915119

ENGINEERING FEASIBILITY STUDY

Wide Beach Development Site
Town of Brant
Erie County, New York
August 1985

Prepared for:

New York State Department of Environmental Conservation

50 Wolf Road, Albany, New York 12233
Henry G. Williams, Commissioner

Division of Solid and Hazardous Waste
Norman H. Nosenchuck, P.E., Director

Prepared by:

EA Engineering, Science, and Technology, Inc.
Tighe & Bond Consulting Engineers REGION IX

ERRATA & ADDENDA

FOR

ENGINEERING FEASIBILITY STUDY
WIDE BEACH DEVELOPMENT SITE
TOWN OF BRANT
ERIE COUNTY, NEW YORK
SEPTEMBER 1985

The Errata includes:

- Table 5-3 Revised 9/3/85
- Table 4-5 Revised 9/3/85

Addendum No. 1 includes various tables as defined below:

- Table 1-1 Study of Costs and Implementation Time for Remedial Alternatives
- Table 1-2 Capital Costs for Excavation, Disposal and Replacement
- Table 1-3 Capital Costs for Excavation, Treatment, and Replacement

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NEW YORK STATE
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TABLE 5-3 ALTERNATIVES B AND B1 COSTS: EXCAVATION AND ONSITE CHEMICAL TREATMENT

	Alternative B[(a)]	Alternative B1[(b)]
Roads (all)	$1,595,000	$1,595,000
Driveways (all)	294,000	294,000
Ditches/storm drains (all)	2,600,000	2,600,000
Front yards	583,000	3,409,000
Back yards ($\geq$10 mg/kg)	25,000	25,000
Fill areas ($\geq$10 mg/kg)	160,000	160,000
Wetlands ($\geq$10 mg/kg)	62,000	62,000
Homes/outbuildings	450,000	450,000
Perched water treatment	200,000	200,000
Totals	$5,969,000	$8,795,000

(a) Alternative B: Onsite chemical treatment of only soils with concentrations $\geq$10 ppm PCB.

(b) Alternative B1: Onsite chemical treatment of soils (all front yards and only remaining areas with PCB concentrations $\geq$10 ppm).

TABLE 4-5 ALTERNATIVES AFTER PRELIMINARY SCREENING

Site Areas			Excavation			In Situ			Additional Activities		Support Activity		
Site Areas \ Alternatives		No Action	Remove/ Landfill/Replace	Remove/ Incinerate/Replace	Remove/Onsite Treatment/Replace	Biological Treatment	Chemical Treatment	Immobilization	House Cleaning	Water Supply		Monitoring	
Road Areas	Roads												
	Drives												
Soils	Front Yards			*									
	Backyards												
	Fill Areas												
	Wetland												
Sewers/ Ditches	Ditches			*									
	Storm Sewers			*									
	Storm Sewer Outlets												
	Sanitary Sewers												
Homes/Outbuildings													
Water	Ground Water												
	Perched Water												

*Incineration of material with PCB concentration ⩾500 mg/kg.

☐ Indicates remaining applicable alternatives.

◪ Indicates alternative is applicable to part of the area.

ADDENDUM #1

WIDE BEACH DEVELOPMENT SITE FEASIBILITY STUDY

TABLE 1-1 STUDY OF COSTS AND IMPLEMENTATION TIME FOR REMEDIAL ALTERNATIVES

	Alternatives				
	Excavate/ Remove		Excavate/Onsite Treatment		No Action
	A	A1	B	B1	
Implementation (years)	1-2	1-2	1-3	1-2	>20
Capital costs ($1,000)	10,858	16,329	5,969	8,795	0
Long-term, annual operation and maintenance costs ($1,000)	2	2	2	2	250
Present worth costs ($1,000)	10,898	16,369	6,009	8,835	5,000

ADDENDUM #1

WIDE BEACH DEVELOPMENT SITE

FEASIBILITY STUDY

TABLE 1-2 CAPITAL COSTS FOR EXCAVATION[(a)], DISPOSAL, AND REPLACEMENT

	Excavation	Disposal	Replacement	Total
Roads	$ 40,000	$ 2,500,000	$ 240,000	$ 2,800,000
Driveways	10,000	720,000	50,000	780,000
Ditches/storm drains	100,000	4,000,000	150,000	4,300,000
Front yards	150,000	5,500,000	700,000	6,300,000
Back yards	2,600	31,000	4,800	38,000
Fill areas	3,500	230,000	16,900	250,000
Wetlands	2,000	70,000	0	72,000
Incineration	--	1,160,000	--	1,160,000
Subtotal	309,100	14,211,000	1,161,700	15,700,000
Additional remediation (cleaning, perched water treatment)				650,000
				16,350,000

(a) Excavation, disposal, and replacement of <u>all</u> roads, driveways, and front yards and areas $\geq$10 ppm in back yards, fill areas, and wetlands.

ADDENDUM #1

WIDE BEACH DEVELOPMENT SITE

FEASIBILITY STUDY

TABLE 1-3 CAPITAL COSTS FOR EXCAVATION, TREATMENT, AND REPLACEMENT

	Excavation	Disposal	Treatment	Replacement	Total
Roads	$ 40,000	$ 380,000	$ 980,000	$ 200,000	$ 1,600,000
Driveways	10,000	98,000	132,000	50,000	290,000
Ditches/storm drains	100,000	10,000	2,310,000	130,000	2,600,000
Front yards	150,000	0	2,900,000	350,000	3,400,000
Back yards	3,000	0	25,000	2,000	30,000
Fill areas	3,500	0	146,000	10,000	160,000
Wetlands	2,500	0	60,000	2,500	65,000
Subtotal	309,000	488,000	6,553,000	744,500	8,145,000
Additional remediation (cleaning, perched water treatment)					650,000
					$ 8,795,000

EA Report DEC41C

ENGINEERING FEASIBILITY STUDY FOR REMEDIAL ACTION AT THE WIDE BEACH DEVELOPMENT SITE, TOWN OF BRANT, ERIE COUNTY, NEW YORK

Prepared for

New York State Department of Environmental Conservation
Division of Solid and Hazardous Waste
Bureau of Remedial Action
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August 1985

CONTENTS

CONTENTS (Cont.)

CONTENTS (Cont.)

CONTENTS (Cont.)

LIST OF TABLES

LIST OF TABLES (Cont.)

LIST OF FIGURES

EXECUTIVE SUMMARY

This report presents the results of the engineering Feasibility Study (FS) conducted by EA Engineering, Science, and Technology, Inc., at the Wide Beach Development Site. By definition, an FS is a process for developing, evaluating, and selecting remedial actions. During the FS, data gathered during the remedial investigation is used to develop response objectives and locate remedial alternatives. These alternatives are initially screened to a workable number; the remaining alternatives are then subjected to a detailed evaluation. This evaluation considers public health, economics, engineering practicality, environmental impacts, and institutional issues.

Based on numerous considerations, several numerical criteria were developed as objectives at Wide Beach. Due to the high potential for public health effects from PCB exposure, it was decided that soil PCB concentrations should be reduced to the lowest possible level consistent with engineering feasibility, public health, and regulatory constraints. This level included removal of soil contaminated at $\geq$10 mg/kg PCB. Additional considerations were maintaining air PCB levels <1.67 ug/m^3, drinking water levels at <1.00 ug/L, and surface water levels at less than the PCB analytical detection limit. Areas at the site with various amounts of contamination were obtained from the RI to determine the amount of treatment or removal necessary to result in the design objectives.

Numerous remedial alternatives were identified for evaluation of their capability to reach the objectives. The No Action Alternative would leave the site in the condition it was following EPA's immediate removal action. Several alternatives involved removal of contaminated soil. The removed soil could then be treated chemically, incinerated, or landfilled. Biological and chemical in-place (*in situ*) treatment options were also considered, as were methods of immobilizing the PCBs. In addition to soil treatment, alternatives were developed which dealt with ground water, drinking water, and personal facility (homes, garages) cleaning. Methods for monitoring the course of remediation were also developed in this phase. These included further studies in support of engineering design, monitoring during the cleanup, and monitoring for long-term effectiveness after cleanup is completed.

All alternatives were initially screened on the basis of engineering feasibility, environmental effects, environmental protection, and costs. After the screening process, three primary alternatives remained. These were the No Action Alternative; removal, landfill, and replacement of contaminated soils; and removal, treatment, and replacement of contaminated soils. In addition to these activities, ground-water treatment, personal facility cleaning, and monitoring would have to take place.

The two removal activities were developed in detail--remediating only areas of >10 mg/kg or including all front yards (termed sitewide in this report)--and yielded four options. Each option was explored fully on the basis of technical engineering criteria (feasibility, reliability, and implementability), environmental protection and effects, public health protection and effects, institutional/permit requirements, and costs.

Following this detailed development, the alternatives were ranked on the basis of 14 factors and tabulated in a matrix (Table 1). The ranking consisted of assigning the highest score (on a 1-10 basis) to the most favorable case. Thus, the least expensive alternative would have the highest ranking, the most reliable alternative the highest ranking, and the alternative with the least environmental impact the highest ranking. An overall rank for each alternative was obtained by summing the ranks for the 14 individual factors. On the basis of this system, the alternatives of partial removal and landfilling, total removal and landfilling, partial removal and treatment, and total removal with treatment scored so closely that no clear differentiation could be made between the alternatives (the difference between the highest and lowest scores of the four was only 6.8 percent). On the other hand, the No Action Alternative clearly scored lower (by 28 percent) than any of the other alternatives.

TABLE 1 ALTERNATIVE EVALUATION MATRIX

Evaluation Factors/Alternatives	A Partial Removal Landfill	A1 Total[a] Removal Landfill	B Partial Removal Chemical Treatment	B1 Total[a] Chemical Treatment	No Action
COST FACTORS					
Capital Costs	5.0	2.8	7.2	8.0	7.8
Operation and Maintenance Costs	8.5	9.0	8.8	9.0	6.8
Monitoring and Postclosure Costs	6.5	7.8	6.2	7.0	4.0
TECHNICAL FACTORS					
Feasibility	8.2	9.0	5.8	5.2	7.8
Implementability	8.2	7.8	6.8	5.5	5.5
Time to Accomplish	8.2	6.5	7.8	6.5	8.5
Reliability	8.2	9.0	5.0	5.8	5.5
HEALTH, WELFARE, AND ENVIRONMENTAL FACTORS					
Reduction in Health Risk	6.8	8.2	6.8	8.2	1.2
Onsite Public Health Effects	8.5	8.0	7.0	6.8	1.8
Offsite Effects	6.5	6.0	9.5	9.6	5.0
Occupational Health Effects	7.2	6.0	7.5	6.5	7.2
Reduction of Environmental Impact	6.5	8.5	6.0	8.0	2.2
Environmental Effects	6.5	7.0	6.5	7.0	2.8
Institutional Factors	8.0	7.5	6.0	6.2	3.5
OVERALL SCORE	103	103	96	99	70

(a) Total refers to cleanup of all front yards; partial refers to areas ≥10 mg/kg.

1. INTRODUCTION

EA Engineering, Science, and Technology, Inc. has prepared this Feasibility Study (FS) Report for New York State Department of Environmental Conservation (NYSDEC). Federal funds for this investigation were allocated through the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 by means of a Cooperative Agreement between the United States Environmental Protection Agency (EPA) and the State of New York. EA, in association with Tighe and Bond, was selected to: (1) undertake this remedial investigation to further define the nature and extent of contamination at and emanating from the Wide Beach Development site in the Town of Brant, Erie County, New York; and (2) conduct a feasibility study to identify, evaluate, and select a cost-effective, environmentally sound, long-term remedial action.

This Feasibility Study (FS) Report presents the results of that second task. The Remedial Investigation (RI) Report was submitted under separate cover.

For approximately 10 years, waste oil was applied to roadways in the Wide Beach Community as a dust suppressant. In July 1981, the Erie County Department of Environment and Planning (ECDEP) investigated this practice and learned that approximately twenty-five 55-gal drums of waste oil were applied two or three times each year, and that samples of oil from drums found at the site contained the PCB Aroclor 1254.

Since the initial finding, the air, water, ground water, and soil in this community has been sampled by ECDEP, EPA Region II Field Investigative Team (FIT), NUS Corporation, and EA. Of all sampled environmental media, the soil was shown to have received and retained the highest concentrations of Aroclor 1254. Consequently, the soil is acting as a reservoir for PCBs leading to migration through surface runoff, ground water, and atmospheric routes.

The detailed results of the RI conducted by EA were submitted to NYSDEC in July 1985 (EA 1985). These results--which define the nature, extent, and effects of the contamination--serve as the basis for this engineering feasibility study.

1.1 APPROACH

According to the National Contingency Plan (NCP) (40 CFR 300.68), the function of the Feasibility Study is to develop and evaluate remedial alternatives at the site. The methodology for performing this function, described in the NCP, consists primarily of developing cost-effective remedial alternatives which:

- Are feasible from the engineering standpoint
- Provide mitigation of damage to public health, welfare, and the environment
- Do not result in a negative environmental impact.

The following sections of this report:

1. Describe the site as it currently (July 1985) exists based on data from the Remedial Investigation and subsequent study. Modifications made to the site by U.S. EPA's Immediate Removal Action (IRA) (Cobiella 1985) and the Town of Brant are also described. (Section 1.2)

2. Develop objectives for remediation with respect to effects of Aroclor 1254. These objectives are public health-based and consistent with relevant federal and New York State regulations. (Section 2)

3. Present the remedial alternatives for the site which basically consist of No Action, removal, <u>in situ</u> treatment, immobilization, and support activities. (Section 3)

4. Screen the alternatives on the basis of engineering feasibility, environmental effects, environmental protection, and costs. (Section 4)

5. Provide detailed evaluation of alternatives surviving the screening process based on technical characteristics, environmental and public health effects, institutional and permit requirements, and costs. (Section 5)

6. Provide an effectiveness analysis and identify a recommended alternative.

1.2 SITE DESCRIPTION

1.2.1 <u>Site History</u>

The community of Wide Beach was incorporated for tax purposes in 1920. The existing roadways throughout the community are constructed of graded native materials and gravel. Application of waste oil to these roadways as a dust suppressant dates back to the 1940s. For approximately 10 years, from 1968 through 1978, residents applied waste oil from an industrial source for dust control throughout the 1.1 mi of dirt roads in the community (NYSDEC 1983; ECDEP 1981).

On 29 July 1981, a Wide Beach resident contacted ECDEP about the possibility that the applied waste oil was contaminated with PCBs. It was reported to ECDEP that approximately twenty-five 55-gal drums of oil were spread on the roads 2-3 times a year during the period 1968-1978. This would represent between 27,500 and 41,000 gal of oil applied to the roadways over a 10-year period.

ECDEP conducted a site investigation on 7 August 1981 during which nineteen 55-gal drums were observed in a wooded area off Fox Street. Six drums contained aqueous material; two contained oil, and four contained water (ECDEP 1981). The two drums containing oil were sampled and analyzed for PCBs. Results show that total PCB concentrations were 12 and 38 mg/L.

To determine if any PCB contamination of soils and ground water was present in the Wide Beach development, ECDEP initiated a field sampling program in September 1981. Samples of residential drinking water, roadway soils, drainage ditch soils, yard soils, and residential dust were collected and determinations for PCBs conducted. Results indicated high levels of PCBs in the Wide Beach soils; ground-water analysis showed very low levels of PCBs in a few wells.

To further define the degree and extent of PCB contamination, EPA Region II's Field Investigation Team conducted another field sampling program in 1983 (NUS 1983a, 1984).

On 15 February 1984, EPA signed a Cooperative Agreement with the State of New York to perform a Remedial Investigation/Feasibility Study (RI/FS) at Wide Beach. In April 1984, NYSDEC contracted with EA to undertake the RI/FS. On 6 March 1985, EA submitted the draft RI report to NYSDEC and the results were presented to the public in the Town of Brant on 8 April 1985. The significant findings are summarized below.

1.2.2 Remedial Investigation Results

Conclusions related to the extent of contamination:

- Polychlorinated biphenyls (PCBs), specifically Aroclor 1254, are the primary contaminants at the site. In general, some degree of contamination exists over the entire site.

- Site contamination resulted from the application of PCB-contaminated oils to the community roadways during 1968-1978.

- In ground water, observation wells screened in the sanitary sewer trenches onsite were most contaminated. Contamination associated with drinking water was sporadic, and in general, at less than microgram-per-liter levels.

- Surficial soils in the roadways, drainage ditches, driveways, and front yards or lots bordering the roadways are highly contaminated with Aroclor 1254. The greatest frequency of high levels of PCB (>50 mg/kg) occurs in the area of the Oval.

- Stormwater runoff from the site contained PCBs in both sorbed and free phases.

- Phthalate esters (12 incidences) and 1,2,4-trichlorobenzene (7 incidences) were also found in soil at the site.

- Soil selenium and ground-water nickel levels were elevated compared to United States averages.

- The wetland sediments south of the site are highly contaminated with PCBs (>50 mg/kg) in the immediate area of two storm sewer outfalls. Very low PCB levels were observed throughout the main stream channels.

- PCB concentrations in three surficial soil samples taken from an offsite recreational area on the south shore of the wetland were very low (<0.03 mg/kg).

Conclusions related to contaminant migration:

- Surficial water transport is the most important route of onsite and offsite migration. Stormwater runoff directed south and west may result in PCB loadings to Lake Erie at the kilogram-per-year level.

- Surface water transport may also be resulting in PCB transport offsite to the north at the level of tenths of kilograms-per-year.

- The soils will act as a long-term source of PCBs to the ground water.

- The sewer trench bedding material appears to be acting as a conduit for potential transport of PCBs to the bedrock aquifer.

- Current ground-water discharge to Lake Erie results in negligible PCB loadings. Potential loadings may be at the tenth of a kilogram-per-year level.

- The potential exists for offsite ground-water transport of PCBs at the level of 1-10 ug/L.

- Both mathematical modeling and ambient air measurements indicate that air transport of PCBs is occurring. Particulate and vapor phase transport are both important and result in ambient concentrations at the nanogram-per-cubic-meter to microgram-per-cubic meter levels.

- Driving of vehicles on dusty roadways may result in increased PCB emissions in the form of soil-bound PCBs.

- Detailed chromatographic analysis indicates that ground-water samples are enriched with lower molecular weight PCB cogeners; vacuum cleaner dust was enriched with higher molecular weight cogeners.

Conclusions related to human health and environmental impact:

- Routes of human exposure to PCBs at Wide Beach include ingestion of contaminated vegetables, ingestion of soil (Pica), inhalation, and dermal absorption.

- The preponderance of evidence in the scientific literature indicates that Aroclor 1254 is carcinogenic in laboratory animals. The strength of evidence indicates that it should be classified as a possible human carcinogen.

- A human health risk assessment indicates excess cancer risks for Wide Beach residents would be at a higher rate than for the general rural population as a result of the current potential for exposure to PCBs at the site.

- Environmental effects may be anticipated from exposure of biota to soil and water containing PCBs at Wide Beach. These effects include phytotoxicity, reproductive and developmental toxicity in birds, and numerous adverse effects in mammals. Additionally, there is evidence of food-chain transport.

Based on the evidence collected and interpreted in the RI, it may be concluded that danger to human health, welfare, and the environment exists from exposure to PCBs at Wide Beach. Areas to be evaluated for remediation in the feasibility study include the roadways and ditches, front yards and driveways, other surficial areas proximate to the roads and ditches, the sewer trench and associated ground-water transport to Lotus Point, the storm drain system and outfall areas, interior space of housing units, and the potable ground-water supply.

After the winter of 1984-1985, which followed the Remedial Investigation/Field Investigation phase, the Town of Brant regraded the Wide Beach roads at the request of the Wide Beach Association. The excess material was placed at the southern edge of the community's access road (Fox Road) just west of the intersection of South Street and Fox Road. This material has been leveled and remains.

1.2.3 Post-RI Construction Activities

During the development of the Feasibility Study, EA was notified of EPA's intent to initiate construction activities, constituting an IRA at the site by the Office of Emergency Response (Cobiella 1985). The intent of the IRA was to reduce human exposure to PCBs primarily by using paving as a dust suppression technique. EPA's announcement occurred during late April, at which time EA's Feasibility Study was suspended, because the site conditions were thought to be altered substantially from those described in EA's Remedial Investigation Report.

From April to July, EA expressed concerns regarding the addition of gravel and blacktop material, which would increase the quantity of contaminated material, and also regarding the implementation of paving activities without additional attempts to improve drainage (Ricotta 1985;

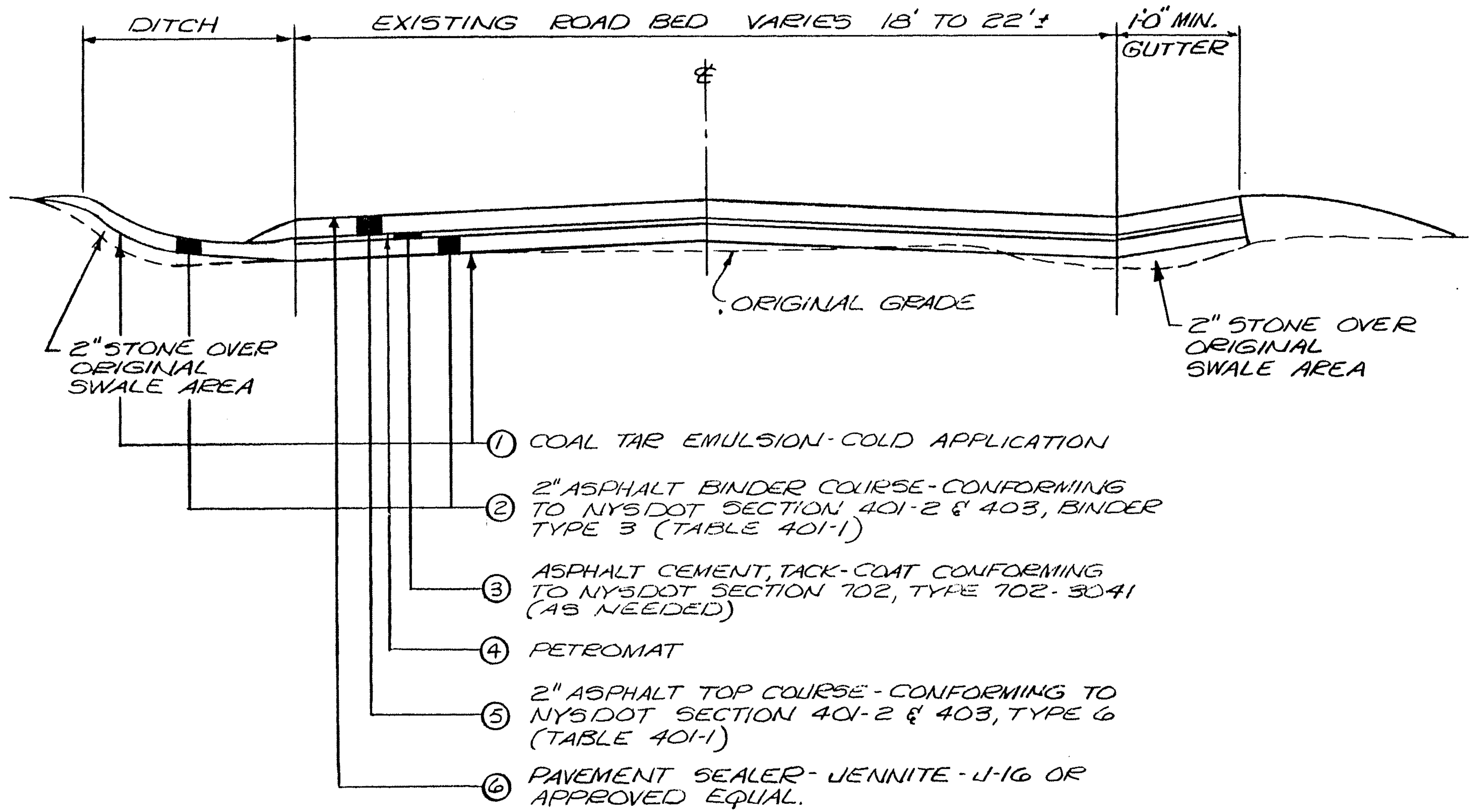
Santoro 1985). After the discussion phase, the Wide Beach IRA project proceeded with the intended purpose of temporarily protecting residents from direct exposure to PCB-contaminated dust and road soils.

Area roads and driveways, etc., were treated during June and July, with a design specifying pavement widths varying between 18 and 22 ft (Figures 1-1 and 1-2). The paved portion of the road extended to the surface swale and/or gutter and entailed regrading with existing material to develop a crown. The crown material was obtained by cutting between 2 and 4 in. of material from the road edges and was supplemented with gravel additions in an effort to fill in potholes and other irregularities. A 2-in. thickness of crushed stone was applied to the road swales and drainage areas. The driveways were regraded with a minor application of beach sand bankover to eliminate potholes. Oil emulsion (cold) was applied to reduce the ultimate contact between the workers installing the pavement and the contaminated PCB material.

During the grading of the roads, there were several attempts made by an EPA representative to get access to homeowners' properties in order to unclog the storm drainage lines. Access to the central outfall was denied. The westernmost outfall was cleaned out with an electric snake; however, it subsequently clogged.

During the grading and paving operations, EA was present at the site to observe the construction progress and, to the extent possible, to ensure the protection of the existing sewer trench wells and other features of the original RI. The application of gravel was done using graders and a vibratory smooth-steel drum roller. All work was performed under Level C protection in accordance with the Health and Safety Plan of OH Materials (the contractor). The onsite activities were directed by the EPA Emergency and Remedial Response Division (ERRD) and were performed along with the EPA subcontractor, OH Materials.

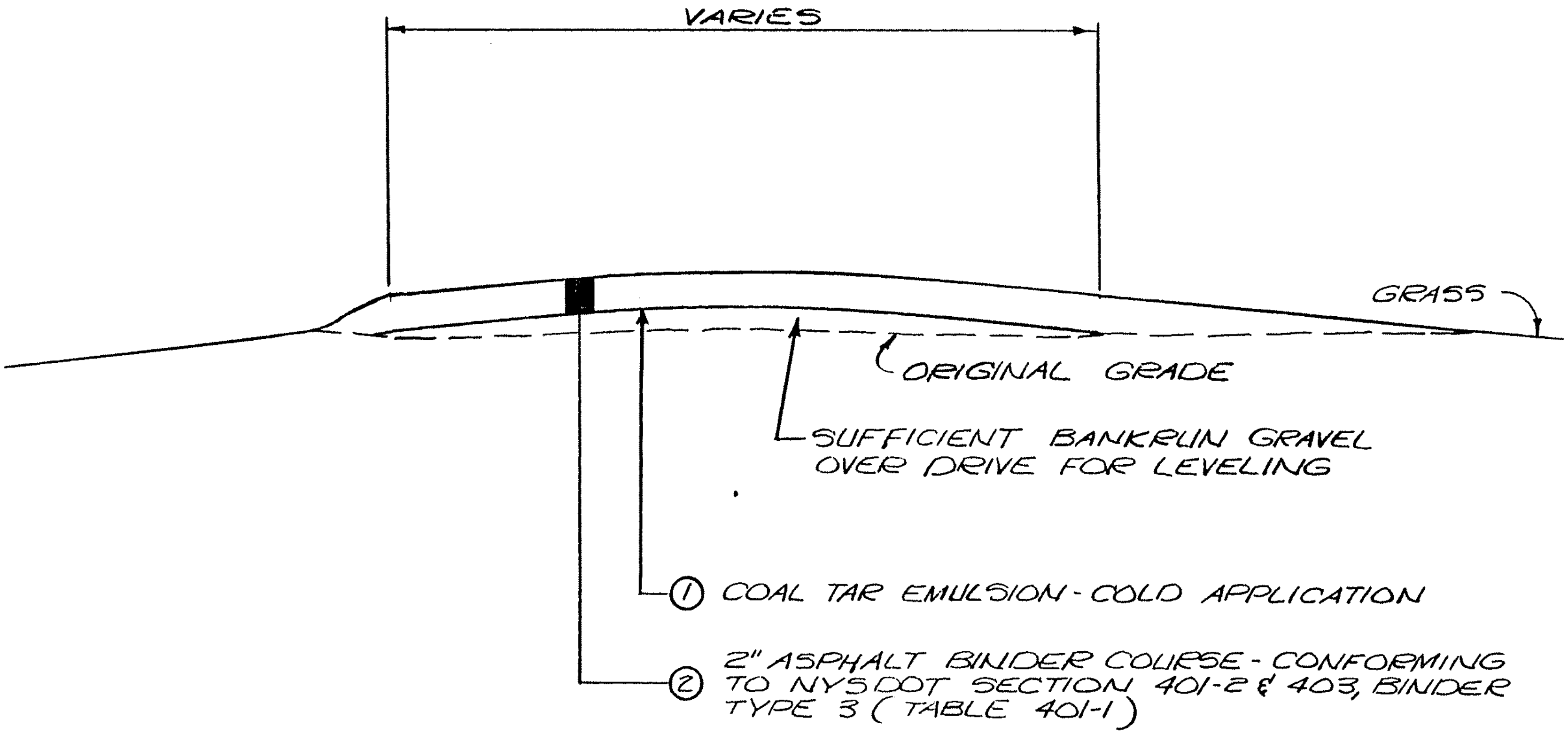
In addition to the road and driveway paving, EPA performed the following activities as part of the IRA: dry vacuuming of homes, cleaning all rugs and carpets, replacing all air conditioning filters, and installing dual-cartridge paticulate filters on all well water supply systems.



TYPICAL ROADWAY & DITCH SECTION

NO SCALE

FIGURE 1-1



TYPICAL DRIVEWAY SECTION

NO SCALE

FIGURE 1-2

2. REMEDIATION OBJECTIVES

A summary of relevant standards, criteria, and guidelines applicable to PCBs is provided in Table 2-1. The overall goal of a remediation program at Wide Beach is to reduce the existing threat to public health, welfare, and the environment posed by PCB-contaminated soil. Routes of exposure considered included soil, air, and water. Program objectives are formulated on the basis of cancer risk reduction and in accordance with established regulatory guidance. A primary assumption in this process is that a 10^{-6} risk from exposure to PCB-contaminated soil is acceptable for public health protection (as are the NYSDEC guidelines for drinking water and air).

NYSDEC suggested a soil removal criterion of $\geq$10 mg/kg. The soil-water partition coefficient for Aroclor 1254 was determined in the Remedial Investigation to be 548 (EA 1985). At equilibrium, a soil concentration of 10 mg/kg could yield an aqueous concentration of 10/548 or 18 ug/L. Thus, if the soil volume is diluted 18 times by the ground-water volume, the concentration in ground water should never exceed the New York State Department of Health (NYSDOH) drinking water advisory level of 1 ug/L. The soil-air partition coefficient was determined in the RI to be 6.7 x 10^4. Thus, at 10 mg/kg, the equilibrium air concentration would be 10/6.7 x 10^4 or 1.5 x 10^{-4} mg/kg. Using the ideal gas law, this translates to a maximum ambient air concentration of 0.18 ug/m^3 which is an order of magnitude lower than the New York State AAL of 1.67 ug/m^3.

EPA has concluded (50 FR 5865) that CERCLA cleanups should comply with other environmental standards, except in specific cases. The response objectives proposed in this Feasibility Study have been developed after consulting the appropriate sections of the Clean Water Act, Occupational Health and Safety Act, Resource Conservation and Recovery Act, and Toxic Substance Control Act.

Compliance with the Clean Water Act is ensured by meeting the ambient water quality criteria for PCBs. For a lifetime cancer risk at 10^{-6}, the appropriate criterion is 7.9 x 10^{-5} ug/L. For aquatic life, the criterion is 0.014 ug/L. The small volume of water in the wetlands indicated that dilution will probably not be a major factor in limiting contamination. Inasmuch as both these values are below the Method Detection Limits (0.065 ug/L for Method 608), nondetection is specified as the objective for surface water. Because of dependence on rainfall occurrence, surface runoff is difficult to study. It is felt that this conservative approach will compensate for data insufficiencies.

Compliance with the Occupational Health and Safety Act is ensured by meeting the OSHA standards during construction. Currently this is 1.0 mg/m^3 for Aroclor 1254 as a time-weighted average. The permissible exposure limit (15 mg/m^3 for total nuisance dust) must also be met during construction.

Compliance with the Resource Conservation and Recovery Act (RCRA) will not be ensured if the remediation level for ground water is the New York State recommended drinking water level of 1.0 ug/L (due to 40 CFR 264.94

requirements for concentration limits). RCRA specifies that, in ground water, the concentration of a hazardous constituent must not exceed the background level for that constituent, unless an alternate concentration limit (ACL) has been established. These limits are set by the Regional Administrator. The NYS drinking water level is recommended as the ACL in this case.

The Toxic Substance Control Act (TSCA) requirements for PCBs will be complied with if soil with ≥50 mg/kg PCB is disposed in a chemically secure landfill and ≥500 mg/kg if disposed at a permitted incinerator. In addition, 40 CFR 761.40 specifies methods of PCB incineration; 40 CFR 761.41 discusses requirements for landfilling PCB. During removal operations, any PCBs stored onsite must comply with 40 CFR 761.42 requirements.

The goals of remediation and monitoring will be to reduce concentrations as follows

Soil	<10 mg/kg
Air	<1.67 ug/m^3
Ground water	<1.00 ug/L
Surface water	<detection limit

In keeping with EPA philosophy, remediation scenarios will also be proposed that exceed the objectives (e.g., sitewide soil cleanup). These will enter into the cost-effectiveness evaluation process.
In developing and evaluating remedial alternatives for the Wide Beach site, the remedial/treatment options were examined within the context of cleanup activities in areas having PCB concentrations ≥500 mg/kg, ≥50 mg/kg, ≥10 mg/kg, and sitewide cleanup. Of these concentrations, the latter two meet and/or exceed the goals of remediation. The first alternative applies only to soils which exclusively must be incinerated. The second alternative does not meet the goals but is provided primarly for cost comparisons. The justification for selecting these specific areas on the basis of PCB concentrations is

≥500 mg/kg--TSCA distinguishes between PCBs at levels higher than 500 mg/kg for disposal purposes. This level was taken as a cleanup criterion, although it is realized that public health may not be protected at this level.

≥50 mg/kg--Under 40 CFR 761 Subpart A, TSCA distinguishes between materials containing PCB concentrations of 50 ppm or greater and those with less than 50 ppm. Human health, environmental protection, costs, and technological impact were used as criteria to arrive at this level. According to Subpart B, materials containing PCBs at ≥50 ppm must be disposed of in a chemically secure landfill. The decision criteria from TSCA are the basis for selecting 50 mg/kg at Wide Beach.

≥10 mg/kg--NYSDEC currently has no established standard for PCB removal. In recent discussions from the Central Remedial Section of NYSDEC (Ricotta, personal communication), it was stated that removal to 10 mg/kg is consistent with the concept of requisite technology. Requisite technology is defined as engineering, science, and construction principles and practices which (1) are technically feasible, and (2) most effectively identify and remediate any present or potential future threat to the environment posed by the disposal of hazardous waste at the site. It was also noted that EPA considered 10 mg/kg as "reasonable" for the Wide Beach site. If both worst-case and average/realistic risk scenarios are considered, removal of soil to <10 mg/kg will lower the overall risk by a factor of 1,000. This factor will reduce all calculated average/realistic risks to $<10^{-6}$. Based on this analysis, it is concluded that the 10 mg/kg level is realistic and will result in removal of the threat posed by PCBs at Wide Beach. However, since there is not a wide margin of safety with this level, it is recommended that this removal level be adopted in conjunction with a postclosure monitoring plan.

Sitewide Removal--Aroclor 1254 has been shown to have a high affinity for soil particles, consequently the transport of PCBs via wind-blown dust particles and surface runoff is a common migration pathway. Contamination, therefore, exists sitewide at varying levels. Further, the nature of soil sampling is such that all contamination zones cannot be detected. As such, sitewide removal affords the greatest assurance of minimizing contamination exposure to the residents of Wide Beach.

Sources of Uncertainty in Defining Zones of Contamination

Definition of contamination zones is based on the application of best professional judgment to results from the RI. The heterogeneity of the site, in conjunction with the limited number of samples obtained, can result in considerable uncertainty concerning the precise identification of areas having contamination at levels ≥ 10 mg/kg. Two types of error can result from this uncertainty. The first error results from identifying an area as contaminated (concentrations ≥ 10 mg/kg) when it contains contamination below the 10 mg/kg level. The consequence of this error is increased cleanup costs, without commensurate increased benefits. The second type of error can occur by improperly identifying an area as uncontaminated. The consequence of this action is increased health risks.

The probability of these errors is related to the number of samples collected in an area, the variability in PCB measurements, and the proximity of the sample mean to 10 mg/kg. For individual areas, the probability may be calculated by testing the hypothesis that the mean value of the samples is greater than 10 mg/kg. Performance of an appropriate statistical test (e.g., student's t; $n \leq 30$) allows for rejection of this hypothesis at a chosen level of confidence. In essence, if the hypothesis is rejected, we must accept an alternate hypothesis that the mean value is actually less than 10. If this occurred, there would be no remediation.

An error could result, however, if we do not remediate and the true level is ≥10 mg/kg. The probability of this occurring would be related to the chosen level of confidence. Use of a procedure based on these concepts would ensure that the definition process was conservative with respect to human health, but may overestimate the costs involved in remediation. By applying this procedure at the time of the RI, the probability of concluding that an area was <10 mg/kg, when it was actually ≥10 mg/kg, was 5 percent.

Since completion of the RI, activities at the site have contributed to increasing this probability. These are mainly related to increased dispersion of PCBs due to transport of construction dust and solubilization of PCBs by oil applied to the roads as a result of the IRA, in addition to the town's regrading activities. It is reasonable to assume that the probability of error has doubled to 10 percent. Because of this error, the necessity for monitoring during and after construction becomes critical. The greater the extent of the monitoring program, the greater the reduction in both error and human health risk.

Qualitative Cleanup Goals

In addition to the quantitative cleanup objectives discussed above, a qualitative goal has been used in developing remedial alternatives. This involves the EPA SUPERFUND Waste Policy (Environment Reporter 1985) which encourages treatment of hazardous waste. This policy states that incineration, chemical treatment, recycling, or reuse of hazardous waste removed from SUPERFUND sites should be considered in remediation actions. It continues by noting that these alternatives should not be screened out on the basis of cost alone, but that the higher long-term costs of land disposal or onsite containment should be balanced against the higher short-term costs of other alternatives.

TABLE 2-1 SUMMARY OF REGULATORY RECOMMENDED OR SUGGESTED LIMITS FOR PCBs

Location of Substance and Type of Recommendation or Standard	Limit
Air	
EPA Ambient Standard	None found
EPA Carcinogen Unit Risk	1.2×10^{-3}
Occupational Federal Standards	
. for PCB 1242	0.5 mg/m^3
. for PCB 1254	1.0 mg/m^3
NIOSH-Recommended Standards	
10-hour TWA	
. for PCB 1242	1.0 ug/m^3
. for PCB 1254	1.0 ug/m^3
IDLH	
. for PCB 1242	10.0 mg/m^3
. for PCB 1254	5.0 mg/m^3
ACGIH	
STEL	
. for PCB 1242	2 mg/m^3
. for PCB 1254	1 mg/m^3
NY State AAL	1.67 ug/m^3
Food Chain	
FDA Action Levels	
. for red meat	3 ppm
. for finished animal feed	10 ppm
FDA Tolerance Levels	
. for milk and dairy products	1.5 ppm
. for fresh eggs	0.3 ppm
. for fish and shellfish	5 ppm
. for poultry	3 ppm
. for infant and junior foods	0.2 ppm
. for food packaging material	10 ppm
Soil/Solids	
EPA Soil Removal Standards	50 ppm
EPA Incineration Guideline	500 ppm

TABLE 2-1 (Cont.)

Location of Substance and Type of Recommendation or Standard	Limit
Drinking Water	
EPA	
. MCL	5 ug/L (unofficial)
. Health Advisory: 1-day	0.125 mg/L
10-day	0.0125 mg/L
. WQC for Human Health	pref 0 ug/L
. WQC for lifetime cancer risk 1/1,000,000	0.00079 ug/L
. Other	
NAS 1-day SNARL	0.35 mg/L
7-day SNARL	0.05 mg/L
NY State Advisory	1.0 ug/L
NY State Ground-Water Standard	0.1 ug/L
Aquatic Life	
WQC for 24 hours	0.014 ug/L
Method Detection Limits	
Method 608 PCB 1242	0.065 ug/L
Method 625 PCB 1254	36 ug/L

3. REMEDIAL ALTERNATIVES

Areas with PCB concentrations in the ranges identified in Section 2 were determined on the basis of soil sample results and are illustrated in Figure 3-1. Based on the data, remediation throughout the entire area of roads, driveways, ditches, and storm drains is recommended. Remediation of the remaining areas (e.g., front yards, back yards, and fill area) is discussed within the context of the removal/treatment of PCB levels $\geq$10, $\geq$50, >500 mg/kg, and sitewide removal scenarios.

Initial consideration of remediation alternatives at the site included technologies for partial or complete remediation. A broad range of technologies was considered to ensure that all possible alternatives had been identified. Table 3-1 identifies the technologies considered and the site areas where the technologies could be applied.

In addition to remedial alternatives, levels of remediation have also been considered in the initial screening. Three levels have been identified--soils with PCB concentrations $\geq$50 mg/kg; soils with PCB concentrations $\geq$10 mg/kg; and all soils within identified areas. Figure 3-2 presents the areas defined as front yards, back yards, roads, etc.

3.1 NO ACTION

A reasonable natural mechanism for the rapid environmental degradation of PCBs at the Wide Beach does not exist. Photolysis and biodegradation occur at very slow rates and may yield harmful reaction by-products. Therefore, if no treatment or removal actions are taken at the site, natural degradation processes are likely to occur. However, the rate and results are relatively unknown, but are expected to be slow.

Remediation activities undertaken in the IRA have affected available final remediation alternatives for the site. Initially, the No Action Alternative described the site as it existed at the completion of the RI. The No Action Alternative has since been revised because roads, driveways, and ditches have now been paved.

The No Action Alternative considered in this section requires several activities to meet the 20-year period stipulated under CERCLA regulations:

- Monitoring of soil, water, and air-to-record exposure levels
- Maintenance of roads, driveways, and ditches installed during the IRA
- Replacement of roads, driveways, and ditches as needed. The existing roads are expected to last only a few years.

The following descriptions include roads, etc., which must be maintained and replaced under the No Action Alternative. The remaining activities (housecleaning and filters for individual wells) completed under the

IRA are not considered for continued maintenance or replacement under No Action.

3.1.1 Roads

The roadways at Wide Beach contain the largest mass load of PCBs onsite. Along with the associated private driveways and road drainage system, these highly contaminated soils are a long-term source of PCBs to surface water, air, and ground water. Because the roadway system was constructed of fine sand and gravel, a significant route of exposure of Wide Beach residents to PCBs existed by way of contaminated dust inhalation and direct contact.

In May 1985, EPA initiated an IRA at the site (Cobiella 1985). This included the asphaltic paving of all roadways, paths, driveways, and parking spaces. The existing gravel roadbed was regraded and presently serves as the base course for a 4-in. layer of asphalt. The asphalt was installed as two 2-in. lifts with a geotextile liner between lifts. The specific construction details are covered in Section 1.2 which describes the current site conditions. Because this action preceded the issuance of the Engineering Feasibility Study, paving over existing roadway surfaces is defined as a No Action remedial alternative.

By design, the road surface installed under the IRA is installed to provide a temporary barrier to reduce population exposure to the highly contaminated dust and surficial materials in the roadway system. The road cover installed under the IRA does not reduce the mass load of PCBs onsite. It does not encapsulate the contaminated soils nor provide an impermeable barrier with respect to ground-water transport. Further, although surface-water contamination attributable to erosion of the original road surface will be temporarily retarded, the newly installed pavement will not provide long-term protection breakup and subsequent erosion. Breakup of the road surface will result, over the long term, in the same risk of PCB exposure to Wide Beach residents as existed prior to the IRA, under the No Action Alternative.

3.1.2 Driveways

Driveways were also included in the IRA. Minor regrading and gravel filling was undertaken on paths, driveways, and parking spaces. The areas were then covered with a 2-in. layer of asphalt. The specific construction details of the new driveways, paths, and parking spaces are discussed in Section 1.2. As discussed in Section 3.1.1, the driveways contain a significant mass load of PCBs which will continue to threaten ground water and, in time, continue to be a source of exposure at the surface under the No Action Alternative.

3.1.3 Ditches/Storm Drains

The roadside ditches and drainage swales were also paved with a 4-in. asphalt surface during the June-July 1985 onsite construction. Pavement was placed directly on a 2-in. lift of crushed stone over the existing soil surface with no excavation, soil addition, or regrading. As discussed in Section 3.1.1, the storm drainage system contains a significant mass load of PCBs which will continue to threaten ground water and, in time, continue to be a source of exposure at the surface under the No Action Alternative. In addition, because the drainage system was not improved by the IRA, continued backflooding of the system will, in the short term, likely spread contaminated suspended solids back into yards and out onto the paved road surface in certain areas.

3.1.4 Storm Drain Outlets

The existing storm drain systems discharge at the southern border of the Wide Beach Development via two drain pipes. Soils in the immediate vicinity of the outfalls (Figure 3-2)) are highly contaminated with PCBs (>50 mg/kg). Under No Action, these soils will serve as a long-term reservoir of PCBs, potentially resulting in releases to surface water offsite and continued exposure to wetland biota.

3.1.5 Sanitary Sewer

Under No Action, the sanitary sewer trench bedding material may be a conduit for transport of PCBs to the bedrock aquifer onsite and offsite into Lotus Point water supply wells. The perched water in the sanitary sewer trenches has been shown to be contaminated with PCBs.

3.1.6 Front and Back Yards

Under No Action, the front yards at Wide Beach are a significant source of PCBs. The surficial soils in the front yards will act as a long-term source of PCBs to the ground water and surface water, and will continue to pose a threat to residents via direct contact and inhalation pathways. Back yards are thought to be the least affected areas of the site (<10 mg/kg in surficial soil) based on available data. Under No Action, these areas would not pose an unreasonable risk to human health and the environment. However, in the design stages of final remediation, additional yard sampling is recommended to confirm that surficial soils in these areas are indeed <10 mg/kg PCBs.

3.1.7 Fill Areas

Certain open lots and yards were improved during the 1980 construction of the sanitary sewer. Fill for these areas (Figure 3-2) was obtained from the road and shoulder excavations. Those fill areas found to contain PCBs at >10 mg/kg pose the same threat to the environment as front yards under the No Action Alternative.

3.1.8 Wetlands

Aside from the storm sewer outfalls discussed in Section 3.1.4, the remainder of the wetland/stream area south of the site appears to be relatively uncontaminated (<10 mg/kg). Under No Action, it is judged that the same degree of protection will be afforded the wetland as will No Action on other areas currently <10 mg/kg PCBs.

3.1.9 Contaminated Dwellings

As evidenced from sampling and analysis of vacuum cleaner contents, the homes, and presumably all associated structures, at Wide Beach are contaminated with PCB-laden dust and soils.

Under the IRA, the homes were cleaned by dry vacuuming. This should have improved current conditions. However, over the long term, homes will be recontaminated until the final remedial action is complete. Therefore, under No Action, the soils and dust that enter and accumulate in residential areas will pose a threat to human health at Wide Beach.

3.1.10 Water Supply

Based on a risk assessment, the RI results, and the previous available data, it was concluded that there is no significant threat from PCBs in drinking water at Wide Beach at the present time. Under No Action residents would be adequately protected only if the source of PCBs is adequately reduced or removed to ensure that contamination of the aquifer does not increase in time. Under the IRA, fine particulate cartridges were installed by EPA on the premise that the filters would reduce the level of particulates in drinking water in each home. Assuming that these filters are effective in reducing particle-sorbed PCBs in the water supply, particularly where poor well grouting is a problem, some additional protection may be afforded. However, the effectiveness of these filters cannot be evaluated and therefore they are not considered part of the No Action Alternative.

3.2 REMOVAL, LANDFILL, AND REPLACE

Removal of PCB-contaminated soils at the Wide Beach site requires that the soils and pavement material be transported to an approved landfill licensed to accept soils contaminated with PCBs and that all excavated areas be replaced/rebuilt to minimize infiltration and maintain adequate runoff patterns. Dust generation during excavation is a concern in this alternative.

3.2.1 Roads

Approximately 1.1 mi of roads are present at the Wide Beach site. Based on an average width of 19 ft, approximately 110,000 ft^2 of roadway is affected.

Oiling occurred entirely on road surfaces, and thus these surfaces are highly contaminated. Due to the directed application of PCBs, and the subsequent paving of the contaminated surface, a 22-in. removal criterion was established to account for significant PCB infiltration. Figure 1-1 presented a typical cross-section of the roads as they presently exist. Figure 3-3 presents the proposed excavation requirements for the roadways and ditches. During the remedial alternative phase of the project, roadways were included in each remediation scheme.

3.2.1.1 Excavation and Pavement Replacement

The existing asphalt surface (Section 1.2) will be broken up with a rotor-grinder, backhoe-mounted jackhammer, or similar equipment necessary to break the pavement into a size suitable for excavation.

Excavation will be conducted using a crawler dozer and a rubber-tired loader with large volume (2-1/4 - 4 yd^3) bucket. Excavation will be to a maximum depth of 18 in. from the base of the existing asphalt roadway surface. Continuous soil sampling and onsite analysis will take place to determine the final depth of excavation (Section 3.10.1). Contaminated material will be removed from the site using a 20-yd^3 trailer dump truck. If possible, asphalt from the site will be salvaged for reuse. All trucks will be properly covered and decontaminated prior to leaving the site. To minimize truck decontamination procedures, the contractor will have the trucks properly lined with polyethylene before loading the dump body. All trucks will meet applicable local, state, federal, DOT-specific, and all disposal regulations.

Following excavation, sufficent gravel and/or compacted fill will be spread and compacted as subbase for the finished roadway. All layers will be compacted to not less than 95 percent of the maximum dry density of the material as determined by a standard proctor test. Compaction will continue until the surface conforms with proposed lines and grades.

A tack coat and structural fiber material will be placed on the base course to improve the structural integrity of the final roadway. A Class I Bituminous Concrete Base Course with a thickness of 2 in. will be placed on the gravel subbase. This base will be composed of mineral aggregate, mineral filler, and bituminous material. The material will be spread and finished using mechanical, self-powered pavers. A final layer of Class I Bituminous Concrete Pavement will be placed on the base course to a thickness of 2 in. The concrete pavement will be composed of mineral aggregate, mineral filler, and bituminous material. Samples of all construction materials will be tested and rigid quality control procedures will be followed to ensure that mixtures remain uniform throughout the project.

3.2.1.2 Quantities and Unit Costs

The roadway area requiring remediation and unit costs of remediation are summarized in Table 3-2. Actual costs--including engineering, contingencies, and present worth factors--are found in Section 4.1.

3.2.2 Driveways

Each home in the Wide Beach community has at least one driveway. Several of the houses have more than one driveway, and many driveways are quite long. Contamination was identified on several driveways with possible transport mechanisms to the driveway surface (prior to the IRA paving) including soils on automobile tires, runoff, and airborne transport. Driveway surfaces are presently paved as a result of the IRA work conducted onsite during June and July 1985. The extensive contamination of driveways, and the potential for both vertical and horizontal migration, necessitate that all driveway areas be included in the remediation analyses.

3.2.2.1 Excavation and Pavement Replacement

Excavation and pavement replacement for driveways is similar to that found in Section 3.2.1.1 under Roads Excavation depth as shown in Figure 3-4. Differences in the driveway replacement are a 3-in. gravel course and a 2-in. bituminous concrete surface designed for the minimal dynamic load anticipated on driveway surfaces.

3.2.2.2 Quantities and Unit Costs

The driveway area requiring remediation is estimated to be 46,000 ft^2 (5,100 yd^2). A removal criterion of 14 in. was established, based on excavation of 12 in. of subgrade soil and 2 in. of pavement (Figure 3-4). The volume of material to be removed is, therefore 53,700 ft^3 (1,980 yd^3). The unit costs of this activity are the same as those provided in Table 3-2, with the exception of the bituminous concrete which will cost \$3.75/yd^2 for the proposed 2-in. pavement.

3.2.3 Ditches/Storm Drains

The current drainage system at the Wide Beach Development consists of ditches, typically on each side of the roadway, and storm drains. Generally, stormwater enters the storm drains through catch basins. This system receives the majority of roadway surface runoff.

The materials used in the construction of the drain system are unknown and the drainage pipes are broken and cracked in several locations. Stormwater in the ditches is either transported via catch basin and storm drains to the wetland area south of the site or, prior to paving, infiltrated into the soils beneath the ditches.

The current drainage system, due to minimal site relief and damaged storm drain lines, is ineffective. The general site area, as reported in the RI, is considered to be poorly drained. During the wet season, pockets of water stand for long periods.

Due to the proximity of the ditches to the oiled roadways and the prevailing drainage patterns, the soils in the ditches and sediment within the storm drains represent the most severely contaminated soils onsite. Four locations in ditches contained soils with PCB concentrations in excess of 500 mg/kg and several soils at a depth greater than 12 in. showed evidence of PCB contamination. Sediment within storm drains typically contained PCB concentrations in excess of 50 mg/kg. Consequently, it was assumed that soil will be removed in all ditches, and that storm drains will be removed or removed and replaced.

During the IRA completed during the summer of 1985, essentially nothing was done to improve site drainage, although attempts were made to improve site drainage pathways adjacent to the roadways. These attempted improvements included minor ditch regrading and paving. (Figure 1-1 depicts typical roadway and ditch section.) No improvements to catch basins or storm drains are anticipated. Because the paving will limit infiltration and no real drainage improvements were made, it is anticipated that site drainage will continue to be poor.

The paving of ditches and gutters, in addition to roadways, has temporarily reduced human exposure to the PCB-laden materials. However, recently paved drainage pathways may tend to transport contaminated water directly to the marsh and Lake Erie. It is also anticipated that, due to the IRA construction procedures used during the summer of 1985 (placement of gravel in the drainage swales over the existing surface of topsoil and grass, followed by the placement of 2 in. of asphalt), that the pavement will tend to deteriorate very quickly because of the lack of a proper subbase.

3.2.3.1 Ditch Excavation, Removal, and Regrade

Excavation and removal of pavement and soils from the ditches will proceed as described in Section 3.2.1.1, but to an excavation depth of 40 in. Several soil samples at depths greater than 12 in. from the prepaved level showed high PCB concentrations. This is presumably a function of greater infiltration of runoff water from the roadways because standing water in the ditches had more time to infiltrate. Following soil removal, ordinary borrow will be placed and regraded in the ditches.

3.2.3.2 Storm Drain Removal

The alternative to storm drain removal and storm drain replacement includes storm drain system design to enhance site drainage and function as described below.

The objectives of a drainage system will include the following:

- To provide adequate drainage to ensure the maximum runoff from the site, in accordance with good engineering practice

- To minimize the potential runoff of PCB-contaminated waters or sediments from the site following implementation of the remedial action. Surface water flowing through and over soil with PCB concentrations of <10 mg/kg may still have unacceptable PCB concentrations based on ambient water quality criteria. The PCB contamination will be largely in the form of suspended solids, as PCBs are poorly soluble in water, and consequently a properly designed storm drain system can control the majority of the potential surface water contamination

- To provide means to monitor the runoff and sediments from the site during the postconstruction period

The proposed drainage system will be designed with a series of outfalls, storm drainage pipes, and catch basins located either in surface swales or possibly in roadway areas.

In order to control surface-water contamination, the primary drainage areas will be divided into smaller subbasins with a series of catch basins providing and performing two functions. The first function will be to transport the water from the roadway and/or surface swales into the pipe. The second function will be to provide an area for settlement of suspended solids, i.e., sediment. The proposed catch basin (Figure 3-5), will allow suspended solids to settle at various locations along the storm drainage system and reduce PCB levels in the stormwater discharge. The catch basins will be located within subareas, and, therefore, will provide the mechanism (by sediment sampling and analysis) to monitor the overall effectiveness of the remedial action, and isolate problem areas. This alternative will require periodic cleaning as well as sampling and analysis.

3.2.3.3 Quantities and Unit Costs

The ditch/storm drain areas requiring remediation and the unit costs of remediation are summarized in Table 3-3. Costs of storm drain replacement are estimated based on the assumption that 18-in. reinforced concrete pipe is used.

3.2.4 Storm Drain Outlets

Water flowing through the storm drains discharges to the wetland at two points referred to as the "Storm Drain Outlets" (Figure 3-1). This item is included separately, due to the deltaic flow pattern of water exiting at the outlets. This pattern causes a wide area of contamination at the outlet in the wetland. As excavation depth of 36 in. of soil at the outlet is recommended, this will require extensive clearing and grubbing at the wetland fringe. Estimated areas and volumes for the excavation/removal activity and unit costs are provided in Table 3-4.

3.2.5 Sanitary Sewer

The existing sanitary sewer in the Wide Beach site consists of approximately 4,500 lin-ft of gravity line and a 500-ft section of force main. Due to the assumed higher porosity of the fill material around the sewer and the infiltration of runoff, this area represents a possible conduit for leaching contaminated water to the ground water. Consequently, two removal alternatives have been identified. The first is partial excavation of soils above the sewer pipe. The second is the excavation, removal, and replacement of the entire system--including sewer pipe, manholes, pipe encasement, and bedding material.

3.2.5.1 Partial Excavation of Soils

The existing sanitary sewer lies either adjacent to the storm sewer or in the roadways. A removal depth of the disturbed soils to the top of the sewer bedding averages 8 ft in depth. The trench width would vary with depth and will average 5 ft.

3.2.5.2 Total Excavation and Replacement

Construction details of the sanitary sewer are included in the Remedial Investigation Report for the Wide Beach Development site. In the general description of the construction detail, it was reported that the total sanitary sewer trench depth varies from 6 to 14 ft, with a width at the surface of approximately 7 ft, tapering to a normal trench width at the bottom. Based on this detail, an average removal width and depth of 5 and 10 ft, respectively, was estimated.

Following removal and excavation of soils and the existing sanitary sewer, a replacement sewer will be installed in the existing excavated trench. The trench will then be backfilled with borrow, compacted, and regraded.

3.2.5.3 Quantities and Unit Cost

As noted above, unit costs for partial excavation of the sewer line are presented in Section 3.2.3. Volumes and unit costs for total excavation of the line are provided in Table 3-5.

3.2.6 Front and Back Yards

Front yards have received contamination via airborne, human-tracked soils, and runoff. Although these areas are substantially less contaminated than roadways, ditches, and driveways, they are more contaminated than back yards, because of their proximity to the roads. Contamination in front yards, and for that matter sitewide contamination, appears to decrease as distance from the roadways increases. Several alternatives were considered under this category, including (1) excavation, (2) removal and replacement, (3) paving, (4) bentonite or liner placement with and without excavation, and (5) topsoil placement without excavation. The descriptions of and unit costs for these alternatives have been presented in previous sections. Those items involving returning the front yards to their original condition (i.e., removal and replacement with topsoil) will include loam, handled and spread, and seeding of the affected areas. Further clearing and grubbing may be necessary in areas where trees and associated root structures interfere with complete soil removal to the recommended 6-in. depth.

3.2.6.1 Remove and Remove/Replace

Options for excavating soils at the three levels of contamination are discussed under 3.2.6.4.

3.2.6.2 Pave Over Existing Yards

The existing front yards will be left in place. A total of 2 in. of bituminous concrete pavement will be placed over the existing surface. The pavement seal was included in this alternative because contaminated soils are not to be removed prior to paving.

3.2.6.3 Liner Placement with Pavement or Gravel Surface

Several different liner types were investigated as to their cost and compatability with PCBs. Of these, two possible alternative liner types were chosen--TYPAR 3358 and bentonite.

The purpose of a liner as a subbase is to inhibit infiltration of water to the existing front yards. Prevention of infiltration is intended to minimize the migration of PCBs through the soil column to the groundwater surface. PCBs, however, will not be removed from the site under this alternative.

One impermeable liner type considered was a bentonite clay barrier. A 3-in. layer of bentonite would be compacted over the existing front yards. The alternate liner design considered substitutes TYPAR 3358 Spunbonded Polypropylene EVA-Coated Impervious Fabric for the bentonite liner system. TYPAR is designed to provide good chemical resistance to PCBs, as well as acids, bases, and phenolics. The TYPAR has a thickness of 15.5 mil, and a very low permeability. Following application, loam and seed will be placed over the liner. Following placement of either liner type over the existing front yards, the area will be loamed and seeded or a paved surface will be installed. Pavement placement will consist of a 2 in. bituminous concrete pavement. The alternative is a 3-in. layer loam and seed that will be put in place conforming to the former contour of the front yard.

3.2.6.4 Quantities and Unit Costs

Estimated quantities of front and back yard soil requiring cleanup are contingent on the remediation level and are summarized along with unit cost data in Table 3-6. In estimating the yard areas to be excavated, a 25-ft diameter circle was drawn around soil sampling points which exhibited PCB concentrations greater than or equal to the remediation level of interest. Removal depths in these areas were set at 6 in.

3.2.7 Fill Areas

Four open lots were identified during the RI as areas where excavated sewer trench material had been used as fill. Sewer trench material has been identified previously as possibly containing higher concentrations of PCBs due to infiltrating water from the ditches which lie above the location of the existing sanitary sewer.

PCB determinations in these open lots indicated that at least one contaminated soil sample was found in each. The highest level of contamination was found in Fill Area 4, whereas the greatest quantity of contaminated samples was found in Fill Area 2, also known as "The Grove."

Fill areas, although identified separately, have the same remediation alternatives as those described for front and back yards. All removal alternatives call for excavation to 6 in.

3.2.7.1 Quantities and Unit Costs

Estimated quantities of soil requiring cleanup in the fill areas are contingent on the remediation level and are summarized along with unit cost data in Table 3-7. For purposes of generating volume estimates, an excavation depth of 6 in. was assumed.

3.2.8 Wetlands

The wetlands, as with back yards, did not contain large areas of contaminated soils. Areas identified as having contamination are those found at the storm drain outlets. As noted, the storm drain outlets are the discharge points for much of the sitewide roadway runoff. Estimated quantities of wetland soil requiring cleanup are contingent on remediation level and are summarized with unit cost data in Table 3-8. For purposes of estimating removal volumes, an excavation depth of 6 in. has been assumed. Clearing and grubbing will also be necessary under all levels of this remediation alternative.

3.3 REMOVE, ONSITE TREATMENT, AND REPLACE

This alternative includes technologies that could be applied onsite to excavated soil in order to remove the PCBs from the soil. Following application of the technologies, the treated soil would be returned to its original location. In general, the treatment technologies applicable to this procedure are those in which reaction times are sufficiently short to permit complete treatment in a reaction vessel or continued treatment once soils are returned to the original location. The technologies include chemical treatment and biological treatment.

Onsite treatment with carbon adsorption is similar to *in situ* carbon adsorption and is, in fact, an immobilization technique. Therefore, further discussion of the carbon adsorption is presented in Section 3.7, Immobilization.

Onsite biological treatment of PCB-contaminated soil has been investigated. In order for the technology to be feasible, the biological degradation would have to continue after soil replacement. Detention time in a reactor is expected to be on the order of two months. Environmental factors (i.e., moisture, temperature, pH) would have to be carefully controlled until PCB degradation is complete. Two biological treatment systems have been identified for Aroclor 1254 degradation. More information relative to the products available is presented under *in situ* treatment. One of the problems with biological treatment systems is the reaction/degradation products. A possible result of PCB degradation is the formation of polychlorinated dibenzofurans (PCDF) (EA 1985).

Chemical treatment technologies can be applied to PCB degradation and can result in accelerated reactions with less environmental restrictions than biological systems. A chemical degradation process has been demonstrated applicable to PCB compounds. The process requires a 2-step procedure. The first step involves extracting PCBs from the soil by using solvents. These solvents are then treated with a sodium- or potassium-based reagent to remove chlorine atoms from the PCB molecule. The optimum conditions for treatment include low moisture content and relatively high temperatures (above 70 F). Further discussion of the onsite chemical treatment system is presented in Section 4.

Unit costs for onsite treatment are given in Table 3-9.

3.4 REMOVE, INCINERATE, AND REPLACE (Soils ≥500 mg/kg)

Several soil samples were identified as having ≥500 mg/kg PCB Aroclor 1254. Under TSCA (40 CFR 761.4), any substances identified with concentrations ≥500 mg/kg of PCBs must be incinerated. Removal criteria for areas under this category involve the excavation of 36 in. of soil in a 25-ft circular radius around the location of the sample. The four removal zones are shown on attached plans. Under this remediation method, the excavated soil will be transported via licensed hauler to an approved hazardous waste incineration facility which will be responsible for the ultimate disposal of the residual ash.

Four outdoor samples, collected and analyzed under the RI, had concentrations in excess of 500 mg/kg

1. Station 38--Front yard composite sample
2. OW-2--Soils collected from around observation well 2
3. Station 18--Roadside ditch
4. CB 6--Sediment sample from catch basin 6

A 25-ft diameter was designated around each soil sample area, providing a total excavation area of 490 ft^2 (55 yd^2). For an excavation depth of 36 in., this provides a removal volume of 1,470 ft^3 (55 yd^3). Using a soil density of 100 lb/ft^3, 588,000 lb of soil must be removed and incinerated.

Unit costs for excavating of the soil are the same as for those in other remedial alternatives. Estimated unit costs for freight are $4,125/load and $1.30/lb for incineration. Estimates for unit costs of incineration, provided by SCA of Chicago, are detailed as follows. Incineration costs are derived on a per pound basis. A rate of $0.38/lb is charged. Any ash, greater than 5 percent of the original volume, remaining after incineration will be additionally charged at the rate of $0.01/lb/percent ash. It is assumed that ±95 percent ash will remain following incineration. There are no approved PCB incinerators located closer to the site.

3.5 *In situ* BIOLOGICAL TREATMENT

Biological degradation has been used to enhance biochemical decomposition of PCBs in contaminated soils. *In situ* biological treatment is applicable only to those areas where the organisms, nutrients, etc. can be mixed with the soil in place. This technology therefore is not applicable to areas which have been paved or which have contamination at depths greater than tilling depths. There has been only limited application of the technology to Aroclor 1254 and only limited data are available on laboratory studies in providing treatment of Aroclor 1254. The transferability of the technology to field conditions is crucial in considering the applicability of in situ biological treatment, since the viability of the organisms depends on soil conditions such as

- Soil moisture
- Oxygen content
- pH
- Microorganisms at the site
- Nutrient content
- Organic matter (in addition to PCBs)
- Temperature

The above soil conditions can be efficiently controlled under laboratory conditions. However, control of field conditions requires significant engineering design of drainage and irrigation, soil aeration, and nutrient control.

Two biological treatment technologies have been identified for the Wide Beach site: (1) Sybron and (2) Detox Industries. In general, these companies have developed specialized organisms to degrade chemicals which are found in ground water and/or soil at industrial disposal sites. The treatment techniques remain relatively uniform. To date, although laboratory tests have shown promise, no field applications have been made. The evaluation is based on limited data.

Costs for biological treatment include several line items. Unit costs for biological treatment include

- Seed organisms
- Equipment for incorporation of product into soil
- Nutrients to sustain biological activity
- Labor for incorporation of material
- Seeding after treatment

In addition to monitoring to ensure completeness of treatment, the unit costs are generally the same for each product, with the exception of the costs of the organism (product) and retreatment required (dependent upon the treatment efficiency of the product). Unit costs for the above items are presented in Table 3-10.

3.6 *In situ* CHEMICAL TREATMENT

A promising new chemical *in situ* treatment procedure has been developed recently under a research program sponsored by U.S. EPA and the U.S. Air Force. The technology is still in a preliminary stage of development and further information is required. In general, the technology is based on the process of using a sodium- or potassium-based reagent to remove chlorine from the PCB molecules. The specific reagents vary from one installation to another. However, conceptually the treatment process involves incorporating a potassium polyethylene glycol reagent in soil and providing sufficient tilling to ensure maximum contact between the soil and the reagent. Other design factors which have not been fully defined include

- Contact time
- Reaction temperature
- Moisture content of the soil

This technology initially appears to be applicable to the Wide Beach site, in particular, because the depth of concern for remediation in areas such as the front yard and back yards is 6 in. This is a depth which can be practically achieved by commercially available tillers. The soil moisture level allowable for the chemical reaction is, however, very restrictive. Therefore, onsite chemical treatment appears to be the practical application of the technology rather than in situ treatment.

Unit costs for in situ chemical treatment include unit costs previously presented under the sections discussing onsite treatment and in situ biological treatment. The exception is the cost for the reagent which will not be recovered in in situ treatment. The reagent costs are therefore estimated to be $300/ton of soil.

3.7 IMMOBILIZATION

The alternative to immobilize the PCBs includes the addition of activated carbon to soils. Activated carbon is a strong sorbent and has been proven effective for Aroclor 1254. Powdered activated carbon (PAC) is the preferred medium as it can be readily incorporated into the soil and allows uniform distribution.

Carbon degrades more readily than PCBs, and a release of PCBs during carbon degradation is anticipated. Therefore, to maintain the immobilization, re-application is required. The re-application schedule depends on the carbon life expected. Of greater concern for carbon addition to the soil is the additional carbon requirements for all the organic material present in the soil. It is expected that the carbon requirements for soil, such as that in the wetlands, where there is a large amount of humus material, would be substantial. More data on the organic material in the soil and carbon adsorption characteristics of those organics are necessary to define the carbon requirements for the site.

The immobilization alternative is based on the following procedures

1. Preparing the soil surface

2. Spreading powdered activated carbon

3. Incorporating the carbon

4. Restoring the area to residential use

Unit costs for immobilization are the same as in situ treatment costs, with the exception of carbon costs at $1.00/lb.

3.8 ONSITE INCINERATION/HIGH-TEMPERATURE DESTRUCTION

The process considered for onsite destruction of PCBs is a proprietary system designed by J.M. Huber Corporation. The system is under development, although a pilot-scale system has been built. The trial burn at the pilot facility showed successful destruction of PCBs. The pilot system was constructed for approximately $4 million. It has a feed rate of 15 lb/min. The cost of developing, designing, and installing a full scale system to handle the feed rates required for the soils at the Wide Beach site is prohibitive. Onsite incineration for the soils was, therefore, not considered.

3.9 ADDITIONAL REMEDIAL AND SUPPORT ACTIVITIES

3.9.1 Personal Facility Cleaning

As part of the Remedial Investigation dust samples from 46 vacuum cleaners were analyzed and found to contain detectable PCB levels. Thirty percent of the samples were $\geq$10 mg/kg and one was >500 mg/kg. The results of this sampling program demonstrate that PCB dust has been transported into homes and that contamination levels vary, i.e., the contamination is not uniformly spread throughout. This is to be expected, as PCB-contaminated soil or dust could be tracked into particular rooms or adhere to particular objects. Since the PCBs are strongly bound to the soil (or dust), the result is expected to be a varying range of contamination.

Samples from cars and garages were not included in the RI. However, due to the fact that the same transport mechanisms which caused home contamination have affected cars and garages, remedial action alternatives considered for homes will also be considered for these facilities. Consequently, for the purpose of this feasibility study, personal facilities are defined as homes, garages, and cars.

The alternatives to remediate this contamination of the personal facilities are listed below. No known treatment technology exists for PCB dust contamination on walls, carpets, or appliances.

1. No Action
2. Develop a systematic sampling and analytical program from which to develop a cleaning program
3. Clean all facilities

The following sections identify more particularly these alternatives.

3.9.1.1 Limited Facility Cleaning

The intent of this alternative is to complete a sampling and analysis program for each facility and then design an appropriate facility cleaning, i.e., PCB removal. Sampling quantities have been estimated to be 10 per home. The sampling and analysis cost is estimated to be $1,700 per home. If onsite chromatography is used (Section 3.10), these costs could be reduced by an order of magnitude. Following analysis, a focused cleaning plan will be developed.

3.9.1.1.1 Conventional Cleaning

Conventional cleaning for carpets, walls, and objects is identified as vacuuming floors, dusting objects, washing walls, and shampooing carpets. This cleaning does not include dust containment or specialty equipment control or disposal.

3.9.1.1.2 Specialty Cleaning Techniques

Organic Solvents

The alternative of using organic solvents as a cleaning medium was considered and discussed with several chemical and industrial companies. The damage to sheetrock walls, fabric covered furniture, and miscellaneous home objects is judged to be significant.

Freon Solvent

The basic technology to remove PCB contaminants from service equipment is to apply a spray and flushing action of liquid Freon to the surfaces to be decontaminated. The cleaning action takes place within an enclosed glove-box chamber in which the contaminated item is placed, and then sprayed with a recylced and continuously purified solvent. Solvent vapors and PCB-contaminated liquids are contained completely within the chamber, eliminating environmental or operator exposure. Contaminated solvent returns to a reservoir, from which it is pumped through a series of particulate filters and PCB separators, using absorbers or distillation.

The purified solvent is then pressurized up to 2,000 psi and sprayed 4 gpm on the object. A mechanical refrigeration system is used to control solvent vapor pressure within the cleaning chamber, to "dry" the item after cleaning, and also to cool the solvent. The volume of PCB disposal wastes is significantly reduced, being concentrated in filters, adsorbants, or as a still bottom. This technology is used extensively within the nuclear utility industry to remove radioactive scale, dusts, and residues from otherwise serviceable equipment.

This alternative is identified as a remediation alternative for appliances and other objects which will not be affected by the Freon.

Water Detergent

A water detergent-based system can be used for cleaning broad areas of structural surfaces such as floors, walls, and exposed items which are compatible with water. The system applies pressurized water through a special nozzle to which a source of high vacuum is connected. The water jet cleans the surface debris, leaving a clean, damp-dry surface. The contaminated cleaning water is cleaned through treatment, filtration, and polishing, and detained for recycle, release, or other disposal.

For areas as noted above, the water-detergent system is recommended.

Vacuum

A high-life high efficiency particulate air filter (HEPA) vacuum system to remove (dry) surface soot, particulates, or other debris has been developed. This system incorporates special filters which appropriately collect PCB-contaminated dust and confine the contamination which will be disposed of as a hazardous waste. Objects which will not be cleaned with freon-solvent or water detergent-based cleaning systems can be cleaned with this system.

3.9.1.2 Total Facility Cleaning

The total personal facility cleaning alternative is defined as cleaning all homes, automobilies, and garages without additional sampling. Cleaning methods are the same as those identified immediately above in Section 3.9.1.1.2.

3.9.1.3 Unit Costs

Unit costs for cleaning alternatives are presented in Table 3-11.

3.9.2 Water Supply

Drinking water samples were collected from 45 residences and analyzed for PCB Aroclors 1016, 1221, 1232, 1242, 1248, and 1254. Aroclor 1254 was detected in six samples, ranging in concentration from 0.06 to 0.16 ug/L.

Samples were also collected from residences served by the public water supply. No detectable levels of PCBs were found in these samples, but trihalomethanes (THMs) were detected.

Past sampling indicates that 21 of 60 residential wells have been contaminated at some time and to some degree. PCB levels in private water supplies have been low and sporadic, but a potential exists for further leaching from contaminated soils and perched water to the ground-water system. Consequently, a new public supply and faucet-mounted treatment of existing supplies was considered.

In addition to point-of-use treatment, the existing wells should be resealed to prevent migration of contaminated water through broken casings.

3.9.2.1 Public Water Supply

The Angola Water Treatment Plant is located approximately 7 mi north of the Wide Beach site. The nearest tie-in to the community is approximately 2 mi northeast of the site along Old Lakeshore Road. Direct tie-in to this water line, as well as 60 house connections, would be required. A 12,400 lin-ft water line must be installed in order to provide curbside service to Wide Beach. An additional 6,000 lin ft of line must be installed for house connections, based on approximately 100 lin ft/per home @ 60 homes.

3.9.2.2 Faucet-Mounted Units

Recent advances in faucet-mounted filtration systems have included technologies for the removal of organic contaminants including PCBs. Installation of units of this type would afford removal at the source without the installation of a new water supply system. Replacement is based upon duration of use at each faucet and is required to ensure satisfactory removal efficiency of the unit. Failure to replace filter cartridges in a timely manner may result in either reduced treatment efficiency or preferential desorption of contaminants at the tap. Assuming approximately 4 faucets per home @ 60 homes, 240 faucet-mounted treatment units would be required. Average life expectancy for cartridge filters is 1 year. Units receiving minor use may have extended life expectancies, but should not be relied upon.

3.9.2.3 Alternative Water Supply

In addition to the faucet-mounted treatment units and public water supply, an alternative onsite water supply has been considered. Although it may be possible to install a deep well(s) for community water supply, an extensive hydrogeologic investigation would be required to define the feasibility and costs for such well(s). Further study would also be required to assess the possible contamination of the well in the future.

3.9.2.4 Unit Costs

New Water System	
Water line installed	$ 35.00/lin ft
House connections	12.00/lin ft
Faucet-Mounted Units	
New Units	$300.00/each
Replacement Cartridges	50.00/each

3.9.3 Perched Water

3.9.3.1 Treatment

Two alternatives have been considered for treatment or control of the perched water in the sewer. PCB concentrations of the water in the sewer trench have been recorded at levels greater than 1 ug/L, but less than 10 ug/L. The generally accepted method to treat ground water containing PCBs is granular activated carbon. This is the accepted method since ground water, such as water in the Wide Beach sewer trenches, has relatively low organic carbon to support biological treatment and chemical methods available to date have not provided adequate treatment. The remaining physical treatment available is granular activated carbon. Unit costs for activated carbon are presented in Table 3-12.

3.9.3.2 Hydraulic Barrier

To prevent the potential offsite migration in the perched water in the sewer trench, a hydraulic barrier to prevent offsite flow may be constructed. This would require excavation of the sewer trench at the site boundary and replacement of the bedding material and backfill with bentonite backfill. At the time of excavation, a sample of perched water will be obtained and analyzed for PCBs. It is not anticipated that PCBs will be present outside of the sewer trench; however, should PCBs be found in excess of 1.0 ug/L, further assessment and remediation, if necessary, of the offsite perched water will be proposed.

To accomplish installation of the barrier, a 4-ft length of the sewer trench will be excavated to a depth of 10 ft and backfilled with a clay bentonite grout mixture to whithin 1 ft of ground surface. The original topsoil will then be replaced and the site revegetated. A sewer-trench type of well, constructed similarly to those wells installed during the RI, will be placed in the bedding material on each side of the barrier to allow future monitoring to assure the hydraulic connection has been severed.

Cost Estimate

Excavation and Backfilling	$ 1,000
Monitoring and Installation	750
Sampling and Analysis	250
Total	$ 2,000

3.10 SUPPORT ACTIVITIES FOR REMEDIATION

3.10.1 Monitoring Program

Due to the nature of contamination at Wide Beach, monitoring will be required, (1) if No Action is chosen or (2) if remediation is planned. For purposes of this feasibility study, monitoring is divided into three tasks: (1) onsite soil and water testing, (2) construction monitoring, and (3) postclosure monitoring.

3.10.1.1 Onsite Soil and Water Testing

There are four primary functions of onsite testing during construction

1. Decision if remediation is necessary. Only soil with PCB levels ≥10 mg/kg (or ≥50 mg/kg) requires remediation.

2. Decision if treatment is necessary. Soil PCBs ≥500 mg/kg requires incineration. Ground-water PCBs ≥1 ug/L requires GAC adsorption for human consumption.

3. Compliance with RCRA manifesting requirements (40 CFR Part 262) and TSCA PCB regulations (40 CFR Part 761).

4. Assistance with construction monitoring for health and safety protection.

For purposes of evaluating the soil and water testing program, some assumptions were made concerning the number of samples to be tested. It was assumed that each PCB-contaminated soil area was circular, with a 10-ft diameter and that one could be 90 percent confident of locating the PCBs by the testing program. Using the methodology of Zirschry and Gilbert (1984), a square grid network for sampling at every 18 ft was obtained. Based on 385,000 ft^2 contaminated with PCB $\geq$10 mg/kg, approximately 2,400 samples need to be obtained and quantitatively analyzed for PCBs. Three options are available for PCB analysis: (1) field testing by wet chemical kits, (2) field testing by onsite chromatography, and (3) transport to the laboratory for EPA Method 608 analysis.

Two field test methods are currently available--the Manleh Engineering colorimetric method and the McGraw-Edison potentiometric method.

Manleh offers soil screening (>50 and >500 mg/kg) kits. These systems are based on stripping Cl ions from the PCB and then quantifying the Cl concentration by a colorimetric reaction. They are calibrated for Aroclor 1242, but some conversion factors can be used to change the measurements to Aroclor 1254. No information was provided by the manufacturer relative to the efficiency of Cl ion stripping or on the method used to extract the PCBs from the soil.

Due to lack of testing in the ranges required at Wide Beach ($\leq$10 mg/kg) and apparent lack of accuracy and precision, this method is not considered further.

McGraw-Edison has a digital chloride ion electrode quantification test which has been on the market for some time. In this set up, PCBs are extracted from the soil with hexane, the Cl is stripped by a two-step procedure, using solutions of biphenyl-diethylene glycol-diethyl ether and nickel nitrate. The Cl ion concentration is measured in millivolts and converted to a PCB concentration. The system is calibrated for Aroclors 1242 and 1260, but conversion to Aroclor 1254 is possible. Problems with the system are stripping efficiency and interferences from soil components. Manleh estimated that the worst-case recovery efficiency is 0.4. Chlorinated organics and chlorinated organic salts will cause inflated PCB levels, but inorganic salts and soil moisture will not interfere with the PCB measurement. McGraw-Edison claims an accuracy of $\pm$20 percent of 30 ppm or greater and a $\pm$3 percent precision. Data provided by the manufacturer showed errors much larger than 20 percent. Many samples were from 25 to 45 percent lower than GC measured concentrations.

The capital cost per unit is approximately $4,100 including the necessary conversion to an oil/soil kit from the oil kit which is standard. No costs were given for chemicals. However, they have been estimated at $15 per sample.

Only one manufacturer--S-Cubed--offers a field-adapted electron capture GC for PCB quantification. The system has a memory for four Aroclor patterns to allow identification and quantification. The dynamic range can be selected for 10-1,000 ppm or 0.5-100 ppm. A strip chart recorder can be added if permanent records of the samples are needed. The system comes with a methanol soil extraction solution and a hexane/sulfuric acid solution for sample cleanup. S-Cubed will provide equipment for testing at no charge.

Costs of the system are: $17,000 for the GC, $750 for an installation kit, $1,000 for a strip chart recorder, $50 for an injection syringe, $15 for a standard, and a sample kit including a battery-operated balance for $1,250. Chemicals are $7.20 per sample.

The alternative to onsite testing is transportation, extraction, and analysis by a contract laboratory. It is envisioned that analysis would be by EPA's Method 608 for PCBs by either a standard or a Contract Laboratory Program (CLP) type QA/QC protocol. Extraction is time consuming, and it is doubtful if a turnaround of less than 2 days would be possible.

3.10.1.2 Air Monitoring During Construction

The purpose of monitoring during construction is primarily to protect workers and the neighboring population from exposure to dustborne PCBs emitted by heavy equipment or hand tools disturbing the soil. For workers, construction monitoring will determine the level of personal protection required. For the population, it will determine the need for evacuation. Inasmuch as the PCBs are primarily associated with the soil particulate material, it is proposed that total suspended particulate (TSP) be used as a surrogate for sorbed PCB. The product of TSP and soil PCB content will yield the airborne PCB level. If the airborne concentration exceeds the New York State AAL of 1.67 ug/m^3, the population should be evacuated.

A minimum of two high-volume (hivol) samplers, placed in the residential area closest to construction, and in the construction zone itself, should be used to monitor TSP. Costs for TSP, including the hivols themselves, in addition to analysis and expendables, are approximately $50 per sample. Monitoring should be conducted at the onset of each new activity or when moving to a new area. At a minimum, once-weekly monitoring is recommended.

It is anticipated that EPA Level C protection will be required for workers at the site. Other levels of protection will be determined by the contractors's health and safety officer, in accordance with OSHA standards.

3.10.1.3 Postconstruction Monitoring

Monitoring will be required for a period following remediation to ensure that remedial efforts were successful at meeting the required objectives, and that future significant exposure to PCBs does not occur. This task would involve periodic measurements of ground water, surface water being discharged from the site, and vacuum cleaner dust.

Annual efforts and costs include:

1. Two vacuum cleaner dust samples at random @ $170 each

2. Ten drinking water samples at random @ $120 each

3. Ten catch basin sediment samples (every 3 years

4. Labor @ $25/hr x 8 hr

Ten drinking water samples will be collected from homes annually. The sampling will be conducted on a random basis but assuring that all homes have been sampled over a 5-year period. Two vacuum cleaner dust samples will also be collected annually at random. The 10 catch basins to be installed as part of the drainage system will have their sediment analyzed each time they are emptied (assumed every 3 years). Additionally, following construction, it is recommended that a runoff collection and analysis effort be conducted following construction to assess the adequacy of remediation. This would consist of a rainfall-activated autosampler which could take samples during a rain event. These samples would then be compared to those obtained during the RI.

For cost purposes, it is estimated that monitoring will be required for 20 years following construction. If water samples are below the detection limit for PCBs for a period of 5 years and PCBs are not detected in an entire round of catch-basin sediments, then monitoring may be terminated.

Annual costs would include:

1.	Two vacuum cleaner samples @ $170 =	$ 340
2.	Ten drinking water samples @ $120 =	1,200
3.	Three and one-third sediment samples @ $170 =	566
4.	Labor @ $25/hr x 8 hr =	200
	Total postconstruction monitoring annual costs =	$2,306

Assuming an annual inflation rate of 5 percent, the total costs would be $127,000. Costs for the initial runoff monitoring would be approximately $3,000.

3.10.2 Additional Sampling

As indicated in the Remedial Investigation Study, two areas which require further study are the back yards and the septic tanks onsite.

3.10.2.1 Back Yard Sampling

The available data do not suggest major problems with contamination of back yards. However, because of the sporadic occurrence of "hot spots" and the potential for PCB redistribution, surface water, and atmospheric transport, back yards should be sampled to determine which areas may require remediation. Activities associated with the IRA may also have contributed to contamination of back yards. Representative sampling of surficial soils in the back yard areas and analysis for PCBs is recommended.

3.10.2.2 Septic Tank Sampling

Septic tanks have reportedly been closed at Wide Beach since residents were required to connect to the sanitary sewer system, which was installed in 1980. The materials remaining in these tanks and overflow systems may pose a threat to the aquifer if sufficient quantities of PCBs are left in place indefinitely. Septic tanks would have received PCB-contaminated soils washed from a number of sources, e.g., clothing and floors. Representative subsampling of the septic tanks (up to 20 tanks) is recommended. Tank sediment will be analyzed for PCBs.

It may also be advisable to sample dilute sewage at the lift station onsite to get an estimate of the relative significance of PCB loadings, if measurable, being washed through the new sanitary sewer system under current conditions. Two 24-hour composite samples are recommended, with analysis for total PCBs.

TABLE 3-1 REMEDIATION ALTERNATIVES FOR WIDE BEACH DEVELOPMENT SITE

Site Areas \ Alternatives		No Action	Excavation: Remove/ Landfill/Replace	Excavation: Remove/ Incinerate/Replace	Excavation: Remove/Onsite Treatment/Replace	In Situ: Biological Treatment	In Situ: Chemical Treatment	In Situ: Immobilization	Additional Activities: House Cleaning	Additional Activities: Water Supply	Support Activity	Support Activity: Monitoring	Support Activity
Road Areas	Roads	□	□	□	◪	■	■	■	■	■		□	
	Drives	□	□	□	◪	■	■	■	■	■		□	
Soils	Front Yards	□	□	□	□	□	□	□	■	■		□	
	Backyards	□	□	□	□	□	□	□	■	■		□	
	Fill Areas	□	□	□	□	□	□	□	■	■		□	
	Wetland	□	□	□	□	□	□	□	■	■		□	
Sewers/ Ditches	Ditches	□	□	□	◪	■	■	■	■	■		□	
	Storm Sewers	□	□	□	◪	□	□	□	■	■		□	
	Storm Sewer Outlets	□	□	□	□	□	□	□	■	■		□	
	Sanitary Sewers	□	□	□	◪	□	□	□	■	■		□	
Homes/Outbuildings		□	■	■	■	■	■	■	□	■		□	
Water	Ground Water	□	■	■	□	□	□	□	■	□		□	
	Perched Water	□	■	■	□	□	□	□	■	■		□	

□ Indicates applicable alternative.

◪ Indicates alternative is applicable to only some parts of the site areas.

TABLE 3-2 AREAS, VOLUMES, AND UNIT COSTS FOR THE REMOVAL, LANDFILLING AND REPLACEMENT OF EXISTING ROADWAYS

Area	Volume
110,000 ft^2	198,200 ft^3
(12,200 yd^2)	(7,300 yd^3)

Unit Costs

Disposal	\$185.00/yd^3
Freight rate	18.75/yd^3
Earth excavation	4.10/yd^3
Gravel for base course	7.00/yd^3
Class 1 Bit. Conc. base course	2.63/yd^2 (@ 2 in.)
Class 1 Bit. Conc. pavement	2.60/yd^2 (@ 2 in.)
Grade and compact subgrade	0.60/yd^2
Fiber material, tack coat, primer	4.00/yd^2
Engineers/office	860.00/mo
Sanitary building	325.00/mo
Rapid cure pavement seal	1.10/gal

Note: Quantities for driveways in text.

TABLE 3-3 AREAS, VOLUMES, AND UNIT COSTS FOR THE REMOVAL, LANDFILLING, AND REPLACEMENT OF EXISTING DITCHES/STORM DRAINS

Areas and Volumes

Area[a]	Ditches	81,000 ft^2
	Storm Drain No. 1[b]	3,800 ft^2
	Storm Drain No. 2[b]	6,200 ft^2
	Total	91,000 ft^2 (10,000 yd^2)

Volume[a] 300,000 ft^3 (11,000 yd^3)

Unit Costs

Most unit costs associated with these alternatives have been previously presented. Those not covered are presented below:

Regrade	\$ 0.60/yd^2
Ordinary borrow	\$ 5.25/yd3
Storm drain replacement	\$ 19.50/lin ft (installed)
Structure removal	\$ 95.00/each
Manholes	\$570.00/each

(a) Assumes 1.1 mi of roadway; ditches on either side of roadway; 7-ft wide ditch, 40-in. removal depth.
(b) Storm Drain No. 1 and No. 2 are itemized as they are not included within the typical ditch area along the road.

TABLE 3-4 AREAS, VOLUMES, AND UNIT COSTS FOR SOIL EXCAVATION AND REMOVAL AT STORM DRAIN OUTLETS

<u>Areas and Volumes</u>	
Area[(a)]	10,500 ft^2 1,170 yd^2
Volume[(a)]	31,500 ft^3 1,170 yd^3
<u>Unit Costs</u>[(b)]	
Clearing and grubbing	$2,775/acre

(a) The storm drain outlets are located entirely in the wetlands area. Therefore, the quantities presented here will also appear as a portion of the quantities under Section 3.2.9.

(b) Most unit costs associated with these alternatives have been previously presented. The item not covered is presented above.

TABLE 3-5 VOLUMES AND UNIT COSTS FOR SANITARY SEWER EXCAVATION

Quantity

Assume	4500 lin-ft gravity line
	500 lin-ft force main
	5 ft wide trench
	10 ft deep trench
Volume	250,000 ft^3
	9,200 yd^3

Unit Costs[(a)]

Sanitary sewer (8 in. PVC pipes)	\$15.00/lin ft (installed)

(a) Most unit costs for this alternative have been presented in previous sections.

TABLE 3-6 AREAS, VOLUMES, AND UNIT COSTS FOR EXCAVATION, REMOVAL, AND REPLACEMENT OF FRONT AND BACK YARDS

Quantities

	Remediation Level		
	$\geq$50 mg/kg	$\geq$10 mg/kg	Sitewide
Area	67,000 ft^2 7,500 yd^2	112,500 ft^2 12,500 yd^2	883,500 ft^2 98,000 yd^2
Volume	33,500 ft^3 1,240 yd^3	56,250 ft^3 2,100 yd^3	442,000 ft^3 16,000 yd^3

Back Yards and Oval Area

	Remediation Level		
	$\geq$50 mg/kg	$\geq$10 mg/kg	Sitewide
Area	500 ft^2 55 yd^2	5,000 ft^2 555 yd^2	740,000 ft^2 82,000 yd^2
Volume	250 ft^3 9 yd^3	2,500 ft^3 93 yd^3	370,000 ft^3 14,000 yd^3

Unit Costs

Most costs associated with this remediation alternative are presented previously. Those items not covered are presented below.

Topsoil (loam borrow)	\$ 10.50/yd^3
Loam handled and spread	4.10/yd^3
Seed	0.16/yd^2
Seeding	0.55/yd^2
Foundation planting	750.00/front yard
Tree planting (3 trees)	1,200.00/front yard
TYPAR 3358 liner and Geotextile fabric	2.50/yd^2
Bentonite liner (@ 6 in.)	50.00/yd^3

TABLE 3-7 AREAS, VOLUMES, AND UNIT COSTS FOR EXCAVATION, REMOVAL, AND REPLACEMENT OF FILL AREAS

Quantity

Open Lot 1	12,000 ft^2	
Open Lot 2	54,000 ft^2	
Open Lot 3	9,000 ft^2	
Open Lot 4	4,500 ft^2	
Total Area	79,500 ft^2	(8,800 yd^2)
Volume	39,750 ft^3	(1,500 yd^3)

	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Area	1,500 ft^2 170 yd^2	35,000 ft^2 3,900 yd^2	79,500 ft^2 8,800 yd^2
Volume	750 ft^3 28 yd^3	17,500 ft^3 650 yd^3	39,750 ft^3 1,500 yd^3

Unit Costs

All unit costs for this item are presented in other unit cost sections of the remedial alternatives.

TABLE 3-8 AREAS, VOLUMES, AND UNIT COSTS FOR EXCAVATION, REMOVAL, AND REPLACEMENT OF WETLAND SEDIMENTS

Areas and Volumes

	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Area	4,000 ft^2 450 yd^2	10,500 ft^2 1,200 yd^2	440,000 ft^2 49,000 yd^2
Volume	2,000 ft^3 75 yd^3	5,250 ft^3 200 yd^3	220,000 ft^3 8,150 yd^3

Unit Costs

All unit costs for this item are presented in other unit cost sections of the remedial alternatives.

TABLE 3-9 UNIT COSTS FOR ONSITE TREATMENT

Onsite Unit Construction	Unit Cost
Capital Costs	
Reaction unit construction	--(a)
Pumping, piping	--(a)
Operation and Maintenance Costs	
Earth excavation	\$ 4.10/yd3
Material relacement	2.00/yd3
Regrade	0.60/yd2
Chemicals	100-150/yd3 of soil
Biological substrate	5-130/yd3 of soil
Activated carbon	1.00/lb - carbon
Labor/treatment system operation	25.00/hr
Utilities/treatment system	0.005 kWh

(a) Depends on unit size.

TABLE 3-10 UNIT COSTS FOR IN SITU BIOLOGICAL TREATMENT

Product Costs (organisms)	
Detox Industries	$60-130/yd^3
Sybron	20/lb @ 1 lb/50-100 ft^3
Equipment and Operator Tiller and Tractor	50/hr
Product application	0.45/yd^2
Seeding (material and labor)	0.55-0.70/yd^2
Monitoring	130/sample

TABLE 3-11 UNIT COSTS FOR CLEANING

	Sampling	Conventional Cleaning	Freon Solvent	Water Detergent	Vacuum
Homes, $/ea.		1,500	1,200	600	600
Garages, $/ea.	170	250	150	300	300
Automobiles, $/ea.		200	--	225	225

TABLE 3-12 GRANULAR ACTIVATED CARBON UNIT COSTS FOR PERCHED WATER TREATMENT

Factory-assembled package, granular-activated carbon unit	\$50,000 - \$100,000
Piping, pumps, controls	\$5,000
Carbon	\$1.00/lb
Utilities	\$0.05/kWh
Labor/treatment system operation	\$25/hr

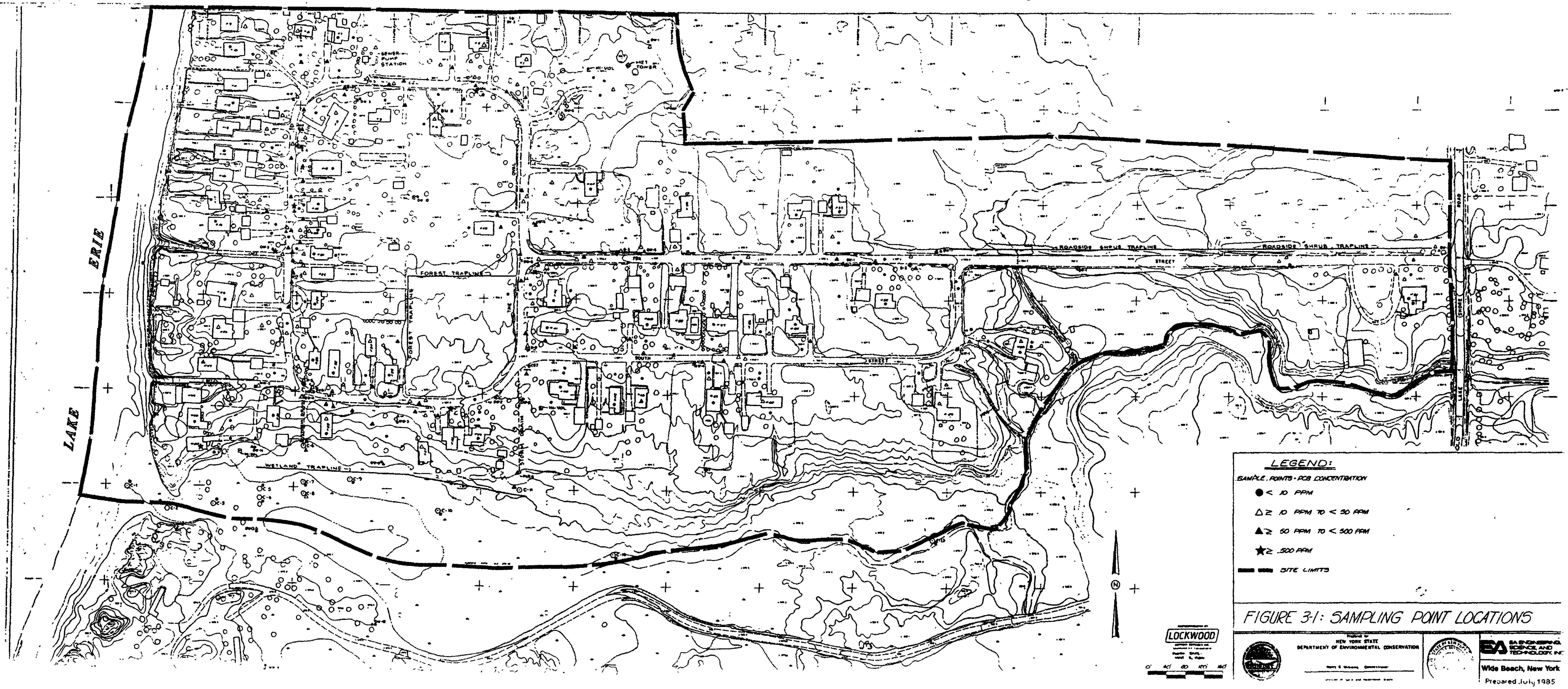


FIGURE 3-1: SAMPLING POINT LOCATIONS

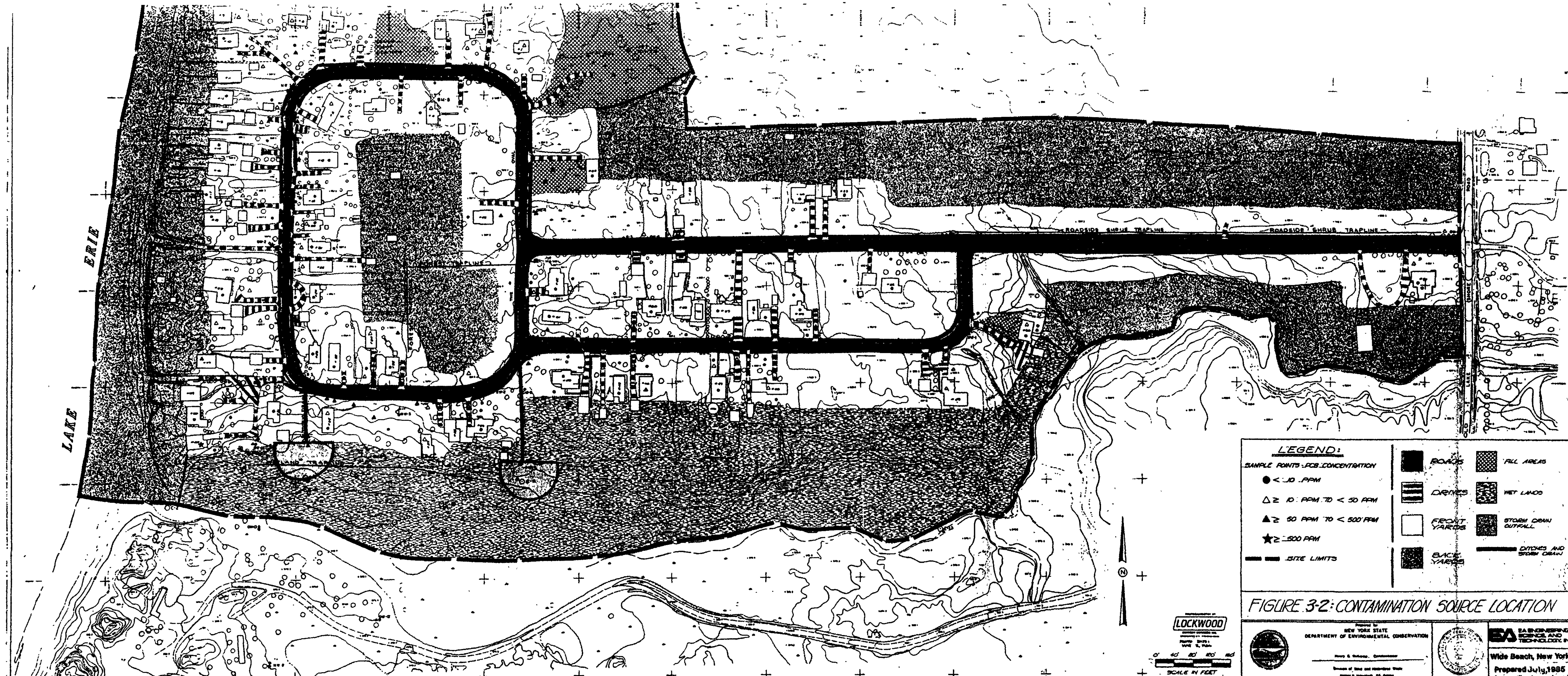
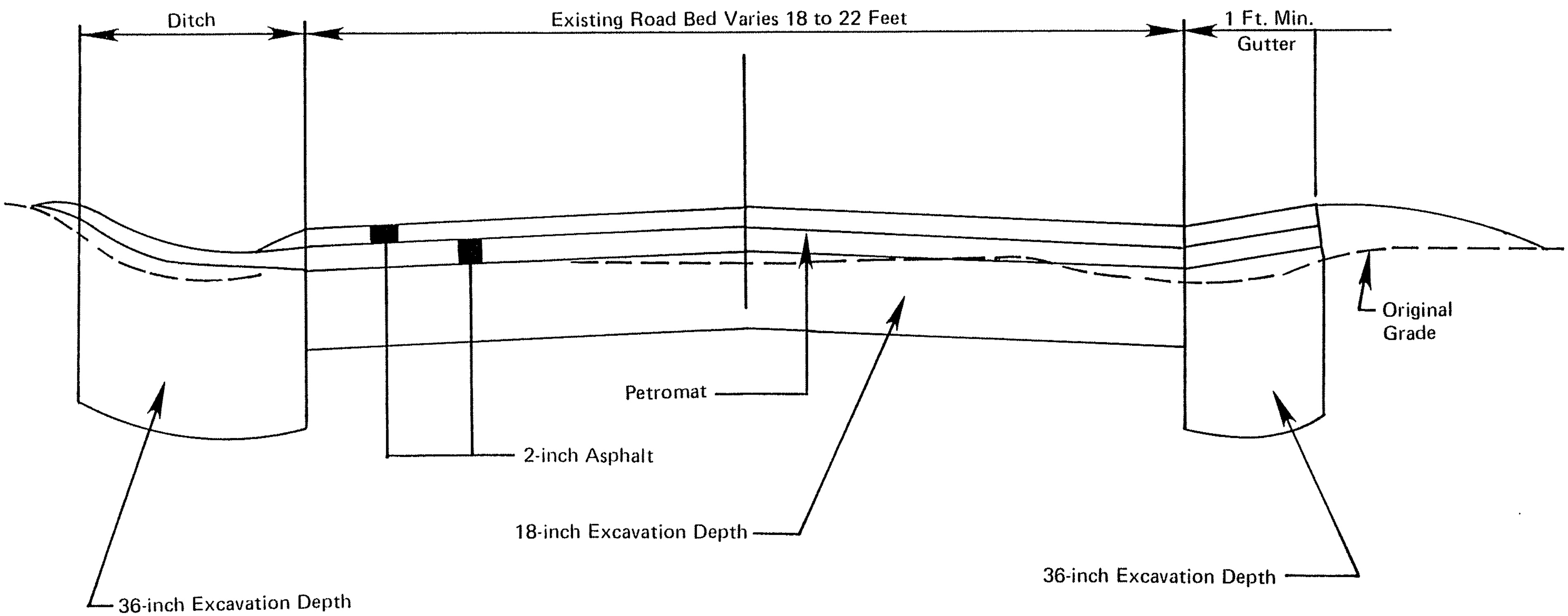
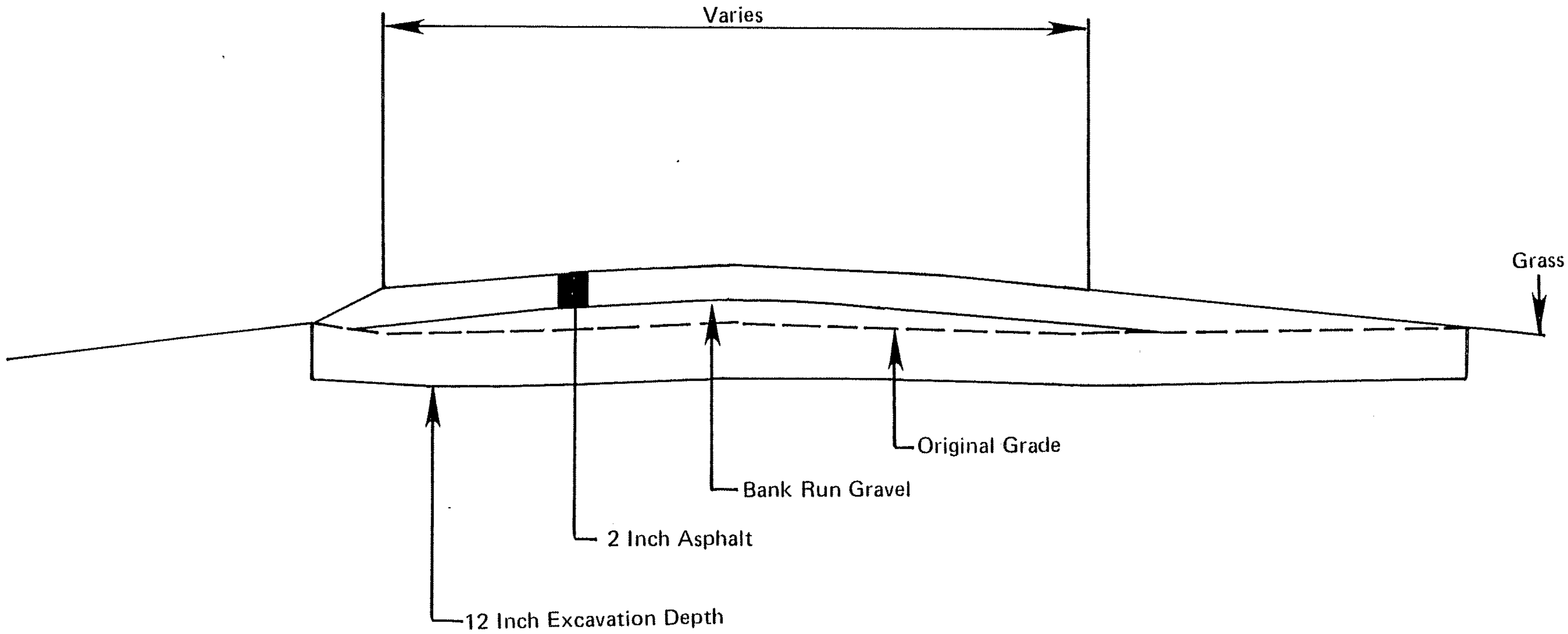


FIGURE 3-2: CONTAMINATION SOURCE LOCATION



Note: Not to scale.

Figure 3-3. Excavation depth for roadways and ditches.



Note: Not to scale.

Figure 3-4. Excavation depth for driveways.

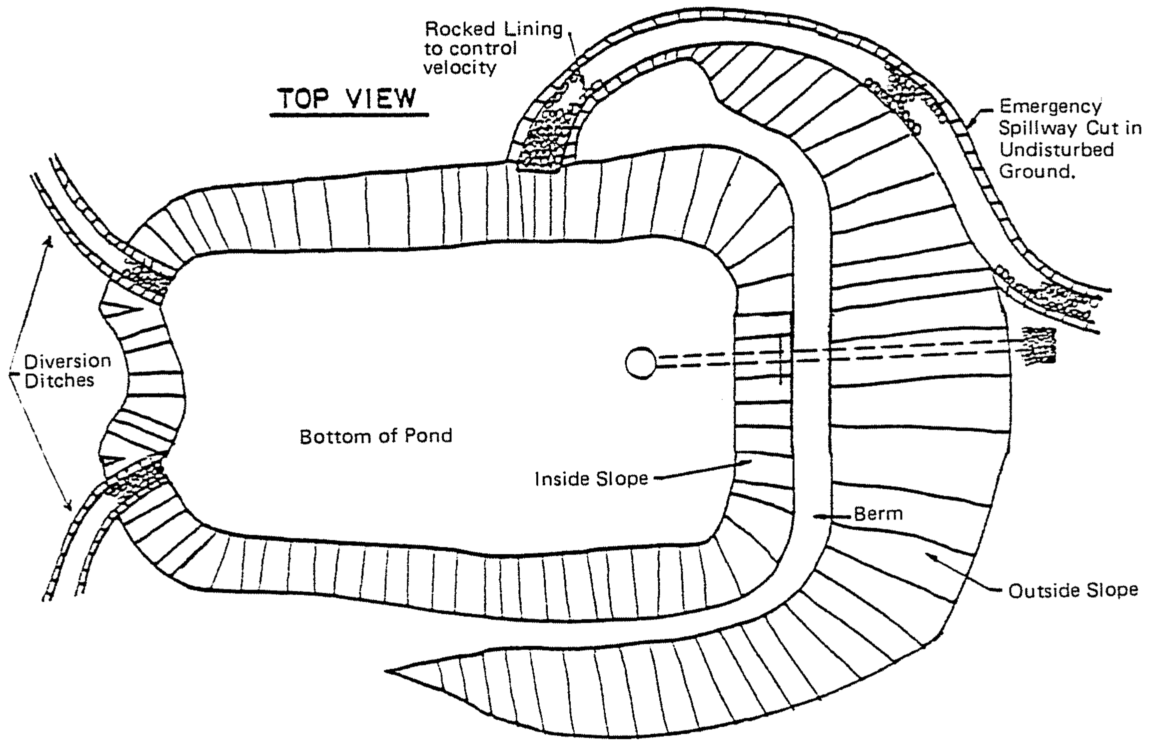


Figure 3-5. Proposed catchment basin.

4. INITIAL SCREENING OF ALTERNATIVES

The NCP 300.68(h) directs that the alternatives, which have been developed in Section 3, be screened using criteria related to cost, effects of the alternative, and acceptable engineering practices. With regard to cost, an alternative which far exceeds the cost of other alternatives without a commensurate increase in public health or environmental benefit will be screened out. Engineering practices criteria eliminate alternatives which are difficult to implement, which do not achieve the remedial objectives in a reasonable time, or which rely on unproven technology. Screening criteria for effects are divided into environmental protection criteria and environmental effects criteria. Alternatives will be eliminated if they do not contribute to protection of public health, welfare, or the environment. Alternatives which themselves may result in adverse environmental or public health effects will also be eliminated.

In the following sections, each of the alternatives developed above will be screened by applying these criteria. The alternatives which remain after this process will then be subjected to a detailed evaluation in Section 5.

4.1 NO ACTION

The No Action Alternative consists of the site as it exists following the implementation of the IRA as discussed in Sections 1, 2, and 3.1. No Action does not preclude implementation of monitoring.

4.1.1 Engineering Feasibility

The engineering feasibility of the No Action Alternative is relatively straightforward. The engineering requirements for No Action are related to repair, maintenance, and replacement of the roads, drives, and ditches constructed under the IRA. Engineering of road repairs, etc. is feasible. Other actions undertaken in the IRA are not considered to impact the No Action Alternative. In particular, maintaining faucet-mounted filters and routine housecleaning are not considered under the No Action Alternative.

4.1.2 Environmental Effects

As conducted at Wide Beach, the IRA probably resulted in further adverse environmental impacts. These impacts are due to enhanced dispersion of PCBs by procedures used in the IRA. Two construction operations probably caused PCB dispersion--oiling and dust generation. During the IRA, the roads appear to have been oiled prior to application of pea gravel.

Although the oil was intended as a dust suppressant, the extremely high affinity of PCBs for road oil leads to the conclusion that oiling solubilized the existing surficial PCBs. Recent (June/July) rainfall was noted as having mobilized the oil which has probably resulted in PCB mobilization. The net effect is a wider distribution of PCBs.

The other operation which probably resulted in PCB dispersion was dust generation by heavy equipment on dirt roads. The roads underwent limited grading and rolling prior to application of oil. Grading at 5 mph may result in emission of 2.2 lb dust per vehicle mile traveled. The EA onsite monitor also noted dust being raised after application of oil and gravel (probably due to oil being washed off). Dust was also noted on roadside vegetation. Since the dust is contaminated with PCBs, it must be assumed that the IRA resulted in greater airborne PCB dispersion.

4.1.3 Environmental Protection

The No Action Alternative does not provide adequate environmental protection. Specifically, although paving will reduce airborne dust emission and direct contact, it will not afford ground-water protection from future contamination. Ground water serves as a drinking water supply at the site and is also a route for PCB migration offsite. There are several reasons for concern for potential contamination if No Action is the chosen alternative. First, the pavement recently installed at the site is not impermeable. It will act only to retard rather than stop percolation and the rate of PCB migration. Second, the possibility of fissures, cracks, and lenses under the road could allow for direct connections between ground water and PCBs. Third, sewer, gas, and other pipelines could also allow transport of contamination to drinking water supplies or offsite.

On those portions of the site which have not been paved, No Action will result in greater airborne PCB emissions. Although PCBs will be biodegraded (EA Remedial Investigation Report, Section 6.3), the process is too slow to be considered a treatment technique. Additionally, biological processes may result in the formation of metabolites which are also toxic.

4.1.4 Costs

The costs of No Action are primarily associated with repair and replacement of the roads, driveways, and ditches. Other relatively minor costs under No Action are limited to monitoring. Since replacement of the roads, driveways, etc., is expected to be required every 2-4 years, the replacement costs will be 5-10 times the IRA costs to maintain the temporary remediation during the regulated 20-year period. In addition to the repair/replacement costs, the monitoring costs are expected to be significant to assure current information on the resident's long-term exposure. Based on the above estimate, the No Action costs are expected to be $2-5 million.

4.2 REMOVE, LANDFILL, AND REPLACE

Under this alternative, the removal and secure landfilling of soil from nine general areas onsite have been considered. The areas included are

- Roads
- Driveways
- Ditches/storm drains
- Storm drain outlets

- Sanitary sewer
- Front yards
- Back yards
- Fill areas
- Wetlands

Following removal, various replacement alternatives have been postulated.

4.2.1 Engineering Feasibility

The removal and disposal of contaminated soil is currently one of the most often used and technically feasible alternatives for remediation at a hazardous waste site. This technique provides source elimination with a permanent remedy to prevent or mitigate the migration of a release of PCBs to the surrounding environment. When employed in conjunction with an engineering replacement alternative (e.g., pavement, liner), it represents an effective source control option. The following discussion will provide a generic description of the engineering feasibility of the removal and disposal of contaminated soils, and the alternatives available for replacement at the Wide Beach site.

4.2.1.1 Removal

As a result of the recent paving of the roads, driveways, and ditches at the site, an excavation of 2-4 in. of asphalt will be required. Rotogrinders, jackhammers, scrapers, or similar equipment can be used to remove the pavement. The asphalt will be reduced to a size convenient for efficient loading and as required by the ultimate disposal area. The bulk of the contaminated material at the site is soil. Track-type dozers and front end loaders are commonly employed to accurately remove a given depth of soil from road and yard surfaces. The minor grade changes at the Wide Beach site will increase the efficiency of the operation.

Trees and shrubs will be removed only when absolutely necessary to reduce contamination. Removal in certain areas will require clearing and grubbing. Small diameter trees and brush can be run through a mechanical wood chipper and taken offsite for resale. Large diameter trees can be removed by a logger and taken offsite for resale as either lumber or cord wood. Some type of mechanized feller-buncher will be used for tree harvesting to prevent skidding problems. Large stumps, which are expected to retain a large percentage of soil on their root structures, should be excavated with the dozer and disposed of with the contaminated soil. The removal of various lengths and sizes of drainage pipe is also anticipated. These pipes are to be considered contaminated and can be excavated and removed with the dozer and loader.

Ditches and storm drains will be considered together to discuss the option of their removal without storm drain replacement. Due to the lack of topographic relief, site drainage will be adversely affected with the replacement of ditches only. Also, if the final remedial action leaves in place PCB concentrations of up to 10 mg/kg, this option will not control surface-water contamination and its migration. If alternatives are chosen so that all PCBs are removed from the site, the surface water runoff would, of course, be environmentally safe.

4.2.1.2 Landfill

Two secure landfills, licensed to dispose of PCB-contaminated material, are located within approximately 50 mi of the Wide Beach site. These are SCA Chemical Services in Model City, New York, and CECOS in Niagara Falls, New York.

The landfills are constructed of low permeability clay and synthetic liners with controlled chemical segregation PCB wastes in a dedicated PCB cell. The landfills maintain elaborate leachate management systems with drainage pipes and pumps enabling the collection, reprocessing, and disposal of any liquids found in the landfill.

The disposal firms will provide 20-yd^3 dump trucks and an onsite coordinator through the life of the project to ensure that all wastes are properly handled and transported.

4.2.1.3 Replacement

Following soil removal, roads are scheduled to be replaced with a new gravel bed, asphalt primer coat protective membrane, asphalt binder course, tack coat, and asphalt top course. The asphaltic surface will have a finished thickness of 4 in. Driveways and paths will also be paved with 2 in. of bituminous concrete. Asphaltic replacement does not involve any unusual design requirement and is, therefore, a feasible alternative.

Alternatives for areas other than driveways and roads include soil replacement, pavement, and liner replacement. All alternatives were considered with and without excavation. Although each alternative constitutes a viable engineering alternative, all provide logistical problems with the exception of excavation followed by landscaping and/or loam and seed. Pavement and liner alternatives without excavation will substantially raise the grade at the homes and around trees and shrubs. The effect of this alternative may be to destroy vegetation, change drainage patterns, and be a nuisance to homeowners. Excavation with liner or pavement is feasible, but unnecessary, as source removal has occurred and the migration potential has been mitigated. Thus, the most logical alternative for nonvehicular areas is source removal followed by loam and seed, and landscaping, if necessary.

In wetland areas, excavation and removal constitute the only alternative. These areas are currently undeveloped and thus no replacement was considered.

The storm drain system (Section 3) can be designed to provide good site and roadway drainage. Also by maintaining proper flow quanitities and velocities, the catch basins will collect the suspended soil particles, which would be a potential source of surface-water contamination.

It is recommended that storm drain replacement be included in the final remedial action. Improved roadway drainage will minimize maintenance costs. Sediment control will minimize the environmental risk of potentially contaminated surface-water runoff and provide a mechanism for site monitoring.

The excavation and replacement of both the water and sanitary sewer systems were evaluated. As previously discussed, the sanitary sewer fill material may provide a conduit for deeper penetration of contaminated perched water, and thus, its removal and replacement was considered. Similarly, the potential exists for perched water to enter existing private ground-water supplies, and a new public supply was considered. Installation of new water and sewer lines is a feasible engineering alternative, but neither is considered necessary at this time.

4.2.2 Environmental Effects

The primary environmental effects are related to mobilization of PCBs during the excavation and removal process. Various construction operations will result in fairly large quantities of PCB-contaminated dust being released into the air without adequate dust control. This dust may subsequently be transported into the breathing zone of both workers onsite and residents. Bulldozing, truck loading, grading, and hauling all may result in substantial dust emissions. There is also the possibility of hauling losses from dump trucks during trips to secure landfills.

Other effects will result from direct removal of vegetation, especially from the wetlands area. Removal of trees and shrubs will result in direct loss of habitat. There is also the possibility of widespread erosion during construction.

4.2.3 Environmental Protection

Removal of soil contaminated with PCBs to the ≥10 mg/kg level will meet the public health, welfare, and environmental objectives of remediation. The landfill alternative, however, will not result in ultimate destruction of the PCBs. Thus, there is the potential for future problems with this material at the ultimate disposal site. Additionally, removal of ≥10 mg/kg will not ensure that the ambient water quality criteria for PCBs will not be exceeded in runoff to the wetlands and Lake Erie. This can only be ensured by the sitewide removal.

4.2.4 Costs

A summary of costs for the remedial alternatives for excavation, disposal, and replacement is presented in Table 4-1.

4.3 REMOVE, ONSITE TREATMENT, AND REPLACE

As indicated in Section 3, onsite treatment of PCB-contaminated soils and water requires designing/building an onsite treatment unit; excavating material/pumping water; operating a treatment system; disposing residues from the treatment system; and replacing decontaminated material onsite.

4.3.1 Engineering Feasibility of Onsite Treatment

Biological and chemical onsite treatment require similar operational processes. In general, system requirements for onsite treatment parallel wastewater treatment unit operations. It is assumed that to meet mixing requirements the soil and chemical or biological reagents will be combined to form a soil/water/reagent slurry which can be pumped, mixed, and handled as a liquid material. For biological systems where detention/reaction times are on the order of months, it is apparent that onsite reactors can only be used for the mixing and initial phase of the treatment and that the material would have to be replaced to complete the necessary biodegration. Therefore, environmental parameters which affect the biological activity must be managed to allow the treatment to continue/complete. It, therefore, is not practical to consider complete treatment of the PCBs with an onsite, biological treatment unit. A combined onsite/in situ biological treatment system would be the only process feasible, based on the time constraints for biological degradation of Aroclor 1254. This is not considered a feasible engineering option.

The engineering feasibility of onsite chemical treatment is limited to the application of potassium polyethylene glycol (KPEG). To date, the extraction process has been demonstrated to be the limiting process in the PCB treatment and that extraction and treatment can be accomplished in 2 hours with a reagent of sufficient concentration. To optimize extraction, solvent requirements are substantial. To reduce solvent costs, a recovery and reuse system should be employed. Onsite treatment may, therefore, be completed with a 2-hour contract time. The reactor capacity for the contaminated soil/reagent slurry must provide adequate volume to allow a sufficient detention period for the chosen feed rate. The engineering of this reactor is feasible and a preliminary process flow diagram is presented in Figure 4-1.

As presently conceived, the system would be a continuous reactor, with a heat source to remove any inhibitory water from the slurry during the 2-hour detention and accelerate the reaction. Soil would be continuously changed to a mixer by a backhoe. In the mixer, it would be slurried with KOH/PEG/DMSO. The slurry would then be pumped to a rotary kiln where it would be heated to 70 C for a detention time of 2 hours. After reaction, the decontaminated solids will be separated from the reagents by sedimentation. The solids would then be water washed, separated, and returned to the earth. Water washings would be combined with used solvent and the solvent separated. The purified would be recycled to the mixer; the bottoms would be wasted.

A treatability study will be required under the conceptual design phase of the remediation project to define and finalize design parameters such as solvent feed rates, detention time, etc.

4.3.2 Environmental Effects of Onsite Treatment

The majority of the environmental effects associated with this alternative are similar to those resulting from removal, landfilling, and replacement. In addition, onsite treatment will require considerably more heavy equipment and chemical process equipment present at the site for large periods of time. This could pose a safety problem to the public. Additional problems both to workers and the public could result from contact with chemical reagents which are associated with onsite treatment.

The products of onsite chemical and biological treatment have not been adequately characterized. This could result in future exposure to additional hazardous materials.

4.3.3 Environmental Protection of Onsite Treatment

Onsite treatment of soils contaminated with ≥50 mg/kg PCBs will meet the objectives for protection of public health, welfare, and the environment. Additionally, this alternative provides for ultimate disposal rather than encapsulation. As with other alternatives involving removal to ≥10 mg/kg, the potential for exceeding the ambient water quality criterion for PCBs still exists. Onsite treatment of only soils contaminated with ≥50 mg/kg will not meet the objectives of remediating to levels of ≥10 mg/kg. Removal efficiencies of onsite chemical treatment have been demonstrated to be 90-99 percent. Further information on the treatment efficiencies would be obtained in treatability studies.

4.3.4 Costs for Onsite Treatment

Costs for onsite chemical treatment are presented in Table 4-2.

4.4 REMOVE, INCINERATE, AND REPLACE

Under Federal regulations, any substance containing PCB concentrations in excess of 500 mg/kg must be incinerated. Five samples at the Wide Beach site were analyzed as being in excess of the 500 mg/kg level.

4.4.1 Engineering Feasibility

Incineration involves controlled combustion to destroy PCB-contaminated materials thermally and to convert them to harmless gases and inert solids. The nearest licenced PCB incinerator to the Wide Beach site is the SCA Chicago unit, approximately 550 mi away. Following incineration, the residual ash will be disposed of in a secure landfill. Incineration represents state-of-the-art technology for the destruction of PCB contaminated solids. Because incineration is required of all solids and liquids contaminated in excess of 500 mg/kg, it must be considered as part of the recommended alternative. A more detailed discussion of incineration will be covered under the Technical Analysis in Section 5.

4.4.2 Environmental Effects

The environmental effects associated with removal, incineration, and replacement are similar to those resulting from the removal, landfilling, and replacement option (Section 4.2.2). The 550-mi distance from Wide Beach to the closest approved PCB incinerator created a possibility for transportation-related incidents to a greater extent than landfilling.

Additionally, it is known that incineration has the potential to convert PCBs to the more hazardous dioxin and dibenzofurans. The incineration of large quantities of highly contaminated soils must be closely monitored to ensure that this does not occur. Scrubber water and ash from the incineration facility must also be closely monitored.

4.4.3 Environmental Protection

This alternative is designed to comply with the TSCA for incineration of material containing >500 mg/kg PCBs. It will not otherwise ensure protection of public health, welfare, or the environment.

4.4.4 Costs for Incineration

Removal/Incineration of soil areas which have concentrations exceeding 500 ppm is estimated to cost $1,060,000.

4.5 *In Situ* BIOLOGICAL TREATMENT

As previously discussed, there are two known suppliers of biological organisms to treat Aroclor 1254. The following discussion addresses the feasibility of using either product.

4.5.1 Engineering Feasibility of In Situ Biological Treatment

The process used to degrade PCBs in-place biologically requires several engineering contributions. They are

- A microorganism capable of using/degrading PCBs
- Method(s) to apply the organisms to the soil contaminated with PCBs
- Methods to control environmental factors which may inhibit/destroy the organisms throughout the period of treatment
- Environmental protection procedures to avoid adverse effects of the treatment

The engineering of the first two requirements is possible. According to the manufacturers, the microorganisms they produce are successful in Aroclor 1254 degradation. The engineering feasibility of the latter two requirements, namely controlling the environmental factors and providing environmental protection from adverse treatment results, are not well defined. The time for PCB degradation is expected to be on the order of months. Therefore, the soil environment must be managed during that period to provide favorable conditions for treatment. To maintain optimal conditions in the field for that length of time is difficult. An irrigation and drainage system would be required. The treatment would have to be applied during the summer months. Retilling and reapplication will most likely be required.

The environmental effects of the treatment are not well known. Engineered control measures are therefore not well known and the engineering feasibility of those controls requires further investigation. At a minimum, dust control during application and tilling and runon/runoff controls would be required.

4.5.2 Environmental Effects of In Situ Biological Treatment

Environmental effects of biological treatment of Aroclor 1254 are not well known. Although two manufacturers have been identified with products designed to degrade PCBs (including Aroclor 1254) in the laboratory, there has been no known field application of the product for a site similar to Wide Beach and environmental results are therefore not available.

It is not clear what by-products would result from biological degradation. Available literature suggests that the resultant constituents could include chlorinated benzoic acids and dibenzofurans and would likely be more soluble/mobile and perhaps more toxic.

4.5.3 Environmental Protection

If all the engineering requirements identified in Section 4.5.1 are met, it is likely the PCBs would be degraded. The extent of degradation is not known. The level of removal or the residual level is expected to depend on the length of time over which treatment is applied, the number of applications, and the success of controlling environmental conditions detrimental to the microorganisms activity. It is anticipated that a 10 mg/kg level is achievable, but further design information is required to define the engineering reqirements to achieve that level. In particular a treatability study would be required to demonstrate the level of environmental protection attainable.

4.5.4 In Situ Biological Costs

Table 4-3 presents the costs for providing *in situ* biological treatment.

4.6 *In Situ* CHEMICAL TREATMENT

Only one viable chemical treatment technique has been identified for PCBs, Aroclor 1254. The chemical treatment identified is APEG Anion Polyethylene Glycol. (KPEG, potassium polyethylene glycol, and NaPEG, Sodium polyethylene glycol are subsets of APEG which were previously identified.)

4.6.1 Engineering Feasibility of In Situ Chemical Treatment

The engineering feasibility of providing *in situ* chemical treatment of PCBs depends upon successful completion of chemical reactions in a soil environment. Control of that environment can be engineered to a certain degree. It is not clear, however, if the environment can be controlled to the degree required for chemical/APEG treatment. Past studies (Brunelle and Singleton 1985) have indicated that soil moisture is a major impediment to PCB treatment by chemical methods and, in fact, soil moisture may have to be maintained at 2-3 percent. In field applications, this requirement further imposes a requirement for an artificial heat source to remove most of the soil moisture. The technology to provide that heat source is in the development stage and the in situ chemical treatment of soils is not considered to be feasible at this time.

4.6.2 Environmental Effects

EPA is presently undertaking studies to define any environmental effects of this treatment. Toxicity studies are being performed and preliminary results indicate no appreciable toxicity of the resultant constituents. The major environmental effect of the application is its tendency to inhibit revegetation.

4.6.3 Environmental Protection

Studies to date have demonstrated complete removal of PCBs using this process in laboratory studies. The soil moisture problem, however, makes the in situ removal efficiency questionable and further data on in situ, PCB pilot studies are required.

4.6.4 In Situ Chemical Costs

Table 4-4 presents costs for in situ chemical treatment. A major unknown in the costs is the development costs for an in situ heat source to obtain low soil moisture levels.

4.7 IMMOBILIZATION

The method of treatment to immobilize PCBs considered in this project is the addition of powdered activated carbon to the soils.

4.7.1 Engineering Feasibility of Immobilization

Long-term/permanent immobilization of PCBs in soils is difficult. The only identified technology is to add a material which will adsorb the material and prevent it from reaching surface water and ground water. PCBs are readily adsorbed into activated carbon and, in fact, PAC is a preferred material because it is easily incorporated into soil and provides the maximum adsorptive capacity per pound of material. The limiting concern in carbon adsorption is the life of the carbon which is expected to be less than the PCBs. Carbon life expectancy in an exposed in situ environment is unknown; therefore, it is expected that reapplication is required. To define PACs′ life, further field investigations are required.

The application/reapplication rate is unknown since the organic and metals content of the soil is unknown. The quantity of carbon required to meet all the adsorptive requirements of the soil is expected to be substantial and unfeasible.

4.7.2 Environmental Effects

Immobilization by activated carbon treatment will result in few adverse environmental effects. Tilling of the soil to incorporate the carbon could result in increased PCB migration via the air route. Use of an artificial cover over the soil would probably be socially unacceptable.

4.7.3 Environmental Protection

The effects of activated carbon can only be considered to be temporary. Once the capacity of the carbon has been reached, the effectiveness of this alternative has been lost. Chromatographic effects may result in premature release of PCBs from the carbon. Once the carbon has been contaminated with PCBs, it becomes a hazardous waste and must be handled according to RCRA and TSCA.

4.7.4 Costs

Costs associated with activated carbon addition to immobilize PCBs are estimated to be substantial.

4.8 ADDITIONAL REMEDIAL ACTIVITIES SCREENING

Engineering feasibility, environmental effects, environmental protection, and costs associated with the additional remediation activities--cleaning, water supply, and perched water treatment--are discussed in this section. The requirements for a No Action choice under these additional remediations has been addressed in Section 4.1 and include No Action costs (e.g., monitoring) for cleaning, water supply, and perched water treatment.

4.8.1 Personal Facility Cleaning

The alternatives identified in Section 3.8.1 are summarized and evaluated in this section.

4.8.1.1 Engineering Feasibility of Personal Facility Cleaning

In terms of engineering feasibility, all the cleaning options are feasible. Conventional cleaning is not expected to include any unique engineering requirements. The specialty cleaning techniques have been designed to remove PCBs from areas such as those identified in this report and have proven successful in past applications. The conventional cleaning alternative can be accomplished readily with common techniques.

4.8.1.2 Environmental Effects

Environmental effects of conventional cleaning methods are expected to be greater than specialty cleaning methods. In general, the specialty cleaning methods provide for removal of dust and contaminated material from the homes and cars, and ultimate disposal of any PCB-laden material.

4.8.1.3 Environmental Protection

However, the uncertainty of the environmental protection and environmental effects associated with the final result is great. That is, dusting does not assure that dust is removed. Also, conventional methods do not provide for ultimate disposal of the contaminated material. Because conventional cleaning is likely to leave or simply disturb contaminated dust and particles within homes, within carpets, and adhered to objects, the alternative is rated low with respect to the goal of minimizing the environmental risks.

Total cleaning provides a greater certainty regarding sufficient reduction of environmental risk to human health. The cleaning techniques identified have been used and can be effected for the facilities. The specialty techniques have been designed to remove PCBs from this type of contamination source and have proved successful.

The total costs of the remaining alternatives are summarized below. These costs are based on 60 houses, 40 garages, and 60 automobiles. Costs are estimated based on unit costs itemized within Section 3, plus approximately 30 percent estimated for engineering and contingencies.

Alternative	Cost
Sampling/Analysis/Cleaning	
Conventional cleaning	$150,000
Specialty cleaning	425,000
Total Facility Cleaning	
Conventional cleaning	$250,000
Specialty cleaning	450,000

The specialty cleaning techniques are recommended for remediating the personal facilities. Due to the lack of assurance that sufficient remediation would be effected, the limited cleanup alternative is removed from further consideration.

4.8.2 Water Supply

4.8.2.1 Engineering Feasibility

The public water supply and faucet-mounted treatment units are feasible alternatives for reducing possible levels of PCBs in drinking water supplies. The feasibility of installing a deep well, with acceptable PCB levels is unknown. Further studies are required to decide if an uncontaminated deep well is feasible for a water supply source.

4.8.2.2 Environmental Effects

There are no significant environmental effects associated with the faucet-mounted or public water supply alternatives.

4.8.2.3 Environmental Protection

Present information does not indicate any increased environmental and public health protection can be provided through end-user water treatment or alternate water supplies. The preceding conclusion is based on the following comparison of health risks for No Action and an alternative water supply source.

No Action Alternative--Aroclor 1254 was found in 14 percent of drinking water samples at Wide Beach. For purposes of analysis, it is assumed that PCBs were present in the remaining samples at half the detection limit. A typical detection limit was 0.06 ug/L. Thus ND is counted as 0.03 ug/L. On this basis, the geometric mean PCB concentration is 0.038 ug/L. Assuming 2 L of water consumption per day, a 70-kg body weight, 70-yr liftetime exposure, and a cancer potency factor of 4.3396 $(mg/kg/day)^{-1}$, the liftetime cancer risk is 4.7×10^{-6}.

Alternative Source--As sampled at the Farnham Firehall, the available public water supply has a total trihalomethane (THM) concentration of 35 ug/L. Using a cancer potency factor of 0.18272 $(mg/kg/day)^{-1}$ for THMs and the same assumptions as above, the lifetime cancer risk from THM exposure is 1.8×10^{-4}. Inasmuch as this is two orders of magnitude higher than No Action, connection to the public water supply is argued against on public health grounds.

4.8.2.4 Costs

Water supply costs have been calculated using the previous unit costs and are estimated to be

Public water supply	$658,000
Faucet-mounted units	$350,000

4.8.3 Perched Water in Sewer Trench

4.8.3.1 Engineering Feasibility

The engineering feasibility of the alternatives for containing or treating the water in the sewer trench is well defined. To treat the water, shallow wells could be installed in the sewer trenches to pump the perched water. As previously discussed, the alternative for treatment of the water is essentially limited to granular activated carbon. These units are readily available and can be relatively easily installed.

4.8.3.2 Environmental Effects

The environmental effects of pumping the contaminated water are expected to be better than those resulting from a contaminant process. The only detrimental result of GAC treatment is that the resultant contaminated carbon must be disposed.

TABLE 4-1 COSTS FOR EXCAVATION, DISPOSAL, AND REPLACEMENT

	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Road Areas			
Roads			
Excavation, disposal, and rebuild	NA	NA	$2,795,000
Driveways			
Excavation, disposal, and pavement replacement	NA	NA	775,000
Soils			
Front Yards			
Excavation/landscape	$483,000	$818,000	6,289,000
Pave existing surface	77,000	129,000	1,005,000
Pave with excavation	522,000	882,000	6,748,000
Bentonite/landscape/no excavation	78,000	132,000	1,067,000
Bentonite/landscape/excavation	523,000	886,000	6,809,000
TYPAR/landscape/no excavation	62,000	105,000	865,000
TYPAR/landscape/excavation	507,000	858,000	6,607,000
Landscape/no excavation	38,000	64,000	547,000
Back Yards			
Excavation/landscape	6,300	38,000	5,516,000
Pave existing surface	570	5,700	844,000
Pave with excavation	4,100	39,000	5,867,000
Bentonite/landscape/no excavation	3,100	6,600	760,000
Bentonite/landscape/excavation	6,500	40,000	5,783,000
TYPAR/landscape/no excavation	2,900	6,700	760,000
TYPAR/landscape/excavation	6,400	40,000	5,783,000
Landscape/no excavation	2,800	4,900	494,000
Fill Areas			
Excavation/landscape	11,000	249,000	575,000
Pave existing surface	1,700	40,000	91,000
Pave with excavation	12,000	274,000	629,000
Bentonite/landscape/no excavation	1,600	37,000	85,000
Bentonite/landscape/excavation	12,000	271,000	624,000
TYPAR/landscape/no excavation	1,200	29,000	65,000
TYPAR/landscape/excavation	12,000	262,000	603,000
Topsoil/no excavation	700	16,000	37,000

TABLE 4-1 (Cont.)

	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Wetlands			
Excavation/removal	$27,000	$72,000	$2,925,000
<u>Ditches and Sewers</u>			
Ditches/Storm Drains			
Excavation, remove, regrade	NA	NA	4,017,000
Excavation, remove, regrade with new storm drain			4,300,000
Sanitary Sewer			
Excavation, remove, replace	NA	NA	5,570,000

TABLE 4-2 COSTS FOR ONSITE CHEMICAL TREATMENT

Areas	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Roads	NA	NA	$1,595,000
Driveways	NA	NA	294,000
Front yards	$ 556,000	$ 758,000	4,432,000
Back yards	4,600	24,000	3,306,000
Fill areas	9,000	160,000	358,000
Wetlands	21,000	62,000	1,928,000
Storm drain outlets	106,000	274,000	274,000
Sanitary sewers	NA	NA	3,607,000
Ditches and storm sewer with new storm drain	NA	NA	2,349,000

TABLE 4-3 SUMMARY OF COSTS FOR *In Situ* BIOLOGICAL TREATMENT

	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Front yards	$30,000-$230,000	$46,000-$380,000	$340,000-$2,840,000
Back yards	$2,000-$4,000	$4,000-$19,000	$300,000-$2,480,000
Fill areas	$2,000-$6,000	$15,000-$120,000	$40,000-$270,000
Wetlands	$4,000-$15,000	$6,000-$40,000	$180,000-$1,450,000

TABLE 4-4 COSTS FOR *In Situ* CHEMICAL TREATMENT

	Remediation Level		
	≥50 mg/kg	≥10 mg/kg	Sitewide
Front yards	$400,000	$680,000	$5,200,000
Back yards	1,000	30,000	4,500,000
Fill areas	10,000	210,000	490,000
Wetland	24,000	64,000	2,600,000

Note: Cost for an *in situ* heating system has not been included in these costs.

TABLE 4-5 ALTERNATIVES AFTER PRELIMINARY SCREENING

Site Areas / Alternatives		Excavation			In Situ			Additional Activities		Support Activity		
	No Action	Remove/ Landfill/Replace	Remove/ Incinerate/Replace	Remove/Onsite Treatment/Replace	Biological Treatment	Chemical Treatment	Immobilization	House Cleaning	Water Supply		Monitoring	
Road Areas Roads												
Drives												
Soils Front Yards			*									
Backyards												
Fill Areas												
Wetland												
Sewers/ Ditches Ditches			*									
Storm Sewers			*									
Storm Sewer Outlets												
Sanitary Sewers												
Homes/Outbuildings												
Water Ground Water												
Perched Water												

*Incineration of material with PCB concentration ≥500 mg/kg.

☐ Indicates remaining applicable alternatives.

◩ Indicates alternative is applicable to part of the area.

TABLE 4-6 SUMMARY OF COSTS FROM PRELIMINARY SCREENING OF ALTERNATIVES

		Remediation Level					
		≥50 mg/kg		≥10 mg/kg		Sitewide	
Areas	No Action	Excavate/ Dispose/ Replace	Onsite Treatment Replace	Excavate/ Dispose/ Replace	Onsite Treatment Replace	Excavate/ Dispose/ Replace	Onsite Treatment Replace
Roads:							
Roads	$3,000,000	NA	NA	NA	NA	$2,795,000	$1,595,000
Driveways	1,000,000	NA	NA	NA	NA	775,000	294,000
Soils:							
Front yards	NA	$483,000	$428,000	$818,000	$583,000	6,289,000	3,409,000
Back yards	NA	6,300	5,000(a)	38,000	25,000(a)	5,516,000	3,306,000(a)
Fill areas	NA	11,000	9,000(a)	249,000	160,000(a)	575,000	358,000(a)
Wetlands	NA	27,000	21,000(a)	72,000	62,000(a)	2,925,000	1,928,000(a)
Sewers							
Ditches/Storm Sewers	500,000	NA	NA	NA	NA	4,300,000	2,349,000
Sanitary Sewers							
Sewer & Fill	NA	NA	NA	NA	NA	3,500,000	2,260,000
Fill only	NA	NA	NA	NA	NA	2,500,000	1,600,000
Areas ≥500 mg/kg	NA					1,161,000	NA
Water Supply	NA						
Perched Water	NA				200,000		
Homes/Outbuilding	NA						

(a) Assumes Treatment Unit construction is included in Frontyard Remediation.

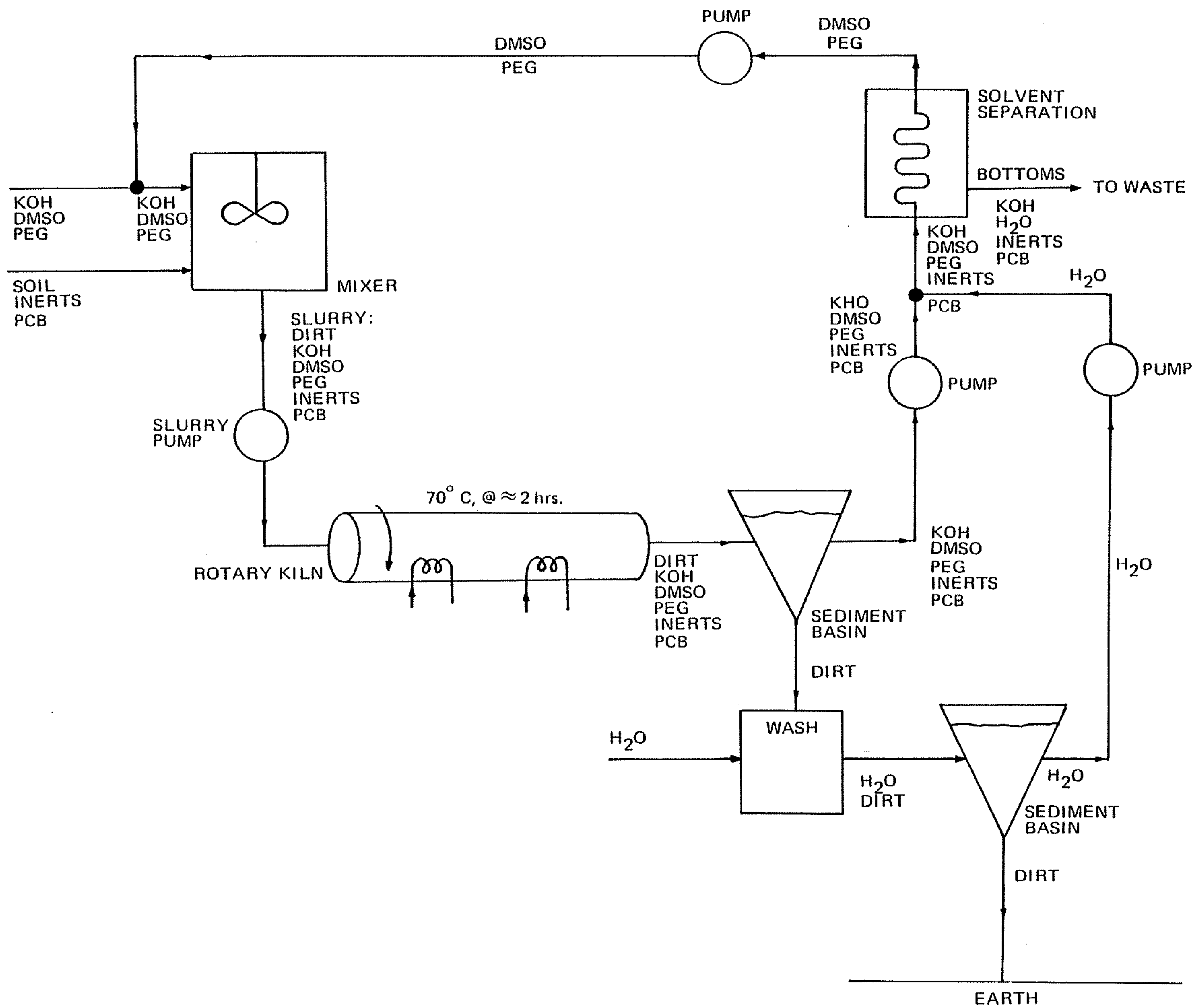


Figure 4-1. Continuous KPEG process.

5. DETAILED ALTERNATIVE EVALUATION

Table 4-5 presented the available alternatives for the remediation of PCB contamination from all areas and sources at the Wide Beach site. Based on the preliminary screening there are two alternatives which remain for the removal of PCBs in the roads, driveways, front yards, back yards, fill area, wetland, sewer trenches, and ditches. The perched water and homes have only one alternative remaining after the preliminary screening. No Action is proposed for drinking water supplies. This discussion is provided to develop more fully the details of possible remediation at the site for all areas and facilities/homes identified. Alternative A is the most conservative approach to remediation with excavation and replacement of contaminated soils. Alternative B provides a promising method to treat and detoxify PCB in the appropriate areas. Alternative B additionally, complies with the remedial objective of ultimate destruction of contaminants. Based on the uncertainty of the extent of soil removal/ treatment in the front yards, the alternatives are further defined as A1 and B1 to estimate costs associated with removal/treatment of all front yards. In addition to the alternatives involving removal, the No Action Alternative remains after initial screening.

5.1. ALTERNATIVE A--REMOVE/LANDFILL/REPLACE CONTAMINATED SOILS

5.1.1 Technical Analysis

Removal and replacement under Alternative A involves the roads, driveways, ditches and storm drains, and areas with PCB concentrations in excess of 500 mg/kg.

5.1.1.1 Roads

All roads in the Wide Beach area were regraded and compacted during June and July of 1985. The regrading invariably altered the existing contamination patterns in the roadways, and altered the depth of contamination zones. The existing contaminated soils were then compacted and covered with a 4-in. layer of asphalt. The asphalt was placed in direct contact with the regraded contaminated soils and is assumed to be contaminated to the same degree as the soil it covers. The regrading and paving necessitates the secure landfilling of 4 in. of pavement and a maximum of 18 in. of soil.

The asphalt surface should be broken up with a rotogrinder, jackhammer, scraper, or similar equipment into pieces which can be easily excavated and which conform to the size requirements of the secure landfill cell. The remaining soils can then be excavated using a crawler dozer and front-end loader. Onsite, PCB soil testing will continue throughout the excavation process to determine the final excavation grade.

The excavated material will be removed from the site by a licensed hazadous material hauler. The material will be placed in 20-yd^3 trailer dump trucks by a front-end loader. All trucks will be polyethylene lined before leaving the site and have adequate covering to prevent the blowing of material while en route to the disposal facility. All trucks will meet applicable local, State, Federal regulations, DOT specific regulations, and all disposal regulations. A hazardous waste coordinator from the disposal facility will be onsite at all times to ensure that all safety and environmental precautions are taken, both with vehicles and personnel onsite. All materials excavated would be immediately transported to the secure landfill.

The excavated material will be transported to a secure landfill facility at either SCA Chemical Services (Model City, NY) or CECOS (Niagara Falls, NY). Both facilities are currently in compliance with all applicable RCRA, TSCA, and other EPA environmental program requirements. Both sites fully anticipate future compliance with all applicable regulations and assure that PCB-dedicated cells will be available in their landfills for years to come.

The landfills are designed with a layer of low permeability clay forming the foundation or primary barrier for the landfill, followed by a synthetic liner and a final 2-ft thick layer of compacted clay. This system represents a "triple liner" system with the top clay layer providing a protective barrier to prevent damage to the synthetic liner. A single PCB-dedicated cell is separted from other waste types in the landfill by segregation berms. A layer of cover material is placed over the wastes and the filling continues in this manner until the cell is full. Upon completion of the cell, a layer of synthetic liner is placed over the last layer of cover material and the cell is completed with a layer of compacted clay. The final unit is then loamed to a depth of 1-2 ft and seeded. The seed, in conjunction with graded slopes on the landfill, minimizes infiltration of ground water.

A leachate manangement system is also maintained in the landfill, consisting of permanently installed drainage pipes and pumps which enable the collection, preprocessing and disposal of any liquids which may accumulate in the landfill. The landfill is maintained on a fulltime basis and monitored with a system of perimeter ground-water observation wells.

Following excavation, the roadway area must be proof rolled. A layer of clean, crushed gravel that is well graded and free from organic and other deleterious material should be put in place as a foundation course and compacted in lifts not greater than 8 in. in depth. All layers should be compacted to not less than 95 percent of the maximum dry density of the material as determined by a standard proctor test. The subgrade must be dry and uniform before placement of the foundation course. The completed subbase should be treated with an asphalt primer, applied with pressure distributors at a rate of 0.2-0.5 gal/yd^2, over a structural fiber in a material. The asphalt should then be treated with an asphalt cement tack coat. The structural fiber material is designed to protect the subgrade from water infiltration, and retard cracking.

A 2-in. asphalt binder course should then be compacted over the structural fiber. A 2-in. asphalt top course, which in turn is coated with a pavement sealer would then be applied. Top course should be compacted to a minimum of 95 percent of standard proctor density. All material requirements and construction requirements would conform to New York

State Department of Transportation (NYSDOT) specifications. Samples of materials must be tested periodically through the life of the project to assure that mixtures remain uniform.

5.1.1.2 Driveways

Excavation of driveways is also affected by the repavement work in June - July 1985. Clean fill was brought onsite to fill potholes in driveway and walkway surfaces, and minor regrading took place in these areas. As a result, an excavation criteria of 2 in. of pavement and a maximum of 12 in. of soil has been established.

Excavation will be conducted in a manner similar to the roadways. Clean, base course fill will be replaced and compacted to within 2 in. of final grade. The bituminous concrete driveway will then be laid in two 1-in. layers. Each layer should be compacted to 95 percent of standared proctor density, with a self-propelled tandem roller weighting 3-5 tons.

Disposal of driveway asphalt and subsoils will also be to one of the landfills described in 5.1.1.1. Similar environmental and safety precautions will be maintained during this phase of the project.

5.1.1.3 Ditches/Storm Drains

The roadside ditches in the Wide Beach area were also paved during the June - July 1985 construction project. The pavement was installed to minimize infiltration through the ditches, and reduce movement via wind dispersion. The ditches contain the most severly contaminated soils on the site. The four areas with concentrations in excess of 500 mg/kg, for example, were in the roadside ditches. Based on the minor regrading and paving which took place in the ditches, a 40-in. removal criterion is recommended. The 4 in. of pavement and a maximum of be removed.

It is assumed that removal to a depth of 40 in. will effectively remove the majority of contamination in the ditches and preclude the need for repaving the drainage ditches. Instead, backfill with clean ordinary borrow is recommended, followed by regrading to assure adequate drainage.

The installation of 18-in. reinforced concrete pipe along the two storm drain areas leading to the wetland is highly recommended. Minor repairs of broken drain pipe were anticipated during the July reconstruction. Total storm drain removal, soil excavation, and new pipe replacement, however, would remove highly contaminated soils and structures and further serve to adequately drain the roadside ditches. This solution would provide a permanent removal alternative, halt the further contamination of wetland soils beyond the storm drain outfalls, and minimize the amount of offsite migration of PCBs to the wetland stream and Lake Erie.

All excavation, disposal, and replacement techniques are the same as described in 5.1.1.1 and 5.1.1.2.

5.1.1.4 Front Yards

Excavation and removal of 6 in. of soil in front yard areas having contamination ≥10 mg/kg PCBs is recommended. Following removal, a 6-in. layer of loam will be placed and spread in the affected area and seeded. In those front yards where shrubs or trees fall within the contaminated zone, removal may be necessary.

It is assumed that some of the larger tree root structures may interfere with soil removal. Foundation plantings and tree replacement will take place on a house-by-house basis as necessary.

An additional alternative considered for front yard remediation is the excavation, disposal, and replacement of all the front yards. Although excavation of areas which do not contain measurable quantities of PCBs is not planned, the extent of contamination within the front yards is unknown. Excavation of all the front yards is considered as Alternative A1.

5.1.1.5 Back Yards

Excavation, disposal and replacement of soils, trees, and shrubs are handled in an identical manner as the front yards. A 6-in. removal criterion has been established based on PCB analysis of the soil; landscaping will take place when removal of trees and shurbs is required.

5.1.1.6 Fill Areas

Excavation, disposal, and replacement of soils in fill areas 1-4 (Figure 3-1) will occur in an identical manner as the front yards. In cases where fill areas are on front yards, shrubbery and tree replacement, commensurate with existing plantings, may be necessary.

5.1.1.7 Storm Sewer Outlets

Excavation and disposal is the only alternative for the wetland area. The character and appearance of the wetland would not be greatly affected by the removal of a 6-in. soil layer. Clearing and grubbing may also be necessary in certain areas where dense brush and extensive tree root systems are encountered. After removal, wetland restoration will take place to a degree compatible with the remainder of the area.

5.1.1.8 Incineration

In both detailed alternative evaluations, the excavation, removal, and incineration of soil contaminated with PCB concentrations in excess of 500 mg/kg must occur. Exterior samples, collected and analyzed under the RI, with this level of contamination are located in the following areas

1. Station 38--Front yard composite sample

2. OW 2--Soils collected from around Observation Well 2

3. Station 18--Roadside ditch sample

4. CB 6--Sludge sample from catch basin 6

The variability of soil analysis for PCBs can be high. Consequently, a 25-ft diameter of soil removal around the sample showing these high PCB concentrations is assumed. Further, the higher the concentration the higher the possibility that migration of the contaminant may have occurred deeper in these soils. Therefore, an excavation depth of 36 in. is also recommended in these areas. Based on a soil density of 100 lb/ft^3 for excavated soils, a total of 648,000 lb of soil must be excavated and incinerated from these four locations. This quantity is expected to include additional soils identified $\geq$500 ppm during the remediation. It is probable that additional hot spots will be located during construction monitoring. However, it is felt that use of the 25-ft radius will provide a conservative estimate of the actual volume to be treated.

Excavation and removal in the four areas with PCB concentrations requiring incineration will be performed in a manner similar to the roads, driveways, and ditches. Following the loading of the trailer dump trucks, the soil will be transported to SCA Chemical Services in Chicago, Illinois for incineration.

The incineration process converts hazardous substances to nonhazardous gases and inert ash residues via thermal destruction. The wastes are first screened at the SCA laboratory and given a full scale combustion analysis. They are then fed into the incineration chamber with a combustion temperature of 2,300 F and a residence time of 2 seconds which guarantees destruction of the PCB to a 99.99 percent minimum. The gases generated during the process pass through a bank of scrubbers which are designed to cleanse the gases and remove particulates and corrosive matter. Any wastewater generated in the scrubber is then sent for further chemical treatment. The cleansed-off gases are then fed through a monitoring system before being vented to the atmosphere. The system uses a rotary kiln incinerator, followed by primary quench of gases, packed stack scrubber, and wet ionized scrubber with a total capacity of 120 million BTUs/hr. The residual ash is then removed and sent to a secure landfill.

5.1.2 Environmental Analysis

The objective of this alternative is removal of contaminated soil from the site. Since the soil acts as a reservoir for PCB migration through air, surface water, and ground-water pathways, removal of the soil will effectively curtail exposure. Adverse effects of the alternative are primarily limited to exposures created by construction activities. Mitigation of adverse effects is possible through a combination of engineering controls and personal protection.

5.1.2.1 Beneficial Effects of the Alternative

The negative environmental effects of a large soil reservoir of PCBs are related to the ability of PCB to migrate via air and water routes. Lake Erie sediments are the ultimate sink for PCB transported by ground- and surface-water routes. Recent evidence (Brown et al. 1985) concludes that PCBs are biodegradable in sediments, although at a slow rate. Removal of contaminated soil from the site will severely limit PCB transport to the lake and allow natural renovation by biodegradation to occur more rapidly.

Due to atmospheric circulation patterns, airborne PCBs are globally dispersed (Atlas and Giam 1981). Although the contribution of Wide Beach to this loading is comparatively small, removal of the soil and subsequent paving or restoration of topsoil will result in effectively halting contamination by this route.

From the standpoint of public perception, the remediation will result in vast improvements to the site. Roads and driveways will be paved where they had not been before. Drainage is presently perceived to be the most significant problem facing the communtiy. Installation of a drainage system as a component of remediation will eliminate this problem. The net effect of these improvements may be an increase in property values.

5.1.2.2 Adverse Effects of the Alternative

For the most part, the adverse effects will occur during construction. Removal of the existing roadways and excavation of unpaved areas may result in further PCB dispersion by the air route. If there are heavy rainfalls during remediation, surface water runoff of PCB-contaminated soil could also occur. It is unlikely that these additional exposures will have any acute effect on the environment; however, additional loadings contradict the objectives of remediation.

Construction itself may result in adverse impacts. Dust raised during construction may settle on plants, clog stomata and result in phytotoxicity. Dredging the wetlands will result in loss of valuable biologically productive habitat which will be difficult to restore. If heavy rains occur during construction, erosion and subsequent sediment transport could also affect the wetlands. Migratory and locally nesting birds are likely to be disturbed by construction.

The action of removal rather than destruction of PCBs must be viewed as an adverse impact. In a secure landfill, biodegradation will be inhibited and it is likely that PCBs will persist almost indefinitely into the future. An accident or unforeseen circumstance in the future could result in further PCB release. This action also appears to contradict the spirit of TSCA PCB policies and recent CERCLA policies.

Remediation will likely result in a fairly severe social impact regardless of its nature. Residents at Wide Beach are concerned that the development will lose its rural character. Rising property values may result in a change in the socioeconomic groups living at the site. Some activities associated with the RIFS and RIA may already have changed the character of the site as shown by disuse of the Grove, lack of improvement at the beach, interpersonal hostility over drainage patterns and dissatisfaction with being advised not to eat home garden vegetables. The presence of large numbers of remedial personnel over long periods will affect the community. An additional financial burden may result from maintenance associated with roads and drainage systems.

5.1.2.3 Activities to Mitigate Adverse Effects

In the design, particular attention should be paid to proper engineering for mitigation. A Remedial Plan should be drawn up and included in bid specifications furnished to contractors. Monitoring during construction is necessary to ensure compliance with the Remedial Plan. A trained field biologist/ecologist should be retained to imput advice related to habitat protection.

Specific engineering controls that will aid in mitigation are primarily related to dust control. This could include suppression by watering, slowing emission by operating graders at low speeds, and covering piles and newly graded areas. Vegetation should be washed free of dust to the greatest extent possible. It is difficult to avoid social impacts. Maintaining open and candid lines of communication between the residents, contractors, EPA, and NYSDEC is the most desirable course of action.

5.1.3 Public Health-Analysis

Remediation will effectively serve to mitigate long-term PCB exposures. There is a potential for both community public health and industrial hygiene impact during remediation.

5.1.3.1 Mitigation of Public Health Effects from PCB Exposures

The risk assessment presented in the RI concluded that the excess cancer risk exposure to soil PCBs at Wide Beach was on the order of 10^{-3}. Removal of soil to ≤ 10 mg/kg level would reduce this risk to the order of 10^{-6}. The definition of removal areas is already fairly conservative. If removal is accompanied by monitoring as recommended, the net excess cancer risk may be even lower than 10^{-6}.

Removal of soil will also eliminate indirect pathways to humans. These include fish contamination through discharge to Lake Erie and offsite inhalation of airborne PCBs.

5.1.3.2 Adverse Health Effects Related to Remediation

The adverse effects are primarily those related to dust generation during construction. Numerous activities may result in dust generation including bulldozing, truck loading, grading, hauling, and trenching. Since the dust is contaminated with PCBs, there is a high probability at additional exposure.

A typical scenario could be constructed as follows: Based on the RI, the average yard PCB concentration is 29.9 mg/kg; 27 percent of the dust is respirable. For one scraper, based on EA (1984), the emission rate of dust may be calculated as:

$$Q_{dust} = \frac{0.058\ lb}{ton} \; \frac{150\ yd^3}{hr^3} \; \frac{2970\ lb}{yd} \; \frac{1\ ton}{2000\ lb} \times \frac{453.6\ g}{1\ lb} \; \frac{1\ hr}{3600} = 1.6\ g$$

This may be converted to a respirable PCB emission rate as

$$Q = \frac{11\ kg}{sec} \; 0.27 \; \frac{29.2\ mg\ PCB}{1000\ g\ soil} \; \frac{100\ mg}{mg} = 12.9\ mg\ PCB/sec$$

By using a BCA model, the onsite PCB concentration resulting from this activity may be modeled as:

$$C = \frac{12.9\ mg\ PCBs}{(10)(63.6)(5)} = 4 \times 10^{-3}\ mg/m^3$$

Using EPA's unit risk of $1.2 \times 10^{-3}\ (mg/m^3)^{-1}$ and assuming that the activity will take place over one year, this results in an excess cancer risk of

$$\frac{(4 \times 10^{-3})\ (1.2 \times -10^{-3})}{70} = 6.9 \times 10^{-8}$$

A worst-case scenario may be constructed for this activity using assumptions from the RI. Based on these assumptions and the above analysis, the worst-case excess cancer risk is 1.3×10^{-5}. EPA (1977) notes that proper dust suppression can cut emissions in half. If dust suppression is employed, the average risk would be 3.4×10^{-8} and the worst case 6.5×10^{-6}. If a risk of 10^{-6} is accepted as de minimus, proper dust control during construction should eliminate any risk contributed by these activities.

Construction workers, on the other hand, will require personal protection to eliminate exposure. Personnel monitoring will be required during construction to determine the appropriate level of protection. Standards for PCBs and nuisance dust must be adhered to. It is anticipated that EPA level C will be required during the removal stage and level D during subsequent stages.

As in the case of environmental protection, a Remedial Plan should be developed which has human health protection as its objective. A qualified industrial hygienist should be retained to ensure contractor compliance with the remedial plan.

5.1.4 Institutional/Permit Requirements

Permit requirements for this alternative are minimal. The only identified additional permit is a SPDES permit for discharge of treated perched water to Lake Erie.

5.1.5 Cost Summary for Alternative A

A breakdown of costs of the various items included in Alternative A and A1 is provided in Table 5-1.

5.2 ALTERNATIVE B--CHEMICAL ONSITE TREATMENT AND EXCAVATION

A site remediation alternative for Wide Beach is to treat those areas amenable to treatment and to dispose offsite the material from those areas which cannot be treated (i.e., asphalt material will be landfilled). The following discussion presents a detailed development of the treatment technology as it presently exists.

5.2.1 Technical Analysis of Chemical Treatment

Chemical treatments for soil PCBs are an attractive method for remediation as they result in ultimate disposal, avoid hazards associated with excavation and transportation, and are cost-effective compared to incineration. In general, PCBs are considered to be inert to most chemical reactions except under extreme conditions. Recent reviews (Tucker and Carson 1985; Kokoszica and Kurtz 1985) indicate that important destructive reactions which PCBs undergo include free radical induced substitutions, catalytic reductions, and nucleophilic substitutions. In addition to PCBs, considerable work has also been performed on chemical destruction of toxins (PCDD) which may also be useful for developing a design for PCB treatment.

The most promising reactions for PCB destruction involve reaction with a Group I metal (either in ionic or metallic form) and a polyether alcohol or related polymer. These reactions have been developed by the Franklin Research Center (FRC), General Electric Co. (GE), Galson Research Corporation (GRC), and a group associated with the University of Turin (UT) in Italy. The four processes are summarized in Table 5-2. There is no consensus concerning differences among these processes, the mechanisms involved, and the effects of environmental conditions on the reactions.

5.2.1.1 Detailed Process Description

The first of the processes to be developed was the FRC process designated NKPEG (Pytlewski et al. 1980). Typically, sodium reacted with PEG400 in a molar ratio of 1.1:1.0 at elevated temperature). This mixture is then contacted with PCB in the presence of oxygen. Dehalogenation of PCB is apparently complete with the products consisting mainly of phenols. The investigators proposed a superoxide radical as the reactive species. A patent (No. 4337368) was issued to Franklin Institute in 1982 for the process.

EPA (Rogers 1983) sponsored further research into the process. It was found that the reaction was first order with respect to chlorinated substrate. However, only 30 percent of dichlorobiphenyl was dechlorinated at 59 C. EPA apparently sponsored some field trials on soils with this reagent, but the results of these trials could not be located.

Subsequent work of FRC demonstrated that KOH rather than metallic K may be used in the reaction (Krevitz et al. 1983). The formulation consisted of KOH and a polyglycol. It could contain up to 20 percent water and was alleged to effect 85 percent dehalogenation at temperatures not exceeding 120 C. This process was also patented by FRC (No. 4400552) in 1983. Subsequent patents (No. 4471143; 1984) covered either form of potassium and involved the superoxide radical.

EPA (Klee et al. 1984) used reagents formed from KOH (KPEG) in field trials for PCDD reduction. Although these experiments experienced both analytical and reaction quality control problems, several significant conclusions could be drawn

1. KPEG is effective at reducing soil PCDD.

2. KOH in pellet form is more effective than 66 percent aqueous KOH.

3. PEGM350 is more effective than PEG400.

4. Two applications of the reagent are more effective than one.

5. The effective formulation apparently involved stoichiometric proportions of K to polyglycol. It was applied on the basis of 100-300 moles reagent to each mole of soil organochlorine.

6. Moisture (4.8 percent) appeared not to interfere.

The GE group seems to have developed a KPEG process concurrently with the FRC group (Brunelle and Singleton 1983, 1984). This group used PEGs as phase transfer catalysts which led to their development as nucleophiles. In laboratory tests on soil PCBs and PCBs on sand, the following conclusions were drawn

1. NaOH is not as effective as KOH as the metal source.

2. Aroclors 1260 and 1254 are more reactive than 1016 and 1242.

3. Water over 2 precent inhibits the reaction.

4. PEGM350 is more effective than PEG or methyl carbitol. KOH/PEG at 3:1 (w/w) ratio is an optional formulation.

Under contract to EPA, GRC has further developed soil testing with KPEG (Peterson and Milicic 1985). Although there are serious quality control problems with their data, some tentative conclusions may be drawn

1. The use of KOH/PEG-400/DMSO in a 1:1:1 ratio appears to be effective in rapid removal of PCDD from soil.

2. Water appears to have little effect on the reaction.

3. Substantial PCDD removal is effected by PEG/DMSO without a K source. The authors attribute this to volatilization of substrate with reagents.

The KPEG process has evolved considerably since its discovery. At this point, it appears that the work by FRC, GE, and GRC has converged to yield a single process which has several modifications. The process developed at UT, however, is conceptually different from KPEG as it is driven in the direction of radical compared to nucleophilic reaction by the intentional addition of sodium peroxide as a reagent.

5.2.1.2 Process Chemistry

The KPEG process relies on nucleophilic aromatic substitution to degrade PCBs. This is a relatively simple process in which the nucleophile (KOH/PEG) attacks a haloaromatic (PCB or PCDD), displacing a halogen and adding a polyglycol to yield aryl poly(ethylene)glycols which may retain some degree of halogenation. The first step in the process is a reaction between potassium hydroxide (KOH) and the polyglycol (ROH) with subsequent dissociation to form an alkoxide anion

$$KOH + ROH \longrightarrow ROK \longrightarrow RO^-$$

which is an effective nucleophile. The alkoxide then attacks the aromatic ring, displacing a halogen. The reaction with PCBs is probably of the SnAr type (March 1977) where electron withdrawing chlorines on the aromatic ring or the end, para to the chlorine of interest activating the ring to nucleophilic attack.

This reaction will continue as long as there are active groups present. OR is electron releasing and deactivating for nucleophilic substitution which probably explains the slowdown after rapid initial reaction noted by GRC. The lack of activators on lower PCB congeners may explain the diminshed reactivity noted by GE.

There may be a qualitative and quantitative difference between PCB and PCDD reactions. PCDDs are not as strongly activated as PCBs due to the possibility of fewer chlorines plus the presence of the ether linkage. This will result in greater reactivity for PCBs and may even indicate a benzene or even SN2 mechanism for PCDD, compared to the SnAr of PCBs.

The effects of DMSO in enhancing nucleophilicity are well known (Harris and Wamser 1976). Polar aprotic solvents such as DMSO cannot solvate anions such as OR^-; thus the anions are rendered more reactive. The presence of water leads to the formation of OH- rather than OR^-. OH- is a weaker nucleophile, therefore the reaction is inhibited. Addition of DMSO overcomes this inhibition.

Results of GRC which showed high PCDD degradation rates in the absence of KOH in the reagents are difficult to explain. GRC researchers attribute this phenomenon to volatilization of TCDD with the reagents. However, this is not supported by the known chemodynamics of TCDD; 2,3,7,8-TCDD as a rather low Henry's Law Constant of 2.1 x 10^{-3} atm^3mol^{-1} (Mabey et al. 1982) for equilibrium between water and air. The higher solubility of TCDD in DMSO/PEG compared to water should result in a lower Henry's Constant and less volatilization.

It is possible that chemical reaction is actually occurring. DMSO is a very strong Lewis base (Gutmann 1976) and, as such, may itself act as a nucleophile. Alternatively, it may be capable of enhancing nucleophilic activity of KOH or ROH following self dissociation to the anion.

5.2.1.3 Environmental and Health Consequences of the Treatment

The human toxicity of PCBs, PCDDs, or PCDFs is a strong function of chemical structure (McKinney 1981). It is anticipated that any chemical treatment which will modify the structure will have a high effect on toxicity. The reaction products of KPEG are arylpolyethers with varying degrees of chlorination. These materials will be more mobile in soil than the parent compounds and thus will have a greater tendency to migrate into ground water. PCBs with fewer chlorines are more biodegradable than those with more chlorines. That is, it is anticipated that the KPEG products will be more degradable. It is also anticipated that they will show less of a tendency to accumulate in tissue.

A relatively small amount of toxicity testing has been conducted on these products (Brunelle and Singleton 1983). The product of KPEG and Aroclor 1260 was found to have no oral toxicity in rats at a dose of 5 g/kg. Toxicity was not found in mice by a dermal route. The material was found to be a mild eye irritant in the rabbit. Tundo et al. (1985) found a LD_{50} of 70.7 mg/kg for the products of a 2,3,7,8 TCDD reaction administered to guinea pigs. This compares with a LD_{50} of 0.001 mg/kg for the unreacted compound. Considerable research, especially in the area of carcinogenicity, is required prior to widespread use of the treatment.

5.2.1.4 Pilot-Scale Feasibility Study

The innovative technology involved in the onsite treatment will require a pilot-scale treatability study prior to full-scale operation. In the conceptual design phase of remediation, several key design parameters related to the treatment system will be developed. These parameters will concern physical dimensions, operating temperatures, and detention times of various system components. Dimensionless groups will be determined from the design parameters and used to scale down the equipment by a factor convenient to pilot plant operations. The pilot plant will be used to test the adequacy of treatment of Wide Beach soil. If pilot-scale treatment is found to be adequate, full-scale treatment will be justified.

5.2.2 Environmental Analysis

In general, comments under Alternative A (Section 5.1.2) also pertain to B1. The discussion in this section is limited to those areas where there is a significant difference in environmental impact between the alternatives.

5.2.2.1 Beneficial Effects of the Alternative

The beneficial effects are similar to those of Alternative A with the exception that B1 will result in ultimate destruction of PCBs. This will eliminate any risks and/or adverse effects which may be associated with hauling of PCB-contaminated soil, by-products of incineration, or landfilling. Onsite treatment virtually guarantees that no future problems will result from PCB escape and consequent exposure.

5.2.2.2 Adverse Effects of the Alternative

Additional adverse effects of this option primarily result from the presence of chemical process equipment and reagents onsite. In the event of an accident or spill, large quantities of materials in process may be released which could result in considerable environmental damage. The by-products (still bottoms) from the process will require disposal in an environmentally sound manner. Neither DMSO nor PEG is considered hazardous under RCRA. However, the presence of KOM is likely to render the waste corrosive (pH $\geq$12) by RCRA standards. Treatment of the soil by this technique is likely to deplete it of organic matter (humus) and trace nutrients.

5.2.2.3 Activities to Mitigate Adverse Effects

A contingency plan incorporating appropriate engineering controls should be developed for this alternative. This will reduce the potential for impact in the event of spills or accidents. By-products should be neutralized to pH~7, drummed and disposed of in a secure facility. The processed soil should be amended by addition of soil conditioners to restore organic matter and nutrients.

5.2.3 Public Health Analysis

The public health risks and benefits of Alternatives B and B1 are similar to Alternatives A and A1 (Section 5.1.3). Only those areas which are significantly different will be discussed in this section.

5.2.3.1 Mitigation of Public Health Impacts of PCB Exposure

Mitigation will be similar to that in Alternative A with the exceptions that there will be reduced workers exposure to PCBs and the probability of future human exposure to landfilled PCBs has been effectively reduced to zero.

5.2.3.2 Adverse Health Effects Related to Remediation

As in the case of environmental impacts, the adverse effects are primarily related to the presence of process equipment and chemicals onsite. There is a high potential for accidents unless access to the treatment facility is closely controlled. Accidents could result from contact with moving machinery, heat sources, or chemicals. DMSO possesses the unique pharmacological property of being able to readily pass through the skin and carry other chemicals with it (Casarett and Doull 1980). KOH is a strong base. Even short contact with it could result in burns.

A Remedial Plan will also have to be developed for this alternative. It should be incorporated into all bid specifications and compliance monitored. An industrial hygienist should be retained to ensure compliance with health, safety, and disposal actions.

5.2.4 Institutional Permit Requirements

There are several institutional requirements particular to the onsite treatment option. Subpart B of TSCA maintains that PCBs must be incinerated or landfilled. EPA approval is required before an alternative destruction method (e.g., onsite chemical destruction) may be used. This approval is based on a written application to the Regional Administrator. The records and monitoring requirements of TSCA (40 CFR 761.45) must also be complied with. Ventilation stack emissions from the onsite treatment equipment may also require permitting.

5.2.5 Alternative B Costs

Costs to implement Alternative B are presented in Table 5-3. The derivation of the costs has been presented in Sections 3 and 4.

5.3 NO ACTION ALTERNATIVE

5.3.1 Technical Analysis

The No Action Alternative involves leaving the roadways and drives in the same state as they were following the IRA. Additionally, PCB-contaminated soil in the yards, wetlands, and fill areas would be allowed to remain. The perched water would not be treated and particulate filters would be left in place on potable water systems.

The feasibility of this alternative is intimately related to the durability of the pavement. If the pavement were to crack due to freeze-thaw, load stress, and/or lack of an adequate subbase, exposure to PCBs would return to a level similar to that prior to implementation of the IRA. Estimates of the effective lifetime of the roadways range from 2-4 years. This implies that during the 20-year lifetime of a CERCLA remediation, roadway replacement will be required 5-10 times.

Since PCBs are left onsite for this alternative, it will require more monitoring than other alternatives. This is especially the case for ground water at the site which is likely to become further contaminated as a result of continued PCB infiltration. The water filters will also require replacement as they become clogged with particulate matter.

5.3.2 Environmental Analysis

The objective of this alternative is to take no further action at the site. In this case, the soil can continue to act as a reservoir for PCBs.

5.3.2.1 Beneficial Effects of the Alternative

The effect of the IRA was to reduce surficial transport (runoff, air transport) of soilborne PCBs to some extent. Both surficial (runoff and airborne) and subsurface PCB transport would also be limited due to this remediation.

5.3.2.2 Adverse Effects of the Alternative

Due to the IRA design, only roadways and drives were paved, leaving a large PCB reservoir in the yards, open areas, and wetlands. The RI indicates that front-yard PCB concentrations do not differ substantially from those on roads and driveways. Forty-one percent of front yards are contaminated at $\geq$10 mg/kg PCB with levels up to 600 mg/kg. The PCBs remaining in the soil may migrate both through rough surface water run-off and air transport, leading to environmental effects similar to those reported as the baseline pre-IRA condition in the RI. Additionally, EPA (1977) notes that paving a road results in only an 85 percent reduction in dust emissions.

There is also a high potential for subsurface migration of PCBs into the ground water, resulting in aquifer deterioration. The permeability of asphalt averages about 10^{-5} cm/sec (???????? 1980). This value depends on the percent asphalt, percent voids, and compaction of the concrete. If the asphalt has not been well compacted (as at Wide Beach due to lack of a subbase), the permeability will be considerably greater. Cracks and fissures are expected to open in the asphalt as it deteriorates, thus effectively raising the permeability. Additionally, as noted above, there is a high potential for subsurface transport of water and water-borne PCBs through cracks in the soil.

From the standpoint of public perception, residents have been well educated as to the potential adverse health effects from PCB exposure and may react negatively to PCBs remaining onsite. At least some residents also feel that the pavement will have an extremely short life and that they will be rapidly re-exposed.

5.3.3 Public Health Analysis

The IRA was only partial and is temporary in nature. Thus, although exposure has been limited, there are still numerous opportunities for PCB contact. This is especially true in the yard areas where children have been playing. Since a considerable amount of soil contaminated with $\geq$10 mg/kg PCBs remains onsite, No Action does not meet the objectives of remediation defined in Section 2.

5.3.4 Costs

Costs for the No Action Alternative (maintenance and monitoring) have been developed in Section 4.

TABLE 5-1 ALTERNATIVES A AND A1 COSTS: EXCAVATION AND LANDFILLING

	Alternative A[(a)]	Alternative A1[(b)]
Roads (all)	$2,795,000	$2,795,000
Driveways (all)	775,000	775,000
Ditches/storm drains (all)	4,300,000	4,300,000
Front yards (all)	818,000	6,289,000
Back yards (≥10 mg/kg)	38,000	38,000
Fill areas (≥10 mg/kg)	249,000	249,000
Wetlands (≥10 mg/kg)	72,000	72,000
Incineration (≥500 mg/kg)	1,161,000	1,161,000
Homes/buildings cleaning	450,000	450,000
Perched water treatment	200,000	200,000
Totals	$10,858,000	$16,329,000

(a) Alternative A: Excavation/disposal (secure landfill) of soils with PCB concentration ≥10 ppm.

(b) Alternative A1: Excavation/disposal (secure landfill) of soils (all front yards and only remaining areas with PCB concentrations ≥10 ppm).

TABLE 5-2 COMPARISON OF APEG TREATMENT TECHNOLOGIES

Developer	FRC	GE	GRC	UT
Reference	Pytlewski et al. 1980 and Rogers 1983	Brunelle and Singleton 1985	Peterson and Milicic 1985	Tundo et al. 1985
Substrates Tested	PCB, Trichloro-benzene, pesticides	Aroclor 1254 Aroclor 1260 Chlorobenzenes	1,2,3,4-TCDD	2,3,7,8-TCDD
Form of Potassium	Metallic K	KOH	KOH	K_2O_3
Polymers	PEG400	PEGM350 MeCarbitol PEG600	PEG400, MEE	PEG6000
Solvents	None	MeOH, None, Heptane, toluene	DMSO	None
Other Reagents	O_2	None	None	Na_2O_2
Effects of H_2O	Inhibits	Inhibits	None	Unknown
Reaction Type	Radical Nucleophilic	Nucleophilic	Nucleophilic	Radical

PEG = Polyethylene glycol
MEE = 2(2-methoxyethoxy) ethanol
DMSO = dimethyl sulfoxide
MeOH = methanol

TABLE 5-3 ALTERNATIVES B AND B1 COSTS: EXCAVATION AND ONSITE CHEMICAL TREATMENT

	Alternative B[a]	Alternative B1[b]
Roads (all)	$1,595,000	$1,595,000
Driveways (all)	294,000	294,000
Ditches/storm drains (all)	2,600,000	2,600,000
Front yards	583,000	3,409,000
Back yards (≥10 mg/kg)	25,000	25,000
Fill areas (≥10 mg/kg)	160,000	160,000
Wetlands (≥10 mg/kg)	62,000	62,000
Highly contaminated areas (≥500 mg/kg)	1,161,000	1,161,000
Homes/outbuildings	450,000	450,000
Perched water treatment	200,000	200,000
Totals	$7,130,000	$9,956,000

(a) Alternative B: Onsite chemical treatment of only soils with concentrations ≥10 ppm PCB.

(b) Alternative B1: Onsite chemical treatment of soils (all front yards and only remaining areas with PCB concentrations ≥10 ppm).

6. EFFECTIVENESS ANALYSIS

6.1 SUMMARY OF ALTERNATIVES

Alternatives A and A1 involve excavation of contaminated soil from the site, landfilling at a secure landfill, and replacement with uncontaminated soil. In accordance with TSCA, soils contaminated at $\geq$500 mg/kg PCB will be incinerated at an approved facility. In addition to soil removal, these alternatives will involve monitoring, additional sampling, personal facility cleaning, and perched water treatment. The difference between A and A1 is one of scale. Alternative A involves only those areas contaminated to $\geq$10 mg/kg PCB, whereas A1 is sitewide for front yards.

Alternatives B and B1 involve excavation, onsite treatment with APEG reagent, and replacement. The primary difference between B/B1 and A/A1 is treatment rather than disposal. Additionally, a pilot scale test (treatability study) would be required. Soil materials contaminated at $\geq$500 mg/kg PCB may be treated by APEG rather than incinerated. Because asphalt is not amenable to APEG treatment, that asphalt which contacted contaminated soil should be disposed at a secure facility or incinerator as appropriate. Alternatives B/B1 also include monitoring, additional sampling, personal facility cleaning, and perched water treatment. As with A/A1, the difference is one of scale, with B involving treatment of soils with $\geq$10 mg/kg PCB and B1 encompassing all the front yards.

The No Action Alternative involves leaving the site in its existing state. This includes a temporary pavement on the roadways and drives and particulate filters on the drinking water supplies. Of all the activities discussed as remedial alternatives, only monitoring would be included in the No Action Alternative. Maintenance of the roadways would also be required.

6.2 EFFECTIVENESS ANALYSES

With the exception of the No Action Alternative, remediation at the Wide Beach site is expected to be fully completed once it is initiated. There are no long-term remediation activities associated with the removal alternatives evaluated in Section 5. These alternatives will, however, require a monitoring program to confirm adequate remediation. Since there are no long-term operating, maintenance, material, or labor costs which require the analysis of present worth costs of remediation, data presented in the preceding section represent present worth costs in 1985 dollars.

<u>Public health impacts</u> are expected to be relatively the same for the removal alternatives at a given remediation level (i.e., removal/disposal of area with PCB $\geq$10 mg/kg and removal/treatment of areas with PCB $\geq$10 mg/kg will have the same public health impact). Health risks differ from one level of remediation to another for the front yards (i.e., all front yards versus areas $\geq$10 mg/kg). In removing the areas with PCB $\geq$10 mg/kg, the goals for remediation would be met. The health risk could be further reduced with removal/treatment of all front yard areas. Since water

supply, perched water treatment, and home cleaning activities are the same for all removal alternatives, the health risks/impacts are assumed to be the same. Public health impacts for the No Action Alternative are anticipated to be relatively severe. The temporary nature of the IRA dictates that future exposures to PCBs are likely to occur. Additionally, the site hydrogeology is such that further ground-water contamination may be anticipated, even while the paving is intact.

Environmental effects of excavating, disposing, and replacing soils are well defined, although the environmental effects of chemical (APEG) treatment of soil are somewhat undefined. However, studies have not demonstrated detrimental environmental effects. The levels of remediation have differing potential environmental effects. In particular, the potential for ground-water contamination is greater for remediation of front yard soils with PCB levels $\geq$10 mg/kg than for remediation of all front yards. As with the public health impacts, the temporary nature of the IRA construction dictates that there will be future environmental exposure to PCB if No Action is chosen. No Action could also result in continued PCB migration by the air and surface water routes.

Community effects for the removal alternatives are expected to be similar. Temporary rerouting of traffic patterns may be required for either. At this time, it is doubtful if public acceptance of No Action is likely. The Wide Beach residents have been educated to the health effects of PCBs. Some residents believe that the roadways constructed by the IRA will last only one or two winters; thus they conclude there will be future exposure.

Technical considerations for all alternatives have been presented in Section 5. In summary, the excavation/disposal/replacement alternative is a proven remediation, though not an ultimate means of destroying PCBs. The effectiveness of the onsite treatment (Alternative B) appears to be promising, but has not been proven.

The remedial action location plan is shown in Figure 6.1.

6.3 DECISION MATRIX

In order to aid in evaluating these alternatives, a decision matrix was constructed (Table 6-2). This matrix ranked the five alternatives (A, A1, B, B1, and No Action) according to 14 different cost factors, technical factors, and health, welfare, and environmental factors. Every factor for each alternative was ranked on a scale of 1-10 by four senior environmental engineers who were familiar with the site. The four matrices generated by this technique were then pooled and subjected to statistical analysis.

A combined analysis of variance (ANOVA) and Newman-Keuls test indicates that there is no difference between the pooled rankings for Alternatives A, A1, B, and B1. The difference between the highest and lowest overall scores for these alternatives was only 6.8 percent. A statistically significant difference was observed between the four removal alternatives and No Action, with a 30 percent difference in scores between the mean score for removal and the score for No Action.

The results of this analysis suggest that No Action is considerably less effective for PCB remediation at Wide Beach than the removal alternatives. Since there is no significant difference among the removal alternatives, EPA policy, which considers ultimate destruction to be more favorable than land disposal, suggests that Alternative B1 is the most effective.

TABLE 6-1 ALTERNATIVE EVALUATION MATRIX

Evaluation Factors/Alternatives	A Partial Removal Landfill	A1 Total Removal Landfill	B Partial Removal Chemical Treatment	B1 Total Chemical Treatment	No Action
COST FACTORS					
Capital Costs	5.0	2.8	7.2	8.0	7.8
Operation and Maintenance Costs	8.5	9.0	8.8	9.0	6.8
Monitoring and Postclosure Costs	6.5	7.8	6.2	7.0	4.0
TECHNICAL FACTORS					
Feasibility	8.2	9.0	5.8	5.2	7.8
Implementability	8.2	7.8	6.8	5.5	5.5
Time to Accomplish	8.2	6.5	7.8	6.5	8.5
Reliability	8.2	9.0	5.0	5.8	5.5
HEALTH, WELFARE, AND ENVIRONMENTAL FACTORS					
Reduction in Health Risk	6.8	8.2	6.8	8.2	1.2
Onsite Public Health Effects	8.5	8.0	7.0	6.8	1.8
Offsite Effects	6.5	6.0	9.5	9.6	5.0
Occupational Health Effects	7.2	6.0	7.5	6.5	7.2
Reduction of Environmental Impact	6.5	8.5	6.0	8.0	2.2
Environmental Effects	6.5	7.0	6.5	7.0	2.8
Institutional Factors	8.0	7.5	6.0	6.2	3.5
OVERALL SCORE	103	103	96	99	70

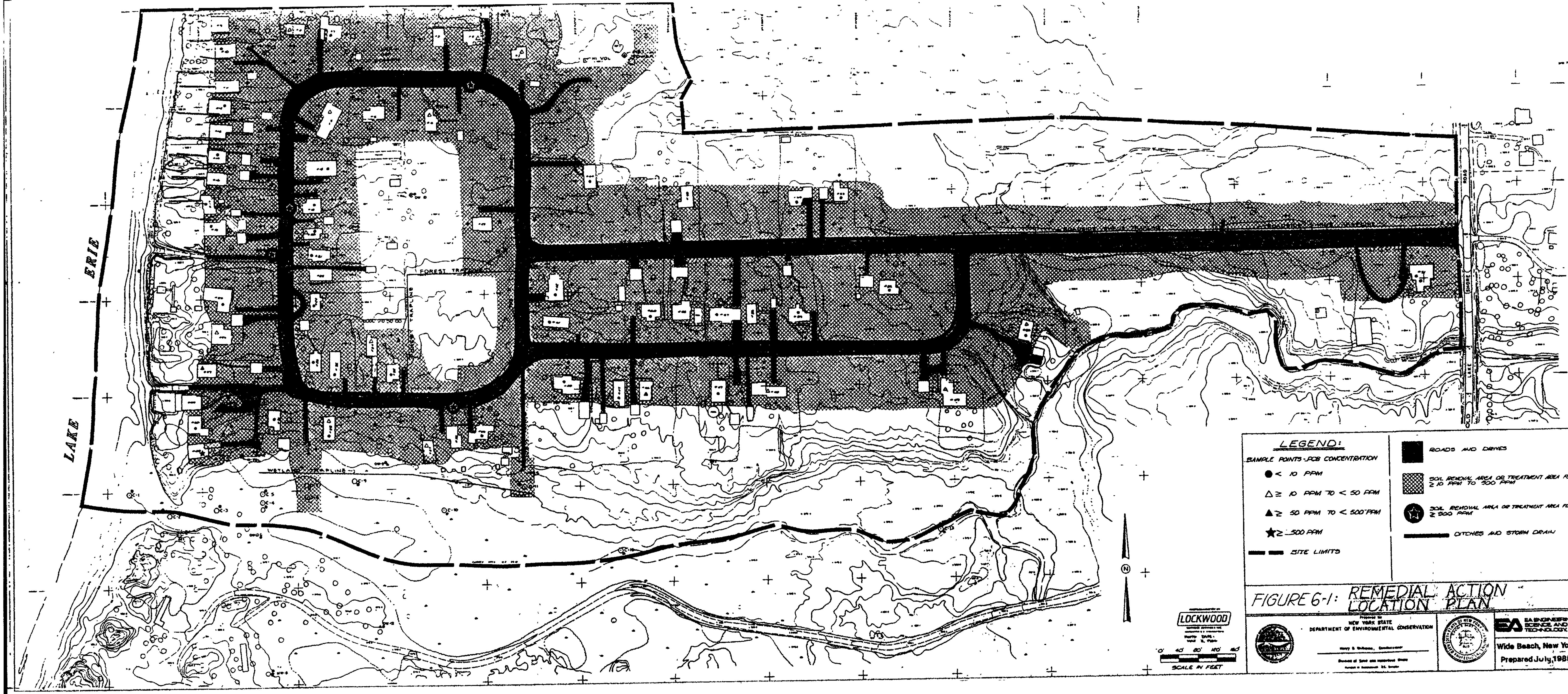


FIGURE 6-1: REMEDIAL ACTION LOCATION PLAN

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