x\ EF} \right] x \left[\frac{1}{ED} \right] x [CF] \right) - (C\_BKG) \right\rangle x [SSDF]$$

The subfactors in this relationship are defined in Table 6-3.

Table 6-3
Primary Factors and Subfactors Affecting the Slope of the Exposure Budget Line

Primary Factor / Subfactors	Name	Determined or Influenced By:
Allowable Ambient Limit		[See Section 3 for development]
TRG	Target Risk Goal	Regulatory Policy
AT	Averaging Time	Regulatory Guidance or Project Operations
DRTF	Dose-Response Toxicity Factor	Chemical Property
BW	Body Weight	Matched to Sensitive Target Receptor
BV	Breath (Lung) Volume	Matched to Sensitive Target Receptor
BR	Breathing Rate	Matched to Sensitive Target Receptor
EF	Exposure Frequency	Matched to Sensitive Target Receptor
ED	Exposure Duration	Project Operations
CF	Conversion Factor	Constant
Background Concentration		[See Section 6.6]
C_BKG	Background Ambient Airborne PCB Concentration at the Target Receptor's Point of Exposure	Site Conditions
Air Dispersion Factor		[See Section 5 for development]
SSDF	Site-Specific Dispersion Factor (Ratio of the PCB concentration at the monitoring station to the PCB concentration at the target receptor location)	Local Meteorology / Spatial Configuration of Emission Sources

It can be seen that the various subfactors affecting the magnitude of the slope of the cumulative exposure budget line are determined or influenced by a broad spectrum of determinations:

- regulatory policy;
- planned project operations;
- chemical/toxicological properties of the volatile PCBs;
- characteristics of the exposed public; and
- site conditions or meteorology.

While all subfactors must be considered in the management of ambient air PCB levels, a number of these subfactors are outside the control of the remediation manager.

6.8 Developing Exposure Budgets for New Bedford Harbor

Using the relationship presented in Section 6.7.3, cumulative exposure budgets were developed for the two primary emission sources associated with the currently proposed remediation process: CDFs C and D. Because of uncertainties relating to project funding and its potential impact on the project duration, cumulative exposure budgets were developed for monitoring stations located at both CDFs for project durations of 5 and 10-years. In addition, two complete sets of site-specific meteorology (relating to the years 1996 and 1999) have been compiled for the New Bedford Harbor site. As the two years of meteorological data were equally valid relative to the prediction of annual average total PCB concentrations, the more conservative (lower) dispersion factors were selected for use in the calculation of the slopes of the cumulative exposure budget lines.

The basic process used to calculate the quantitative cumulative exposure budget lines proposed for the New Bedford Harbor remediation project, and the principal decisions made along the way, are highlighted below. The results of this process are cumulative exposure budgets tailored specifically to each projected monitoring station at each CDF to be protective of the public assuming 5 or 10-year project durations and the range of anticipated operational and meteorological conditions at the Harbor.

6.8.1 Calculation of the Site-Specific Dispersion Factors

The last remaining primary factor in the cumulative exposure budget slope relationship to be quantified is the site-specific air dispersion factor (SSDF) for each scenario evaluated. The dispersion factor between a monitoring station and a representative receptor location is defined simply as the ratio of the projected annual average total PCB concentration at the monitoring station to the projected annual average total PCB concentration at the target receptor location.

Table J-1 in Appendix J presents the calculations of the dispersion factors for total PCBs for the monitoring stations projected to be placed around CDF C and CDF D. As can be seen, monitoring stations were assumed to be located on the north, south, east and west sides of each CDF. The predicted ambient concentrations at these monitoring points were presented in Appendix G. Table J-1 also identifies the representative receptor locations identified during the windshield survey as the "Representative Receptor Locations", each on a separate row of the table. Because the spatial configuration of the various sources of PCB emissions and the level of PCB contamination in the sediments being excavated and handled are projected to change somewhat from year-to-year, the annual average airborne PCB concentrations projected by the air dispersion model also change slightly from year-to-year at any given location. The relatively small variation in the projected concentrations for a given monitoring station or target receptor location from year-to-year is evident in Table J-1 for the four different years of projected operation (see Section 4). All annual average PCB concentrations, calculated as described in Sections 4.0 and 5.0, are presented in units of ug/m^3. The dispersion factors are calculated by dividing the projected PCB concentration at the monitoring station for that year by the PCB concentration projected for the target receptor location for that year. The calculated dispersion factors typically range from approximately 2 to over 100 for some location pairs. Table J-1 is based on air dispersion modeling using the 1996 site-specific meteorology. Table J-2 presents the same dispersion factor calculations for CDF C and CDF D using the air dispersion modeling results based on the 1999 site-specific meteorology.

6.8.2 Calculation of the Cumulative Exposure Budget Slopes

Once the Allowable Ambient Limits, annual average background PCB concentrations, and dispersion factors have been calculated, the health-based slopes of the cumulative exposure budget lines can be calculated from the expression:

$$Slope = \langle (Allowable\ Ambient\ Limit) - (Background\ Concentration) \rangle \ x \left[Air\ Dispersion\ Factor \right]$$

Table J-3 presents these calculations for CDF C and CDF D for years 1 through 4 (reflecting the different PCB source configurations that are expected to occur over the course of the remediation project) assuming a 5-year project duration and the 1996 site-specific meteorology. The calculations for CDF C are presented first in Table J-3, followed by those for CDF D. Once again, the representative target receptors are identified as individual rows of this table. The "Receptor-Specific Risk-Based Exposure Point Concentration" listed for each target receptor was taken from the results presented in Section 3.0

assuming a 5-year project duration. If the representative receptor location was a residential location or a school, the lower (most stringent) of the child and adult resident Allowable Ambient Limit values was adopted for that receptor location. If the target receptor was a commercial or industrial location, the Allowable Ambient Limit of the adult worker was adopted for that receptor location. The "Receptor-Specific Annual Average PCB Background Concentration" for each target receptor location was taken from Figure H-4. The "Dispersion Factors" for each monitoring station-target receptor location pair were calculated in either Table J-1 or Table J-2, as appropriate (the dispersion factors in Table J-3 were calculated in Table J-1). As the dispersion factors vary for each monitoring station relative to a given target receptor location, the calculation is performed separately for each monitoring station in each year. The resulting "Risk-Based Concentration at the Monitoring Point" (Total PCB concentrations in units of ug/m^3) is the slope of the cumulative exposure budget line for that monitoring station that would maintain exposure at the specified target receptor location at the allowable health-based limit. The last two rows of Table J-3 also identify the lowest calculated "Risk-Based Concentration" for each monitoring station and the target receptor location requiring the concentration to be kept that low. As all target receptors must be protected, this minimum "Risk-Based Concentration" becomes the candidate value of the slope of the cumulative exposure budget for that monitoring station for that year (for the 1996 meteorology). Table J-4 presents the same calculations for CDF C and CDF D for years 1 through 4 assuming a 5-year project duration and the 1999 site-specific meteorology. The lower of the minimum "Risk-Based Concentrations" for each monitoring station from the two meteorological scenarios becomes the slope of the cumulative exposure budget for that monitoring station for that year.

Table J-5 and Table J-6 present the same calculations for CDF C and CDF D for years 1 through 4 simulation periods (reflecting the range of remediation activities that will occur over a 10-year project duration) and the 1996 and 1999 site-specific meteorologies, respectively.

6.8.3 Simplifying the Cumulative Exposure Budget Program

The calculations described above and presented in Tables J-3 through J-6 result in four cumulative exposure budgets for each CDF (for the north, south, east and west monitoring stations) for each of the forty-six target receptor locations, each with a slightly different slope for each year of remediation operations.

The quantitative results were critically evaluated to identify ways to reduce and simplify this program while still ensuring that the public remains protected. The calculated cumulative exposure budget lines were reviewed relative to three sequential assumptions or considerations. A graphical representation of this review is presented in Figure I-2 relative to the cumulative total PCB exposure budgets calculated for the CDF C monitoring stations assuming a 5-year project duration and the 1996 site-specific meteorology.

It was a stated objective of the ambient air management program that it be protective of all representative target receptors. The large arrow "1" shown on Figure I-2 highlights the five most stringent cumulative exposure budget lines calculated for the east monitoring station (the most stringent being for target receptor location R9, which was identified as the most impacted receptor location under those conditions). This part of Figure I-2 is broken out and depicted in Figure I-3. The insert box on Figure I-3 also shows how the slope of each line in year 3 was calculated. Since all representative target receptors must be protected, only the lowest cumulative exposure budget line can be used and the higher (less stringent) lines can be ignored. As such, this assumption or requirement, represented by the large arrow "1" on Figure I-2, serves to greatly reduce the number of candidate cumulative exposure budgets for each monitoring station.

Because of the strong effect of wind direction on the projected ambient air PCB concentrations around the Harbor, appreciable differences are apparent in the cumulative exposure budget lines calculated for the four monitoring stations relative to ensuring the protection of the most impacted receptor - R9. These cumulative exposure budget lines are highlighted by the large arrow "2" shown on Figure I-2. This part of Figure I-2 is broken out and depicted in Figure I-4. In this case, the east monitoring station has the highest (least stringent) exposure budget, with increasingly lower (more stringent) exposure budgets calculated for the west, north, and south monitoring stations (see Figure H-3 for the location of target receptor location R9). Because the differences in the magnitude of these cumulative exposure budgets are significant, it was decided to maintain separate budgets for each monitoring station and not to apply the most stringent cumulative exposure budget line to all four monitoring stations at a given CDF. It must be emphasized that the cumulative exposure budgets shown in Figure I-4 are all calculated to ensure that the exposures at target receptor location R9 will not exceed the health-based target level for the residential exposure of a child. As such, tracking the four monitoring station exposure budgets separately provides some redundancy in "diagnosing" the conditions at the potential points of public exposure.

Finally, because the major PCB emission sources for the modeled remedial operations are the stationary CDFs (with relatively minor emission contributions from the mobile dredges), Figure I-2 shows that the change in the slope of the cumulative budget line from year-to-year is small compared to the differences across the target receptor locations or across the four monitoring stations. These cumulative exposure budget lines are highlighted by the small arrow "3" shown on Figure I-2. This part of Figure I-2 is broken out and depicted in Figure I-5. The higher cumulative exposure budget line shown on Figure I-5 is the budget line reflecting the minor year-to-year changes in the slope. The lower cumulative exposure budget line shown on Figure I-5 reflects applying the minimum slope calculated for years 1 through 4 for all years of the project. As the quantitative difference in the resulting cumulative exposure budget lines is relatively small, it was decided to adopt the simpler and more conservative (protective) approach of applying the minimum slope calculated for years 1 through 4 for all years of the project.

It should be reemphasized that the most conservative result from applying the two separate years of meteorology data in the air dispersion modeling was used as the starting point for this entire review (see the insert box on Figure I-3 as an example).

6.9 The Proposed Cumulative Exposure Budgets for the New Bedford Harbor Ambient Air Management Program

This review, and the decisions noted, resulted in one remaining cumulative exposure budget line with a single-value slope for each of the four assumed monitoring stations at each CDF. Each of these budget lines is designed to protect the most potentially impacted target receptor location to the specified health-based exposure limit in consideration of the full range of projected operational source configurations and the more constraining meteorological conditions. Figure I-6 presents these proposed cumulative exposure budgets for total PCBs for CDF C assuming a 5-year project duration.

A similar review was conducted on the calculated cumulative exposure budgets for CDF C for a 10-year assumed project duration. The four proposed cumulative exposure budgets for total PCBs for CDF C assuming a 10-year project duration are graphically presented in Figure I-7. Similarly, the four proposed cumulative exposure budgets for total PCBs for CDF D assuming a 5-year and a 10-year project duration are graphically presented in Figure I-8 and Figure I-9, respectively.

6.10 Implementation of the Ambient Air Management Program

The Draft Final Implementation Plan describes and illustrates the process of applying air action levels and a cumulative exposure budget to ensure the protection of the public from volatile PCBs released during sediment remediation activities at New Bedford Harbor. The underlying methodology and development of cumulative exposure budgets is presented in Sections 3.0 through 6.0 of this document. This Draft

Final Implementation Plan builds on these air action levels and cumulative exposure budgets, and outlines the practical implementation of this approach to public protection. The Draft Final Implementation Plan (FWENC, 2001) is summarized below and is included in its entirety as Appendix M to this report.

The Draft Final Implementation Plan describes the key elements of a sampling and analysis program that will collect information on airborne PCB levels during the remediation project. Aspects of selecting the locations for the monitoring stations, sampling frequency, and analytical methods are discussed, as is the relationship between the Implementation Plan and the Sampling and Analysis Plan for ambient air monitoring.

This Draft Final Implementation Plan also illustrates how the information obtained from an ambient air sampling and analysis program can be used to track and analyze the conditions that determine the level of exposure of the public to volatile PCBs. A prototype Public Exposure Tracking System (PETS) for a monitoring station is presented as a simple tool for compiling the monitoring data collected over the course of a clean-up operation and automatically conducting an initial screening assessment of that data against the baseline cumulative exposure budget developed for that monitoring station. The prototype PETS is a spreadsheet-based tool that is tailored for each monitoring station. The prototype PETS calculates various statistics and parameters based on the monitoring data and checks the results against pre-defined criteria to alert the user of conditions and triggers that may indicate a potential or eventual exceedance of the established cumulative exposure budget. The prototype PETS also differentiates the conditions and triggers on the basis of the general level of response that may be required to remedy the unfavorable conditions and ensure continued protectiveness of the public relative to the potential inhalation exposures to volatile PCBs. The development and logic of the prototype PETS is detailed below.

The initial screening assessment begins with a check of whether any of a predefined set of conditions relative to the ambient air measurements has been created. These particular conditions were identified as the circumstances or occurrences that alone, or in combination, provide an indication that some component of the cumulative exposure-based public protection program may be diverging from the baseline levels and that some attention or response to the situation may be necessary. These conditions were identified to provide a conservative assessment of potential exposures. They are designed to provide "early warning" of potentially unfavorable exposure conditions so that timely, effective steps may be taken to eliminate these conditions and maintain public protectiveness.

The prototype PETS performs three types of condition checks as part of its screening assessment:

1. Comparison of the monitoring data directly to benchmark concentration criteria;
2. Comparison of the calculated cumulated exposure for the project to date to the baseline cumulative exposure budget developed for that monitoring station; and
3. Comparison of the cumulated exposure projected for the end of the project assuming continued conditions as they then exist to the baseline cumulative exposure budget at that point in time

The prototype PETS was tested on two remediation activities at New Bedford Harbor (the Early Action Removal Area work and the ongoing Commonwealth Electric Cable Crossing Relocation project), and illustrative outputs are presented.

Finalizing and tailoring this Draft Final Implementation Plan for effective utilization would include the following general steps:

- Locating the monitoring points relative to the primary volatile PCB emission sources associated with the selected remediation approach and the nearby potential public receptors;

- Establishing the cumulative exposure budget for each monitoring point (reflecting the appropriate PCB release scenarios and the local atmospheric fate and transport analysis);
- Locating additional monitoring stations at public exposure points indicated to be potentially most impacted based on modeling (i.e., to "ground truth" the projections used in the exposure budget development process);
- Developing the corresponding elements of the Sampling and Analysis Plan (e.g., frequency of sampling, analytical protocols, QA/QC) for the remedial activities being conducted;
- Conducting the ambient air sampling program as defined;
- Incorporating the results into the PETS framework; and
- Acting proactively on the recommendations generated through the initial screening analysis performed by the PETS to control and minimize public exposure to volatile PCBs released during the remediation effort.

7.0 CONCLUSIONS

This document presents work that was performed to address the potential impact of volatile PCBs released during remediation on the public health of the community. Two principal goals were accomplished with this assessment:

- The potential for health impacts associated with emissions of volatile PCB during the remediation of the contaminated New Bedford Harbor sediments under a baseline scenario was assessed using risk-based allowable ambient limits, emissions modeling, and dispersion modeling.
- An exposure budgeting program that, when implemented, will ensure the protection of public health was developed using the allowable ambient limits, current background concentrations, and the results of the air dispersion modeling.

As described previously, there were several distinct efforts undertaken to complete this assessment, that have been described in this document. These efforts include:

- Development of risk-based allowable ambient limits (Section 3.0);
- Emissions modeling to estimate potential releases of volatile PCBs during remediation activities (Section 4.0);
- Atmospheric dispersion modeling to determine ambient air concentrations of volatile PCBs (Section 5.0); and
- Development of a cumulative exposure budgeting program and plan for implementation that will ensure the protection of public health (Section 6.0).

The principal results and conclusions for each of these distinct efforts are summarized below.

7.1 Section 3.0 – Development of Allowable Ambient Limits

Section 3.0 presented the methods used to develop the health-based allowable ambient limits for potentially impacted segments of the public. Ambient allowable limits for PCBs are annual average air concentrations at a point of exposure that, below which, adverse health effects associated with inhalation exposures are not anticipated. The allowable ambient limit is an annual average concentration because the inhalation of PCBs is principally a health concern due to long term, or chronic, exposure. Short-term concentration limits (i.e., hourly or daily) typically associated with contaminants exhibiting acute health effects have not been defined and published for PCBs.

For this project, allowable ambient limits for PCBs were calculated for two types of public receptors: (1) a child and adult resident and (2) an adult non-remediation worker at a commercial or industrial facility. It was determined that the child resident was the most potentially impacted public receptor.

There are many exposure factors that influence an allowable ambient limit including body weight, breathing rate, body mass, and exposure duration. For this project, it was determined that the project or exposure duration was the most significant exposure parameter. Allowable ambient limits were calculated assuming a 5-year and a 10-year project duration. The allowable ambient limit for the most impacted public receptor (a child resident) for 5- and 10-year project durations are 660 ng/m^3 and 409 ng/m^3, respectively.

It is important to note that these allowable ambient limits are for total PCBs. Based upon the homologue and congener distributions from the sampling conducted to date, it was determined that PCB toxicity for this project can be described in terms of total PCB concentrations with continued monitoring of the congener distribution in the ambient air.

7.2 Section 4.0 – Emissions Modeling and Section 5.0 - Air Dispersion Modeling

Sections 4.0 and 5.0 of this document present the emissions and dispersion modeling that was performed to determine the maximum annual average concentrations at potentially exposed public receptors and to evaluate the contributions and characteristics of the emissions sources for the proposed remediation. Emission modeling was performed for the planned remedial activities at New Bedford Harbor using a combination of theoretical relationships and field test data. The theoretical modeling provided a mechanism to model emissions sources with relatively unique physical and operational characteristics. The field test data was used to fine-tune the theoretical modeling such that it more accurately predicted volatile PCB emissions for this project. These emissions estimates were used in an air dispersion model to predict annual average concentrations at possible receptor locations around the site. Several conclusions were drawn from these modeling studies that may be important for future remediation planning activities.

It was determined from the modeling that the wet sediment CDFs were quantitatively the largest and most influential emissions sources for potential impacts under the baseline scenario. This significance is due to the large emitting area in the storage units. The CDFs are very large, and, when wet sediment is placed in the CDF, it covers all available surface area. This makes the CDFs very large, continuous emissions sources. It should be noted that open filling of the CDFs with an above-the-water fill pipe opening also creates a significant emissions source. On a relative basis, emissions from open filling are less than the emissions from the CDFs. However, the PCB emissions from the CDFs occur over a large area, while the emissions from open filling occur as a concentrated point source. Therefore, there could potentially be high local impacts from open filling. For this reason, uncontrolled open filling is not recommended as an operational strategy.

The emissions modeling also indicated that dredging was not a significant contributor to project emissions. While the theoretical modeling indicated much higher dredging emissions, field tests showed much lower releases. This is likely due to the selection of dredging technologies for the Pre-Design Field Test (PDFT). One of the criteria in selecting dredges for the PDFT was minimization of sediment disturbance, which effectively reduces emissions.

Air dispersion modeling results indicate that the maximum impacts will occur near the source areas. Since the CDFs are the largest sources, the maximum predicted ambient PCB concentrations occur near the CDFs. These close-in impacts also are due to the characteristics of the CDF sources. These sources are large, ground level area sources that have no velocity or temperature-induced buoyancy. Consequently, their emission plumes tend to hug the ground, creating higher local impacts.

The maximum predicted annual average concentration of total PCBs was approximately 22 ng/m^3. This maximum impact occurred at the eastern monitoring point around CDF C using 1996 meteorological data. The maximum predicted annual average concentration is significantly less than the 5- and 10-year allowable ambient limits of 660 ng/m^3 and 409 ng/m^3 respectively.

It is important to note that two years of on-site meteorological data were used in the dispersion modeling analysis. Modeling results indicate that the annual average concentrations do not vary greatly from year to year. This indicates that it is appropriate to use the dispersion factors from modeling two years of meteorological data in the cumulative exposure budgeting even though exposures will be tracked over the duration of the project, which may be several years.

Although the cumulative exposure budgets presented in this report were developed using detailed air dispersion modeling results from an assessment of the baseline wet sediment scenario, a preliminary air dispersion screening assessment also was performed to evaluate the impact of various dewatered sediment source area sizes and orientations on potential ambient air concentrations in the areas near the CDF. This preliminary modeling used SCREEN3 to determine the impact of various source configurations on maximum ground level concentrations. The maximum ground-level concentration predicted by this screening study is 1,140 ng/m^3 at the northern edge of the CDF. This maximum concentration was predicted assuming the entire area of a CDF (with dimensions 1,200 feet by 450 feet) would have exposed dewatered sediment that produced an emissions flux of 43,000 ng/m^2/min or 258 ng/cm^2/hr. This is the maximum measured flux from the Koester process sample at room temperature. As discussed in Section 4.3.2, it is difficult to confidently conclude, based upon the limited data, that dewatering the New Bedford Harbor sediment would result in this increased emission rate. If the maximum flux of the MPS dewatered sediment were used in the screening study, maximum predicted concentrations would be approximately 70 ng/m^3.

It is important to note that SCREEN3 is a very conservative screening level dispersion model that is typically used to measure short-term concentrations (e.g., one-hour averages). Screening level applications are most appropriate for SCREEN3 because the model assumes that the wind blows in only one direction, directly at the receptor. In addition, the model chooses the wind speed and atmospheric stability class combination from a set of standard conditions that results in the highest ground-level concentration. However, despite these characteristics, the SCREEN3 model is appropriate and suitable for evaluating the relative impact of area source configurations on ambient air concentrations, which was the primary purpose of this preliminary, screening study. Should the dewatered sediment alternative be selected for application for all or part of the New Bedford Harbor cleanup effort, the atmospheric dispersion of the volatile PCB emissions from the dewatering process and dry sediment handling and disposal operations could be modeled using the ISCST3 model and assessment approach that was applied to the wet sediments as described in this report.

7.3 Section 6.0 – Cumulative Exposure Budgeting

Section 6.0 of this document presents the development of a cumulative exposure budget to ensure the protection of public health during the remediation. This study illustrates that a project-specific, cumulative exposure budget can be developed by integrating project emissions, atmospheric dispersion modeling, measured background concentrations, and health-based exposure concentrations. This cumulative exposure budget was designed to be protective of the most potentially impacted public receptor.

There were several decisions made during the development of the budget curves that affect the final implementation of the budgeting program. The first is that changes in dredge location and deployment sequence (i.e. north to south) do not significantly affect the magnitude of the exposure budget. This allowed a conservative assumption to be made which simplified the resulting budgets.

It also was determined that the spatial relationship between the source and the nearby monitoring stations was significant relative to the specification of the magnitude of the exposure budget. This required that an exposure budget for each directional monitor be established and tracked independently.

A Draft Final Implementation Plan was presented which illustrated the process of applying air action levels and a cumulative exposure budget to ensure the protection of the public from volatile PCBs released during sediment remediation activities at New Bedford Harbor. The Implementation Plan also illustrated how the information obtained from an ambient air sampling and analysis program can be used to track and analyze the conditions that determine the level of exposure of the public to volatile PCBs. A prototype Public Exposure Tracking System (PETS) for a monitoring station was presented as a simple tool for compiling the monitoring data collected over the course of a clean-up operation and automatically conducting an initial screening assessment of that data against the baseline cumulative exposure budget developed for that monitoring station. The prototype PETS was tested on two remediation activities at New Bedford Harbor, and illustrative outputs were presented in Appendix M.

7.4 Summary and Next Steps

Several changes to the planned approach for remediation of the contaminated sediments at NBH have been proposed during and since the scoping and performance of this study. The most significant of these changes included:

- Reducing the construction of proposed CDFs from four (A, B, C, and D) to two (C and D); and
- Proposing to dewater the sediment prior to disposal in a CDF or disposal off-site.

At the time this study was completed, the baseline remediation scenario included the following principal elements:

- Dredging of contaminated sediments from the Harbor over a 5- or 10-year period starting in the north and working to the south;
- Hydraulic transport of wet sediment to two CDFs (C and D);
- Storage and settling of the sediment in the CDFs (C and D);
- Decanting and treating water from the CDFs; and
- Capping the remaining sediments in the CDFs.

While this assessment was based upon a baseline wet sediment scenario, most of the information obtained from this study can be applied to other remediation approaches or variations. The allowable ambient limits (see Section 3.0) are not dependent on remediation alternatives. They can be used as presented in this document moving forward without any adjustment due to changes in remedial operations.

As mentioned previously, the estimated project emissions are dependent upon the remediation scenarios. However, the qualitative results of the modeling can be applied to other operating plans. As an example, the modeling effectively identifies the relative contribution of different emissions sources associated with remediation technologies. This knowledge can be used to assist in future planning activities. For example, the analysis has shown that dredging is a small contributor to overall project emissions. Consequently, changes in dredging technologies, operations and locations would likely not have a great impact on potential exposures.

Flux box testing has shown that that dewatered sediment may have a higher emissions flux than wet sediment. However, this indication was based on very limited data. Emissions and dispersion modeling indicate that the predicted ambient air concentrations for volatile PCBs are expected to be much less than the allowable ambient limits. Consequently, it is likely that a potential increase in emissions from handling and storing dewatered sediment would not result in an exceedance of the cumulative exposure budgets or cause adverse health impacts. The emissions and dispersion modeling also illustrate that the impact of an area source can be effectively reduced by reducing the size of the emitting area. This was further illustrated in a screening study of the ambient air impacts from storage of dewatered sediment.

The atmospheric dispersion modeling results were used for two purposes, to predict annual average air concentrations, and to develop dispersion factors for use in the cumulative exposure budget development process. The dispersion factors will still be appropriate for use in the exposure budgeting, even if the magnitude of project emissions (but not the overall source configuration) changes, because the factors are based on a ratio of ambient air concentrations (please see Section 6.0). The dispersion factors will change if the overall source configuration is significantly altered. Significant alterations could include addition of emissions sources, changes in source size, and changes in source type (i.e., area vs. point). Under these circumstances, the dispersion factors used in the cumulative exposure budget would need to be re-calculated.

Finally, this study has established a defensible method for developing cumulative exposure budgets. This methodology can be easily applied to future remediation scenarios. In addition, the creation of a flexible Implementation Plan, with links to the Ambient Air Sampling and Analysis Plan, will help to accommodate any alternative remediation plans. The final Implementation Plan can be tailored to fit the operations as construction commences.

Subsequent efforts required to finalize and tailor the current program for the protection of the public from potential releases of volatile PCBs during remediation activities at the Harbor would include the following general steps:

- Establishing the key processes, operational parameters, and time sequencing associated with the remediation approach to be implemented;
- Revise / update the PCB emission source estimates and spatial source distribution developed in Section 4.0;
- Adjust the spatial source distribution associated with the remediation approach to be implemented and recalculate the atmospheric dispersion factors (as was demonstrated in Section 5.0);
- Review aspects of the toxicology of PCBs (especially the reevaluation of the carcinogenicity of the dioxin-like compounds) to determine if any developments warrant changes to the development of the allowable ambient limits currently presented in Section 3.0;
- Locate monitoring stations relative to the primary volatile PCB emission sources associated with the selected remediation approach and the nearby potential public receptors;
- Establish the cumulative exposure budget for each monitoring station (reflecting the appropriate PCB release scenarios and the local atmospheric fate and transport analysis);
- Locate additional monitoring stations at public exposure points indicated to be potentially most impacted based on modeling (i.e., to “ground truth” the projections used in the exposure budget development process);
- Develop the corresponding elements of the Sampling and Analysis Plan (e.g., frequency of sampling, analytical protocols, and QA/QC) for the remedial activities being conducted;
- Conduct the ambient air sampling program, as defined, during the performance of the remedial activities;
- Incorporate the results into the PETS framework; and
- Act proactively on the recommendations generated through the initial screening analysis performed by the PETS to control and minimize public exposure to volatile PCBs released during the remediation effort.

APPENDIX A

Results of NTEL Calculations

TABLE A-1

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR TOTAL PCBs FOR THE CHILD RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Child

$$NTEL^1 = \frac{TR*BWc*ATc*CV}{EF*ED*IRc*CSF}$$

$$NTEL^2 = \frac{\frac{TR*ATc*CV}{EF*CSF}}{\frac{IRc*EDc}{BWc} + \frac{IRa*EDa}{BWa}}$$

Target Risk TR (unitless)			Cancer Slope Factor CSF $(mg/kg\text{-}day)^{-1}$			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	2	0.4	0.07	5	10 (6+4)	
X			X			X		13.19
X			X				X	8.18
X				X		X		65.96
X				X			X	40.89
X					X	X		377
X					X		X	234
	X		X			X		132
	X		X				X	82
	X			X		X		660
	X			X			X	409
	X				X	X		3,769
	X				X		X	2,337
		X	X			X		1,319
		X	X				X	818
		X		X		X		6,596
		X		X			X	4,089
		X			X	X		37,694
		X			X		X	23,367

Threshold Effects Exposure Level TEL (ng/m^3)
680

NOTES:

Both NTELs calculated using:

ATc = Averaging Time (Carcinogenic) = 25,550 days
EF = Exposure Frequency = 350 days/year
IRc = Inhalation Rate (child) = 12 m^3/day
CV = Conversion Factor = 1,000,000 ng/mg
BWc = Body Weight (child) = 15 kg

$NTEL^1$ calculated using:
ED = Exposure Duration = 5 years

$NTEL^2$ calculated using:
BWa = Body Weight (adult) = 70 kg
EDc = Exposure Duration (child) = 6 years
EDa = Exposure Duration (adult) = 4 years
IRa = Inhalation Rate (adult) = 20 m^3/day

TABLE A-2

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 114 FOR THE CHILD RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Child

$$NTEL^1 = \frac{TR*BWc*ATc*CV}{EF*ED*IRc*CSF*TEF}$$

$$NTEL^2 = \frac{\frac{TR*ATc*CV}{EF*CSF*TEF}}{\frac{IRc*EDc}{BWc} + \frac{IRa*EDa}{BWa}}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10 (6+4)	
X			X		0.3518
X				X	0.2181
	X		X		3.518
	X			X	2.181
		X	X		35.18
		X		X	21.81

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

Both NTELs calculated using:
BWc = Body Weight (child) = 15 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IRc = Inhalation Rate (child) = 12 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.0005

NTEL^1 calculated using:
ED = Exposure Duration = 5 years

NTEL^2 calculated using:
BWa = Body Weight (adult) = 70 kg
EDc = Exposure Duration (child) = 6 years
EDa = Exposure Duration (adult) = 4 years
IRa = Inhalation Rate (adult) = 20 m^3/day

TABLE A-3

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 118 FOR THE CHILD RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

$$NTEL^1 = \frac{TR*BWc*ATc*CV}{EF*ED*IRc*CSF*TEF}$$

$$NTEL^2 = \frac{\dfrac{TR*ATc*CV}{EF*CSF*TEF}}{\dfrac{IRc*EDc}{BWc} + \dfrac{IRa*EDa}{BWa}}$$

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Child

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10 (6+4)	
X			X		1.7590
X				X	1.0905
	X		X		17.590
	X			X	10.905
		X	X		175.90
		X		X	109.05
					Threshold Effects Exposure Level TEL (ng/m^3)
					N/A

NOTES:
N/A = Not Applicable

Both NTELs calculated using:
BWc = Body Weight (child) = 15 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year

IRc = Inhalation Rate (child) = 12 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.0001

NTEL^1 calculated using:
ED = Exposure Duration = 5 years

NTEL^2 calculated using:
BWa = Body Weight (adult) = 70 kg
EDc = Exposure Duration (child) = 6 years

EDa = Exposure Duration (adult) = 4 years
IRa = Inhalation Rate (adult) = 20 m^3/day

TABLE A-4

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 126 FOR THE CHILD RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Child

$$NTEL^1 = \frac{TR*BWc*ATc*CV}{EF*ED*IRc*CSF*TEF}$$

$$NTEL^2 = \frac{\dfrac{TR*ATc*CV}{EF*CSF*TEF}}{\dfrac{IRc*EDc}{BWc} + \dfrac{IRa*EDa}{BWa}}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10 (6+4)	
X			X		0.0018
X				X	0.0011
	X		X		0.018
	X			X	0.011
		X	X		0.18
		X		X	0.11

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

Both NTELs calculated using:
BWc = Body Weight (child) = 15 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IRc = Inhalation Rate (child) = 12 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.1

NTEL^1 calculated using:
ED = Exposure Duration = 5 years

NTEL^2 calculated using:
BWa = Body Weight (adult) = 70 kg
EDc = Exposure Duration (child) = 6 years
EDa = Exposure Duration (adult) = 4 years
IRa = Inhalation Rate (adult) = 20 m^3/day

TABLE A-5

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 169 FOR THE CHILD RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Child

$$NTEL^1 = \frac{TR*BWc*ATc*CV}{EF*ED*IRc*CSF*TEF}$$

$$NTEL^2 = \frac{\dfrac{TR*ATc*CV}{EF*CSF*TEF}}{\dfrac{IRc*EDc}{BWc} + \dfrac{IRa*EDa}{BWa}}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10 (6+4)	
X			X		0.0176
X				X	0.0109
	X		X		0.176
	X			X	0.109
		X	X		1.76
		X		X	1.09

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

Both NTELs calculated using:
BWc = Body Weight (child) = 15 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IRc = Inhalation Rate (child) = 12 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.01

NTEL^1 calculated using:
ED = Exposure Duration = 5 years

NTEL^2 calculated using:
BWa = Body Weight (adult) = 70 kg
EDc = Exposure Duration (child) = 6 years
EDa = Exposure Duration (adult) = 4 years
IRa = Inhalation Rate (adult) = 20 m^3/day

TABLE A-6

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR TOTAL PCBs FOR THE ADULT RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Adult

$$NTEL = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF}$$

Target Risk TR (unitless)			Cancer Slope Factor CSF $(mg/kg\text{-}day)^{-1}$			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	2	0.4	0.07	5	10	
X			X			X		25.55
X			X				X	12.78
X				X		X		128
X				X			X	63.88
X					X	X		730
X					X		X	365
	X		X			X		256
	X		X				X	128
	X			X		X		1,278
	X			X			X	639
	X				X	X		7,300
	X				X		X	3,650
		X	X			X		2,555
		X	X				X	1,278
		X		X		X		12,775
		X		X			X	6,388
		X			X	X		73,000
		X			X		X	36,500
								Threshold Effects Exposure Level TEL (ng/m^3)
								1,190

NOTES:
NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IR = Inhalation Rate = 20 m^3/day

TABLE A-7

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 114 FOR THE ADULT RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Adult

$$NTEL = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m³)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		0.6813
X				X	0.3407
	X		X		6.813
	X			X	3.407
		X	X		68.13
		X		X	34.07
					Threshold Effects Exposure Level TEL (ng/m³)
					N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5×10^5 $(mg/kg\text{-}day)^{-1}$
TEF = Toxicity Equivalency Factor = 0.0005

TABLE A-8

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 118 FOR THE ADULT RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Adult

$$\text{NTEL} = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		3.4067
X				X	1.7033
	X		X		34.067
	X			X	17.033
		X	X		340.67
		X		X	170.33

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year

IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.0001

TABLE A-9

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 126 FOR THE ADULT RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Adult

$$NTEL = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		0.0034
X				X	0.0017
	X		X		0.034
	X			X	0.017
		X	X		0.34
		X		X	0.17

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.1

TABLE A-10

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 169 FOR THE ADULT RESIDENT NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Resident
Receptor Age: Adult

$$\text{NTEL} = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		0.0341
X				X	0.0170
	X		X		0.341
	X			X	0.170
		X	X		3.41
		X		X	1.70
					Threshold Effects Exposure Level TEL (ng/m^3)
					N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 350 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.01

TABLE A-11

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR TOTAL PCBs FOR THE COMMERCIAL WORKER NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Commercial Worker
Receptor Age: Adult

$$\text{NTEL} = \frac{\text{TR*BW*ATc*CV}}{\text{EF*ED*IRa*CSF}}$$

Target Risk TR (Unitless)			Cancer Slope Factor CSF $(mg/kg\text{-}day)^{-1}$			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	2	0.4	0.07	5	10	
X			X			X		35.77
X			X				X	17.89
X				X		X		179
X				X			X	89.43
X					X	X		1,022
X					X		X	511
	X		X			X		358
	X		X				X	179
	X			X		X		1,789
	X			X			X	894
	X				X	X		10,220
	X				X		X	5,110
		X	X			X		3,577
		X	X				X	1,789
		X		X		X		17,885
		X		X			X	8,943
		X			X	X		102,200
		X			X		X	51,100

Threshold Effects Exposure Level TEL (ng/m^3)
50,000

NOTES:
NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 250 days/year
IR = Inhalation Rate = 20 m^3/day

TABLE A-12

NON-THRESHOLD EFFECTS EXPSOURE LIMIT RESULTS FOR CONGENER NO. 114 FOR THE COMMERCIAL WORKER NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Commercial Worker
Receptor Age: Adult

$$NTEL = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		0.9539
X				X	0.4769
	X		X		9.539
	X			X	4.769
		X	X		95.39
		X		X	47.69

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 250 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.0005

TABLE A-13

NON-THRESHOLD EFFECTS EXPOSURE LEVEL RESULTS FOR CONGENER NO. 118 FOR THE COMMERCIAL WORKER NEW BEFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Commercial Worker
Receptor Age: Adult

$$NTEL = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		4.7693
X				X	2.3847
	X		X		47.693
	X			X	23.847
		X	X		476.93
		X		X	238.47

Threshold Effects Exposure Level TEL (ng/m^3)
N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 250 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.0001

TABLE A-14

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 126 FOR THE COMMERCIAL WORKER NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Commercial Worker
Receptor Age: Adult

$$\text{NTEL} = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		0.0048
X				X	0.0024
	X		X		0.048
	X			X	0.024
		X	X		0.48
		X		X	0.24
					Threshold Effects Exposure Level TEL (ng/m^3)
					N/A

NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 250 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicity Equivalency Factor = 0.1

TABLE A-15

NON-THRESHOLD EFFECTS EXPOSURE LIMIT RESULTS FOR CONGENER NO. 169 FOR THE COMMERCIAL WORKER NEW BEDFORD HARBOR SUPERFUND SITE

Exposure Medium: Air
Exposure Point: Ambient Air
Receptor Population: Commercial Worker
Receptor Age: Adult

$$NTEL = \frac{TR*BW*ATc*CV}{EF*ED*IR*CSF*TEF}$$

Target Risk TR (unitless)			Exposure Duration ED (years)		Non-Threshold Effects Exposure Level NTEL (ng/m^3)
1.00E-06	1.00E-05	1.00E-04	5	10	
X			X		0.0477
X				X	0.0238
	X		X		0.477
	X			X	0.238
		X	X		4.77
		X		X	2.38
					Threshold Effects Exposure Level TEL (ng/m^3)
					N/A

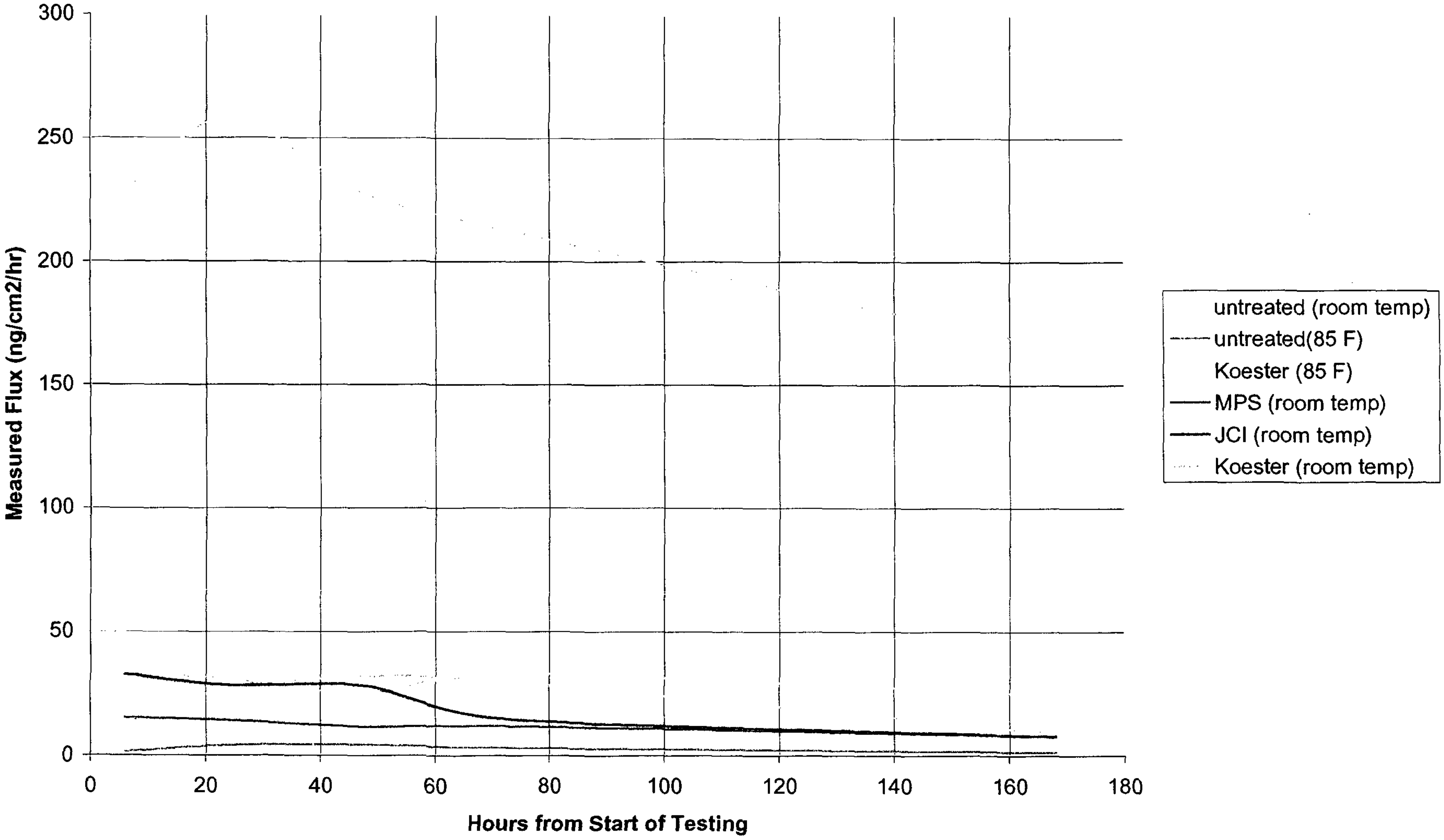
NOTES:
N/A = Not Applicable

NTEL calculated using:
BW = Body Weight = 70 kg
ATc = Averaging Time (Carcinogenic) = 25,550 days
CV = Conversion Factor = 1,000,000 ng/mg
EF = Exposure Frequency = 250 days/year
IR = Inhalation Rate = 20 m^3/day
CSF = Cancer Slope Factor for TCDD = 1.5 x 10^5 (mg/kg-day)$^{-1}$
TEF = Toxicty Equivalency Factor = 0.01

APPENDIX B

Supporting Calculations for Emissions Modeling

Figure B-1
Summary of WES Laboratory Flux Box Data for Aroclor 1242



Estimation of Potential Contribution of the Dioxin-Like PCB Congeners to Carcinogenic Risk (Child Resident Receptor - 5-Year Project Duration)

World Health Organization (WHO) Congener Number	Weight % of Total Homologues (i.e., Total PCBs)	Toxicity Equivalency Factor (TEF)	Mass Fraction of Total PCBs Weighted by Toxicity Equivalency to 2,3,7,8-TCDD	
118	0.7000	0.0001	7.0000E-07	
105	0.2000	0.0001	2.0000E-07	
114	0.0900	0.0005	4.5000E-07	
77	0.1000	0.0001	1.0000E-07	
170	0.0900		0.0	
180	0.0700		0.0	
156	0.0100	0.0005	5.0000E-08	
123	0.0100	0.0001	1.0000E-08	
169	0.0100	0.01	1.0000E-06	
167	0.0050	0.00001	5.0000E-10	
81	0.0040	0.0001	4.0000E-09	
157	0.0010	0.0005	5.0000E-09	
126	0.0002	0.1	2.0000E-07	
189	0.0050	0.0001	5.0000E-09	
Total WHO Congeners	**1.2952**		**2.7245E-06**	ng/m3
***Remaining Total PCBs (assuming* 100% total)**	**98.7048**		**0.9870**	ng/m3
TOTAL	**100.00** [100% normalized to 1 ng/m3 of Total PCBs]**	**TOTAL**	**0.9871**	ng/m3

	Calculated Risk	Averaging Time-Cancer AT-C (days)	Conversion Factor CV (ng/mg)	Exposure Frequency EF (days/year)	Cancer Slope Factor - PCBs CSF $(mg/kg\text{-}day)^{-1}$	Cancer Slope Factor - Dioxin CSF $(mg/kg\text{-}day)^{-1}$	Inhalation Rate IRc (m^3/day)	Exposure Duration EDc (years)	Body Weight BWc (kg)
Risk per ng/m3 With Dioxin-like Congeners Included =	**3.0452E-08**	25,550	1,000,000	350	0.4	150,000	8.3	5	15
Remaining Total PCB Contribution	1.4963E-08	25,550	1,000,000	350	0.4	150,000	8.3	5	15
WHO Congener Contribution	1.5489E-08	25,550	1,000,000	350	0.4	150,000	8.3	5	15
Risk per ng/m3 Without Dioxin-like Congeners Included =	**1.5160E-08**	25,550	1,000,000	350	0.4	150,000	8.3	5	15

RISK/C = RISK/ 1 ng/m3 = [MASSFRAC*CSF*IRc*EF*ED] / [CV*BWc*AT-C]

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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CHKD. BY DATE

OFS NO. DEPT. NO.

CLIENT US ACE

PROJECT DEVELOPEMENT OF AIR ACTION LEVELS

SUBJECT EMISSIONS MODELING - DREDGING - Pre - PDFT

Disturbed Water Surface

$$n = K_w \left(C_w - \cancelto{0}{C_w^*} \right)$$

$$n = K_w C_w$$

$$K_w = k_w = 19.6\, \nu_x^{2.23} D_w^{2/3}$$

$$C_w = \omega \rho_s / 1 + K_d \rho_s$$

parameters in Table 4-2

$$k_w = (19.6)(8.7\ \text{mi/hr})^{2.23} (4.6 \times 10^{-6}\ \text{cm}^2/\text{hr})^{2/3}$$

$$k_w = .675\ \text{cm/hr} = 6.75 \times 10^{-3}\ \text{m/hr}$$

$$C_w = \frac{(4.32 \times 10^{-4}\ \text{kg/kg})(0.49\ \text{kg/m}^3)}{1 + (188\ \text{m}^3/\text{kg})(0.49\ \text{kg/m}^3)}$$

$$C_w = 2.27 \times 10^{-6}\ \text{kg/m}^3$$

$$n = (6.75 \times 10^{-3})(2.27 \times 10^{-6})(60)$$

$$n = 9.19 \times 10^{-7}\ \text{kg/m}^2\,\text{hr} = \boxed{2.56 \times 10^{-10}\ \frac{\text{kg}}{\text{m}^2\,\text{sec}}}$$

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CLIENT USACE
PROJECT Development of Air Action Levels
SUBJECT EMISSIONS FROM DREDGING - Pre - PDFT

Dredge Bucket

$$n = k_g \left(C_a^* - \overset{0}{\cancel{C_a}} \right)$$

$$n = k_g C_a$$

$$\frac{k_g D}{D_a} = 2 + 0.6 \left[\frac{D v_x}{\nu} \right]^{1/2} \left[\frac{\nu}{D_a} \right]^{1/3}$$

$$C_a^* = \omega H_c / K_d$$

parameters in Table 4 - 3

$$\frac{K_g (3.66)}{3.6 \times 10^{-6}} = 2 + 0.6 \left[\frac{(3.66)(3.9)}{1.5 \times 10^{-5}} \right]^{1/2} \left[\frac{1.5 \times 10^{-5}}{3.6 \times 10^{-6}} \right]$$

$$k_g (1.02 \times 10^6) = 2 + 0.6 \left[975.5 \right] \left[1.61 \right]$$

$$k_g (1.02 \times 10^6) = 2 + 943.8$$

$$k_g = 9.27 \times 10^{-4} \text{ m/sec}$$

$$C_a^* = \frac{(4.32 \times 10^{-4})(0.0249)}{188} = 5.72 \times 10^{-8} \text{ kg/m}^3$$

$$n = (9.27 \times 10^{-4})(5.72 \times 10^{-8}) = \boxed{5.3 \times 10^{-11} \text{ kg/m}^2 \cdot \text{sec}}$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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PROJECT Development of Air Action Levels

SUBJECT Emissions from Dredging – Pre-PDFT

Surface Renewing Model

$$n = k_g\left(C_a^* - \cancel{C_a}^{\,0}\right)$$

$$\frac{k_a L}{D_a} = 0.036\left(1 - \frac{z}{D}\right)\left(\frac{D\,v_x}{\nu}\right)^{1/1.25}\left(\frac{\nu}{D_a}\right)^{1/3}$$

C_a^* same as dredge bucket

parameters in Table 4-4

$$\frac{k_g(5.16)}{3.6\times10^{-6}} = 0.036\left(1 - \frac{1}{5.16}\right)\left(\frac{(5.16)(3.9)}{1.5\times10^{-5}}\right)^{1/1.25}\left(\frac{1.5\times10^{-5}}{3.6\times10^{-6}}\right)^{1/3}$$

$k_g = 2.601\times10^{-3}$ m/sec

$C_a^* = 5.72\times10^{-8}$ kg/m³ (from dredge bucket calc)

$$n = (2.601\times10^{-3})(5.72\times10^{-8}) = \boxed{1.49\times10^{-10}\ \text{kg/m}^2\cdot\text{sec}}$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY RB DATE ____ SHEET 1 OF 1

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CLIENT USACE

PROJECT Development of Air Action Levels

SUBJECT Emissions from Open Filling

$$E = Q F C_w$$

$$F = \frac{0.033ab\left(1+0.046(T-273)\right) K_d \left[\frac{D_w}{D_{2w}}\right]^{\frac{1}{2}}}{1 + 0.033ab\left(1+0.046(T-273)\right) K_d \left[\frac{D_w}{D_{2,w}}\right]^{1/2}}$$

$$C_w = \frac{\omega \rho_s}{1+K_d \rho_s} = 2.27\times10^{-6}\ \text{kg}/\text{m}^3$$

(from dredge water surface)

parameters in Table 4-5

$F = 0.067$

$Q = 0.00065\ \text{m}^3/\text{sec}$ (from Table 4-5)

$E = (0.00065)(0.067)(2.27\times10^{-6})$

$E = 9.9\times10^{-11}\ \text{kg/sec} = \boxed{9.9\times10^{-8}\ \text{g/sec}}$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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CLIENT USACE

PROJECT Development of Air Action Levels

SUBJECT Ponded Sediment - Pre - PDFT

$$n = K_w\left(C_w - \overset{0}{\cancel{C_A^*}}\right)$$

$$n = K_w C_w$$

$$C_w = \frac{\omega \rho_s}{1 + K_d \rho_s} = 2.27 \times 10^{-6} \ \frac{kg}{m^3}$$ (from dredge water surface)

$$k_w = 19.6 \ \nu_x^{2.23} \ D_w^{2/3}$$

parameters in Table 4-6

$$k_w = 19.6 \times 3.[illegible]^{2.23} \left(4.6 \times 10^{-6}\right)^{2/3}$$

$$K_w = .675 \ cm/hr$$

$$K_w = 6.75 \times 10^{-3} \ m/hr$$

$$n = (2.27 \times 10^{-6})(6.75 \times 10^{-3})$$

$$n = 1.53 \times 10^{-8} \ kg/m^2 \cdot hr$$

$$\boxed{n = 4.26 \times 10^{-12} \ kg/m^2 \cdot sec}$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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CLIENT USACE

PROJECT Development of Air Action Levels

SUBJECT Emissions from Exposed Sediment - Pre-PDFT

$$n = \frac{\left(\frac{\omega H_c}{K_d} - \cancelto{0}{C_a}\right)}{\left[\left[\frac{\pi t}{D_{eff}\left(\frac{\varepsilon_a H_c + K_d \rho_b}{H_c}\right)}\right]\right]^{\frac{1}{2}} + \frac{1}{k_{gs}}}$$

$$D_{eff} = D_a * \frac{e_a^{10/3}}{e_T^2}$$

$$Sc = \frac{\nu}{D_a}$$

$$Re = V_x \cdot \frac{L}{\nu}$$

$$k_{a_{gs}} = 0.036 * Re^{4/5} * Sc^{1/3} * \frac{D_a}{L}$$

Parameters in Table 4-7

$$k_{a_{gs}} = 5.327 \ m/hr$$

$$n = 2.14 \times 10^{-9} \ kg/m^2 \cdot hr = 5.9 \times 10^{-13} \ kg/m^2 \cdot sec$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY TLB DATE ____ SHEET 1 OF 1

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CLIENT US ACE

PROJECT Development of Air Action Levels

SUBJECT Capped Sediment — Pre-POFT

$$n = \frac{D_{eff}}{h}\left[\frac{\omega\ H_c}{K_d} - \cancel{C_a}^{\,0}\right]$$

$$n = \frac{D_{eff}}{h}\left[\frac{\omega\ H_c}{K_d}\right]$$

$$D_{eff} = D_a * \frac{e_a^{10/3}}{e_T^{\ 2}}$$

Parameters in Table 2-?

$$D_{eff} = (3.6 \times 10^{-6})\left[\frac{.3^{10/3}}{.7^{2}}\right]$$

$$D_{eff} = 1.33 \times 10^{-7}\ m^2/sec$$

$$r = \left[\frac{1.33 \times 10^{-7}}{0.155}\right]\left[\frac{(2.22 \times 10^{-4})(0.0249)}{188}\right]$$

$$\boxed{n = 4.61 \times 10^{-14}\ kg/m^2 \cdot sec}$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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CLIENT USACE

PROJECT Development of Air Action Levels

SUBJECT [illegible] Sediment - Post - PDFT

$$n = K_w \left(C_w - \overset{\overset{0}{\Delta}}{\cancel{C_w^{*}}} \right)$$

$$n = K_w C_w$$

$K_w = 6.6 \times 10^{-3}$ m/hr (from previous calcs)

$C_w = 4.02$ ug/m^3 $= 4.02 \times 10^{-6}$ kg/m^3
(from flux box measurements)

$$n = (6.6 \times 10^{-3} \text{ m/hr})(4.02 \times 10^{-6})$$

$$n = 2.7 \times 10^{-8} \frac{\text{kg}}{\text{m}^2 \cdot \text{hr}} * \frac{1000\text{g}}{\text{kg}} * \frac{10^9 \text{ng}}{\text{g}} * \frac{\text{hr}}{60\text{min}}$$

$$n = 450 \text{ ng/m}^2 \text{ min}$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

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CLIENT USACE

PROJECT Development of Air Action Levels

SUBJECT Dredging - Post - PDFT

$$n = k_w (C_w - C_w^{**})$$

$$n = k_w C_w$$

$k_w = 6.6 \times 10^{-3}$ m/hr (previously calculated)

$C_w = 14.3\ \mu g/m^3 = 1.43 \times 10^{-5}\ kg/m^3$
(from flux box measurements)

$$n = (6.75 \times 10^{-3})(1.43 \times 10^{-5})$$

$$n = 9.65 \times 10^{-8}\ kg/m^2 \cdot hr = 1.6 \times 10^{3}\ ng/m^2\,min$$

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY TLB/DS DATE ______ SHEET 1 OF 2
CHKD. BY ______ DATE ______ OFS NO. ______ DEPT. NO. ______
CLIENT USACE
PROJECT Development of Air Action Levels
SUBJECT Emissions from Oil Sheen - Post - PDFT

$$E = K C_L$$

$$K = k_g K_{eq}$$

$$K_{eq} = \frac{P^* \rho_a MW_{oil}}{C_L MW_a P_o}$$

$$k_g = 4.83 \times 10^{-3} u^{0.78} Sc_G^{-0.67} d_e^{-0.11}$$

In order to estimate the concentration of PCBs in the oil phase (C_L), we can use the test results to back calculate a value for C_L.

During testing $F \stackrel{\sim}{=} 2500$ ng/m^2·min

Assume that $C_L = 2230$ mg/l (there were several iterations to arrive @ this value)
$= 2230$ g/m^3

$$E = K \cdot 2230$$

Using other parameters in table 4-12 except windspeed which was <u>0.1 m/sec</u> in the flux box during testing.

$$k_{eq} = \frac{(5.7 \times 10^{-6})(1.17 \times 10^{-3})(240)}{(\ 1\ )(28.8)(1)}$$

$$K_{eq} = 5.56 \times 10^{-8}$$

$$k_g = (4.83 \times 10^{-3})(0.1)^{.78}(4.18)^{-.67}(0.41)^{-0.11}$$

$$k_g = 3.39 \times 10^{-4} \text{ m/sec}$$

NOTE: Area of flux box was 0.13 m^2 so $d_e = 0.41$ m

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BY TLB/DS DATE

SHEET 2 OF 2

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CLIENT USACE

PROJECT Development of Air Action Levels

SUBJECT Emissions from Oil Sheen - Post PDFT

Used as $C_L = 2230$.

$$E = (3.39 \times 10^{-4})(5.56 \times 10^{-8})(2230)$$

$$E = 4.2 \times 10^{-8}\ g/m^2 \cdot sec * \frac{10^9 ng}{g} * \frac{60 sec}{min}$$

$$E \simeq 2520\ ng/m^2 \cdot min$$

This corresponds to flux on testing

$\therefore$ $C_L = 2230$ is a reasonable estimate of conc. of PCBs in oil phase.

Now we can calculate the emission flux from the oil sheen with site specific parameters:

ie. $\Rightarrow$ $u = 8.7\ mi/hr = 3.9\ m/sec$

area of sheen = 45 ft * 45 ft = 2000 ft^2

$d_e = 13.7\ m$

$K_{eg} = 5.56 \times 10^{-8}$ (from previous calculation)

$$k_g = (4.83 \times 10^{-3})(3.9)^{.78}(4.18)^{-.67}(13.7)^{-.11}$$

$$k_g = 4.01 \times 10^{-3}$$

$$E = K_{eg} K_g C_L = (5.56 \times 10^{-8})(4.01 \times 10^{-3})(2230)$$

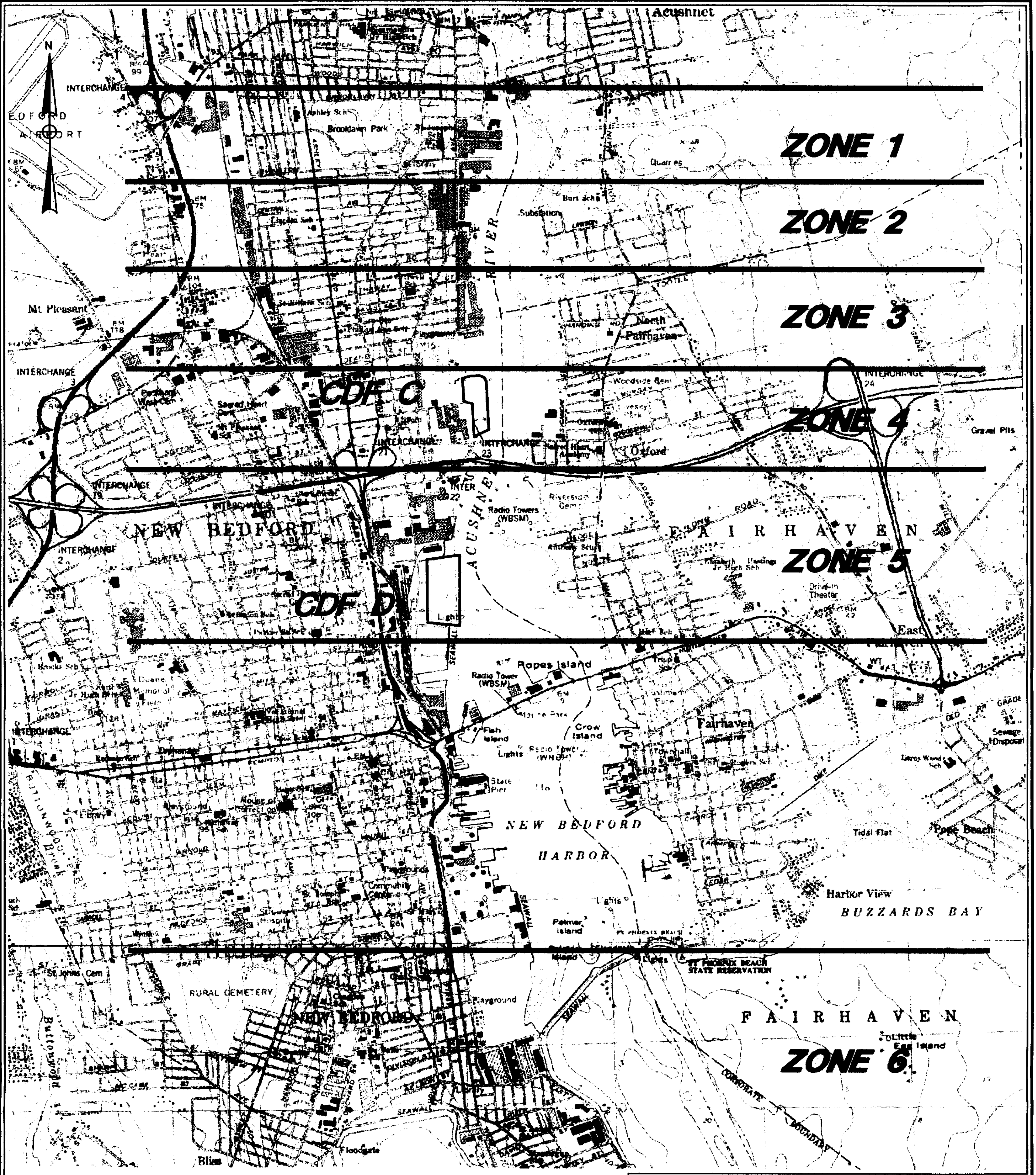
$$E = 4.98 \times 10^{-7}\ g/m^2 \cdot sec * \frac{10^9 ng}{g} * \frac{60 sec}{min}$$

$$E \simeq 29,800\ ng/m^2 \cdot min$$

FWENC 581D 10/96

APPENDIX C

Dredging Zone Locations



Originals in color.

FIGURE C-1

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

LOCATIONS OF ZONES

FOSTER WHEELER ENVIRONMENTAL CORPORATION
NEW ENGLAND TERC

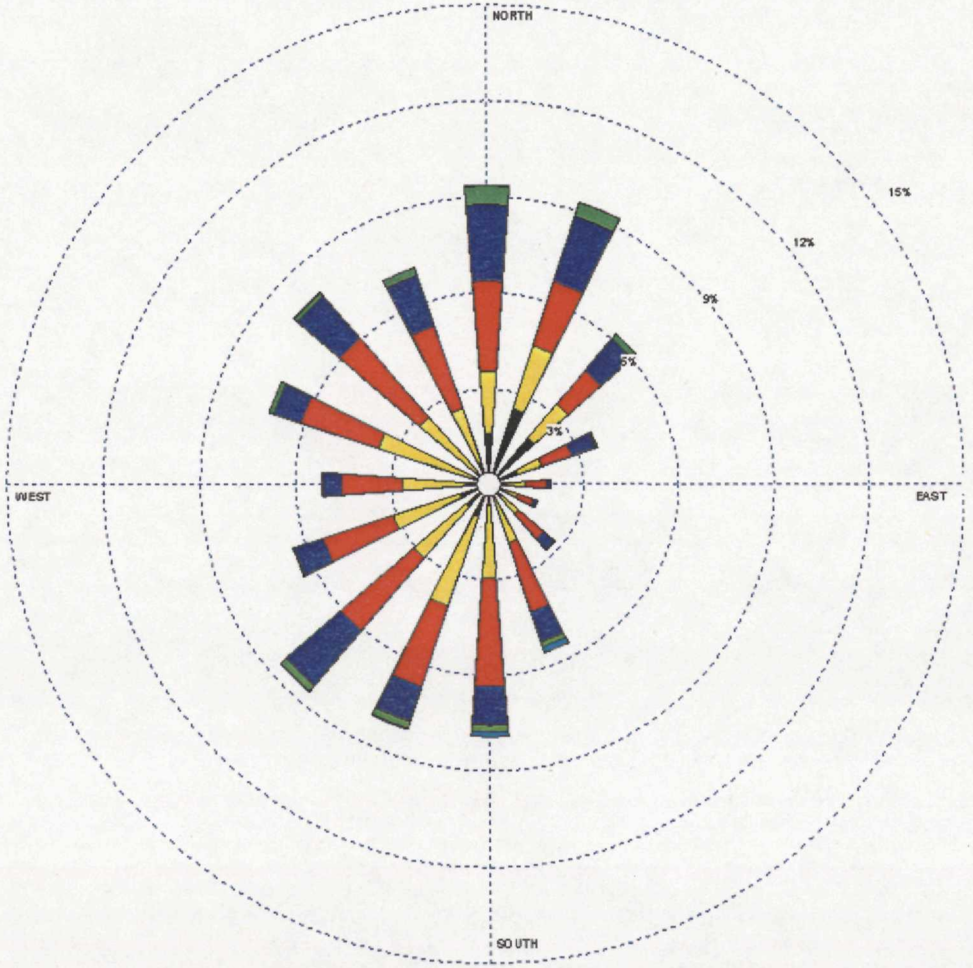
CADDFILE: AIR_SAMP_06.DWG

APPENDIX D

Windroses

WIND ROSE PLOT

New Bedford Superfund Site 1999 On-Site Meteorological Data - Wind Speed



COMMENTS

PLOT YEAR-DATE-TIME
1999
Jan 1 - Dec 31
Midnight - 11 PM

ORIENTATION
Direction (blowing from)

DISPLAY
Wind Speed

UNIT
Knots

CALM WINDS
1.09%

AVG. WIND SPEED
7.71 Knots

DATE
4/19/01

Wind Speed (Knots)

🟦 >21
🟩 17 - 21
🟦 11 - 16
🟥 7 - 10
🟨 4 - 6
⬛ 1 - 3

MODELER
J. Tsun

COMPANY NAME
FWENC

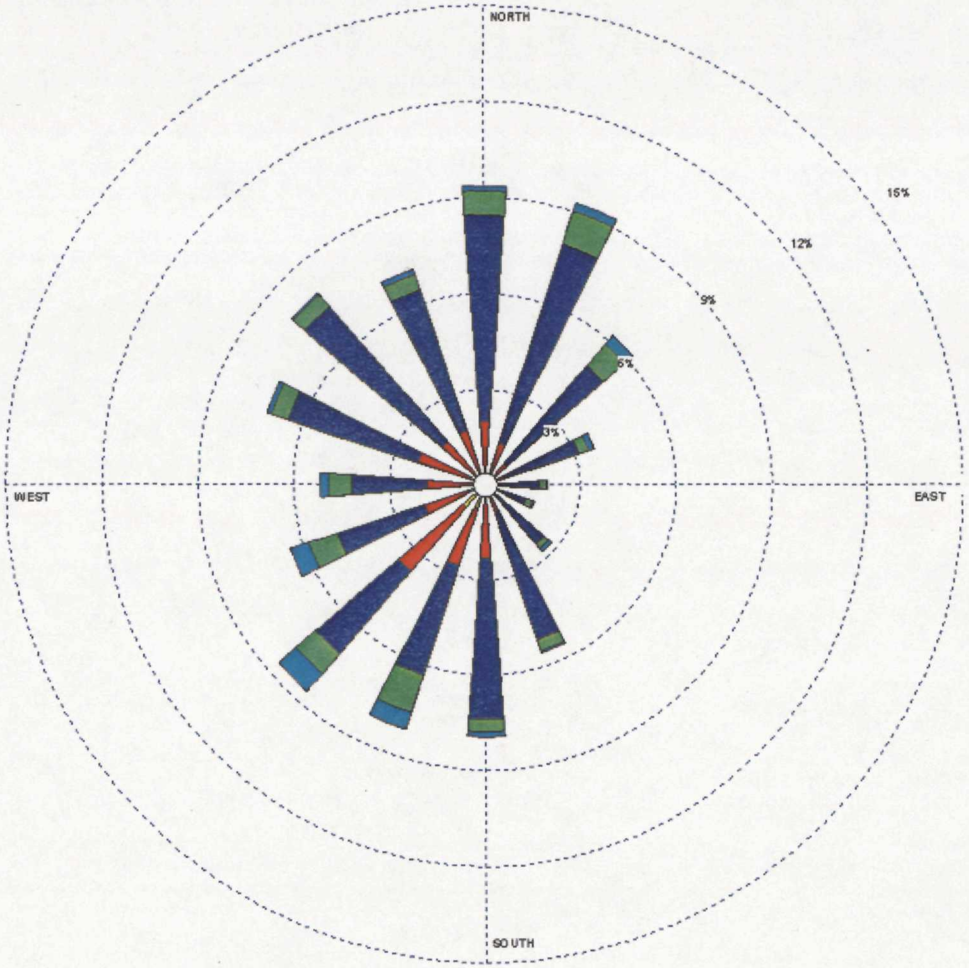
PROJECT/PLOT NO.
5197.1712.0191.10310

WRPLOT View 3.15 by Lakes Environmental Software - www.lakes-environmental.com

NOTE: The wind directions are based on magnetic north which is 15.5° CCW from True North.

WIND ROSE PLOT

New Bedford Superfund Site 1999 On-Site Meteorological Data - Stability Class



COMMENTS

PLOT YEAR-DATE-TIME
1999
Jan 1 - Dec 31
Midnight - 11 PM

ORIENTATION
Direction
(blowing from)

DISPLAY
Stability Classes

UNIT
N/A

CALM WINDS
1.09%

AVG. WIND SPEED
7.71 Knots

DATE
4/19/01

Stability Class
🟦 F
🟩 E
🟦 D
🟥 C
🟨 B
⬛ A

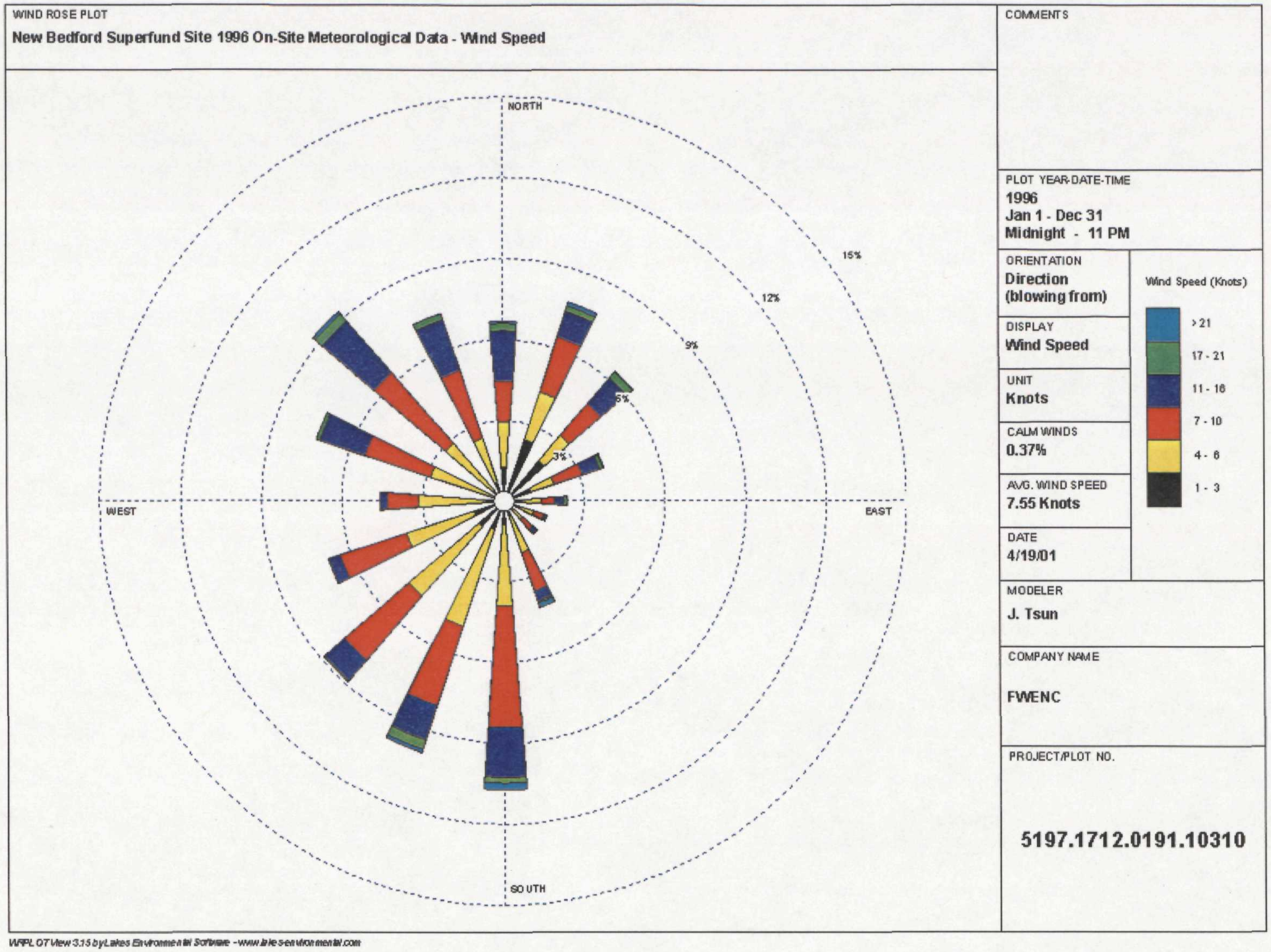
MODELER
J. Tsun

COMPANY NAME
FWENC

PROJECT/PLOT NO.
5197.1712.0191.10310

WRPLOT View 3.15 by Lakes Environmental Software - www.lakes-environmental.com

NOTE: The wind directions are based on magnetic north which is 15.5° CCW from True North.



WIND ROSE PLOT

New Bedford Superfund Site 1996 On-Site Meteorological Data - Wind Speed

COMMENTS

PLOT YEAR-DATE-TIME

1996
Jan 1 - Dec 31
Midnight - 11 PM

ORIENTATION

Direction (blowing from)

DISPLAY

Wind Speed

UNIT

Knots

CALM WINDS

0.37%

AVG. WIND SPEED

7.55 Knots

DATE

4/19/01

Wind Speed (Knots)

- 🟦 >21
- 🟩 17 - 21
- 🟦 11 - 16
- 🟥 7 - 10
- 🟨 4 - 6
- ⬛ 1 - 3

MODELER

J. Tsun

COMPANY NAME

FWENC

PROJECT/PLOT NO.

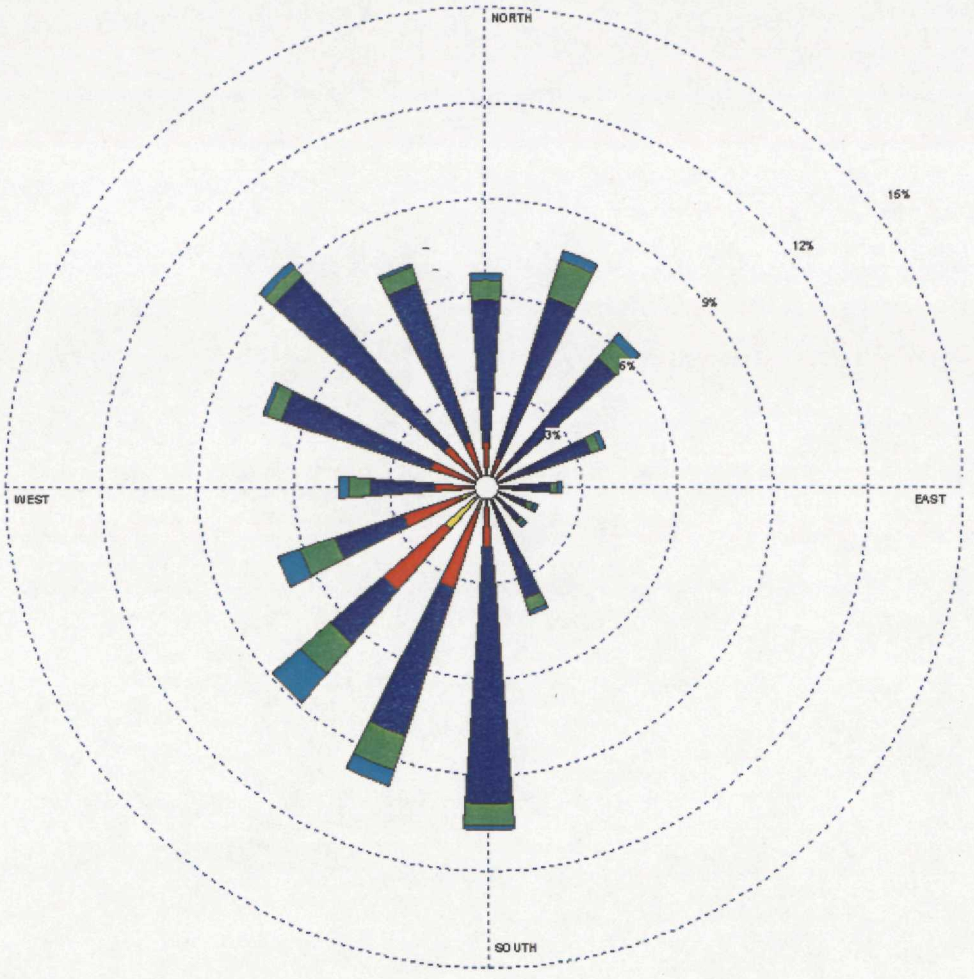
5197.1712.0191.10310

WRPLOT View 3.15 by Lakes Environmental Software - www.lakes-environmental.com

NOTE: The wind directions are based on magnetic north which is 15.5° CCW from True North.

WIND ROSE PLOT

New Bedford Superfund Site 1996 On-Site Meteorological Data - Stability Class



COMMENTS

PLOT YEAR-DATE-TIME
1996
Jan 1 - Dec 31
Midnight - 11 PM

ORIENTATION
Direction
(blowing from)

DISPLAY
Stability Classes

UNIT
N/A

CALM WINDS
0.37%

AVG. WIND SPEED
7.55 Knots

DATE
4/19/01

Stability Class

🟦	F
🟩	E
🟦	D
🟥	C
🟨	B
⬛	A

MODELER
J. Tsun

COMPANY NAME
FWENC

PROJECT/PLOT NO.
5197.1712.0191.10310

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

NOTE: The wind directions are based on magnetic north which is 15.5° CCW from True North.

APPENDIX E

Receptor Locations for Dispersion Modeling

LEGEND:

⌖ REPRESENTATIVE RECEPTOR LOCATIONS

R = RESIDENTIAL LOCATION
C = COMMERCIAL LOCATION
S = SCHOOL LOCATION

△ HYPOTHETICAL CDF MONITORING STATION LOCATION

FIGURE E-1

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

LOCATIONS OF
DISCRETE RECEPTORS FOR
AIR DISPERSION MODELING

FOSTER WHEELER ENVIRONMENTAL CORPORATION
NEW ENGLAND TERC

CADDFILE: AIR_SAMP_02.DWG

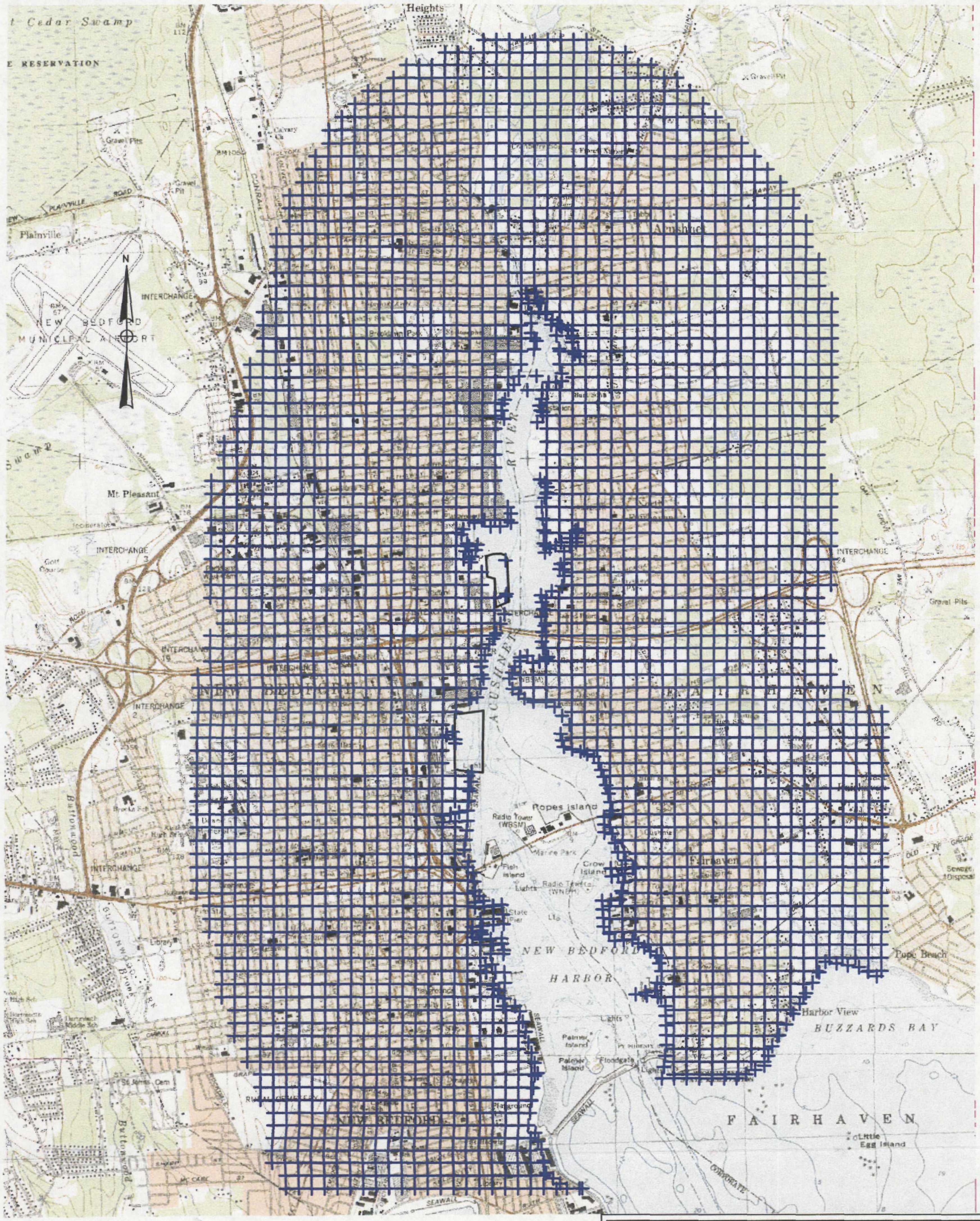


FIGURE E-2

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

LOCATION OF RECEPTOR GRID

FOSTER WHEELER ENVIRONMENTAL CORPORATION
NEW ENGLAND TERC

CADDFILE: AIR_SAMP_07.DWG

LOCATIONS OF INTEREST	RECEPTORS		
	Receptor ID	UTM - East (m)	UTM - North (m)
Residential	R1	340,729.0	4,615,970.0
	R2	340,829.0	4,615,570.0
	R3	340,229.0	4,615,670.0
	R4	339,929.0	4,614,470.0
	R5	340,829.0	4,614,370.0
	R6	340,026.0	4,614,034.0
	R7	340,017.0	4,615,150.0
	R8	339,717.0	4,613,331.0
	R9	339,922.0	4,613,123.0
	R10	340,821.0	4,613,530.0
	R11	340,821.0	4,613,308.0
	R12	339,829.0	4,612,907.0
	R13	339,653.0	4,612,787.0
	R14	339,317.0	4,612,216.0
	R15	339,525.0	4,611,308.0
	R16	341,068.0	4,611,732.0
	R17	341,146.0	4,612,012.0
	R18	340,829.0	4,612,325.0
	R19	340,610.0	4,612,532.0
Schools	S1	340,994.0	4,613,123.0
	S2	341,227.0	4,611,755.0
Commercial	C1	340,368.0	4,615,610.0
	C2	340,129.0	4,615,370.0
	C3	340,329.0	4,615,270.0
	C4	340,229.0	4,615,270.0
	C5	340,207.0	4,615,128.0
	C6	339,929.0	4,614,870.0
	C7	340,729.0	4,614,970.0
	C8	340,029.0	4,614,770.0
	C9	340,108.0	4,614,508.0
	C10	340,150.0	4,613,998.0
	C11	339,968.0	4,613,442.0
	C12	340,040.0	4,613,302.0
	C13	340,729.0	4,613,570.0
	C14	340,659.0	4,613,387.0
	C15	340,480.0	4,613,325.0
	C16	339,816.0	4,612,725.0
	C17	339,601.0	4,612,517.0
	C18	339,714.0	4,612,120.0
	C19	339,683.0	4,611,735.0
	C20	339,842.0	4,611,409.0
	C21	339,875.0	4,611,283.0
	C22	340,071.0	4,611,270.0
	C23	340,472.0	4,611,472.0
	C24	341,035.0	4,611,533.0
	C25	340,987.0	4,611,985.0
CDF C Monitors	North Monitor	340,121.2	4,613,610.5
	South Monitor	340,198.0	4,613,225.0
	East Monitor	340,225.0	4,613,470.0
	West Monitor	340,122.2	4,613,427.5
CDF D Monitors	North Monitor	339,939.0	4,612,364.5
	South Monitor	339,935.0	4,611,906.0
	East Monitor	340,044.6	4,612,162.5
	West Monitor	339,829.4	4,612,161.5

APPENDIX F

Source Parameters for Dispersion Modeling

New Bedford Harbor Air Dispersion Model Setup[1]

Year	Months	%	Dredge Operations			Activity @			
			Location	Source (Type)		CDF C	Source Type	CDF D	Source Type
1	1-3	25.0%	Zone 1	Grizzly (Point)	Moon Pool (area)	Fill	Point	None	
	4-9	50.0%	Zone 1	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
	10-12	25.0%	Zone 2	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
2	1-7	58.3%	Zone 2	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
	8-12	41.7%	Zone 3	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
3	1-2	16.7%	Zone 3	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
	3-9	58.3%	Zone 4	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
	10-12	25.0%	Zone 5	Grizzly (Point)	Moon Pool (area)	Cure	Area	Fill	Point
4			None			Cure	Area	Cure	Area

Note:

1 - 2 dredges will be operating at one time for years 1, 2 and 3.

Modeling Scenarios

Model Input Parameters for Annual Emissions

Yr	Zone	Sources	Source Type	Emissions			UTM		Point Source Parameters			Area Source Parameters		
				ug/min	g/s	g/m2-s	X (m)	Y (m)	Temp (oK)	Vel (m/s)	Dia (m)	Rel Ht (m)	X (m)	Y (m)
1	1	Dredging	Point	9.20	1.53E-07		340,524.0	4,615,299.0	288	0.03	1.0			
	2	Dredging	Point	2.50	4.17E-08		340,331.0	4,614,649.0	288	0.03	1.0			
	1	Moon Pool	Area			6.02E-09	340,524.0	4,615,299.0					13.00	13.00
	2	Moon Pool	Area			1.64E-09	340,331.0	4,614,649.0					13.00	13.00
		CDFC Sheen	Area			3.80E-08	340,175.0	4,613,466.0				2.0	13.63	13.63
		CDFC Near Sheen	Area			2.07E-08	340,175.0	4,613,466.0				2.0	14.30	14.30
		CDFD Sheen	Area			1.07E-07	339,937.0	4,612,150.0				2.0	13.63	13.63
		CDFD Near Sheen	Area			5.84E-08	339,937.0	4,612,150.0				2.0	14.30	14.30
		CDFC Ponded	Areapoly			3.97E-09	340,198.0	4,613,226.0				2.0		
							340,240.0	4,613,355.0						
							340,209.0	4,613,597.0						
							340,173.0	4,613,608.0						
							340,136.0	4,613,610.0						
							340,060.0	4,613,600.0						
		CDFD Ponded	Areapoly			2.79E-09	339,827.0	4,611,910.0				2.0		
							339,835.0	4,612,359.0						
							340,043.0	4,612,367.0						
							340,046.0	4,611,904.0						

Modeling Inputs - Year 1

Model Input Parameters for Annual Emissions

Yr	Zone	Sources	Source Type	Emissions			UTM		Point Source Parameters			Area Source Parameters		
							X	Y	Temp	Vel	Dia	Rel Ht	X	Y
				ug/min	g/s	g/m2-s	(m)	(m)	(oK)	(m/s)	(m)	(m)	(m)	(m)
2	2	Dredging	Point	5.84	9.73E-08		340,331.0	4,614,649.0	288	0.03	1.0			
	3	Dredging	Point	1.27	2.12E-08		340,379.0	4,614,046.0	288	0.03	1.0			
	2	Moon Pool	Area			3.83E-09	340,331.0	4,614,649.0					13.00	13.00
	3	Moon Pool	Area			8.31E-10	340,379.0	4,614,046.0					13.00	13.00
		CDFC Sheen	Area			0.00E+00	340,175.0	4,613,466.0				2.0	13.63	13.63
		CDFC Near Sheen	Area			0.00E+00	340,175.0	4,613,466.0				2.0	14.30	14.30
		CDFD Sheen	Area			1.08E-07	339,937.0	4,612,150.0				2.0	13.63	13.63
		CDFD Near Sheen	Area			5.89E-08	339,937.0	4,612,150.0				2.0	14.30	14.30
		CDFC Ponded	Areapoly			3.97E-09	340,198.0	4,613,226.0				2.0		
							340,240.0	4,613,355.0						
							340,209.0	4,613,597.0						
							340,173.0	4,613,608.0						
							340,136.0	4,613,610.0						
							340,060.0	4,613,600.0						
		CDFD Ponded	Areapoly			2.82E-09	339,827.0	4,611,910.0				2.0		
							339,835.0	4,612,359.0						
							340,043.0	4,612,367.0						
							340,046.0	4,611,904.0						

Modeling Inputs - Year 2

Model Input Parameters for Annual Emissions

Yr	Zone	Sources	Source Type	Emissions			UTM		Point Source Parameters			Area Source Parameters		
				ug/min	g/s	g/m2-s	X (m)	Y (m)	Temp (oK)	Vel (m/s)	Dia (m)	Rel Ht (m)	X (m)	Y (m)
3	3	Dredging	Point	0.51	8.50E-09		340,379.0	4,614,046.0	288	0.03	1.0			
	4	Dredging	Point	0.61	1.02E-08		340,375.0	4,613,417.0	288	0.03	1.0			
	5	Dredging	Point	0.31	5.17E-09		340,189.0	4,612,435.0	288	0.03	1.0			
	6	Dredging	Point	0.15	2.48E-09		341,018.0	4,609,158.0	288	0.03	1.0			
	3	Moon Pool	Area			3.32E-10	340,379.0	4,614,046.0					13.00	13.00
	4	Moon Pool	Area			4.02E-10	340,375.0	4,613,417.0					13.00	13.00
	5	Moon Pool	Area			2.01E-10	340,189.0	4,612,435.0					13.00	13.00
	6	Moon Pool	Area			9.73E-11	341,018.0	4,609,158.0					13.00	13.00
		CDFC Sheen	Area			0.00E+00	340,175.0	4,613,466.0				2.0	13.63	13.63
		CDFC Near Sheen	Area			0.00E+00	340,175.0	4,613,466.0				2.0	14.30	14.30
		CDFD Sheen	Area			7.16E-08	339,937.0	4,612,150.0				2.0	13.63	13.63
		CDFD Near Sheen	Area			3.91E-08	339,937.0	4,612,150.0				2.0	14.30	14.30
		CDFC Ponded	Areapoly			3.97E-09	340,198.0	4,613,226.0				2.0		
							340,240.0	4,613,355.0						
							340,209.0	4,613,597.0						
							340,173.0	4,613,608.0						
							340,136.0	4,613,610.0						
							340,060.0	4,613,600.0						
		CDFD Ponded	Areapoly			1.87E-09	339,827.0	4,611,910.0				2.0		
							339,835.0	4,612,359.0						
							340,043.0	4,612,367.0						
							340,046.0	4,611,904.0						

Modeling Inputs - Year 3

Model Input Parameters for Annual Emissions

Yr	Zone	Sources	Source Type	Emissions			UTM		Point Source Parameters			Area Source Parameters		
							X (m)	Y (m)	Temp (oK)	Vel (m/s)	Dia (m)	Rel Ht (m)	X (m)	Y (m)
				ug/min	g/s	g/m2-s								
4		CDFC Ponded	Areapoly			3.97E-09	340,198.0	4,613,226.0				2.0		
							340,240.0	4,613,355.0						
							340,209.0	4,613,597.0						
							340,173.0	4,613,608.0						
							340,136.0	4,613,610.0						
							340,060.0	4,613,600.0						
		CDFD Ponded	Areapoly			1.87E-09	339,827.0	4,611,910.0				2.0		
							339,835.0	4,612,359.0						
							340,043.0	4,612,367.0						
							340,046.0	4,611,904.0						

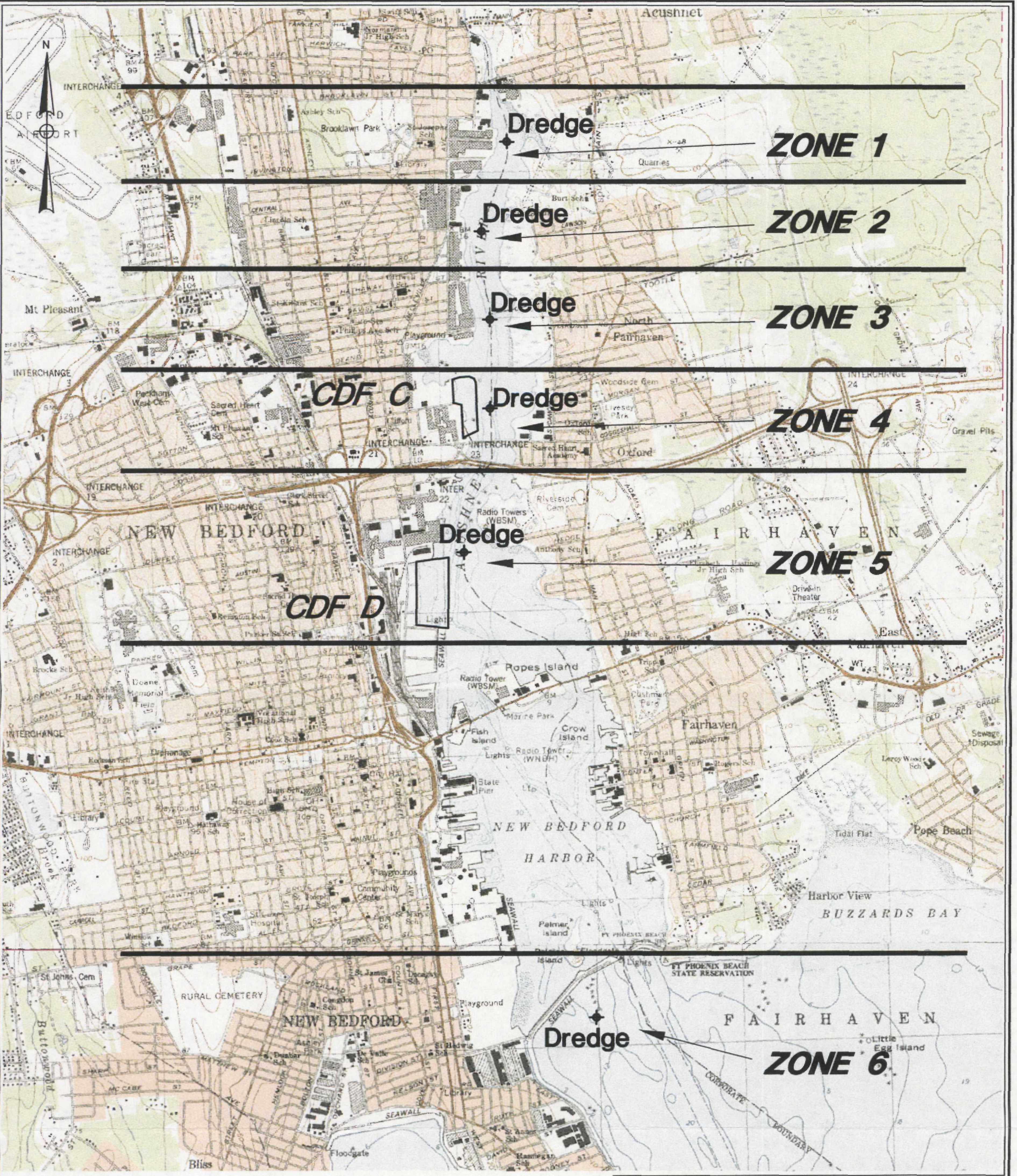


FIGURE F-1

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

LOCATIONS OF SOURCES

FOSTER WHEELER ENVIRONMENTAL CORPORATION
NEW ENGLAND TERC

CADDFILE: AIR_SAMP_05.DWG

APPENDIX G

Tabulated Modeling Results

Predicted Annual Emissions for Year 1 Redmedial Activities in Zone 1 and 2 - 1996 MET Data

Rural Dispersion Coefficient

Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)	Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)
CDFC Near Sheen	CDFCNS	1.216	340,225.03	4,613,470.00	0.615	340,213.50	4,613,559.50
CDFC Ponded	CDFCP	18.301	340,225.03	4,613,470.00	16.872	340,213.50	4,613,559.50
CDFC Sheen	CDFCS	1.941	340,225.03	4,613,470.00	0.992	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.853	340,044.63	4,612,162.50	0.404	339,831.34	4,612,127.00
CDFD Ponded	CDFDP	18.446	339,714.00	4,612,120.00	14.818	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	1.372	340,044.63	4,612,162.50	0.662	339,831.34	4,612,127.00
Dredging Zone 1	DRGZ1	0.002	340,329.00	4,615,270.00	0.030	340,561.31	4,615,372.50
Dredging Zone 2	DRGZ2	0.000	340,108.00	4,614,508.00	0.003	340,455.00	4,614,620.00
Moon Pool Zone 1	MOONZ1	0.013	340,329.00	4,615,270.00	0.295	340,561.31	4,615,372.50
Moon Pool Zone 2	MOONZ2	0.003	340,108.00	4,614,508.00	0.020	340,455.00	4,614,620.00
CDFC - Near Sheen, Sheen and Ponded	CDFC	21.458	340,225.03	4,613,470.00	18.479	340,213.50	4,613,559.50
CDFD - Near Sheen, Sheen and Ponded	CDFD	20.671	340,044.63	4,612,162.50	15.617	339,831.34	4,612,127.00
Dredge Zone 1 - Dredging and Moon Pool	DZ1T	0.015	340,329.00	4,615,270.00	0.325	340,561.31	4,615,372.50
Dredge Zone 2 - Dredging and Moon Pool	DZ2T	0.004	340,108.00	4,614,508.00	0.022	340,455.00	4,614,620.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	21.907	340,225.03	4,613,470.00	18.903	340,213.50	4,613,559.50

Urban Dispersion Coefficient

Sources		Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)	Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)
CDFC Near Sheen	CDFCNS	0.717	340,225.03	4,613,470.00	0.288	340,225.03	4,613,470.00
CDFC Ponded	CDFCP	11.707	340,225.03	4,613,470.00	10.963	340,225.03	4,613,470.00
CDFC Sheen	CDFCS	1.140	340,225.03	4,613,470.00	0.463	340,225.03	4,613,470.00
CDFD Near Sheen	CDFDNS	0.365	340,044.63	4,612,162.50	0.159	340,044.63	4,612,162.50
CDFD Ponded	CDFDP	10.134	340,044.63	4,612,162.50	7.827	340,044.63	4,612,162.50
CDFD Sheen	CDFDS	0.586	340,044.63	4,612,162.50	0.260	340,044.63	4,612,162.50
Dredging Zone 1	DRGZ1	0.007	340,329.00	4,615,270.00	0.012	340,329.00	4,615,270.00
Dredging Zone 2	DRGZ2	0.002	340,108.00	4,614,508.00	0.001	340,455.00	4,614,620.00
Moon Pool Zone 1	MOONZ1	0.005	340,329.00	4,615,270.00	0.107	340,329.00	4,615,270.00
Moon Pool Zone 2	MOONZ2	0.001	340,108.00	4,614,508.00	0.007	340,455.00	4,614,620.00
CDFC - Near Sheen, Sheen and Ponded	CDFC	13.564	340,225.03	4,613,470.00	11.714	340,225.03	4,613,470.00
CDFD - Near Sheen, Sheen and Ponded	CDFD	11.085	340,044.63	4,612,162.50	8.120	340,044.63	4,612,162.50
Dredge Zone 1 - Dredging and Moon Pool	DZ1T	0.005	340,329.00	4,615,270.00	0.119	340,329.00	4,615,270.00
Dredge Zone 2 - Dredging and Moon Pool	DZ2T	0.001	340,108.00	4,614,508.00	0.008	340,455.00	4,614,620.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	13.707	340,225.03	4,613,470.00	11.843	340,225.03	4,613,470.00

Months 1-3: Dredging Zone 1, Fill CDFC
Months 4-9: Dredging Zone 1, Cure CDFC and Fill CDFD
Months 10-12: Dredging Zone 2, Cure CDFC and Fill CDFD

Predicted Annual Emissions for Year 1 Redmedial Activities in Zone 1 and 2 - 1999 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted	UTM		Predicted	UTM	
		Conc	X	Y	Conc	X	Y
		(ng/m^3)	(m)	(m)	(ng/m^3)	(m)	(m)
CDFC Near Sheen	CDFCNS	1.265	340,225.03	4,613,470.00	0.567	340,213.50	4,613,559.50
CDFC Ponded	CDFCP	17.609	340,225.03	4,613,470.00	15.681	340,213.50	4,613,559.50
CDFC Sheen	CDFCS	2.005	340,225.03	4,613,470.00	0.916	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.834	340,044.63	4,612,162.50	0.362	339,830.06	4,612,159.00
CDFD Ponded	CDFDP	17.929	340,044.63	4,612,162.50	15.780	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	1.342	340,044.63	4,612,162.50	0.591	339,830.06	4,612,159.00
Dredging Zone 1	DRGZ1	0.002	340,368.00	4,615,610.00	0.025	340,561.31	4,615,372.50
Dredging Zone 2	DRGZ2	0.000	340,108.00	4,614,508.00	0.003	340,455.00	4,614,620.00
Moon Pool Zone 1	MOONZ1	0.017	340,368.00	4,615,610.00	0.245	340,561.31	4,615,372.50
Moon Pool Zone 2	MOONZ2	0.003	340,108.00	4,614,508.00	0.022	340,455.00	4,614,620.00
CDFC - Near Sheen, Sheen and Ponded	CDFC	20.879	340,225.03	4,613,470.00	17.164	340,213.50	4,613,559.50
CDFD - Near Sheen, Sheen and Ponded	CDFD	20.105	340,044.63	4,612,162.50	16.652	339,958.00	4,611,900.00
Dredge Zone 1 - Dredging and Moon Pool	DZ1T	0.019	340,368.00	4,615,610.00	0.269	340,561.31	4,615,372.50
Dredge Zone 2 - Dredging and Moon Pool	DZ2T	0.004	340,108.00	4,614,508.00	0.025	340,455.00	4,614,620.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	21.245	340,225.03	4,613,470.00	17.496	340,213.50	4,613,559.50

Urban Dispersion Coefficient							
Sources		Discrete Receptors			Master Grid		
		Predicted	UTM		Predicted	UTM	
		Conc	X	Y	Conc	X	Y
		(ng/m^3)	(m)	(m)	(ng/m^3)	(m)	(m)
CDFC Near Sheen	CDFCNS	0.768	340,225.03	4,613,470.00	0.243	340,213.50	4,613,559.50
CDFC Ponded	CDFCP	11.246	340,225.03	4,613,470.00	10.287	340,213.50	4,613,559.50
CDFC Sheen	CDFCS	1.218	340,225.03	4,613,470.00	0.390	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.375	340,044.63	4,612,162.50	0.140	339,831.34	4,612,127.00
CDFD Ponded	CDFDP	9.818	340,044.63	4,612,162.50	8.300	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	0.603	340,044.63	4,612,162.50	0.228	339,831.34	4,612,127.00
Dredging Zone 1	DRGZ1	0.001	340,329.00	4,615,270.00	0.010	340,561.50	4,615,372.50
Dredging Zone 2	DRGZ2	0.000	340,108.00	4,614,508.00	0.001	340,455.00	4,614,620.00
Moon Pool Zone 1	MOONZ1	0.004	340,329.00	4,615,270.00	0.089	340,561.50	4,615,372.50
Moon Pool Zone 2	MOONZ2	0.001	340,108.00	4,614,508.00	0.008	340,455.00	4,614,620.00
CDFC - Near Sheen, Sheen and Ponded	CDFC	13.232	340,225.03	4,613,470.00	10.920	340,213.50	4,613,559.50
CDFD - Near Sheen, Sheen and Ponded	CDFD	10.796	340,044.63	4,612,162.50	8.591	339,958.00	4,611,900.00
Dredge Zone 1 - Dredging and Moon Pool	DZ1T	0.004	340,329.00	4,615,270.00	0.099	340,561.50	4,615,372.50
Dredge Zone 2 - Dredging and Moon Pool	DZ2T	0.001	340,108.00	4,614,508.00	0.009	340,455.00	4,614,620.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	13.359	340,225.03	4,613,470.00	11.036	340,213.50	4,613,559.50

Months 1-3: Dredging Zone 1, Fill CDFC
Months 4-9: Dredging Zone 1, Cure CDFC and Fill CDFD
Months 10-12: Dredging Zone 2, Cure CDFC and Fill CDFD

Predicted Annual Emissions for Year 2 Redmedial Activities in Zone 2 and 3 - 1996 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM		Predicted Conc (ng/m^3)	UTM	
			X (m)	Y (m)		X (m)	Y (m)
CDFC Ponded = CDFC	CDFCP	18.301	340,225.03	4,613,470.00	16.872	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.860	340,044.63	4,612,162.50	0.408	339,831.34	4,612,127.00
CDFD Ponded	CDFDP	18.644	340,044.63	4,612,162.50	14.978	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	1.385	340,044.63	4,612,162.50	0.668	339,831.34	4,612,127.00
Dredging Zone 2	DRGZ2	0.001	340,108.00	4,614,508.00	0.006	340,455.00	4,614,620.00
Dredging Zone 3	DRGZ3	0.000	340,150.00	4,613,998.00	0.001	340,493.00	4,613,970.00
Moon Pool Zone 2	MOONZ2	0.008	340,108.00	4,614,508.00	0.046	340,455.00	4,614,620.00
Moon Pool Zone 3	MOONZ3	0.001	340,150.00	4,613,998.00	0.009	340,493.00	4,613,970.00
CDFD - Near Sheen, Sheen and Ponded	CDFD	20.839	340,044.63	4,612,162.50	15.784	339,958.00	4,611,900.00
Dredge Zone 2 - Dredging and Moon Pool	DZ2T	0.009	340,108.00	4,614,508.00	0.052	340,455.00	4,614,620.00
Dredge Zone 3 - Dredging and Moon Pool	DZ3T	0.002	340,150.00	4,613,998.00	0.010	340,493.00	4,613,970.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	21.145	340,044.63	4,612,162.50	17.302	340,213.50	4,613,559.50

Months 1-7: Dredging Zone 2, Cure CDFC and Fill CDFD
Months 8-12: Dredging Zone 3, Cure CDFC and Fill CDFD

Predicted Annual Emissions for Year 2 Redmedial Activities in Zone 2 and 3 - 1999 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM		Predicted Conc (ng/m^3)	UTM	
			X (m)	Y (m)		X (m)	Y (m)
CDFC Ponded = CDFC	CDFCP	17.609	340,225.03	4,613,470.00	15.681	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.841	340,044.63	4,612,162.50	0.365	339,830.06	4,612,159.00
CDFD Ponded	CDFDP	18.122	340,044.63	4,612,162.50	15.950	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	1.354	340,044.63	4,612,162.50	0.596	339,830.06	4,612,159.00
Dredging Zone 2	DRGZ2	0.001	340,108.00	4,614,508.00	0.007	340,455.00	4,614,620.00
Dredging Zone 3	DRGZ3	0.000	340,044.63	4,612,162.50	0.001	340,493.00	4,613,970.00
Moon Pool Zone 2	MOONZ2	0.008	340,108.00	4,614,508.00	0.052	340,455.00	4,614,620.00
Moon Pool Zone 3	MOONZ3	0.001	340,044.63	4,612,162.50	0.009	340,516.00	4,614,040.00
CDFD - Near Sheen, Sheen and Ponded	CDFD	20.317	340,044.63	4,612,162.50	16.829	339,958.00	4,611,900.00
Dredge Zone 2 - Dredging and Moon Pool	DZ2T	0.009	340,108.00	4,614,508.00	0.059	340,455.00	4,614,620.00
Dredge Zone 3 - Dredging and Moon Pool	DZ3T	0.001	340,044.63	4,612,162.50	0.010	340,516.00	4,614,040.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	20.576	340,044.63	4,612,162.50	17.038	339,958.00	4,611,900.00

Months 1-7: Dredging Zone 2, Cure CDFC and Fill CDFD

Months 8-12: Dredging Zone 3, Cure CDFC and Fill CDFD

Predicted Annual Emissions for Year 3 Redmedial Activities in Zone 3, 4, 5 and 6 - 1996 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)	Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)
CDFC Ponded = CDFC	CDFCP	18.301	340,225.03	4,613,470.00	16.873	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.571	340,044.63	4,612,162.50	0.271	339,831.34	4,612,127.00
CDFD Ponded	CDFDP	12.363	340,044.63	4,612,162.50	9.932	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	0.918	340,044.63	4,612,162.50	0.443	339,831.34	4,612,127.00
CDFD - Near Sheen, Sheen and Ponded	CDFD	13.853	340,044.63	4,612,162.50	10.467	339,958.00	4,611,900.00
Dredging Zone 3	DRGZ3	0.000	340,150.00	4,613,998.00	0.001	340,493.00	4,613,970.00
Dredging Zone 4	DRGZ4	0.001	340,480.00	4,613,325.00	0.000	340,490.00	4,613,290.00
Dredging Zone 5	DRGZ5	0.000	340,044.63	4,612,162.50	0.000	340,265.00	4,612,560.00
Dredging Zone 6	DRGZ6	0.000	341,035.00	4,611,533.00	0.000	340,829.00	4,608,670.00
Moon Pool Zone 3	MOOMZ3	0.001	340,150.00	4,613,998.00	0.004	340,493.00	4,613,970.00
Moon Pool Zone 4	MOONZ4	0.004	340,480.00	4,613,325.00	0.003	340,490.00	4,613,290.00
Moon Pool Zone 5	MOONZ5	0.001	340,044.63	4,612,162.50	0.003	340,265.00	4,612,560.00
Moon Pool Zone 6	MOONZ6	0.000	341,035.00	4,611,533.00	0.000	340,829.00	4,608,670.00
Dredge Zone 3 - Dredging and Moon Pool	DZ3T	0.001	340,150.00	4,613,998.00	0.004	340,493.00	4,613,970.00
Dredge Zone 4 - Dredging and Moon Pool	DZ4T	0.004	340,480.00	4,613,325.00	0.003	340,490.00	4,613,290.00
Dredge Zone 5 - Dredging and Moon Pool	DZ5T	0.000	340,044.63	4,612,162.50	0.003	340,265.00	4,612,560.00
Dredge Zone 6 - Dredging and Moon Pool	DZ6T	0.000	341,035.00	4,611,533.00	0.000	340,829.00	4,608,670.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	18.603	340,225.03	4,613,470.00	17.157	340,213.50	4,613,559.50

Months 1-2: Dredging Zone 3, Cure CDFC and Fill CDFD
Months 3-9: Dredging Zone 4, Cure CDFC and Fill CDFD
Months 10-12: Dredging Zone 5 and 6, Cure CDFC and Fill CDFD

Predicted Annual Emissions for Year 3 Redmedial Activities in Zone 3, 4, 5 and 6 - 1999 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)	Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)
CDFC Ponded = CDFC	CDFCP	17.609	340,225.03	4,613,470.00	15.681	340,213.50	4,613,559.50
CDFD Near Sheen	CDFDNS	0.558	340,044.63	4,612,162.50	0.242	339,830.06	4,612,159.00
CDFD Ponded	CDFDP	12.017	340,044.63	4,612,162.50	10.577	339,958.00	4,611,900.00
CDFD Sheen	CDFDS	0.898	340,044.63	4,612,162.50	0.395	339,830.06	4,612,159.00
CDFD - Near Sheen, Sheen and Ponded	CDFD	13.473	340,044.63	4,612,162.50	11.160	339,958.00	4,611,900.00
Dredging Zone 3	DRGZ3	0.000	340,044.63	4,612,162.50	0.000	339,830.06	4,612,159.00
Dredging Zone 4	DRGZ4	0.001	340,480.00	4,613,325.00	0.000	340,490.00	4,613,290.00
Dredging Zone 5	DRGZ5	0.000	340,044.63	4,612,162.50	0.000	340,265.00	4,612,560.00
Dredging Zone 6	DRGZ6	0.000	339,875.00	4,611,283.00	0.000	340,905.41	4,608,671.00
Moon Pool Zone 3	MOOMZ3	0.001	340,225.03	4,613,470.00	0.004	340,516.00	4,614,040.00
Moon Pool Zone 4	MOONZ4	0.004	340,480.00	4,613,325.00	0.003	340,490.00	4,613,290.00
Moon Pool Zone 5	MOONZ5	0.001	340,044.63	4,612,162.50	0.002	340,265.00	4,612,560.00
Moon Pool Zone 6	MOONZ6	0.000	339,875.00	4,611,283.00	0.000	340,905.41	4,608,671.00
Dredge Zone 3 - Dredging and Moon Pool	DZ3T	0.001	340,225.03	4,613,470.00	0.004	340,516.00	4,614,040.00
Dredge Zone 4 - Dredging and Moon Pool	DZ4T	0.004	340,480.00	4,613,325.00	0.003	340,490.00	4,613,290.00
Dredge Zone 5 - Dredging and Moon Pool	DZ5T	0.001	340,044.63	4,612,162.50	0.003	340,265.00	4,612,560.00
Dredge Zone 6 - Dredging and Moon Pool	DZ6T	0.000	339,875.00	4,611,283.00	0.000	340,905.41	4,608,671.00
ALL - CDFC, CDFD, Dredging & Moon Pool	ALL	15.164	340,225.03	4,613,470.00	15.903	340,213.50	4,613,559.50

Months 1-2: Dredging Zone 3, Cure CDFC and Fill CDFD
Months 3-9: Dredging Zone 4, Cure CDFC and Fill CDFD
Months 10-12: Dredging Zone 5 and 6, Cure CDFC and Fill CDFD

Predicted Annual Emissions for Year 4 Redmedial Activities - 1996 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM		Predicted Conc (ng/m^3)	UTM	
			X (m)	Y (m)		X (m)	Y (m)
CDFC - Ponded	CDFCP	18.301	340,225.03	4,613,470.00	16.872	340,213.50	4,613,559.50
CDFD - Ponded	CDFD	12.363	340,044.63	4,612,162.50	9.932	339,958.00	4,611,900.00
ALL - CDFC and CDFD	ALL	18.569	340,225.03	4,613,470.00	17.124	340,213.50	4,613,559.50

Months 1-12: Cure CDFC and CDFD

Predicted Annual Emissions for Year 4 Redmedial Activities - 1999 MET Data

Rural Dispersion Coefficient							
Sources	Model Source ID	Discrete Receptors			Master Grid		
		Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)	Predicted Conc (ng/m^3)	UTM X (m)	UTM Y (m)
CDFC - Ponded	CDFCP	17.609	340,225.03	4,613,470.00	15.681	340,213.50	4,613,559.50
CDFD - Ponded	CDFD	12.017	340,044.63	4,612,162.50	10.577	339,958.00	4,611,900.00
ALL - CDFC and CDFD	ALL	17.828	340,225.03	4,613,470.00	15.879	340,213.50	4,613,559.50

Months 1-12: Cure CDFC and CDFD

APPENDIX H

Cumulative Exposure Budget - Figures

Figure H-1

Levels of Airborne PCBs and Periods of Inhalation Exposure Associated with Adverse Human Health Effects and Reference Benchmark Concentrations

(A through G refer to the studies listed in Table 6-1)

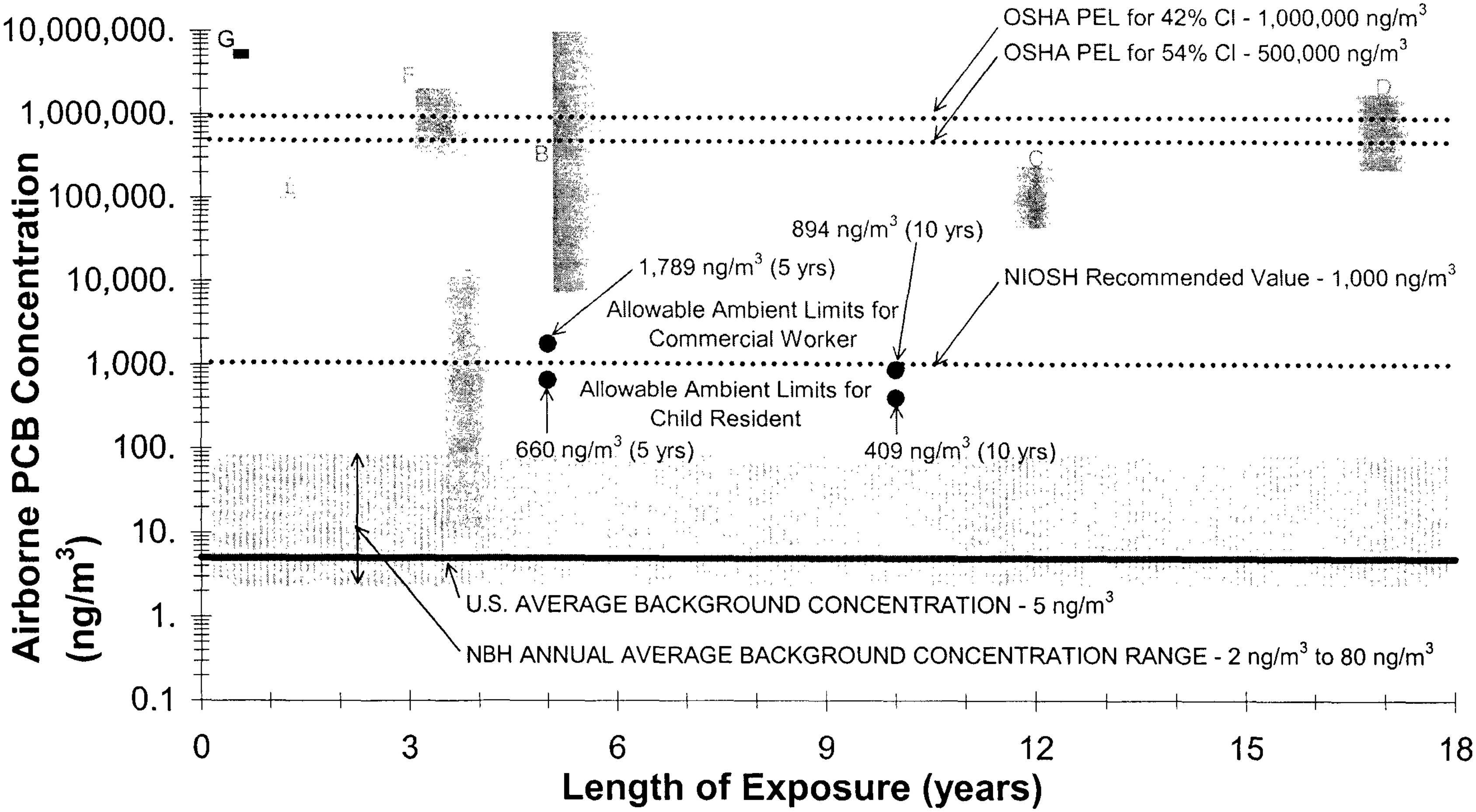
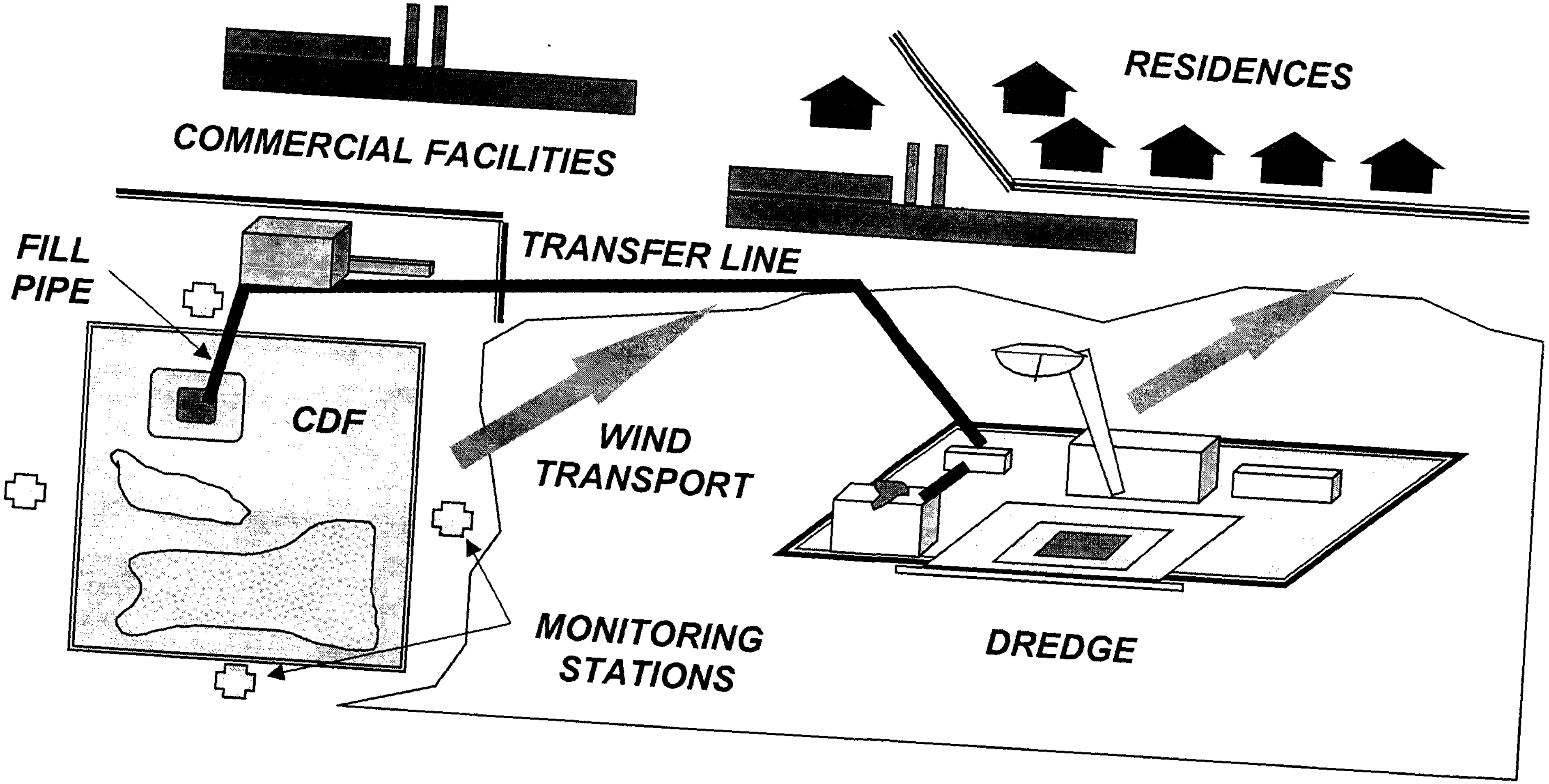


Figure H-2
Conceptual Site Model for Potential PCB Inhalation Exposures
from Sediment Remediation Operations



LEGEND:

⌖ REPRESENTATIVE RECEPTOR LOCATIONS
R = RESIDENTIAL LOCATION
C = COMMERCIAL LOCATION
S = SCHOOL LOCATION

△ HYPOTHETICAL CDF MONITORING STATION LOCATION

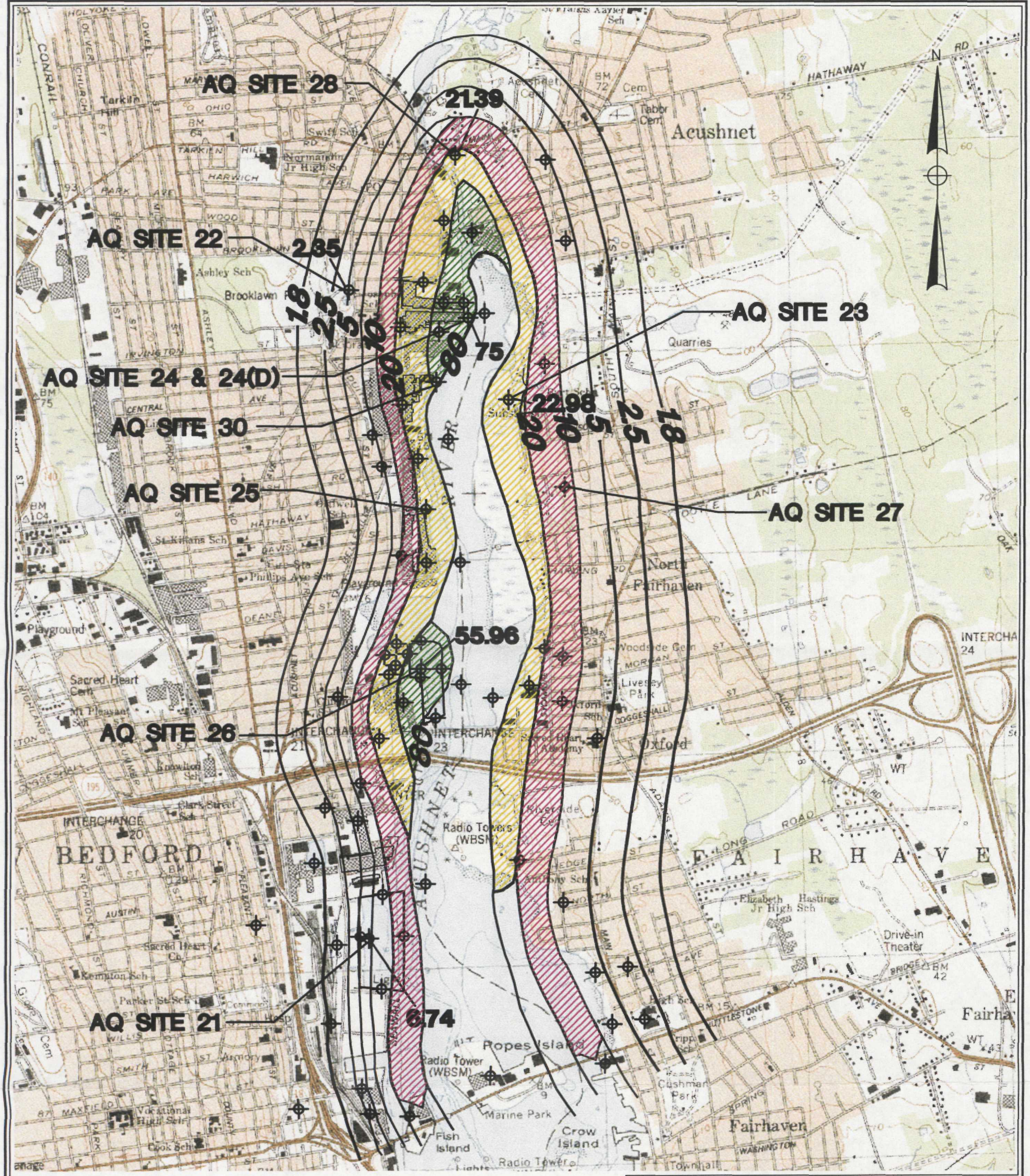
CADDFILE: AIR_SAMP_02.DWG

FIGURE H-3

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

REPRESENTATIVE RECEPTORS IN THE VICINITY OF NEW BEDFORD HARBOR

FOSTER WHEELER ENVIRONMENTAL CORPORATION
NEW ENGLAND TERC



LEGEND:

- 🟩 40–80 (ng/m³)
- 🟨 20–40 (ng/m³)
- 🟥 10–20 (ng/m³)

FIGURE H-4

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

ANNUAL AVERAGE TOTAL PCB BACKGROUND CONCENTRATIONS (ng/m³) FOR THE NEW BEDFORD HARBOR AREA

FOSTER WHEELER ENVIRONMENTAL CORPORATION
NEW ENGLAND TERC

CADDFILE: AIR_SAMP_03.DWG

APPENDIX I

Cumulative Exposure Budget - Curves

Figure I-1
Example Cumulative Exposure Budget For a Hypothetical Monitoring Station

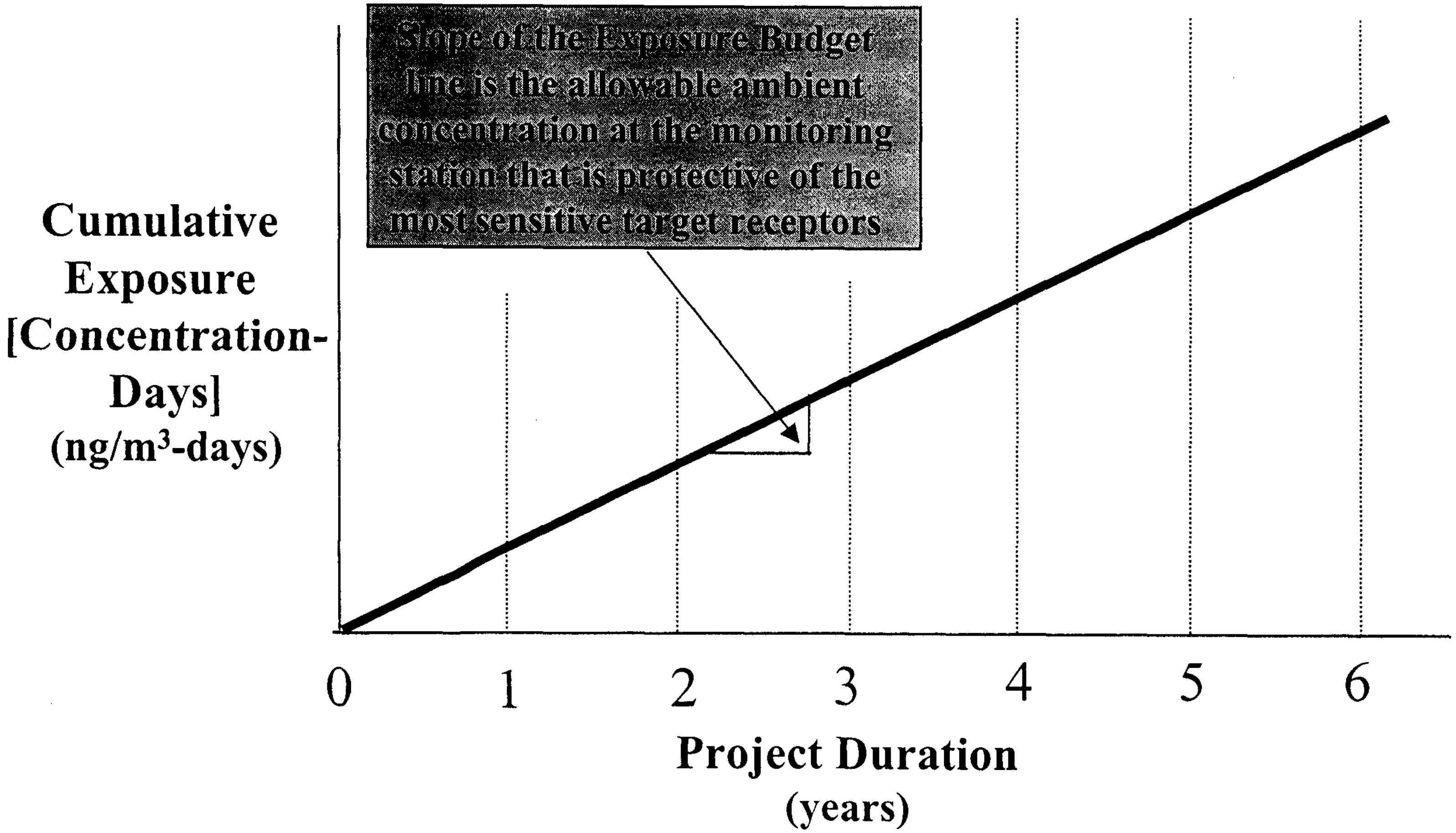
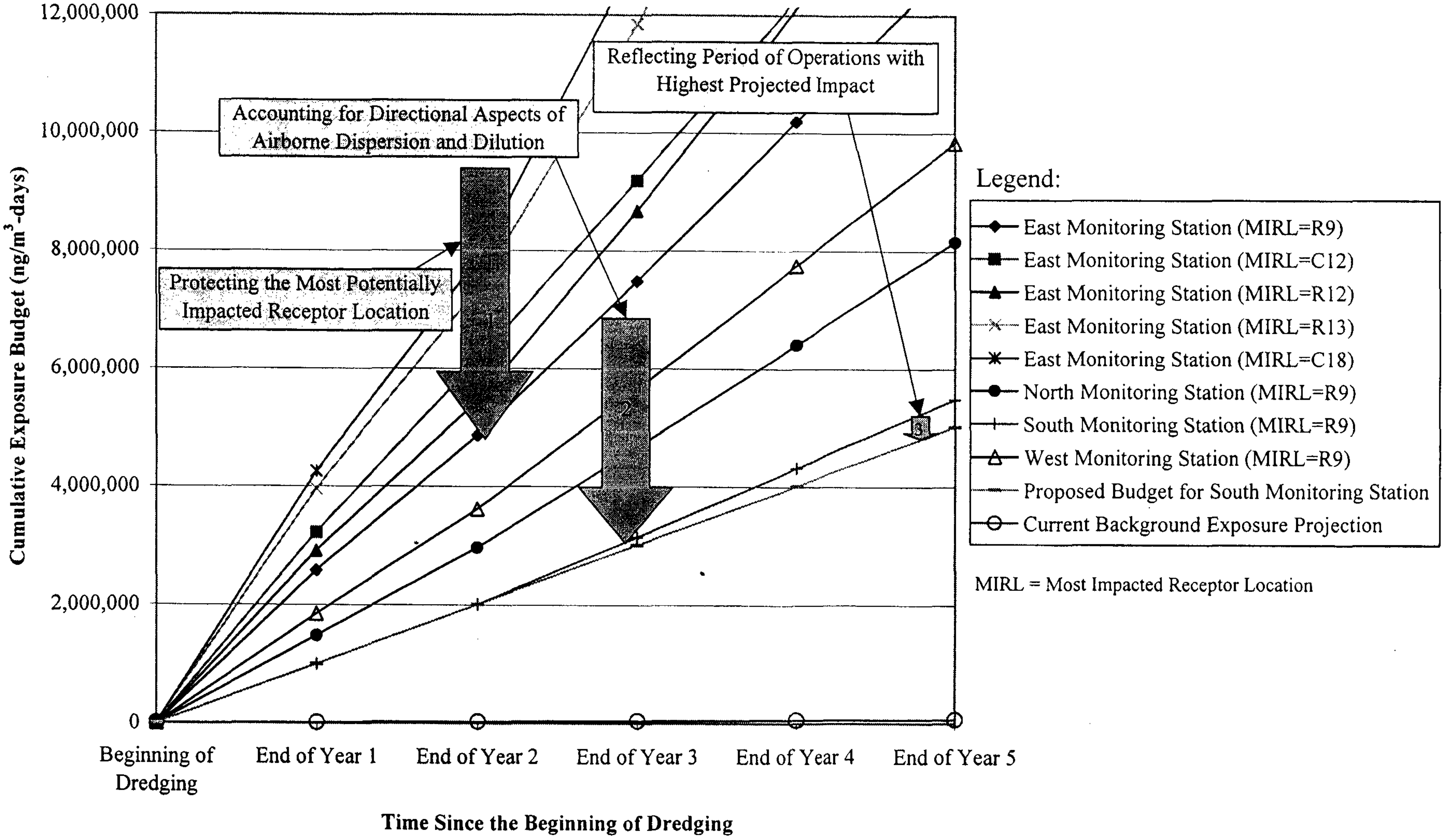


Figure I-2

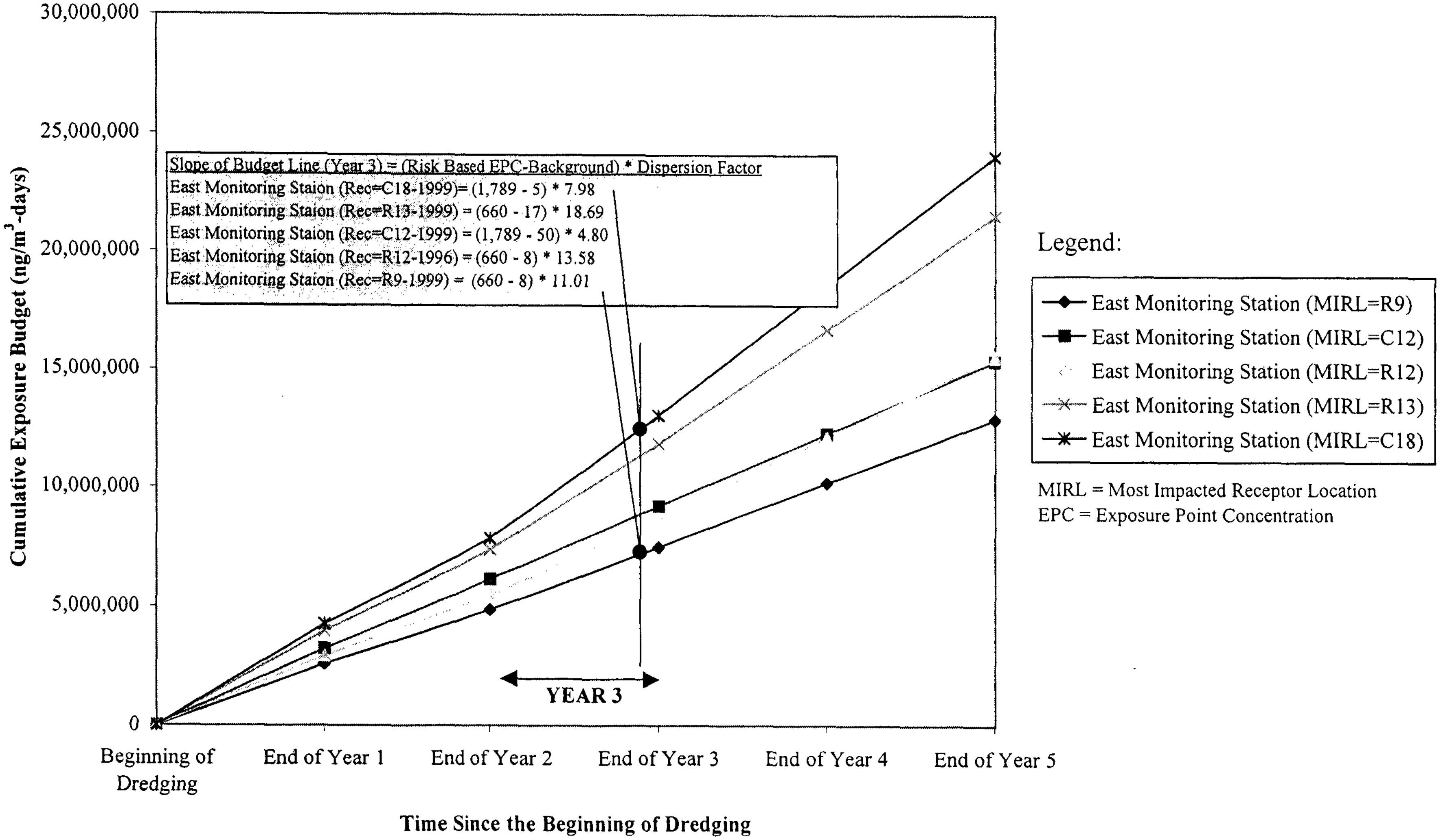
Establishing the Exposure Budgets for the CDF C Monitoring Stations: Three Principal Assumptions and Considerations

(Total PCBs, 5-Year Project Duration, 1996 Site-Specific Meteorology)



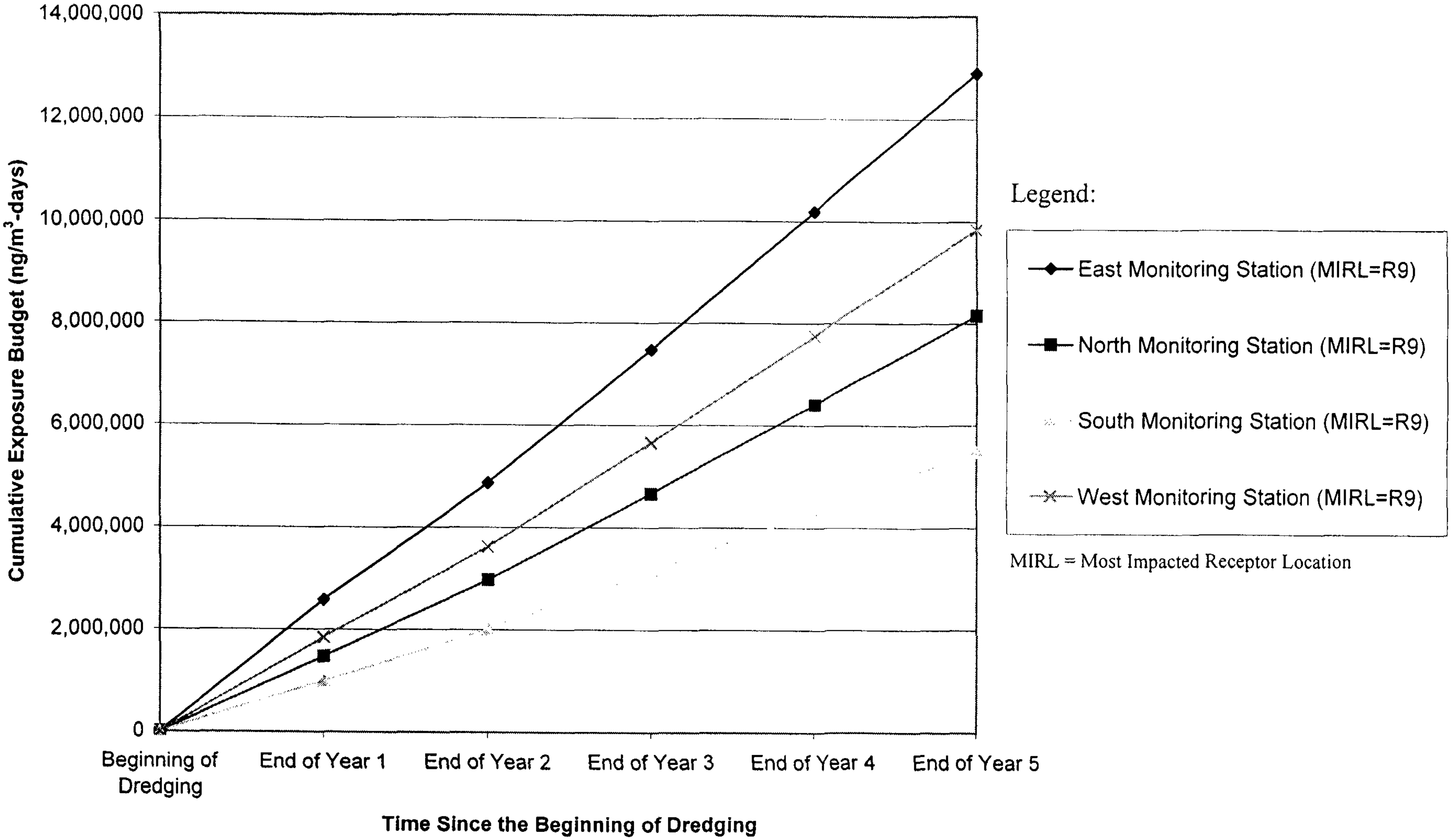
1996 and 1999 Total PCBs CDF C-5 yr
3 sequential assump

Figure I-3
First Assumption for Protectiveness:
Identifiying the Most Potentially Impacted Receptor Location Relative to the Monitoring Station
(CDF C, East Monitoring Station, Total PCBs, 5-Year Project Duration, 1996 Meteorology)



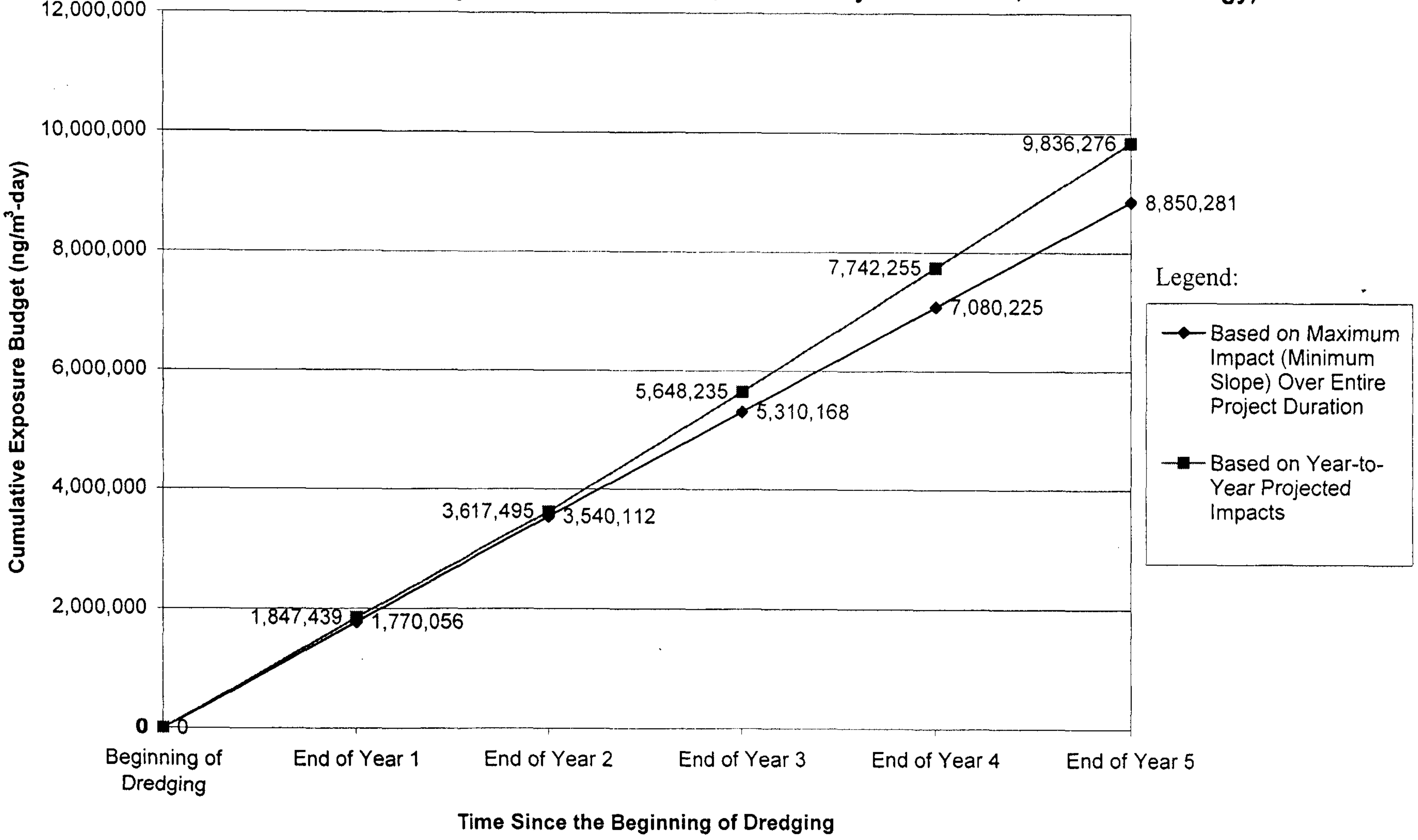
1996 and 1999 Total PCBs CDF C-5 yr
First Assumption chart

Figure I-4
Second Assumption for Protectiveness:
Accounting for Directional Aspects of Airborne Dispersion and Dilution
(CDF C, Four Monitoring Stations, Total PCBs, 5-Year Project Duration, 1996 Meteorology)



1996 and 1999 Total PCBs CDF C-5 yr
Second Assumption

Figure I-5
Third Assumption for Protectiveness:
Reflecting Period of Operations with Highest Projected Impact
(CDF C, West Monitoring Station, Total PCBs, 5-Year Project Duration, 1996 Meteorology)



1996 and 1999 Total PCBs CDF C-5 yr

Figure I-6

Proposed Exposure Budgets for the CDF C Monitoring Stations Oriented to the Four Primary Compass Points (N-S-E-W) (Total PCBs, 5-Year Project Duration)

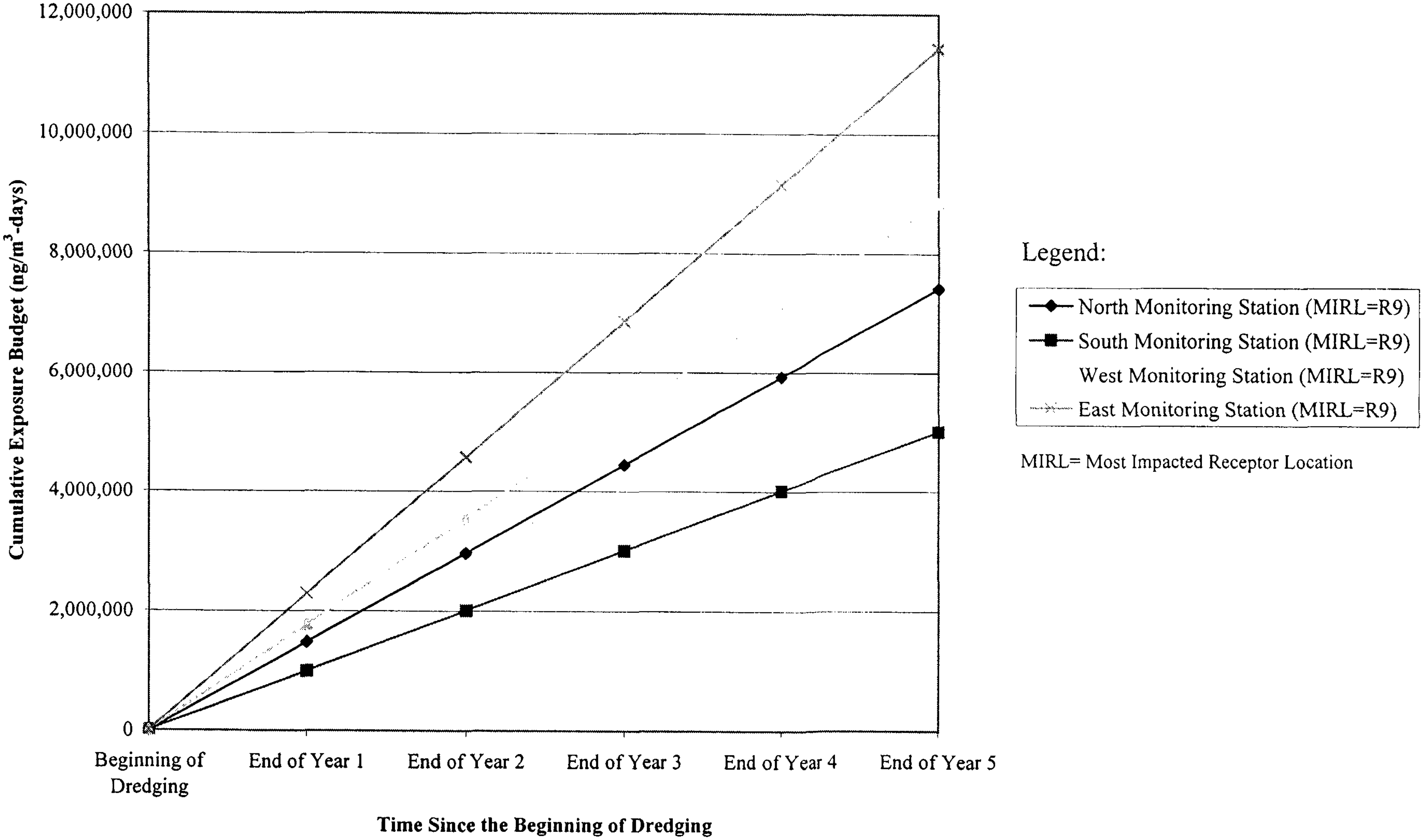
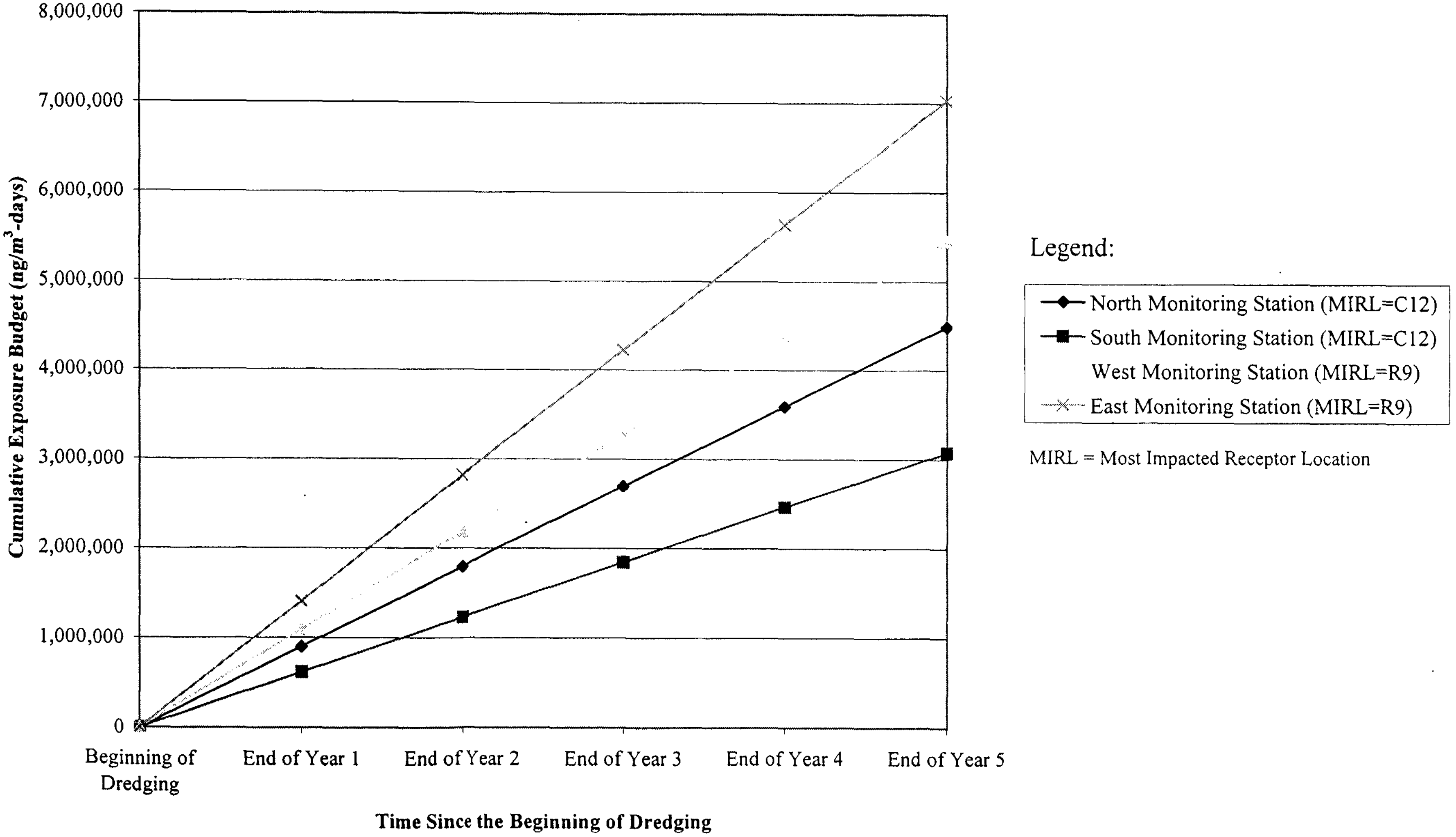
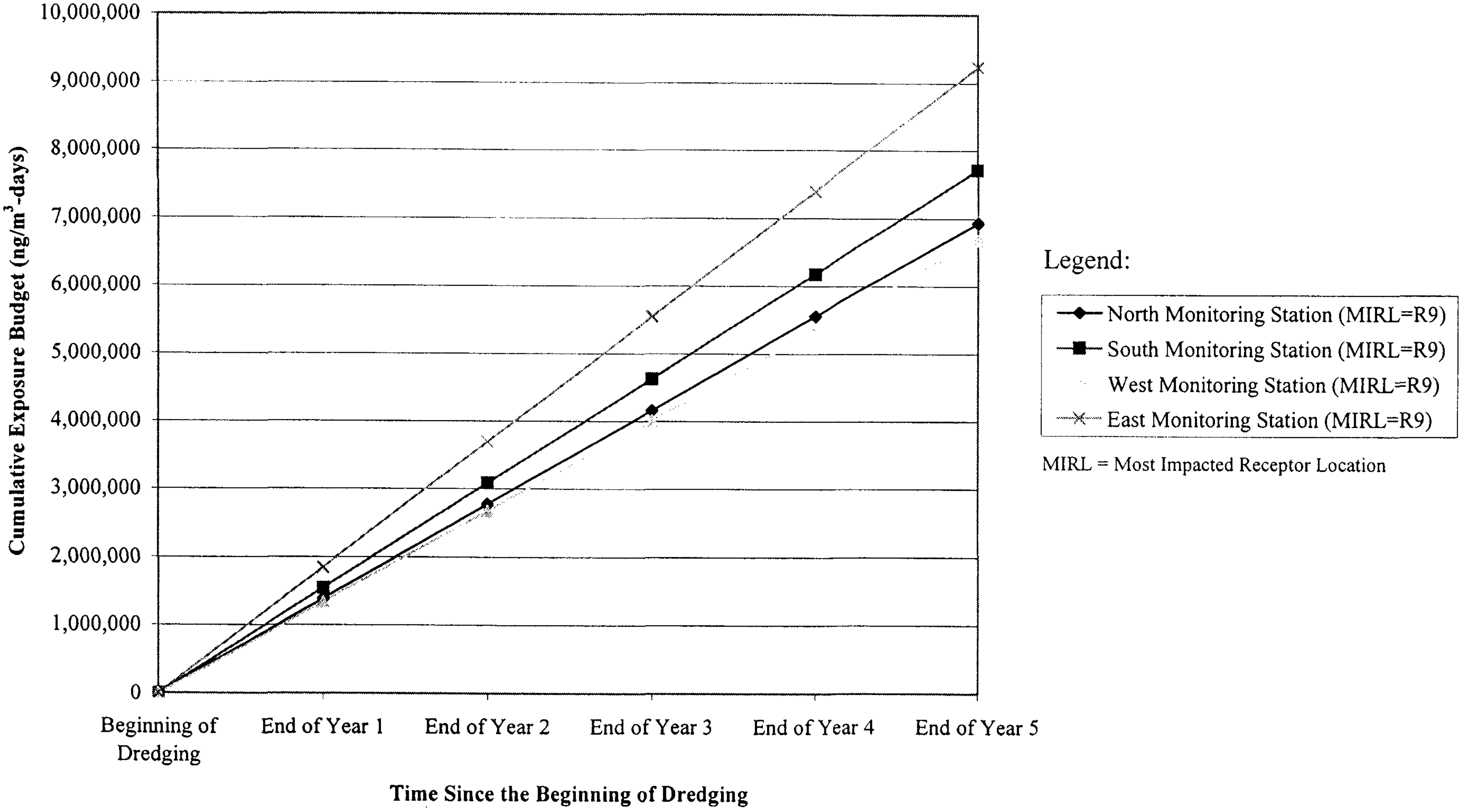


Figure I-7
Proposed Exposure Budgets for the CDF C Monitoring Stations Oriented to the Four Primary Compass Points (N-S-E-W)
(Total PCBs, 10-Year Project Duration)



1996 and 1999 Total PCBs CDF C-10 yr

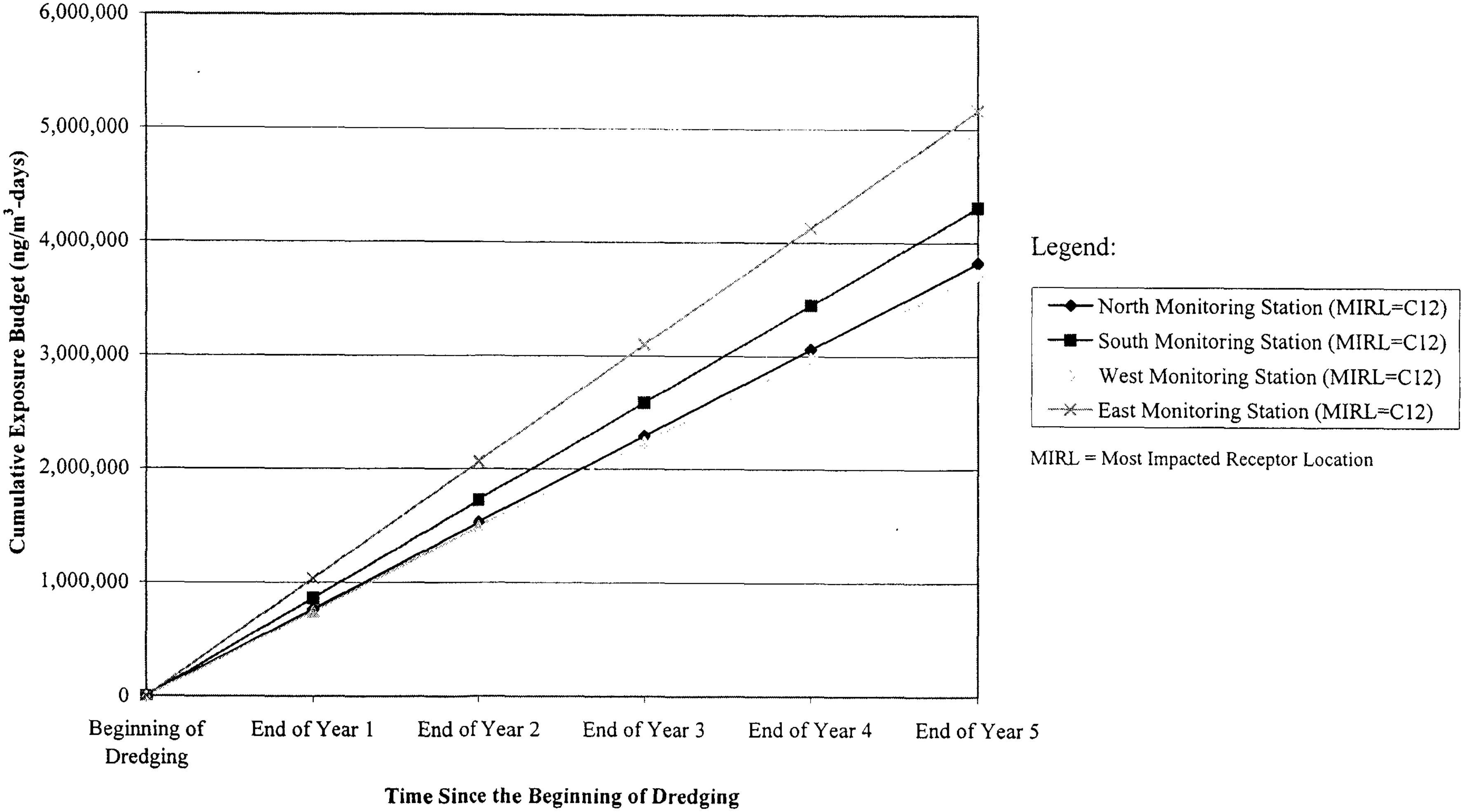
Figure I-8
Proposed Exposure Budgets for the CDF D Monitoring Stations Oriented to the Four Primary Compass Points (N-S-E-W)
(Total PCBs, 5-Year Project Duration)



1996 and 1999 Total PCBs CDF D-5 yr

Figure I-9

Proposed Exposure Budgets for the CDF D Monitoring Stations Oriented to the Four Primary Compass Points (N-S-E-W) (Total PCBs, 10-Year Project Duration)



1996 and 1999 Total PCBs CDF D-10 yr

APPENDIX J

Cumulative Exposure Budget – Calculation Tables

Table J-1 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1996 Site-Specific Meteorology

	Total PCBs									
	CDF C									
	Year 1					Year 2				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.013816	0.008526	0.021907	0.015708		0.013254	0.008238	0.018756	0.014532
R1	0.000178	77.84	48.03	123.42	88.50	0.000168	78.85	49.01	111.58	86.46
R2	0.000187	73.74	45.51	116.93	83.84	0.000172	77.00	47.86	108.97	84.43
R3	0.000237	58.26	35.95	92.38	66.24	0.000227	58.51	36.37	82.81	64.16
R4	0.000533	25.90	15.98	41.07	29.45	0.000512	25.91	16.10	36.66	28.41
R5	0.000475	29.07	17.94	46.10	33.05	0.000458	28.96	18.00	40.98	31.75
R6	0.001192	11.59	7.15	18.37	13.18	0.001132	11.71	7.28	16.57	12.84
R7	0.000307	45.03	27.79	71.39	51.19	0.000295	44.85	27.88	63.47	49.18
R8	0.000989	13.97	8.62	22.14	15.88	0.000962	13.77	8.56	19.49	15.10
R9	0.002022	6.83	4.22	10.83	7.77	0.001953	6.79	4.22	9.60	7.44
R10	0.000731	18.90	11.67	29.97	21.49	0.000703	18.84	11.71	26.66	20.66
R11	0.000828	16.70	10.30	26.47	18.98	0.000794	16.69	10.38	23.62	18.30
R12	0.001792	7.71	4.76	12.23	8.77	0.001758	7.54	4.69	10.67	8.27
R13	0.001327	10.41	6.42	16.51	11.84	0.001312	10.10	6.28	14.29	11.07
R14	0.000597	23.16	14.29	36.72	26.33	0.000590	22.47	13.97	31.80	24.64
R15	0.000953	14.49	8.94	22.98	16.48	0.000953	13.90	8.64	19.67	15.24
R16	0.000433	31.92	19.70	50.61	36.29	0.000431	30.77	19.12	43.54	33.74
R17	0.000404	34.19	21.10	54.21	38.87	0.000401	33.06	20.55	46.78	36.25
R18	0.000613	22.53	13.91	35.73	25.62	0.000607	21.83	13.57	30.90	23.94
R19	0.001047	13.20	8.14	20.93	15.01	0.001040	12.74	7.92	18.03	13.97
S1	0.000628	22.00	13.58	34.89	25.02	0.000609	21.75	13.52	30.78	23.85
S2	0.000363	38.05	23.48	60.33	43.26	0.000361	36.76	22.85	52.02	40.31
C1	0.000256	53.94	33.29	85.52	61.32	0.000239	55.54	34.52	78.60	60.90
C2	0.000273	50.61	31.23	80.25	57.54	0.000263	50.42	31.34	71.35	55.29
C3	0.000317	43.53	26.87	69.03	49.50	0.000295	45.00	27.97	63.68	49.34
C4	0.000305	45.29	27.95	71.81	51.49	0.000290	45.67	28.39	64.63	50.08
C5	0.000335	41.21	25.43	65.35	46.86	0.000320	41.40	25.74	58.59	45.40
C6	0.000363	38.05	23.48	60.33	43.26	0.000349	38.01	23.63	53.80	41.68
C7	0.000294	46.97	28.98	74.47	53.40	0.000277	47.88	29.76	67.76	52.50
C8	0.000416	33.20	20.49	52.64	37.74	0.000400	33.16	20.61	46.93	36.36
C9	0.000565	24.45	15.09	38.76	27.80	0.000544	24.37	15.15	34.49	26.72
C10	0.001490	9.28	5.72	14.71	10.55	0.001413	9.38	5.83	13.28	10.29
C11	0.002455	5.63	3.47	8.92	6.40	0.002336	5.67	3.53	8.03	6.22
C12	0.004270	3.24	2.00	5.13	3.68	0.004030	3.29	2.04	4.65	3.61
C13	0.000881	15.68	9.68	24.86	17.83	0.000844	15.71	9.77	22.23	17.23
C14	0.001183	11.67	7.20	18.51	13.27	0.001123	11.81	7.34	16.71	12.95
C15	0.002142	6.45	3.98	10.23	7.33	0.002024	6.55	4.07	9.27	7.18
C16	0.002276	6.07	3.75	9.63	6.90	0.002255	5.88	3.65	8.32	6.44
C17	0.001168	11.83	7.30	18.75	13.44	0.001157	11.45	7.12	16.21	12.56
C18	0.003337	4.14	2.56	6.57	4.71	0.003353	3.95	2.46	5.59	4.33
C19	0.002455	5.63	3.47	8.92	6.40	0.002466	5.37	3.34	7.60	5.89
C20	0.001652	8.37	5.16	13.26	9.51	0.001657	8.00	4.97	11.32	8.77
C21	0.001239	11.15	6.88	17.68	12.68	0.001242	10.67	6.63	15.10	11.70
C22	0.000905	15.26	9.42	24.20	17.35	0.000905	14.64	9.10	20.72	16.06
C23	0.000710	19.47	12.02	30.87	22.14	0.000709	18.70	11.62	26.47	20.51
C24	0.000404	34.20	21.11	54.23	38.89	0.000403	32.91	20.45	46.57	36.08
C25	0.000501	27.57	17.02	43.72	31.35	0.000498	26.62	16.55	37.68	29.19

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = School Receptor

Table J-1 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1996 Site-Specific Meteorology

	Total PCBs									
	CDF C									
	Year 3					Year 4				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.013103	0.008032	0.018603	0.014351		0.013071	0.007989	0.018569	0.014311
R1	0.000136	96.31	59.04	136.73	105.48	0.000129	100.95	61.70	143.41	110.53
R2	0.000141	93.25	57.16	132.39	102.13	0.000134	97.39	59.52	138.36	106.63
R3	0.000185	70.80	43.40	100.51	77.54	0.000177	73.95	45.20	105.06	80.97
R4	0.000440	29.79	18.26	42.30	32.63	0.000425	30.74	18.79	43.67	33.65
R5	0.000389	33.71	20.66	47.85	36.92	0.000374	34.93	21.35	49.62	38.24
R6	0.001029	12.73	7.81	18.08	13.95	0.001008	12.97	7.93	18.43	14.20
R7	0.000244	53.70	32.92	76.24	58.81	0.000234	55.95	34.19	79.48	61.25
R8	0.000787	16.65	10.21	23.64	18.24	0.000750	17.42	10.65	24.74	19.07
R9	0.001681	7.80	4.78	11.07	8.54	0.001626	8.04	4.91	11.42	8.80
R10	0.000594	22.06	13.52	31.32	24.16	0.000571	22.91	14.00	32.54	25.08
R11	0.000672	19.49	11.95	27.67	21.35	0.000646	20.22	12.36	28.72	22.14
R12	0.001370	9.57	5.86	13.58	10.48	0.001290	10.13	6.19	14.39	11.09
R13	0.000982	13.34	8.18	18.94	14.61	0.000916	14.27	8.72	20.28	15.63
R14	0.000440	29.81	18.28	42.33	32.65	0.000407	32.15	19.65	45.67	35.20
R15	0.000669	19.58	12.00	27.80	21.44	0.000609	21.45	13.11	30.47	23.49
R16	0.000310	42.23	25.89	59.95	46.25	0.000285	45.94	28.08	65.26	50.30
R17	0.000293	44.75	27.43	63.53	49.01	0.000269	48.59	29.70	69.03	53.20
R18	0.000449	29.20	17.90	41.46	31.98	0.000414	31.54	19.28	44.81	34.53
R19	0.000757	17.30	10.60	24.56	18.95	0.000696	18.79	11.48	26.69	20.57
S1	0.000495	26.45	16.21	37.55	28.97	0.000473	27.65	16.90	39.28	30.28
S2	0.000262	49.99	30.64	70.98	54.75	0.000243	53.72	32.83	76.32	58.82
C1	0.000195	67.10	41.13	95.26	73.48	0.000187	70.07	42.83	99.54	76.72
C2	0.000215	60.86	37.31	86.40	66.65	0.000206	63.51	38.81	90.22	69.53
C3	0.000242	54.04	33.12	76.72	59.18	0.000232	56.27	34.39	79.93	61.60
C4	0.000239	54.85	33.62	77.87	60.08	0.000229	57.11	34.90	81.13	62.53
C5	0.000264	49.70	30.46	70.55	54.43	0.000253	51.67	31.58	73.40	56.57
C6	0.000293	44.77	27.44	63.56	49.03	0.000281	46.50	28.42	66.06	50.91
C7	0.000234	56.07	34.37	79.60	61.41	0.000226	57.92	35.40	82.28	63.42
C8	0.000337	38.92	23.86	55.26	42.63	0.000324	40.36	24.67	57.33	44.19
C9	0.000464	28.26	17.32	40.12	30.95	0.000449	29.14	17.81	41.40	31.91
C10	0.001304	10.05	6.16	14.27	11.01	0.001281	10.20	6.23	14.49	11.17
C11	0.002160	6.07	3.72	8.61	6.64	0.002123	6.16	3.76	8.75	6.74
C12	0.003813	3.44	2.11	4.88	3.76	0.003768	3.47	2.12	4.93	3.80
C13	0.000724	18.10	11.09	25.69	19.82	0.000698	18.71	11.44	26.59	20.49
C14	0.000981	13.36	8.19	18.97	14.63	0.000950	13.76	8.41	19.54	15.06
C15	0.001849	7.09	4.34	10.06	7.76	0.001806	7.24	4.42	10.28	7.93
C16	0.001656	7.91	4.85	11.23	8.66	0.001533	8.53	5.21	12.11	9.33
C17	0.000854	15.34	9.40	21.78	16.80	0.000799	16.37	10.00	23.25	17.92
C18	0.002297	5.70	3.50	8.10	6.25	0.002088	6.26	3.83	8.89	6.85
C19	0.001689	7.76	4.76	11.02	8.50	0.001545	8.46	5.17	12.02	9.27
C20	0.001142	11.48	7.03	16.29	12.57	0.001045	12.51	7.64	17.77	13.69
C21	0.000862	15.20	9.32	21.58	16.65	0.000790	16.54	10.11	23.50	18.11
C22	0.000637	20.58	12.61	29.21	22.54	0.000587	22.27	13.61	31.64	24.38
C23	0.000500	26.20	16.06	37.19	28.69	0.000460	28.39	17.35	40.33	31.08
C24	0.000287	45.61	27.96	64.76	49.96	0.000264	49.50	30.25	70.32	54.20
C25	0.000361	36.26	22.23	51.48	39.72	0.000331	39.47	24.12	56.08	43.22

NOTES:
R = Residential Receptor
C = Commercial Receptor
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Table J-1 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1996 Site-Specific Meteorology

	Total PCBs									
	CDF D									
	Year 1					Year 2				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.01641	0.01656	0.02095	0.01438		0.016551	0.016717	0.021145	0.014515
R1	0.0001775	92.43	93.29	118.01	81.04	0.0001681	98.46	99.45	125.80	86.35
R2	0.0001874	87.57	88.38	111.80	76.78	0.0001721	96.16	97.12	122.85	84.33
R3	0.0002371	69.19	69.82	88.33	60.66	0.0002265	73.07	73.81	93.35	64.08
R4	0.0005335	30.76	31.04	39.27	26.96	0.0005116	32.35	32.68	41.33	28.37
R5	0.0004752	34.52	34.84	44.08	30.27	0.0004576	36.16	36.53	46.20	31.72
R6	0.0011922	13.76	13.89	17.57	12.06	0.0011321	14.62	14.77	18.68	12.82
R7	0.0003069	53.47	53.96	68.26	46.88	0.0002955	56.01	56.57	71.56	49.12
R8	0.0009893	16.58	16.74	21.17	14.54	0.0009623	17.20	17.37	21.97	15.08
R9	0.0020224	8.11	8.19	10.36	7.11	0.0019528	8.48	8.56	10.83	7.43
R10	0.0007309	22.45	22.65	28.66	19.68	0.0007034	23.53	23.76	30.06	20.63
R11	0.0008276	19.83	20.01	25.31	17.38	0.0007940	20.85	21.05	26.63	18.28
R12	0.0017916	9.16	9.24	11.69	8.03	0.0017578	9.42	9.51	12.03	8.26
R13	0.0013271	12.36	12.48	15.78	10.84	0.0013123	12.61	12.74	16.11	11.06
R14	0.0005965	27.50	27.76	35.11	24.11	0.0005898	28.06	28.34	35.85	24.61
R15	0.0009532	17.21	17.37	21.98	15.09	0.0009533	17.36	17.54	22.18	15.23
R16	0.0004329	37.90	38.25	48.39	33.23	0.0004308	38.42	38.81	49.09	33.70
R17	0.0004041	40.60	40.98	51.83	35.60	0.0004009	41.28	41.70	52.74	36.20
R18	0.0006132	26.76	27.00	34.16	23.46	0.0006070	27.27	27.54	34.84	23.91
R19	0.0010468	15.67	15.82	20.01	13.74	0.0010404	15.91	16.07	20.32	13.95
S1	0.0006279	26.13	26.37	33.36	22.91	0.0006093	27.16	27.44	34.70	23.82
S2	0.0003631	45.19	45.60	57.69	39.61	0.0003605	45.91	46.37	58.65	40.26
C1	0.0002562	64.05	64.64	81.77	56.15	0.0002386	69.35	70.05	88.61	60.82
C2	0.0002730	60.10	60.65	76.73	52.69	0.0002629	62.96	63.60	80.44	55.22
C3	0.0003174	51.70	52.17	66.00	45.32	0.0002945	56.19	56.76	71.79	49.28
C4	0.0003051	53.78	54.28	68.66	47.15	0.0002902	57.03	57.61	72.87	50.02
C5	0.0003352	48.94	49.39	62.49	42.91	0.0003201	51.70	52.22	66.06	45.34
C6	0.0003631	45.18	45.60	57.68	39.61	0.0003487	47.47	47.95	60.65	41.63
C7	0.0002942	55.78	56.29	71.21	48.90	0.0002768	59.79	60.39	76.39	52.43
C8	0.0004162	39.42	39.79	50.33	34.56	0.0003997	41.41	41.83	52.91	36.32
C9	0.0005651	29.03	29.30	37.06	25.45	0.0005438	30.43	30.74	38.88	26.69
C10	0.0014895	11.01	11.12	14.06	9.66	0.0014126	11.72	11.83	14.97	10.27
C11	0.0024552	6.68	6.74	8.53	5.86	0.0023364	7.08	7.15	9.05	6.21
C12	0.0042705	3.84	3.88	4.90	3.37	0.0040305	4.11	4.15	5.25	3.60
C13	0.0008811	18.62	18.79	23.77	16.33	0.0008436	19.62	19.82	25.07	17.21
C14	0.0011834	13.86	13.99	17.70	12.15	0.0011225	14.74	14.89	18.84	12.93
C15	0.0021424	7.66	7.73	9.78	6.71	0.0020242	8.18	8.26	10.45	7.17
C16	0.0022759	7.21	7.28	9.20	6.32	0.0022551	7.34	7.41	9.38	6.44
C17	0.0011684	14.04	14.17	17.93	12.31	0.0011574	14.30	14.44	18.27	12.54
C18	0.0033369	4.92	4.96	6.28	4.31	0.0033525	4.94	4.99	6.31	4.33
C19	0.0024546	6.68	6.75	8.53	5.86	0.0024663	6.71	6.78	8.57	5.89
C20	0.0016515	9.93	10.03	12.68	8.71	0.0016575	9.99	10.09	12.76	8.76
C21	0.0012393	13.24	13.36	16.90	11.61	0.0012420	13.33	13.46	17.02	11.69
C22	0.0009054	18.12	18.29	23.14	15.89	0.0009050	18.29	18.47	23.36	16.04
C23	0.0007096	23.12	23.34	29.52	20.27	0.0007087	23.35	23.59	29.84	20.48
C24	0.0004039	40.62	40.99	51.86	35.61	0.0004027	41.09	41.51	52.50	36.04
C25	0.0005010	32.75	33.05	41.81	28.71	0.0004978	33.25	33.58	42.48	29.16

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = School Receptor

Table J-1 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1996 Site-Specific Meteorology

	Total PCBs									
	CDF D									
	Year 3					Year 4				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.011090	0.011152	0.014108	0.009710		0.010273	0.010542	0.012618	0.009125
R1	0.000136	81.52	81.97	103.70	71.37	0.000129	79.34	81.42	97.45	70.48
R2	0.000141	78.93	79.37	100.41	69.10	0.000134	76.55	78.55	94.02	67.99
R3	0.000185	59.92	60.25	76.23	52.46	0.000177	58.12	59.64	71.39	51.63
R4	0.000440	25.22	25.35	32.08	22.08	0.000425	24.16	24.79	29.67	21.46
R5	0.000389	28.53	28.69	36.29	24.98	0.000374	27.45	28.17	33.72	24.38
R6	0.001029	10.78	10.84	13.71	9.44	0.001008	10.19	10.46	12.52	9.06
R7	0.000244	45.45	45.70	57.82	39.79	0.000234	43.97	45.12	54.01	39.06
R8	0.000787	14.10	14.17	17.93	12.34	0.000750	13.69	14.05	16.82	12.16
R9	0.001681	6.60	6.63	8.39	5.78	0.001626	6.32	6.49	7.76	5.61
R10	0.000594	18.67	18.77	23.75	16.35	0.000571	18.00	18.48	22.11	15.99
R11	0.000672	16.50	16.59	20.99	14.44	0.000646	15.89	16.31	19.52	14.12
R12	0.001370	8.10	8.14	10.30	7.09	0.001290	7.96	8.17	9.78	7.07
R13	0.000982	11.29	11.35	14.36	9.88	0.000916	11.22	11.51	13.78	9.96
R14	0.000440	25.23	25.37	32.10	22.09	0.000407	25.27	25.93	31.03	22.44
R15	0.000669	16.57	16.66	21.08	14.51	0.000609	16.86	17.30	20.71	14.98
R16	0.000310	35.74	35.94	45.47	31.29	0.000285	36.11	37.05	44.35	32.07
R17	0.000293	37.87	38.08	48.18	33.16	0.000269	38.19	39.19	46.91	33.92
R18	0.000449	24.72	24.85	31.44	21.64	0.000414	24.79	25.44	30.45	22.02
R19	0.000757	14.64	14.72	18.63	12.82	0.000696	14.77	15.15	18.14	13.12
S1	0.000495	22.39	22.51	28.48	19.60	0.000473	21.73	22.30	26.69	19.31
S2	0.000262	42.31	42.55	53.83	37.05	0.000243	42.22	43.33	51.86	37.51
C1	0.000195	56.79	57.10	72.24	49.72	0.000187	55.07	56.51	67.64	48.92
C2	0.000215	51.51	51.80	65.53	45.10	0.000206	49.91	51.22	61.31	44.34
C3	0.000242	45.74	45.99	58.18	40.04	0.000232	44.22	45.38	54.32	39.28
C4	0.000239	46.43	46.68	59.06	40.65	0.000229	44.88	46.06	55.13	39.87
C5	0.000264	42.06	42.29	53.51	36.83	0.000253	40.61	41.67	49.88	36.07
C6	0.000293	37.89	38.10	48.21	33.18	0.000281	36.55	37.50	44.89	32.46
C7	0.000234	47.46	47.72	60.37	41.55	0.000226	45.52	46.71	55.91	40.44
C8	0.000337	32.94	33.13	41.91	28.84	0.000324	31.72	32.55	38.96	28.18
C9	0.000464	23.92	24.05	30.42	20.94	0.000449	22.90	23.50	28.13	20.35
C10	0.001304	8.50	8.55	10.82	7.45	0.001281	8.02	8.23	9.85	7.12
C11	0.002160	5.13	5.16	6.53	4.50	0.002123	4.84	4.97	5.94	4.30
C12	0.003813	2.91	2.92	3.70	2.55	0.003768	2.73	2.80	3.35	2.42
C13	0.000724	15.32	15.40	19.49	13.41	0.000698	14.71	15.09	18.07	13.07
C14	0.000981	11.31	11.37	14.38	9.90	0.000950	10.81	11.10	13.28	9.61
C15	0.001849	6.00	6.03	7.63	5.25	0.001806	5.69	5.84	6.99	5.05
C16	0.001656	6.70	6.73	8.52	5.86	0.001533	6.70	6.88	8.23	5.95
C17	0.000854	12.98	13.06	16.52	11.37	0.000799	12.86	13.20	15.80	11.43
C18	0.002297	4.83	4.86	6.14	4.23	0.002088	4.92	5.05	6.04	4.37
C19	0.001689	6.57	6.60	8.35	5.75	0.001545	6.65	6.83	8.17	5.91
C20	0.001142	9.71	9.77	12.36	8.50	0.001045	9.83	10.09	12.07	8.73
C21	0.000862	12.86	12.94	16.37	11.26	0.000790	13.00	13.34	15.97	11.55
C22	0.000637	17.42	17.51	22.16	15.25	0.000587	17.50	17.96	21.50	15.55
C23	0.000500	22.17	22.30	28.21	19.41	0.000460	22.31	22.90	27.41	19.82
C24	0.000287	38.61	38.82	49.11	33.80	0.000264	38.90	39.92	47.79	34.56
C25	0.000361	30.69	30.86	39.05	26.87	0.000331	31.02	31.83	38.11	27.56

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = Rece

Table J-2 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1999 Site-Specific Meteorology

	Total PCBs									
	CDF C									
	Year 1					Year 2				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		**0.012200**	**0.009432**	**0.021245**	**0.016416**		**0.011665**	**0.009107**	**0.017980**	**0.015306**
R1	**0.000135**	90.61	70.05	157.79	121.93	**0.000127**	92.06	71.88	141.90	120.79
R2	**0.000190**	64.35	49.75	112.06	86.59	**0.000173**	67.58	52.77	104.17	88.68
R3	**0.000208**	58.60	45.30	102.05	78.85	**0.000197**	59.32	46.31	91.43	77.83
R4	**0.000432**	28.22	21.82	49.15	37.98	**0.000416**	28.01	21.87	43.17	36.75
R5	**0.000406**	30.04	23.22	52.31	40.42	**0.000392**	29.79	23.26	45.92	39.09
R6	**0.000891**	13.70	10.59	23.86	18.43	**0.000849**	13.73	10.72	21.17	18.02
R7	**0.000272**	44.82	34.65	78.05	60.31	**0.000265**	44.08	34.41	67.94	57.83
R8	**0.000776**	15.72	12.15	27.37	21.15	**0.000749**	15.58	12.17	24.02	20.45
R9	**0.001957**	6.23	4.82	10.85	8.39	**0.001871**	6.23	4.87	9.61	8.18
R10	**0.000661**	18.46	14.27	32.14	24.84	**0.000635**	18.38	14.35	28.33	24.12
R11	**0.000792**	15.40	11.91	26.82	20.72	**0.000753**	15.50	12.10	23.89	20.33
R12	**0.001520**	8.03	6.20	13.98	10.80	**0.001484**	7.86	6.14	12.11	10.31
R13	**0.001287**	9.48	7.33	16.51	12.76	**0.001268**	9.20	7.18	14.18	12.07
R14	**0.000537**	22.73	17.58	39.59	30.59	**0.000528**	22.08	17.24	34.03	28.97
R15	**0.000891**	13.69	10.59	23.84	18.42	**0.000891**	13.10	10.23	20.19	17.19
R16	**0.000454**	26.88	20.78	46.82	36.18	**0.000451**	25.84	20.18	39.84	33.91
R17	**0.000423**	28.85	22.31	50.24	38.82	**0.000419**	27.84	21.73	42.91	36.52
R18	**0.000590**	20.69	16.00	36.03	27.84	**0.000583**	20.00	15.61	30.83	26.24
R19	**0.000987**	12.36	9.55	21.52	16.63	**0.000976**	11.95	9.33	18.41	15.68
S1	**0.000651**	18.73	14.48	32.62	25.20	**0.000633**	18.42	14.38	28.39	24.17
S2	**0.000390**	31.26	24.17	54.44	42.07	**0.000388**	30.05	23.47	46.32	39.44
C1	**0.000206**	59.15	45.73	103.00	79.59	**0.000182**	63.98	49.95	98.61	83.95
C2	**0.000251**	48.56	37.54	84.56	65.34	**0.000241**	48.34	37.74	74.51	63.43
C3	**0.000244**	49.94	38.61	86.97	67.20	**0.000229**	50.99	39.81	78.59	66.90
C4	**0.000261**	46.70	36.10	81.32	62.84	**0.000248**	46.95	36.66	72.37	61.61
C5	**0.000295**	41.35	31.97	72.01	55.64	**0.000279**	41.78	32.62	64.40	54.83
C6	**0.000295**	41.40	32.00	72.09	55.70	**0.000286**	40.75	31.81	62.81	53.47
C7	**0.000290**	42.06	32.51	73.24	56.59	**0.000273**	42.79	33.41	65.95	56.14
C8	**0.000352**	34.71	26.83	60.44	46.70	**0.000340**	34.27	26.76	52.83	44.97
C9	**0.000502**	24.29	18.78	42.30	32.69	**0.000484**	24.10	18.82	37.15	31.62
C10	**0.001288**	9.47	7.32	16.50	12.75	**0.001216**	9.59	7.49	14.79	12.59
C11	**0.002332**	5.23	4.04	9.11	7.04	**0.002261**	5.16	4.03	7.95	6.77
C12	**0.004187**	2.91	2.25	5.07	3.92	**0.003903**	2.99	2.33	4.61	3.92
C13	**0.000788**	15.48	11.96	26.95	20.82	**0.000748**	15.59	12.17	24.02	20.45
C14	**0.001152**	10.59	8.19	18.45	14.26	**0.001080**	10.80	8.43	16.65	14.17
C15	**0.002047**	5.96	4.61	10.38	8.02	**0.001931**	6.04	4.72	9.31	7.92
C16	**0.001833**	6.65	5.14	11.59	8.95	**0.001814**	6.43	5.02	9.91	8.44
C17	**0.001295**	9.42	7.28	16.40	12.67	**0.001288**	9.06	7.07	13.96	11.88
C18	**0.003251**	3.75	2.90	6.53	5.05	**0.003268**	3.57	2.79	5.50	4.68
C19	**0.002442**	5.00	3.86	8.70	6.72	**0.002453**	4.76	3.71	7.33	6.24
C20	**0.001744**	7.00	5.41	12.18	9.42	**0.001749**	6.67	5.21	10.28	8.75
C21	**0.001288**	9.47	7.32	16.50	12.75	**0.001290**	9.04	7.06	13.94	11.86
C22	**0.001083**	11.26	8.71	19.61	15.16	**0.001085**	10.75	8.39	16.57	14.11
C23	**0.000777**	15.70	12.13	27.33	21.12	**0.000773**	15.08	11.78	23.25	19.79
C24	**0.000400**	30.53	23.60	53.17	41.08	**0.000397**	29.41	22.96	45.33	38.59
C25	**0.000525**	23.26	17.98	40.51	31.30	**0.000521**	22.38	17.47	34.49	29.36

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = School Receptor

Table J-2 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1999 Site-Specific Meteorology

	Total PCBs									
	CDF C									
	Year 3					Year 4				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.011547	0.008930	0.017854	0.015164		0.011522	0.008894	0.017829	0.015134
R1	0.000103	111.77	86.44	172.82	146.78	0.000099	116.82	90.18	180.76	153.44
R2	0.000143	80.79	62.48	124.93	106.10	0.000137	84.16	64.97	130.23	110.55
R3	0.000164	70.56	54.57	109.10	92.66	0.000157	73.39	56.65	113.56	96.40
R4	0.000346	33.34	25.78	51.55	43.78	0.000332	34.74	26.82	53.76	45.63
R5	0.000328	35.17	27.20	54.39	46.19	0.000315	36.59	28.24	56.62	48.06
R6	0.000757	15.26	11.80	23.60	20.05	0.000737	15.64	12.07	24.19	20.54
R7	0.000213	54.12	41.86	83.69	71.08	0.000203	56.65	43.73	87.66	74.41
R8	0.000626	18.45	14.27	28.53	24.23	0.000601	19.16	14.79	29.65	25.17
R9	0.001622	7.12	5.50	11.01	9.35	0.001567	7.35	5.68	11.38	9.66
R10	0.000544	21.21	16.40	32.79	27.85	0.000524	21.98	16.97	34.01	28.87
R11	0.000654	17.64	13.64	27.28	23.17	0.000635	18.15	14.01	28.08	23.83
R12	0.001186	9.73	7.53	15.05	12.78	0.001134	10.16	7.84	15.73	13.35
R13	0.000956	12.08	9.35	18.69	15.87	0.000886	13.01	10.04	20.13	17.09
R14	0.000399	28.96	22.39	44.77	38.03	0.000374	30.78	23.76	47.62	40.43
R15	0.000627	18.41	14.24	28.47	24.18	0.000577	19.98	15.43	30.92	26.25
R16	0.000325	35.52	27.48	54.93	46.66	0.000300	38.43	29.66	59.46	50.48
R17	0.000308	37.45	28.96	57.91	49.18	0.000283	40.69	31.41	62.96	53.45
R18	0.000433	26.65	20.61	41.22	35.01	0.000399	28.90	22.31	44.73	37.97
R19	0.000726	15.91	12.31	24.60	20.90	0.000673	17.12	13.21	26.48	22.48
S1	0.000514	22.46	17.37	34.73	29.50	0.000486	23.69	18.29	36.66	31.12
S2	0.000280	41.19	31.85	63.69	54.09	0.000258	44.73	34.52	69.21	58.75
C1	0.000150	76.95	59.51	118.98	101.06	0.000144	80.22	61.93	124.14	105.38
C2	0.000201	57.47	44.45	88.87	75.48	0.000193	59.76	46.13	92.48	78.50
C3	0.000189	61.02	47.19	94.36	80.14	0.000182	63.41	48.95	98.12	83.29
C4	0.000209	55.30	42.77	85.51	72.63	0.000201	57.32	44.25	88.70	75.30
C5	0.000235	49.09	37.97	75.91	64.48	0.000227	50.81	39.22	78.62	66.74
C6	0.000230	50.19	38.81	77.60	65.91	0.000218	52.77	40.74	81.66	69.32
C7	0.000229	50.45	39.02	78.00	66.25	0.000220	52.27	40.35	80.88	68.66
C8	0.000280	41.17	31.84	63.65	54.06	0.000268	42.93	33.14	66.44	56.39
C9	0.000415	27.83	21.52	43.03	36.54	0.000402	28.66	22.13	44.35	37.65
C10	0.001129	10.22	7.91	15.81	13.43	0.001112	10.36	8.00	16.04	13.61
C11	0.002095	5.51	4.26	8.52	7.24	0.002058	5.60	4.32	8.66	7.35
C12	0.003719	3.10	2.40	4.80	4.08	0.003682	3.13	2.42	4.84	4.11
C13	0.000653	17.68	13.67	27.33	23.21	0.000633	18.20	14.05	28.16	23.91
C14	0.000966	11.96	9.25	18.49	15.70	0.000940	12.26	9.46	18.97	16.10
C15	0.001787	6.46	5.00	9.99	8.49	0.001751	6.58	5.08	10.18	8.64
C16	0.001354	8.53	6.60	13.19	11.20	0.001269	9.08	7.01	14.05	11.93
C17	0.000935	12.35	9.55	19.09	16.22	0.000873	13.19	10.18	20.41	17.33
C18	0.002238	5.16	3.99	7.98	6.78	0.002108	5.46	4.22	8.46	7.18
C19	0.001681	6.87	5.31	10.62	9.02	0.001540	7.48	5.78	11.58	9.83
C20	0.001208	9.56	7.39	14.78	12.55	0.001105	10.42	8.05	16.13	13.69
C21	0.000897	12.88	9.96	19.91	16.91	0.000826	13.95	10.77	21.58	18.32
C22	0.000755	15.30	11.83	23.65	20.09	0.000686	16.80	12.96	25.99	22.06
C23	0.000557	20.74	16.04	32.08	27.24	0.000511	22.53	17.40	34.87	29.60
C24	0.000288	40.06	30.99	61.95	52.62	0.000266	43.30	33.42	67.00	56.87
C25	0.000377	30.64	23.70	47.38	40.25	0.000342	33.73	26.04	52.20	44.31

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = [illegible] Rece

Table J-2 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1999 Site-Specific Meteorology

	Total PCBs									
	CDF D									
	Year 1					Year 2				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.01465	0.01756	0.02038	0.01407		0.014773	0.017727	0.020576	0.014200
R1	0.0001346	108.82	130.42	151.39	104.53	0.0001267	116.59	139.90	162.38	112.07
R2	0.0001896	77.28	92.62	107.51	74.24	0.0001726	85.59	102.71	119.21	82.27
R3	0.0002082	70.38	84.34	97.91	67.60	0.0001967	75.12	90.14	104.63	72.21
R4	0.0004323	33.90	40.62	47.15	32.56	0.0004165	35.47	42.56	49.41	34.10
R5	0.0004062	36.07	43.23	50.19	34.65	0.0003916	37.73	45.27	52.55	36.26
R6	0.0008906	16.45	19.72	22.89	15.80	0.0008494	17.39	20.87	24.22	16.72
R7	0.0002722	53.83	64.51	74.89	51.71	0.0002647	55.82	66.98	77.75	53.66
R8	0.0007763	18.87	22.62	26.26	18.13	0.0007486	19.73	23.68	27.49	18.97
R9	0.0019574	7.49	8.97	10.41	7.19	0.0018713	7.89	9.47	11.00	7.59
R10	0.0006610	22.17	26.57	30.84	21.29	0.0006346	23.28	27.93	32.42	22.38
R11	0.0007922	18.49	22.17	25.73	17.77	0.0007527	19.63	23.55	27.34	18.87
R12	0.0015202	9.64	11.55	13.41	9.26	0.0014844	9.95	11.94	13.86	9.57
R13	0.0012866	11.39	13.65	15.84	10.94	0.0012681	11.65	13.98	16.23	11.20
R14	0.0005366	27.30	32.72	37.98	26.23	0.0005283	27.96	33.55	38.95	26.88
R15	0.0008910	16.44	19.71	22.88	15.80	0.0008906	16.59	19.90	23.10	15.94
R16	0.0004538	32.29	38.69	44.92	31.01	0.0004513	32.73	39.28	45.59	31.46
R17	0.0004228	34.65	41.53	48.21	33.28	0.0004191	35.25	42.30	49.10	33.89
R18	0.0005897	24.85	29.78	34.57	23.87	0.0005833	25.33	30.39	35.28	24.35
R19	0.0009874	14.84	17.78	20.64	14.25	0.0009764	15.13	18.16	21.07	14.54
S1	0.0006514	22.49	26.96	31.29	21.61	0.0006332	23.33	27.99	32.49	22.42
S2	0.0003903	37.54	45.00	52.23	36.06	0.0003881	38.06	45.67	53.01	36.59
C1	0.0002063	71.04	85.13	98.82	68.24	0.0001823	81.02	97.22	112.85	77.88
C2	0.0002513	58.32	69.89	81.13	56.02	0.0002413	61.22	73.46	85.27	58.85
C3	0.0002443	59.98	71.88	83.44	57.61	0.0002288	64.57	77.49	89.94	62.07
C4	0.0002612	56.09	67.22	78.02	53.87	0.0002484	59.46	71.36	82.82	57.16
C5	0.0002950	49.66	59.52	69.09	47.70	0.0002792	52.92	63.50	73.70	50.87
C6	0.0002947	49.71	59.58	69.16	47.75	0.0002863	51.60	61.92	71.88	49.60
C7	0.0002901	50.51	60.53	70.27	48.52	0.0002726	54.19	65.02	75.47	52.09
C8	0.0003515	41.68	49.95	57.99	40.04	0.0003404	43.40	52.08	60.45	41.72
C9	0.0005022	29.17	34.96	40.59	28.02	0.0004840	30.52	36.62	42.51	29.34
C10	0.0012878	11.38	13.63	15.83	10.93	0.0012158	12.15	14.58	16.92	11.68
C11	0.0023322	6.28	7.53	8.74	6.03	0.0022605	6.54	7.84	9.10	6.28
C12	0.0041869	3.50	4.19	4.87	3.36	0.0039032	3.78	4.54	5.27	3.64
C13	0.0007884	18.59	22.27	25.85	17.85	0.0007485	19.74	23.68	27.49	18.97
C14	0.0011516	12.72	15.25	17.70	12.22	0.0010800	13.68	16.41	19.05	13.15
C15	0.0020475	7.16	8.58	9.96	6.87	0.0019313	7.65	9.18	10.65	7.35
C16	0.0018335	7.99	9.58	11.12	7.68	0.0018136	8.15	9.77	11.35	7.83
C17	0.0012955	11.31	13.55	15.73	10.86	0.0012879	11.47	13.76	15.98	11.03
C18	0.0032512	4.51	5.40	6.27	4.33	0.0032675	4.52	5.43	6.30	4.35
C19	0.0024416	6.00	7.19	8.35	5.76	0.0024529	6.02	7.23	8.39	5.79
C20	0.0017436	8.40	10.07	11.69	8.07	0.0017488	8.45	10.14	11.77	8.12
C21	0.0012877	11.38	13.64	15.83	10.93	0.0012900	11.45	13.74	15.95	11.01
C22	0.0010832	13.53	16.21	18.82	12.99	0.0010851	13.61	16.34	18.96	13.09
C23	0.0007773	18.85	22.59	26.22	18.11	0.0007734	19.10	22.92	26.60	18.36
C24	0.0003996	36.67	43.95	51.01	35.22	0.0003967	37.24	44.69	51.87	35.80
C25	0.0005245	27.93	33.48	38.86	26.83	0.0005213	28.34	34.01	39.47	27.24

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = School Receptor

Table J-2 Calculation of Dispersion Factors for Total PCBs for the CDF C and D Monitoring Stations for Occupational Years 1-4 Using the 1999 Site-Specific Meteorology

	Total PCBs									
	CDF D									
	Year 3					Year 4				
	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station	Projected Annual Average Concentration (ug/m^3)	North Monitoring Station	South Monitoring Station	East Monitoring Station	West Monitoring Station
		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)		(ug/m^3)	(ug/m^3)	(ug/m^3)	(ug/m^3)
REPRESENTATIVE RECEPTOR LOCATIONS		0.009923	0.011828	0.013732	0.009506		0.009136	0.011188	0.012275	0.008902
R1	0.000103	96.05	114.49	132.92	92.01	0.000099	92.63	113.44	124.45	90.26
R2	0.000143	69.43	82.76	96.08	66.51	0.000137	66.73	81.73	89.66	65.03
R3	0.000164	60.63	72.28	83.91	58.09	0.000157	58.19	71.27	78.19	56.71
R4	0.000346	28.65	34.15	39.65	27.44	0.000332	27.55	33.74	37.01	26.84
R5	0.000328	30.23	36.03	41.83	28.96	0.000315	29.01	35.53	38.98	28.27
R6	0.000757	13.12	15.64	18.15	12.57	0.000737	12.40	15.18	16.66	12.08
R7	0.000213	46.51	55.44	64.37	44.56	0.000203	44.92	55.01	60.35	43.77
R8	0.000626	15.86	18.90	21.94	15.19	0.000601	15.19	18.61	20.42	14.81
R9	0.001622	6.12	7.29	8.46	5.86	0.001567	5.83	7.14	7.83	5.68
R10	0.000544	18.22	21.72	25.22	17.46	0.000524	17.43	21.34	23.41	16.98
R11	0.000654	15.16	18.07	20.98	14.52	0.000635	14.39	17.62	19.33	14.02
R12	0.001186	8.36	9.97	11.57	8.01	0.001134	8.06	9.87	10.83	7.85
R13	0.000956	10.38	12.38	14.37	9.95	0.000886	10.31	12.63	13.86	10.05
R14	0.000399	24.88	29.66	34.44	23.84	0.000374	24.40	29.89	32.79	23.78
R15	0.000627	15.82	18.86	21.90	15.16	0.000577	15.85	19.41	21.29	15.44
R16	0.000325	30.53	36.39	42.25	29.25	0.000300	30.47	37.32	40.94	29.69
R17	0.000308	32.18	38.36	44.54	30.83	0.000283	32.26	39.51	43.35	31.44
R18	0.000433	22.91	27.30	31.70	21.94	0.000399	22.92	28.07	30.79	22.33
R19	0.000726	13.67	16.30	18.92	13.10	0.000673	13.57	16.62	18.23	13.22
S1	0.000514	19.30	23.01	26.71	18.49	0.000486	18.78	23.00	25.24	18.30
S2	0.000280	35.39	42.19	48.98	33.91	0.000258	35.46	43.43	47.65	34.56
C1	0.000150	66.12	78.82	91.51	63.35	0.000144	63.61	77.90	85.47	61.98
C2	0.000201	49.39	58.88	68.35	47.32	0.000193	47.39	58.03	63.67	46.18
C3	0.000189	52.44	62.51	72.57	50.24	0.000182	50.28	61.58	67.56	48.99
C4	0.000209	47.52	56.65	65.77	45.53	0.000201	45.45	55.67	61.07	44.29
C5	0.000235	42.19	50.29	58.39	40.42	0.000227	40.29	49.34	54.13	39.26
C6	0.000230	43.13	51.41	59.68	41.32	0.000218	41.85	51.25	56.22	40.78
C7	0.000229	43.35	51.68	59.99	41.53	0.000220	41.45	50.76	55.69	40.39
C8	0.000280	35.38	42.17	48.96	33.89	0.000268	34.04	41.69	45.74	33.17
C9	0.000415	23.91	28.50	33.09	22.91	0.000402	22.73	27.83	30.54	22.15
C10	0.001129	8.79	10.47	12.16	8.42	0.001112	8.22	10.06	11.04	8.01
C11	0.002095	4.74	5.65	6.55	4.54	0.002058	4.44	5.44	5.96	4.32
C12	0.003719	2.67	3.18	3.69	2.56	0.003682	2.48	3.04	3.33	2.42
C13	0.000653	15.19	18.11	21.02	14.55	0.000633	14.43	17.67	19.39	14.06
C14	0.000966	10.27	12.25	14.22	9.84	0.000940	9.72	11.91	13.06	9.47
C15	0.001787	5.55	6.62	7.69	5.32	0.001751	5.22	6.39	7.01	5.08
C16	0.001354	7.33	8.74	10.14	7.02	0.001269	7.20	8.82	9.67	7.02
C17	0.000935	10.61	12.65	14.69	10.17	0.000873	10.46	12.81	14.05	10.19
C18	0.002238	4.43	5.29	6.14	4.25	0.002108	4.33	5.31	5.82	4.22
C19	0.001681	5.90	7.04	8.17	5.65	0.001540	5.93	7.27	7.97	5.78
C20	0.001208	8.21	9.79	11.37	7.87	0.001105	8.26	10.12	11.10	8.05
C21	0.000897	11.06	13.19	15.31	10.60	0.000826	11.06	13.54	14.86	10.78
C22	0.000755	13.15	15.67	18.19	12.59	0.000686	13.32	16.31	17.89	12.98
C23	0.000557	17.83	21.25	24.67	17.08	0.000511	17.87	21.88	24.01	17.41
C24	0.000288	34.43	41.04	47.65	32.98	0.000266	34.33	42.04	46.13	33.45
C25	0.000377	26.33	31.39	36.44	25.23	0.000342	26.75	32.76	35.94	26.06

NOTES:
R = Residential Receptor
C = Commercial Receptor
S = School Receptor

Table J-3

Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 1

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m³)	Receptor-Specific Annual Average PCB Background Concentration ³	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)
R1	660	4	77.84	51,033	48.03	31,493	123.42	80,918	88.50	58,022	92.43	60,603	93.29	61,161	118.01	77,370	81.04	53,131
R2	660	8	73.74	48,055	45.51	29,655	116.93	76,196	83.84	54,636	87.57	57,067	88.36	57,592	111.80	72,855	76.78	50,031
R3	660	70	58.26	34,353	35.95	21,200	92.38	54,470	66.24	39,058	69.19	40,795	69.82	41,171	88.33	52,082	60.66	35,765
R4	660	7.5	25.90	16,890	15.98	10,423	41.07	26,780	29.45	19,203	30.76	20,057	31.04	20,242	39.27	25,606	26.96	17,584
R5	660	12	29.07	18,828	17.94	11,619	46.10	29,854	33.05	21,407	34.52	22,359	34.84	22,565	44.08	28,545	30.27	19,602
R6	660	31	11.59	7,285	7.15	4,496	18.37	11,551	13.18	8,283	13.76	8,651	13.89	8,731	17.57	11,045	12.06	7,584
R7	660	36	45.03	28,125	27.79	17,356	71.39	44,594	51.19	31,977	53.47	33,399	53.96	33,706	68.26	42,639	46.88	29,281
R8	660	8	13.97	9,101	8.62	5,616	22.14	14,430	15.88	10,347	16.58	10,807	16.74	10,907	21.17	13,797	14.54	9,475
R9	660	2	6.83	4,452	4.22	2,747	10.83	7,059	7.77	5,061	8.11	5,287	8.19	5,335	10.36	6,749	7.11	4,635
R10	660	11	18.90	12,261	11.67	7,566	29.97	19,441	21.49	13,940	22.45	14,560	22.65	14,695	28.66	18,589	19.68	12,765
R11	660	9	16.70	10,863	10.30	6,703	26.47	17,224	18.98	12,350	19.83	12,900	20.01	13,018	25.31	16,468	17.38	11,309
R12	660	8	7.71	5,025	4.76	3,101	12.23	7,968	8.77	5,713	9.16	5,968	9.24	6,022	11.69	7,619	8.03	5,232
R13	660	3	10.41	6,836	6.42	4,219	16.51	10,839	11.84	7,772	12.36	8,118	12.48	8,193	15.78	10,364	10.84	7,117
R14	660	0.8	23.16	15,260	14.29	9,417	36.72	24,196	26.33	17,350	27.50	18,121	27.76	18,288	35.11	23,135	24.11	15,887
R15	660	0.8	14.49	9,550	8.94	5,893	22.98	15,142	16.48	10,858	17.21	11,341	17.37	11,445	21.98	14,478	15.09	9,942
R16	660	6	31.92	20,861	19.70	12,874	50.61	33,078	36.29	23,719	37.90	24,774	38.25	25,002	48.39	31,628	33.23	21,719
R17	660	2.3	34.19	22,474	21.10	13,869	54.21	35,635	38.87	25,552	40.60	26,689	40.98	26,935	51.83	34,073	35.60	23,398
R18	660	7.5	22.53	14,695	13.91	9,068	35.73	23,300	25.62	16,707	26.76	17,450	27.00	17,611	34.16	22,278	23.46	15,299
R19	660	17	13.20	8,482	8.14	5,234	20.93	13,449	15.01	9,644	15.67	10,073	15.82	10,165	20.01	12,859	13.74	8,831
S1	660	4	22.00	14,427	13.58	8,903	34.89	22,875	25.02	16,402	26.13	17,132	26.37	17,290	33.36	21,872	22.91	15,020
S2	660	2.2	38.05	25,016	23.48	15,437	60.33	39,665	43.26	28,442	45.19	29,707	45.60	29,981	57.69	37,926	39.61	26,044
C1	1,789	80	53.94	92,152	33.29	56,868	85.52	146,116	61.32	104,773	64.05	109,433	64.64	110,441	81.77	139,710	56.15	95,941
C2	1,789	40	50.61	88,492	31.23	54,609	80.25	140,312	57.54	100,612	60.10	105,087	60.65	106,055	76.73	134,161	52.69	92,130
C3	1,789	80	43.53	74,379	26.87	45,900	69.03	117,934	49.50	84,565	51.70	88,327	52.17	89,140	66.00	112,764	45.32	77,436
C4	1,789	73	45.29	77,695	27.95	47,946	71.81	123,192	51.49	88,335	53.78	92,265	54.28	93,114	68.66	117,791	47.15	80,889
C5	1,789	80	41.21	70,416	25.43	43,454	65.35	111,651	46.86	80,060	48.94	83,621	49.39	84,391	62.49	106,756	42.91	73,311
C6	1,789	15	38.05	67,475	23.48	41,639	60.33	106,988	43.26	76,716	45.18	80,128	45.60	80,866	57.68	102,297	39.61	70,249
C7	1,789	14	46.97	83,345	28.98	51,433	74.47	132,151	53.40	94,759	55.78	98,974	56.29	99,886	71.21	126,357	48.90	86,771
C8	1,789	33	33.20	58,279	20.49	35,965	52.64	92,407	37.74	66,261	39.42	69,208	39.79	69,846	50.33	88,356	34.56	60,675
C9	1,789	26	24.45	43,089	15.09	26,590	38.76	68,322	27.80	48,990	29.03	51,169	29.30	51,641	37.06	65,326	25.45	44,860
C10	1,789	50	9.28	16,126	5.72	9,951	14.71	25,569	10.55	18,334	11.01	19,150	11.12	19,326	14.06	24,448	9.66	16,788
C11	1,789	58	5.63	9,738	3.47	6,009	8.92	15,440	6.40	11,072	6.68	11,564	6.74	11,671	8.53	14,763	5.86	10,138
C12	1,789	60	3.24	5,625	2.00	3,471	5.13	8,918	3.68	6,395	3.84	6,679	3.88	6,741	4.90	8,527	3.37	5,856
C13	1,789	19	15.68	27,748	9.68	17,123	24.86	43,997	17.83	31,548	18.62	32,951	18.79	33,255	23.77	42,068	16.33	28,889
C14	1,789	20	11.67	20,647	7.20	12,741	18.51	32,738	13.27	23,475	13.86	24,519	13.99	24,745	17.70	31,302	12.15	21,496
C15	1,789	28	6.45	11,353	3.98	7,006	10.23	18,002	7.33	12,908	7.66	13,482	7.73	13,606	9.78	17,212	6.71	11,820
C16	1,789	6	6.07	10,821	3.75	6,678	9.63	17,158	6.90	12,303	7.21	12,850	7.28	12,969	9.20	16,406	6.32	11,266
C17	1,789	4	11.83	21,108	7.30	13,026	18.75	33,469	13.44	23,999	14.04	25,066	14.17	25,297	17.93	32,001	12.31	21,976
C18	1,789	5	4.14	7,384	2.56	4,557	6.57	11,709	4.71	8,396	4.92	8,769	4.96	8,850	6.28	11,195	4.31	7,688
C19	1,789	2.5	5.63	10,053	3.47	6,204	8.92	15,940	6.40	11,430	6.68	11,938	6.75	12,048	8.53	15,241	5.86	10,466
C20	1,789	5	8.37	14,920	5.16	9,207	13.26	23,658	9.51	16,964	9.93	17,718	10.03	17,882	12.68	22,621	8.71	15,534
C21	1,789	5	11.15	19,883	6.88	12,270	17.68	31,526	12.68	22,606	13.24	23,611	13.36	23,829	16.90	30,144	11.61	20,700
C22	1,789	11	15.26	27,126	9.42	16,739	24.20	43,010	17.35	30,841	18.12	32,212	18.29	32,509	23.14	41,125	15.89	28,241
C23	1,789	40	19.47	34,045	12.02	21,009	30.87	53,981	22.14	38,707	23.12	40,429	23.34	40,801	29.52	51,615	20.27	35,444
C24	1,789	12	34.20	60,764	21.11	37,498	54.23	96,347	38.89	69,086	40.62	72,159	40.99	72,823	51.86	92,123	35.61	63,262
C25	1,789	5	27.57	49,180	17.02	30,349	43.72	77,979	31.35	55,915	32.75	58,402	33.05	58,940	41.81	74,560	28.71	51,202
Minimum Allowable Concentration at each Monitoring Station (ng/m³)			4,452		2,747		7,059		5,061		5,287		5,335		6,749		4,635	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-3
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 2

Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration [3]	CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
			Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	660	4	78.85	51,696	49.01	32,132	111.58	73,158	86.46	56,684	98.46	64,556	99.45	65,205	125.80	82,476	86.35	56,615
R2	660	8	77.00	50,177	47.86	31,188	108.97	71,010	84.43	55,019	96.16	62,660	97.12	63,290	122.85	80,054	84.33	54,952
R3	660	70	58.51	34,502	36.37	21,445	82.81	48,827	64.16	37,831	73.07	43,085	73.81	43,519	93.35	55,046	64.08	37,785
R4	660	7.5	25.91	16,895	16.10	10,501	36.66	23,909	28.41	18,525	32.35	21,097	32.68	21,310	41.33	26,954	28.37	18,502
R5	660	12	28.96	18,756	18.00	11,658	40.98	26,543	31.75	20,566	36.16	23,422	36.53	23,657	46.20	29,924	31.72	20,541
R6	660	31	11.71	7,359	7.28	4,574	16.57	10,415	12.84	8,069	14.62	9,190	14.77	9,282	18.68	11,741	12.82	8,059
R7	660	36	44.85	28,017	27.88	17,414	63.47	39,649	49.18	30,720	56.01	34,986	56.57	35,338	71.56	44,698	49.12	30,683
R8	660	8	13.77	8,975	8.56	5,578	19.49	12,700	15.10	9,840	17.20	11,207	17.37	11,320	21.97	14,318	15.08	9,828
R9	660	8	6.79	4,423	4.22	2,749	9.60	6,259	7.44	4,849	8.48	5,523	8.56	5,578	10.83	7,056	7.43	4,844
R10	660	11	18.84	12,221	11.71	7,596	26.66	17,295	20.66	13,400	23.53	15,261	23.76	15,415	30.06	19,498	20.63	13,384
R11	660	9	16.69	10,861	10.38	6,751	23.62	15,370	18.30	11,909	20.85	13,563	21.05	13,699	26.63	17,327	18.28	11,894
R12	660	6	7.54	4,913	4.69	3,054	10.67	6,953	8.27	5,387	9.42	6,136	9.51	6,197	12.03	7,839	8.26	5,381
R13	660	3	10.10	6,632	6.28	4,122	14.29	9,385	11.07	7,271	12.61	8,281	12.74	8,365	16.11	10,580	11.06	7,263
R14	660	0.8	22.47	14,805	13.97	9,202	31.80	20,952	24.64	16,234	28.06	18,488	28.34	18,674	35.85	23,620	24.61	16,214
R15	660	0.8	13.90	9,160	8.64	5,693	19.67	12,962	15.24	10,043	17.36	11,438	17.54	11,553	22.18	14,613	15.23	10,031
R16	660	6	30.77	20,112	19.12	12,500	43.54	28,461	33.74	22,052	38.42	25,115	38.81	25,367	49.09	32,086	33.70	22,025
R17	660	2.3	33.06	21,731	20.55	13,507	46.78	30,753	36.25	23,827	41.28	27,137	41.70	27,409	52.74	34,670	36.20	23,798
R18	660	7.5	21.83	14,239	13.57	8,850	30.90	20,151	23.94	15,613	27.27	17,781	27.54	17,960	34.84	22,717	23.91	15,594
R19	660	17	12.74	8,187	7.92	5,089	18.03	11,586	13.97	8,977	15.91	10,223	16.07	10,326	20.32	13,061	13.95	8,966
S1	660	4	21.75	14,261	13.52	8,864	30.78	20,182	23.85	15,637	27.16	17,809	27.44	17,988	34.70	22,752	23.82	15,618
S2	660	2.2	36.76	24,168	22.85	15,022	52.02	34,202	40.31	26,500	45.91	30,180	46.37	30,484	58.65	38,558	40.26	26,468
C1	1,789	80	55.54	94,886	34.52	58,978	78.60	134,280	60.90	104,041	69.35	118,491	70.05	119,682	88.61	151,383	60.82	103,915
C2	1,789	40	50.42	88,160	31.34	54,797	71.35	124,762	55.29	96,666	62.96	110,091	63.60	111,198	80.44	140,652	55.22	96,549
C3	1,789	80	45.00	76,881	27.97	47,786	63.68	108,799	49.34	84,298	56.19	96,006	56.76	96,971	71.79	122,657	49.28	84,196
C4	1,789	73	45.67	78,350	28.39	48,699	64.63	110,879	50.08	85,910	57.03	97,841	57.61	98,824	72.87	125,001	50.02	85,805
C5	1,789	80	41.40	70,739	25.74	43,969	58.59	100,108	45.40	77,565	51.70	88,337	52.22	89,225	66.06	112,859	45.34	77,470
C6	1,789	15	38.01	67,418	23.63	41,904	53.80	95,408	41.68	73,922	47.47	84,189	47.95	85,035	60.65	107,559	41.63	73,833
C7	1,789	14	47.88	84,959	29.76	52,807	67.76	120,232	52.50	93,156	59.79	106,094	60.39	107,161	76.39	135,545	52.43	93,043
C8	1,789	33	33.16	58,215	20.61	36,184	46.93	82,384	36.36	63,831	41.41	72,696	41.83	73,427	52.91	92,876	36.32	63,754
C9	1,789	26	24.37	42,954	15.15	26,699	34.49	60,788	26.72	47,099	30.43	53,640	30.74	54,179	38.88	68,530	26.69	47,041
C10	1,789	50	9.38	16,311	5.83	10,138	13.28	23,083	10.29	17,885	11.72	20,368	11.83	20,573	14.97	26,022	10.27	17,863
C11	1,789	58	5.67	9,816	3.53	6,101	8.03	13,892	6.22	10,763	7.08	12,258	7.15	12,382	9.05	15,661	6.21	10,750
C12	1,789	60	3.29	5,717	2.04	3,553	4.65	8,090	3.61	6,268	4.11	7,139	4.15	7,211	5.25	9,121	3.60	6,261
C13	1,789	19	15.71	27,800	9.77	17,280	22.23	39,342	17.23	30,483	19.62	34,716	19.82	35,065	25.07	44,353	17.21	30,446
C14	1,789	20	11.81	20,880	7.34	12,978	16.71	29,549	12.95	22,895	14.74	26,074	14.89	26,337	18.84	33,313	12.93	22,867
C15	1,789	28	6.55	11,527	4.07	7,165	9.27	16,313	7.18	12,639	8.18	14,395	8.26	14,539	10.45	18,391	7.17	12,624
C16	1,789	6	5.88	10,476	3.65	6,511	8.32	14,825	6.44	11,487	7.34	13,082	7.41	13,213	9.38	16,713	6.44	11,473
C17	1,789	4	11.45	20,440	7.12	12,705	16.21	28,926	12.56	22,412	14.30	25,525	14.44	25,781	18.27	32,610	12.54	22,385
C18	1,789	5	3.95	7,051	2.46	4,382	5.59	9,978	4.33	7,731	4.94	8,805	4.99	8,893	6.31	11,249	4.33	7,722
C19	1,789	2.5	5.37	9,598	3.34	5,965	7.60	13,582	5.89	10,524	6.71	11,985	6.78	12,106	8.57	15,312	5.89	10,511
C20	1,789	5	8.00	14,261	4.97	8,864	11.32	20,182	8.77	15,637	9.99	17,809	10.09	17,988	12.76	22,753	8.76	15,618
C21	1,789	5	10.67	19,031	6.63	11,829	15.10	26,933	11.70	20,868	13.33	23,766	13.46	24,005	17.02	30,363	11.69	20,842
C22	1,789	11	14.64	26,031	9.10	16,180	20.72	36,838	16.06	28,542	18.29	32,506	18.47	32,833	23.36	41,530	16.04	28,508
C23	1,789	40	18.70	32,700	11.62	20,325	26.47	46,276	20.51	35,855	23.35	40,835	23.59	41,245	29.84	52,170	20.48	35,811
C24	1,789	12	32.91	58,462	20.45	36,338	46.57	82,734	36.08	64,102	41.09	73,005	41.51	73,739	52.50	93,271	36.04	64,025
C25	1,789	5	26.62	47,483	16.55	29,514	37.68	67,197	29.19	52,065	33.25	59,295	33.58	59,892	42.48	75,756	29.16	52,002
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			**4,423**		**2,749**		**6,259**		**4,849**		**5,523**		**5,578**		**7,056**		**4,844**	
Representative Receptor Location Requiring Lowest Concentration			**R9**		**R9**		**R9**		**R9**		**R9**		**R9**		**R9**		**R9**	

Table J-3
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 3

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^{3})	Receptor-Specific Annual Average PCB Background Concentration ^{2}	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^{3})
R1	660	4	96.31	63,146	59.04	38,706	136.73	89,648	105.48	69,158	81.52	53,446	81.97	53,741	103.70	67,990	71.37	46,792
R2	660	8	93.25	60,768	57.16	37,249	132.39	86,273	102.13	66,554	78.93	51,434	79.37	51,717	100.41	65,430	69.10	45,031
R3	660	70	70.80	41,745	43.40	25,588	100.51	59,266	77.54	45,720	59.92	35,333	60.25	35,527	76.23	44,948	52.46	30,934
R4	660	7.6	29.79	19,428	18.26	11,909	42.30	27,582	32.63	21,278	25.22	16,444	25.35	16,535	32.08	20,919	22.08	14,397
R5	660	12	33.71	21,829	20.66	13,381	47.85	30,991	36.92	23,908	28.53	18,476	28.69	18,578	36.29	23,504	24.98	16,176
R6	660	31	12.73	8,005	7.81	4,907	18.08	11,365	13.95	8,767	10.78	6,776	10.84	6,813	13.71	8,619	9.44	5,932
R7	660	35	53.70	33,544	32.92	20,562	76.24	47,623	58.81	36,738	45.45	28,391	45.70	28,548	57.82	36,118	39.79	24,857
R8	660	8	16.65	10,853	10.21	6,653	23.64	15,408	18.24	11,886	14.10	9,186	14.17	9,236	17.93	11,686	12.34	8,042
R9	660	8	7.80	5,080	4.78	3,114	11.07	7,212	8.54	5,564	6.60	4,300	6.63	4,323	8.39	5,470	5.78	3,764
R10	660	11	22.06	14,308	13.52	8,770	31.32	20,313	24.16	15,670	18.67	12,110	18.77	12,177	23.75	15,405	16.35	10,602
R11	660	9	19.49	12,681	11.95	7,773	27.67	18,004	21.35	13,889	16.50	10,733	16.59	10,793	20.99	13,654	14.44	9,397
R12	660	8	9.57	6,234	5.86	3,821	13.58	8,850	10.48	6,827	8.10	5,276	8.14	5,305	10.30	6,712	7.09	4,619
R13	660	3	13.34	8,759	8.18	5,369	18.94	12,435	14.61	9,593	11.29	7,414	11.35	7,455	14.36	9,431	9.88	6,491
R14	660	0.8	29.81	19,643	18.28	12,040	42.33	27,887	32.65	21,513	25.23	16,625	25.37	16,717	32.10	21,149	22.09	14,556
R15	660	0.8	19.58	12,900	12.00	7,907	27.80	18,314	21.44	14,128	16.57	10,919	16.66	10,979	21.08	13,890	14.51	9,559
R16	660	6	42.23	27,603	25.89	16,920	59.95	39,189	46.25	30,231	35.74	23,363	35.94	23,492	45.47	29,721	31.29	20,455
R17	660	2.3	44.75	29,413	27.43	18,029	63.53	41,757	49.01	32,213	37.87	24,895	38.08	25,032	48.18	31,669	33.16	21,796
R18	660	7.5	29.20	19,045	17.90	11,674	41.46	27,038	31.98	20,858	24.72	16,120	24.85	16,208	31.44	20,506	21.64	14,113
R19	660	17	17.30	11,117	10.60	6,815	24.56	15,783	18.95	12,176	14.64	9,410	14.72	9,461	18.63	11,970	12.82	8,238
S1	660	4	26.45	17,342	16.21	10,630	37.55	24,621	28.97	18,994	22.39	14,679	22.51	14,759	28.48	18,673	19.60	12,851
S2	660	2.2	49.99	32,867	30.64	20,147	70.98	46,662	54.75	35,997	42.31	27,819	42.55	27,972	53.83	35,389	37.05	24,356
C1	1,789	80	67.10	114,634	41.13	70,267	95.26	162,746	73.48	125,548	56.79	97,025	57.10	97,560	72.24	123,428	49.72	84,946
C2	1,789	40	60.86	106,414	37.31	65,229	86.40	151,077	66.65	116,546	51.51	90,068	51.80	90,565	65.53	114,578	45.10	78,855
C3	1,789	60	54.04	92,320	33.12	56,590	76.72	131,068	59.18	101,111	45.74	78,139	45.99	78,570	58.18	99,403	40.04	68,412
C4	1,789	73	54.85	94,100	33.62	57,680	77.87	133,594	60.08	103,059	46.43	79,645	46.68	80,084	59.06	101,319	40.65	69,730
C5	1,789	80	49.70	84,905	30.46	52,044	70.55	120,540	54.43	92,989	42.06	71,863	42.29	72,259	53.51	91,419	36.83	62,916
C6	1,789	16	44.77	79,402	27.44	48,671	63.56	112,727	49.03	86,962	37.89	67,205	38.10	67,576	48.21	85,493	33.18	58,839
C7	1,789	14	56.07	99,498	34.37	60,989	79.60	141,258	61.41	108,971	47.46	84,214	47.72	84,678	60.37	107,131	41.55	73,730
C8	1,789	33	38.92	68,330	23.86	41,884	55.26	97,009	42.63	74,836	32.94	57,834	33.13	58,153	41.91	73,572	28.84	50,634
C9	1,789	26	28.26	49,802	17.32	30,527	40.12	70,705	30.95	54,544	23.92	42,152	24.05	42,385	30.42	53,623	20.94	36,905
C10	1,789	60	10.05	17,469	6.16	10,708	14.27	24,801	11.01	19,133	8.50	14,786	8.55	14,867	10.82	18,809	7.45	12,945
C11	1,789	58	6.07	10,497	3.72	6,434	8.61	14,903	6.64	11,497	5.13	8,885	5.16	8,934	6.53	11,302	4.50	7,779
C12	1,789	60	3.44	5,974	2.11	3,662	4.88	8,481	3.76	6,542	2.91	5,056	2.92	5,084	3.70	6,432	2.55	4,427
C13	1,789	19	18.10	32,025	11.09	19,631	25.69	45,467	19.82	35,075	15.32	27,106	15.40	27,256	19.49	34,482	13.41	23,732
C14	1,789	20	13.36	23,627	8.19	14,483	18.97	33,544	14.63	25,877	11.31	19,998	11.37	20,108	14.38	25,440	9.90	17,508
C15	1,789	28	7.09	12,474	4.34	7,646	10.06	17,710	7.76	13,662	6.00	10,558	6.03	10,616	7.63	13,431	5.25	9,244
C16	1,789	6	7.91	14,101	4.85	8,644	11.23	20,019	8.66	15,444	6.70	11,935	6.73	12,001	8.52	15,163	5.86	10,449
C17	1,789	4	15.34	27,383	9.40	16,785	21.78	38,875	16.80	29,990	12.98	23,176	13.06	23,304	16.52	29,483	11.37	20,291
C18	1,789	5	5.70	10,175	3.50	6,237	8.10	14,445	6.25	11,143	4.83	8,612	4.86	8,659	6.14	10,955	4.23	7,540
C19	1,789	2.5	7.76	13,859	4.76	8,495	11.02	19,675	8.50	15,178	6.57	11,730	6.60	11,794	8.35	14,922	5.75	10,270
C20	1,789	5	11.48	20,469	7.03	12,547	16.29	29,059	12.57	22,417	9.71	17,324	9.77	17,420	12.36	22,039	8.50	15,168
C21	1,789	6	15.20	27,109	9.32	16,617	21.58	38,486	16.65	29,690	12.86	22,945	12.94	23,071	16.37	29,188	11.26	20,088
C22	1,789	11	20.58	36,576	12.61	22,420	29.21	51,927	22.54	40,059	17.42	30,958	17.51	31,128	22.16	39,382	15.25	27,104
C23	1,789	40	26.20	45,808	16.06	28,079	37.19	65,034	28.69	50,170	22.17	38,772	22.30	38,985	28.21	49,323	19.41	33,945
C24	1,789	12	45.61	81,034	27.96	49,672	64.76	115,044	49.96	88,749	38.61	68,587	38.82	68,965	49.11	87,251	33.80	60,048
C25	1,789	5	36.26	64,676	22.23	39,645	51.48	91,822	39.72	70,835	30.69	54,742	30.86	55,043	39.05	69,638	26.87	47,927
Minimum Allowable Concentration at each Monitoring Station (ng/m^{3})			5,080		3,114		7,212		5,564		4,300		4,323		5,470		3,764	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-3
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Representative Receptor Locations
Emissions: Total PCBs
Project Duration: 5-Year
Year: 4

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration^3	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	660	4	100.95	66,187	61.70	40,451	143.41	94,026	110.53	72,467	79.34	52,020	81.42	53,380	97.45	63,894	70.48	46,207
R2	660	8	97.39	63,465	59.52	38,788	138.36	90,159	106.63	69,486	76.55	49,880	78.55	51,184	94.02	61,266	67.99	44,307
R3	660	70	73.95	43,605	45.20	26,650	105.06	61,946	80.97	47,742	58.12	34,271	59.64	35,167	71.39	42,095	51.63	30,442
R4	660	7.5	30.74	20,046	18.79	12,251	43.67	28,477	33.65	21,947	24.16	15,755	24.79	16,167	29.67	19,351	21.46	13,994
R5	660	12	34.93	22,621	21.35	13,825	49.62	32,135	38.24	24,767	27.45	17,779	28.17	18,244	33.72	21,837	24.38	15,792
R6	660	31	12.97	8,154	7.93	4,983	18.43	11,583	14.20	8,927	10.19	6,408	10.46	6,576	12.52	7,871	9.06	5,692
R7	660	36	55.95	34,946	34.19	21,358	79.48	49,644	61.25	38,261	43.97	27,465	45.12	28,184	54.01	33,735	39.06	24,397
R8	660	8	17.42	11,351	10.65	6,937	24.74	16,125	19.07	12,428	13.69	8,921	14.05	9,154	16.82	10,957	12.16	7,924
R9	660	8	8.04	5,240	4.91	3,202	11.42	7,444	8.80	5,737	6.32	4,118	6.49	4,226	7.76	5,058	5.61	3,658
R10	660	11	22.91	14,859	14.00	9,081	32.54	21,109	25.08	16,269	18.00	11,678	18.48	11,984	22.11	14,344	15.99	10,374
R11	660	9	20.22	13,156	12.36	8,040	28.72	18,689	22.14	14,404	15.89	10,340	16.31	10,610	19.52	12,700	14.12	9,184
R12	660	8	10.13	6,600	6.19	4,034	14.39	9,377	11.09	7,227	7.96	5,188	8.17	5,323	9.78	6,372	7.07	4,608
R13	660	3	14.27	9,373	8.72	5,728	20.28	13,315	15.63	10,262	11.22	7,366	11.51	7,559	13.78	9,048	9.96	6,543
R14	660	0.8	32.15	21,179	19.65	12,944	45.67	30,088	35.20	23,189	25.27	16,646	25.93	17,081	31.03	20,446	22.44	14,786
R15	660	0.8	21.45	14,133	13.11	8,638	30.47	20,077	23.49	15,474	16.86	11,108	17.30	11,398	20.71	13,643	14.98	9,867
R16	660	6	45.94	30,028	28.08	18,352	65.26	42,657	50.30	32,877	36.11	23,600	37.05	24,217	44.35	28,987	32.07	20,963
R17	660	2.3	48.59	31,941	29.70	19,521	69.03	45,376	53.20	34,971	38.19	25,104	39.19	25,760	46.91	30,834	33.92	22,299
R18	660	7.6	31.54	20,570	19.28	12,572	44.81	29,222	34.53	22,521	24.79	16,167	25.44	16,590	30.45	19,857	22.02	14,361
R19	660	17	18.79	12,073	11.48	7,379	26.69	17,151	20.57	13,219	14.77	9,489	15.15	9,737	18.14	11,655	13.12	8,429
S1	660	4	27.65	18,130	16.90	11,080	39.28	25,756	30.28	19,850	21.73	14,249	22.30	14,622	26.69	17,502	19.31	12,657
S2	660	2.2	53.72	35,319	32.83	21,586	76.32	50,174	58.82	38,670	42.22	27,759	43.33	28,485	51.86	34,095	37.51	24,657
C1	1,789	80	70.07	119,717	42.83	73,167	99.54	170,070	76.72	131,075	55.07	94,091	56.51	96,551	67.64	115,569	48.92	83,578
C2	1,789	40	63.51	111,043	38.81	67,865	90.22	157,748	69.53	121,578	49.91	87,274	51.22	89,556	61.31	107,196	44.34	77,523
C3	1,789	80	56.27	96,130	34.39	58,751	79.93	136,563	61.60	105,250	44.22	75,553	45.38	77,529	54.32	92,800	39.28	67,112
C4	1,789	73	57.11	97,970	34.90	59,876	81.13	139,177	62.53	107,265	44.88	76,999	46.06	79,013	55.13	94,576	39.87	68,396
C5	1,789	80	51.67	88,279	31.58	53,953	73.40	125,410	56.57	96,655	40.61	69,383	41.67	71,197	49.88	85,221	36.07	61,631
C6	1,789	15	46.50	82,465	28.42	50,399	66.06	117,150	50.91	90,288	36.55	64,813	37.50	66,507	44.89	79,608	32.46	57,571
C7	1,789	14	57.92	102,781	35.40	62,816	82.28	146,012	63.42	112,533	45.52	80,781	46.71	82,893	55.91	99,220	40.44	71,755
C8	1,789	33	40.36	70,850	24.67	43,301	57.33	100,650	44.19	77,572	31.72	55,685	32.55	57,141	38.96	68,396	28.18	49,463
C9	1,789	28	29.14	51,364	17.81	31,392	41.40	72,968	31.91	56,237	22.90	40,369	23.50	41,425	28.13	49,585	20.35	35,859
C10	1,789	60	10.20	17,735	6.23	10,839	14.49	25,195	11.17	19,418	8.02	13,939	8.23	14,303	9.85	17,121	7.12	12,382
C11	1,789	58	6.16	10,654	3.76	6,511	8.75	15,135	6.74	11,665	4.84	8,373	4.97	8,592	5.94	10,285	4.30	7,438
C12	1,789	50	3.47	6,031	2.12	3,686	4.93	8,568	3.80	6,603	2.73	4,740	2.80	4,864	3.35	5,822	2.42	4,211
C13	1,789	19	18.71	33,116	11.44	20,239	26.59	47,045	20.49	36,258	14.71	26,027	15.09	26,708	18.07	31,969	13.07	23,119
C14	1,789	20	13.76	24,331	8.41	14,870	19.54	34,565	15.06	26,640	10.81	19,123	11.10	19,623	13.28	23,488	9.61	16,987
C15	1,789	28	7.24	12,743	4.42	7,788	10.28	18,103	7.93	13,952	5.69	10,015	5.84	10,277	6.99	12,302	5.05	8,896
C16	1,789	6	8.53	15,197	5.21	9,288	12.11	21,588	9.33	16,638	6.70	11,944	6.88	12,256	8.23	14,670	5.95	10,609
C17	1,789	4	16.37	29,215	10.00	17,855	23.25	41,503	17.92	31,987	12.86	22,962	13.20	23,562	15.80	28,203	11.43	20,396
C18	1,789	5	6.26	11,165	3.83	6,823	8.89	15,860	6.85	12,224	4.92	8,775	5.05	9,004	6.04	10,778	4.37	7,794
C19	1,789	2.5	8.46	15,115	5.17	9,237	12.02	21,472	9.27	16,549	6.65	11,879	6.83	12,190	8.17	14,591	5.91	10,552
C20	1,789	5	12.51	22,304	7.64	13,632	17.77	31,685	13.69	24,420	9.83	17,530	10.09	17,988	12.07	21,531	8.73	15,571
C21	1,789	5	16.54	29,501	10.11	18,030	23.50	41,910	18.11	32,300	13.00	23,186	13.34	23,793	15.97	28,479	11.55	20,596
C22	1,789	11	22.27	39,588	13.61	24,195	31.64	56,239	24.38	43,344	17.50	31,114	17.96	31,928	21.50	38,217	15.55	27,638
C23	1,789	40	28.39	49,642	17.35	30,340	40.33	70,522	31.08	54,352	22.31	39,016	22.90	40,036	27.41	47,922	19.82	34,657
C24	1,789	12	49.50	87,938	30.25	53,744	70.32	124,925	54.20	96,281	38.90	69,114	39.92	70,921	47.79	84,891	34.56	61,392
C25	1,789	5	39.47	70,400	24.12	43,026	56.08	100,011	43.22	77,079	31.02	55,331	31.83	56,777	38.11	67,961	27.56	49,149
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			5,240		3,202		7,444		5,737		4,118		4,226		5,058		3,658	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-4

Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 1

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m³)	Receptor-Specific Annual Average PCB Background Concentration ³	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)
R1	660	4	90.61	59,410	70.05	45,928	157.79	103,454	121 93	79,941	108.82	71,348	130 42	85,508	151 39	99,256	104.53	68,535
R2	660	8	64.35	41,933	49.75	32,418	112.06	73,021	86 59	56,425	77 28	50,360	92 62	60,354	107.51	70,058	74 24	48,374
R3	660	70	58.60	34,554	45.30	26,713	102 05	60,171	78 85	46,495	70 38	41 497	84.34	49,733	97.91	57,729	67.60	39,861
R4	*660*	*7.5*	*28 22*	*18,406*	*21.82*	*14,229*	*49 15*	*32,052*	*37 98*	*24,767*	*33 90*	*22,105*	*40.62*	*26,492*	*47.15*	*30,751*	*32.56*	*21,233*
R5	660	12	30 04	19,454	23.22	15,040	52.31	33,877	40 42	26,177	36.07	23,363	43 23	28,000	50.19	32,502	34.65	22,442
R6	660	31	13.70	8,612	10.59	6,658	23.86	14,996	18 43	11,588	16 45	10,342	19 72	12,395	22 89	14,388	15 80	9,935
R7	660	35	44.82	27,998	34.65	21,645	78.05	48,754	60 31	37,673	53 83	33,624	64.51	40,297	74 89	46,776	51 71	32,298
R8	660	8	15.72	10,241	12.15	7,917	27.37	17,833	21 15	13,780	18 87	12,299	22 62	14,740	26.26	17,110	18 13	11,814
R9	660	8	6.23	4,062	4.82	3,140	10.85	7,073	8.39	5,465	7 49	4,878	8 97	5,846	10.41	6,788	7.19	4,685
R10	660	11	18.46	11,972	14.27	9,255	32.14	20,848	24.84	16,109	22.17	14,378	26.57	17,231	30.84	20,002	21.29	13,811
R11	660	9	15.40	10,020	11 91	7,746	26 82	17,448	20.72	13,483	18.49	12,033	22.17	14,421	25.73	16,740	17 77	11,559
R12	660	8	8.03	5,230	6.20	4,043	13 98	9,107	10 80	7,037	9 64	6,281	11.55	7,527	13.41	8,738	9.26	6,033
R13	660	3	9.48	6,226	7.33	4,813	16.51	10,842	12.76	8,378	11.39	7,478	13.65	8,962	15.84	10,402	10 94	7,183
R14	660	0.8	22.73	14,978	17.58	11,579	39.59	26,083	30.59	20,155	27 30	17,988	32.72	21,558	37.98	25,024	26 23	17,279
R15	660	0.8	13.69	9,021	10 59	6,974	23.84	15,709	18.42	12,138	16.44	10,834	19 71	12,984	22.88	15,071	15 80	10,407
R16	660	6	26.88	17,573	20.78	13,585	46.82	30,601	36.18	23,646	32.29	21,104	38.69	25,292	44.92	29,359	31 01	20,272
R17	660	2.3	28.85	18,966	22 31	14,662	50.24	33,027	38.82	25,521	34 65	22,777	41.53	27,298	48.21	31,687	33.28	21,879
R18	660	7.5	20.69	13,493	16.00	10,431	36 03	23,497	27.84	18,156	24.85	16,205	29.78	19,421	34 57	22,543	23.87	15,566
R19	660	17	12.36	7,941	9.55	6,139	21 52	13,828	16 63	10,685	14 84	9,536	17 78	11,429	20 64	13,266	14 25	9,160
S1	660	4	18.73	12,280	14.48	9,494	32.62	21,384	25.20	16,524	22.49	14,748	26.96	17,675	31 29	20,517	21.61	14,166
S2	660	2.2	31.26	20,553	24.17	15,889	54.44	35,791	42.07	27,656	37.54	24,683	45.00	29,582	52 23	34,338	36.06	23,710
C1	1,789	80	59 15	101,057	45.73	78,125	103.00	175,978	79 59	135,981	71 04	121,364	85.13	145,450	98.82	168,837	68 24	116,580
C2	1,789	40	48.56	84,904	37 54	65,637	84 56	147,849	65.34	114,245	58 32	101,965	69.89	122,201	81 13	141,850	56.02	97,945
C3	1,789	80	49.94	85,325	38.61	65,963	86.97	148,582	67.20	114,812	59 98	102,471	71.88	122,807	83.44	142,553	57 61	98,431
C4	1,789	73	46.70	80,116	36.10	61,936	81.32	139,511	62 84	107,803	56.09	96,215	67.22	115,310	78 02	133,850	53 87	92,422
C5	1,789	80	41.35	70,651	31.97	54,619	72.01	123,029	55.64	95,066	49.66	84,848	59.52	101,687	69.09	118,037	47.70	81,503
C6	*1,789*	*16*	*41.40*	*73,416*	*32.00*	*56,756*	*72.09*	*127,844*	*55.70*	*98,787*	*49 71*	*88,166*	*59.56*	*105,666*	*69 16*	*122,656*	*47.75*	*84,693*
C7	1,789	14	42.06	74,632	32.51	57,697	73.24	129,962	56 59	100,424	50 51	89,629	60.53	107,417	70 27	124,689	48 52	86,096
C8	1,789	33	34.71	60,930	26 83	47,104	60.44	106,101	46 70	81,986	41.68	73,174	49.95	87,696	57 99	101,796	40 04	70,289
C9	1,789	26	24.29	42,815	18.78	33,099	42.30	74,556	32 69	57,611	29.17	51,418	34 96	61,623	40.59	71,531	28.02	49,391
C10	1,789	60	9 47	16,470	7 32	12,732	16.50	28,679	12.75	22,161	11 38	19,779	13 63	23,704	15.83	27,516	10.93	18,999
C11	1,789	58	5.23	9,053	4 04	6,998	9.11	15,764	7.04	12,181	6 28	10,872	7.53	13,029	8 74	15,124	6.03	10,443
C12	1,789	50	2.91	5,066	2.25	3,916	5.07	8,822	3 92	6,817	3 50	6,084	4 19	7,291	4 87	8,464	3.36	5,844
C13	1,789	19	15.48	27,384	11.96	21,170	26.95	47,685	20.82	36,847	18.59	32,886	22 27	39,413	25.85	45,750	17.85	31,590
C14	1,789	20	10.59	18,736	8.19	14,484	18.45	32,626	14 26	25,211	12.72	22,501	15.25	26,966	17.70	31,302	12 22	21,614
C15	1,789	28	5.96	10,490	4.61	8,110	10.38	18,267	8.02	14,116	7.16	12,598	8.58	15,098	9 96	17,526	6.87	12,102
C16	1,789	6	6.65	11,861	5.14	9,169	11 59	20,654	8.95	15,960	7 99	14,244	9.58	17,071	11.12	19,816	7.68	13,683
C17	1,789	4	9.42	16,811	7 28	12,996	16 40	29,274	12.67	22,620	11 31	20,189	13 55	24,195	15.73	28,086	10 86	19,393
C18	1,789	5	3.75	6,693	2.90	5,174	6.53	11,654	5.05	9,006	4 51	8,038	5 40	9,633	6.27	11,182	4 33	7,721
C19	1,789	2.5	5.00	8,924	3.86	6,899	8.70	15,541	6 72	12,009	6.00	10,718	7.19	12,845	8.35	14,910	5.76	10,295
C20	1,789	5	7.00	12,479	5.41	9,647	12.18	21,731	9.42	16,792	8.40	14,987	10 07	17,961	11.69	20,849	8 07	14,396
C21	*1,789*	*5*	*9.47*	*16,897*	*7.32*	*13,063*	*16.50*	*29,424*	*12.75*	*22,737*	*11.38*	*20,293*	*13 64*	*24,320*	*15.83*	*28,230*	*10.93*	*19,493*
C22	1,789	11	11 26	20,020	8 71	15,477	19.61	34,862	15 16	26,939	13.53	24,043	16.21	28,815	18 82	33,448	12.99	23,095
C23	1,789	40	15.70	27,445	12.13	21,217	27.33	47,792	21.12	36,929	18.85	32,960	22.59	39,501	26 22	45,852	18 11	31,661
C24	1,789	12	30.53	54,241	23.60	41,933	53.17	94,454	41 08	72,986	36 67	65,141	43.95	78,069	51.01	90,621	35 22	62,573
C25	1,789	8	23 26	41,485	17 98	32,071	40.51	72,241	31 30	55,822	27 93	49,822	33.48	59,709	38.86	69,310	26 83	47,858
Minimum Allowable Concentration at each Monitoring Station (ng/m³)			4,062		3,140		7,073		5,465		4,878		5,846		6,788		4,685	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-4
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 2

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m³)	Receptor-Specific Annual Average PCB Background Concentration[3]	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)
R1	660	4	92.06	60,357	71.88	47,124	141.90	93,033	120.79	79,197	116.59	76,438	139.90	91,725	162.38	106,466	112.07	73,476
R2	660	8	67.58	44,039	52.77	34,384	104.17	67,881	88.68	57,786	85.59	55,773	102.71	66,927	119.21	77,682	82.27	53,612
R3	660	70	59.32	34,976	46.31	27,307	91.43	53,910	77.83	45,893	75.12	44,294	90.14	53,153	104.63	61,695	72.21	42,578
R4	660	7.5	28.01	18,266	21.87	14,261	43.17	28,154	36.75	23,967	35.47	23,132	42.56	27,758	49.41	32,219	34.10	22,236
R5	660	12	29.79	19,292	23.26	15,063	45.92	29,737	39.09	25,314	37.73	24,432	45.27	29,319	52.55	34,030	36.26	23,486
R6	660	31	13.73	8,633	10.72	6,740	21.17	13,306	18.02	11,327	17.39	10,933	20.87	13,119	24.22	15,227	16.72	10,509
R7	660	35	44.08	27,532	34.41	21,495	67.94	42,436	57.83	36,125	55.82	34,867	66.98	41,840	77.75	48,564	53.66	33,516
R8	660	8	15.58	10,154	12.17	7,928	24.02	15,651	20.45	13,323	19.73	12,859	23.68	15,431	27.49	17,911	18.97	12,361
R9	660	8	6.23	4,062	4.87	3,171	9.61	6,261	8.18	5,330	7.89	5,144	9.47	6,173	11.00	7,165	7.59	4,945
R10	660	11	18.38	11,922	14.35	9,308	28.33	18,377	24.12	15,644	23.28	15,099	27.93	18,118	32.42	21,030	22.38	14,514
R11	660	9	15.50	10,083	12.10	7,872	23.89	15,542	20.33	13,230	19.63	12,769	23.55	15,323	27.34	17,786	18.87	12,275
R12	660	8	7.86	5,121	6.14	3,998	12.11	7,893	10.31	6,719	9.95	6,485	11.94	7,782	13.86	9,033	9.57	6,234
R13	660	3	9.20	6,040	7.18	4,716	14.18	9,310	12.07	7,926	11.65	7,650	13.98	9,179	16.23	10,655	11.20	7,353
R14	660	0.8	22.08	14,547	17.24	11,358	34.03	22,422	28.97	19,088	27.96	18,423	33.55	22,107	38.95	25,660	26.88	17,709
R15	660	0.8	13.10	8,629	10.23	6,737	20.19	13,300	17.19	11,322	16.59	10,928	19.90	13,114	23.10	15,221	15.94	10,505
R16	660	6	25.84	16,893	20.18	13,189	39.84	26,038	33.91	22,166	32.73	21,394	39.28	25,672	45.59	29,798	31.46	20,565
R17	660	2.3	27.84	18,298	21.73	14,286	42.91	28,204	36.52	24,009	35.25	23,173	42.30	27,807	49.10	32,276	33.89	22,275
R18	660	7.5	20.00	13,043	15.61	10,183	30.83	20,103	26.24	17,114	25.33	16,517	30.39	19,821	35.28	23,006	24.35	15,877
R19	660	17	11.95	7,678	9.33	5,994	18.41	11,834	15.68	10,074	15.13	9,723	18.16	11,668	21.07	13,543	14.54	9,346
S1	660	4	18.42	12,077	14.38	9,429	28.39	18,616	24.17	15,847	23.33	15,295	27.99	18,354	32.49	21,304	22.42	14,702
S2	660	2.2	30.05	19,759	23.47	15,427	46.32	30,456	39.44	25,926	38.06	25,023	45.67	30,028	53.01	34,853	36.59	24,054
C1	1,789	80	63.98	109,303	49.95	85,339	98.61	168,476	83.95	143,420	81.02	138,424	97.22	166,108	112.85	192,802	77.88	133,061
C2	1,789	40	48.34	84,525	37.74	65,993	74.51	130,284	63.43	110,908	61.22	107,044	73.46	128,452	85.27	149,095	58.85	102,897
C3	1,789	80	50.99	87,115	39.81	68,015	78.59	134,276	66.90	114,306	64.57	110,324	77.49	132,388	89.94	153,664	62.07	106,050
C4	1,789	73	46.95	80,550	36.66	62,889	72.37	124,156	61.61	105,692	59.46	102,010	71.36	122,411	82.82	142,083	57.16	98,058
C5	1,789	80	41.78	71,388	32.62	55,736	64.40	110,034	54.83	93,670	52.92	90,407	63.50	108,488	73.70	125,922	50.87	86,904
C6	1,789	15	40.75	72,266	31.81	56,422	62.81	111,388	53.47	94,822	51.60	91,519	61.92	109,822	71.88	127,471	49.60	87,973
C7	1,789	14	42.79	75,924	33.41	59,278	65.95	117,026	56.14	99,622	54.19	96,152	65.02	115,382	75.47	133,924	52.09	92,427
C8	1,789	33	34.27	60,164	26.76	46,973	52.83	92,735	44.97	78,943	43.40	76,193	52.08	91,432	60.45	106,125	41.72	73,241
C9	1,789	26	24.10	42,476	18.82	33,163	37.15	65,471	31.62	55,734	30.52	53,792	36.62	64,551	42.51	74,924	29.34	51,708
C10	1,789	50	9.59	16,680	7.49	13,023	14.79	25,711	12.59	21,887	12.15	21,124	14.58	25,349	16.92	29,423	11.68	20,306
C11	1,789	58	5.16	8,930	4.03	6,972	7.95	13,764	6.77	11,717	6.54	11,309	7.84	13,571	9.10	15,752	6.28	10,871
C12	1,789	50	2.99	5,196	2.33	4,056	4.61	8,008	3.92	6,817	3.78	6,580	4.54	7,896	5.27	9,165	3.64	6,325
C13	1,789	19	15.59	27,578	12.17	21,532	24.02	42,508	20.45	36,186	19.74	34,925	23.68	41,910	27.49	48,646	18.97	33,572
C14	1,789	20	10.80	19,102	8.43	14,914	16.65	29,442	14.17	25,064	13.68	24,191	16.41	29,029	19.05	33,694	13.15	23,253
C15	1,789	28	6.04	10,633	4.72	8,302	9.31	16,389	7.92	13,952	7.65	13,466	9.18	16,159	10.65	18,756	7.35	12,944
C16	1,789	6	6.43	11,465	5.02	8,951	9.91	17,672	8.44	15,044	8.15	14,519	9.77	17,423	11.35	20,223	7.83	13,957
C17	1,789	4	9.06	16,167	7.07	12,623	13.96	24,919	11.88	21,213	11.47	20,474	13.76	24,569	15.98	28,518	11.03	19,681
C18	1,789	5	3.57	6,367	2.79	4,971	5.50	9,814	4.68	8,354	4.52	8,063	5.43	9,676	6.30	11,231	4.35	7,751
C19	1,789	2.5	4.76	8,493	3.71	6,631	7.33	13,091	6.24	11,144	6.02	10,756	7.23	12,907	8.39	14,982	5.79	10,339
C20	1,789	5	6.67	11,896	5.21	9,288	10.28	18,337	8.75	15,610	8.45	15,066	10.14	18,079	11.77	20,984	8.12	14,482
C21	1,789	5	9.04	16,127	7.06	12,591	13.94	24,857	11.86	21,160	11.45	20,423	13.74	24,508	15.95	28,446	11.01	19,632
C22	1,789	11	10.75	19,108	8.39	14,919	16.57	29,452	14.11	25,072	13.61	24,199	16.34	29,038	18.96	33,705	13.09	23,261
C23	1,789	40	15.08	26,372	11.78	20,590	23.25	40,649	19.79	34,604	19.10	33,398	22.92	40,078	26.60	46,518	18.36	32,104
C24	1,789	12	29.41	52,242	22.96	40,788	45.33	80,525	38.59	68,549	37.24	66,161	44.69	79,393	51.87	92,152	35.80	63,598
C25	1,789	5	22.38	39,910	17.47	31,160	34.49	61,516	29.36	52,368	28.34	50,543	34.01	60,652	39.47	70,399	27.24	48,585
Minimum Allowable Concentration at each Monitoring Station (ng/m³)			4,062		3,171		6,261		5,330		5,144		6,173		7,165		4,945	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-4
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 3

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m³)	Receptor-Specific Annual Average PCB Background Concentration 3	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)
R1	660	4	111.77	73,279	86.44	56,674	172.82	113,310	146.78	96,238	96.05	62,971	114.49	75,064	132.92	87,147	92.01	60,327
R2	660	8	80.79	52,646	62.48	40,717	124.93	81,406	106.10	69,141	69.43	45,241	82.76	53,929	96.08	62,610	66.51	43,341
R3	660	70	70.56	41,603	54.57	32,176	109.10	64,330	92.66	54,638	60.63	35,751	72.28	42,617	83.91	49,477	58.09	34,250
R4	660	7.5	33.34	21,740	25.78	16,814	51.55	33,616	43.78	28,551	28.65	18,682	34.15	22,270	39.65	25,854	27.44	17,897
R5	660	12	35.17	22,780	27.20	17,618	54.39	35,225	46.19	29,917	30.23	19,576	36.03	23,335	41.83	27,092	28.96	18,754
R6	660	31	15.26	9,595	11.80	7,421	23.60	14,837	20.05	12,601	13.12	8,245	15.64	9,829	18.15	11,411	12.57	7,899
R7	660	35	54.12	33,807	41.86	26,147	83.69	52,276	71.08	44,400	46.51	29,052	55.44	34,631	64.37	40,206	44.56	27,832
R8	660	8	18.45	12,023	14.27	9,299	28.53	18,591	24.23	15,790	15.86	10,332	18.90	12,316	21.94	14,299	15.19	9,898
R9	660	8	7.12	4,638	5.50	3,587	11.01	7,172	9.35	6,091	6.12	3,986	7.29	4,751	8.46	5,516	5.86	3,818
R10	660	11	21.21	13,755	16.40	10,639	32.79	21,270	27.85	18,065	18.22	11,821	21.72	14,091	25.22	16,359	17.46	11,324
R11	660	9	17.64	11,479	13.64	8,878	27.28	17,749	23.17	15,075	15.16	9,864	18.07	11,758	20.98	13,651	14.52	9,450
R12	660	8	9.73	6,342	7.53	4,905	15.05	9,807	12.78	8,329	8.36	5,450	9.97	6,497	11.57	7,542	8.01	5,221
R13	660	3	12.08	7,935	9.35	6,137	18.69	12,270	15.87	10,421	10.38	6,819	12.38	8,128	14.37	9,437	9.95	6,532
R14	660	0.8	28.96	19,077	22.39	14,754	44.77	29,499	38.03	25,054	24.88	16,394	29.66	19,542	34.44	22,688	23.84	15,705
R15	660	0.8	18.41	12,131	14.24	9,382	28.47	18,757	24.18	15,931	15.82	10,424	18.86	12,426	21.90	14,426	15.16	9,987
R16	660	6	35.52	23,220	27.48	17,959	54.93	35,905	46.66	30,496	30.53	19,954	36.39	23,786	42.25	27,615	29.25	19,116
R17	660	2.3	37.45	24,617	28.96	19,039	57.91	38,066	49.18	32,330	32.18	21,155	38.36	25,217	44.54	29,277	30.83	20,266
R18	660	7.5	26.65	17,382	20.61	13,444	41.22	26,878	35.01	22,828	22.91	14,937	27.30	17,806	31.70	20,672	21.94	14,310
R19	660	17	15.91	10,225	12.31	7,908	24.60	15,811	20.90	13,429	13.67	8,787	16.30	10,474	18.92	12,160	13.10	8,418
S1	660	4	22.46	14,725	17.37	11,388	34.73	22,769	29.50	19,338	19.30	12,654	23.01	15,084	26.71	17,512	18.49	12,122
S2	660	2.2	41.19	27,079	31.85	20,943	63.69	41,871	54.09	35,563	35.39	23,270	42.19	27,738	48.98	32,203	33.91	22,292
C1	1,789	80	76.95	131,463	59.51	101,674	118.98	203,280	101.06	172,653	66.12	112,972	78.82	134,667	91.51	156,344	63.35	108,228
C2	1,789	40	57.47	100,494	44.45	77,723	88.87	155,393	75.48	131,980	49.39	86,359	58.88	102,943	68.35	119,514	47.32	82,732
C3	1,789	80	61.02	104,256	47.19	80,632	94.36	161,210	80.14	136,921	52.44	89,592	62.51	106,797	72.57	123,988	50.24	85,830
C4	1,789	73	55.30	94,872	42.77	73,374	85.51	146,698	72.63	124,596	47.52	81,527	56.65	97,184	65.77	112,827	45.53	78,103
C5	1,789	80	49.09	83,879	37.97	64,872	75.91	129,700	64.48	110,159	42.19	72,080	50.29	85,923	58.39	99,754	40.42	69,053
C6	1,789	15	50.19	89,004	38.81	68,836	77.60	137,625	65.91	116,890	43.13	76,484	51.41	91,173	59.68	105,848	41.32	73,272
C7	1,789	14	50.45	89,517	39.02	69,233	78.00	138,418	66.25	117,564	43.35	76,925	51.68	91,698	59.99	106,459	41.53	73,695
C8	1,789	33	41.17	72,267	31.84	55,891	63.65	111,745	54.06	94,909	35.38	62,102	42.17	74,028	48.96	85,944	33.89	59,494
C9	1,789	26	27.83	49,042	21.52	37,929	43.03	75,833	36.54	64,407	23.91	42,144	28.50	50,237	33.09	58,324	22.91	40,374
C10	1,789	50	10.22	17,775	7.91	13,747	15.81	27,485	13.43	23,344	8.79	15,275	10.47	18,208	12.16	21,139	8.42	14,633
C11	1,789	58	5.51	9,538	4.26	7,377	8.52	14,748	7.24	12,526	4.74	8,196	5.65	9,770	6.55	11,343	4.54	7,852
C12	1,789	50	3.10	5,397	2.40	4,174	4.80	8,345	4.08	7,088	2.67	4,638	3.18	5,528	3.69	6,418	2.56	4,443
C13	1,789	19	17.68	31,277	13.67	24,190	27.33	48,363	23.21	41,077	15.19	26,878	18.11	32,039	21.02	37,197	14.55	25,749
C14	1,789	20	11.96	21,144	9.25	16,353	18.49	32,695	15.70	27,769	10.27	18,170	12.25	21,660	14.22	25,146	9.84	17,407
C15	1,789	28	6.46	11,378	5.00	8,800	9.99	17,594	8.49	14,943	5.55	9,778	6.62	11,655	7.69	13,532	5.32	9,367
C16	1,789	6	8.53	15,201	6.60	11,757	13.19	23,505	11.20	19,964	7.33	13,063	8.74	15,572	10.14	18,078	7.02	12,514
C17	1,789	4	12.35	22,042	9.55	17,047	19.09	34,083	16.22	28,948	10.61	18,942	12.65	22,579	14.69	26,214	10.17	18,146
C18	1,789	5	5.16	9,203	3.99	7,118	7.98	14,231	6.78	12,087	4.43	7,909	5.29	9,427	6.14	10,945	4.25	7,576
C19	1,789	2.5	6.87	12,267	5.31	9,488	10.62	18,969	9.02	16,111	5.90	10,542	7.04	12,566	8.17	14,589	5.65	10,099
C20	1,789	5	9.56	17,048	7.39	13,185	14.78	26,361	12.55	22,389	8.21	14,650	9.79	17,463	11.37	20,274	7.87	14,035
C21	1,789	5	12.88	22,963	9.96	17,760	19.91	35,507	16.91	30,158	11.06	19,733	13.19	23,523	15.31	27,309	10.60	18,904
C22	1,789	11	15.30	27,190	11.83	21,029	23.65	42,044	20.09	35,709	13.15	23,366	15.67	27,853	18.19	32,336	12.59	22,384
C23	1,789	40	20.74	36,271	16.04	28,052	32.08	56,086	27.24	47,635	17.83	31,169	21.25	37,155	24.67	43,136	17.08	29,860
C24	1,789	12	40.06	71,172	30.99	55,045	61.95	110,053	52.62	93,472	34.43	61,161	41.04	72,907	47.65	84,642	32.98	58,593
C25	1,789	6	30.64	54,653	23.70	42,269	47.38	84,510	40.25	71,777	26.33	46,966	31.39	55,985	36.44	64,997	25.23	44,994
Minimum Allowable Concentration at each Monitoring Station (ng/m³)			4,638		3,587		7,172		6,091		3,986		4,751		5,516		3,818	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-4
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 5-Year
Year: 4

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration[3]	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	660	4	116.82	76,590	90.18	59,122	180.76	118,514	153.44	100,603	92.63	60,729	113.44	74,373	124.45	81,597	90.26	59,177
R2	660	8	84.16	54,843	64.97	42,335	130.23	84,863	110.55	72,038	66.73	43,486	81.73	53,255	89.66	58,428	65.03	42,374
R3	660	70	73.39	43,274	56.65	33,405	113.56	66,962	96.40	56,842	58.19	34,313	71.27	42,022	78.19	46,103	56.71	33,436
R4	660	7.5	34.74	22,656	26.82	17,489	53.76	35,057	45.63	29,759	27.55	17,964	33.74	22,000	37.01	24,137	26.84	17,505
R5	660	12	36.59	23,696	28.24	18,292	56.62	36,667	48.06	31,126	29.01	18,789	35.53	23,010	38.98	25,245	28.27	18,309
R6	660	31	15.64	9,829	12.07	7,587	24.19	15,209	20.54	12,911	12.40	7,794	15.18	9,545	16.66	10,472	12.08	7,594
R7	660	35	56.65	35,385	43.73	27,315	87.66	54,754	74.41	46,479	44.92	28,057	55.01	34,361	60.35	37,698	43.77	27,340
R8	660	8	19.16	12,487	14.79	9,639	29.65	19,323	25.17	16,402	15.19	9,901	18.61	12,126	20.42	13,304	14.81	9,648
R9	660	8	7.35	4,791	5.68	3,698	11.38	7,414	9.66	6,293	5.83	3,799	7.14	4,652	7.83	5,104	5.68	3,702
R10	660	11	21.98	14,255	16.97	11,004	34.01	22,059	28.87	18,725	17.43	11,303	21.34	13,843	23.41	15,187	16.98	11,015
R11	660	9	18.15	11,806	14.01	9,114	28.08	18,269	23.83	15,508	14.39	9,361	17.62	11,464	19.33	12,578	14.02	9,122
R12	660	8	10.16	6,622	7.84	5,112	15.73	10,247	13.35	8,698	8.06	5,251	9.87	6,431	10.83	7,055	7.85	5,117
R13	660	3	13.01	8,541	10.04	6,593	20.13	13,217	17.09	11,219	10.31	6,773	12.63	8,294	13.86	9,100	10.05	6,599
R14	660	0.8	30.78	20,277	23.76	15,652	47.62	31,376	40.43	26,634	24.40	16,078	29.89	19,690	32.79	21,602	23.78	15,667
R15	660	0.8	19.98	13,166	15.43	10,164	30.92	20,373	26.25	17,294	15.85	10,440	19.41	12,785	21.29	14,027	15.44	10,173
R16	660	6	38.43	25,119	29.66	19,390	59.46	38,868	50.48	32,994	30.47	19,917	37.32	24,391	40.94	26,761	29.69	19,408
R17	660	2.3	40.69	26,748	31.41	20,648	62.96	41,389	53.45	35,134	32.26	21,209	39.51	25,974	43.35	28,497	31.44	20,667
R18	660	7.6	28.90	18,849	22.31	14,550	44.73	29,167	37.97	24,759	22.92	14,946	28.07	18,304	30.79	20,082	22.33	14,564
R19	660	17	17.12	10,999	13.21	8,490	26.48	17,020	22.48	14,447	13.57	8,721	16.62	10,681	18.23	11,718	13.22	8,498
S1	660	4	23.69	15,531	18.29	11,989	36.66	24,033	31.12	20,401	18.78	12,315	23.00	15,082	25.24	16,547	18.30	12,000
S2	660	2.2	44.73	29,404	34.52	22,698	69.21	45,500	58.75	38,623	35.46	23,315	43.43	28,553	47.65	31,327	34.56	22,719
C1	1,789	80	80.22	137,062	61.93	105,803	124.14	212,088	105.38	180,035	63.61	108,679	77.90	133,095	85.47	146,023	61.98	105,901
C2	1,789	40	59.76	104,496	46.13	80,664	92.48	161,695	78.50	137,258	47.39	82,856	58.03	101,471	63.67	111,327	46.18	80,739
C3	1,789	80	63.41	108,337	48.95	83,629	98.12	167,639	83.29	142,304	50.28	85,902	61.58	105,201	67.56	115,420	48.99	83,707
C4	1,789	73	57.32	98,341	44.25	75,912	88.70	152,171	75.30	129,173	45.45	77,976	55.67	95,494	61.07	104,770	44.29	75,983
C5	1,789	80	50.81	86,805	39.22	67,008	78.62	134,321	66.74	114,021	40.29	68,829	49.34	84,293	54.13	92,480	39.26	67,070
C6	1,789	15	52.77	93,595	40.74	72,249	81.66	144,828	69.32	122,940	41.85	74,213	51.25	90,886	56.22	99,714	40.78	72,317
C7	1,789	14	52.27	92,752	40.35	71,598	80.88	143,523	68.66	121,832	41.45	73,544	50.76	90,067	55.69	98,815	40.39	71,665
C8	1,789	33	42.93	75,370	33.14	58,181	66.44	116,627	56.39	99,001	34.04	59,762	41.69	73,189	45.74	80,298	33.17	58,235
C9	1,789	26	28.66	50,519	22.13	38,997	44.35	78,172	37.65	66,358	22.73	40,057	27.83	49,056	30.54	53,821	22.15	39,033
C10	1,789	50	10.36	18,016	8.00	13,907	16.04	27,878	13.61	23,665	8.22	14,285	10.06	17,495	11.04	19,194	8.01	13,920
C11	1,789	58	5.60	9,686	4.32	7,477	8.66	14,988	7.35	12,723	4.44	7,680	5.44	9,406	5.96	10,319	4.32	7,484
C12	1,789	60	3.13	5,441	2.42	4,200	4.84	8,419	4.11	7,147	2.48	4,314	3.04	5,283	3.33	5,797	2.42	4,204
C13	1,789	19	18.20	32,204	14.05	24,860	28.16	49,833	23.91	42,301	14.43	25,535	17.67	31,272	19.39	34,310	14.06	24,883
C14	1,789	20	12.26	21,683	9.46	16,738	18.97	33,552	16.10	28,481	9.72	17,193	11.91	21,055	13.06	23,100	9.47	16,753
C15	1,789	28	6.58	11,585	5.08	8,942	10.18	17,926	8.64	15,217	5.22	9,186	6.39	11,249	7.01	12,342	5.08	8,951
C16	1,789	6	9.08	16,186	7.01	12,495	14.05	25,047	11.93	21,261	7.20	12,834	8.82	15,718	9.67	17,245	7.02	12,506
C17	1,789	4	13.19	23,545	10.18	18,176	20.41	36,434	17.33	30,928	10.46	18,670	12.81	22,864	14.05	25,085	10.19	18,192
C18	1,789	5	5.46	9,746	4.22	7,523	8.46	15,081	7.18	12,802	4.33	7,728	5.31	9,464	5.82	10,383	4.22	7,530
C19	1,789	2.5	7.48	13,364	5.78	10,316	11.58	20,679	9.83	17,554	5.93	10,596	7.27	12,977	7.97	14,237	5.78	10,326
C20	1,789	5	10.42	18,588	8.05	14,349	16.13	28,763	13.69	24,416	8.26	14,739	10.12	18,050	11.10	19,804	8.05	14,362
C21	1,789	5	13.95	24,874	10.77	19,201	21.58	38,489	18.32	32,672	11.06	19,723	13.54	24,154	14.86	26,500	10.78	19,219
C22	1,789	11	16.80	29,854	12.96	23,045	25.99	46,195	22.06	39,214	13.32	23,671	16.31	28,989	17.89	31,805	12.98	23,066
C23	1,789	40	22.53	39,402	17.40	30,415	34.87	60,970	29.60	51,755	17.87	31,242	21.88	38,261	24.01	41,978	17.41	30,444
C24	1,789	12	43.30	76,917	33.42	59,375	67.00	119,020	56.87	101,032	34.33	60,989	42.04	74,690	46.13	81,945	33.45	59,430
C25	1,789	5	33.73	60,164	26.04	46,442	52.20	93,097	44.31	79,027	26.75	47,705	32.76	58,422	35.94	64,097	26.06	46,486
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			4,791		3,698		7,414		6,293		3,799		4,652		5,104		3,702	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-5
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 1

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual *Average PCB* Background Concentration ^{3}	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	409	4	77.84	31,524	48.03	19,454	123.42	49,984	88.50	35,841	92.43	37,436	93.29	37,780	118.01	47,793	81.04	32,820
R2	409	8	73.74	29,572	45.51	18,249	116.93	46,889	83.84	33,622	87.57	35,117	88.38	35,441	111.80	44,833	76.78	30,787
R3	409	70	58.26	19,751	35.95	12,188	92.38	31,316	66.24	22,456	69.19	23,454	69.82	23,670	88.33	29,944	60.66	20,563
R4	409	7.5	25.90	10,398	15.98	6,417	41.07	16,488	29.45	11,823	30.76	12,348	31.04	12,462	39.27	15,765	26.96	10,826
R5	409	12	29.07	11,542	17.94	7,122	46.10	18,301	33.05	13,122	34.52	13,706	34.84	13,832	44.08	17,498	30.27	12,016
R6	409	31	11.59	4,380	7.15	2,703	18.37	6,946	13.18	4,980	13.76	5,202	13.89	5,250	17.57	6,641	12.06	4,561
R7	409	35	45.03	16,840	27.79	10,392	71.39	26,701	51.19	19,146	53.47	19,997	53.96	20,182	68.26	25,530	46.88	17,532
R8	409	8	13.97	5,600	8.62	3,456	22.14	8,880	15.88	6,367	16.58	6,650	16.74	6,712	21.17	8,490	14.54	5,830
R9	409	8	6.83	2,739	4.22	1,691	10.83	4,344	7.77	3,115	8.11	3,253	8.19	3,283	10.36	4,153	7.11	2,852
R10	409	11	18.90	7,523	11.67	4,643	29.97	11,929	21.49	8,554	22.45	8,934	22.65	9,016	28.66	11,406	19.68	7,833
R11	409	9	16.70	6,678	10.30	4,121	26.47	10,589	18.98	7,593	19.83	7,930	20.01	8,003	25.31	10,124	17.38	6,953
R12	409	8	7.71	3,092	4.76	1,908	12.23	4,903	8.77	3,516	9.16	3,672	9.24	3,706	11.69	4,688	8.03	3,219
R13	409	3	10.41	4,227	6.42	2,608	16.51	6,702	11.84	4,806	12.36	5,019	12.48	5,066	15.78	6,408	10.84	4,401
R14	409	0.8	23.16	9,455	14.29	5,834	36.72	14,991	26.33	10,749	27.50	11,228	27.76	11,331	35.11	14,334	24.11	9,843
R15	409	0.8	14.49	5,917	8.94	3,651	22.98	9,382	16.48	6,727	17.21	7,026	17.37	7,091	21.98	8,970	15.09	6,160
R16	409	6	31.92	12,862	19.70	7,937	50.61	20,394	36.29	14,624	37.90	15,274	38.25	15,415	48.39	19,500	33.23	13,391
R17	409	2.3	34.19	13,905	21.10	8,581	54.21	22,048	38.87	15,809	40.60	16,513	40.98	16,665	51.83	21,081	35.60	14,477
R18	409	7.5	22.53	9,047	13.91	5,583	35.73	14,345	25.62	10,286	26.76	10,744	27.00	10,842	34.16	13,716	23.46	9,419
R19	409	17	13.20	5,174	8.14	3,193	20.93	8,204	15.01	5,882	15.67	6,144	15.82	6,201	20.01	7,844	13.74	5,387
S1	409	4	22.00	8,912	13.58	5,499	34.89	14,130	25.02	10,132	26.13	10,583	26.37	10,680	33.36	13,511	22.91	9,278
S2	409	2.2	38.05	15,479	23.48	9,552	60.33	24,543	43.26	17,599	45.19	18,382	45.60	18,551	57.69	23,467	39.61	16,115
C1	894	80	53.94	43,905	33.29	27,094	85.52	69,616	61.32	49,918	64.05	52,139	64.64	52,619	81.77	66,564	56.15	45,710
C2	894	40	50.61	43,221	31.23	26,672	80.25	68,531	57.54	49,141	60.10	51,326	60.65	51,799	76.73	65,527	52.69	44,998
C3	894	80	43.53	35,437	26.87	21,868	69.03	56,189	49.50	40,290	51.70	42,082	52.17	42,470	66.00	53,725	45.32	36,894
C4	894	73	45.29	37,183	27.95	22,946	71.81	58,957	51.49	42,275	53.78	44,156	54.28	44,562	68.66	56,372	47.15	38,711
C5	894	80	41.21	33,549	25.43	20,703	65.35	53,195	46.86	38,144	48.94	39,840	49.39	40,207	62.49	50,863	42.91	34,928
C6	894	15	38.05	33,443	23.48	20,638	60.33	53,026	43.26	38,023	45.18	39,714	45.60	40,080	57.68	50,702	39.61	34,817
C7	894	14	46.97	41,332	28.98	25,506	74.47	65,535	53.40	46,992	55.78	49,083	56.29	49,535	71.21	62,662	48.90	43,031
C8	894	33	33.20	28,584	20.49	17,639	52.64	45,322	37.74	32,498	39.42	33,944	39.79	34,256	50.33	43,335	34.56	29,759
C9	894	26	24.45	21,221	15.09	13,095	38.76	33,647	27.80	24,127	29.03	25,200	29.30	25,432	37.06	32,172	25.45	22,093
C10	894	50	9.28	7,829	5.72	4,831	14.71	12,413	10.55	8,901	11.01	9,297	11.12	9,382	14.06	11,869	9.66	8,150
C11	894	58	5.63	4,704	3.47	2,903	8.92	7,459	6.40	5,349	6.68	5,587	6.74	5,638	8.53	7,132	5.86	4,898
C12	894	50	3.24	2,731	2.00	1,685	5.13	4,330	3.68	3,105	3.84	3,243	3.88	3,272	4.90	4,140	3.37	2,843
C13	894	19	15.68	13,721	9.68	8,467	24.86	21,756	17.83	15,600	18.62	16,294	18.79	16,444	23.77	20,802	16.33	14,285
C14	894	20	11.67	10,204	7.20	6,297	18.51	16,179	13.27	11,601	13.86	12,117	13.99	12,229	17.70	15,470	12.15	10,623
C15	894	28	6.45	5,585	3.98	3,446	10.23	8,855	7.33	6,350	7.66	6,632	7.73	6,693	9.78	8,467	6.71	5,814
C16	894	6	6.07	5,391	3.75	3,327	9.63	8,548	6.90	6,129	7.21	6,402	7.28	6,461	9.20	8,173	6.32	5,612
C17	894	4	11.83	10,530	7.30	6,498	18.75	16,697	13.44	11,973	14.04	12,505	14.17	12,620	17.93	15,965	12.31	10,963
C18	894	5	4.14	3,681	2.56	2,271	6.57	5,836	4.71	4,185	4.92	4,371	4.96	4,411	6.28	5,580	4.31	3,832
C19	894	2.5	5.63	5,018	3.47	3,097	8.92	7,957	6.40	5,705	6.68	5,959	6.75	6,014	8.53	7,608	5.86	5,224
C20	894	6	8.37	7,437	5.16	4,590	13.26	11,792	9.51	8,456	9.93	8,832	10.03	8,913	12.68	11,275	8.71	7,743
C21	894	5	11.15	9,911	6.88	6,116	17.68	15,714	12.68	11,268	13.24	11,769	13.36	11,878	16.90	15,026	11.61	10,318
C22	894	11	15.26	13,475	9.42	8,316	24.20	21,366	17.35	15,321	18.12	16,002	18.29	16,149	23.14	20,429	15.89	14,029
C23	894	40	19.47	16,628	12.02	10,261	30.87	26,365	22.14	18,905	23.12	19,746	23.34	19,928	29.52	25,210	20.27	17,312
C24	894	12	34.20	30,168	21.11	18,617	54.23	47,834	38.89	34,300	40.62	35,825	40.99	36,155	51.86	45,737	35.61	31,408
C25	894	5	27.57	24,514	17.02	15,128	43.72	38,869	31.35	27,871	32.75	29,111	33.05	29,379	41.81	37,165	28.71	25,522
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			2,731		1,685		4,330		3,105		3,243		3,272		4,140		2,843	
Representative Receptor Location Requiring Lowest Concentration			C12		C12		C12		C12		C12		C12		C12		C12	

Table J-5
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 2

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration^1	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	409	4	78.85	31,933	49.01	19,849	111.58	45,191	86.46	35,014	98.46	39,877	99.45	40,278	125.80	50,947	86.35	34,972
R2	409	8	77.00	30,878	47.86	19,192	108.97	43,697	84.43	33,857	96.16	38,559	97.12	38,947	122.85	49,263	84.33	33,816
R3	409	70	58.51	19,836	36.37	12,330	82.81	28,072	64.16	21,750	73.07	24,771	73.81	25,020	93.35	31,647	64.08	21,724
R4	409	7.5	25.91	10,401	16.10	6,465	36.66	14,720	28.41	11,405	32.35	12,989	32.68	13,120	41.33	16,595	28.37	11,391
R5	409	12	28.96	11,497	18.00	7,146	40.98	16,271	31.75	12,607	36.16	14,357	36.53	14,502	46.20	18,343	31.72	12,591
R6	409	31	11.71	4,425	7.28	2,750	16.57	6,262	12.84	4,852	14.62	5,526	14.77	5,581	18.68	7,060	12.82	4,846
R7	409	35	44.85	16,775	27.88	10,427	63.47	23,739	49.18	18,393	56.01	20,948	56.57	21,159	71.56	26,763	49.12	18,371
R8	409	8	13.77	5,523	8.56	3,433	19.49	7,816	15.10	6,055	17.20	6,896	17.37	6,966	21.97	8,811	15.08	6,048
R9	409	8	6.79	2,722	4.22	1,692	9.60	3,852	7.44	2,984	8.48	3,399	8.56	3,433	10.83	4,342	7.43	2,981
R10	409	11	18.64	7,499	11.71	4,661	26.66	10,612	20.66	8,222	23.53	9,364	23.76	9,458	30.06	11,964	20.63	8,212
R11	409	9	16.69	6,677	10.38	4,150	23.62	9,449	18.30	7,321	20.85	8,338	21.05	8,422	26.63	10,653	18.28	7,312
R12	409	8	7.54	3,024	4.69	1,879	10.67	4,279	8.27	3,315	9.42	3,776	9.51	3,814	12.03	4,824	8.26	3,311
R13	409	3	10.10	4,100	6.28	2,549	14.29	5,803	11.07	4,496	12.61	5,120	12.74	5,172	16.11	6,542	11.06	4,491
R14	409	0.8	22.47	9,173	13.97	5,702	31.80	12,981	24.64	10,058	28.06	11,455	28.34	11,570	35.85	14,635	24.61	10,046
R15	409	0.8	13.90	5,675	8.64	3,527	19.67	8,031	15.24	6,223	17.36	7,087	17.54	7,158	22.18	9,054	15.23	6,215
R16	409	6	30.77	12,400	19.12	7,707	43.54	17,548	33.74	13,596	38.42	15,484	38.81	15,640	49.09	19,783	33.70	13,580
R17	409	2.3	33.06	13,445	20.55	8,357	46.78	19,027	36.25	14,742	41.28	16,790	41.70	16,958	52.74	21,450	36.20	14,724
R18	409	7.6	21.83	8,767	13.57	5,449	30.90	12,406	23.94	9,612	27.27	10,947	27.54	11,057	34.84	13,986	23.91	9,601
R19	409	17	12.74	4,994	7.92	3,104	18.03	7,067	13.97	5,476	15.91	6,236	16.07	6,299	20.32	7,967	13.95	5,469
S1	409	4	21.75	8,809	13.52	5,476	30.78	12,467	23.85	9,659	27.16	11,001	27.44	11,111	34.70	14,054	23.82	9,648
S2	409	2.2	36.76	14,954	22.85	9,295	52.02	21,163	40.31	16,397	45.91	18,675	46.37	18,862	58.65	23,859	40.26	16,377
C1	894	80	55.54	45,208	34.52	28,099	78.60	63,977	60.90	49,570	69.35	56,454	70.05	57,021	88.61	72,125	60.82	49,509
C2	894	40	50.42	43,059	31.34	26,764	71.35	60,936	55.29	47,214	62.96	53,771	63.60	54,311	80.44	68,697	55.22	47,156
C3	894	80	45.00	36,629	27.97	22,767	63.68	51,837	49.34	40,163	56.19	45,741	56.76	46,201	71.79	58,439	49.28	40,115
C4	894	73	45.67	37,497	28.39	23,306	64.63	53,064	50.08	41,114	57.03	46,824	57.61	47,295	72.87	59,823	50.02	41,065
C5	894	80	41.40	33,703	25.74	20,949	58.59	47,696	45.40	36,955	51.70	42,087	52.22	42,510	66.06	53,771	45.34	36,910
C6	894	15	38.01	33,414	23.63	20,769	53.80	47,287	41.68	36,638	47.47	41,726	47.95	42,146	60.65	53,310	41.63	36,594
C7	894	14	47.88	42,133	29.76	26,188	67.76	59,625	52.50	46,198	59.79	52,614	60.39	53,142	76.39	67,219	52.43	46,142
C8	894	33	33.16	28,552	20.61	17,747	46.93	40,406	36.36	31,307	41.41	35,654	41.83	36,013	52.91	45,552	36.32	31,269
C9	894	26	24.37	21,154	15.15	13,149	34.49	29,937	26.72	23,195	30.43	26,417	30.74	26,682	38.88	33,750	26.69	23,167
C10	894	50	9.38	7,919	5.83	4,922	13.28	11,206	10.29	8,683	11.72	9,888	11.83	9,988	14.97	12,633	10.27	8,672
C11	894	58	5.67	4,742	3.53	2,948	8.03	6,711	6.22	5,200	7.08	5,922	7.15	5,981	9.05	7,566	6.21	5,193
C12	894	60	3.29	2,775	2.04	1,725	4.65	3,928	3.61	3,043	4.11	3,466	4.15	3,501	5.25	4,428	3.60	3,039
C13	894	19	15.71	13,747	9.77	8,545	22.23	19,454	17.23	15,073	19.62	17,167	19.82	17,339	25.07	21,932	17.21	15,055
C14	894	20	11.81	10,319	7.34	6,414	16.71	14,603	12.95	11,315	14.74	12,886	14.89	13,016	18.84	16,463	12.93	11,301
C15	894	28	6.55	5,670	4.07	3,524	9.27	8,024	7.18	6,217	8.18	7,081	8.26	7,152	10.45	9,046	7.17	6,210
C16	894	6	5.88	5,219	3.65	3,244	8.32	7,386	6.44	5,722	7.34	6,517	7.41	6,583	9.38	8,326	6.44	5,715
C17	894	4	11.45	10,197	7.12	6,338	16.21	14,431	12.56	11,181	14.30	12,734	14.44	12,862	18.27	16,269	12.54	11,167
C18	894	6	3.95	3,515	2.46	2,184	5.59	4,974	4.33	3,854	4.94	4,389	4.99	4,433	6.31	5,607	4.33	3,849
C19	894	2.5	5.37	4,791	3.34	2,978	7.60	6,780	5.89	5,253	6.71	5,982	6.78	6,043	8.57	7,643	5.89	5,247
C20	894	5	8.00	7,109	4.97	4,419	11.32	10,060	8.77	7,795	9.99	8,877	10.09	8,966	12.76	11,341	8.76	7,785
C21	894	6	10.67	9,486	6.63	5,896	15.10	13,425	11.70	10,402	13.33	11,846	13.46	11,965	17.02	15,135	11.69	10,389
C22	894	11	14.64	12,931	9.10	8,038	20.72	18,300	16.06	14,179	18.29	16,148	18.47	16,310	23.36	20,631	16.04	14,162
C23	894	40	18.70	15,971	11.62	9,927	26.47	22,602	20.51	17,512	23.35	19,944	23.59	20,145	29.84	25,481	20.48	17,491
C24	894	12	32.91	29,025	20.45	18,041	46.57	41,076	36.08	31,826	41.09	36,246	41.51	36,610	52.50	46,307	36.04	31,787
C25	894	6	26.62	23,668	16.55	14,711	37.68	33,495	29.19	25,952	33.25	29,556	33.58	29,853	42.48	37,761	29.16	25,921
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			2,722		1,692		3,852		2,984		3,399		3,433		4,342		2,981	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-5
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 3

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration ^{3}	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	409	4	96.31	39,006	59.04	23,910	136.73	55,377	105.48	42,720	81.52	33,015	81.97	33,197	103.70	41,999	71.37	28,905
R2	409	8	93.25	37,395	57.16	22,922	132.39	53,090	102.13	40,956	78.93	31,651	79.37	31,825	100.41	40,264	69.10	27,711
R3	409	70	70.80	24,000	43.40	14,712	100.51	34,073	77.54	26,285	59.92	20,314	60.25	20,426	76.23	25,842	52.46	17,785
R4	409	7.6	29.79	11,961	18.26	7,332	42.30	16,982	32.63	13,100	25.22	10,124	25.35	10,180	32.08	12,879	22.08	8,864
R5	409	12	33.71	13,381	20.66	8,202	47.85	18,997	36.92	14,655	28.53	11,326	28.69	11,388	36.29	14,406	24.98	9,916
R6	409	31	12.73	4,814	7.81	2,951	18.08	6,834	13.95	5,272	10.78	4,074	10.84	4,097	13.71	5,183	9.44	3,567
R7	409	35	53.70	20,084	32.92	12,311	76.24	28,514	58.81	21,997	45.45	16,999	45.70	17,093	57.82	21,625	39.79	14,883
R8	409	8	16.65	6,679	10.21	4,094	23.64	9,482	18.24	7,314	14.10	5,653	14.17	5,684	17.93	7,191	12.34	4,949
R9	409	9	7.80	3,126	4.78	1,916	11.07	4,438	8.54	3,424	6.60	2,646	6.63	2,660	8.39	3,366	5.78	2,317
R10	409	11	22.06	8,779	13.52	5,381	31.32	12,464	24.16	9,615	18.67	7,431	18.77	7,472	23.75	9,453	16.35	6,506
R11	409	9	19.49	7,796	11.95	4,779	27.67	11,068	21.35	8,539	16.50	6,599	16.59	6,635	20.99	8,394	14.44	5,777
R12	409	8	9.57	3,836	5.86	2,351	13.58	5,446	10.48	4,201	8.10	3,247	8.14	3,265	10.30	4,130	7.09	2,843
R13	409	3	13.34	5,416	8.18	3,320	18.94	7,689	14.61	5,931	11.29	4,584	11.35	4,609	14.36	5,831	9.88	4,013
R14	409	0.8	29.81	12,170	18.28	7,460	42.33	17,278	32.65	13,329	25.23	10,301	25.37	10,357	32.10	13,104	22.09	9,018
R15	409	0.8	19.58	7,993	12.00	4,899	27.80	11,347	21.44	8,754	16.57	6,765	16.66	6,802	21.08	8,606	14.51	5,923
R16	409	6	42.23	17,019	25.89	10,432	59.95	24,162	46.25	18,639	35.74	14,405	35.94	14,484	45.47	18,324	31.29	12,611
R17	409	2.3	44.75	18,198	27.43	11,155	63.53	25,836	49.01	19,931	37.87	15,403	38.08	15,487	48.18	19,594	33.16	13,485
R18	409	7.8	29.20	11,725	17.90	7,187	41.46	16,647	31.98	12,842	24.72	9,924	24.85	9,979	31.44	12,625	21.64	8,689
R19	409	17	17.30	6,781	10.60	4,157	24.56	9,628	18.95	7,427	14.64	5,740	14.72	5,771	18.63	7,302	12.82	5,025
S1	409	4	26.45	10,713	16.21	6,567	37.55	15,209	28.97	11,733	22.39	9,067	22.51	9,117	28.48	11,535	19.60	7,938
S2	409	2.2	49.99	20,337	30.64	12,466	70.98	28,873	54.75	22,274	42.31	17,213	42.55	17,308	53.83	21,897	37.05	15,070
C1	894	80	67.10	54,616	41.13	33,478	95.26	77,539	73.48	59,816	56.79	46,227	57.10	46,482	72.24	58,806	49.72	40,472
C2	894	40	60.86	51,975	37.31	31,859	86.40	73,789	66.65	56,923	51.51	43,991	51.80	44,233	65.53	55,962	45.10	38,514
C3	894	80	54.04	43,985	33.12	26,962	76.72	62,446	59.18	48,173	45.74	37,229	45.99	37,434	58.18	47,360	40.04	32,594
C4	894	73	54.85	45,034	33.62	27,605	77.87	63,935	60.08	49,322	46.43	38,116	46.68	38,327	59.06	48,489	40.65	33,371
C5	894	80	49.70	40,452	30.46	24,796	70.55	57,430	54.43	44,304	42.06	34,238	42.29	34,427	53.51	43,556	36.83	29,976
C6	894	16	44.77	39,354	27.44	24,123	63.56	55,871	49.03	43,101	37.89	33,309	38.10	33,492	48.21	42,373	33.18	29,162
C7	894	14	56.07	49,342	34.37	30,245	79.60	70,052	61.41	54,040	47.46	41,763	47.72	41,993	60.37	53,128	41.55	36,564
C8	894	33	38.92	33,513	23.86	20,543	55.26	47,579	42.63	36,704	32.94	28,365	33.13	28,522	41.91	36,084	28.84	24,834
C9	894	26	28.26	24,527	17.32	15,034	40.12	34,821	30.95	26,862	23.92	20,759	24.05	20,874	30.42	26,409	20.94	18,175
C10	894	50	10.05	8,481	6.16	5,199	14.27	12,040	11.01	9,288	8.50	7,178	8.55	7,218	10.82	9,132	7.45	6,285
C11	894	58	6.07	5,071	3.72	3,108	8.61	7,200	6.64	5,554	5.13	4,292	5.16	4,316	6.53	5,460	4.50	3,758
C12	894	50	3.44	2,900	2.11	1,778	4.88	4,117	3.76	3,176	2.91	2,455	2.92	2,468	3.70	3,123	2.55	2,149
C13	894	19	18.10	15,836	11.09	9,707	25.69	22,483	19.82	17,344	15.32	13,404	15.40	13,478	19.49	17,051	13.41	11,735
C14	894	20	13.36	11,677	8.19	7,157	18.97	16,577	14.63	12,788	11.31	9,883	11.37	9,937	14.38	12,572	9.90	8,653
C15	894	28	7.09	6,136	4.34	3,761	10.06	8,712	7.76	6,720	6.00	5,194	6.03	5,222	7.63	6,607	5.25	4,547
C16	894	6	7.91	7,025	4.85	4,306	11.23	9,973	8.66	7,694	6.70	5,946	6.73	5,978	8.52	7,564	5.86	5,206
C17	894	4	15.34	13,661	9.40	8,374	21.78	19,394	16.80	14,961	12.98	11,562	13.06	11,626	16.52	14,709	11.37	10,123
C18	894	5	5.70	5,072	3.50	3,109	8.10	7,200	6.25	5,554	4.83	4,293	4.86	4,316	6.14	5,461	4.23	3,758
C19	894	2.5	7.76	6,918	4.76	4,240	11.02	9,821	8.50	7,576	6.57	5,855	6.60	5,887	8.35	7,448	5.75	5,126
C20	894	5	11.48	10,203	7.03	6,254	16.29	14,485	12.57	11,174	9.71	8,635	9.77	8,683	12.36	10,985	8.50	7,560
C21	894	5	15.20	13,513	9.32	8,283	21.58	19,184	16.65	14,799	12.86	11,437	12.94	11,500	16.37	14,549	11.26	10,013
C22	894	11	20.58	18,170	12.61	11,138	29.21	25,796	22.54	19,900	17.42	15,379	17.51	15,463	22.16	19,564	15.25	13,464
C23	894	40	26.20	22,374	16.06	13,714	37.19	31,764	28.69	24,504	22.17	18,937	22.30	19,041	28.21	24,090	19.41	16,579
C24	894	12	45.61	40,232	27.96	24,661	64.76	57,117	49.96	44,063	38.61	34,052	38.82	34,240	49.11	43,318	33.80	29,813
C25	894	5	36.26	32,238	22.23	19,761	51.48	45,769	39.72	35,308	30.69	27,286	30.86	27,437	39.05	34,712	26.87	23,890
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			2,900		1,778		4,117		3,176		2,455		2,468		3,123		2,149	
Representative Receptor Location Requiring Lowest Concentration			C12		C12		C12		C12		C12		C12		C12		C12	

Table J-5
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1996 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 4

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration[3]	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	409	4	100.95	40,885	61 70	24,987	143 41	58,082	110.53	44,764	79 34	32,133	81 42	32,974	97 45	39,469	70 48	28,543
R2	409	8	97.39	39,055	59 52	23,869	138.36	55,481	106.63	42,760	76.55	30,695	78.55	31,497	94 02	37,701	67 99	27,265
R3	409	70	73.95	25,070	45.20	15,322	105 06	35,614	80.97	27,448	58.12	19,704	59.64	20,219	71.39	24,201	51.63	17,502
R4	409	7.5	30.74	12,341	18 79	7,543	43.67	17,532	33.65	13,512	24 16	9,700	24.79	9,953	29.67	11,914	21.46	8,616
R5	409	12	34.93	13,866	21.35	8,475	49.62	19,699	38.24	15,182	27.45	10,898	28.17	11,183	33 72	13,386	24.38	9,681
R6	409	31	12.97	4,903	7.93	2,996	18.43	6,965	14.20	5,368	10.19	3,853	10.46	3,954	12.52	4,733	9.06	3,423
R7	409	36	55.95	20,924	34 19	12,788	79.48	29,724	61.25	22,909	43.97	16,445	45 12	16,875	54.01	20,199	39.06	14,607
R8	409	8	17.42	6,985	10.65	4,269	24 74	9,923	19.07	7,648	13 69	5,490	14.05	5,633	16.82	6,743	12.16	4,876
R9	409	8	8.04	3,224	4.91	1,971	11 42	4,581	8.80	3,530	6.32	2,534	6.49	2,601	7 76	3,113	5 61	2,251
R10	409	11	22.91	9,117	14 00	5,572	32.54	12,952	25.08	9,982	18.00	7,166	18.48	7,353	22.11	8,802	15.99	6,365
R11	409	9	20.22	8,088	12.36	4,943	28 72	11,490	22.14	8,855	15 89	6,357	16.31	6,523	19.52	7,808	14.12	5,646
R12	409	8	10.13	4,062	6 19	2,482	14.39	5,770	11.09	4,447	7.96	3,192	8.17	3,276	9.78	3,921	7.07	2,836
R13	409	3	14.27	5,795	8.72	3,542	20 28	8,233	15.63	6,345	11 22	4,555	11 51	4,674	13.78	5,594	9.96	4,046
R14	409	0.8	32.15	13,122	19.65	8,020	45.67	18,641	35 20	14,367	25.27	10,313	25.93	10,583	31.03	12,668	22.44	9,161
R15	409	0.8	21.45	8,756	13.11	5,352	30.47	12,439	23.49	9,587	16.86	6,882	17.30	7,062	20.71	8,453	14.98	6,113
R16	409	6	45 94	18,514	28.08	11,315	65.26	26,300	50.30	20,270	36.11	14,551	37.05	14,931	44.35	17,872	32.07	12,925
R17	409	2.3	48.59	19,762	29.70	12,078	69.03	28,074	53.20	21,637	38.19	15,532	39.19	15,938	46 91	19,077	33.92	13,797
R18	409	7.5	31 54	12,664	19.28	7,740	44.81	17,991	34.53	13,866	24.79	9,953	25 44	10,214	30.45	12,225	22.02	8,841
R19	409	17	18.79	7,365	11.48	4,501	26.69	10,462	20.57	8,063	14 77	5,788	15.15	5,939	18.14	7,109	13.12	5,141
S1	409	4	27.65	11,199	16 90	6,845	39 28	15,910	30 28	12,262	21.73	8,802	22 30	9,032	26.69	10,811	19.31	7,819
S2	409	2.2	53.72	21,854	32.83	13,356	76.32	31,046	58.82	23,928	42.22	17,176	43.33	17,625	51 86	21,097	37.51	15,257
C1	894	80	70.07	57,038	42.83	34,860	99.54	81,029	76.72	62,449	55.07	44,829	56 51	46,001	67.64	55,062	46.92	39,820
C2	894	40	63.51	54,235	38.81	33,147	90.22	77,047	69 53	59,381	49 91	42,626	51 22	43,741	61.31	52,356	44 34	37,863
C3	894	80	56.27	45,800	34.39	27,992	79.93	65,064	61.60	50,146	44.22	35,997	45.38	36,938	54 32	44,214	39.28	31,975
C4	894	73	57.11	46,886	34 90	28,655	81.13	66,607	62.53	51,335	44 88	36,850	46.06	37,814	55.13	45,262	39.87	32,733
C5	894	80	51.67	42,060	31 58	25,705	73.40	59,750	56.57	46,050	40 61	33,057	41 67	33,921	49.88	40,603	36 07	29,363
C6	894	15	46.50	40,872	28.42	24,979	66 06	58,063	50.91	44,750	36 55	32,123	37.50	32,963	44 89	39,456	32.46	28,534
C7	894	14	57.92	50,971	35.40	31,152	82.28	72,409	63.42	55,807	45 52	40,060	46.71	41,108	55 91	49,205	40.44	35,584
C8	894	33	40.36	34,749	24.67	21,237	57.33	49,365	44.19	38,046	31 72	27,311	32.55	28,025	38 96	33,545	28.18	24,260
C9	894	26	29.14	25,296	17 81	15,460	41.40	35,935	31.91	27,696	22.90	19,881	23.50	20,401	28.13	24,420	20 35	17,660
C10	894	60	10.20	8,610	6.23	5,262	14 49	12,231	11.17	9,427	8.02	6,767	8 23	6,944	9.85	8,312	7.12	6,011
C11	894	68	6.16	5,147	3.76	3,146	8 75	7,312	6.74	5,635	4.84	4,045	4 97	4,151	5.94	4,969	4.30	3,593
C12	894	60	3.47	2,928	2.12	1,789	4.93	4,160	3.80	3,206	2.73	2,301	2.80	2,361	3.35	2,827	2.42	2,044
C13	894	19	18.71	16,376	11 44	10,008	26.59	23,263	20.49	17,929	14.71	12,870	15.09	13,207	18.07	15,808	13.07	11,432
C14	894	20	13.76	12,025	8.41	7,349	19.54	17,082	15 06	13,165	10 81	9,451	11.10	9,698	13 28	11,608	9 61	8,395
C15	894	28	7.24	6,268	4.42	3,831	10.28	8,905	7.93	6,863	5.69	4,927	5.84	5,055	6.99	6,051	5 05	4,376
C16	894	6	8.53	7,571	5 21	4,627	12.11	10,755	9.33	8,289	6.70	5,950	6.88	6,106	8.23	7,308	5.95	5,285
C17	894	4	16.37	14,575	10.00	8,908	23.25	20,705	17.92	15,958	12.86	11,455	13.20	11,755	15.80	14,070	11.43	10,175
C18	894	6	6.26	5,565	3.83	3,401	8.89	7,906	6.85	6,093	4.92	4,374	5.05	4,488	6.04	5,372	4 37	3,885
C19	894	2.5	8.46	7,545	5.17	4,611	12.02	10,718	9.27	8,260	6.65	5,930	6.83	6,085	8.17	7,283	5.91	5,267
C20	894	5	12 51	11,118	7.64	6,795	17.77	15,794	13.69	12,172	9.83	8,738	10 09	8,966	12.07	10,733	8.73	7,762
C21	894	5	16.54	14,705	10.11	8,987	23.50	20,890	18.11	16,100	13.00	11,557	13 34	11,860	15 97	14,196	11.55	10,266
C22	894	11	22.27	19,666	13.61	12,019	31.64	27,938	24.38	21,532	17 50	15,456	17.96	15,861	21.50	18,985	15.55	13,729
C23	894	40	28.39	24,246	17 35	14,818	40.33	34,444	31 08	26,547	22.31	19,056	22 90	19,555	27.41	23,406	19.82	16,927
C24	894	12	49.50	43,659	30.25	26,683	70.32	62,023	54.20	47,802	38 90	34,314	39 92	35,211	47 79	42,147	34.56	30,480
C25	894	6	39.47	35,092	24.12	21,447	56 08	49,851	43.22	38,421	31 02	27,580	31.83	28,301	38.11	33,876	27 56	24,499
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			2,928		1,789		4,160		3,206		2,301		2,361		2,827		2,044	
Representative Receptor Location Requiring Lowest Concentration			C12		C12		C12		C12		C12		C12		C12		C12	

Table J-6

Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 1

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	**Receptor-Specific Risk-Based Exposure Point *Concentration* (ng/m^3)**	**Receptor-Specific Annual Average PCB Background Concentration[3]**	**Dispersion Factor**	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion Factor**	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion Factor**	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion Factor**	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion *Factor***	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion *Factor***	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion *Factor***	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**	**Dispersion *Factor***	**Risk-Based Concentration *at Monitoring Point* (ng/m^3)**
R1	**409**	**4**	90.61	36,699	70.05	28,371	157.79	63,906	121.93	49,381	108.82	44,073	130.42	52,820	151.39	61,313	104.53	42,336
R2	**409**	**8**	64.35	25,805	49.75	19,949	112.06	44,935	86.59	34,722	77.28	30,990	92.62	37,140	107.51	43,112	74.24	29,768
R3	**409**	**70**	58.60	19,866	45.30	15,358	102.05	34,594	78.85	26,731	70.38	23,858	84.34	28,593	97.91	33,190	67.60	22,917
R4	**409**	**7.5**	28.22	11,332	21.82	8,761	49.15	19,733	37.98	15,248	33.90	13,609	40.62	16,310	47.15	18,933	32.56	13,073
R5	**409**	**12**	30.04	11,925	23.22	9,219	52.31	20,766	40.42	16,047	36.07	14,322	43.23	17,164	50.19	19,924	34.65	13,757
R6	**409**	**31**	13.70	5,178	10.59	4,003	23.86	9,017	18.43	6,968	16.45	6,219	19.72	7,453	22.89	8,651	15.80	5,974
R7	**409**	**36**	44.82	16,764	34.65	12,960	78.05	29,192	60.31	22,557	53.83	20,132	64.51	24,128	74.89	28,007	51.71	19,339
R8	**409**	**8**	15.72	6,302	12.15	4,872	27.37	10,974	21.15	8,480	18.87	7,568	22.62	9,070	26.26	10,529	18.13	7,270
R9	**409**	**8**	6.23	2,499	4.82	1,932	10.85	4,352	8.39	3,363	7.49	3,002	8.97	3,597	10.41	4,176	7.19	2,883
R10	**409**	**11**	18.46	7,346	14.27	5,679	32.14	12,792	24.84	9,885	22.17	8,822	26.57	10,573	30.84	12,273	21.29	8,474
R11	**409**	**9**	15.40	6,160	11.91	4,762	26.82	10,727	20.72	8,289	18.49	7,398	22.17	8,866	25.73	10,292	17.77	7,106
R12	***409***	***8***	*8.03*	*3,218*	*6.20*	*2,488*	*13.98*	*5,604*	*10.80*	*4,330*	*9.64*	*3,865*	*11.55*	*4,632*	*13.41*	*5,377*	*9.26*	*3,713*
R13	**409**	**3**	9.48	3,850	7.33	2,976	16.51	6,704	12.76	5,180	11.39	4,623	13.65	5,541	15.84	6,432	10.94	4,441
R14	**409**	**0.8**	22.73	9,280	17.58	7,174	39.59	16,160	30.59	12,487	27.30	11,145	32.72	13,357	37.98	15,505	26.23	10,706
R15	**409**	**0.8**	13.69	5,589	10.59	4,321	23.84	9,733	18.42	7,521	16.44	6,712	19.71	8,044	22.88	9,338	15.80	6,448
R16	**409**	**6**	26.88	10,835	20.78	8,376	46.82	18,867	36.18	14,579	32.29	13,012	38.69	15,594	44.92	18,101	31.01	12,499
R17	**409**	**2.3**	28.85	11,735	22.31	9,072	50.24	20,434	38.82	15,790	34.65	14,093	41.53	16,889	48.21	19,605	33.28	13,537
R18	**409**	**7.5**	20.69	8,307	16.00	6,422	36.03	14,466	27.84	11,178	24.85	9,977	29.78	11,957	34.57	13,879	23.87	9,583
R19	**409**	**17**	12.36	4,844	9.55	3,745	21.52	6,435	16.63	6,518	14.84	5,817	17.78	6,971	20.64	8,092	14.25	5,588
S1	**409**	**4**	18.73	7,586	14.48	5,864	32.62	13,209	25.20	10,207	22.49	9,110	26.96	10,918	31.29	12,673	21.61	8,751
S2	**409**	**2.2**	31.26	12,718	24.17	9,832	54.44	22,146	42.07	17,113	37.54	15,273	45.00	18,304	52.23	21,247	36.06	14,671
C1	**894**	**80**	59.15	48,148	45.73	37,222	103.00	83,843	79.59	64,787	71.04	57,823	85.13	69,299	98.82	80,441	68.24	55,544
C2	**894**	**40**	48.56	41,469	37.54	32,058	84.56	72,212	65.34	55,799	58.32	49,802	69.89	59,685	81.13	69,282	56.02	47,838
C3	**894**	**80**	49.94	40,652	38.61	31,428	86.97	70,791	67.20	54,701	59.98	48,821	71.88	58,511	83.44	67,918	57.61	46,897
C4	**894**	**73**	46.70	38,342	36.10	29,641	81.32	66,767	62.84	51,592	56.09	46,046	67.22	55,185	78.02	64,058	53.87	44,231
C5	**894**	**80**	41.35	33,661	31.97	26,023	72.01	58,616	55.64	45,294	*49.66*	*40,425*	*59.52*	*48,448*	*69.09*	*56,238*	*47.70*	*38,831*
C6	**894**	**15**	41.40	36,387	32.00	28,130	72.09	63,363	55.70	48,962	49.71	43,699	59.58	52,371	69.16	60,792	47.75	41,976
C7	**894**	**14**	42.06	37,011	32.51	28,613	73.24	64,450	56.59	49,802	50.51	44,448	60.53	53,270	70.27	61,835	48.52	42,696
C8	**894**	**33**	34.71	29,884	26.83	23,102	60.44	52,038	46.70	40,211	41.68	35,889	49.95	43,011	57.99	49,927	40.04	34,474
C9	**894**	**26**	24.29	21,086	18.78	16,301	42.30	36,718	32.69	28,372	29.17	25,323	34.96	30,348	40.59	35,228	28.02	24,324
C10	**894**	**60**	9.47	7,996	7.32	6,181	16.50	13,923	12.75	10,759	11.38	9,602	13.63	11,508	15.83	13,358	10.93	9,224
C11	**894**	**58**	5.23	4,373	4.04	3,381	9.11	7,616	7.04	5,885	6.28	5,252	7.53	6,294	8.74	7,307	6.03	5,045
C12	**894**	**50**	2.91	2,459	2.25	1,901	5.07	4,283	3.92	3,309	3.50	2,954	4.19	3,540	4.87	4,109	3.36	2,837
C13	**894**	**19**	15.48	13,541	11.96	10,468	26.95	23,580	20.82	18,221	18.59	16,262	22.27	19,489	25.85	22,623	17.85	15,621
C14	**894**	**20**	10.59	9,259	8.19	7,158	18.45	16,124	14.26	12,459	12.72	11,120	15.25	13,327	17.70	15,470	12.22	10,682
C15	**894**	**28**	5.96	5,160	4.61	3,989	10.38	8,986	8.02	6,944	7.16	6,197	8.58	7,427	9.96	8,621	6.87	5,953
C16	**894**	**6**	6.65	5,909	5.14	4,568	11.59	10,289	8.95	7,951	7.99	7,096	9.56	8,505	11.12	9,872	7.68	6,816
C17	**894**	**4**	9.42	8,387	7.28	6,483	16.40	14,604	12.67	11,285	11.31	10,072	13.55	12,071	15.73	14,011	10.86	9,675
C18	**894**	***5***	3.75	3,336	2.90	2,579	6.53	5,809	5.05	4,489	4.51	4,006	5.40	4,802	6.27	5,574	4.33	3,848
C19	***894***	***2.5***	*5.00*	*4,455*	*3.86*	*3,444*	*8.70*	*7,757*	*6.72*	*5,994*	6.00	5,350	7.19	6,412	8.35	7,442	5.76	5,139
C20	**894**	**6**	7.00	6,220	5.41	4,809	12.18	10,832	9.42	8,370	8.40	7,470	10.07	8,953	11.69	10,392	8.07	7,176
C21	**894**	**8**	9.47	8,423	7.32	6,511	16.50	14,667	12.75	11,333	11.38	10,115	13.64	12,122	15.83	14,072	10.93	9,716
C22	**894**	**11**	11.26	9,945	8.71	7,688	19.61	17,318	15.16	13,382	13.53	11,944	16.21	14,314	18.82	16,616	12.99	11,473
C23	**894**	**40**	15.70	13,405	12.13	10,363	27.33	23,342	21.12	18,037	18.85	16,098	22.59	19,293	26.22	22,395	18.11	15,464
C24	**894**	**12**	30.53	26,930	23.60	20,819	53.17	46,895	41.08	36,236	36.67	32,341	43.95	38,760	51.01	44,992	35.22	31,066
C25	**894**	**8**	23.26	20,679	17.98	15,986	40.51	36,009	31.30	27,825	27.93	24,834	33.48	29,763	38.86	34,548	26.83	23,855
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			**2,459**		**1,901**		**4,283**		**3,309**		**2,954**		**3,540**		**4,109**		**2,837**	
Representative Receptor Location Requiring Lowest Concentration			C12		C12		C12		C12		C12		C12		C12		C12	

Table J-6
Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 2

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration 3	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	409	4	92.06	37,284	71.88	29,109	141.90	57,468	120.79	48,921	116.59	47,217	139.90	56,660	162.38	65,766	112.07	45,388
R2	409	8	67.58	27,101	52.77	21,159	104.17	41,772	88.68	35,560	85.59	34,321	102.71	41,185	119.21	47,803	82.27	32,991
R3	409	70	59.32	20,109	46.31	15,700	91.43	30,995	77.83	26,385	75.12	25,466	90.14	30,559	104.63	35,470	72.21	24,479
R4	409	7.5	28.01	11,245	21.87	8,780	43.17	17,333	36.75	14,756	35.47	14,242	42.56	17,090	49.41	19,836	34.10	13,690
R5	409	12	29.79	11,826	23.26	9,233	45.92	18,229	39.09	15,518	37.73	14,977	45.27	17,972	52.55	20,861	36.26	14,397
R6	409	31	13.73	5,191	10.72	4,053	21.17	8,001	18.02	6,811	17.39	6,574	20.87	7,888	24.22	9,156	16.72	6,319
R7	409	35	44.06	16,485	34.41	12,870	67.94	25,409	57.83	21,630	55.82	20,876	66.98	25,051	77.75	29,077	53.66	20,068
R8	409	8	15.58	6,249	12.17	4,879	24.02	9,631	20.45	8,199	19.73	7,913	23.68	9,496	27.49	11,022	18.97	7,607
R9	409	8	6.23	2,500	4.87	1,952	9.61	3,853	8.18	3,280	7.89	3,166	9.47	3,799	11.00	4,409	7.59	3,043
R10	409	11	18.38	7,315	14.35	5,712	28.33	11,276	24.12	9,599	23.28	9,264	27.93	11,117	32.42	12,904	22.38	8,905
R11	409	9	15.50	6,199	12.10	4,840	23.89	9,555	20.33	8,134	19.63	7,850	23.55	9,420	27.34	10,934	18.87	7,546
R12	409	8	7.86	3,151	6.14	2,460	12.11	4,857	10.31	4,135	9.95	3,991	11.94	4,789	13.86	5,559	9.57	3,836
R13	409	3	9.20	3,735	7.18	2,916	14.18	5,757	12.07	4,900	11.65	4,730	13.98	5,676	16.23	6,588	11.20	4,547
R14	409	0.8	22.08	9,013	17.24	7,037	34.03	13,892	28.97	11,826	27.96	11,414	33.55	13,697	38.95	15,898	26.88	10,972
R15	409	0.8	13.10	5,346	10.23	4,174	20.19	8,241	17.19	7,015	16.59	6,771	19.90	8,125	23.10	9,431	15.94	6,508
R16	409	6	25.84	10,415	20.18	8,132	39.84	16,054	33.91	13,666	32.73	13,190	39.28	15,828	45.59	18,372	31.46	12,679
R17	409	2.3	27.84	11,321	21.73	8,839	42.91	17,450	36.52	14,855	35.25	14,337	42.30	17,205	49.10	19,969	33.89	13,782
R18	409	7.5	20.00	8,030	15.61	6,269	30.83	12,377	26.24	10,536	25.33	10,169	30.39	12,203	35.28	14,164	24.35	9,775
R19	409	17	11.95	4,683	9.33	3,656	18.41	7,219	15.68	6,145	15.13	5,931	18.16	7,117	21.07	8,261	14.54	5,701
S1	409	4	18.42	7,460	14.38	5,825	28.39	11,499	24.17	9,789	23.33	9,448	27.99	11,338	32.49	13,160	22.42	9,082
S2	409	2.2	30.05	12,226	23.47	9,546	46.32	18,845	39.44	16,042	38.06	15,484	45.67	18,580	53.01	21,566	36.59	14,884
C1	894	80	63.98	52,077	49.95	40,659	98.61	80,269	83.95	68,331	81.02	65,951	97.22	79,141	112.85	91,859	77.88	63,396
C2	894	40	48.34	41,284	37.74	32,232	74.51	63,633	63.43	54,169	61.22	52,282	73.46	62,739	85.27	72,821	58.85	50,257
C3	894	80	50.99	41,505	39.81	32,405	78.59	63,974	66.90	54,460	64.57	52,563	77.49	63,075	89.94	73,212	62.07	50,527
C4	894	73	46.95	38,549	36.66	30,097	72.37	59,418	61.61	50,582	59.46	48,820	71.36	58,583	82.82	67,998	57.16	46,928
C5	894	80	41.78	34,012	32.62	26,555	64.40	52,425	54.83	44,628	52.92	43,074	63.50	51,688	73.70	59,994	50.87	41,405
C6	894	15	40.75	35,817	31.81	27,964	62.81	55,207	53.47	46,997	51.60	45,359	61.92	54,431	71.88	63,178	49.60	43,602
C7	894	14	42.79	37,652	33.41	29,397	65.95	58,035	56.14	49,404	54.19	47,683	65.02	57,219	75.47	66,415	52.09	45,836
C8	894	33	34.27	29,508	26.76	23,039	52.83	45,483	44.97	38,718	43.40	37,370	52.08	44,843	60.45	52,050	41.72	35,922
C9	894	26	24.10	20,919	18.82	16,332	37.15	32,243	31.62	27,448	30.52	26,492	36.62	31,790	42.51	36,899	29.34	25,465
C10	894	50	9.59	8,098	7.49	6,322	14.79	12,482	12.59	10,626	12.15	10,255	14.58	12,306	16.92	14,284	11.68	9,858
C11	894	58	5.16	4,314	4.03	3,368	7.95	6,649	6.77	5,661	6.54	5,463	7.84	6,556	9.10	7,610	6.28	5,252
C12	894	50	2.99	2,522	2.33	1,969	4.61	3,888	3.92	3,310	3.78	3,194	4.54	3,833	5.27	4,449	3.64	3,071
C13	894	19	15.59	13,637	12.17	10,647	24.02	21,020	20.45	17,894	19.74	17,270	23.68	20,724	27.49	24,055	18.97	16,601
C14	894	20	10.80	9,440	8.43	7,370	16.65	14,551	14.17	12,387	13.68	11,955	16.41	14,346	19.05	16,652	13.15	11,492
C15	894	28	6.04	5,230	4.72	4,084	9.31	8,062	7.92	6,863	7.65	6,624	9.18	7,949	10.65	9,226	7.35	6,367
C16	894	6	6.43	5,712	5.02	4,459	9.91	8,804	8.44	7,494	8.15	7,233	9.77	8,680	11.35	10,075	7.83	6,953
C17	894	4	9.06	8,065	7.07	6,297	13.96	12,432	11.88	10,583	11.47	10,214	13.76	12,257	15.98	14,227	11.03	9,819
C18	894	5	3.57	3,174	2.79	2,478	5.50	4,892	4.68	4,164	4.52	4,019	5.43	4,823	6.30	5,598	4.35	3,863
C19	894	2.5	4.76	4,240	3.71	3,310	7.33	6,535	6.24	5,563	6.02	5,369	7.23	6,443	8.39	7,478	5.79	5,161
C20	894	5	6.67	5,930	5.21	4,630	10.28	9,140	8.75	7,781	8.45	7,510	10.14	9,012	11.77	10,460	8.12	7,219
C21	894	5	9.04	8,038	7.06	6,276	13.94	12,390	11.86	10,548	11.45	10,180	13.74	12,216	15.95	14,179	11.01	9,786
C22	894	11	10.75	9,492	8.39	7,411	16.57	14,631	14.11	12,455	13.61	12,021	16.34	14,425	18.96	16,744	13.09	11,555
C23	894	40	15.08	12,881	11.78	10,057	23.25	19,854	19.79	16,901	19.10	16,312	22.92	19,575	26.60	22,720	18.36	15,680
C24	894	12	29.41	25,937	22.96	20,251	45.33	39,979	38.59	34,033	37.24	32,848	44.69	39,417	51.87	45,752	35.80	31,575
C25	894	5	22.38	19,894	17.47	15,532	34.49	30,663	29.36	26,103	28.34	25,194	34.01	30,232	39.47	35,091	27.24	24,218
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			2,500		1,952		3,853		3,280		3,166		3,799		4,409		3,043	
Representative Receptor Location Requiring Lowest Concentration			R9		R9		R9		R9		R9		R9		R9		R9	

Table J-6

Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 3

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m^3)	Receptor-Specific Annual Average PCB Background Concentration [3]	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m^3)
R1	409	4	111.77	45,266	86.44	35,009	172.82	69,993	146.78	59,448	96.05	38,899	114.49	46,369	132.92	53,833	92.01	37,265
R2	409	8	80.79	32,397	62.48	25,056	124.93	50,095	106.10	42,548	69.43	27,840	82.76	33,187	96.08	38,529	66.51	26,671
R3	409	70	70.56	23,919	54.57	18,499	109.10	36,985	92.66	31,413	60.63	20,554	72.28	24,502	83.91	28,446	58.09	19,691
R4	409	7.5	33.34	13,384	25.78	10,352	51.55	20,696	43.78	17,578	28.65	11,502	34.15	13,711	39.65	15,918	27.44	11,019
R5	409	12	35.17	13,964	27.20	10,800	54.39	21,593	46.19	18,339	30.23	12,000	36.03	14,304	41.83	16,607	28.96	11,496
R6	409	31	15.26	5,769	11.80	4,462	23.60	8,921	20.05	7,577	13.12	4,958	15.64	5,910	18.15	6,861	12.57	4,750
R7	409	35	54.12	20,242	41.86	15,655	83.69	31,300	71.08	26,584	46.51	17,395	55.44	20,735	64.37	24,073	44.56	16,664
R8	409	8	18.45	7,399	14.27	5,722	28.53	11,441	24.23	9,717	15.86	6,358	18.90	7,579	21.94	8,799	15.19	6,091
R9	409	8	7.12	2,854	5.50	2,207	11.01	4,413	9.35	3,748	6.12	2,453	7.29	2,924	8.46	3,394	5.86	2,350
R10	409	11	21.21	8,440	16.40	6,528	32.79	13,051	27.85	11,085	18.22	7,253	21.72	8,646	25.22	10,038	17.46	6,948
R11	409	9	17.64	7,057	13.64	5,458	27.28	10,912	23.17	9,268	15.16	6,064	18.07	7,229	20.98	8,392	14.52	5,810
R12	409	8	9.73	3,903	7.53	3,018	15.05	6,035	12.78	5,126	8.36	3,354	9.97	3,998	11.57	4,641	8.01	3,213
R13	409	3	12.08	4,906	9.35	3,794	18.69	7,586	15.87	6,443	10.38	4,216	12.38	5,026	14.37	5,835	9.95	4,039
R14	409	0.8	28.96	11,820	22.39	9,141	44.77	18,277	38.03	15,523	24.88	10,157	29.66	12,108	34.44	14,057	23.84	9,731
R15	409	0.8	18.41	7,516	14.24	5,813	28.47	11,622	24.18	9,871	15.82	6,459	18.86	7,699	21.90	8,938	15.16	6,187
R16	409	6	35.52	14,316	27.48	11,072	54.93	22,137	46.66	18,802	30.53	12,303	36.39	14,665	42.25	17,026	29.25	11,786
R17	409	2.3	37.45	15,231	28.96	11,780	57.91	23,551	49.18	20,003	32.18	13,089	38.36	15,602	44.54	18,114	30.83	12,539
R18	409	7.5	26.65	10,702	20.61	8,277	41.22	16,548	35.01	14,055	22.91	9,196	27.30	10,962	31.70	12,727	21.94	8,810
R19	409	17	15.91	6,237	12.31	4,824	24.60	9,644	20.90	8,191	13.67	5,360	16.30	6,389	18.92	7,418	13.10	5,135
S1	409	4	22.46	9,096	17.37	7,035	34.73	14,065	29.50	11,946	19.30	7,816	23.01	9,317	26.71	10,817	18.49	7,488
S2	409	2.2	41.19	16,755	31.85	12,959	63.69	25,908	54.09	22,005	35.39	14,398	42.19	17,164	48.98	19,926	33.91	13,794
C1	894	80	76.95	62,635	59.51	48,442	118.98	96,851	101.06	82,259	66.12	53,825	78.82	64,161	91.51	74,489	63.35	51,564
C2	894	40	57.47	49,083	44.45	37,961	88.87	75,897	75.48	64,462	49.39	42,179	58.88	50,279	68.35	58,373	47.32	40,408
C3	894	80	61.02	49,672	47.19	38,417	94.36	76,807	80.14	65,235	52.44	42,685	62.51	50,883	72.57	59,073	50.24	40,893
C4	894	73	55.30	45,403	42.77	35,115	85.51	70,207	72.63	59,629	47.52	39,017	56.65	46,510	65.77	53,997	45.53	37,379
C5	894	60	49.09	39,963	37.97	30,908	75.91	61,795	64.48	52,484	42.19	34,342	50.29	40,937	58.39	47,527	40.42	32,900
C6	894	15	50.19	44,113	38.81	34,117	77.60	68,211	65.91	57,934	43.13	37,908	51.41	45,188	59.68	52,462	41.32	36,316
C7	894	14	50.45	44,393	39.02	34,333	78.00	68,644	66.25	58,301	43.35	38,148	51.68	45,475	59.99	52,794	41.53	36,546
C8	894	33	41.17	35,444	31.84	27,412	63.65	54,806	54.06	46,549	35.38	30,458	42.17	36,308	48.96	42,152	33.89	29,179
C9	894	26	27.83	24,152	21.52	18,679	43.03	37,346	36.54	31,720	23.91	20,755	28.50	24,741	33.09	28,723	22.91	19,883
C10	894	50	10.22	8,629	7.91	6,674	15.81	13,344	13.43	11,333	8.79	7,416	10.47	8,840	12.16	10,263	8.42	7,104
C11	894	58	5.51	4,608	4.26	3,564	8.52	7,125	7.24	6,051	4.74	3,960	5.65	4,720	6.55	5,480	4.54	3,793
C12	894	50	3.10	2,620	2.40	2,026	4.80	4,051	4.08	3,441	2.67	2,252	3.18	2,684	3.69	3,116	2.56	2,157
C13	894	19	17.68	15,466	13.67	11,962	27.33	23,915	23.21	20,312	15.19	13,291	18.11	15,843	21.02	18,393	14.55	12,733
C14	894	20	11.96	10,450	9.25	8,082	18.49	16,158	15.70	13,724	10.27	8,980	12.25	10,704	14.22	12,427	9.84	8,603
C15	894	28	6.46	5,597	5.00	4,329	9.99	8,655	8.49	7,351	5.55	4,810	6.62	5,733	7.69	6,656	5.32	4,608
C16	894	6	8.53	7,573	6.60	5,857	13.19	11,710	11.20	9,946	7.33	6,508	8.74	7,757	10.14	9,006	7.02	6,234
C17	894	4	12.35	10,996	9.55	8,505	19.09	17,003	16.22	14,442	10.61	9,450	12.65	11,264	14.69	13,077	10.17	9,053
C18	894	5	5.16	4,587	3.99	3,548	7.98	7,093	6.78	6,025	4.43	3,942	5.29	4,699	6.14	5,456	4.25	3,777
C19	894	2.5	6.87	6,123	5.31	4,736	10.62	9,469	9.02	8,042	5.90	5,262	7.04	6,273	8.17	7,282	5.65	5,041
C20	894	6	9.56	8,498	7.39	6,572	14.78	13,140	12.55	11,160	8.21	7,302	9.79	8,705	11.37	10,106	7.87	6,996
C21	894	5	12.88	11,446	9.96	8,852	19.91	17,699	16.91	15,032	11.06	9,836	13.19	11,725	15.31	13,612	10.60	9,423
C22	894	11	15.30	13,507	11.83	10,446	23.65	20,886	20.09	17,739	13.15	11,607	15.67	13,836	18.19	16,063	12.59	11,120
C23	894	40	20.74	17,716	16.04	13,701	32.08	27,393	27.24	23,266	17.83	15,224	21.25	18,147	24.67	21,068	17.08	14,584
C24	894	12	40.06	35,336	30.99	27,329	61.95	54,639	52.62	46,407	34.43	30,366	41.04	36,197	47.65	42,023	32.98	29,090
C25	894	6	30.64	27,242	23.70	21,069	47.38	42,125	40.25	35,778	26.33	23,411	31.39	27,906	36.44	32,398	25.23	22,427
Minimum Allowable Concentration at each Monitoring Station (ng/m^3)			2,620		2,026		4,051		3,441		2,252		2,684		3,116		2,157	
Representative Receptor Location Requiring Lowest Concentration			C12		C12		C12		C12		C12		C12		C12		C12	

Table J-6

Calculation of Risk-Based Target Concentrations (Exposure Budget Line Slopes) for Total PCBs for the CDF C and D Monitoring Stations

Time: 1999 Site-Specific Meteorology
Emissions: Total PCBs
Project Duration: 10-Year
Year: 4

			CDF C								CDF D							
			North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station		North Monitoring Station		South Monitoring Station		East Monitoring Station		West Monitoring Station	
Representative Receptor Locations	Receptor-Specific Risk-Based Exposure Point Concentration (ng/m³)	Receptor-Specific Annual Average PCB Background Concentration [3]	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)	Dispersion Factor	Risk-Based Concentration at Monitoring Point (ng/m³)
R1	409	4	116.82	47,311	90.18	36,521	180.76	73,209	153.44	62,144	92.63	37,514	113.44	45,942	124.45	50,404	90.26	36,555
R2	409	8	84.16	33,749	64.97	26,052	130.23	52,222	110.55	44,330	66.73	26,760	81.73	32,772	89.66	35,955	65.03	26,076
R3	409	70	73.39	24,880	56.65	19,205	113.56	38,498	96.40	32,680	58.19	19,727	71.27	24,160	78.19	26,506	56.71	19,223
R4	409	7.5	34.74	13,948	26.82	10,767	53.76	21,583	45.63	18,322	27.55	11,060	33.74	13,545	37.01	14,860	26.84	10,777
R5	409	12	36.59	14,526	28.24	11,213	56.62	22,477	48.06	19,080	29.01	11,518	35.53	14,105	38.98	15,475	28.27	11,223
R6	409	31	15.64	5,910	12.07	4,562	24.19	9,145	20.54	7,763	12.40	4,686	15.18	5,739	16.66	6,297	12.08	4,567
R7	409	35	56.65	21,186	43.73	16,355	87.66	32,784	74.41	27,829	44.92	16,799	55.01	20,573	60.35	22,572	43.77	16,370
R8	409	8	19.16	7,684	14.79	5,932	29.65	11,891	25.17	10,094	15.19	6,093	18.61	7,462	20.42	8,187	14.81	5,937
R9	409	8	7.35	2,948	5.68	2,276	11.38	4,562	9.66	3,873	5.83	2,338	7.14	2,863	7.83	3,141	5.68	2,276
R10	409	11	21.98	8,747	16.97	6,752	34.01	13,535	28.87	11,490	17.43	6,936	21.34	8,494	23.41	9,319	16.98	6,758
R11	409	9	18.15	7,258	14.01	5,603	28.08	11,231	23.83	9,534	14.39	5,755	17.62	7,048	19.33	7,733	14.02	5,608
R12	409	8	10.16	4,075	7.84	3,146	15.73	6,306	13.35	5,353	8.06	3,231	9.87	3,957	10.83	4,342	7.85	3,149
R13	409	3	13.01	5,281	10.04	4,077	20.13	8,172	17.09	6,937	10.31	4,187	12.63	5,128	13.86	5,626	10.05	4,080
R14	409	0.8	30.78	12,563	23.76	9,698	47.62	19,440	40.43	16,502	24.40	9,961	29.89	12,199	32.79	13,384	23.78	9,707
R15	409	0.8	19.98	8,158	15.43	6,297	30.92	12,623	26.25	10,715	15.85	6,468	19.41	7,921	21.29	8,691	15.44	6,303
R16	409	6	38.43	15,487	29.66	11,955	59.46	23,964	50.48	20,342	30.47	12,280	37.32	15,039	40.94	16,499	29.69	11,966
R17	409	2.3	40.69	16,549	31.41	12,775	62.96	25,608	53.45	21,738	32.26	13,122	39.51	16,070	43.35	17,631	31.44	12,787
R18	409	7.5	28.90	11,605	22.31	8,958	44.73	17,957	37.97	15,243	22.92	9,202	28.07	11,269	30.79	12,364	22.33	8,967
R19	409	17	17.12	6,709	13.21	5,179	26.48	10,382	22.48	8,813	13.57	5,320	16.62	6,515	18.23	7,148	13.22	5,184
S1	409	4	23.69	9,594	18.29	7,406	36.66	14,846	31.12	12,602	18.78	7,607	23.00	9,316	25.24	10,221	18.30	7,413
S2	409	2.2	44.73	18,194	34.52	14,045	69.21	28,154	58.75	23,899	35.46	14,427	43.43	17,668	47.65	19,384	34.56	14,058
C1	894	80	80.22	65,302	61.93	50,409	124.14	101,047	105.38	85,776	63.61	51,779	77.90	63,412	85.47	69,571	61.98	50,456
C2	894	40	59.76	51,038	46.13	39,398	92.48	78,975	78.50	67,039	47.39	40,469	58.03	49,560	63.67	54,374	46.18	39,434
C3	894	80	63.41	51,616	48.95	39,844	98.12	79,870	83.29	67,799	50.28	40,927	61.58	50,122	67.56	54,991	48.99	39,881
C4	894	73	57.32	47,064	44.25	36,330	88.70	72,826	75.30	61,819	45.45	37,318	55.67	45,701	61.07	50,140	44.29	36,364
C5	894	80	50.81	41,358	39.22	31,925	78.62	63,996	66.74	54,324	40.29	32,793	49.34	40,161	54.13	44,061	39.26	31,955
C6	894	16	52.77	46,389	40.74	35,809	81.66	71,781	69.32	60,933	41.85	36,782	51.25	45,046	56.22	49,421	40.78	35,842
C7	894	14	52.27	45,997	40.35	35,507	80.88	71,175	68.66	60,418	41.45	36,472	50.76	44,666	55.69	49,004	40.39	35,540
C8	894	33	42.93	36,966	33.14	28,535	66.44	57,201	56.39	48,556	34.04	29,311	41.69	35,896	45.74	39,383	33.17	28,562
C9	894	26	28.66	24,880	22.13	19,205	44.35	38,498	37.65	32,680	22.73	19,727	27.83	24,159	30.54	26,506	22.15	19,223
C10	894	50	10.36	8,746	8.00	6,752	16.04	13,534	13.61	11,489	8.22	6,935	10.06	8,493	11.04	9,318	8.01	6,758
C11	*894*	*58*	*5.60*	*4,679*	*4.32*	*3,612*	*8.66*	*7,241*	*7.35*	*6,146*	*4.44*	*3,710*	*5.44*	*4,544*	*5.96*	*4,985*	*4.32*	*3,615*
C12	894	60	3.13	2,641	2.42	2,039	4.84	4,087	4.11	3,470	2.48	2,094	3.04	2,565	3.33	2,814	2.42	2,041
C13	894	19	18.20	15,925	14.05	12,293	28.16	24,642	23.91	20,918	14.43	12,627	17.67	15,464	19.39	16,966	14.06	12,304
C14	894	20	12.26	10,716	9.46	8,272	18.97	16,581	16.10	14,075	9.72	8,497	11.91	10,406	13.06	11,416	9.47	8,280
C15	894	28	6.58	5,699	5.08	4,399	10.18	8,818	8.64	7,485	5.22	4,518	6.39	5,534	7.01	6,071	5.08	4,403
C16	894	6	9.08	8,064	7.01	6,225	14.05	12,478	11.93	10,592	7.20	6,394	8.82	7,830	9.67	8,591	7.02	6,230
C17	894	4	13.19	11,746	10.18	9,067	20.41	18,176	17.33	15,429	10.46	9,314	12.81	11,406	14.05	12,514	10.19	9,076
C18	894	5	5.46	4,858	4.22	3,750	8.46	7,517	7.18	6,381	4.33	3,852	5.31	4,717	5.82	5,176	4.22	3,754
C19	894	2.5	7.48	6,671	5.78	5,149	11.58	10,322	9.83	8,762	5.93	5,269	7.27	6,478	7.97	7,107	5.78	5,154
C20	894	5	10.42	9,265	8.05	7,152	16.13	14,337	13.69	12,170	8.26	7,347	10.12	8,997	11.10	9,871	8.05	7,159
C21	894	5	13.95	12,399	10.77	9,571	21.58	19,185	18.32	16,286	11.06	9,831	13.54	12,040	14.86	13,209	10.78	9,580
C22	894	11	16.80	14,830	12.96	11,448	25.99	22,948	22.06	19,480	13.32	11,759	16.31	14,401	17.89	15,800	12.98	11,459
C23	894	40	22.53	19,245	17.40	14,855	34.87	29,779	29.60	25,278	17.87	15,259	21.88	18,688	24.01	20,503	17.41	14,869
C24	894	12	43.30	38,188	33.42	29,478	67.00	59,091	56.87	50,161	34.33	30,280	42.04	37,082	46.13	40,684	33.45	29,506
C25	894	5	33.73	29,989	26.04	23,150	52.20	46,405	44.31	39,392	26.75	23,779	32.76	29,121	35.94	31,950	26.06	23,171
Minimum Allowable Concentration at each Monitoring Station (ng/m³)			2,641		2,039		4,087		3,470		2,094		2,565		2,814		2,041	
Representative Receptor Location Requiring Lowest Concentration			C12		C12		C12		C12		C12		C12		C12		C12	

APPENDIX K

WES Flux Box Testing Report

Laboratory Assessment of PCB Volatilization from New Bedford Harbor Sediment

Background

The U.S. Army Engineer District, New England (CENAE), requested assistance with evaluating volatile emissions from New Bedford Harbor sediment. The CENAE is currently conducting a "Pre-Design Field Test" which includes evaluation of material handling systems in order to produce the most cost effective and efficient harbor cleanup activities. New Bedford Harbor contains high concentrations of polychlorinated biphenyls (PCBs) and volatilization of these compounds during dredging and disposal is a concern for impacts on air quality. The emission of volatile and semi-volatile organic compounds to air depends upon a variety of factors (Valsaraj et al. 1997). Apart from contaminant concentrations in the sediment, other variables affecting air emissions include sediment moisture content, temperature, and relative air humidity. As part of the design activities, Foster Wheeler in coordination with the USAE and USEPA, is working to develop PCB air action levels during the harbor cleanup.

Mechanical dewatering of the sediment prior to placement has been proposed as a means to reduce PCB volatilization and enhance placement of the dredged slurry. Three different mechanical dewatering systems were evaluated and material from each of these tests and an untreated sediment sample has been tested for volatile emissions. To determine the effects of increased temperature on PCB emissions, two additional emissions tests were conducted on the untreated material and one of the dewatered sediment samples at an increased temperature (6.7°C higher). Contaminants of concern include the fourteen World Health Organization (WHO) Congeners (Table 1), National Oceanic and Atmospheric Administration (NOAA) list of PCB congeners (Table 2), PCB totals, and arochlors.

This "memorandum for record" summarizes the laboratory results and includes all PCB fluxes from the three dewatered sediment samples and the untreated New Bedford Harbor sediment sample. Also included are additional flux measurements from congeners that were also analyzed and are included on the "Canadian List of PCB Congeners" routinely analyzed in the analytical laboratory at the Engineering Research and Development Center (ERDC), Environmental Laboratory, Vicksburg, MS (Appendix A).

Methods

Flux Chamber

Testing was conducted using a flux chamber designed by LSU and constructed at WES (Figure 1). This chamber has been used in numerous studies using both field sediments and laboratory spiked sediments (Price et al. 1997, 1998, 1999a, 1999b, Valsaraj et al. 1997, 1999, Ravikrishna et al., 1998). The two-piece anodized aluminum chamber is devised to hold sediment at a depth of 10 cm and has a surface area of 375 cm^2. The top portion of the chamber is designed with channels to distribute airflow uniformly across the sediment surface. The chamber is sealed with an O-ring and threaded fasteners for an airtight fit.

Experimental Design

Volatile emissions tests were conducted to provide information on maximum contaminant fluxes from exposed sediment under ambient room temperature conditions (~23°C/73.4°F) and at an increased temperature which simulated summer conditions in the New Bedford area (29.4°C/85°F).

Four separate New Bedford Harbor sediment samples were shipped to the WES on ice and stored under refrigeration until used in emissions testing. These included an untreated (not dewatered) sample, and three dewatered samples using processes provided by Koester Environmental Services (Koester), Mineral Processing Service (MPS), and JCI/Upcycle Associates (JCI). The untreated and the JCI-dewatered sediment samples, which contained 61 and 72 percent water, respectively, were thoroughly mixing before being added to the chamber. The Koester and MPS dewatered samples were comprised of pieces of the dewatered filter-cake material. It was necessary to break the pieces up before mixing them an to as even a consistency as possible. The mixed samples were then added to the chamber.

The chamber was filled with a known amount of homogenized sediment (oven dry weight (ODW)) and sealed (untreated (1.6 kg); Koester (2.1 kg); MPS (2.2 kg); JCI (1.0 kg). Air was passed over the sediment surface at 1.7 L/min. This rate was based upon earlier investigations conducted with flow rates using this chamber (Valsaraj et al. 1997). The flow rate was chosen to eliminate fluxes controlled by air-side resistance, thereby maximizing contaminant fluxes which are sediment-side controlled. Increasing the flow rate does not result in increased flux rates signifying that sediment-side resistance becomes the controlling factor. If air-side resistance dominates, fluxes would be low and at a constant rate; whereas, fluxes controlled by sediment-side resistance show initial high values (maximum flux) followed by decreasing emissions. A thermohygrometer (Cole-Parmer) was connected to the exit port to monitor air temperature and relative humidity. Sediment moisture content was also determined before and after running the experiment with each sediment sample and at each temperature (Table 3). Contaminant-specific adsorbent-filled air sampling traps (XAD-2 resin (Orbo 44 from Supelco, Inc.)) were attached to the chamber exit port. Traps were removed from the exit lines at the end of each sampling interval, solvent extracted, and analyzed according to USEPA method 8082 (USEPA 1982).

For the increased temperature conditions the chamber was heated to 85°F using a temperature controlled water bath. This increased temperature was chosen to simulate average maximum temperatures in the New Bedford area. Fresh samples of the untreated and the Koester dewatered sediment were used for emission testing under the higher temperature. The sampling schedule for all tests consisted of one continuous sampling interval over a period of seven days with samples being collected at 6, 24, 48, 72 hours, and 7 days after the initiation of dry air (0% relative humidity) over the sediment surface.

Contaminant flux, N(t), through the chamber was calculated using the equation

$$N(t) = \frac{\Delta m}{\Delta t A_c}$$

where

Δm = mass (ng) of compound collected on the trap in time Δt (hr)

A_c = area of the sediment-air interface, cm^2

Results

Emissions from Untreated New Bedford Harbor Sediment

The majority of PCB congeners detected, exhibited increasing fluxes in the first 2-3 days following passage of dry air over the sediment surface with a subsequent decrease in flux to near or below initial emissions by day 7 of sampling. These trends are indicative of the diffusive transport of the chemicals to the air. As the sediment surface dries, there is little competition for sorption sites and fluxes decrease to low levels. Figures 2 and 3 give fluxes from congeners on the WHO and NOAA lists from tests conducted at both 73° and 85°F. Figure 3 also shows fluxes for total congeners and the single arochlor (Arochlor 1242) detected in the exit air. Tables 4, 5, 6, and 7 give congener fluxes for the WHO, NOAA, arochlors, and total congeners, respectively. Table 8 gives fluxes of the additional congeners run which are included on the Canadian list. The lower chlorinated congeners 8, 18, and 28 (all included on the NOAA congener list) showed the highest emissions with fluxes peaking at 1.27, 0.26, and 0.279 ng/cm^2/hr 48 and 72 hours after application of dry air over the sediment surface (Table 5). All other congener fluxes were below 0.10 ng/cm^2/hr. PCB 1242 was the only arochlor detected and reached a flux of 31.8 ng/cm^2/hr 48 hours after application of air over the sediment surface (Table 6).

Emission rates from the sediment under the higher temperature conditions were lower for the majority of congeners and the arochlor detected (Figures 2 and 3). In comparison to emissions from the non-heated sediment sample, congeners 8, 18 and 28 fluxes peaked at 0.58, 0.48, and 0.079 ng/cm^2/hr at the 48 hours sample interval and arochlor 1242 emissions reached 4.22 ng/cm^2/hr at the 48 hour sampling. Emission trends were similar to those in the experiment conducted at room temperature indicating the same type of diffusive transport of the compounds from the sediment to the air. Sediment moisture was monitored for both experiments and it can be noted that there was no significant decrease in moisture content from either test (Table 3). It would be expected that the increase in temperature would result in increased water loss from the sediment; thereby, resulting in increased pore air space causing increased emissions. Sediment surface drying in effect decreases the sediment sorptive capacity for compounds and a resultant increase in fluxes is normally seen. The higher temperature did not result in a decreased surface moisture concentration and increased emissions from the heated sediment as compared to the room temperature test were not observed. Emission trends during these investigations indicate that PCB fluxes will be highest shortly after disposal.

Emissions from Dewatered (Koester Method) New Bedford Harbor Sediment

An additional four NOAA congeners (congeners 66, 87, 138, and 187) were detected in the exit air in experiments conducted with dewatered (Koester) New Bedford Harbor sediment (Figures 4, 5, and 6) as compared to emissions from untreated sediment. Tables 9, 10, 6, and 7 give congener fluxes for the WHO, NOAA, arochlors, and total congeners detected, respectively. Table 11 gives fluxes from the additional "Canadian" list of congeners. Fluxes for all congeners were higher than those from the untreated sediment. In comparing fluxes to the untreated sediment emissions; congeners 8, 18, and 28 fluxes peaked at 12.3, 7.5, and 4.0 ng/cm^2/hr 24, 6, and 24 hours, respectively, after dry air was passed over the sediment (Table 10). All other individual congener fluxes were at or below 1.0 ng/cm^2/hr. Arochlor 1242 reached 258 ng/cm^2/hr at the 24 hour sample interval. These emission trends are in contrast to emissions from the untreated sediment where peak fluxes occurred later (48 to 72 hours). The increased fluxes from the treated material are likely a result of the increased porosity of the dewatered sediment which would lead to much easier diffusion of the compounds through the sediment to the air. The pore air space in the untreated sediment would be completely saturated thereby leading to a slower diffusion of chemical to the sediment surface.

Another difference in emission trends from the Koester-treated sediment is that fluxes remained relatively constant over the course of the seven day experiment and did not show the decrease to day 7 observed for fluxes from the untreated material. Due to the conditions of the dewatered cake material, the porosity would remain relatively consistent throughout the deeper layers and fluxes would remain more constant over the short time. This behavior has been observed in previous investigations where the long term flux of polyaromatic hydrocarbons was lower from a high moisture content sediment as compared to a lower moisture sediment sample. A drop in moisture content (7%) in the surface layer of the sediment was seen which would increase the sorptive capacity of the sediment for chemicals resulting in a decrease in emissions over time.

Congener emissions from the sediment under the higher temperature were generally lower than those from the room temperature experiment. Congeners 8, 18, and 28 reached fluxes of 8.4, 6.4, and 0 (none detected) 72 hours after initiation of air over the sediment. Arochlor 1242 also peaked in 72 hours at 33 ng/cm^2/hr. Emission trends were similar to those of the unheated test. The same percent drop in sediment moisture was also observed in this test.

Emission trends in these experiments indicate that the dewatering process resulted in significantly increased fluxes as compared to those of the untreated material. The decreased moisture content and increased air-filled pore space of the sediment would result in initially higher and longer term emissions following disposal.

Emissions from Dewatered (MPS) New Bedford Harbor Sediment

Congener emissions from the MPS dewatered sample were higher than those from the untreated sediment sample but lower than those from the Koester dewatered sample (Figures 7 and 8). Tables 12, 13, 6 and 7 give the WHO, NOAA, arochlors, and total congeners analyzed, respectively. Table 14 gives the list of Canadian congeners analyzed and detected. Two NOAA congeners (23 and 44) were not detected, but did appear in the tests conducted with the untreated and Koester dewatered samples. Congeners 87 and 180 were detected in the air samples from the MPS test, but were not detected in the untreated sediment sample experiments.

The MPS sample had a slightly higher moisture content than that of the Koester dewatered sample which may have resulted in slower diffusion of the compounds through the sediment layers. Flux trends from the MPS dewatered sample were similar to those from the Koester sample, revealing a more constant emission rate over time due to the decreased moisture content and increased porosity throughout the sample. However, a majority of the emissions had decreased back to or below initial concentrations by day 7. The majority of individual congener fluxes peaked 72 hours after passage of dry air over the sediment. Congener 8 and 18 fluxes peaked at 3.1 and 2.1 ng/cm2/hr 24 and 72 hours after initiation of the test. All other congener emissions were below 0.40 ng/cm^2/hr. The moisture content of the sediment decreased from 39 to 28 % over the course of the experiment.

Emissions trends from this experiment indicate that the MPS dewatered material would result in lower initial fluxes than those from the Koester sediment sample. Slightly higher emissions were observed from this material as compared to the untreated sediment at field moisture content.

Emissions from Dewatered (JCI Method) New Bedford Harbor Sediment

Emissions from the JCI dewatered sediment sample were initially slightly higher than those from the MPS sample, but decreased to approximately the same levels as the MPS emissions by day seven. Fluxes for most congeners peaked 24 to 48 hours after dry air was applied over the sediment surface. Figures 9 and 10 show emission of all detected congeners and arochlors. Table 15, 16, 6 and 7 present emissions for the WHO, NOAA, arochlors and total congeners analyzed, respectively. Emission trends were similar to those in the MPS test, revealing an increase in flux followed by a decrease to initial or lower fluxes. Table 17 gives emissions of the additional congeners run included in the Canadian list.

Congeners 8 and 18 peaked at 6.1 and 4.4 ng/cm^2/hr 6 and 48 hours after application of air. All other emissions were at or below 1.0 ng/cm^2/hr. Arochlor 1242 showed a high flux of 32.6 ng/cm^2/hr at the 6 hour sample interval. Dewatering of this sample was not successful, making it difficult to ascertain flux emissions.

When comparing emissions from the JCI treated sample to the untreated sediment, congeners

28 and 44 were not detected in this test. In addition, congeners 28, 44, 66, 87, 138, and 187 were absent from this test but appeared in the exit air from the Koester treated sample. Congeners 87 and 180 were present in the traps from the MPS sediment test, but were absent in this experiment; whereas, congener 153 appeared in the exit air of the JCI test but was absent from the MPS sample.

Summary of Data

In order to facilitate comparison of fluxes, Table 18 gives maximum comparative fluxes between all sediment samples for all congeners and arochlors detected in the exit air from each test. The highest fluxes were from the unheated Koester sediment test due to the low moisture content and high sediment porosity. The lowest emission rates were from the untreated sediment and the second lowest were from the MPS dewatered sample. Congener 118 was the only WHO congener detected in the exit air from all sediment samples. The remaining congeners listed in this table are from the NOAA list. Table 18 also give arochlor 1242 and total congener fluxes.

Results of these investigations reveal that PCB emissions will be highest during the initial placement stages of the material. Results imply that dewatered sediment will initially result in increased fluxes over the short term as compared to disposing of a wetter, untreated sediment.

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Table 1. WHO Congeners	
Congener Number	**IUPAC Name**
PCB 77	33'44'-Tetrachlorobiphenyl
PCB 81	344'5-Tetrachlorobiphenyl
PCB 105	233'44'-Pentachlorobiphenyl
PCB 114	2344'5-Pentachlorobiphenyl
PCB 118	23'44'5-Pentachlorobiphenyl
PCB 123	2'344'5-Pentachlorobiphenyl
PCB 126	33'44'5-Pentachlorobiphenyl
PCB 156	233'44'5-Hexachlorobiphenyl
PCB 157	233'44'5'-Hexachlorobiphenyl
PCB 167	23'44'55'-Hexachlorobiphenyl
PCB 169	33'44'55'-Hexachlorobiphenyl
PCB 170	22'33'44'5-Heptachlorobiphenyl
PCB 180	22'344'55'-Heptachlorobiphenyl
PCB 189	233'44'55'-Heptachlorobiphenyl

Table 2. N.O.A.A. Congeners

Congener Number	IUPAC Name
PCB 8	24'-Dichlorobiphenyl
PCB 18	22'5-Trichlorobiphenyl
PCB 28	244'-Trichlorobiphenyl
PCB 44	22'35'-Tetrachlorobiphenyl
PCB 52	22'55'-Tetrachlorobiphenyl
PCB 66	243'4'-Tetrachlorobiphenyl
PCB 49	22'45'-Tetrachlorobiphenyl
PCB 87	22'345'-Pentachlorobiphenyl
PCB 101	22'455'-Pentachlorobiphenyl
PCB 105	233'44'-Pentachlorobiphenyl
PCB 118	23'44'5-Pentachlorobiphenyl
PCB 128	22'33'44'-Hexachlorobiphenyl
PCB 138	22'344'5'-Hexachlorobiphenyl
PCB 153	22'44'55'-Hexachlorobiphenyl
PCB 170	22'33'44'5-Heptachlorobiphenyl
PCB 180	22'344'55'-Heptachlorobiphenyl
PCB 183	22'344'5'6-Heptachlorobiphenyl
PCB 184	22'344'66'-Heptachlorobiphenyl
PCB 187	22'34'55'6-Heptachlorobiphenyl
PCB 195	22'33'44'56'-Octachlorobiphenyl
PCB 206	22'33'44'55'6-Nonachlorobiphenyl
PCB 209	22'33'44'55'66'-Decachlorobiphenyl

Table 3. Sediment Moisture Contents Before and After Emissions Testing

Sediment Sample	Initial Moisture (%)	Ending Moisture (%)
Untreated	61.3	63.9
Untreated @ 85°F	61.3	60.1
Dewatered (Koester)	34.4	27.7
Dewatered (Koester) @ 85°F	34.4	28.2
Dewatered (MPS)	39.1	27.7
Dewatered (JCI)	71.9	71.5

Table 4. PCB Fluxes (ng/cm^2/hr) (WHO Congeners) from Untreated New Bedford Harbor Sediment at Room Temperature (73°F) and at 85°F

Sample Time	PCB 77		PCB 81		PCB 105*		PCB 114		PCB 118*		PCB 123		PCB 126	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	0.0015	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10	0.00036	0.00037	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	0.00051	0.0010	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10	0.00048	0.00028	<10	<10	<10	<10

Sample Time	PCB 156		PCB 157		PCB 167		PCB 169		PCB 170*		PCB 180*		PCB 189	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0.0020	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
7 days	.000056	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 5. PCB Fluxes (ng/cm^2/hr) (NOAA Congeners) from Untreated New Bedford Harbor Sediment at Room Temperature (73°F) and at 85°F

Sample Time	PCB 8		PCB 18		PCB 28		PCB 44		PCB 49		PCB 52		PCB 66	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	0.562	0.159	0.368	0.108	0.056	0.024	0.0051	0.0027	0.015	0.0044	0.019	0.0055	<10	<10
24 hour	1.07	0.575	0.733	0.444	0.172	0.059	0.024	0.016	0.058	0.030	0.067	0.032	<10	<10
48 hour	1.27	0.581	0.903	0.484	0.254	0.079	0.039	0.024	0.085	0.049	0.097	0.059	<10	<10
72 hour	1.20	0.347	0.926	0.370	0.279	0.062	0.044	0.040	0.095	0.068	0.109	0.078	<10	<10
7 days	0.339	0.118	0.377	0.211	0.150	0.032	0.025	0.0051	0.049	0.022	0.056	0.027	<10	<10

Sample Time	PCB 87		PCB 101		PCB 128		PCB 138		PCB 153		PCB 183		PCB 184	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	0.0032	0.0050	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	0.0042	0.0026	<10	<10	<10	<10	0.00038	<10	<10	<10	<10	<10
72 hour	<10	<10	0.0062	0.0060	<10	<10	<10	<10	0.00027	<10	<10	<10	<10	<10
7 days	<10	0.00009	0.0044	0.0023	<10	<10	<10	0.00022	0.00023	<10	<10	<10	<10	<10

Sample Time	PCB 187		PCB 195		PCB 206		PCB 209	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	0.0035	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10

Table 6. PCB Flux (ng/cm2/hr) (Arochlors) from Untreated New Bedford Harbor Sediment
(detection limit = 250 ng)

Sample Time	PCB 1016	PCB 1221	PCB 1242	PCB 1248	PCB 1254	PCB 1260
6 hours	<250	<250	12.8	<250	<250	<250
24 hours	<250	<250	27.2	<250	<250	<250
48 hours	<250	<250	31.8	<250	<250	<250
72 hours	<250	<250	30.0	<250	<250	<250
7 days	<250	<250	9.09	<250	<250	<250

Untreated New Bedford Harbor Sediment @ 85°F

Sample Time	PCB 1016	PCB 1221	PCB 1242	PCB 1248	PCB 1254	PCB 1260
6 hours	<250	<250	1.41	<250	<250	<250
24 hours	<250	<250	3.91	<250	<250	<250
48 hours	<250	<250	4.22	<250	<250	<250
72 hours	<250	<250	3.00	<250	<250	<250
7 days	<250	<250	1.26	<250	<250	<250

Dewatered Koester Sediment Sample

Sample Time	PCB 1016	PCB 1221	PCB 1242	PCB 1248	PCB 1254	PCB 1260
6 hours	<250	<250	229	<250	<250	<250
24 hours	<250	<250	258	<250	<250	<250
48 hours	<250	<250	227	<250	<250	<250
72 hours	<250	<250	213	<250	<250	<250
7 days	<250	<250	165	<250	<250	<250

Table 6 (continued). Dewatered Koester Sediment Sample @ 85oF

Sample Time	PCB 1016	PCB 1221	PCB 1242	PCB 1248	PCB 1254	PCB 1260
6 hours	<250	<250	32.7	<250	<250	<250
24 hours	<250	<250	30.9	<250	<250	<250
48 hours	<250	<250	24.9	<250	<250	<250
72 hours	<250	<250	33.3	<250	<250	<250
7 days	<250	<250	24.5	<250	<250	<250

Dewatered MPS Sediment Sample

Sample Time	PCB 1016	PCB 1221	PCB 1242	PCB 1248	PCB 1254	PCB 1260
6 hours	<250	<250	15.2	<250	<250	<250
24 hours	<250	<250	14.1	<250	<250	<250
48 hours	<250	<250	11.5	<250	<250	<250
72 hours	<250	<250	11.8	<250	<250	<250
7 days	<250	<250	7.79	<250	<250	<250

Dewatered JCI Sediment Sample

Sample Time	PCB 1016	PCB 1221	PCB 1242	PCB 1248	PCB 1254	PCB 1260
6 hours	<250	<250	32.6	<250	<250	<250
24 hours	<250	<250	28.3	<250	<250	<250
48 hours	<250	<250	28.0	<250	<250	<250
72 hours	<250	<250	14.8	<250	<250	<250
7 days	<250	<250	7.70	<250	<250	<250

Table 7. PCB Flux (ng/cm2/hr) (Total Congeners) from New Bedford Harbor Sediment Samples

Sample Time	Untreated	Untreated @ 85oC	Koester	Koester @ 85oC	MPS	JCI
6 hours	0.540	0.134	11.8	6.54	2.32	4.79
24 hours	0.901	0.529	11.3	7.22	2.20	4.26
48 hours	1.11	0.622	10.5	8.00	2.43	5.66
72 hours	1.14	0.528	10.2	8.21	2.67	3.60
7 days	0.643	0.253	10.4	6.45	1.99	2.28

Table 8. PCB Fluxes ($ng/cm^2/hr$) (Canadian Congeners) from Untreated New Bedford Harbor Sediment at Room Temperature (73°F) and at 85°F

Sample Time	PCB 1		PCB 5		PCB 7		PCB 15		PCB 31		PCB 40		PCB 50	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	0.080	0.017	<10	<10	0.029	0.009	0.006	<10	<10	<10	<10	<10	<10	<10
24 hour	0.071	0.032	0.0026	<10	0.056	0.030	<10	<10	<10	<10	0.014	0.00062	<10	<10
48 hour	0.062	0.028	0.0033	<10	0.065	0.030	<10	<10	<10	<10	0.025	0.0015	<10	<10
72 hour	0.044	0.030	0.0030	<10	0.057	0.019	<10	<10	<10	<10	0.030	0.0030	<10	<10
7 days	0.010	0.003	<10	<10	0.027	0 010	<10	<10	0 166	<10	0.019	0.00081	<10	<10

Sample Time	PCB 54		PCB 60		PCB 66		PCB 70		PCB 81		PCB 82		PCB 86	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	0.068	0.0031	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	0.155	0.0074	<10	<10	<10	<10	0.0017	0.00055	<10	<10	<10	<10	<10	<10
48 hour	0.201	0.0046	<10	<10	<10	<10	0.0035	0.0012	<10	<10	<10	<10	0.00067	<10
72 hour	0.210	0.0091	<10	<10	<10	<10	0.0046	0.0028	<10	<10	<10	<10	0.0010	<10
7 days	0.091	0.00076	0.00007	<10	<10	<10	0.0035	0.00087	<10	<10	<10	<10	0.00091	<10

Sample Time	PCB 97		PCB 103		PCB 110		PCB 121		PCB 129		PCB 136		PCB 137	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	0.00042	<10	0.00088	<10	<10	<10	<10	<10	<10	<10	0.0016	<10
48 hour	0.00077	<10	0.0013	<10	0.0022	0.00066	<10	<10	<10	<10	0.00044	<10	<10	<10
72 hour	0.0011	0.00078	0.0014	<10	0.0041	0.0027	<10	<10	<10	<10	0.00064	<10	<10	<10
7 days	0.0010	<10	0.0014	<10	0.0037	0.00038	<10	<10	<10	<10	0.00050	<10	<10	<10

Table 8 (continued).

Sample Time	PCB 141		PCB 143		PCB 151		PCB 154		PCB 155		PCB 157		PCB 159	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	0.0007	<10	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	0.00025	0.00082	<10	<10	<10	<10	<10	<10	<10	<10
7 days	0.00009	<10	<10	<10	0.00037	<10	<10	<10	<10	<10	<10	<10	<10	<10

Sample Time	PCB 171		PCB 173		PCB 182		PCB 185		PCB 190		PCB 191		PCB 194	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0.0015	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0.0020	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Sample Time	PCB 196		PCB 198		PCB 199		PCB 200		PCB 201		PCB 202		PCB 203	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 8 (continued).

Sample Time	PCB 205		PCB 206		PCB 207		PCB 208	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10

Table 9. PCB Fluxes (ng/cm2/hr) (WHO Congeners) from Dewatered (Koester method) New Bedford Harbor Sediment at Room Temperature (73°F) and at 85°F

Sample Time	PCB 77		PCB 81		PCB 105*		PCB 114		PCB 118*		PCB 123		PCB 126	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	0.0074	0.0030	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	0.0075	0.0045	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	0.00012	<10	0.0097	0.0058	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	0.00024	<10	0.0099	0.0086	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	0.00012	<10	0.0092	0.0074	<10	<10	<10	<10
Sample Time	PCB 156		PCB 157		PCB 167		PCB 169		PCB 170*		PCB 180*		PCB 189	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	0.00046	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
7 days	0.00016	<10	<10	<10	0.00023	<10	<10	<10	<10	<10	0.00031	<10	<10	<10

Table 10. PCB Fluxes (ng/cm^{2}/hr) (NOAA Congeners) from Dewatered (Koester method) New Bedford Harbor Sediment at Room Temperature (73°F) and at 85°F

Sample Time	PCB 8		PCB 18		PCB 28		PCB 44		PCB 49		PCB 52		PCB 66	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	10.9	5.82	7.49	5.46	3.80	<10	0.322	0.155	0.860	0.425	1.02	0.456	<10	<10
24 hour	12.3	7.69	7.02	5.74	3.96	<10	0.441	0.287	0.989	0.584	1.16	0.612	<10	0.037
48 hour	11.4	8.15	6.35	6.13	2.31	<10	0.438	0.306	0.968	0.634	1.12	0.863	<10	0.044
72 hour	12.0	8.41	6.02	6.39	2.21	<10	0.751	0.325	1.38	0.671	1.08	0.915	<10	0.049
7 days	8.38	3.92	6.23	4.90	2.18	<10	0.380	0.270	0.817	0.524	0.929	0.790	0.037	0.053

Sample Time	PCB 87		PCB 101		PCB 128		PCB 138		PCB 153		PCB 183		PCB 184	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	0.047	0.022	<10	<10	<10	<10	0.0037	0.0023	<10	<10	<10	<10
24 hour	0.00098	<10	0.050	0.037	<10	<10	0.0020	<10	0.0020	0.0030	<10	<10	<10	<10
48 hour	0.00088	<10	0.055	0.052	<10	<10	0.0016	<10	0.0061	0.0039	<10	<10	<10	<10
72 hour	0.00099	<10	0.051	0.047	<10	<10	0.0021	<10	0.0063	0.0049	<10	<10	<10	<10
7 days	0.0011	<10	0.043	0.053	0.00016	<10	0.0015	<10	0.0069	0.0059	0.00022	<10	<10	<10

Sample Time	PCB 187		PCB 195		PCB 206		PCB 209	
	73°F	85°F	73°F	85°F	73°F	85°F	73°F	85°F
6 hour	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	0.00035	<10	<10	<10	<10	<10	<10	<10
72 hour	0.00036	<10	<10	<10	<10	<10	<10	<10
7 days	0.00038	0.00033	<10	<10	<10	<10	<10	<10

Table 11. PCB Fluxes (ng/cm2/hr) (Canadian Congeners) from Dewatered (Koester method) New Bedford Harbor Sediment at Room Temperature (73°F) and at 85°F

Sample Time	PCB 1		PCB 5		PCB 7		PCB 15		PCB 31		PCB 40		PCB 50	
	73°F	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	0.784	0.428	0.026	<10	0.564	0.402	<10	<10	2.10	<10	0.023	0.012	<10	<10
24 hour	0.685	0.479	0.023	<10	0.529	0.407	<10	<10	1.91	<10	0.028	0.022	<10	<10
48 hour	0.458	0.555	0.017	<10	0.474	0.435	<10	<10	1.94	<10	0.028	0.024	<10	<10
72 hour	0.493	0.431	0.015	<10	0.440	0.452	<10	<10	1.72	<10	0.026	0.024	<10	<10
7 days	0.329	0.034	0.013	<10	0.386	0.362	<10	<10	2.34	<10	0.032	0.019	<10	<10
Sample Time	**PCB 54**		**PCB 60**		**PCB 66**		**PCB 70**		**PCB 81**		**PCB 82**		**PCB 86**	
	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	1.69	0.016	<10	<10	<10	<10	0.048	0.018	<10	<10	<10	<10	0.008	<10
24 hour	1.96	0.035	0.0016	<10	<10	0.037	0.055	0.039	<10	<10	<10	<10	0.011	<10
48 hour	1.84	0.032	0.0011	<10	<10	0.044	0.053	0.041	<10	<10	<10	<10	0.013	<10
72 hour	1.73	0.025	0.0009	<10	<10	0.049	0.049	0.044	<10	<10	0.00048	<10	0.012	<10
7 days	1.50	0.030	0.0014	<10	0.037	0.053	0.071	0.049	<10	<10	0.00027	<10	0.011	<10
Sample Time	**PCB 97**		**PCB 103**		**PCB 110**		**PCB 121**		**PCB 129**		**PCB 136**		**PCB 137**	
	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	0.0092	0.0028	0.0095	0.0024	0.034	0.014	<10	<10	<10	<10	0.0044	0.0028	<10	<10
24 hour	0.012	0.0061	0.0099	0.0040	0.043	0.029	<10	<10	<10	<10	0.0054	0.0061	<10	<10
48 hour	0.014	0.0082	0.010	0.0056	0.053	0.041	<10	<10	<10	<10	0.0062	0.0083	<10	<10
72 hour	0.014	0.0093	0.0096	0.0065	0.050	0.047	<10	<10	<10	<10	0.0059	0.0093	<10	<10
7 days	0.013	0.0081	0.0095	0.0055	0.057	0.041	0.0013	<10	<10	<10	0.0056	0.0082	0.00028	<10

Table 11 (continued).

Sample Time	PCB 141		PCB 143		PCB 151		PCB 154		PCB 155		PCB 157		PCB 159	
	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	<10	<10	<10	<10	0.0025	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	0.0039	0.0023	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	0.00014	<10	<10	<10	0.0033	0.0030	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	0.00025	<10	<10	<10	0.0042	0.0034	<10	<10	<10	<10	<10	<10	<10	<10
7 days	0.00016	<10	<10	<10	0.0038	0.0031	<10	<10	<10	<10	<10	<10	<10	<10

Sample Time	PCB 171		PCB 173		PCB 182		PCB 185		PCB 190		PCB 191		PCB 194	
	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Sample Time	PCB 196		PCB 198		PCB 199		PCB 200		PCB 201		PCB 202		PCB 203	
	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 11 (continued).

Sample Time	PCB 205		PCB 206		PCB 207		PCB 208	
	73oF	85oF	73oF	85oF	73oF	85oF	73oF	85oF
6 hour	<10	<10	<10	<10	<10	<10	<10	<10
24 hour	<10	<10	<10	<10	<10	<10	<10	<10
48 hour	<10	<10	<10	<10	<10	<10	<10	<10
72 hour	<10	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10	<10

Table 12. PCB Fluxes (ng/cm^2/hr) from Dewatered New Bedford Sediment (MPS method)
WHO Congeners
(detection limit = 10 ng)

Sample Time	PCB 77	PCB 81	PCB 105*	PCB 114	PCB 118*	PCB 123	PCB 126
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	0.0030	<10	<10
48 hours	<10	<10	<10	<10	0.0026	<10	<10
72 hours	<10	<10	<10	<10	0.0062	<10	<10
7 days	<10	<10	<10	<10	0.0048	<10	<10

Sample Time	PCB 156	PCB 157	PCB 167	PCB 169	PCB 170*	PCB 180*	PCB 189
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	<10	<10	<10
48 hours	<10	<10	<10	<10	<10	0.0010	<10
72 hours	<10	<10	<10	<10	<10	0.015	<10
7 days	0.0033	<10	<10	<10	<10	0.0041	<10

* = Congeners on both the WHO and NOAA lists

Table 13. PCB Fluxes (ng/cm^2/hr) from Dewatered New Bedford Harbor Sediment (MPS Method)
NOAA Congeners
(detection limit = 10 ng)

Sample Time	PCB 8	PCB 18	PCB 28	PCB 44	PCB 49	PCB 52	PCB 66
6 hours	2.71	1.87	<10	<10	0.204	0.231	<10
24 hours	3.09	1.68	<10	<10	0.295	0.340	<10
48 hours	1.74	1.98	<10	<10	0.269	0.308	<10
72 hours	2.37	2.13	<10	<10	0.299	0.341	<10
7 days	1.44	1.52	<10	<10	0.220	0.353	<10

Sample Time	PCB 87	PCB 101	PCB 128	PCB 138	PCB 153	PCB 183	PCB 184
6 hours	<10	0.0087	<10	<10	<10	<10	<10
24 hours	<10	0.018	<10	<10	<10	<10	<10
48 hours	<10	0.023	<10	<10	<10	<10	<10
72 hours	0.0084	0.047	<10	<10	<10	<10	<10
7 days	0.0034	0.027	<10	<10	0.0039	<10	<10

Sample Time	PCB 187	PCB 195	PCB 206	PCB 209
6 hours	<10	<10	<10	<10
24 hours	<10	<10	<10	<10
48 hours	<10	<10	<10	<10
72 hours	<10	<10	<10	<10
7 days	<10	<10	<10	<10

Table 14. PCB Fluxes (ng/cm^2/hr) from Dewatered New Bedford Harbor Sediment (MPS Method)
Canadian List (detection limit = 10 ng)

Sample Time	PCB 1	PCB 5	PCB 7	PCB 15	PCB 31	PCB 40	PCB 50
6 hours	0.200	<10	0.159	<10	<10	0.0053	<10
24 hours	0.148	<10	0.158	<10	<10	0.0159	<10
48 hours	0.102	<10	0.113	<10	<10	0.011	<10
72 hours	0.076	<10	0.122	<10	<10	0.021	<10
7 days	0.045	<10	0.079	<10	<10	0.0076	<10

Sample Time	PCB 54	PCB 60	PCB 66	PCB 70	PCB 81	PCB 82	PCB 86
6 hours	0.011	<10	<10	0.0066	<10	<10	<10
24 hours	0.020	<10	<10	0.014	<10	<10	<10
48 hours	0.013	<10	<10	0.013	<10	<10	<10
72 hours	0.035	<10	<10	0.028	<10	<10	<10
7 days	0.0048	<10	<10	0.016	<10	<10	<10

Sample Time	PCB 97	PCB 103	PCB 110	PCB 121	PCB 129	PCB 136	PCB 137
6 hours	0.0012	0.0020	0.0088	<10	<10	<10	<10
24 hours	0.0035	0.0050	0.017	<10	<10	0.0016	<10
48 hours	0.0039	0.0041	0.020	<10	<10	0.0017	<10
72 hours	0.021	0.018	0.045	<10	<10	0.024	<10
7 days	0.0054	0.010	0.026	<10	<10	0.0065	<10

Table 14 (continued).

Sample Time	PCB 141	PCB 143	PCB 151	PCB 154	PCB 155	PCB 157	PCB 159
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	0.0016	<10	<10	<10	<10
48 hours	<10	<10	0.0023	<10	<10	<10	<10
72 hours	<10	<10	0.0097	0.0066	<10	<10	<10
7 days	<10	<10	0.0043	0.0068	<10	<10	<10

Sample Time	PCB 171	PCB 173	PCB 182	PCB 185	PCB 190	PCB 191	PCB 194
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	<10	<10	<10
48 hours	<10	<10	<10	<10	<10	<10	<10
72 hours	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10

Sample Time	PCB 196	PCB 198	PCB 199	PCB 200	PCB 201	PCB 202	PCB 203
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	<10	<10	<10
48 hours	<10	<10	<10	<10	<10	<10	<10
72 hours	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10

Sample Time	PCB 205	PCB 206	PCB 207	PCB 208
6 hours	<10	<10	<10	<10
24 hours	<10	<10	<10	<10
48 hours	<10	<10	<10	<10
72 hours	<10	<10	<10	<10
7 days	<10	<10	<10	<10

Table 15. PCB Fluxes (ng/cm²/hr) from Dewatered New Bedford Sediment (JCI method) WHO Congeners (detection limit = 10 ng)							
Sample Time	**PCB 77**	**PCB 81**	**PCB 105***	**PCB 114**	**PCB 118***	**PCB 123**	**PCB 126**
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	0.00076	<10	<10
48 hours	<10	<10	<10	<10	0.0034	<10	<10
72 hours	<10	<10	<10	<10	0.0039	<10	<10
7 days	<10	<10	<10	<10	0.0044	<10	<10
Sample Time	**PCB 156**	**PCB 157**	**PCB 167**	**PCB 169**	**PCB 170***	**PCB 180***	**PCB 189**
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	<10	<10	<10
48 hours	<10	<10	<10	<10	<10	<10	<10
72 hours	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10

* = Congeners on both the WHO and NOAA lists

Table 16. PCB Fluxes (ng/cm²/hr) from Dewatered New Bedford Harbor Sediment (JCI Method) NOAA Congeners (detection limit = 10 ng)							
Sample Time	**PCB 8**	**PCB 18**	**PCB 28**	**PCB 44**	**PCB 49**	**PCB 52**	**PCB 66**
6 hours	6.06	4.09	<10	<10	0.306	0.385	<10
24 hours	4.19	3.55	<10	<10	0.484	0.578	<10
48 hours	4.79	4.41	<10	<10	1.18	1.12	<10
72 hours	2.18	2.59	<10	<10	0.551	0.880	<10
7 days	0.797	1.55	<10	<10	0.517	0.618	<10
Sample Time	**PCB 87**	**PCB 101**	**PCB 128**	**PCB 138**	**PCB 153**	**PCB 183**	**PCB 184**
6 hours	<10	0.0087	<10	<10	<10	<10	<10
24 hours	<10	0.022	<10	<10	<10	<10	<10
48 hours	<10	0.015	<10	<10	0.0021	<10	<10
72 hours	<10	0.062	<10	<10	0.0020	<10	<10
7 days	<10	0.053	<10	<10	0.0029	<10	<10

Sample Time	PCB 187	PCB 195	PCB 206	PCB 209
6 hours	<10	<10	<10	<10
24 hours	<10	<10	<10	<10
48 hours	<10	<10	<10	<10
72 hours	<10	<10	<10	<10
7 days	0.00010	<10	<10	<10

Table 17. PCB Fluxes (ng/cm^2/hr) from Dewatered New Bedford Harbor Sediment (JCI Method)
Canadian List (detection limit = 10 ng)

Sample Time	PCB 1	PCB 5	PCB 7	PCB 15	PCB 31	PCB 40	PCB 50
6 hours	0.298	<10	0.393	<10	<10	0.006	<10
24 hours	0.092	<10	0.249	<10	<10	0.012	<10
48 hours	0.064	<10	0.174	<10	<10	0.026	<10
72 hours	0.021	<10	0.068	<10	<10	0.019	<10
7 days	0.009	<10	0.027	<10	<10	0.024	<10

Sample Time	PCB 54	PCB 60	PCB 66	PCB 70	PCB 81	PCB 82	PCB 86
6 hours	0.014	<10	<10	0.009	<10	<10	<10
24 hours	0.023	<10	<10	0.020	<10	<10	<10
48 hours	0.025	<10	<10	0.058	<10	<10	<10
72 hours	0.014	<10	<10	0.044	<10	<10	<10
7 days	0.007	<10	<10	0.037	<10	<10	<10

Sample Time	PCB 97	PCB 103	PCB 110	PCB 121	PCB 129	PCB 136	PCB 137
6 hours	0.0010	0.0031	0.0063	<10	<10	<10	<10
24 hours	0.0026	0.0051	0.010	<10	<10	0.0015	<10
48 hours	0.010	0.013	0.042	<10	<10	0.0056	<10
72 hours	0.0087	0.0090	0.038	<10	<10	0.0044	<10
7 days	0.0087	0.0070	0.043	<10	<10	0.0043	<10

Table 17 (continued).

Sample Time	**PCB 141**	**PCB 143**	**PCB 151**	**PCB 154**	**PCB 155**	**PCB 157**	**PCB 159**
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	0.0012	<10	<10	<10	<10
48 hours	<10	<10	0.0022	0.00063	<10	<10	<10
72 hours	<10	<10	0.0040	<10	<10	<10	<10
7 days	<10	<10	0.0024	<10	<10	<10	<10
Sample Time	**PCB 171**	**PCB 173**	**PCB 182**	**PCB 185**	**PCB 190**	**PCB 191**	**PCB 194**
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	<10	<10	<10
48 hours	<10	<10	<10	<10	<10	<10	<10
72 hours	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10
Sample Time	**PCB 196**	**PCB 198**	**PCB 199**	**PCB 200**	**PCB 201**	**PCB 202**	**PCB 203**
6 hours	<10	<10	<10	<10	<10	<10	<10
24 hours	<10	<10	<10	<10	<10	<10	<10
48 hours	<10	<10	<10	<10	<10	<10	<10
72 hours	<10	<10	<10	<10	<10	<10	<10
7 days	<10	<10	<10	<10	<10	<10	<10

Table 17 (continued).

Sample Time	PCB 205	PCB 206	PCB 207	PCB 208
6 hours	<10	<10	<10	<10
24 hours	<10	<10	<10	<10
48 hours	<10	<10	<10	<10
72 hours	<10	<10	<10	<10
7 days	<10	<10	<10	<10

Table 18. Comparison of Maximum PCB Fluxes (ng/cm2/hr) Detected from New Bedford harbor Sediment Samples

Congener	Untreated	Untreated @85^{o}C	Koester	Koester @85^{o}C	MPS	JCL
118	0.00051	0.0015	0.0099	0.0086	0.0062	0.0044
8	1.27	0.581	12.3	8.41	3.09	6.06
18	0.926	0.484	7.49	6.39	2.13	4.41
28	0.279	0.079	3.96	<10	<10	<10
44	0.044	0.040	0.751	0.325	<10	<10
49	0.095	0.068	1.38	0.671	0.299	1.18
52	0.097	0.078	1.16	0.915	0.353	1.12
66	<10	<10	0.037	0.053	<10	<10
87	<10	0.00009	0.0011	<10	0.0084	<10
101	0.0062	0.0060	0.055	0.053	0.047	0.062
138	<10	0.00022	0.0021	<10	<10	<10
153	0.00038	<10	0.0069	0.0059	0.0039	0.0029
187	<10	<10	0.00038	0.00033	<10	0.00010
Arochlor 1242	31.8	4.22	258	33.3	15.2	32.6
Totals	1.14	0.622	11.8	8.21	2.67	5.66

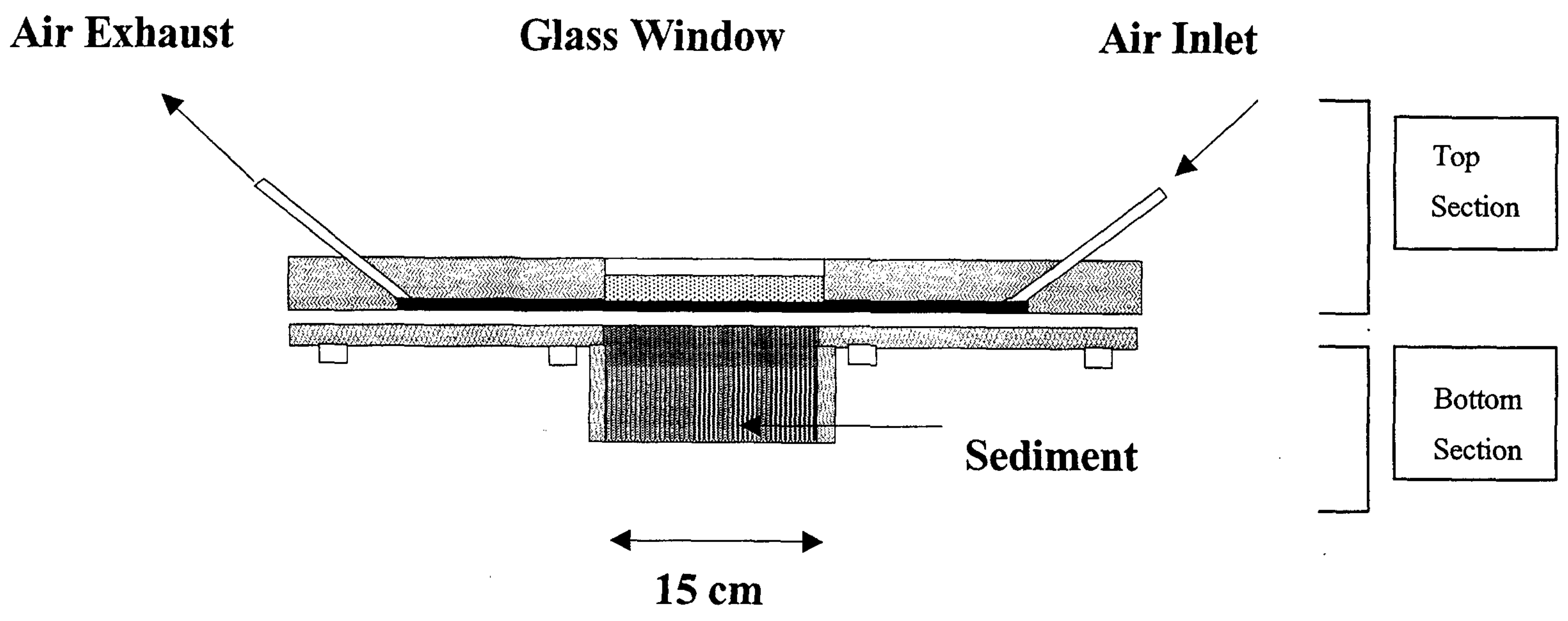


Figure 1. Laboratory Flux Chamber

Figure 2 not available

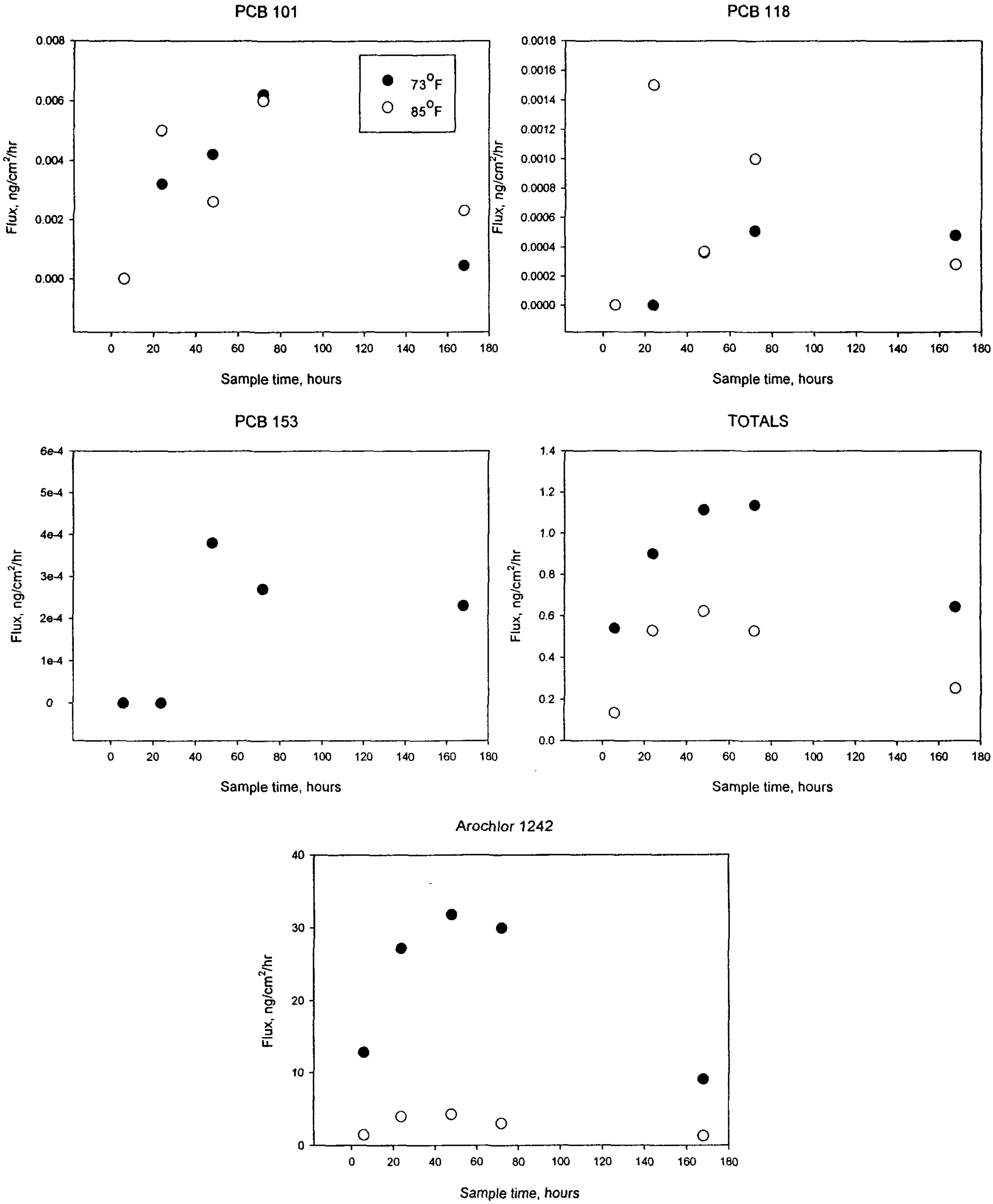


Figure 3. Congener and arochlor fluxes from untreated New Bedford Harbor sediment

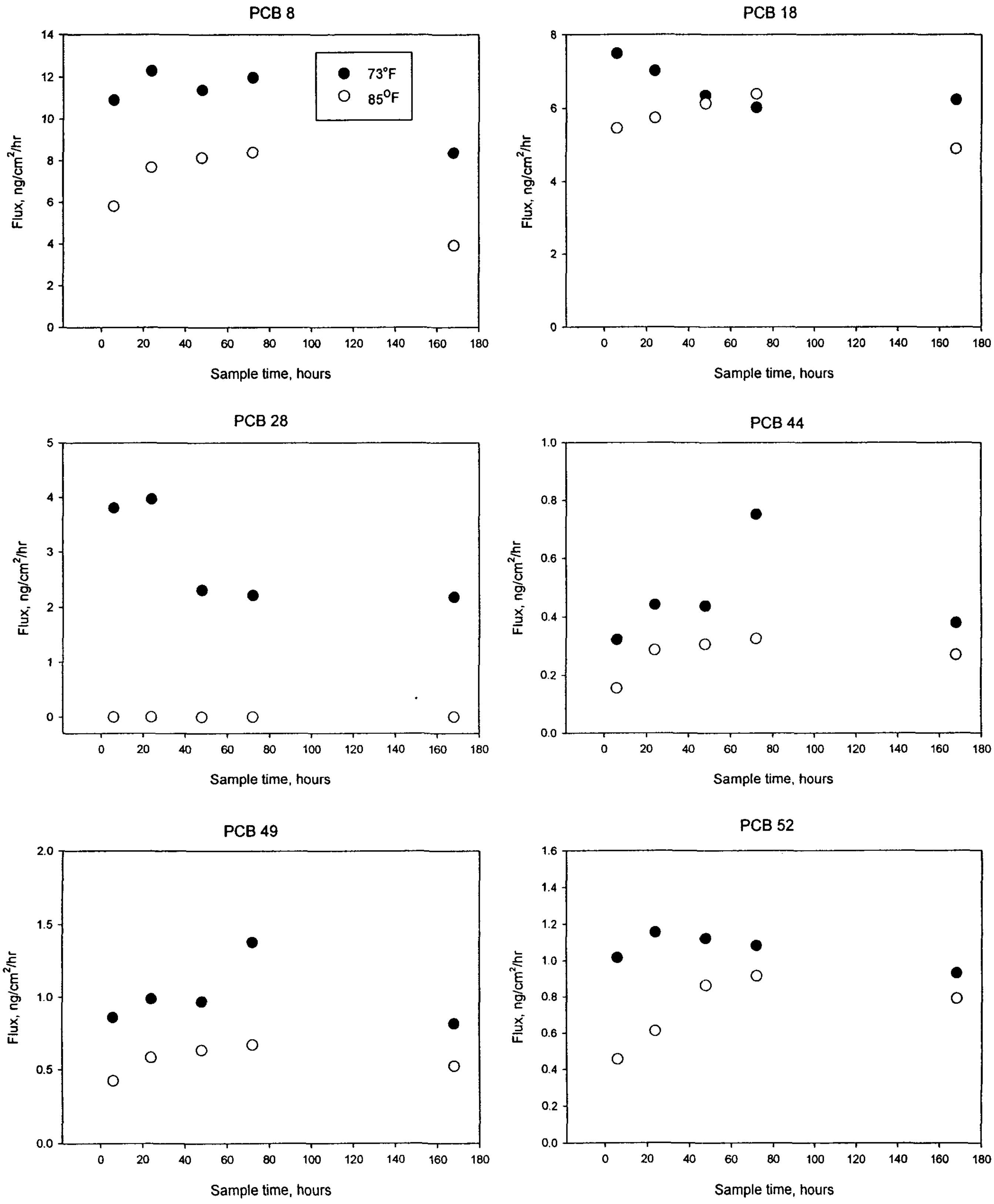


Figure 4. Congener fluxes from dewatered (Koester) New Bedford Harbor sediment

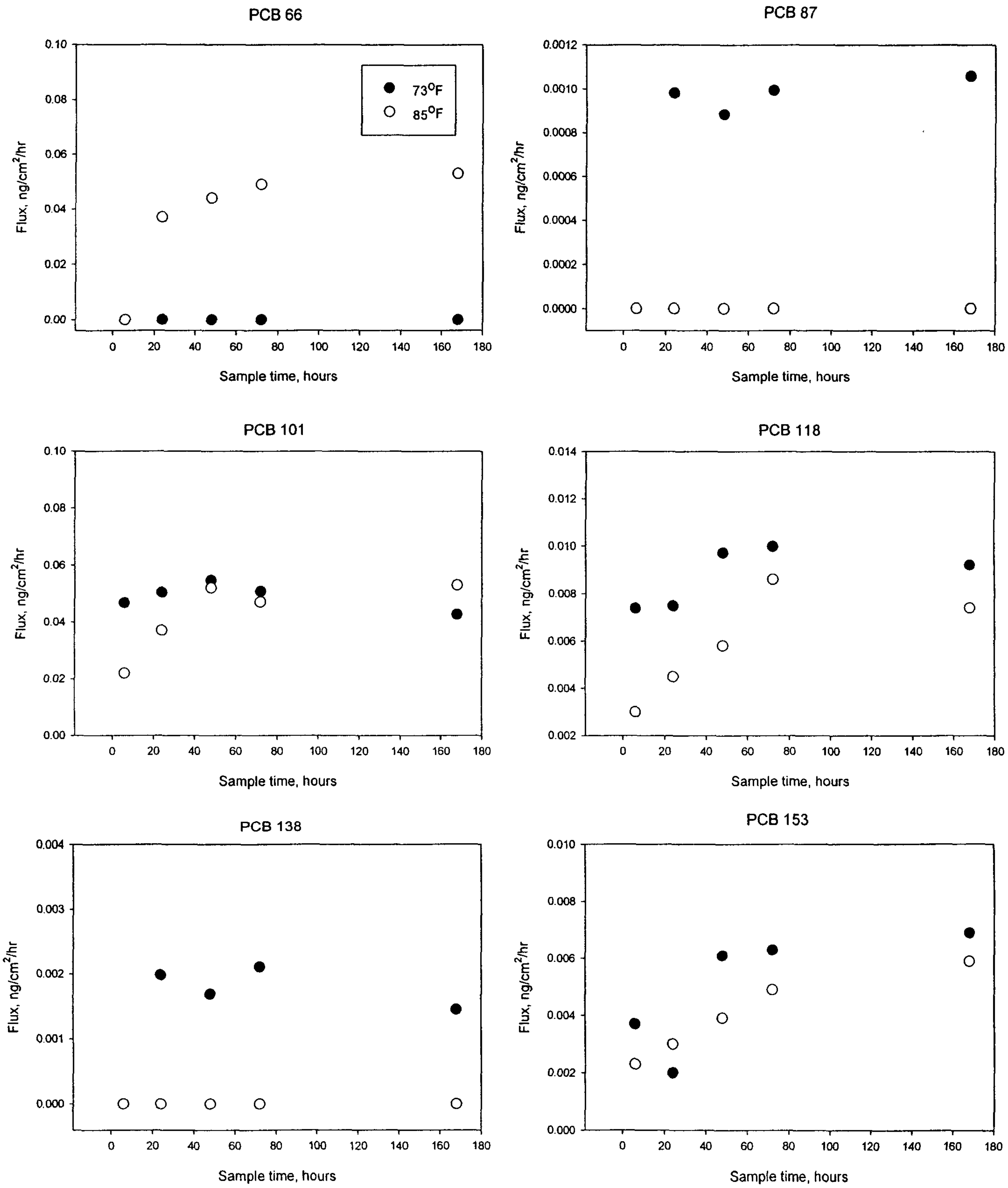


Figure 5. Congener fluxes from dewatered (Koester) New Bedford Harbor sediment

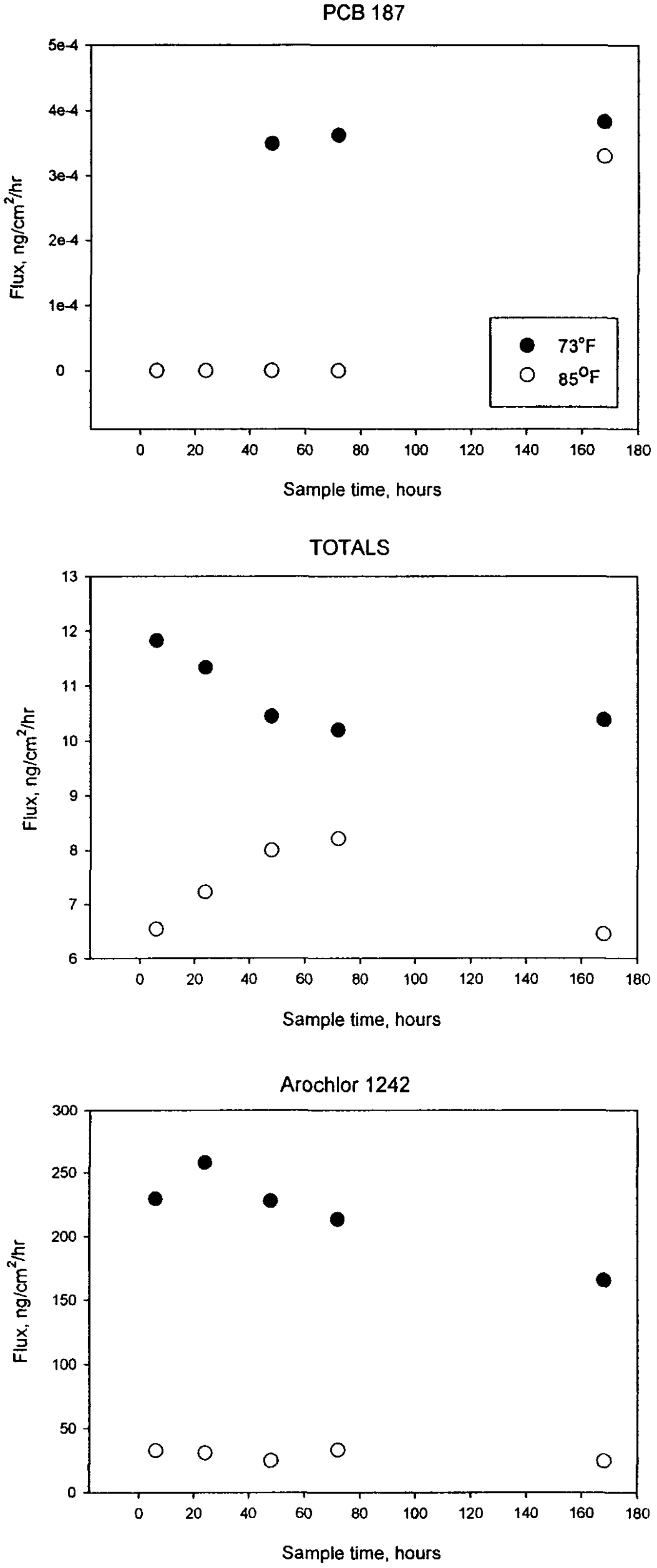


Figure 6. Congener and arochlor fluxes from dewatered (Koester) New Bedford Harbor sediment

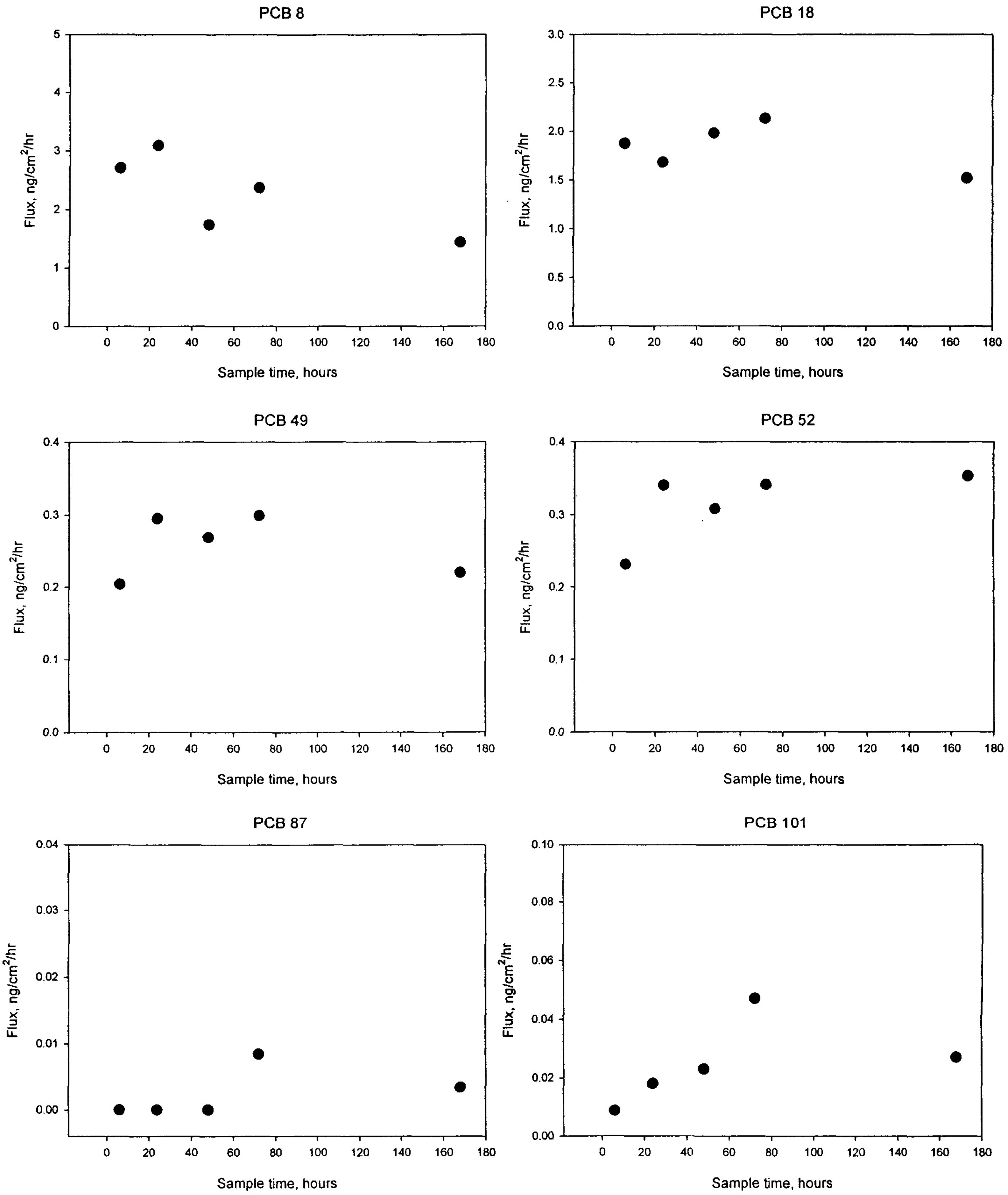


Figure 7. Congener fluxes from dewatered (MPS) New Bedford Harbor sediment

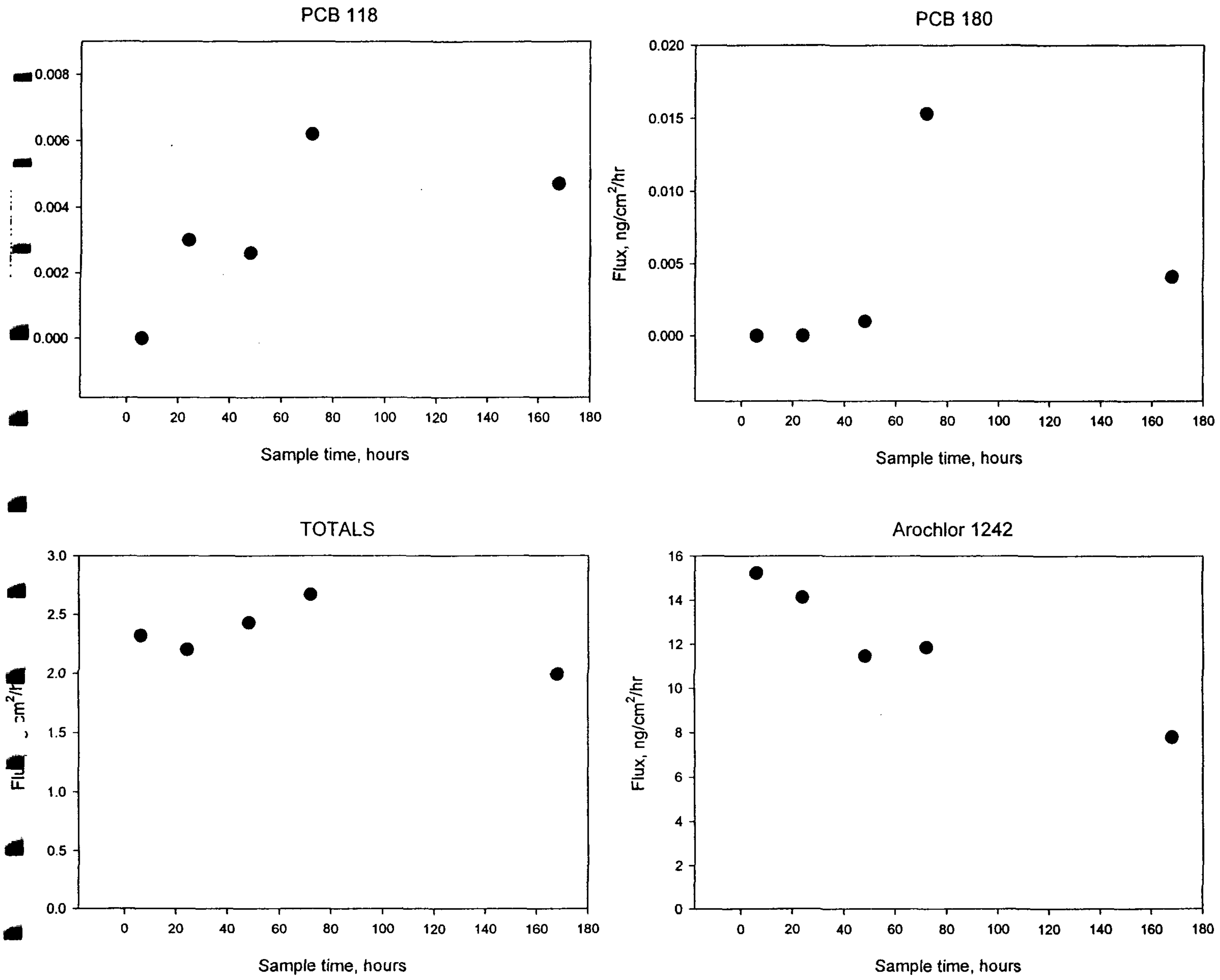


Figure 8. Congener and arochlor fluxes from dewatered (MPS) New Bedford Harbor sediment

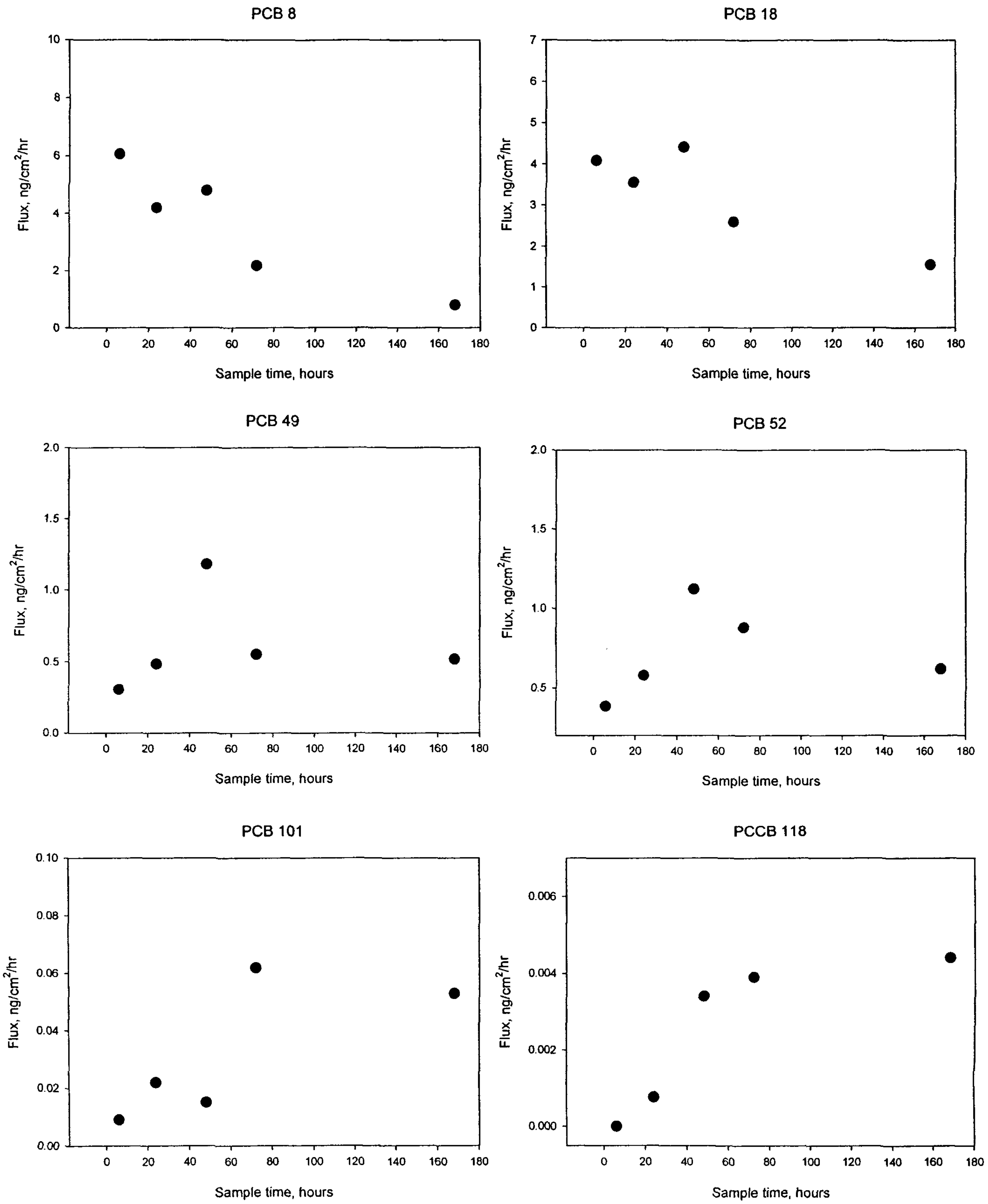


Figure 9. Congener fluxes from dewatered (JCI) New Bedford Harbor sediment

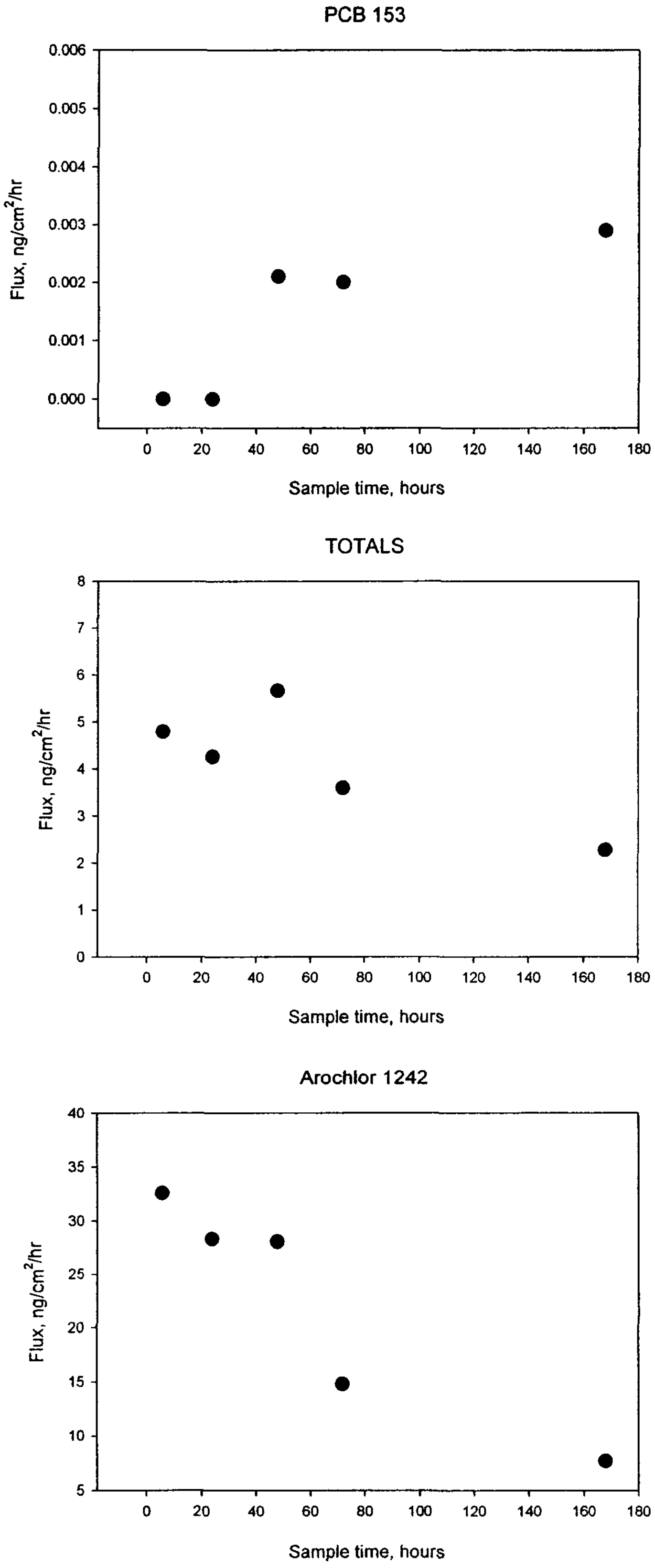


Figure 10. Congener and arochlor fluxes from dewatered (JCI) New Bedford Harbor sediment

APPENDIX L

Dewatered Sediment Screening Analysis

FOSTER WHEELER

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Memorandum

DRAFT

TO: Patricia Sumner, ACOE

CC: Ron Marnicio, FWENC; Helen Douglas, FWENC

FROM: Tina Berceli-Boyle

DATE: March 30, 2001

SUBJECT: Dewatered Sediment Screening Analysis

The Army Corp of Engineers (ACOE) has asked Foster Wheeler Environmental (FWENC) to perform a conservative screening analysis to evaluate the ambient air concentrations of volatilized PCBs emitted from dewatered sediment placed in a confined disposal facility (CDF) at the New Bedford Harbor Site. Specifically, FWENC has been asked to look at the predicted changes in ambient air concentrations that result from varying the surface area of the sediment acting as an active source.

There are several reasons that a dewatering option is being considered. Under the wet sediment scenario, the wet slurry would be pumped into the CDFs where it would be treated over a period of time. Because of the consistency of the slurry, the wet sediment would cover the entire bottom of the CDF's, so that volatile PCBs would be emitted from the entire area. Preliminary reviews have identified few practical options to control the volatile emissions from the wet sediment.

Required storage capacities would also be reduced if the dewatered option is used. The wet slurry occupies a much larger volume per mass of dry sediment stored than a dewatered sediment would occupy. It has been estimated by vendors that dewatering will reduce the in situ sediment volume by 50%, allowing for reduced storage requirements.

However, an additional effect of dewatering the sediment is a higher PCB emissions flux from the dewatered versus the wet sediment. Studies performed by WES have shown an emission flux of ~258 ng/cm^2/hr for detected Aroclors from sediment dewatered using the Koester method. In comparison, WES has shown wet sediment to have a flux of detected Aroclors of ~31.8 ng/cm^2/hr. The area of exposed dewatered sediment is directly related to the amount of volatile PCB's released.

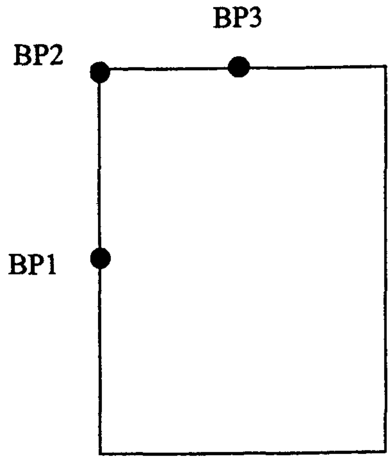
It appears that there is more flexibility to define the area of exposed sediment with the dewatered option than with the wet option. As mentioned above, the wet slurry will cover the entire area of the CDF. But, the dewatered sediment has a much different consistency and can be placed in the CDF in lifts, so that the entire area of the CDF does not need to be exposed. In addition, it appears that there are more practical options for controlling emissions from dewatered sediment that has already been placed in the CDF. However, the effectiveness of these options can only be assessed if the effect of changing source areas and configurations on ambient air concentrations can be scaled. For these reasons, the ACOE has asked FWENC to take a preliminary look at potential changes in ambient concentrations that result from different emissions source area sizes and orientations.

There are several factors that could influence ambient air concentrations caused by emissions from a CDF storing dewatered sediment. These factors include:

- Size of exposed area
- Location of exposed area within the CDF
- Suppression of emissions from exposed areas using engineering controls (i.e., interim covers, sprays)

The effect of each of these factors has been quantitatively evaluated using the SCREEN3 model. SCREEN3 is an EPA-recommended model that estimates short-term ground level concentrations for point, area and volume sources. Area sources are modeled using a numerical integration approach that allows for the area to be approximated as a rectangle. Since the ground level concentration at a particular distance downwind from an area source is dependent upon its orientation, SCREEN3 allows the user to choose a wind direction whose orientation is relative to the long axis of the rectangular area source. It is important to note that SCREEN3 is a very conservative dispersion model. It is traditionally used to measure short term concentrations (i.e. one-hour averages), because the model assumes that the wind is blowing in only one direction, directly at the receptor. In addition, the model chooses the wind speed and stability class combination from their set of standard conditions that results in the highest ground level concentration. However, SCREEN3 is appropriate for purposes of evaluating the relative impact of area source configurations on ambient air concentrations. Because this analysis focuses on the relative impact of changing source configurations, the model was run with a unit emission flux of 1 $ug/m^3/g/s/m^2$. These normalized concentrations can be converted to ambient air concentrations by multiplication with the emission flux in $g/s/m^2$.

At the time of this study, it appeared that the dewatered sediment would be stored in CDF D. For this reason, the modeling was run using CDF D as our main area source. The *CDF D Alternatives Analysis Report (Rev. A)* indicates that the area of CDF D in a dewatering scenario would be 542,436 ft^2. For purposes of modeling, the CDF D was approximated using a rectangular area measuring 1200 ft (365.8 m) by 450 ft (137.2 m). The proposed location of CDF D places land mass mostly on the north, northwest, west and southwestern directions. For this reason, throughout the modeling analysis, boundary receptors were placed on the north, northwest, and west sides of the area source as shown below.



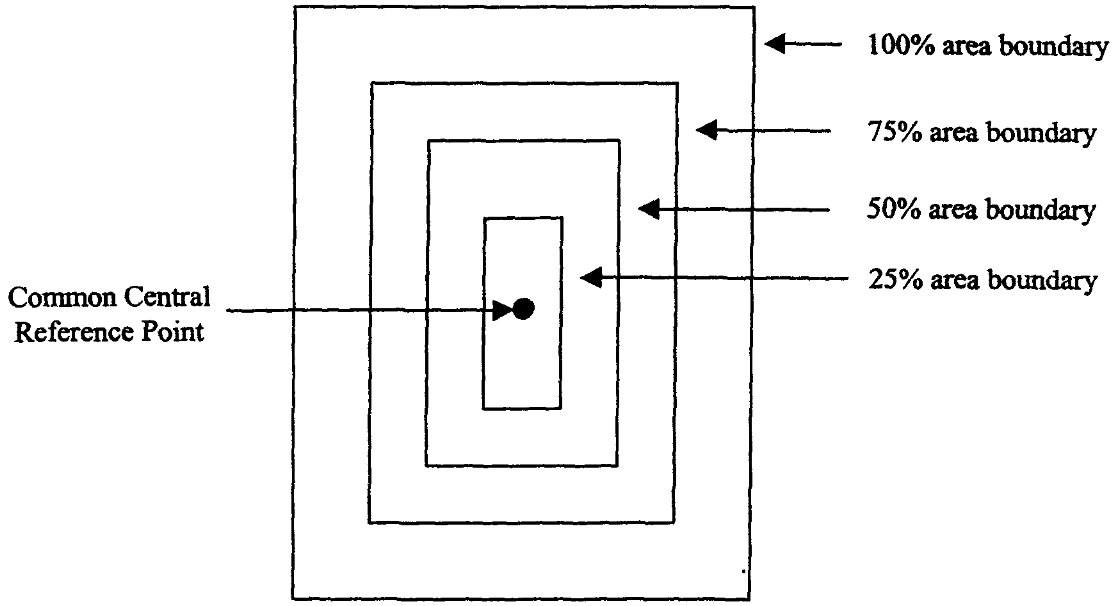
This screening analysis has been divided into four segments. Segment I evaluates the effect of changing the size of the emitting area on maximum ground-level concentrations. For this portion of the analysis, all of the rectangular source areas were centered on the same point (see below). Segment II shows the effect of varying the location of the emitting area within the CDF (relative to receptor location) on maximum ground-level concentrations. Segment III illustrates the effect of using a daily vapor suppressing cover on portions of the CDF that are not being actively disturbed. This segment uses proposed operating parameters as presented in the *CDF D Alternatives Analysis Report (Rev. A).* to define more realistic source configurations. Finally, Segment IV brings all of these source configurations together and evaluates the reduction in ground-level concentrations as one moves away from the CDF. Each of these segment analyses are presented in greater detail below.

Segment I

As presented above, Segment I of the analysis illustrates the change in maximum ground-level concentrations as the size of the emitting area is changed. Four different area sizes were evaluated:

- 100% of the CDF D area (50,188 m^2)
- 75% of the CDF D area (~37,840 m^2)
- 50% of the CDF D area (~25,120 m^2)
- 25% of the CDF D area (~12,380 m^2)

SCREEN3 allows placement of receptors around a point located at the center of the rectangle. For this segment analysis, the four areas were evaluated around the same center point as shown below.



For modeling purposes, receptors were placed on the west, northwest, and north sides of each source area (not the edge of the entire CDF) (BP1, BP2 and BP3 respectively). The source configurations are illustrated on the attached worksheet labeled "Segment 1". The SCREEN3 model was run for each of these areas using the following inputs/options (please note that these same inputs are used throughout the analyses):

- 1 g/s/m^2 emission rate
- 0 m source release height
- 0 m receptor height
- rural option (uses more conservative rural dispersion parameters)
- specified direction based on location of receptors
- full meteorology (search through all combination of windspeed and stability and chooses the combination with maximum impacts)

The results of these runs are presented on the attached worksheet (labeled Segment I). Two conclusions can be reached from this set of data.

- Ground-level concentrations at a fixed receptor location (i.e., on the edge of the full CDF) decrease as the emitting area decreases. This trend is illustrated on the attached Chart 1 for BP1(100).
- The maximum ground-level concentrations for each size area (which are at the boundaries of the emitting area) decrease as the size of the emitting area decreases. This trend is illustrated on the attached Chart 2 for BP1(100), BP1(75), BP1(50) and BP1(25).

Segment II

The Segment II analysis illustrates the change in maximum ground-level concentrations associated with changing the location of the emitting area within the CDF. For this analysis, four source configurations were constructed as illustrated on the attached worksheet labeled Segment II. In each configuration, it was assumed that 50% of the area of the CDF would be emitting volatile PCBs. As shown on the worksheet, the emitting area was sequentially set in the north, south, east and west halves of the CDF area. As in segment I, three receptors were placed around the boundaries of each source configuration: BP1, BP2, and BP3. The SCREEN3 model was run for each of these receptors for each configuration. The source-specific SCREEN3 parameters used in the model runs are presented on the worksheets. Other general inputs/options are the same as those used in Segment I (and presented above).

The results of these modeling runs are summarized in the worksheet labeled "Segment II". As shown by these results, the location of the emitting area within the CDF greatly affects the location of the maximum ground-level concentration. This variation is illustrated in the Table 1 below, which shows the boundary point exhibiting the maximum ground-level concentration for each configuration.

Table 1
Location of Maximum Ground-Level Concentrations for Segment II Source Configurations

Source Configuration	Receptor with Maximum Ground Level Concentration
Configuration 1	BP2/BP3
Configuration 2	BP3
Configuration 3	BP1/BP2
Configuration 4	BP1

These results reflect both the influence of both the distance between the center of the emitting area and the receptor location and the projection of the length of the source area in the direction of the receptor. This is an important relationship because it indicates that the maximally exposed receptor would likely change depending on where the emitting area is located in the CDF.

Segment III

Segment III looks at several source configurations that may reflect plausible operating scenarios. One proposed method for storing the dewatered sediment is to place the sediment into the CDF in one foot lifts. The sediment placed during the course of a typical day was considered the "active" area for this analysis. It has also been suggested that the active area could be covered with a vapor suppressant at the end of each day to reduce emissions. Under this type of scenario, the location of the emitting area (i.e. the 100% emitting area) within the CDF would change daily, with the remainder of the CDF emitting at a reduced rate. Four source configurations were constructed to mimic this "real life" scenario, as illustrated in the worksheet labeled "Segment III". In these configurations, the active area is approximated as a square, and is placed in all four central edge locations in the CDF. This active area would emit at 100% strength. The remainder of the CDF is assumed to have a vapor suppressant cover, that would reduce emissions by 90%. Consequently, the remainder of the area would emit at 10% strength. In the modeling, this was represented as 1 $g/s/m^2$ and 0.1 $g/s/m^2$ respectively. The daily active area was calculated to be 20,250 ft (43.37 m x 43.37m). The following assumptions were used in this calculation:

- Maximum dredging rate was 75 CY/hr of wet slurry
- Dredging will occur 20 hours per day
- Dewatering will reduce the in situ sediment volume by 50%
- Dewatered sediment will be placed in one foot lifts.

Predicted concentrations at the boundary points (BP1, BP2 and BP3) for each of these configurations were estimated using SCREEN3. Each source configuration was broken down into two smaller sub-sources (please see worksheet labeled "Segment III"), which were then modeled in separate SCREEN3 runs. The results from the two runs were then superimposed to get the total projected concentration. It is important to note that maximum ground-level concentrations predicted for Segment III configurations are extremely conservative because SCREEN3 is not really designed to model multiple sources. As mentioned previously, SCREEN3 assumes that the wind is blowing in only one direction - directly at the receptor. In the source configurations analyzed in this segment, it was assumed that the wind would be blowing directly at the receptor for both of the sub-sources at the same time. Since wind direction is determined by an axis through the center of the source, it would be physically impossible for the wind to be blowing in two directions at the same time. Consequently, the maximum-ground level concentrations predicted in this segment are overestimates. The results of the SCREEN3 runs are presented in the attached worksheet labeled "Segment III".

Even with the conservative modeling approach, the result of these analyses show a distribution of maximum ground-level concentrations that are, on the whole, much less than the previous analyses with the larger areas. Placing the dewatered sediment in lifts and using a vapor suppressing cover will effectively reduce the overall exposure to surrounding receptors.

This trend is illustrated in Table 2 which presents percent reduction of predicted concentrations for the Segment III scenarios versus the predicted concentrations for the 100% emitting area (Segment I) scenario.

Table 2
% Reductions in Normalized Concentrations Using Segment III Configurations

	Segment III Config 1	**Segment III Config 2**	**Segment III Config 3**	**Segment III Config 4**
BP1	81.4%	81.4%	22.4%	78.7%
BP2	76.8%	58.8%	84.3%	84.6%
BP3	39.1%	81.5%	84.2%	84.2%

Based on this screening level analysis, the table shows that although in both Segment III and Segment I configurations the entire area of the CDF is emitting at varying magnitudes, using the vapor suppressant could reduce the maximum ground-level concentrations between 22% to 85%.

Segment IV

Segment IV brings all of the previous source configurations together and evaluates the reduction in ground-level concentrations as one gets farther from the CDF. For this segment, source configurations from the first three segments were revisited to determine predicted concentrations at distances radially out from the sides of the CDF. The following configurations were used in this segment:

- The configuration from Segment I – 100% emitting area ("Segment IVa")
- All four configurations from Segment II - 50% emitting area ("Segment IVb")
- All four configurations from Segment III – 3.7% emitting area ("Segment IVc")

All of these configurations are presented on the attached worksheets labeled "Segment IV#). In order to evaluate the impact of these different configurations on concentrations away from the edge of the CDF, receptors were placed in the northern and western directions at the following locations.

- At the CDF boundary
- 5 m from the CDF boundary
- 10 m from the CDF boundary
- 30 m from the CDF boundary

The receptor locations for each configuration are also illustrated on the attached worksheet. The results indicate that for certain source configurations, the predicted emission flux normalized concentrations do not change dramatically as you move away from the CDF. This trend is illustrated is Chart 3 and Chart 4 (attached). Chart 3 shows the off-site normalized concentrations moving away from the CDF in the northern direction and Chart 4 shows concentrations moving away in the western direction. As shown on these charts, for the configurations with smaller active areas that are located on the far side of the CDF, concentrations change (on average) by about 10% or approximately 6 x 10^6 ug/m^3/g/s/m^2. Conversely, the concentration for the 100% active area changes by a factor of two or approximately 6 x 10^7 ug/m^3/g/s/m^2 between the boundary and 30 m. This indicates that for certain source configurations, the distance from the boundary of the CDF may not change ground-level concentrations significantly.

Conclusions

These analyses presented above have effectively illustrated the effect of size of exposed area, the location of exposed area within the CDF and use of emissions controls on predicted ground level concentrations in a dewatered sediment scenario. The main conclusions from these analyses include:

- Decreasing the emitting area will decrease ground-level concentrations
- The location of the emitting area within the CDF has a significant impact on the location and magnitude of the predicted ground-level concentrations.
- Use of a emission control like a vapor suppressing cover will effectively reduce the magnitude of ground-level concentrations near the CDF.
- There are certain source configurations (i.e. smaller emitting areas located on far side of CDF) where the ground-level concentrations at receptor locations away from the CDF change relatively little with distance.

If you have any questions concerning this analysis, please feel free to give me a call at (617) 457-8204.

Source Inputs for SCREEN3

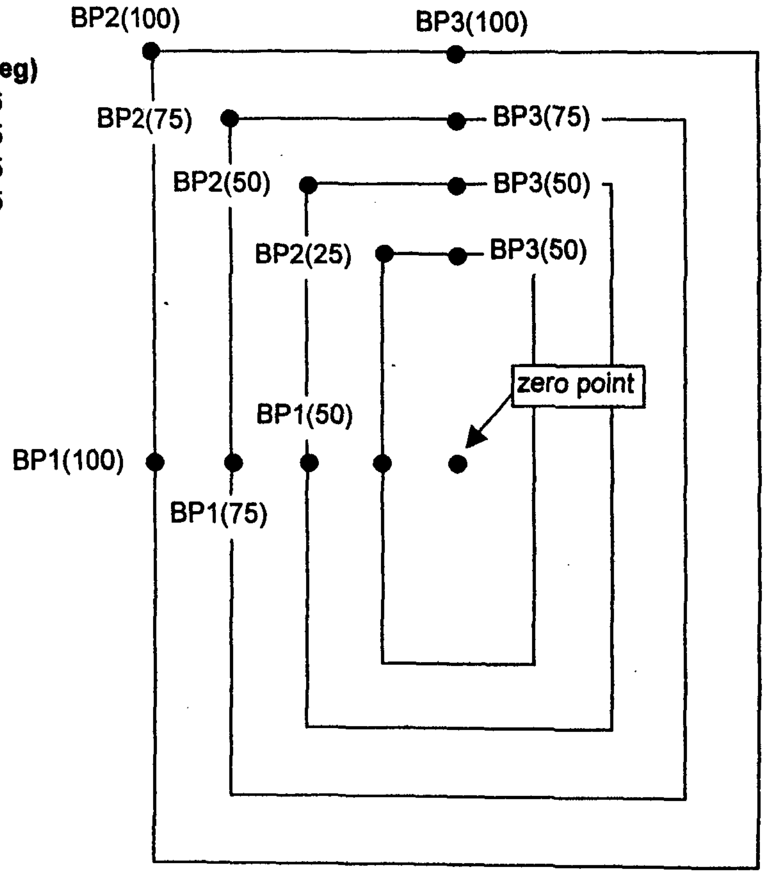
	long side	short side	BP1	BP2	BP3	
	(m)	(m)	(m)	(m)	(m)	BP2 (deg)
100%	365.8	137.2	68.6	195.3	182.9	20.6
75%	318	119	59.5	169.8	159	20.5
50%	259	97	48.5	138.3	129.5	20.5
25%	182	68	34	97.1	91	20.5

Unit Concentrations (ug/m3/g/s/m2) * 10^{-8}

	100%	75%	50%	25%
BP 1 (100)	1.182	0.7522	0.5317	0.3395
BP 1 (75)		1.129	0.6488	0.3915
BP 1 (50)			1.056	0.4927
BP 1 (25)				0.9364

	100%	75%	50%	25%
BP 2 (100)	1.587	0.8846	0.6126	0.3779
BP 2 (75)		1.522	0.7535	0.4405
BP 2 (50)			1.433	0.5649
BP 2 (25)				1.295

	100%	75%	50%	25%
BP 3 (100)	1.571	0.9076	0.6937	0.4093
BP 3 (75)		1.509	0.7775	0.4705
BP 3 (50)			1.427	0.5926
BP 3 (25)				1.283



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Segment I

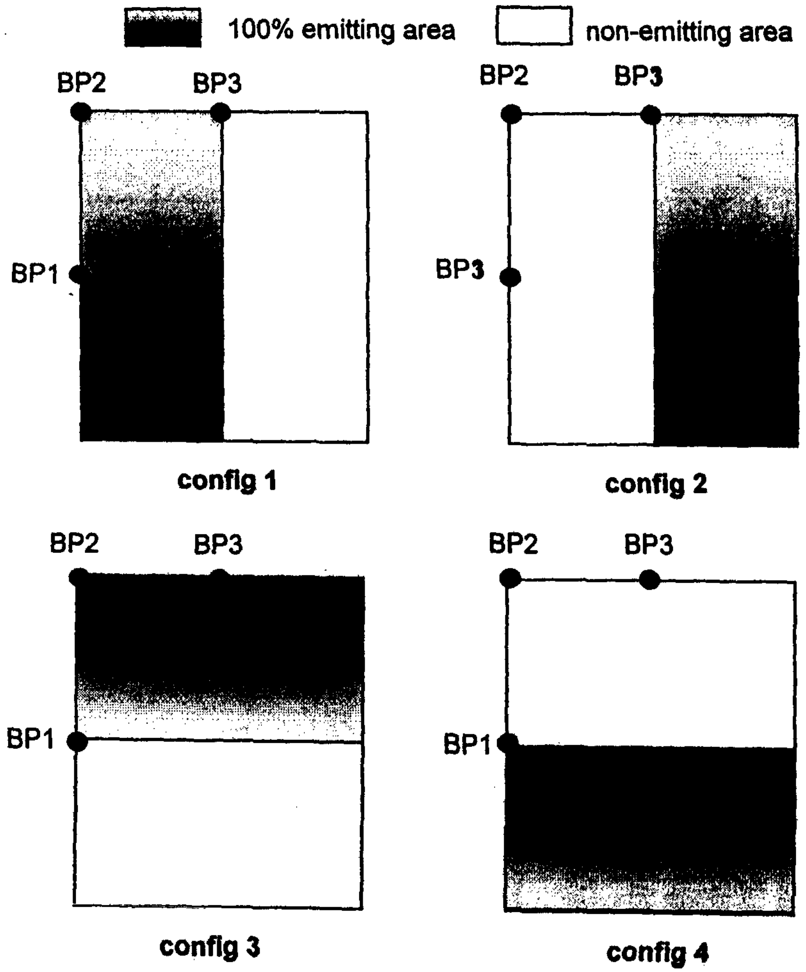
Summary of Source Parameters for SCREEN3 Modeling

source configuration	long side (m)	short side (m)	BP1 (deg)	BP1 (m)	BP2 (deg)	BP2 (m)	BP3 (deg)	BP3 (m)
1	365.8	68.6	90	34.3	10.6	186.1	10.6	186.1
2	365.8	68.6	90	102.9	29.4	209.9	10.6	186.1
3	182.9	137.2	36.9	114.3	36.9	114.3	90.0	91.5
4	182.9	137.2	36.9	114.3	51.3	146.4	90.0	205.8

Note: "Deg" references the orientation of the point relative to the direction of the long side of the rectangle.
"m" references the distance of the border points (BP) from the center of the emitting area.

Unit Concentrations (ug/m3/g/s/m2) * 10^{-6}

	BP1	BP2	BP3	Max Impacted Point
config 1	0.9392	1.547	1.547	BP2/BP3
config 2	0.2367	0.2702	1.547	BP3
config 3	1.36	1.36	0.6115	BP1/BP2
config 4	1.36	0.4917	0.2696	BP1



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Summary of Source Parameters for SCREEN3 Modeling

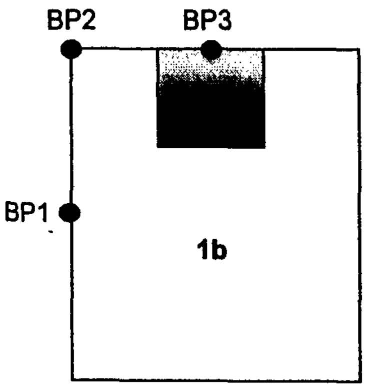
source configuration	long side (m)	short side (m)	BP1		BP2		BP3	
			(deg)	(m)	(deg)	(m)	(deg)	(m)
1a	43.37	43.37	23.1	175.2	72.4	72.0	0.0	21.7
1b	365.80	137.2	90.0	68.6	20.6	195.3	0.0	182.9

source configuration	long side (m)	short side (m)	BP1		BP2		BP3	
			(deg)	(m)	(deg)	(m)	(deg)	(m)
2a	43.37	43.37	23.1	175.2	11.3	350.9	0.0	115.5
2b	365.80	137.20	90.0	68.6	20.6	195.3	0.0	182.9

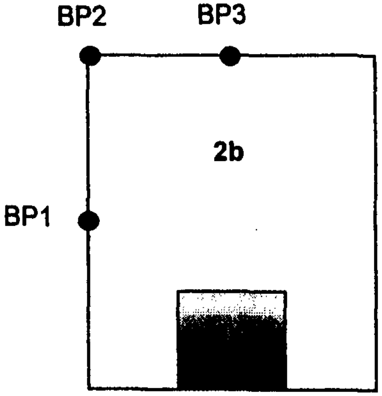
source configuration	long side (m)	short side (m)	BP1		BP2		BP3	
			(deg)	(m)	(deg)	(m)	(deg)	(m)
3a	43.37	43.37	90.0	21.7	6.8	184.2	14.4	188.8
3b	365.80	137.20	90.0	68.6	20.6	195.3	0.0	182.9

source configuration	long side (m)	short side (m)	BP1		BP2		BP3	
			(deg)	(m)	(deg)	(m)	(deg)	(m)
4a	43.37	43.37	90.0	115.5	32.3	216.3	14.4	188.8
4b	365.80	137.20	90.0	68.6	20.6	195.3	0.0	182.9

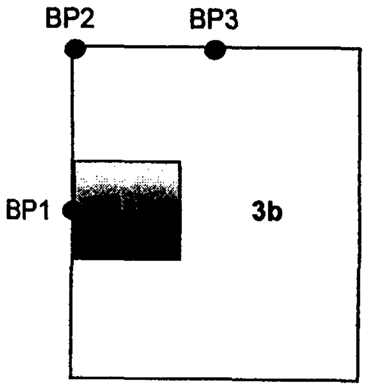
▆ 100% emitting area ☐ 10% emitting area



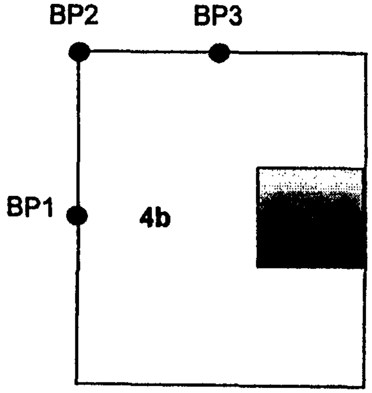
Config 1



Config 2



Config 3



Config 4

Unit Concentrations (ug/m3/g/s/m2) * 10^{-8}

	BP1	BP2	BP3
config 1	0.2194	0.368	0.9566
config 2	0.2194	0.6543	0.2906
config 3	0.9177	0.2497	0.2481
config 4	0.2517	0.2451	0.2481

daily active area	20250 ft2
daily active area	1881.29 m2
long side	43.37 m
short side ~	43.37 m
size of total area	365.8 m x 137.2 m 50187.8

Not to Scale

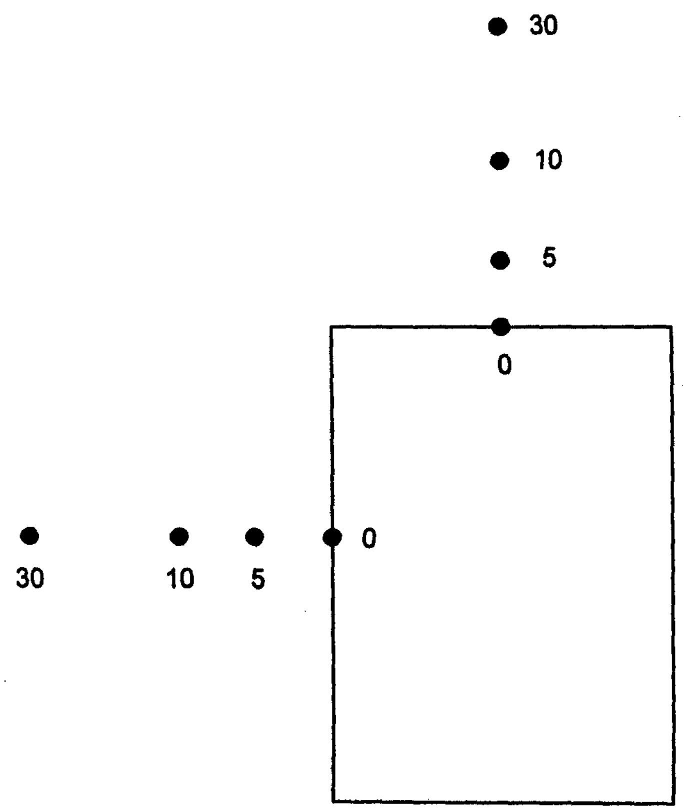
"Deg" references the orientation of the point relative to the direction of the long side of the rectangle.
"m" references the distance of the border points (BP) from the center of the emitting area.

Inputs for SCREEN3 Modeling

	(m)	(m)	deg	0 (m)	5 (m)	10 (m)	30 (m)
100% (N)	365.8	137.2	0	182.9	187.9	192.9	212.9
100% (W)	365.8	137.2	90	68.6	73.6	78.6	98.6

Unit Concentrations (ug/m3/g/s/m2) * 10^{-8}

	0 (m)	5 (m)	10 (m)	30 (m)
100% (N)	1.5710	1.3020	1.1630	0.9114
100% (W)	1.1820	0.9151	0.7819	0.5556



Not to Scale

Segment IVa

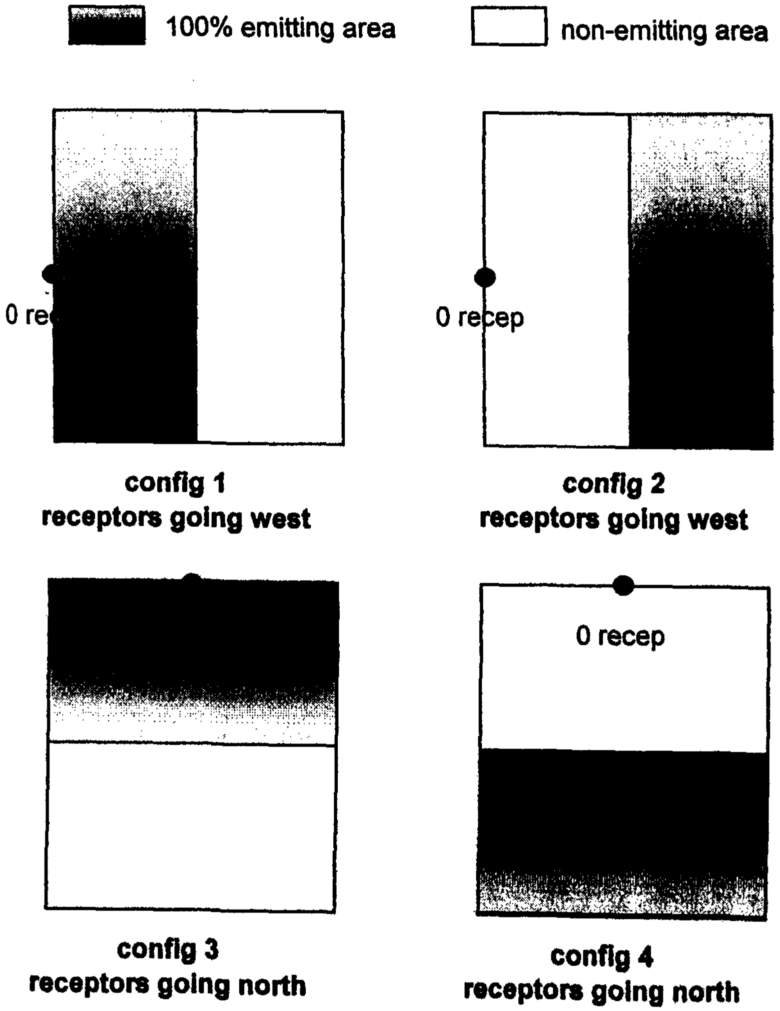
Summary of Source Parameters for SCREEN3 Modeling

source configuration	long side (m)	short side (m)	(deg)	0 (m)	5 (m)	10 (m)	30 (m)
1 - west	365.8	68.6	90.0	34.3	39.3	44.3	64.3
2 - west	365.8	68.6	90.0	102.9	107.9	112.9	132.9
3 - north	182.9	137.2	90.0	68.6	73.6	78.6	98.6
4 - north	182.9	137.2	90.0	205.8	210.8	215.8	235.8

Note: "Deg" references the orientation of the point relative to the direction of the long side of the rectangle.
"m" references the distance of the border points (BP) from the center of the emitting area.

Unit Concentrations (ug/m3/g/s/m2) * 10^{-8}

source configuration	0 (m)	5 (m)	10 (m)	30 (m)
1 - west	0.9392	0.6880	0.5629	0.3656
2 - west	0.2367	0.2271	0.2183	0.1898
3 - north	1.1820	0.9151	0.7819	0.5556
4 - north	0.2696	0.2641	0.2588	0.2401



config 1
receptors going west

config 2
receptors going west

config 3
receptors going north

config 4
receptors going north

Not to Scale

Summary of Source Parameters for SCREEN3 Modeling

source configuration	long side (m)	short side (m)	(deg)	0 (m)	5 (m)	10 (m)	30 (m)
1a -north	43.37	43.37	0	21.7	26.7	31.7	51.7
1b -north	365.80	137.2	0	182.9	187.9	192.9	212.9

source configuration	long side (m)	short side (m)	(deg)	0 (m)	5 (m)	10 (m)	30 (m)
2a - north	43.37	43.37	0	344.1	349.1	354.1	374.1
2b - north	365.80	137.2	0	182.9	187.9	192.9	212.9

source configuration	long side (m)	short side (m)	(deg)	0 (m)	5 (m)	10 (m)	30 (m)
3a - west	43.37	43.37	90	21.7	26.7	31.7	51.7
3b - west	365.80	137.2	90	68.6	73.6	78.6	98.6

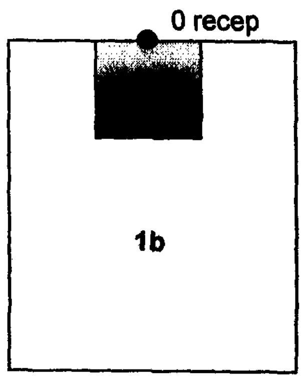
source configuration	long side (m)	short side (m)	(deg)	0 (m)	5 (m)	10 (m)	30 (m)
2a - west	43.37	43.37	90	115.5	120.5	125.5	145.5
2b - west	365.80	137.2	90	68.6	73.6	78.6	98.6

Unit Concentrations (ug/m3/g/s/m2) * 10^{-8}

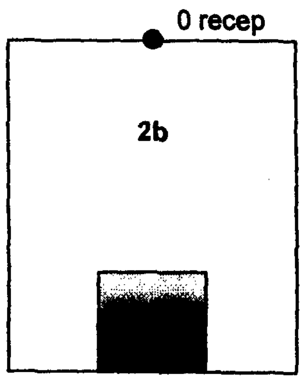
	0 (m)	5 (m)	10 (m)	30 (m)
config 1	0.9566	0.6863	0.5564	0.3582
config 2	0.2075	0.1798	0.1651	0.137
config 3	0.9177	0.6476	0.5183	0.3227
config 4	0.2517	0.2203	0.2028	0.1658

daily active area	20250 ft2
daily active area	1881.29 m2
long side	43.37 m
short side ~	43.37 m
size of total area	365.8 m x 137.2 m

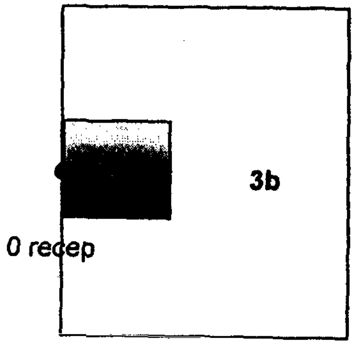
▨ emitting area ☐ 10% emitting area



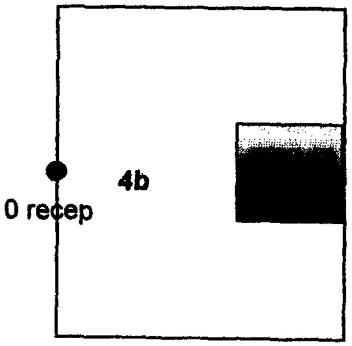
config 1
receptors going north



config 2
receptors going north



config 3
receptors going west



config 4
receptors going west

Not to Scale

"Deg" references the orientation of the point relative to the direction of the long side of the rectangle.
"m" references the distance of the border points (BP) from the center of the emitting area.

Chart 1
Segment I - Impact of Area Size on the Concentration Projected for a Fixed Point on the Edge of the CDF

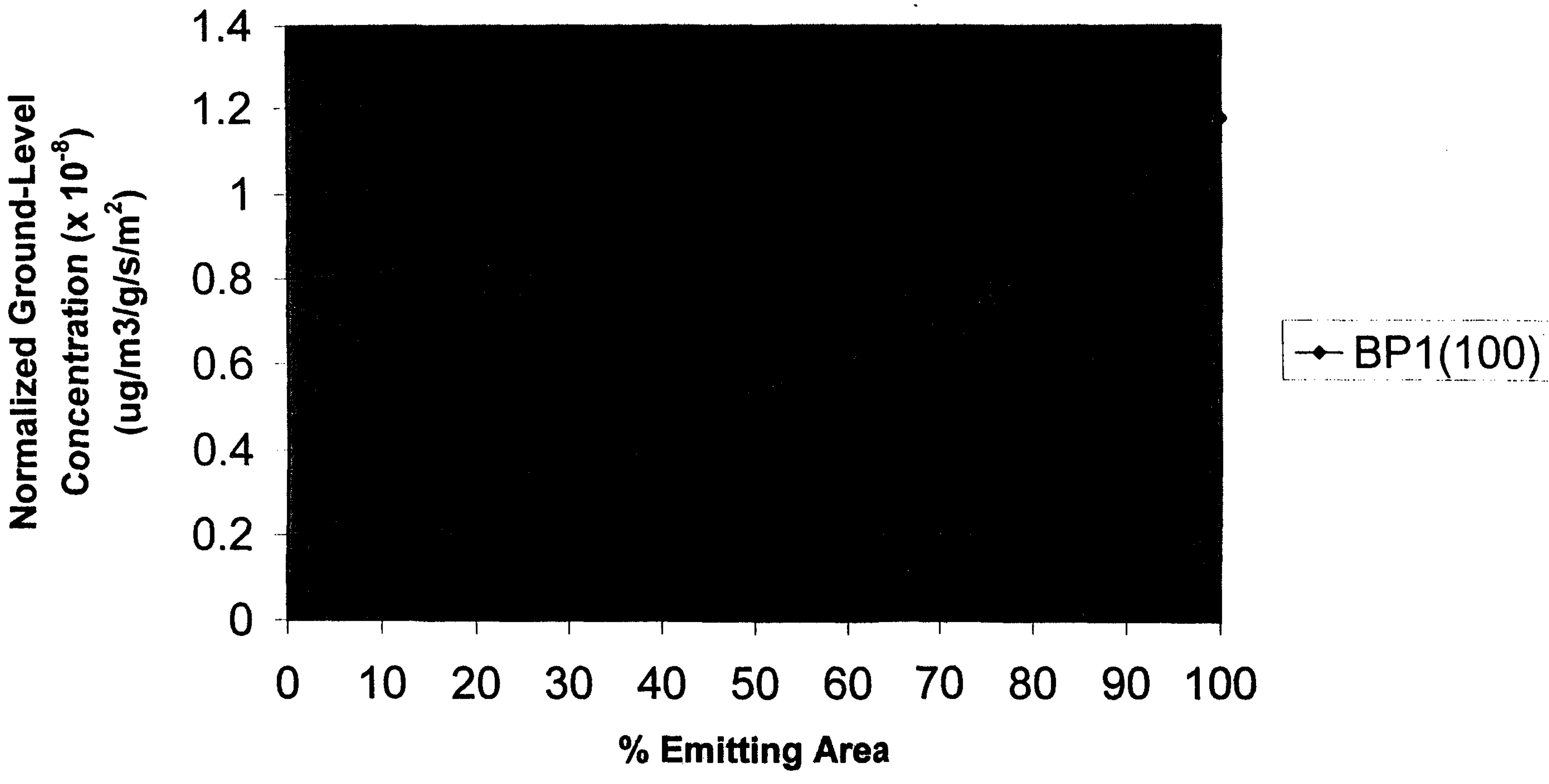


Chart 2
Segment I - Impact of Area Size on the Concentration Projected for a Point on the Edge of the Emitting Source Area

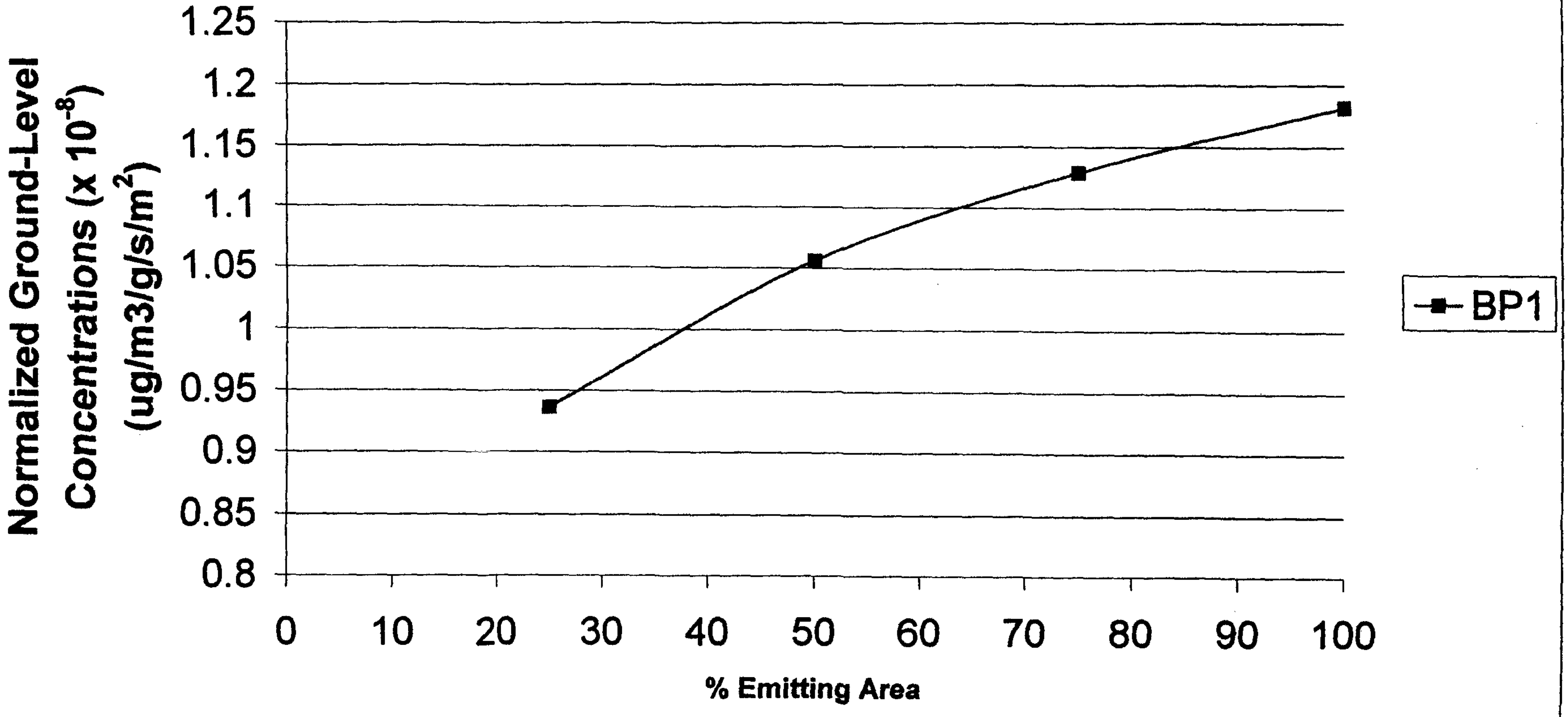


Chart 3

Normalized Concentration vs. Distance from CDF for Receptors Located North of the CDF Centroid

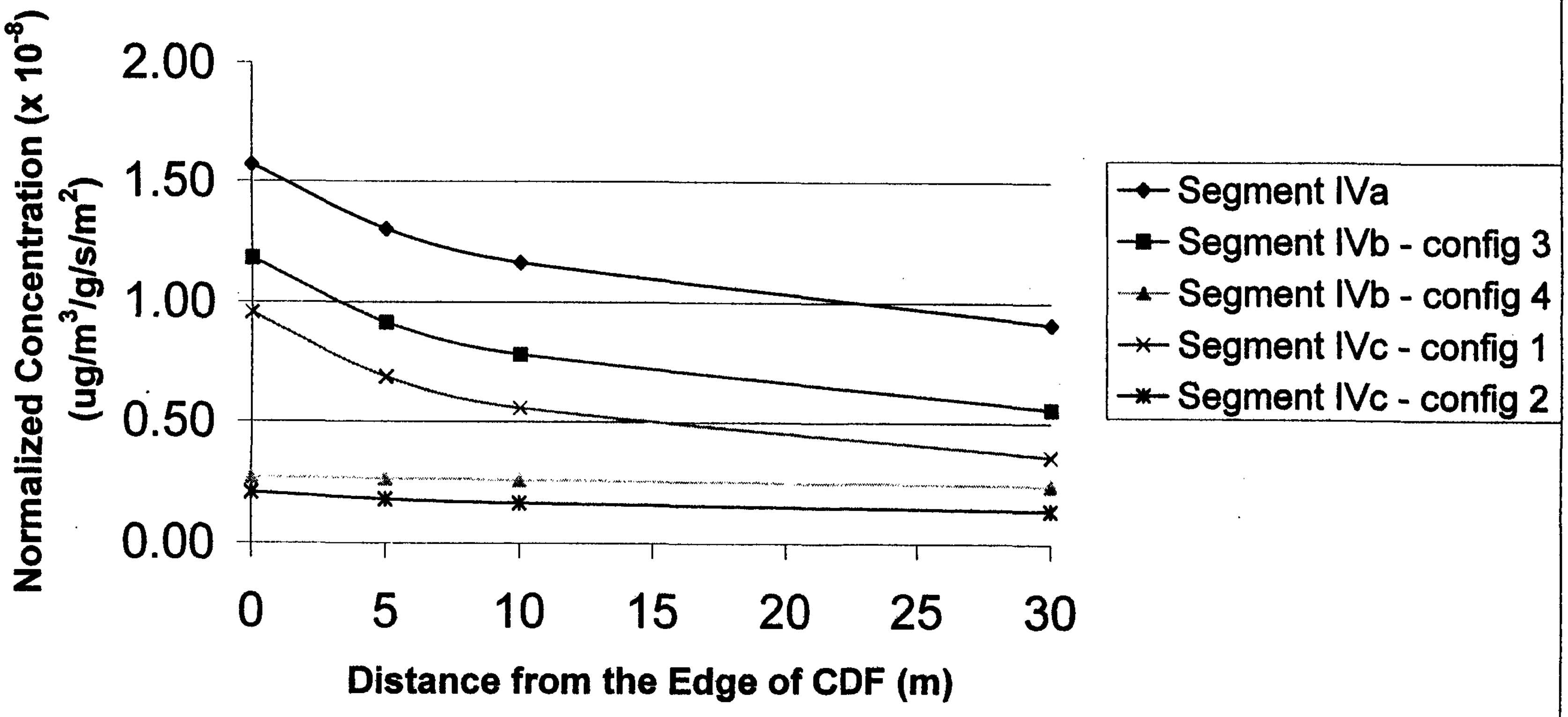
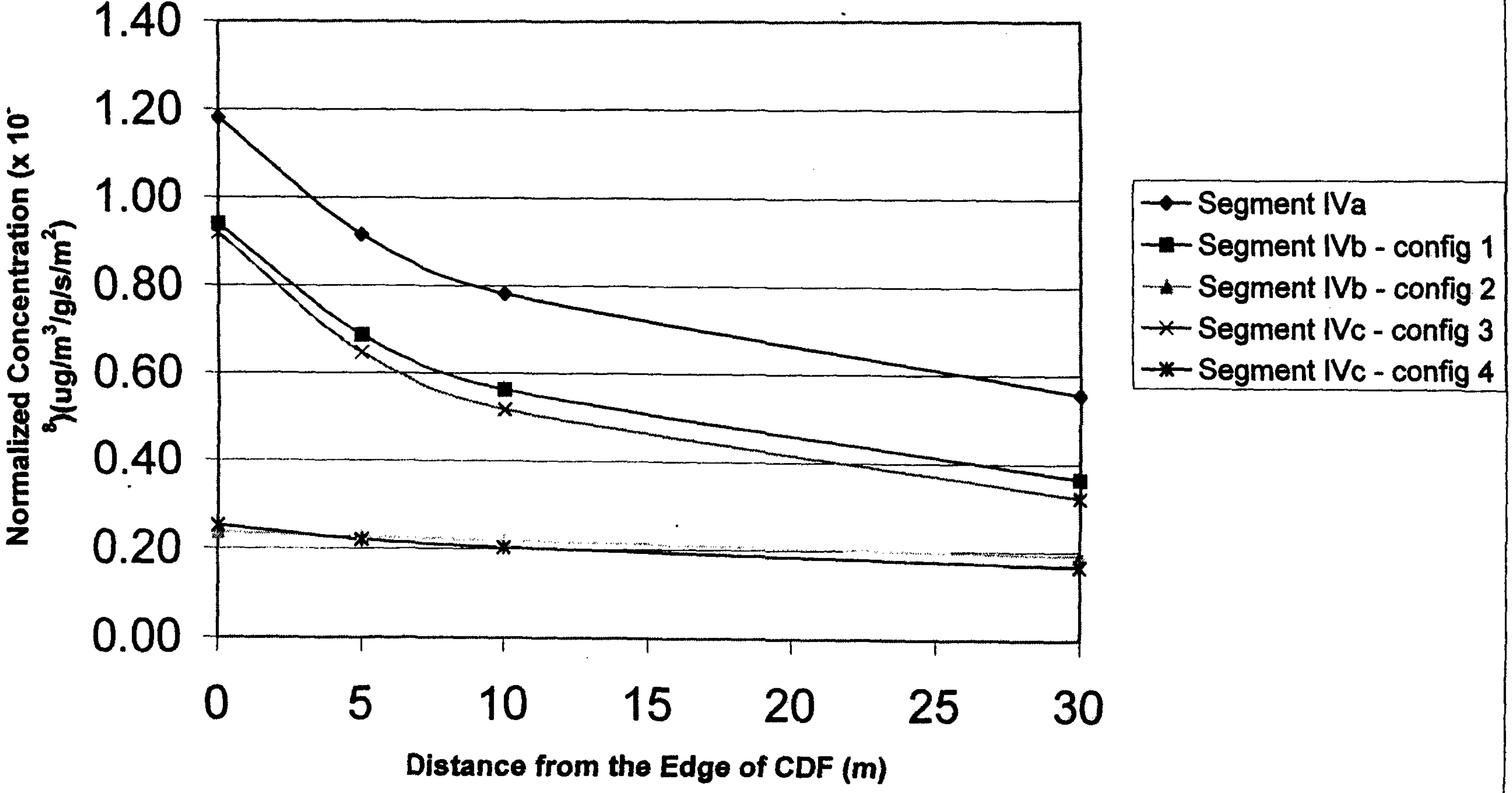


Chart 4
Normalized Concentration vs. Distance from CDF for Receptors Located West of the CDF Centroid



APPENDIX M

Draft Final Implementation Plan for the Protection of Public Health From Volatilized PCBs During Contaminated Sediment Remediation At New Bedford Harbor Superfund Site

USACE CONTRACT NO. DACW33-94-D-0002
DELIVERY ORDER NO. 017
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

DRAFT FINAL IMPLEMENTATION PLAN FOR THE PROTECTION OF PUBLIC HEALTH FROM VOLATILIZED PCBS DURING CONTAMINATED SEDIMENT REMEDIATION AT NEW BEDFORD HARBOR SUPERFUND SITE

New Bedford Harbor, Massachusetts

December 2001

Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

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Prepared for

U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

Prepared by

Foster Wheeler Environmental Corporation
133 Federal Street, 6th Floor
Boston, Massachusetts 02110

Revision	Date	Prepared By	Approved By	Pages Affected
2	12/12/01	T. Berceli-Boyle	R. Marnicio	

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1.0 PURPOSE OF IMPLEMENTATION PLAN

The remediation activities at New Bedford Harbor (NBH) are currently planned to involve the excavation and removal of sediments that are contaminated with polychlorinated biphenyls (PCBs) from their current location. Several remediation alternatives are being evaluated relative to the management of the dredged sediments, including storage and disposal in Confined Disposal Facilities (CDFs), dewatering prior to storage and disposal, and off-site disposal. These alternatives will disturb contaminated sediments directly or indirectly and expose these sediments to the open air for varying periods of time. Due to the remedial activities, some increased amount of vapor phase PCBs will be released into the atmosphere that may impact the neighboring community. The amount of volatile PCBs released will be affected by both operational and meteorological factors.

This increase in emissions will be short-lived, and occurring in relation to certain elements of the clean-up operation. The cleanup activities will likely increase ambient airborne concentrations by some amount for a short period of time, however, long-term ambient concentrations will be significantly lower than current levels once the sources of uncontrolled PCB emissions are removed from the Site. The release of PCBs into the air at the site are currently uncontrolled and are increased at times by natural forces (e.g., wind and water effects from storms) and man's activities (e.g., boating and other Harbor commerce and recreation). Until the Harbor is cleaned-up, PCB emissions from the contaminated sediments (including exposed mudflats, beach areas, and the surface water) will lead to continued public exposure at roughly current levels. The short-term increase in airborne PCB concentrations above the currently elevated levels, if properly managed during the clean-up activities, will lead to a far greater benefit in terms of reduced, long-term releases and public exposure. The sooner the clean-up is accomplished, the more the long-term public exposure to PCBs will be reduced relative to the current levels.

Health-based allowable ambient limits at the point of inhalation exposure were determined for residential and commercial (occupational) receptors. These ambient limits were used in conjunction with measured background concentrations and dispersion modeling to develop air action levels for monitoring stations located near the principal sources of emissions. Air action levels define the ambient air concentrations near the emissions sources associated with a specified level of acceptable risk to the most sensitive receptors at their respective points of potential exposure. The air action levels were then used to develop cumulative exposure budgets. The methodology and development of cumulative exposure budgets is presented in the Draft Final *Development of PCB Air Action Levels for the Protection of the Public* (FWENC, August 2001). Cumulative exposure budgets for PCBs will be integrated into an ambient air management program for the remediation operations at NBH. The approach for implementing this ambient air management program and tracking conditions relative to these cumulative exposure budgets are described in this Draft Final Implementation Plan.

This draft Implementation Plan addresses how to put the ambient air management program into practice, including how to: locate monitoring stations; collect air samples; evaluate the data obtained from the laboratory analysis of the samples; track cumulative exposures; manage and publish information; and make decisions regarding what responses are appropriate to reduce emissions and exposure. The general approach to implementation is illustrated in Figure 1-1.

The Implementation Plan defines the principal aspects of the air monitoring that will be performed. The monitoring will be designed to ensure that actual exposures are at or below the levels expected based on the modeling work and that the public is being protected from any volatile PCBs released into the air. Regular monitoring will be performed to evaluate concentration trends over time. The Implementation Plan will dovetail with a Sampling and Analysis Plan that defines the sampling frequency, required turnaround time, analytical methods, and required QA/QC to be performed as part of the ambient air monitoring effort. Finally, the Implementation Plan identifies "triggers" or conditions that indicate that follow-up analysis of projected emission sources and their potential impact on exposures to the public is warranted. A graded scale of priority is defined to facilitate matching a response to the severity of the potential consequences of the triggering condition.

The following sections present these aspects of the Implementation Plan for the ambient air management program at NBH. Section 2.0 describes the elements and role of a sampling and analysis plan highlighting the selection of the locations of monitoring stations and the sampling strategy. Section 3.0 describes the methods for tracking and analyzing the ambient air monitoring data. This section includes the description of a prototype spreadsheet-based tool for compiling monitoring data and conducting an initial screening assessment of that data against a specified cumulative exposure budget.

2.0 DEVELOPMENT OF SAMPLING AND ANALYSIS PLAN

This section discusses the fundamental elements of the Sampling and Analysis Plan that will be implemented as part of the ambient air management program. The basis of the sampling strategy will be the tracking of ambient air concentrations at specified monitoring locations as they relate to long-term exposures to the public at those or other locations. This section briefly describes the cumulative exposure budgeting approach and discusses the placement of air monitoring stations to track the budgets. The development of cumulative exposure budgets is fully described in the Draft Final *Development of PCB Air Action Levels for the Protection of the Public* (FWENC, August 2001). It is important to note that this section is not meant to be or replace a sampling and analysis plan. The sampling and analysis plan for the ambient air monitoring program during remediation will most likely be a modification to the *Sampling and Analysis Plan, New Bedford Harbor Superfund Site* (FWENC, 2001). However, the basic components of this Sampling and Analysis Plan are discussed below as they relate to the protection of the public from volatile PCBs released into the air from remediation operations.

2.1 Cumulative Exposure Budgets

An exposure budget is a target ambient air concentration trend over time at a monitoring station near a major emission source that is designed to keep total public exposures to airborne PCBs below acceptable health-based target levels. Because the documented adverse health effects associated with PCB inhalation are associated with long-term or chronic exposure, the most appropriate exposure budgets for public protection from volatilized PCBs at the Harbor also focus on chronic exposure. As such, the exposure budget is referred to as a "cumulative" exposure budget because the projected exposures are tracked, summed, and managed over time as the remediation operations are performed.

A simple cumulative exposure budget is a straight, upward sloping line on a graph where the x-axis marks time (e.g., duration of exposure or time since the beginning of dredging) and the y-axis marks cumulative exposure (measured in "concentration-days" or the multiplicative product of a health-based target PCB air concentration and the period of time over which public exposure may occur at that level). Figure 2-1 shows an example of a cumulative exposure budget curve for a hypothetical monitoring station near a major PCB emission source. The slope of the budget line is the allowable ambient PCB concentration at that monitoring point that is protective of the most sensitive target receptors in the vicinity.

Two different monitoring points may have different exposure budgets, depending on their locations. The linkage between the airborne concentration of volatile PCBs at the monitoring location and at the location of the most sensitive public receptor is established using air dispersion modeling. In the Draft Final *Development of PCB Air Action Levels for the Protection of the Public* (FWENC, August 2001), cumulative exposure budgets were established for eight monitoring stations located around the two proposed CDFs (C and D). In each case, the cumulative exposure budget was developed to protect the most sensitive public receptor. Since that time, other operational alternatives have been proposed, including sediment dewatering and off-site disposal. The choice of a specific remediation alternative will affect where the monitors used to track exposure budgets should be placed. The primary considerations in locating these ambient air monitoring stations are discussed in the following section.

2.2 Ambient Air Monitoring Locations

The monitoring stations and air samplers used to track cumulative exposure budgets should be placed where the impacts from PCBs emitted from remediation related sources are expected to be greatest or at locations where the more potentially sensitive receptors may be found. These locations of maximum impact are dependent on the remediation plans because they are affected by the location and magnitude of the emissions and the emissions source type. For the original remediation scenario (i.e., storage of non-dewatered sediment in CDFs), the CDFs were identified as the largest emission sources during the remediation process (It must be highlighted that the uncontrolled releases from the contaminated sediment associated with the Site will be the most extensive and largest sources of volatile PCBs until the cleanup activities are complete). In addition, because they were ground level area sources, their impacts would be larger closer to the CDF. For these reasons, the monitors for cumulative exposure budgeting were placed near to and around the two CDFs for this remediation scenario.

As the remediation approach, design, and operational plans are finalized, the placement of the monitors will need to be reevaluated to ensure that they are located in areas of maximum impact or greatest diagnostic utility. This reevaluation should include an assessment of source emissions and dispersion characteristics. For example, emissions from a dewatering facility will likely be controlled, making it a smaller emissions source. But, since the emissions will be treated and then released through a vent at some height, the point of maximum airborne concentration may be somewhat further away from the source in the downwind direction. Both of these source considerations would be important in locating the monitors.

Monitors may also be placed at locations in the community to "ground truth" the air dispersion modeling. These community monitors may be used to verify that the dispersion factors used to create cumulative exposure budgets at the source monitors are accurately representing the ambient air concentrations at locations where sensitive receptors may be present. Sampling at these community monitors may not be as frequent as sampling of the source-related monitors. Instead they would be used primarily for confirmatory testing and not cumulative exposure estimation.

2.3 Elements of a Sampling and Analysis Plan

Locating the monitoring stations and air samplers is one important element of an overall sampling strategy, but there are other important elements that should be addressed in the Sampling and Analysis Plan for the ambient air management program. As mentioned previously, the Sampling Plan for this program will likely take the form of a modification to the *Sampling and Analysis Plan for the New Bedford Harbor Superfund Site* (FWENC, 2001). This Sampling and Analysis Plan will be designed to specifically address the implementation of the final remediation design and operational plan.

The final Sampling and Analysis Plan for the ambient air management program will need to include the following:

- Sampling Locations (as discussed above)
- Sampling Frequency - The frequency of sampling events will primarily be dictated by the type and duration of remediation activities. Sampling will likely be more frequent during periods of high remedial activity. Sampling also may be necessary less frequently during periods of low or no activity. Sampling frequency and location may be specified in terms of clear evaluation and decision criteria such that subsequent sampling may be modified (reduced or increased) or refocused geographically based on the results of the prior sampling.
- Analytical Methods/Turnaround Times - The analytical methods for airborne PCBs will be based on the speciation requirements. Typically, the PCBs are speciated by homologue groups that are summed for a total PCB measurement. In the Draft Final *Development of PCB Air Action Levels for Protection of the Public* it was recommended that congener analyses be performed on a periodic basis once remediation begins. These results could be used to evaluate whether the parameter choices and assumptions related to the distribution of congeners present (e.g., toxicological factors, exposure pathways and routes of intake, etc.) remain valid, and to reassess the contribution to risk from any dioxin-like PCB congeners that are present. This reassessment also should consider the implications

of the USEPA Dioxin Reassessment Study that may be published late in 2001or early in 2002 (See also Section 3.5 of the Draft Final *Development of PCB Air Action Levels for Protection of the Public* document). The turnaround times for the samples will likely be selected based on the remediation activities. In the past, a faster turnaround time has been used during periods of higher activity or when subsequent actions depend on the sampling results or when significant time or cost savings would accrue from more timely information.

- QA/QC Program - The QA/QC program will likely be similar to the program that has been used for recent air sampling programs, which includes regular field blank and duplicate samples.

These elements will ultimately be defined or established in consideration of the final remediation plans and logistical scenario for the site.

3.0 TRACKING AND ANALYSIS

Once the Sampling and Analysis Plan has been established and implemented, ambient air concentration data will become available. This section discusses how this information will be managed and assessed to ensure public protection from airborne PCBs.

3.1 Public Exposure Tracking System (PETS)

The prototype Public Exposure Tracking System (PETS) for a monitoring station is a simple tool for compiling the monitoring data collected over the course of a clean-up operation and automatically facilitating an initial screening assessment of that data against the baseline cumulative exposure budget developed for that monitoring station. The overall tracking and screening assessment process included in the prototype PETS is shown in Figure 3-1. The prototype PETS is a spreadsheet-based tool that is tailored for each monitoring station. The prototype PETS calculates various statistics and parameters based on the monitoring data and checks the results against pre-defined criteria to alert the user of conditions and triggers that may indicate a potential or eventual exceedance of the established cumulative exposure budget. The prototype PETS also differentiates the conditions and triggers on the basis of the general level of response that may be required to remedy the unfavorable conditions and ensure continued protectiveness of the public relative to the potential inhalation exposures to volatile PCBs. The development and logic of the prototype PETS is detailed below.

The initial screening assessment begins with a check of whether any of a predefined set of conditions relative to the ambient air measurements has been created. These particular conditions were identified as the circumstances or occurrences that alone, or in combination, provide an indication that some component of the cumulative exposure-based public protection program may be diverging from the baseline levels and that some attention or response to the situation may be necessary. These conditions were identified to provide a conservative assessment of potential exposures. They are designed to provide "early warning" of potentially unfavorable exposure conditions so that timely, effective steps may be taken to eliminate these conditions and maintain public protectiveness.

The prototype PETS performs three types of condition checks as part of its screening assessment:

1. Comparison of the monitoring data directly to benchmark concentration criteria;
2. Comparison of the calculated cumulated exposure for the project to date to the baseline cumulative exposure budget developed for that monitoring station; and
3. Comparison of the cumulated exposure projected for the end of the project assuming continued conditions as they then exist to the baseline cumulative exposure budget at that point in time

The specific conditions associated with each of these categories are defined in Table 3-1 through Table 3-3, respectively:

Table 3-1
Conditions Related to Measured Concentrations (C) that are Tracked by the Prototype PETS

Condition Identifier	Unfavorable Condition Relative to Potential Exposures
C1	The Measured Concentration Exceeds a Relevant Occupational Limit
C2	The Measured Concentration Exceeds the Minimum Health-Based Threshold Effect Level / Non-Threshold Effect Level for a Worker in the General Public
C3	The Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget for that Monitoring Station
C4	The Measured Concentration Exceeds the Annual Average Background Concentration at that Location by More than 10%, But by Less than 25%
C5	The Measured Concentration Exceeds the Annual Average Background Concentration at that Location by More than 25%
C6	The Previous Two Measured Concentrations Exceed the Running Average Concentration Up Through that Monitoring Event by More than 25%
C7	The Measured Concentration has Doubled Since the Last Monitoring Event
C8	The Measured Concentration has Increased for Three Monitoring Periods in a Row

Table 3-2
Conditions Related to Calculated Cumulative Exposures (CCE) that are Tracked by the Prototype PETS

Condition Identifier	Unfavorable Condition Relative to Potential Exposures
CCE1	The Cumulative Exposure Calculated To Date Exceeds 75% of the Cumulative Exposure Budget Established for This Point in the Project
CCE2	The Cumulative Exposure Calculated To Date Exceeds 100% of the Cumulative Exposure Budget Established for This Point in the Project
CCE3	The Cumulative Exposure Calculated for the Recent Monitoring Events has Exceeded the Respective Cumulative Exposure Budget Values for Three Monitoring Periods in a Row
CCE4	The Cumulative Exposure Calculated To Date Currently Exceeds the Cumulative Exposure Budget Established for This Point in the Project by More than 25%

Table 3-3
Conditions Related to Projected Cumulative Exposures (PCE) at the End of the Project that are Tracked by the Prototype PETS

Condition Identifier	Unfavorable Condition Relative to Potential Exposures
PCE1	The Cumulative Exposure Projected for the End of the Project (Assuming Conditions Remain Unaltered) Exceeds the Baseline Budget Established for This Monitoring Station, and There is Between 25% to 50% of the Overall Project Duration Remaining
PCE2	The Cumulative Exposure Projected for the End of the Project Assuming (Conditions Remain Unaltered) Exceeds the Baseline Budget Established for This Monitoring Station, and There is Between 10% to 25% of the Overall Project Duration Remaining
PCE3	The Cumulative Exposure Projected for the End of the Project Assuming (Conditions Remain Unaltered) Exceeds the Baseline Budget Established for This Monitoring Station, and There is Less Than 10% of the Overall Project Duration Remaining

3.1.1 Responses to Unfavorable Conditions

Having defined the unfavorable monitoring conditions that may be created with regard to maintaining protective ambient air conditions in the public, the range of possible responses needed to adjust or control emissions was considered. These responses could include altering the clean-up activities to reduce or redistribute the volatile PCB emissions, waiting for more favorable meteorological conditions, or applying some form of engineering control to reduce emissions. While a number of specific actions may be identified, the appropriateness or suitability of a particular response can best be judged only in the context of the specific circumstance. For example, engineering a permanent control may not be warranted if the unfavorable condition or conditions were caused by a temporary, unusual weather pattern or the discovery and removal of a small quantity of more highly contaminated sediment in a "hot spot." As such, it was judged that specific response actions could not and should not be generically recommended based on an initial screening of site conditions. However, it was determined that the various unfavorable monitoring conditions could be distinguished on the basis of the level of response that may be warranted if they were found to exist. The different levels of response reflect either the speed with which the condition should be changed or the degree to which the condition must be changed to maintain public protectiveness. Three general categories of response were identified, as shown in Table 3-4.

In all categories of response, it is important to first evaluate the cause of the warning condition(s). This is the first step in determining the most appropriate response. It is also possible that the sampling data for a particular monitoring event may trigger none of the identified conditions. In that case, continued monitoring and tracking would be all that would be indicated as a response. As the entire cumulative exposure budget program is designed to maintain chronic inhalation PCB exposures to the public below levels associated with adverse health effects and to identify unfavorable trends in air quality in a proactive and timely manner, it is not anticipated that work would ever need to be stopped because of potential exposures to the public. The possible need to temporarily stop work for reasons not related to controlling exposures to the public or to control or mitigate PCB emissions for purposes of ensuring remediation worker safety is outside the scope of this Draft Final Implementation Plan (which is focused primarily on public protection).

Table 3-4
General Categories of Response Based on the Speed or the Degree to Which the Unfavorable Condition must be Changed to Maintain Public Protectiveness

Response Level	Nature of Potentially Warranted Response
Low	Evaluate the Cause of the Unfavorable Condition(s); Operational Adjustments Likely to not Be Required
Medium	Consider or Plan for Operational Adjustments or Engineering Control Options
High	Implement Operational Adjustments or Engineering Controls

3.1.2 Triggers

Once the conditions and the general categories of responses were identified, it remained to link the presence of the conditions, individually or in specified combinations, to the appropriate response category. The individual conditions or combinations of conditions associated with a particular response level are referred to as the recommended "triggers" for that response level. This correlation of triggers to response level was established using best professional judgment, with an appreciation for the most practical or effective ways in which to respond to particular conditions and the likely period of time it may take to reduce emissions and the corresponding public exposures. After an initial mapping of the conditions/triggers to response categories was developed on a case-by-case basis, the full set of relationships was re-reviewed with an eye to maintaining overall consistency and a logical progression of priorities across the whole set. The resulting mapping of triggers to response categories is presented in Table 3-5.

3.1.3 The Prototype PETS Spreadsheets

An Excel workbook containing a series of 7 spreadsheets was developed to facilitate and streamline the tracking and screening analysis of the prototype PETS. The workbook contains the following components:

- <u>Entry of Descriptive Information about the Project Being Tracked and Monitored</u> – Such as the name of the monitoring station and the start and end dates of the project being tracked. [Worksheet HOME SHEET] This spreadsheet also is where the applicable benchmark concentration criteria for airborne PCBs are entered (e.g., entered once per project).
- <u>Entry of the Date of the Monitoring Event and the Measured Concentration of Total PCBs</u> – The monitoring date is entered in month-day-year format and the monitored concentration is entered in units of ng/m^3. [Worksheet TIME TREND]
- <u>Graphical Plot of Time Series Monitoring Results Relative to the Baseline Cumulative Exposure Budget</u> - [Worksheet STATUS SHEET]
- <u>Internal Calculations Associated with the Conditions, Triggers, and Screening Assessment Relative to the Recommendation of General Responses</u> - [Worksheets TRIGGERS, HIGH, MED, and LOW]. These spreadsheets need <u>not</u> be accessed by the typical user of the prototype PETS.

- Summary Status / Screening Report Based on the Current Monitoring Result and the Monitoring Conducted Up to the Time – Includes the name of the monitoring station, the most recent monitoring date, the most recent monitored Total PCB concentration, the recommended response level, and the triggering condition(s) justifying that response level.

A brief User's Guide for the prototype PETS is presented in Appendix A.

Table 3-5
Mapping of Triggers to General Responses

Trigger(s)	General Response Level / General Response
C1	**LOW** Evaluate the Cause of the Unfavorable Condition(s)
C2	
C3	
C4 and C8	
C5	
C6	
C7	
CCE1	
PCE1	
C1 and C8	**MEDIUM** Consider or Plan for Operational Adjustments or Engineering Control Options
C2 and C8	
C3 and C8	
C5 and C8	
C6 and C8	
CCE2	
PCE2	
CCE3	**HIGH** Implement Operational Adjustments or Engineering Controls
CCE4	
PCE2 and C8	
PCE3	

3.2 Example Applications of Prototype PETS

Sample applications of the prototype PETS were for conducted for a trial application using hypothetical data, and for two actual clean-up activities at the New Bedford Harbor. These example applications are presented below.

3.2.1 Testing Using Hypothetical Sampling Data

The prototype PETS was tested initially using a contrived set of monitoring results. The constructed string of concentration values and data was designed to make each condition and trigger included in the prototype PETS switch from being absent or "false" to being present or "true". A hypothetical cumulative exposure budget line slope of 720 ng/m^3 was assumed for this testing. As the diagnostic screening assessment report generated by the entry of the results of each monitoring event identifies which condition(s) "trigger" the noted response level, this constructed data set was used to test the internal calculations for checking and reporting the status of each condition. Table B-1 in Appendix B presents this test data set and a sequential listing of all of the sequence of identified conditions and triggers flagged by the check of the data. As noted in the table, the triggers shown in bold represent the first time that condition was present or "true", given the specified sequence of concentration values. The diagnostic screening assessment reports for each hypothetical monitoring event are presented in Appendix B. These reports were used to confirm that the correct response level and general recommended response were reported for the set of conditions and triggers highlighted.

3.2.2 Trial Application for Two Preliminary Remedial Operations at New Bedford Harbor

Following the checking of the conditions, triggers, and assigned general response levels incorporated into the prototype PETS, the workbook was tested using the actual data collected during two recent field activities: (1) the Early Action Removal Action at the Acushnet Dock Area and (2) the Commonwealth Electric cable crossing relocation project. The use of the prototype PETS as an aid in tracking and screening the ambient air monitoring data collected during these two efforts is described and presented in the following sections.

3.2.2.1 Acushnet Dock Area Early Action Removal Area

Ambient air monitoring was conducted at two stations during the excavation of contaminated sediments and restoration activities associated with the Early Action effort at the Acushnet Dock Area at the northern end of the Harbor. The monitoring stations were AQ Site 28 (located at 20 Main Street) and AQ Site 29 (located at 12 Main Street) in Acushnet. The locations of these monitoring stations are shown in Figure 3-2. Ten (10) samples were collected over the period from February 27, 2001 to April 11, 2001. The time intervals between the sequential sampling events ranged from 2 to 7 days.

Each sample was collected over a 24-hour period, and was analyzed for the ten PCB homologue groups. The collected mass of each homologue group was quantified and normalized to the total volume of air collected by the sampler to develop concentrations for each homologue group. The homologue group concentrations were then summed to obtain the ambient air concentration of Total PCBs. During this period, the measured Total PCB concentration at AQ Site 28 (the 20 Main Street monitoring station) ranged from 1.96 to 24 ng/m^3. At AQ Site 29 (the 12 Main Street monitoring station), the Total PCB concentrations ranged from 1.26 to 19 ng/m^3 during the same period. The time series of measured concentrations (based on the preliminary data reported) for the Acushnet Dock Early Action activity for AQ Site 28 is presented in Appendix C in the "Time Trend" spreadsheet of the prototype PETS for this project.

The cumulative exposure budget for this short duration field effort was conservatively based on the child resident allowable ambient limit for a 5-year project duration (i.e., 660 ng/m^3) given the nearness of the removal action activities to residential properties and places potentially accessible to children. The annual average background concentrations of Total PCBs at the two monitoring stations also were explicitly considered (i.e., 21.4 ng/m^3 at AQ Site 28 [measured] and 20 ng/m^3 at AQ Site 29 [extrapolated]). As the monitoring stations were located so close to the potential points of public exposure to children, a dispersion factor of 1 (reflecting no reduction in ambient air levels between the monitoring station and the potential public exposure point) was applied to develop the slope of the cumulative exposure budget line. Consequently, the slope of the cumulative exposure budget for both of these monitoring stations was:

$$Slope = \langle(Allowable\ Ambient\ Limit) - (Background\ Concentration)\rangle\ x\left[Air\ Dispersion\ Factor\right]$$

$$Slope\ of\ the\ Cumulative\ Exposure\ Budget\ \ (AQ\ Site\ 28)\ =\ [660 - 21.4]\ x\ 1.0 = 638.6\ ng/m^3$$

Slope of the Cumulative Exposure Budget (AQ Site 29) $= [660 - 20.0] \times 1.0 = 640.0\ ng/m^3$

Appendix C contains the following illustrative supporting materials associated with the tracking and screening of the ambient air monitoring data for the Acushnet Dock Area Early Action activity as monitored at AQ Site 28:

- The tabulated measured analytical results (Preliminary Data) for the March 14, 2001 monitoring event;
- The corresponding site-specific meteorological conditions recorded for the March 14, 2001 monitoring event (tabulated station readings for wind, temperature, solar radiation, barometric pressure, relative humidity, and precipitation and the compiled wind rose);
- The tabulated time series of the measured Total PCB ambient air concentrations (i.e., the "Time Trend" spreadsheet);
- The graphical plot of the calculated cumulative exposures versus the established cumulative exposure budget up through the March 14, 2001 monitoring event; and
- The Status / Screening Report generated by the prototype PETS following the entry of the data for the March 14, 2001 monitoring event.

Appendix C illustrates that a "Low" level response was indicated following the March 14, 2001 monitoring event, with the corresponding recommendation to "Evaluate the Cause of the Triggered Conditions". The particular "Low Response" conditions triggered at this time were:

<u>Monitoring Event 5 – 3/14/01</u>

Trigger C6:	Previous Two Measured Concentrations Exceed the Running Average Concentration Through that Monitoring Event by more than 25%.
Trigger C7:	Measured Concentration has Doubled Since the Last Monitoring Period.
Trigger C4 & C8	Measured Concentration Exceeds the Annual Average Background Trigger Concentration by more than 10% but less than 25% and Measured Concentration Increased for Three Monitoring Periods In a Row.

It should be noted that the measured concentration was relatively low (i.e., 11 ng/m^3) when the measured concentration doubled since the previous measurement (i.e., Trigger C7).

A similar prototype PETS was tailored and used to track and screen the monitoring results for AQ Site 29.

3.2.2.2 Commonwealth Electric Cable Crossing Relocation Project

Ambient air monitoring was conducted at three stations during the excavation and handling of sediments during a utility cable crossing relocation project in the northern portion of the Harbor near the Commonwealth Electric Acushnet Substation. The monitoring stations were AQ Site 23 (located at the Acushnet Substation), AQ Site 25 (located at the Cliftex Facility), and AQ Site 30 (located at the Fiber Leather Facility). The locations of these monitoring stations also are shown in Figure 3-2. Twelve (12) samples were collected over the period from April 10, 2001 to July 5, 2001 (NOTE: This activity is still ongoing). The time intervals between the sequential sampling events ranged from 3 to 19 days.

Each sample was collected over a 24-hour period, and was analyzed for the ten PCB homologue groups. The collected mass of each homologue group was quantified and normalized to the total volume of air collected by the sampler to develop concentrations for each homologue group. The homologue group concentrations were then summed to obtain the ambient air concentration of Total PCBs. During this period, the measured Total PCB concentration at AQ Site 23 (the Acushnet Substation monitoring station) ranged from 3.8 to 76 ng/m^3. At AQ Site 25 (the Cliftex Facility monitoring station), the Total PCB concentrations ranged from 2.2 to 180 ng/m^3 during the same period. At AQ Site 30 (the Fiber Leather Facility monitoring station), the Total PCB concentrations ranged from 4.7 to 230 ng/m^3 during this period. The time series of measured concentrations (based on preliminary data reported) for the Commonwealth Electric Cable Crossing Relocation activity for AQ Site 30 is presented in Appendix D in the "Time Trend" spreadsheet of the prototype PETS for this project.

The cumulative exposure budget for this short duration field effort was conservatively based on the child resident allowable ambient limit for a 5-year project duration (i.e., 660 ng/m^3) given the nearness of the excavation and handling activities to residential properties (although all three of these monitoring stations are located on commercial / industrial properties). The annual average background concentrations of Total PCBs at the three monitoring stations also were explicitly considered (i.e., 30 ng/m^3 at AQ Site 23 [interpolated], 25 ng/m^3 at AQ Site 25 [interpolated], and 45 ng/m^3 at AQ Site 30 [interpolated]). As the monitoring stations were located close to the potential points of public exposure to children in the general public, a dispersion factor of 1 (reflecting no reduction in ambient air levels between the monitoring station and the potential public exposure point) was applied to develop the slope of the cumulative exposure budget line. Consequently, the slope of the cumulative exposure budgets for these monitoring stations were:

$$Slope = \langle(Allowable\ Ambient\ Limit) - (Background\ Concentration)\rangle\ x\ [Air\ Dispersion\ Factor]$$

$$Slope\ of\ the\ Cumulative\ Exposure\ Budget\ \ (AQ\ Site\ 23)\ =\ [660 - 30.0]\ x\ 1.0 = 630.0\ ng/m^3$$

$$Slope\ of\ the\ Cumulative\ Exposure\ Budget\ \ (AQ\ Site\ 25)\ =\ [660 - 25.0]\ x\ 1.0 = 635.0\ ng/m^3$$

$$Slope\ of\ the\ Cumulative\ Exposure\ Budget\ \ (AQ\ Site\ 30)\ =\ [660 - 45.0]\ x\ 1.0 = 615.0\ ng/m^3$$

Appendix D contains the following illustrative supporting materials associated with the tracking and screening of the ambient air monitoring data for the Commonwealth Electric Cable Crossing Relocation activity as monitored at AQ Site 30:

- The tabulated measured analytical results (Preliminary Data) for the June 21, 2001 monitoring event;
- The corresponding site-specific meteorological conditions recorded for the June 21, 2001 monitoring event (tabulated station readings for wind, temperature, solar radiation, barometric pressure, relative humidity, and precipitation and the compiled wind rose);
- The tabulated time series of the measured Total PCB ambient air concentrations (i.e., the "Time Trend" spreadsheet);
- The graphical plot of the calculated cumulative exposures versus the established cumulative exposure budget up through the June 21, 2001 monitoring event; and
- The Status / Screening Report generated by the prototype PETS following the entry of the data for the June 21, 2001 monitoring event.

Appendix D illustrates that a "Low" level response was indicated following the June 21, 2001 monitoring event, with the corresponding recommendation to "Evaluate the Cause of the Triggered Conditions". The particular "Low Response" conditions triggered were:

Monitoring Event 10 – 6/21/01

Trigger C5:	Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%
Trigger C7:	Measured Concentration has Doubled Since the Last Monitoring Period.

A similar prototype PETS was tailored and used to track and screen the monitoring results for AQ Sites 23 and 25.

4.0 SUMMARY

This Draft Final Implementation Plan describes and illustrates the process of applying air action levels and a cumulative exposure budget to ensure the protection of the public from volatile PCBs released during sediment remediation activities at New Bedford Harbor. The underlying methodology and development of cumulative exposure budgets is presented in the Draft Final *Development of PCB Air Action Levels for the Protection of the Public* (FWENC, August 2001). This Draft Final Implementation Plan, building on these air action levels and cumulative exposure budgets, outlines the practical implementation of this approach to public protection.

This document described the key elements of a sampling and analysis program that will collect information on airborne PCB levels during the remediation project. Aspects of selecting the locations for the monitoring stations, sampling frequency, and analytical methods were discussed, as was the relationship between this Implementation Plan and the Sampling and Analysis Plan for ambient air monitoring.

This Draft Final Implementation Plan also illustrated how the information obtained from an ambient air sampling and analysis program can be used to track and analyze the conditions that determine the level of exposure of the public to volatile PCBs. A prototype Public Exposure Tracking System (PETS) for a monitoring station was presented as a simple tool for compiling the monitoring data collected over the course of a clean-up operation and automatically conducting an initial screening assessment of that data against the baseline cumulative exposure budget developed for that monitoring station. The prototype PETS was tested on two remediation activities at New Bedford Harbor, and illustrative outputs were presented.

Subsequent efforts to finalize and tailor this Draft Final Implementation Plan for effective utilization would include the following general steps:

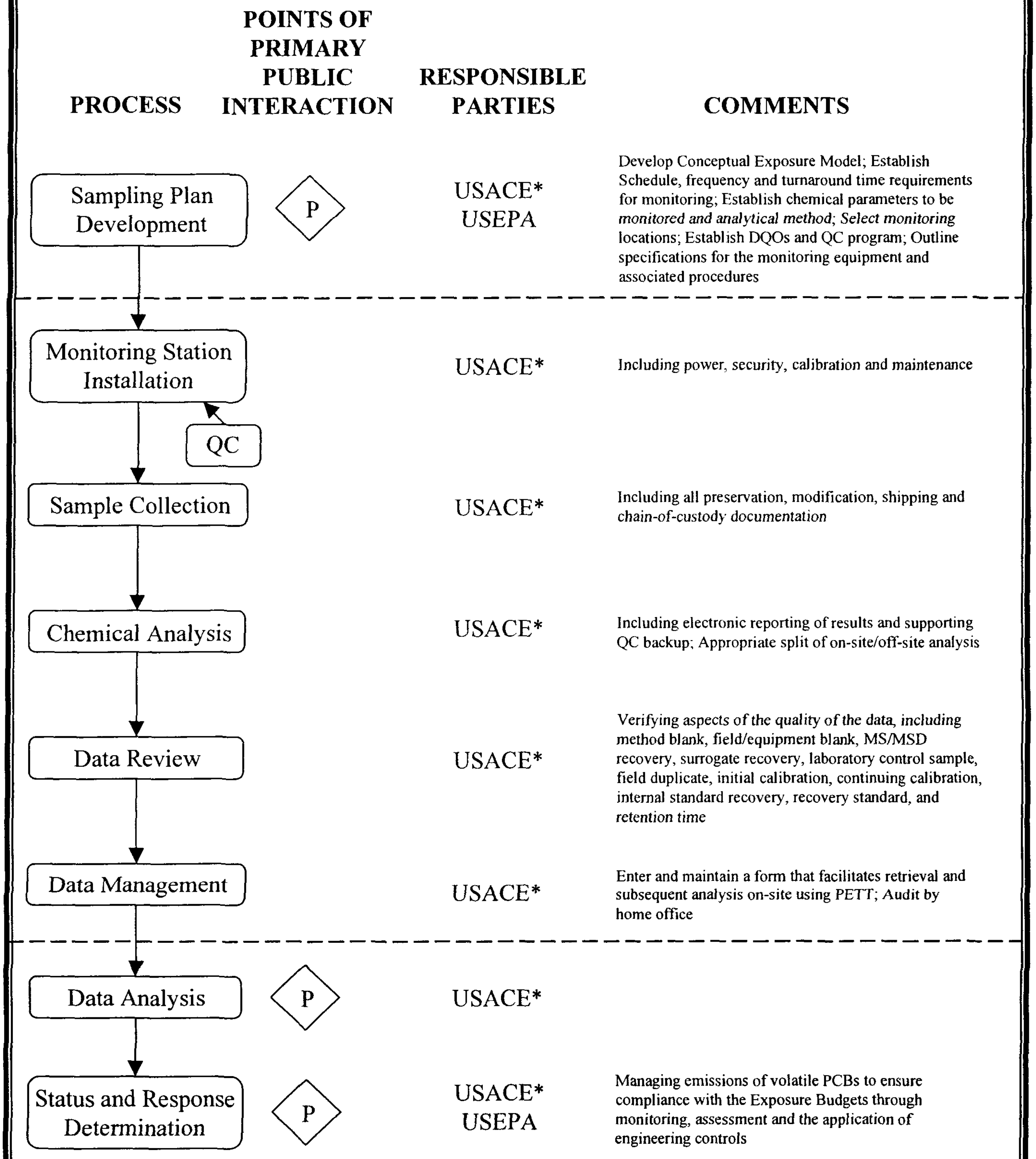
- Locating the monitoring points relative to the primary volatile PCB emission sources associated with the selected remediation approach and the nearby potential public receptors;
- Establishing the cumulative exposure budget for each monitoring point (reflecting the appropriate PCB release scenarios and the local atmospheric fate and transport analysis);
- Locating additional monitoring stations at public exposure points indicated to be potentially most impacted based on modeling (i.e., to "ground truth" the projections used in the exposure budget development process);
- Developing the corresponding elements of the Sampling and Analysis Plan (e.g., frequency of sampling, analytical protocols, QA/QC) for the remedial activities being conducted;
- Conducting the ambient air sampling program as defined;
- Incorporating the results into the PETS framework; and
- Acting on the recommendations generated through the initial screening analysis performed by the PETS.

5.0 REFERENCES

Sampling and Analysis Plan, New Bedford Harbor Superfund Site, Prepared by Foster Wheeler Environmental Corporation for the U.S. Army Corps of Engineers, New England District, Concord, MA, Task Order 017, Rev. 12 dated March 2001.

Development of PCB Air Action Levels for the Protection of the Public, New Bedford Harbor Superfund Site, Prepared by Foster Wheeler Environmental Corporation for the U.S. Army Corps of Engineers, New England District, Concord, MA, Task Order 017, Draft Final, August 2001.

FIGURES



PROCESS	POINTS OF PRIMARY PUBLIC INTERACTION	RESPONSIBLE PARTIES	COMMENTS
Sampling Plan Development	P	USACE* USEPA	Develop Conceptual Exposure Model; Establish Schedule, frequency and turnaround time requirements for monitoring; Establish chemical parameters to be monitored and analytical method; Select monitoring locations; Establish DQOs and QC program; Outline specifications for the monitoring equipment and associated procedures
Monitoring Station Installation		USACE*	Including power, security, calibration and maintenance
Sample Collection		USACE*	Including all preservation, modification, shipping and chain-of-custody documentation
Chemical Analysis		USACE*	Including electronic reporting of results and supporting QC backup; Appropriate split of on-site/off-site analysis
Data Review		USACE*	Verifying aspects of the quality of the data, including method blank, field/equipment blank, MS/MSD recovery, surrogate recovery, laboratory control sample, field duplicate, initial calibration, continuing calibration, internal standard recovery, recovery standard, and retention time
Data Management		USACE*	Enter and maintain a form that facilitates retrieval and subsequent analysis on-site using PETT; Audit by home office
Data Analysis	P	USACE*	
Status and Response Determination	P	USACE* USEPA	Managing emissions of volatile PCBs to ensure compliance with the Exposure Budgets through monitoring, assessment and the application of engineering controls

USACE* signifies the USACE or the USACE TERC Contractor

Figure 1-1

New Bedford Harbor Superfund Site
New Bedford, Massachusetts
IMPLEMENTATION PLAN FLOW DIAGRAM

Foster Wheeler Environmental Corporation
TERC Program

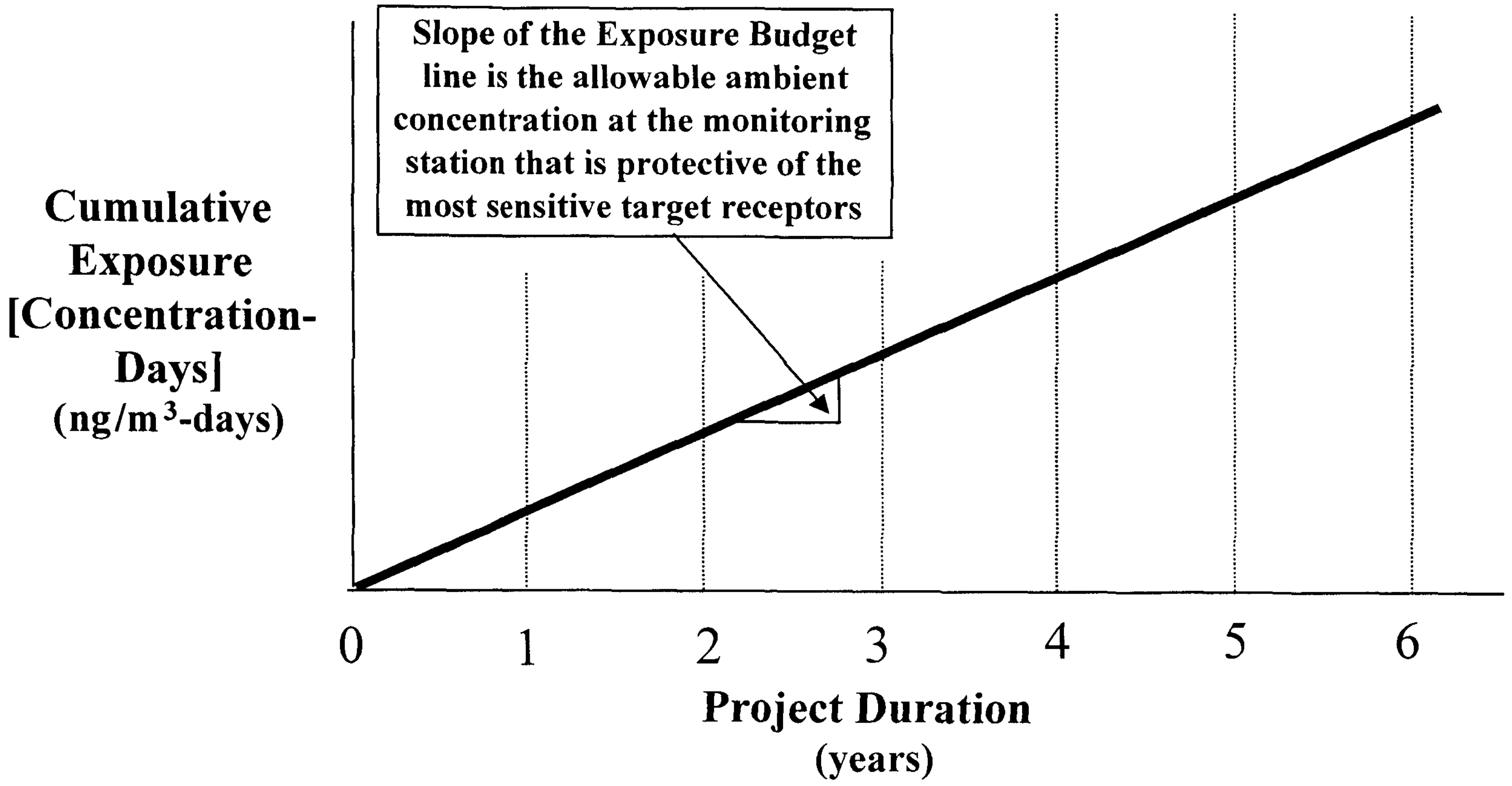


Figure 2-1

New Bedford Harbor Superfund Site
New Bedford, Massachusetts
EXAMPLE CUMULATIVE EXPOSURE BUDGET CURVE

Foster Wheeler Environmental Corporation
TERC Program

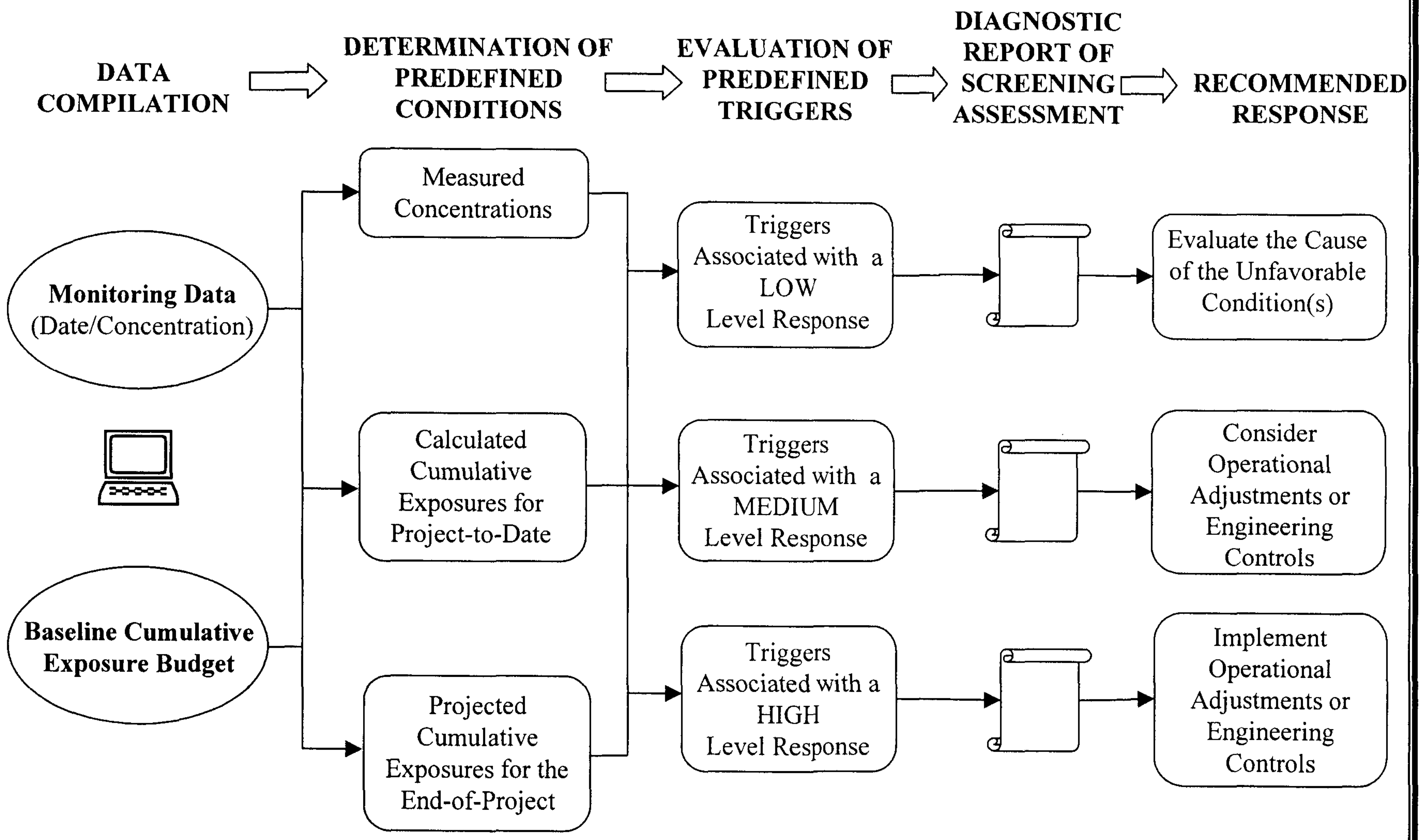


Figure 3-1

New Bedford Harbor Superfund Site
New Bedford, Massachusetts
PETS PROGRAM SCREENING AND TRACKING PROCESS

Foster Wheeler Environmental Corporation
TERC Program

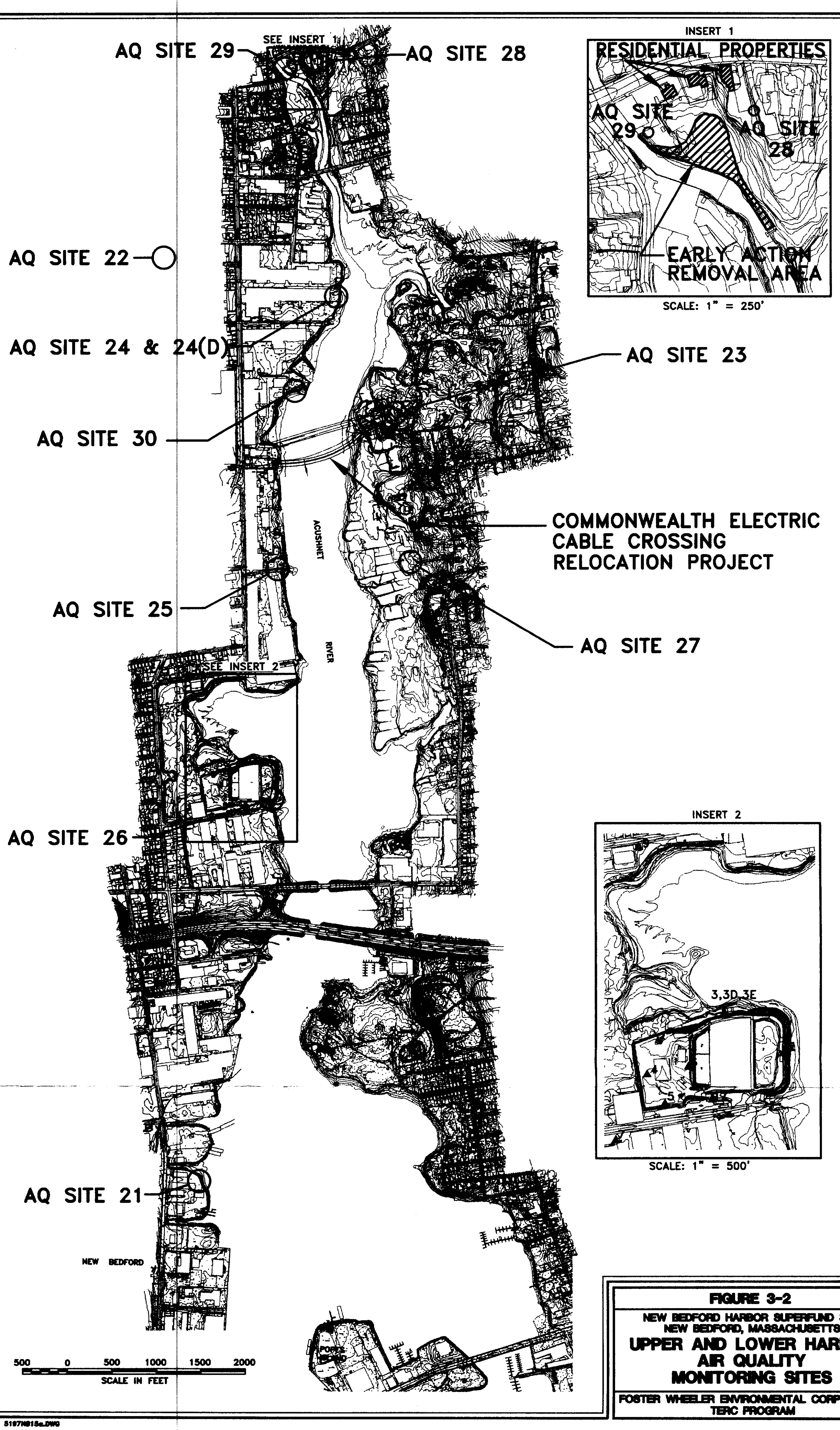


FIGURE 3-2

NEW BEDFORD HARBOR SUPERFUND SITE
NEW BEDFORD, MASSACHUSETTS

UPPER AND LOWER HARBOR AIR QUALITY MONITORING SITES

FOSTER WHEELER ENVIRONMENTAL CORPORATION
TERC PROGRAM

CADDFILE: 5197NB15a.DWG

APPENDIX A

Prototype Public Exposure Tracking System User Notes

Prototype Public Exposure Tracking System (PETS) User Notes

This appendix presents user notes for the prototype Public Exposure Tracking System (PETS). The prototype PETS is a spreadsheet designed to compile the monitoring data collected over the course of a clean-up operation and automatically conduct an initial screening assessment of the data against the baseline cumulative exposure budget developed for that monitoring station. The prototype PETS is an Excel workbook containing a series of 7 worksheets. Each workbook is tailored to a specific monitoring station. Each of the worksheets in the workbook briefly described below:

"*Home Sheet*" This worksheet provides the descriptive information about the project being tracked and monitored. The project-specific information contained in this worksheet includes the start and end date of the project. The monitoring station specific information in this spreadsheet includes the cumulative exposure budget slope and the background ambient air concentration. Finally, risk-based concentration criteria are found in this spreadsheet. These values are set and entered on time at the beginning of the project. The user is required to input most of this information.

"Time Trend" This worksheet is used perform to calculate the parameters for three types of condition checks:

- Comparison of monitoring data to predefined benchmark concentration criteria (e.g., occupational limits).
- Comparison of calculated cumulative exposure for the project-to-date (using the monitoring data) to the baseline cumulative exposure budget for that monitoring station.
- Comparison of the cumulative exposure extrapolated to the end of the project to the baseline *cumulative exposure budget for the end of the project.*

The conditions associated with these comparisons are more fully described in Section 3.1 of this document. To complete these calculations, the user is required to input the monitoring data and the dates of the monitoring events.

"*Triggers*" This worksheet is an internal worksheet that has no user inputs. It uses the data in the "Time Trend" worksheet to determine which conditions have been triggered.

"High", "Med", "Low" These worksheets are internal to the program and do not require any user inputs. They are used to assign the level of response for conditions that have been triggered in the "*Triggers*" worksheet.

"*Status Sheet*" This worksheet presents a summary status or screening report based on the current monitoring result and the monitoring conducted up to that point in the project. This summary sheet includes the name of the monitoring station, the most recent monitoring date, the most recent monitored total PCB concentration, the recommended response level, and the triggering condition(s) justifying that response level. This worksheet also includes an imbedded chart showing the cumulative exposure for the project-to-date and the baseline cumulative exposure budget for that monitoring station. There are no user inputs for this worksheet.

In practice, the user must create and tailor a separate workbook for each individual monitoring station. Once created, the user should input project specific and monitor specific information into the *"Home*

Sheet" worksheet. This creates unique PETS for each monitoring station. Then, as data is received for each monitoring event at each station, the table on the worksheet named '*Time Trend*' should be added to.

The steps that should be taken to use the prototype PETS are listed below:

- Tailor an existing PETS workbook with project specific information in *"Home Sheet*" (i.e., start date, end date and risk-based criteria for remediation project).
- Copy this workbook into a separate workbook for each monitoring station. Input information specific to each monitoring station (i.e., exposure budget slope and background concentration) into "*Home Sheet*".

  NOTE: There is no need to copy the formulas from a previous monitoring event row into the next row when entering the next result. A large number of rows have been pre-coded to accept the new information.
- In the *"Time Trend*" worksheet, enter the date of the monitoring event under the column headed "Monitoring Date" on the first available row. On this same row, enter air sampling results in the corresponding "Monitored Results" column (i.e., Total PCB Concentration in ng/m^3). Do not write over data entered for previous monitoring events, as all sampling results are used in tracking cumulative exposures.
- After the results of each sampling event have been input, review the *"Status Sheet"* worksheet to determine if any conditions have been triggered. This worksheet will also identify the level of response (Low, Medium or High) for any conditions that have been triggered. Please note that the *"Status Sheet"* is specific to the last sampling event entered in the *"Time Trend"* worksheet. The "Status Sheet" will be updated as you add new monitoring data. For this reason, the user may want to print out the *"Status Sheet"* corresponding to each monitoring event for record-keeping purposes.
- Determine appropriate response to conditions that have been triggered. This response will be determined by field personnel. The most appropriate response may be based on many factors including trigger level (i.e., High, Medium, Low), duration of project remaining and fraction of cumulative budget that has been expended up to that point. The amount of budget that has been utilized is graphically illustrated on the imbedded chart in the "*Status Sheet"* worksheet. This graph can also help to identify trends in ambient concentrations that may impact the exposure budget.
- Enter date and results for the next sampling event in the *"Time Trends"* worksheet and follow the steps listed above until monitoring has been completed for the project.

APPENDIX B

Diagnostic Test Data Set for the Prototype PETS

TABLE B-1 Diagnostic Test Data Set for the Prototype PETS

[Hypothetical Data - Not Actual Monitoring Measurements]

Test Assumptions:

Slope of the Cumulative Exposure Budget: 730
Work Start Date: 2/26/01
Projected Work End Date: 5/1/01

Monitoring Event [#]	Monitoring Date [mo/day/yr]	Monitored Result [ng/m^3]	Triggers [1]
1	02/26/01	10000	**C1**; **C2**; **C3**; **C5**
2	03/02/01	11	**CCE1**; **CCE2**; **CCE4**
3	03/07/01	23	CCE1; **C7**; CCE2; CCE4
4	03/10/01	24	CCE1; CCE2; **CCE3**; CCE4
5	03/15/01	25	**C4 and C8**; CCE2; CCE3; CCE4
6	03/20/01	30	C5; **C5 and C8**; CCE2; CCE3; CCE4
7	03/25/01	2110	C5; C7; **C1 and C8**; **C2 and C8**; **C3 and C8**; C5 and C8; CCE2; CCE3; CCE4
8	04/01/01	2185	C5; **C6**; C1 and C8; C2 and C8; C3 an dC8; C5 and C8; **C6 and C8**; CCE2; CCE3; CCE4
9	04/02/01	2000	C1; C2; C3; C5; CCE1; **PCE1**; CCE2; CCE3; CCE4
10	04/10/01	2010	C1; C2; C3; C5; CCE1; PCE1; CCE2; CCE3; CCE4
11	04/12/01	2020	C1; C2; C3; C5; CCE1; PCE1; CCE2; CCE3; CCE4
12	04/16/01	2030	C5; C1 and C8; C2 and C8; C3 and C8; C5 and C8; CCE2; **PCE2**; CCE3; CCE4; **PCE2 and C8**
13	04/25/01	2000	C1; C2; C3; C5; CCE1; CCE2; CCE3; CCE4; **PCE3**

Notes:

[1] Triggers in *Bold and Underlined* indicate the *first time that corresponding* condition was "true" given this data sequence.

[2] The diagnostic screening test data set was developed to demonstrate that all triggers were properly calibrated and will be displayed on the Status Sheet. Since the Status Sheet displays the triggers associated with the latest date entered into the workbook, each monitoring date and corresponding monitoring result must be entered in the order presented. After entry of each row, the Status Sheet will show the triggers presented *in the the last column* of this table. The Status sheets for each monitoring event are also contained in this appendix.

STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 2/26/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **10,000**
Response Level: LOW
Response: Evaluate the Cause of Triggered Conditions

Triggers:

High

Medium

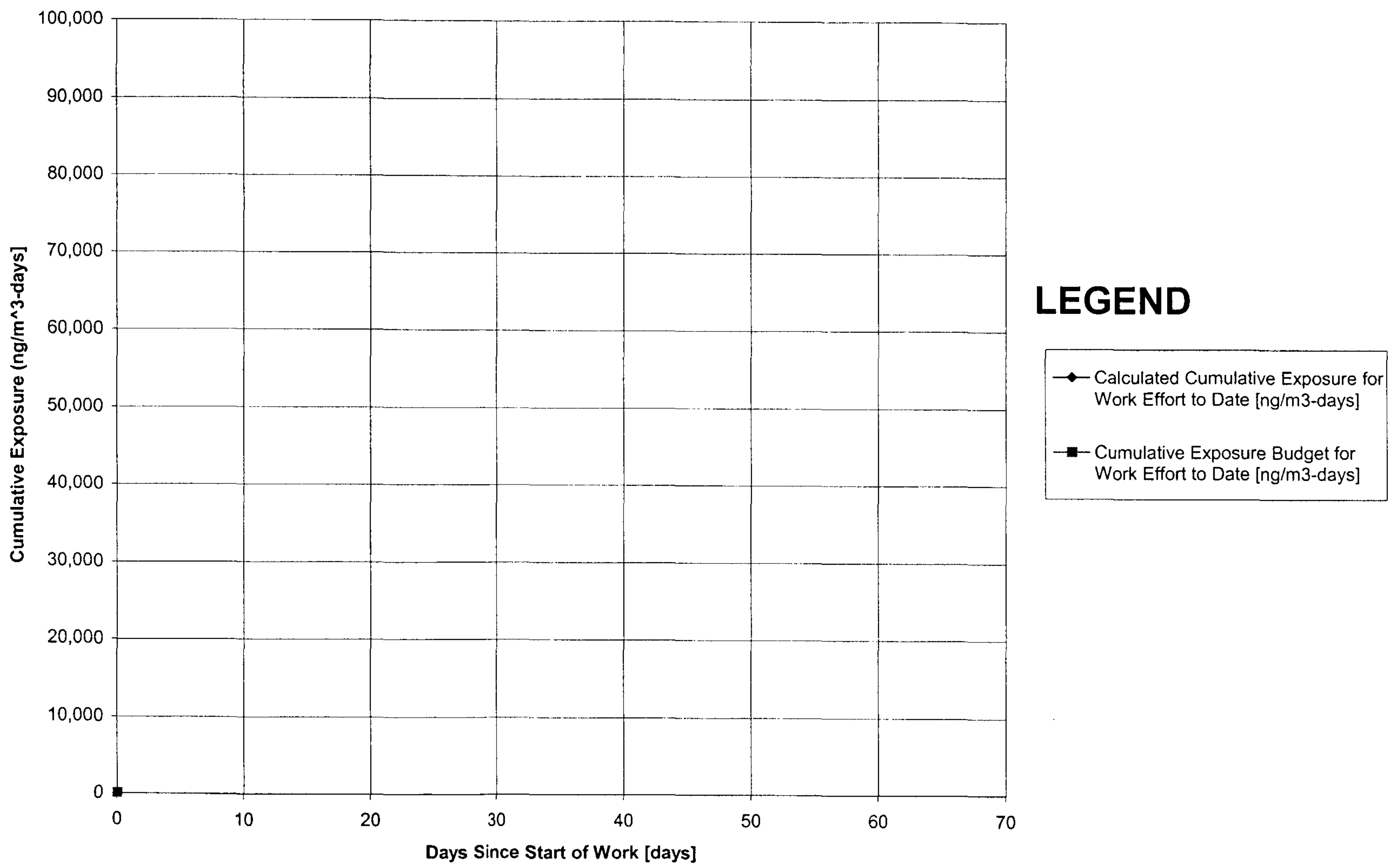
Low

Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C1: Measured Concentration Exceeds Maximum Occupational Limit
Trigger C2: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public
Trigger C3: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line

STATUS REPORT

Cumulative Exposure Budget Tracking at Hypothetical Monitoring Station for Diagnostic Test Data Set



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 3/2/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **11**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

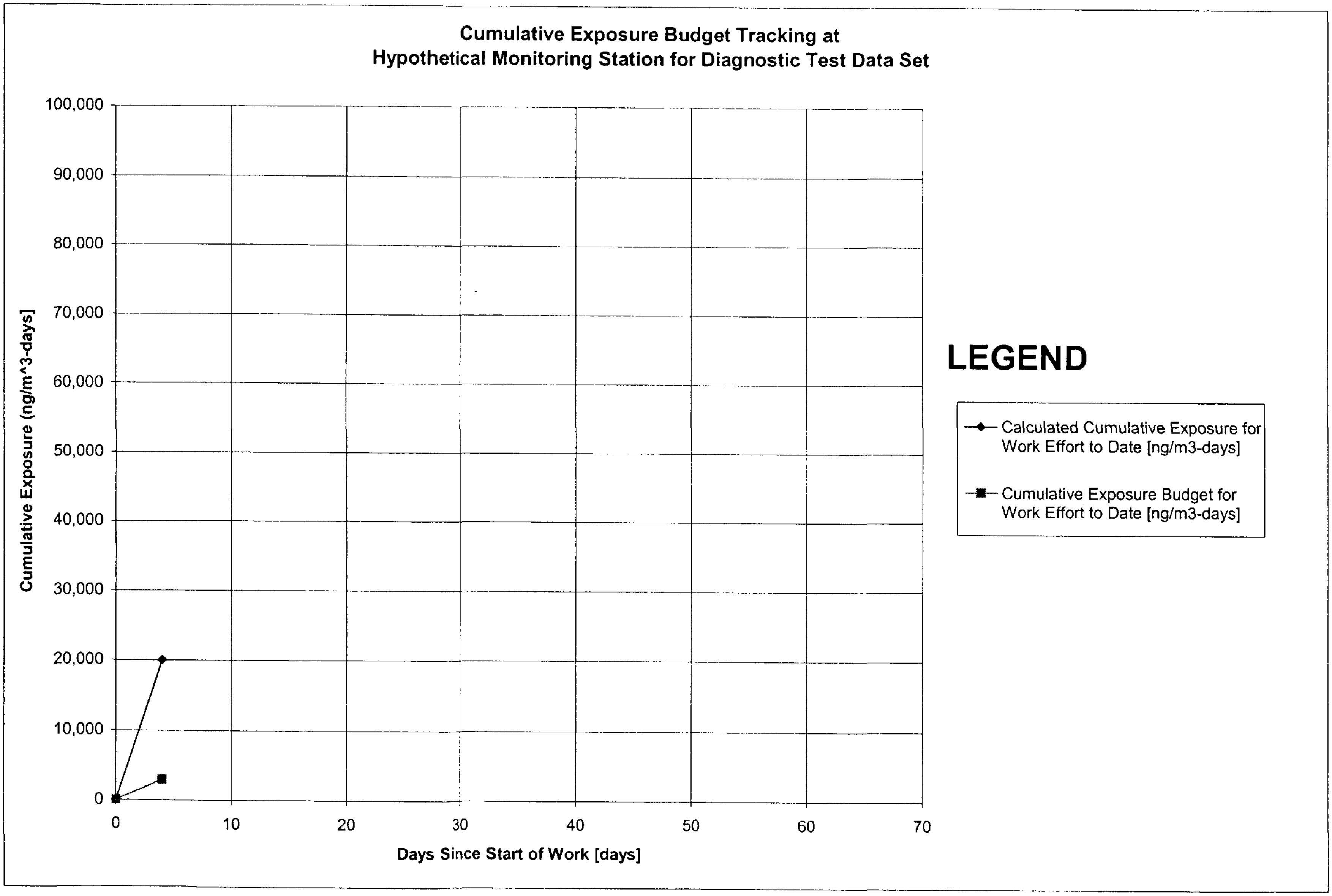
High

Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium
Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Low
Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now

STATUS REPORT



Cumulative Exposure Budget Tracking at Hypothetical Monitoring Station for Diagnostic Test Data Set

STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 3/7/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **23**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

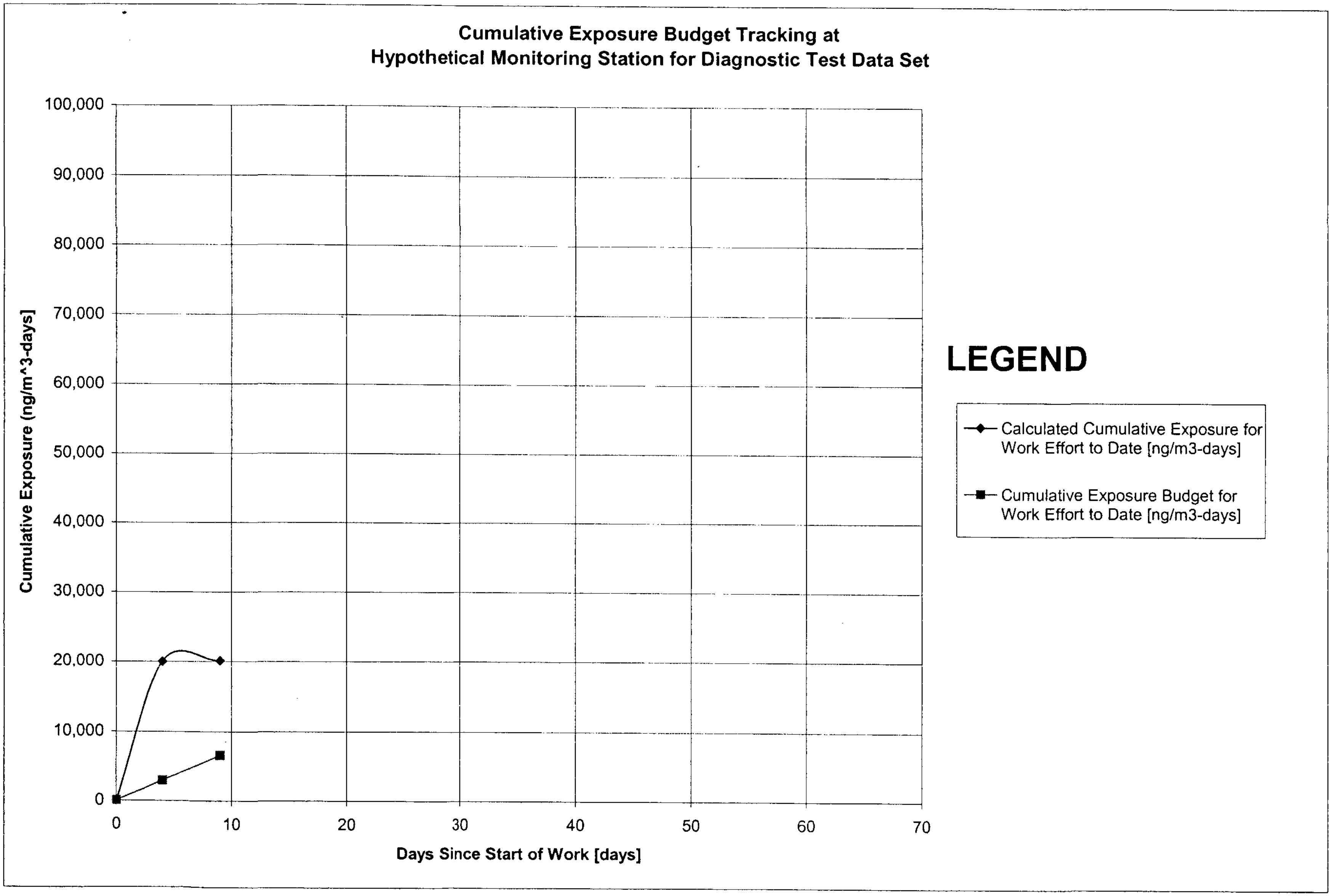
Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Low

Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now

Trigger C7: Measured Concentration has Doubled Since the Last Monitoring Period

STATUS REPORT



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 3/10/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **24**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

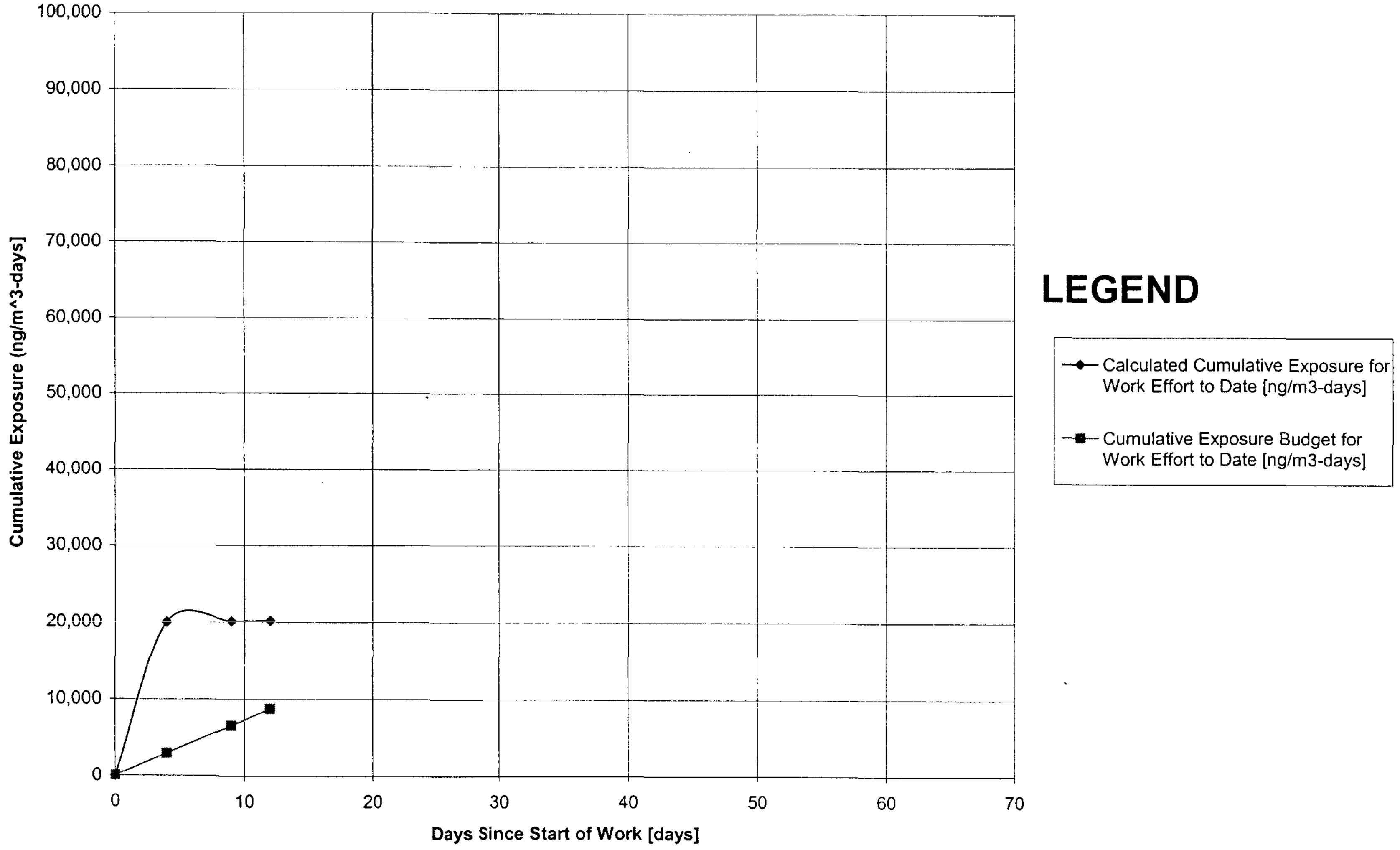
Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Low

Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now

STATUS REPORT

Cumulative Exposure Budget Tracking at Hypothetical Monitoring Station for Diagnostic Test Data Set



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 3/15/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **25**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

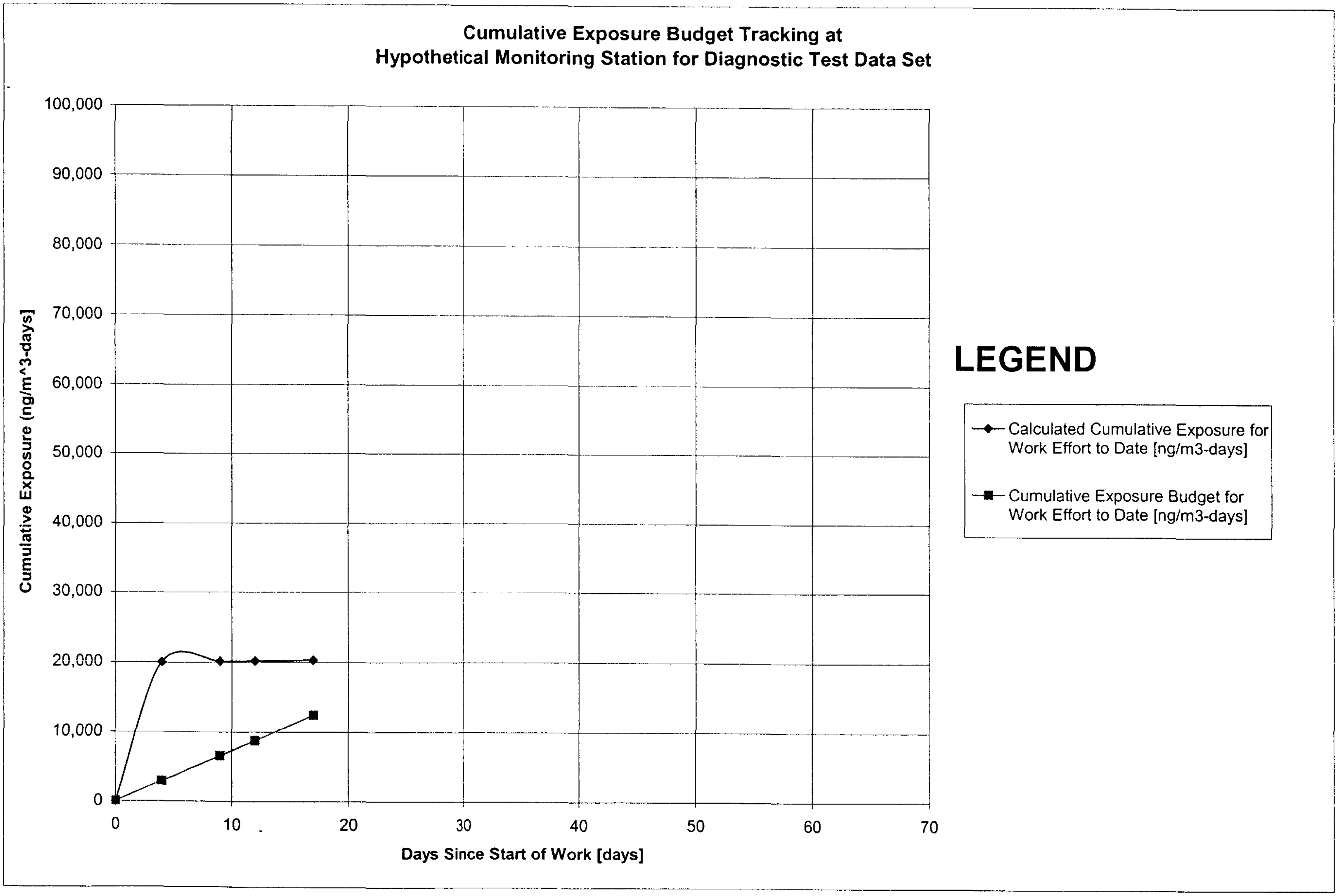
Medium

Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Low

Trigger C4 and Trigger C8: Measured Concentration Exceeds the Annual Average Background Concentration by more than 10% but less than 25% and Measured Concentration has Increased for Three Monitoring Periods In a Row

STATUS REPORT



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 3/20/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **30**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

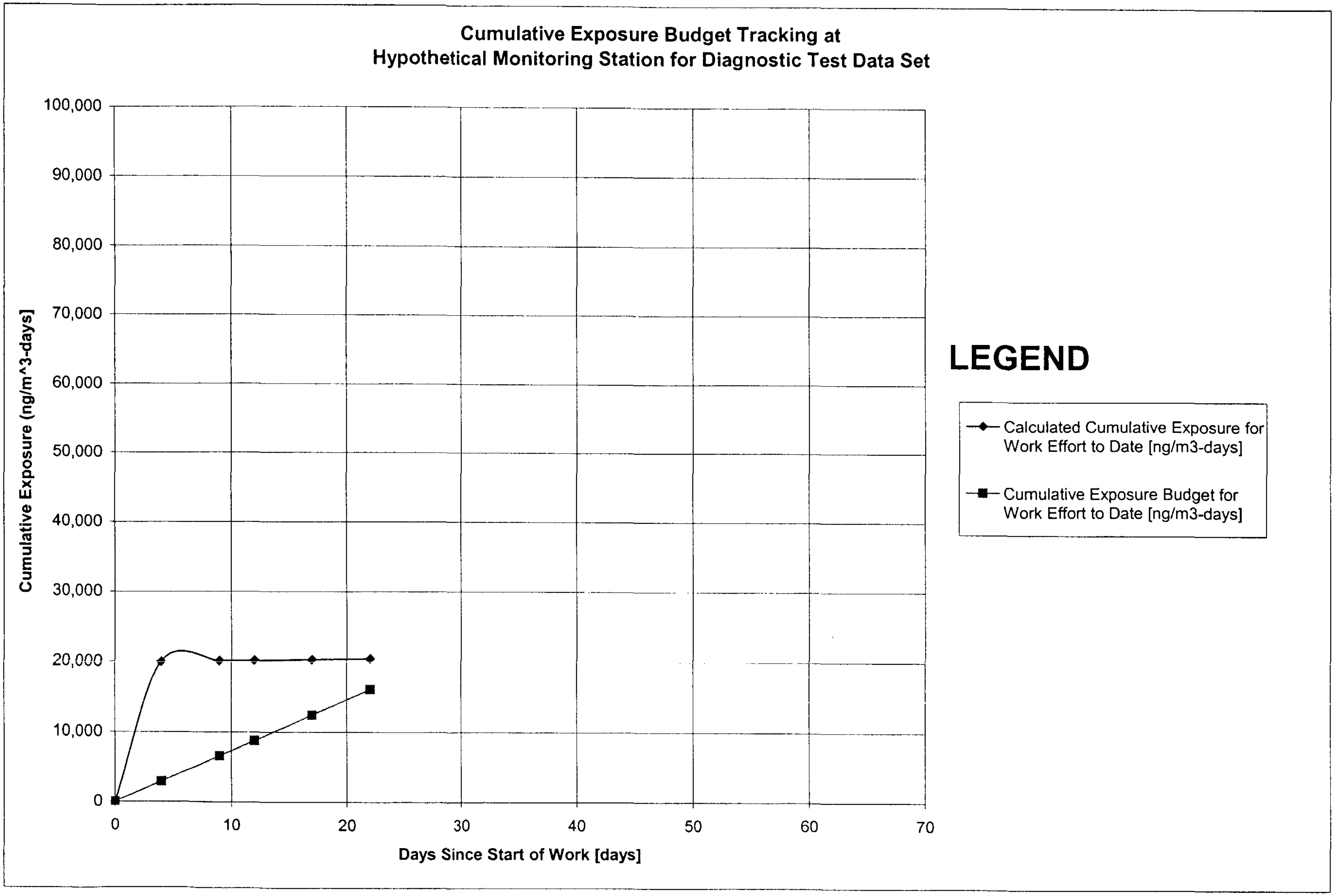
Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Trigger C5 and Trigger C8: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25% and Measured Concentration has Increased for Three Monitoring Periods In a Row

Low

Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

STATUS REPORT



Cumulative Exposure Budget Tracking at
Hypothetical Monitoring Station for Diagnostic Test Data Set

STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 3/25/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,100**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Trigger C5 and Trigger C8: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25% and Measured Concentration has Increased for Three Monitoring Periods In a Row

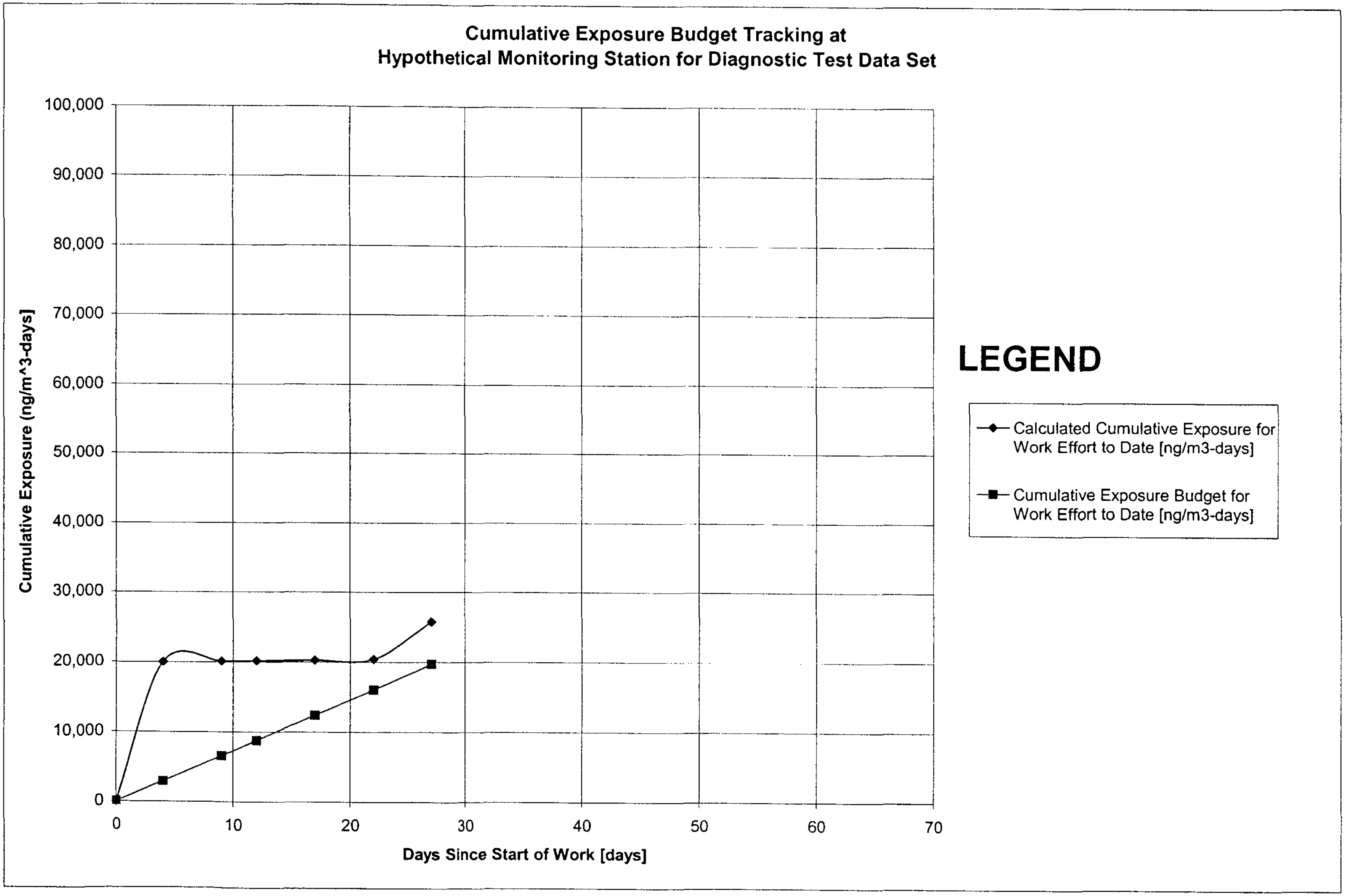
Trigger C1 and Trigger C8: Measured Concentration Exceeds Maximum Occupational Limit and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C2 and Trigger C8: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C3 and Trigger C8: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line and Measured Concentration has Increased for Three Monitoring Periods In a Row

Low

Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C7: Measured Concentration has Doubled Since the Last Monitoring Period

STATUS REPORT



Cumulative Exposure Budget Tracking at
Hypothetical Monitoring Station for Diagnostic Test Data Set

STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 4/1/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,185**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

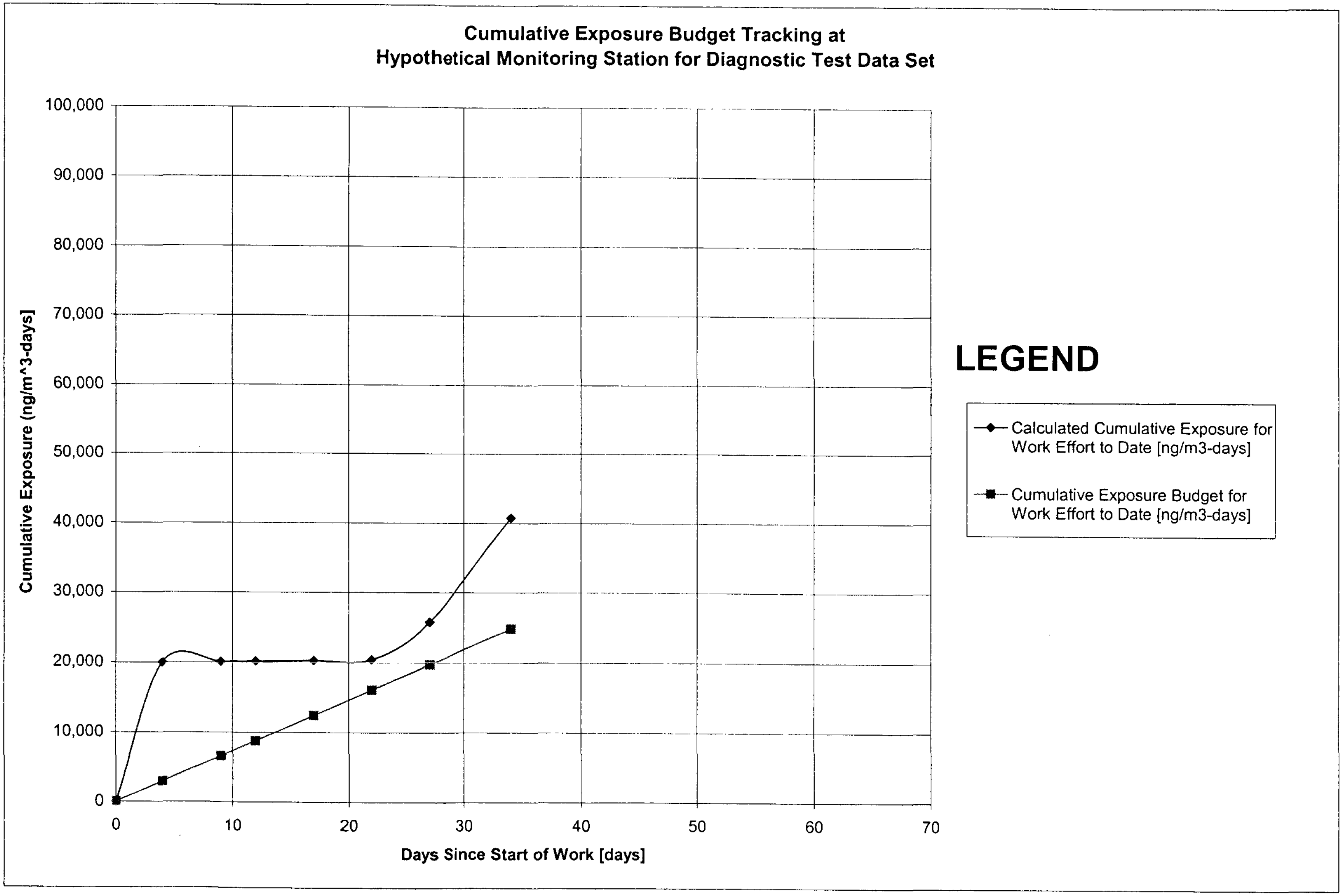
Trigger C5 and Trigger C8: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25% and Measured Concentration has Increased for Three Monitoring Periods In a Row

Trigger C1 and Trigger C8: Measured Concentration Exceeds Maximum Occupational Limit and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C2 and Trigger C8: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C3 and Trigger C8: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line and Measured Concentration has Increased for Three Monitoring Periods In a Row

Low

Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

STATUS REPORT



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 4/2/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,000**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

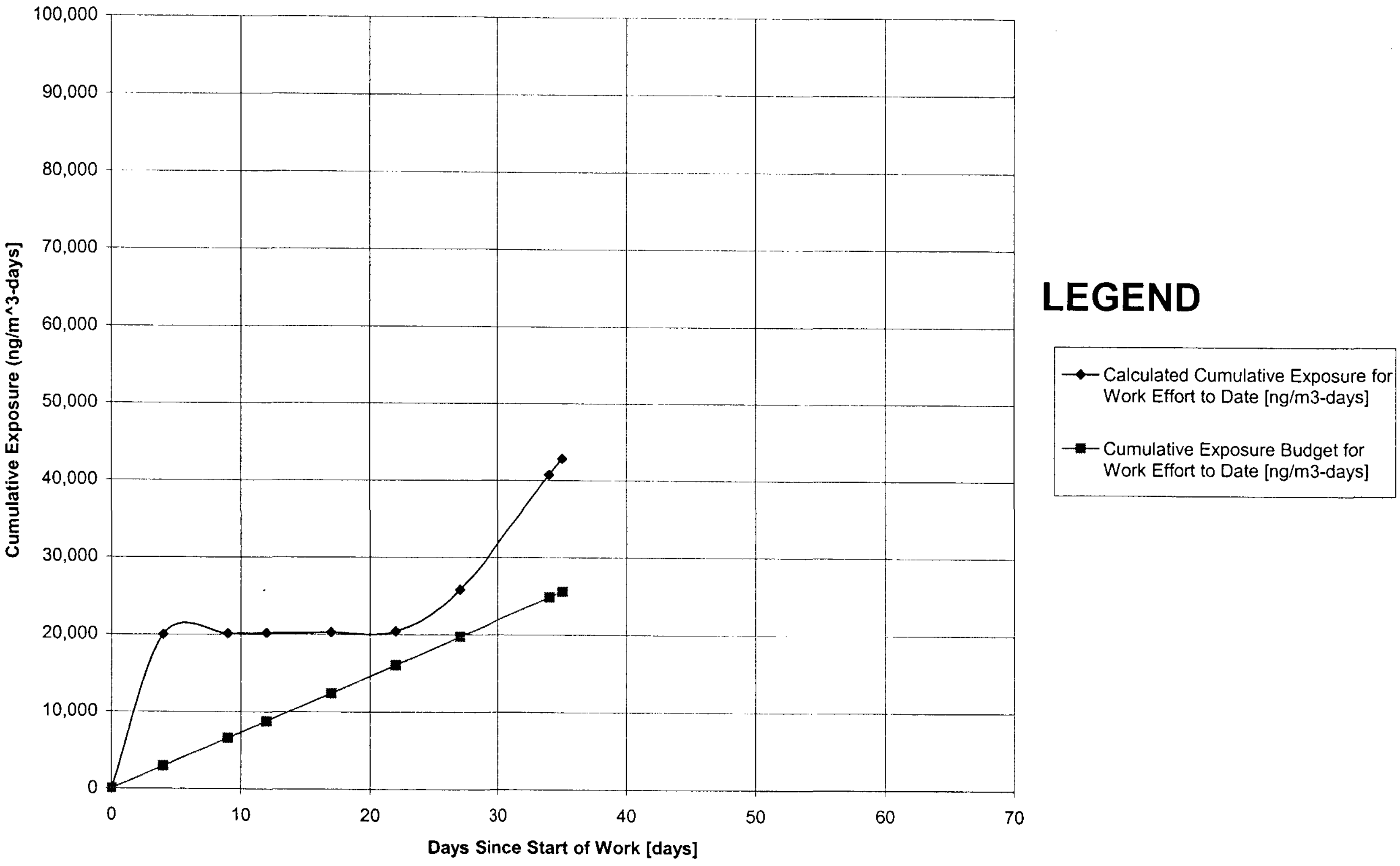
Low

Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now
Trigger PCE1: Projected Cumulative Exposure Budget Exceeded Based on Most Recent Exposure Rate for the Remainder of the Project with 25% to 50% of the Project Duration Remaining
Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C1: Measured Concentration Exceeds Maximum Occupational Limit
Trigger C2: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public
Trigger C3: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line

STATUS REPORT

Cumulative Exposure Budget Tracking at Hypothetical Monitoring Station for Diagnostic Test Data Set



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 4/10/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,010**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

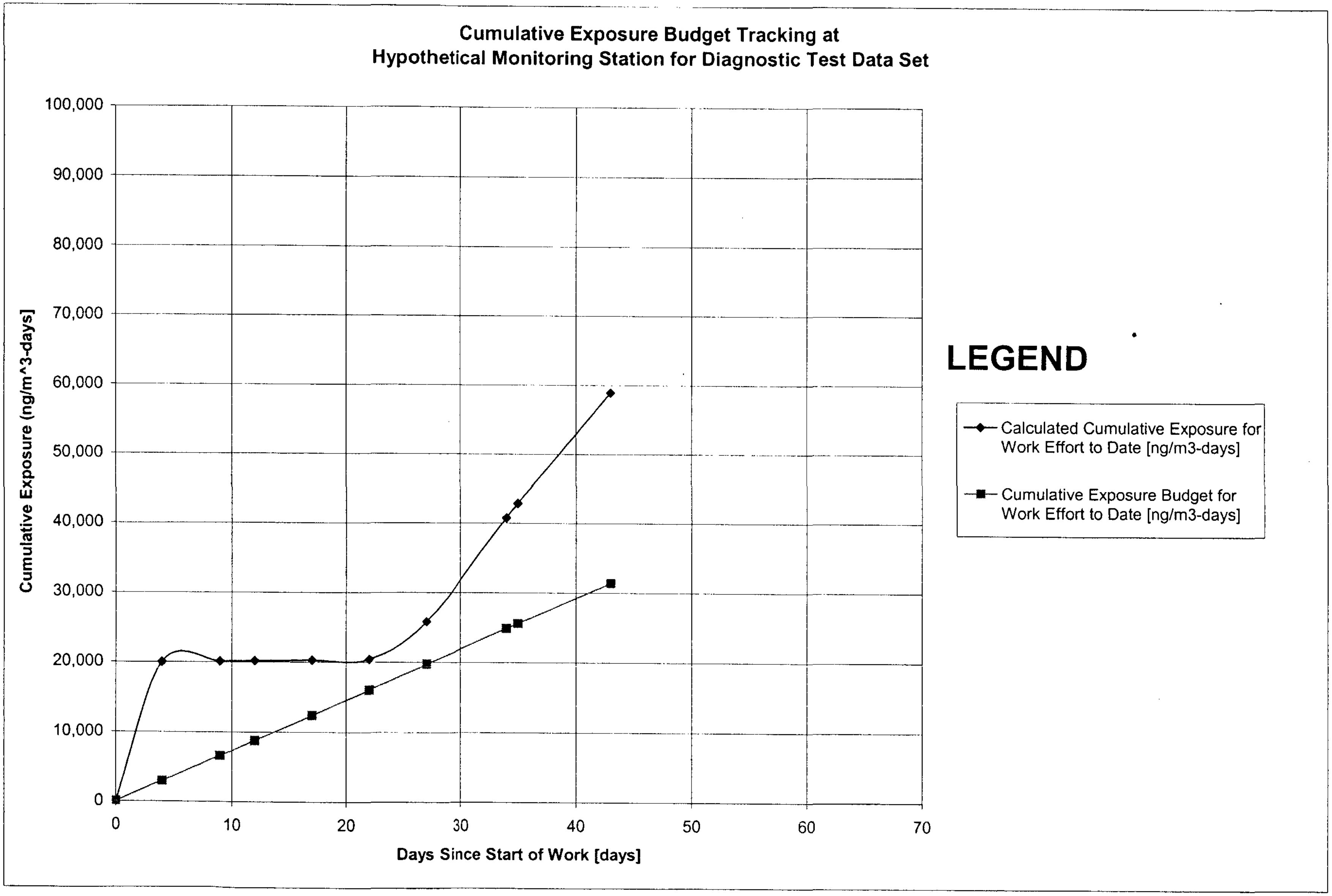
Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Low

Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now
Trigger PCE1: Projected Cumulative Exposure Budget Exceeded Based on Most Recent Exposure Rate for the Remainder of the Project with 25% to 50% of the Project Duration Remaining
Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C1: Measured Concentration Exceeds Maximum Occupational Limit
Trigger C2: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public
Trigger C3: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line

STATUS REPORT



Cumulative Exposure Budget Tracking at Hypothetical Monitoring Station for Diagnostic Test Data Set

STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 4/12/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,020**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More

Medium

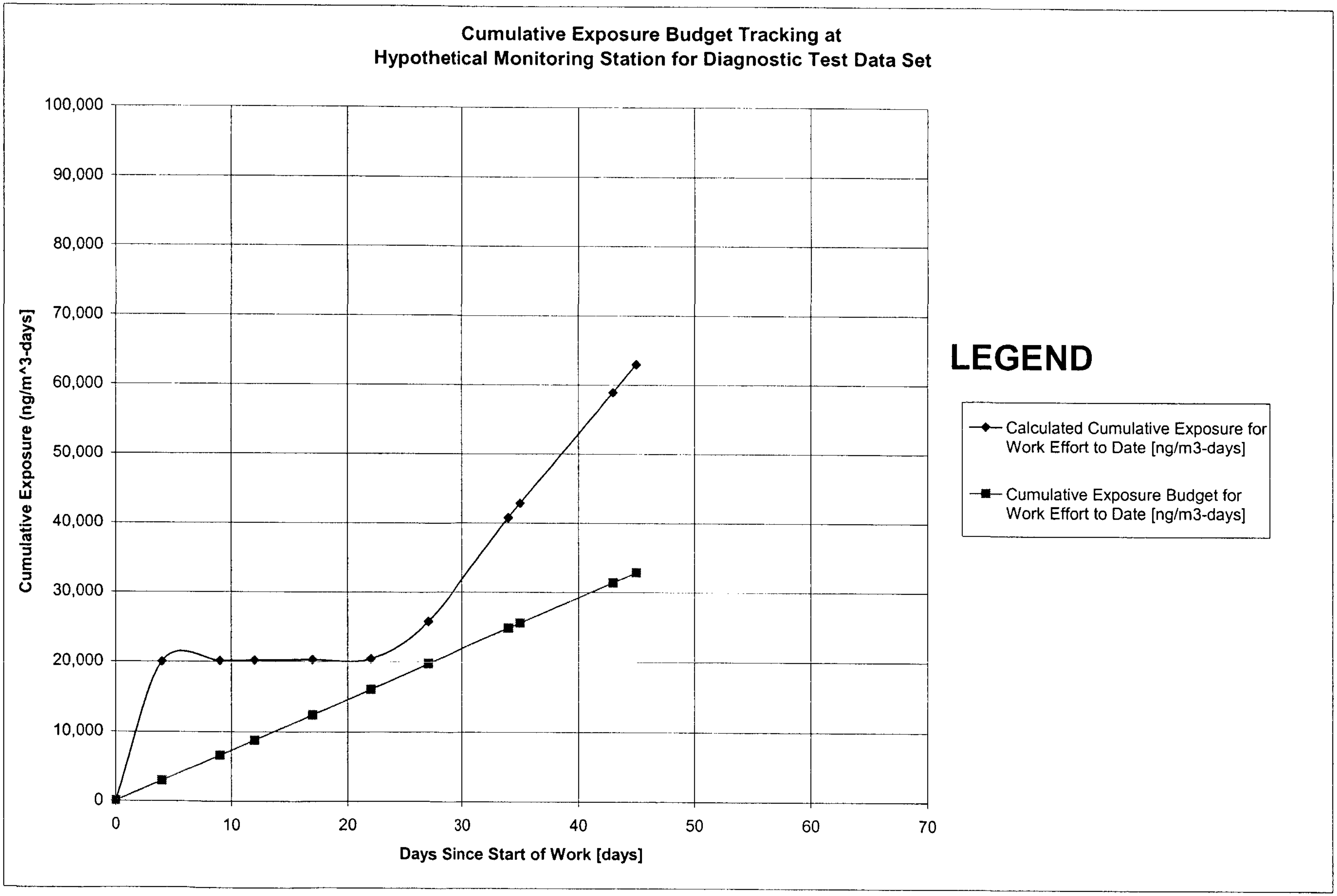
Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

Low

Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now
Trigger PCE1: Projected Cumulative Exposure Budget Exceeded Based on Most Recent Exposure Rate for the Remainder of the Project with 25% to 50% of the Project Duration Remaining
Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C1: Measured Concentration Exceeds Maximum Occupational Limit
Trigger C2: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public
Trigger C3: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line

STATUS REPORT



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 4/16/01

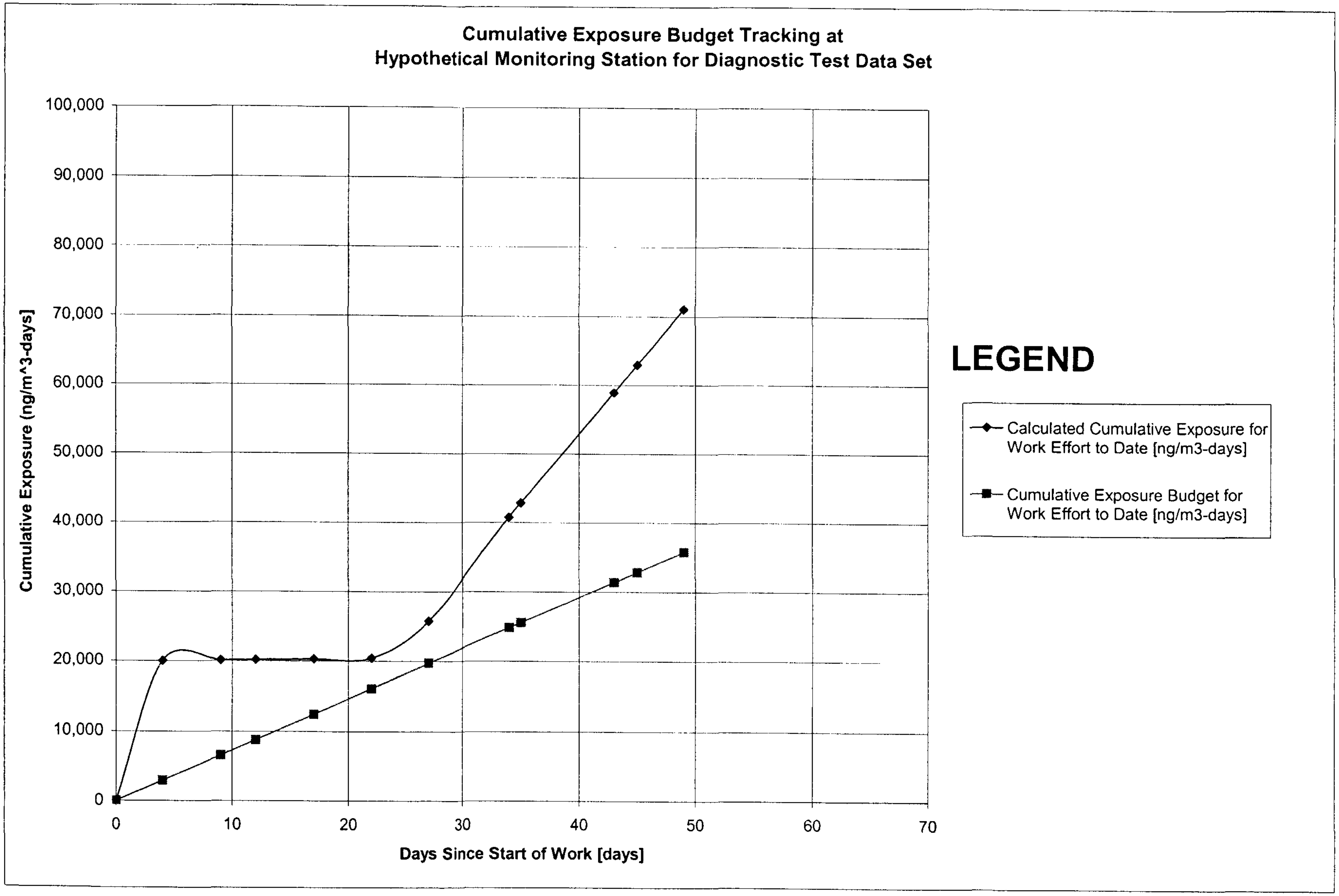
[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,030**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High	
Trigger C8 and Trigger PCE2:	Measured Concentration has Increased for Three Monitoring Periods In a Row and Projected Cumulative Exposure Budget Exceeded Based on Most Recent Exposure Rate for the Remainder of the Project with 10% to 25% of the Project Duration Remaining
Trigger CCE3:	Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4:	Cumulative Exposure Budget Exceeded by 25% or More
Medium	
Trigger CCE2:	Exceeding 100% of the Cumulative Exposure Budget Now
Trigger PCE2:	Projected Cumulative Exposure Budget Exceeded Based on Most Recent Exposure Rate for the Remainder of the Project with 10% to 25% of the Project Duration Remaining
Trigger C5 and Trigger C8:	Measured Concentration Exceeds the Annual Average Background Concentration by more than 25% and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C1 and Trigger C8:	Measured Concentration Exceeds Maximum Occupational Limit and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C2 and Trigger C8:	Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public and Measured Concentration has Increased for Three Monitoring Periods In a Row
Trigger C3 and Trigger C8:	Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line and Measured Concentration has Increased for Three Monitoring Periods In a Row
Low	
Trigger C5:	Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

STATUS REPORT



STATUS REPORT

Monitoring Station : Hypothetical Monitoring Station for Diagnostic Test Data Set
Monitoring Date: 4/25/01

[Hypothetical Data - Not an Actual Monitoring Measurement]

Monitored Concentration (ng/m^3): **2,000**
Response Level: HIGH
Response: Implement Engineering Controls

Triggers:

High

Trigger CCE3: Measured Concentration Exceeds the Cumulative Exposure Budget for Three Monitoring Periods In a Row
Trigger CCE4: Cumulative Exposure Budget Exceeded by 25% or More
Trigger PCE3: Projected Cumulative Exposure Budget Exceeded Based on Most Recent Exposure Rate for the Remainder of the Project with less than 10% of the Project Duration Remaining

Medium

Trigger CCE2: Exceeding 100% of the Cumulative Exposure Budget Now

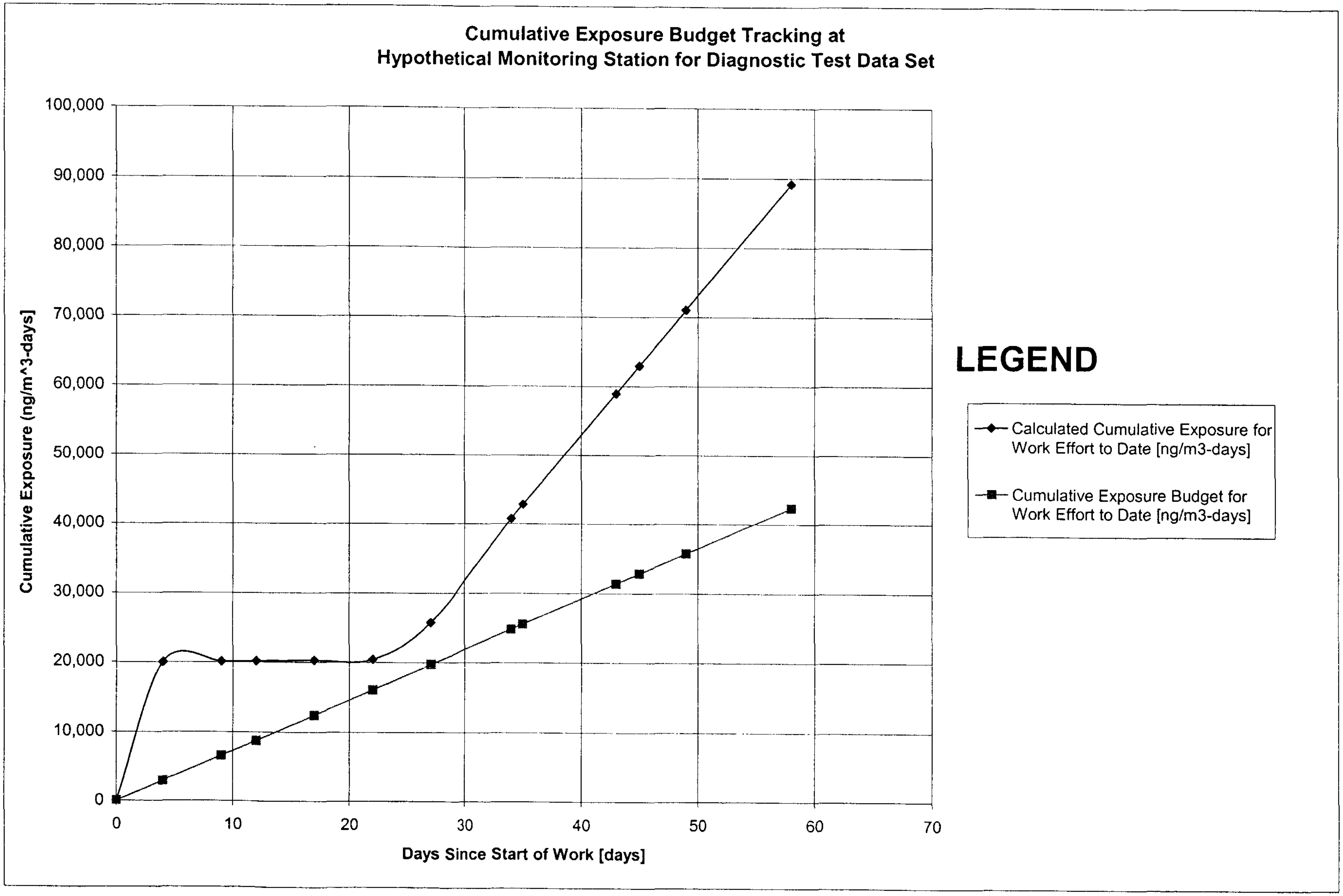
Low

Trigger CCE1: Exceeding 75% of the Cumulative Exposure Budget Now

Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C1: Measured Concentration Exceeds Maximum Occupational Limit
Trigger C2: Measured Concentration Exceeds Minimum TEL/NTEL for a Worker in the Public
Trigger C3: Measured Concentration Exceeds the Risk-Based Exposure Point Concentration Forming the Basis of the Cumulative Exposure Budget Line

STATUS REPORT



APPENDIX C

Sample of Tracking and Screening for the Acushnet Dock Area Early Action Removal

Preliminary Data: Do not cite or quote.

Sample Event Date	3/14/01	**Lab Sample Number**	03140128	**Prevailing Wind Direction**	WNW
Project Number		**Preliminary Flow (slpm)**	225	**Average Temperature (°F)**	42.5
Station	28 20 Main Street	**Run Time (hours)**	24.08	**Average Solar Radiation (w•m²)**	132
Sample Type	Normal Sample	**Sample Volume (m³)**	325.08	**Total Precipitation (inches H_2O)**	0.00

Analyte	**Detsym**	**Detection Limit (ng)**	**Mass (ng)**	**EMPC***	**QFlag**	**Concentration (ng/m³)**	**TEF**	**TEQ† (ng/m³)**
PCB Homologue Groups								
Total MonoCB	=	0.0755	122	—		0.375		
Total DiCB	=	0.315	2260	—		6.95		
Total TriCB	=	0.569	3940	—		12.1		
Total TetraCB	=	0.661	1260	—		3.88		
Total PentaCB	=	0.0983	129	—		0.397		
Total HexaCB	=	0.0371	27.6	—		0.0849		
Total HeptaCB	=	0.045	1.69	—		0.00520		
Total OctaCB	=	0.032	0.089	—		0.00027		
Total NonaCB	<	0.0661	—	—	ND	0.0002		
DecaCB (#209)	<	0.0254	—	—	ND	0.00008		
Homologue Groups Sum			7740			24		

* M indicates all or a portion of the result has a calculated EMPC value.

† TEQ is the product of the concentration and its TEF value.

New Bedford Harbor

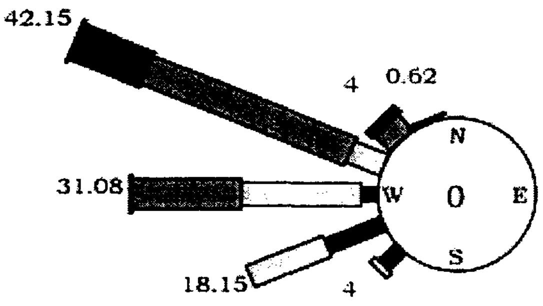
Meteorological Data

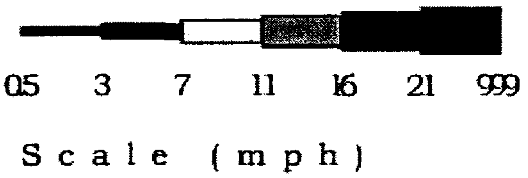
Hourly Summary
14 Mar - 15 Mar, 2001 (0800 EST - 1100 EST)

Date	Time	Wind Speed	Wind Direction		STD	Temp. (10m)	Temp. (2m)	Delta Temp	Solar Radiation	Batt.	Barr. Press.	Relative Humidity	Precip.
Mo. Day	**EST**	**mph**	**deg**	**compass**	**deg**	**°F**	**°F**	**°F**	**w•m^2**	**vdc**	**in. Hg**	**%RH**	**in. H_2O**
03/14	800	6.26	259.86	W	15.76	43.22	42.27	0.95	175.79	13.86	29	92	0
03/14	900	9.26	263.99	W	13.82	44.7	44.3	0.4	216.04	13.81	29	85	0
03/14	1000	11.91	271.12	W	14.8	47.38	46.68	0.7	445.2	13.76	29	78	0
03/14	1100	13.59	289.1	WNW	12.62	48.86	48.27	0.59	363.01	13.7	29	73	0
03/14	1200	14.29	313.54	NW	11.74	46.91	46.57	0.34	217.66	13.72	29	70	0
03/14	1300	16.72	299.97	WNW	12.78	47.73	47.4	0.32	488.33	13.72	29	66	0
03/14	1400	16.08	293.2	WNW	12.77	47.18	46.87	0.31	336.88	13.72	29	62	0
03/14	1500	17.82	291.49	WNW	13.06	48.2	48.01	0.19	445.11	13.71	29	55	0
03/14	1600	16.7	294.53	WNW	13.13	47.1	46.89	0.21	322.48	13.72	29	53	0
03/14	1700	13.98	291.83	WNW	12.92	45.97	45.66	0.31	79.24	13.73	29	53	0
03/14	1800	12.2	290.8	WNW	12.78	44.49	44.14	0.35	25.88	13.77	29	53	0
03/14	1900	9.71	276.7	W	12.27	43.03	42.6	0.43	0	13.8	29	54	0
03/14	2000	12.47	285.3	WNW	12.7	42.48	42.07	0.41	-0.17	13.82	29	56	0
03/14	2100	12.8	292.05	WNW	12.64	41.85	41.46	0.39	-0.16	13.84	29	56	0
03/14	2200	10.54	271.48	W	15.08	41.21	40.78	0.43	-0.17	13.85	29	57	0
03/14	2300	11.29	277.03	W	13.11	40.78	40.37	0.41	-0.15	13.86	29	57	0
03/15	2400	10.09	284.99	WNW	14.45	40.18	39.77	0.41	-0.09	13.87	29	59	0
03/15	100	7.8	267.77	W	15.42	39.48	39.06	0.42	-0.1	13.88	29	60	0
03/15	200	6.91	239.24	WSW	17.1	38.42	38.1	0.32	-0.07	13.89	29	61	0
03/15	300	6.77	253.89	WSW	15.28	37.95	37.63	0.32	0.01	13.91	29	63	0
03/15	400	7.76	257.9	WSW	14.28	38.18	37.83	0.35	0.07	13.91	29	63	0
03/15	500	7.09	240.61	WSW	16.55	37.81	37.52	0.29	0.05	13.92	29	64	0
03/15	600	7.4	246.09	WSW	16.23	38.04	37.74	0.3	1.13	13.92	29	63	0
03/15	700	5.93	240.14	WSW	17.79	39.64	38.9	0.74	55.74	13.9	29	63	0
03/15	800	10.59	264.81	W	14.81	43.26	42.26	1	211.69	13.84	29	61	0
03/15	900	13.52	279.14	W	13.96	45.35	44.73	0.62	401.82	13.77	29	59	0
03/15	1000	13.45	286.04	WNW	14.32	47.26	46.35	0.9	574.29	13.72	29	56	0
03/15	1100	13.89	282.76	WNW	14.05	49.71	49.09	0.62	686.74	13.68	29	53	0
Average		11.31			14.15	43.44	42.98	0.47	180.22	13.81	29	62.32	0
Minimum		5.93			11.74	37.81	37.52	0.19	-0.17	13.68	29	53	0
Maximum		17.82			17.79	49.71	49.09	1	686.74	13.92	29	92	0
Total													0

New Bedford Harbor

14 Mar - 15 Mar, 2001 (0800 EST - 1100 EST)





Wind Speed (mph) Percent Occurance

	0.5-3	3-7	7-11	11-16	16-21	>21
N	0	0	0	0	0	0
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0

Wind Speed (mph) Percent Occurance

	0.5-3	3-7	7-11	11-16	16-21	>21
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	3.08	0.92	0	0	0
WSW	0	7.69	10.46	0	0	0
W	0	2.15	15.08	13.54	0.31	0
WNW	0	0	4.62	27.69	9.54	0.31
NW	0	0	0	2.77	1.23	0
NNW	0	0	0	0.31	0.31	0

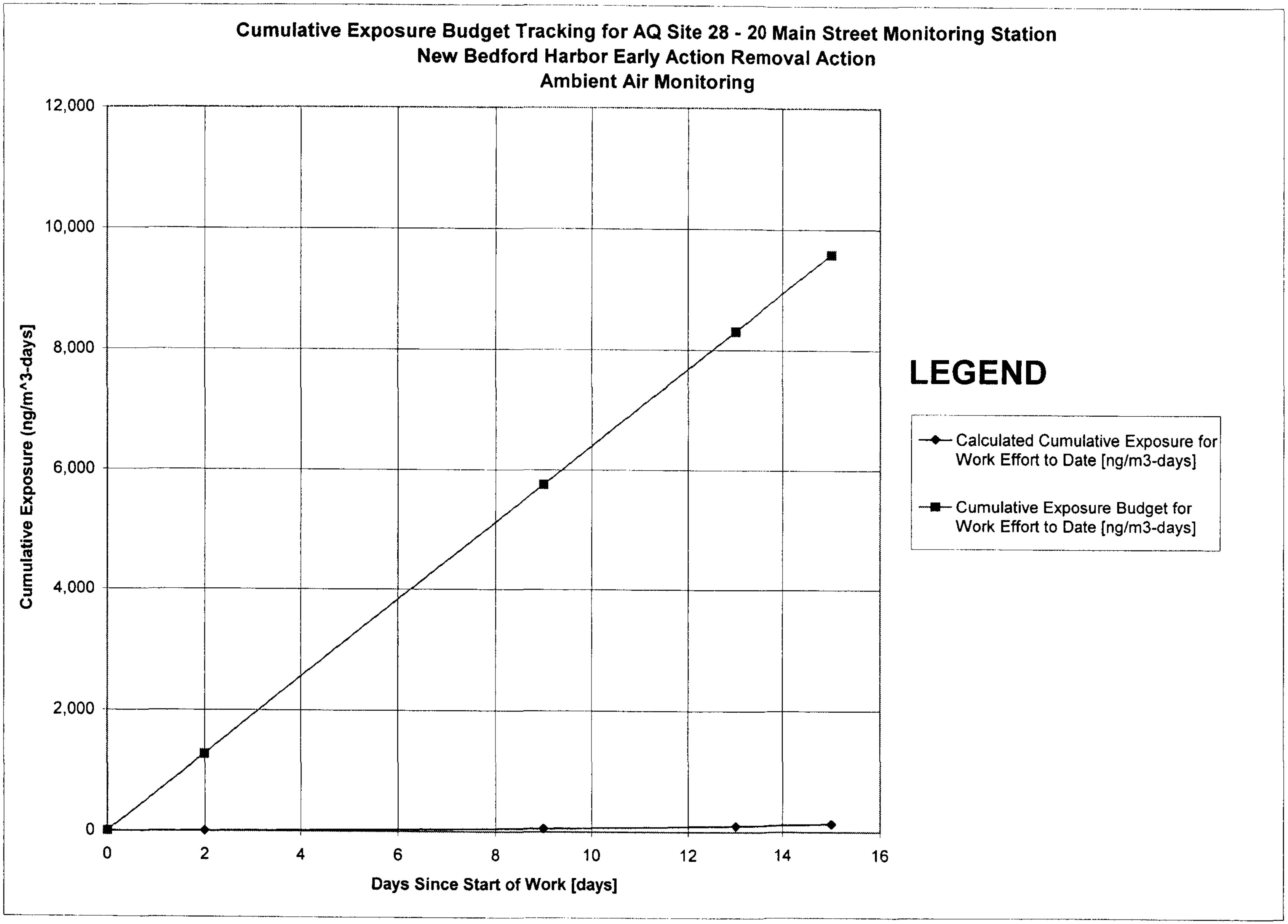
Home Sheet

Monitoring Station		AQ Site 28 - 20 Main Street Monitoring Station
Exposure Budget Slope		639
Work Start Date		2/26/01
Projected Work End Date		4/11/01
Occupational Limit Used as Ceiling	[ng/m^3]	1,000
TEL for Worker in Public	[ng/m^3]	50,000
NTEL for Worker in Public	[ng/m^3]	1,789
Miniumum of TEL/NTEL	[ng/m^3]	1,789
Background Concentration	[ng/m^3]	21.4

Time Trend
AQ Site 28 - 20 Main Street Monitoring Station
Early Action Removal Action
Ambient Air Monitoring

Event	Monitoring Date	Days Since Previous Monitoring Event	Work Effort Elapsed Time	Monitored Result	Average Monitoring Result During Monitoring Period	Measured Exposure During This Monitoring Period	Exposure Budget During This Monitoring Period	Work Effort Elapsed Time	Calculated Cumulative Exposure for Work Effort to Date	Cumulative Exposure Budget for Work Effort to Date	Running Average of Monitored Results	Work Effort Remaning
[#]	[month/day/year]	[days]	[days]	[ng/m^3]	[ng/m^3]	[ng/m^3-days]	[ng/m^3-days]	[days]	[ng/m^3-days]	[ng/m^3-days]	[ng/m^3]	[days]
1	2/27/01	0	0	1.96	0	0.00	0	0	0	0	0.00	44
2	3/1/01	2	2	3.9	2.93	5.86	1,277	2	5.86	1,277	2.93	42
3	3/8/01	7	9	10	6.95	48.65	4,470	9	54.51	5,747	5.29	35
4	3/12/01	4	13	***11***	10.50	42.00	2,554	13	97	8,302	6.72	31
5	3/14/01	2	15	24	17.50	35.00	1,277	15	132	9,579	10.17	29
6	3/16/01	2	17	9.1	16.55	33.10	1,277	17	165	10,856	9.99	27
7	3/23/01	7	24	7.1	8.10	56.70	4,470	24	221	15,326	9.58	20
8	3/28/01	5	29	7.1	7.10	35.50	3,193	29	257	18,519	9.27	15
9	4/4/01	7	36	11	9.05	63.35	4,470	36	320	22,990	9.46	8
10	4/11/01	7	43	10	10.50	73.50	4,470	43	394	27,460	9.52	1

STATUS/SCREENING REPORT



STATUS/SCREENING REPORT

Monitoring Station : AQ Site 28 - 20 Main Street Monitoring Station
Monitoring Date: 3/14/01

Monitored Concentration (ng/m^3): 24
Response Level: LOW
Response: Evaluate the Cause of Triggered Conditions

Triggers:

High

Medium

Low

Trigger C6: Previous Two Measured Concentrations Exceed the Running Average Concentration Through that Monitoring Event by more than 25%
Trigger C7: Measured Concentration has Doubled Since the Last Monitoring Period

Trigger C4 and Trigger C8: Measured Concentration Exceeds the Annual Average Background Concentration by more than 10% but less than 25% and Measured Concentration has Increased for Three Monitoring Periods In a Row

APPENDIX D

Sample of Tracking and Screening for the Commonwealth Electric Cable Crossing Relocation Project

Preliminary Data: Do not cite or quote.

Sample Event Date	6/21/2001	**Sample Number**	06210130	**Prevailing Wind Direction**	NE
Lab Sample ID	L3566-3	**Preliminary Flow (slpm)**	225	**Average Temperature (°F)**	70.1
Station ID/Name	30/Fiber Leather	**Run Time (hours)**	24.05	**Average Solar Radiation (w •m²)**	215
Sample Type	Normal Sample	**Sample Volume (m³)**	324.675	**Total Precipitation (inches H_2O)**	0.00

Analyte	**Detsym**	**Detection Limit (ng)**	**Mass (ng)**	**EMPC***	**QFlag**	**Concentration (ng/m³)**	**TEF**	**TEQ† (ng/m³)**
PCB Homologue Groups								
Total MonoCB	=	0.059	347	—		1.07		
Total DiCB	=	0.262	17100	—		52.7		
Total TriCB	=	0.356	28200	—		86.9		
Total TetraCB	=	0.621	21400	—		65.9		
Total PentaCB	=	0.22	4410	—		13.6		
Total HexaCB	=	0.358	1040	—		3.2		
Total HeptaCB	=	0.0194	66	—		0.20		
Total OctaCB	=	0.0199	2.8	—		0.0086		
Total NonaCB	=	0.045	0.458	—		0.00141		
DecaCB (#209)	=	0.0255	0.062	—		0.00019		
Homologue Groups Sum			**72600**			**220**		

* M indicates all or a portion of the result has a calculated EMPC value.

† TEQ is the product of the concentration and its TEF value.

New Bedford Harbor

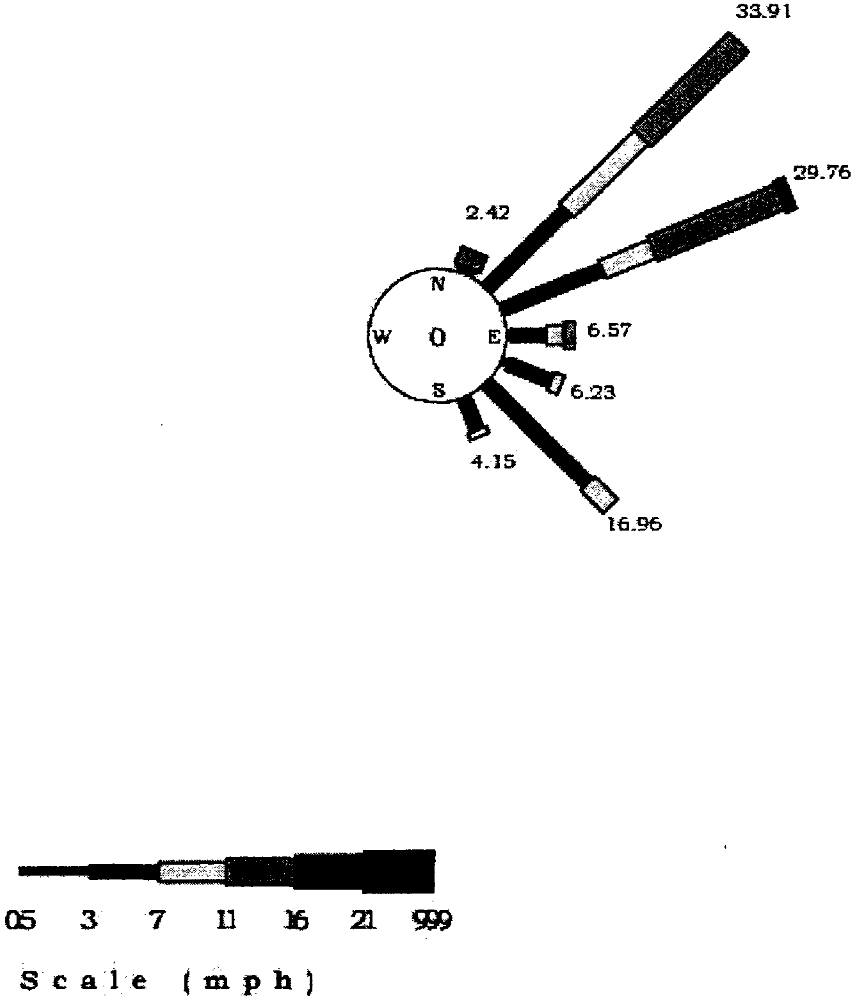
Meteorological Data

Hourly Summary
21 Jun - 22 Jun, 2001 (0900 EST - 0900 EST)

Date	Time	Wind Speed	Wind Direction		STD	Temp. (10m)	Temp. (2m)	Delta Temp	Solar Radiation	Batt.	Barr. Press.	Relative Humidity	Precip.
Mo. Day	EST	mph	deg	compass	deg	°F	°F	°F	w•m^2	vdc	in. Hg	%RH	in. H$_2$O
06/21	900	14.08	47.03	NE	9.04	73.58	73.76	-0.18	433.04	13.34	30	73	0
06/21	1000	13.93	66.44	ENE	11.89	76	75.89	0.11	614.06	13.28	30	66	0
06/21	1100	14.69	71.35	ENE	10.1	77.04	76.9	0.14	779.29	13.25	30	62	0
06/21	1200	13.3	57.81	ENE	10.33	77.1	77.57	-0.47	661.01	13.24	30	64	0
06/21	1300	14.35	53.88	NE	9.16	75	76.05	-1.06	592.89	13.25	30	66	0
06/21	1400	11.95	52.68	NE	10.9	74.76	76.04	-1.28	623.2	13.26	30	67	0
06/21	1500	10.62	59.67	ENE	11.29	74.78	75.84	-1.06	479.16	13.27	30	69	0
06/21	1600	9.99	71.19	ENE	10.83	73.4	74.02	-0.62	298.46	13.28	30	71	0
06/21	1700	11.14	58.07	ENE	7.54	71.75	72.46	-0.71	195.4	13.3	30	71	0
06/21	1800	11.58	34.24	NE	8.6	70.64	71.38	-0.74	218.66	13.33	30	72	0
06/21	1900	11.83	39.88	NE	8.34	67.9	68.77	-0.88	126.15	13.36	30	75	0
06/21	2000	9.11	43.39	NE	9.57	66.7	67.28	-0.58	42.5	13.39	30	77	0
06/21	2100	6.22	59.44	ENE	10.82	65.82	66	-0.18	3.84	13.42	30	80	0
06/21	2200	5.86	46.15	NE	9.25	65.92	66.06	-0.14	0	13.43	30	82	0
06/21	2300	5.66	47.92	NE	9.41	65.99	66.09	-0.11	0	13.44	30	83	0
06/22	2400	4.47	75.8	ENE	10.81	66.44	66.32	0.12	0	13.44	30	83	0
06/22	100	3.92	68.05	ENE	11.42	66.61	66.51	0.11	0	13.45	30	84	0
06/22	200	3.94	55.49	NE	8.25	64.9	65.15	-0.24	-0.02	13.45	30	87	0
06/22	300	4.37	104.37	ESE	10.47	65.76	65.58	0.19	-0.05	13.46	30	90	0
06/22	400	5.37	125.9	SE	9.19	66.46	66.33	0.12	-0.05	13.45	30	92	0
06/22	500	5.42	145.54	SE	10.25	67.11	66.97	0.13	-0.03	13.44	30	92	0
06/22	600	5.33	121.99	ESE	9.92	67.11	66.94	0.17	6.08	13.44	30	93	0
06/22	700	6.5	132.72	SE	10.19	66.77	66.54	0.23	27.89	13.44	30	95	0
06/22	800	6.69	126.72	SE	8.9	67.89	67.45	0.44	92.94	13.42	30	95	0
06/22	900	7.22	135.78	SE	9.95	69.81	69.39	0.42	168.14	13.4	30	93	0
Average		8.7			9.86	69.81	70.05	-0.24	214.5	13.37	30	79.28	0
Minimum		3.92			7.54	64.9	65.15	-1.28	-0.05	13.24	30	62	0
Maximum		14.69			11.89	77.1	77.57	0.44	779.29	13.46	30	95	0
Total													0

New Bedford Harbor

21 Jun - 22 Jun, 2001 (0900 EST - 0900 EST)



Wind Speed (mph) Percent Occurance

	0.5-3	3-7	7-11	11-16	16-21	>21
N	0	0	0	0	0	0
NNE	0	0.35	0.35	1.73	0	0
NE	0	10.73	10.03	13.15	0	0
ENE	0	10.38	5.19	13.15	1.04	0
E	0.35	3.46	1.73	1.04	0	0
ESE	0.69	4.5	1.04	0	0	0
SE	0	13.84	3.11	0	0	0
SSE	0	3.46	0.69	0	0	0

Wind Speed (mph) Percent Occurance

	0.5-3	3-7	7-11	11-16	16-21	>21
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0

Home Sheet

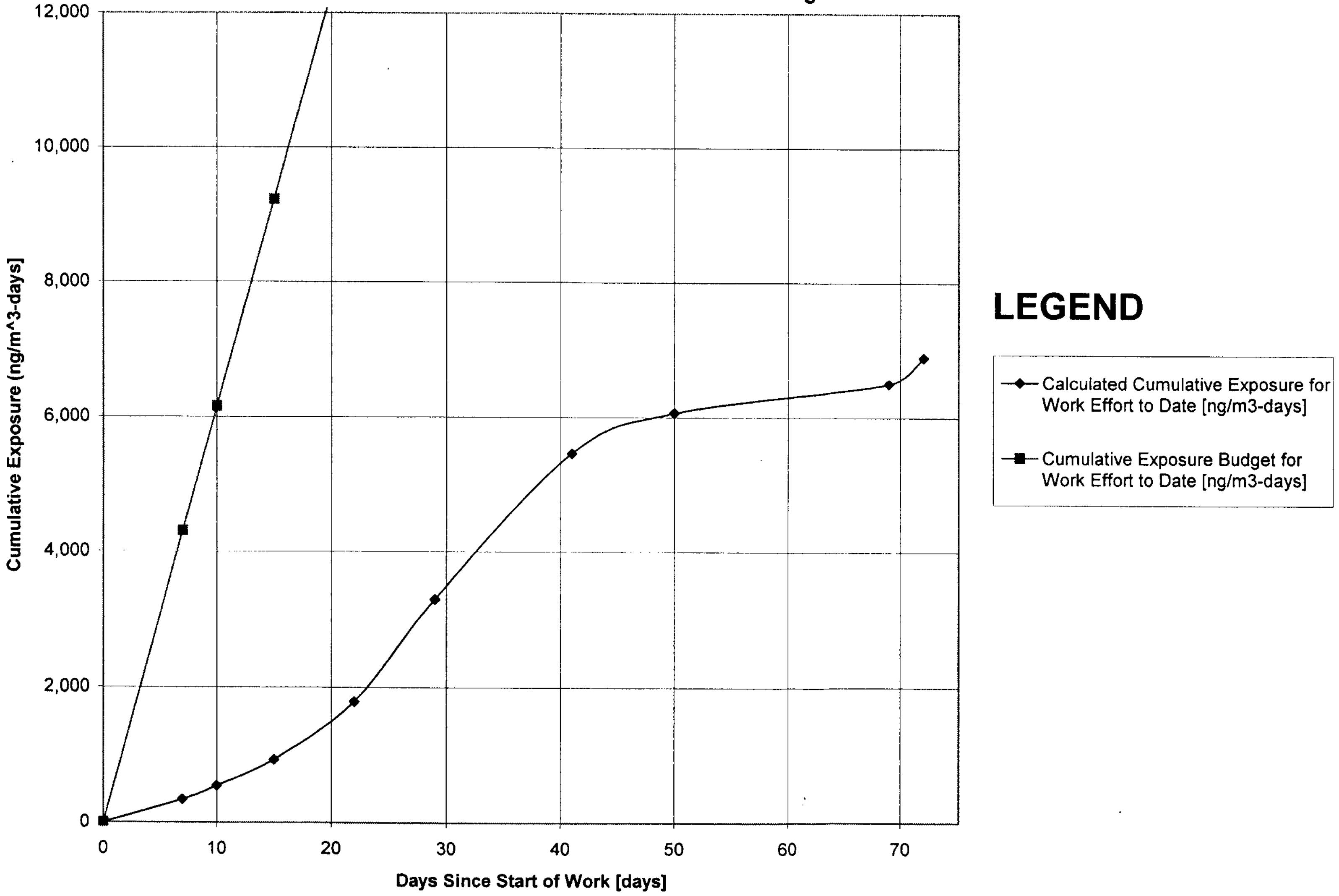
Monitoring Station		*AQ Site 30 - Fiber Leather Facility Monitoring Station*
Exposure Budget Slope		615
Work Start Date		4/10/01
Projected Work End Date		7/10/01
Occupational Limit Used as Ceiling	[ng/m^3]	1,000
TEL for Worker in Public	[ng/m^3]	50,000
NTEL for Worker in Public	[ng/m^3]	1,789
Miniumum of TEL/NTEL	[ng/m^3]	1,789
Background Concentration	[ng/m^3]	45

Time Trend
AQ Site 30 - Fiber Leather Facility Monitoring Station
Commonwealth Electric Cable Crossing Relocation Project
Ambient Air Monitoring

Event	Monitoring Date	Days Since Previous Monitoring Event	Work Effort Elapsed Time	Monitored Result	Average Monitoring Result During Monitoring Period	Measured Exposure During This Monitoring Period	Exposure Budget During This Monitoring Period	Work Effort Elapsed Time	Calculated Cumulative Exposure for Work Effort to Date	Cumulative Exposure Budget for Work Effort to Date	Running Average of Monitored Results	Work Effort Remaning
[#]	[month/day/year]	[days]	[days]	[ng/m^3]	[ng/m^3]	[ng/m^3-days]	[ng/m^3-days]	[days]	[ng/m^3-days]	[ng/m^3-days]	[ng/m^3]	[days]
1	4/10/01	0	0	70	0	0.00	0	0	0	0	0.00	91
2	4/17/01	7	7	28	49.00	343.00	4,305	7	343.00	4,305	49.00	84
3	4/20/01	3	10	110	69.00	207.00	1,845	10	550.00	6,150	69.33	81
4	4/25/01	5	15	44	77.00	385.00	3,075	15	935	9,225	63.00	76
5	5/2/01	7	22	200	122.00	854.00	4,305	22	1,789	13,530	90.40	69
6	5/9/01	7	29	230	215.00	1505.00	4,305	29	3,294	17,835	113.67	62
7	5/21/01	12	41	130	180.00	2160.00	7,380	41	5,454	25,215	116.00	50
8	5/30/01	9	50	4.7	67.35	606.15	5,535	50	6,060	30,750	102.09	41
9	6/18/01	19	69	41	22.85	434.15	11,685	69	6,494	42,435	95.30	22
10	6/21/01	3	72	220	130.50	391.50	1,845	72	6,886	44,280	107.77	19

STATUS/SCREENING REPORT

Cumulative Exposure Budget Tracking for AQ Site 30 - Fiber Leather Facility Monitoring Station
New Bedford Harbor Commonwealth Electric Cable Crossing Relocation Project
Ambient Air Monitoring



STATUS/SCREENING REPORT

Monitoring Station : AQ Site 30 - Fiber Leather Facility Monitoring Station
Monitoring Date: 6/21/01

Monitored Concentration (ng/m^3): 220
Response Level: LOW
Response: Evaluate the Cause of Triggered Conditions

Triggers:

High

Medium

Low

Trigger C5: Measured Concentration Exceeds the Annual Average Background Concentration by more than 25%

Trigger C7: Measured Concentration has Doubled Since the Last Monitoring Period