# SDMS US EPA REGION V -1

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U.S. Department of Justice

*United States Attorney*
*Northern District of Illinois*

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JTH:ejd

*United States Courthouse*
*Chicago, Illinois 60604*

HAND DELIVERY

September 30, 1982

Richard Phelan, Esquire
PHELAN, POPE & JOHN, LTD.
180 North Wacker Drive
Chicago, Illinois 60606

Re: United States of America v. Outboard Marine Corp. and Monsanto Company
No. 78 C 1004 - USDC ND Ill. ED

Dear Dick:

Enclosed herewith are copies of exhibits of the deposition taken from Richard P. Brownell.

Please contact me with any questions.

Very truly yours,

DAN K. WEBB
United States Attorney

BY:
JAMES T. HYNES
Assistant United States Attorney

enclosure

cc: see page 2

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RICHARD P. BROWNELL
Vice President

ENFORCEMENT SENSITIVE

EDUCATION

BS (Civil Engineering) 1966; Rensselaer Polytechnic Institute
MS (Civil Engineering) 1967; Stanford University
MBA 1976; New York University

REGISTRATION

Professional Engineer: New York, Virginia

DEPOSITION EXHIBIT
BROWNELL-OMC
1-ID 8-10-82

SOCIETIES

American Society of Civil Engineers
Water Pollution Control Federation

RECOGNITION

Author: Articles on nitrification, high purity oxygen activated sludge, industrial and municipal wastewater treatment, landfarming, composting. Seminars on hazardous waste management.

DETAILED EXPERIENCE

1969 to Date — Malcolm Pirnie, Inc.

As Vice President in charge of MPI's hazardous waste and industrial waste process development groups, Mr. Brownell's involvement bridges the areas of problem identification and problem solving. He has directed projects on site evaluation, groundwater pollution, remedial measures for hazardous waste problems, industrial sludge removal from lagoons and disposal, leachate, wastewater process design, and detailed design for hazardous and industrial wastewaters and landfill closure. All significant private sector hazardous waste work performed by Malcolm Pirnie, Inc. is reviewed by Mr. Brownell.

He has served as Project Officer on environmental evaluations for portions of the Upper Hudson River PCB project; on bench scale and pilot treatability studies on PCB wastes for the New York State Department of Environmental Conservation; thiosulfate, pesticide, and other industrial wastewaters for several divisions of the American Cyanamid Company, and has directed studies of new processes for treating numerous types of industrial wastes for such companies as Olin Chemical Group, The Upjohn Company, Pfizer, Inc., Textron, Inc., Colgate-Palmolive, Scott Paper, and Gulf + Western. On several projects, he has been involved with the elimination of odors from industrial waste treatment facilities. He directed an appraisal of PBB contamination of land at an industrial site for Ameribrom, Inc., ground water and/or site investigations for industrial clients in New Jersey, New Hampshire,

MALCOLM PIRNIE

(continued)

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DETAILED EXPERIENCE (continued)

Connecticut, Massachusetts, Kentucky and Virginia. Remedial measures considered included: relining lagoons, groundwater, soil and sludge recovery, air stripping, activated carbon treatment, landfill closure, slurry walls, surface water diversions. He has directed multiplant, regional industrial/hazardous waste disposal evaluations for two major industrial corporations.

As Project Manager: Directed the design of a wastewater facility expansion for The Upjohn Company in North Haven, CT; testing and feasibility study for disposal of alum sludges from Scott Paper Company; treatability, feasibility and engineering design reports for approximately 20 corporations in the paper, pharmaceutical, organic chemicals, food, private utility, computer and metal finishing industries, pilot and prototype sludge application studies for municipal and industrial sludges. Also directed facility planning effort for the Atlantic Plant of Hampton Roads Sanitation District. Was in charge of laboratory activities for the company.

As Project Engineer: Responsible for major pilot/prototype studies at Akron and Cleveland, OH, and for several corporations including American Cyanamid Company (Lederle Laboratories Division) where high purity oxygen activated sludge was studied. Involved in design studies for wastewater pollution control projects in Akron, OH; Cleveland, OH; Saratoga County, NY, and Westchester County, NY; water distribution studies for the New Haven Water Company.

1967-69 U.S. Army Corps of Engineers
California and Republic of Korea

As Lieutenant: Served as Deputy Post Engineer for 1,500-man organization; responsible for all facility planning; involved in small project design and planning.

1966 J. Kenneth Fraser and Associates
Rensselaer, New York

As Engineer: Involved in comprehensive report for wastewater treatment facilities.

WAUKEGAN HARBOR

PROJECT BIBLIOGRAPHY

JULY 23, 1982

MALCOLM PIRNIE, INC.
WHITE PLAINS, NEW YORK

DEPOSITION
EXHIBIT
BROWNELL-OM
2-ID 8-10-82

MALCOLM PIRNIE, INC

Inter-Office Correspondence

To: R.P. Brownell

Date: 8/4/82

From: J.B. Mulligan

Subject: Waukegan Harbor PCB Problem

As requested, we have prepared preliminary cost estimates for a number of alternative methods of reducing the potential for environmental danger from PCB contamination in the Waukegan Harbor area. The alternatives considered are subdivided into two groups: those affecting the north ditch and parking lot and those affecting the harbor. In some instances, however, combined north ditch - harbor solutions have been considered. In these instances, a share of the costs of facilities which would be used jointly has been assigned to both the north ditch and harbor projects in accordance with the ratios of the volumes of contaminated materials removed from each location.

The various alternatives considered are as follows:

North Ditch and Parking Lot Alternatives

A-1 No action - monitor long term losses of PCB's to environment only.

A-2 Construct a new storm drain to divert water from the north ditch; fill in ditch with clean material obtained from off-site sources to prevent PCB losses through erosion of ditch sediments and volatilization.

A-3a-1
A-3a-2
A-3a-3 Remove selected, highly contaminated material from the north ditch and parking lot and dispose of in containment site to be constructed on OMC's vacant lot; fill in remainder of ditch and excavated areas with clean material. The containment site would also be used for disposal of material dredged from Slip 3 and the upper harbor under Alternatives B-3a, B-3b and B-3c.

A-3b Remove selected, highly contaminated material from the north ditch and parking lot and dispose of in a containment site constructed by sealing off Slip 3. Fill in remainder of ditch and excavated areas with clean material. Contaminated material in the upper harbor outside of Slip 3 would be dredged and placed in the containment site under Alternative B-2a.

A-4 Remove 50 ppm and greater contaminated material from the north ditch and parking lot and dispose of in a secure containment site constructed in the parking lot. The containment site would also be used for disposal of material dredged from the harbor under Alternative B-4.

DEPOSITION EXHIBIT
BROWNELL-OMC
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A-5 Remove 50 ppm and greater contaminated material from the north ditch and parking lot and dispose of in secure containment site to be constructed at a site to be selected with 20+ miles of Waukegan Harbor. This containment site would also be used for disposal of dredged material from the harbor under Alternative B-5.

Harbor Alternatives

B-1 No action - monitor long term losses of PCB's to environment only.

B-2a Convert Slip 3 into a containment site; fill with material dredged from upper harbor outside of Slip 3. This containment site would also be used for disposal of material removed from the ditch and parking lot under Alternative A-3b.

B-2b Convert Slip 3 into a containment site, dredge 50 ppm contaminated material from upper harbor and dispose of in slip.

B-3a Dredge Slip 3 and approximately 500 c.y. of selected, highly contaminated material near mouth of Slip 3 and dispose of in secure containment site constructed on OMC's vacant lot. Selected, highly contaminated material from the north ditch and parking lot would also be placed in this containment site under Alternative A-3a.

B-3b Same as Alternative B-3c but remove 20,000 c.y. from upper harbor outside of Slip 3. Material from the north ditch and parking lot would also be placed in this containment site under Alternative A-3a-2.

B-3c Dredge Slip 3 and upper harbor and dispose in containment site on OMC's vacant lot. This containment site would also be used to dispose of selected, highly contaminated material removed from the north ditch and parking lot under Alternative A-3a-3.

B-4 Dredge Slip 3 and upper harbor and dispose of in containment site on OMC's parking lot. The containment site would also be used for disposal of material removed from the north ditch and parking lot under Alternative A-4.

B-5 Dredge Slip 3 and upper harbor and dispose in a secure containment site to be constructed within 20+ miles of Waukegan Harbor. This containment site would also be used for the disposal of material removed from the north ditch and parking lot under Alternative A-5.

B-6 Dredge Slip 3 and approximately 500 C.Y. of selected, highly contaminated material near the mouth of the slip and dispose of in a secure containment site on OMC's vacant lot.

JBM:mhn:mrw

## ALTERNATIVE A-1

### NORTH DITCH AND PARKING LOT AREA - NO ACTION

Under Alternative A-1, the only action which would be taken would consist of the installation of ground water monitoring wells, a permanent gaging and sampling station on the North Ditch, and an air monitoring station. The six existing monitoring wells would be sampled periodically, if still available, and two new nested well systems consisting of three wells each would be constructed near the easterly end of the ditch.

Estimates of capital costs and annual sampling and maintenance costs are presented below.

### ESTIMATED CAPITAL COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Monitoring wells | 2 Nests of 3 EA. | $ 8,000.00 | $ 16,000 |
| Purchase Flow meter and remote chart recorder | 1 EA. | 2,500.00 | 2,500 |
| Purchase automatic water sampler | 1 EA. | 4,000.00 | 4,000 |
| Purchase automatic air sampler | 1 EA. | 8,000.00 | 8,000 |
| Construct small building | 100 S.F. | 30.00 | 3,000 |
| Install Electrical Power | L.S. | L.S. | 3,000 |
| Construct concrete weir | L.S. | L.S. | 4,000 |
| Install equipment in building | L.S. | L.S. | 3,000 |
| TOTAL ESTIMATED CONSTRUCTION COST | | | $ 43,500 |
| Contingencies @ 20% | | | 8,700 |
| Engineering, Legal & Administrative @ 28% | | | 12,180 |
| TOTAL CAPITAL COST | | | $ 64,380 |

### ESTIMATED ANNUAL O&M COSTS

| | | | |
|---|---|---|---|
| Equipment maintenance and Electric Power Charges | L.S. | L.S. | 2,500 |
| Ground Water Sampling and analysis | 24 Samples | 210.00 | 5,040 |
| Air sampling and analysis | 4 Samples/Yr. | 400.00 | 1,600 |
| Surface water sampling and analysis | 6 Samples/Yr. | 220.00 | 1,320 |
| Annual reports & misc. paper work | L.S. | L.S. | 5,000 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 15,460 |

ALTERNATIVE B-1

HARBOR AREA - NO ACTION

Under Alternative B-1, the only action which would be taken would consist of the installation of ground water monitoring wells around the harbor, flow recording and sampling equipment in the harbor entrance and a permanent air monitoring station.

The ground water monitoring wells would consist of four nests of two wells each. Each well would be sampled four (4) times per year.

The flow recording and sampling station in the harbor entrance would be run continuously for the first year to develop background data. Thereafter, sampling and flow measurements would be done on a quarterly basis.

Estimates of capital costs and annual operation and maintenance costs are presented below

ESTIMATED CAPITAL COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Monitoring wells | 4 nests of 2 EA. | $ 5,500.00 | $ 22,000 |
| Purchase & Install Automatic Air Sampler | 1 EA. | 8,000.00 | 8,000 |
| Install electric power to automatic equipment | L.S. | L.S. | 3,000 |
| TOTAL ESTIMATED CONSTRUCTION COST | | | $ 33,000 |
| Contingencies @ 20% | | | 6,600 |
| Engineering, Legal & Administrative @ 28% | | | 9,200 |
| TOTAL ESTIMATED CAPITAL COST | | | $ 48,800 |

ESTIMATED ANNUAL O&M COSTS

| FIRST YEAR COSTS | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,000 |
| Ground water sampling and analysis | 16 Samples | $ 210.00 | 3,360 |
| Air Sampling and Analysis | 4 Samples | 400.00 | 1,600 |
| Continuous flow monitoring and sampling in harbor | L.S. | L.S. | 125,000 |
| Annual reports & Misc. paper work | L.S. | L.S. | 5,000 |
| TOTAL ESTIMATED FIRST YEAR COST | | | $ 136,960 |

ALTERNATIVE B-1 (continued)

| SUBSEQUENT YEARS COSTS | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,000 |
| Ground Water Sampling and analysis | 16 Samples/yr. | $ 210.00 | 3,360 |
| Air Sampling and Analysis | 4 Samples/yr. | 400.00 | 1,600 |
| Water samples from harbor | 24 Samples/yr. | 220.00 | 5,280 |
| Annual report and misc. paper work | L.S. | L.S. | 5,000 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 17,240 |

## ALTERNATIVE A-2

Under Alternative A-2, a new storm drain would be constructed from the existing 36-inch diameter drain near the railroad to the lake to divert surface runoff and cooling water from the north ditch. The ditch would then be filled in and covered with a clay cap, topsoil and vegetative cover to prevent a catastrophic loss of PCB laden sediments to the lake. Monitoring wells would be constructed near the ditch on the easterly end of the parking lot and ground water monitoring would be carried out to determine the long term losses of PCBs via that route.

No action would be taken with respect to PCBs under the surface of the parking lot. However, contaminated material excavated during the construction of the new storm drain through the parking lot would be used to fill a portion of the crescent ditch.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-2

STABILIZE NORTH DITCH

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL COST |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP Storm Drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| Manholes 8-FT. dia. precast | 9 ea. | 5,000.00 | 45,000 |
| Dewatering-well point | 2,650 L.F. | 20.00 | 53,000 |
| Riprap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of Contaminated Exc. (in ditch) | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Fill in Ditch, Crescent Ditch & Lagoon | | | |
| Backfill E-W portion of ditch | 4,730 C.Y. | 10.00 | 47,300 |
| Backfill lagoon | 1,060 C.Y. | 10.00 | 10,600 |
| Backfill Crescent ditch | 1,400 C.Y. | 10.00 | 14,000 |
| 1-FT. Clay Seal, topsoil & seed | 6,000 S.Y. | 6.00 | 36,000 |
| Monitoring Wells | L.S. | | 10,000 |
| TOTAL ESTIMATED CONSTRUCTION COST | | | $ 565,400 |
| Contingencies @ 20% | | | 113,080 |
| Engineering @ 25% | | | 141,350 |
| Legal and Administrative @ 3% | | | 16,962 |
| TOTAL PROJECT COST | | | $ 836,792 |

ALTERNATIVE A-2

ESTIMATED ANNUAL O&M COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 6 Samples | $ 210.00 | 1,260 |
| Air sampling and analysis | 1 Sample | 400.00 | 400 |
| Annual inspection & Report | 40 Hours | 60.00 | 2,400 |
| TOTAL ESTIMATED ANNUAL COSTS | | | $ 6,560 |

ALTERNATIVE A-2

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Storm Drain | 76 | 107 |
| 3. | Restore Parking Lot over Drain | 10) | 16 |
| 3a. | Backfill Ditch | 12) | |
| 4. | Seal Surface of Ditch, Topsoil & Seed | 8) | 10 |
| 4a. | Install Monitoring Wells | 3) | |
| 5. | Demobilization | 2 | 2 |
| | TOTAL | | 156 |

## ALTERNATIVES A-3a-1 AND B-3a

Under Alternative A-3a-1, a new drain would be constructed across the parking lot to divert water away from the north ditch, as in Alternative A-2, and approximately 10,100 C.Y. of the most highly contaminated material in the crescent ditch, oval lagoon and parking lot would be excavated and disposed of in a secure containment site constructed on OMC's vacant lot. Excavation would be accomplished by driving interlocked steel sheeting around small areas to be excavated, dewatering within the sheeted areas, and trucking the excavated material to the containment cell in a relatively dry state.

Under Alternative B-3a, approximately 10,875 C.Y. of material would be dredged from slip 3, together with an additional 500 C.Y. of sediment in the upper harbor near the mouth of slip 3 which will have to be removed to prevent loss of use of the harbor by Larsen Marine Co. This material would be pumped, as a slurry, to the containment site on OMC's vacant lot. The slurry water would be passed through a settling basin and returned to the area of the dredge. To insure that losses of PCB's to the lake were minimized during dredging, the area to be dredged would be sealed off through the installation of a temporary sheet pile wall. The water treatment plant would be dismantled and placed inside the containment cell upon completion of the dredging, and the cell dewatered thru a carbon filter to remove high levels of PCBs.

The capacity of the containment cell was determined as follows:

| | |
|---|---|
| Material to be dredged from Harbor | 11,375 C.Y. |
| Allowance for Water Treatment Plant disposal | 5,500 C.Y. |
| Material to be excavated from north ditch | 10,100 C.Y. |
| Contaminated material from storm drain construction | 2,000 C.Y. |
| SUBTOTAL | 28,975 C.Y. |
| Allowance for expansion of material 20% | 5,800 C.Y. |
| TOTAL | 34,775 C.Y. |
| SAY | 35,000 C.Y. |

An additional two (2) feet of freeboard was allowed in determining the height of the berms surrounding the cell. The area would be filled with the remainder of the material used for the construction of the water treatment plant.

Cost estimates for Alternatives A-3a-1 and B-3a are presented in the attached tables. In preparing these estimates, each Alternative was assigned a share of the "common" cost of the disposal site. It should be noted, however, that if only one of the Alternatives were to be built, the disposal site costs would be entirely different from those shown.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3a-1

Remove Selected Highly Contaminated Material from the North Ditch and Parking Lot and Dispose of in Containment Site on OMC's Vacant Lot.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP storm drain | 2,650 L.F. | $ 100.00 | $ 265.000 |
| Manholes 8' dia. precast | 9 EACH | 5,000.00 | 45,000 |
| Dewatering - well point | 2,650 L.F. | 20.00 | 53,000 |
| Rip rap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of contaminated excavation in containment site | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material From Ditch and Parking Lot | | | |
| Relocate utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well point dewatering | L.S. | L.S. | 60,000 |
| Excavation and hauling to containment site | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alternative A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' clay seal, topsoil and seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air monitoring during excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,155,000 |
| Ditch and Parking Lot Share of Cost of Containment Site on OMC's Vacant Lot (see estimate attached) | | | 369,482 |
| TOTAL CONSTRUCTION COST: | | | $1,524,482 |
| Contingencies @ 20% | | | 304,896 |
| Engineering @ 25% | | | 381,120 |
| Legal and Administrative @ 3% | | | 45,734 |
| TOTAL PROJECT COST: | | | $2,256,232 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-3a

DREDGE SLIP 3 AND UPPER HARBOR AND DISPOSE OF IN CONTAINMENT SITE ON OMC'S VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 11,375 C.Y. | $ 10.00 | $ 113,750 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & labor for water treatment | L.S. | L.S. | 12,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 25,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 11,000 C.Y. | 6.00 | 66,000 |
| Synthetic liner | 50,000 S.F. | 0.85 | 42,500 |
| Gravel blanket | 2,000 C.Y. | 10.00 | 20,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed pumps, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 30,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 606,695 |
| Share of Containment Site Cost for Dredging (See Attached Estimate) | L.S. | L.S. | 531,693 |
| TOTAL CONSTRUCTION COST | | | $1,138,388 |
| Contingencies @ 20% | | | 227,678 |
| Engineering @ 25% | | | 284,597 |
| Legal & Administrative @ 3% | | | 34,152 |
| TOTAL CONSTRUCTION COST | | | $1,684,815 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S VACANT LOT
USE WITH ALTERNATIVES B-3a AND A-3a-1
(Construct Containment Site for 35,000 c.y.)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Level and compact site | L.S. | L.S. | $ 35,000 |
| 1' clay blanket | 4,000 C.Y. | $ 10.00 | 40,000 |
| 3' thick clay cut-off walls | 2,625 C.Y. | 10.00 | 26,250 |
| 1' gravel blanket | 4,000 C.Y. | 10.00 | 40,000 |
| 3' clay liner | 12,500 C.Y. | 10.00 | 125,000 |
| 6" dia. PVC leachate collector | 1,200 L.F. | 10.00 | 12,000 |
| 6" dia. PVC dewatering pipe | 1,250 L.F. | 10.00 | 12,500 |
| Manholes - 48" dia. precast | 2 EACH | 1,600.00 | 3,200 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Sand berms | 60,400 C.Y. | 6.00 | 362,400 |
| Rip rap slope protection | 110 C.Y. | 40.00 | 4,400 |
| Final Cover Over Site | | | |
| 2' clay cover | 8,000 C.Y. | 10.00 | 80,000 |
| 1' topsoil and cover | 5,925 C.Y. | 10.00 | 59,250 |
| Seeding | 4.5 AC. | 750.00 | 3,375 |
| Monitoring Wells | 4 NESTS | 8,000.00 | 32,000 |
| Air Sampling Unit | L.S. | L.S. | 20,000 |
| Permanent Fence | 1,800 L.F. | 6.00 | 10,800 |
| Electric Power | L.S. | L.S. | 10,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $ 901,175 |

Ditch and Parking Lot share of
Cost for Constructing Containment Site

$\frac{12,100 \text{ C.Y.}}{29,475 \text{ C.Y. total}}$ = 0.41 x $901.175 = $ 369,482

Dredging Share of Cost of
Constructing Containment Site

$\frac{17,375 \text{ C.Y.}}{29,475 \text{ C.Y. total}}$ = 0.59 x $901,175 = $ 531,693

ALTERNATIVE A-3a-1 COMBINED WITH B-3a

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 5 Ac. | 180.00 | 900 |
| Annual maintenance and repair to cover | L.S. | L.S. | 3,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 14,640 |

ALTERNATIVE A-3a-1 & B-3a

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Containment Site on OMC's Vacant Lot | 125) | 175 |
| 2a. | Construct New Storm Drain thru Parking Lot(Complete) | 86) | |
| 3. | Close Harbor & Reinforce Exist Sheet Pile Wall in Slip 3 | 20 | 28 |
| 4. | Dredge Slip 3 and Harbor | 12 | 16 |
| 5. | Open Harbor | 2) | |
| 6. | Dewater Containment Site | 30) | 42 |
| 6a. | Sheet 1st section of Ditch | 5) | |
| 7. | Excavate & Backfill Ditch | 125) | 190 |
| 7a. | Cover Containment Site | 20) | |
| 8. | Seal Surface of Ditch, Topsoil & Seed | 8 | 10 |
| 9. | Clean-up and Demobilization | 5 | 7 |
| | TOTAL | | 489 |

## ALTERNATIVES A-3a-2 AND B-3b

These Alternatives are the same as A-3a-1 and B-3a except that the volume of material to be dredged from the harbor outside of slip 3 is 20,000 C.Y. rather than 500 C.Y. As a result, the cost of the containment site is greater and the shares of the site costs assigned to the two Alternatives are different.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3a-2

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP storm drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| Manholes - 8' dia. precast | 9 EACH | 5,000.00 | 45,000 |
| Dewatering - well point | 2,650 L.F. | 20.00 | 53,000 |
| Rip rap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of contaminated excavation in containment site | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material from Parking Lot | | | |
| Relocate utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well point dewatering | L.S. | L.S. | 60,000 |
| Excavation and hauling to containment site | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alternative A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' clay seal, topsoil and seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air monitoring during excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,155,300 |
| Ditch and Parking Lot Share of Containment Site Cost on OMC's Vacant Lot (see estimate attached) | | | 283,088 |
| TOTAL CONSTRUCTION COST: | | | $1,438,388 |
| Contingencies @ 20% | | | 287,678 |
| Engineering @ 25% | | | 359,597 |
| Legal and Administrative @ 3% | | | 43,152 |
| TOTAL PROJECT COST: | | | $2,128,815 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-3b

DREDGE SLIP 3 AND UPPER HARBOR AND DISPOSE OF
IN CONTAINMENT SITE ON OMC'S VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 30,875 C.Y. | $ 10.00 | $ 308,750 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & labor for water treatment | L.S. | L.S. | 15,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 25,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 13,900 C.Y. | 6.00 | 83,400 |
| Synthetic liner | 64,000 S.F. | 0.85 | 54,400 |
| Gravel blanket | 2,400 C.Y. | 10.00 | 24,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed pumps, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 50,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 857,995 |
| Share of Containment Site Cost for Dredging (See Attached Estimate) | L.S. | L.S. | 805,712 |
| TOTAL CONSTRUCTION COST | | | $1,663,707 |
| Contingencies @ 20% | | | 332,741 |
| Engineering @ 25% | | | 415,927 |
| Legal & Administrative @ 3% | | | 49,911 |
| TOTAL CONSTRUCTION COST | | | $2,462,286 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S VACANT LOT
USE WITH ALTERNATIVES B-3b AND A-3a-2
(Construct Containment Site for 54,000 c.y.)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Level and compact site | L.S. | L.S. | $ 40,000 |
| 1' clay blanket | 5,520 C.Y. | $ 10.00 | 55,200 |
| 3' thick clay cut-off walls | 3,260 C.Y. | 10.00 | 32,600 |
| 1' gravel blanket | 5,520 C.Y. | 10.00 | 55,200 |
| 3' clay liner | 16,600 C.Y. | 10.00 | 166,000 |
| 6" dia. PVC leachate collector | 1,600 L.F. | 10.00 | 16,000 |
| 6" dia. PVC dewatering pipe | 2,000 L.F. | 10.00 | 20,000 |
| Manholes - 48" dia. precast | 2 EACH | 1,600.00 | 3,200 |
| Overflow weir piping | L.S. | L.S. | 25,000 |
| Sand berms | 67,400 C.Y. | 6.00 | 404,400 |
| Rip rap slope protection | 120 C.Y. | 40.00 | 4,800 |
| Final Cover Over Site | | | |
| 2' clay cover | 11,050 C.Y. | 10.00 | 110,500 |
| 1' topsoil and cover | 7,500 C.Y. | 10.00 | 75,000 |
| Seeding | 6 AC. | 750.00 | 4,500 |
| Monitoring Wells | 4 NESTS | 8,000.00 | 32,000 |
| Air Sampling Unit | L.S. | L.S. | 20,000 |
| Permanent Fence | 2,400 L.F. | 6.00 | 14,400 |
| Electric Power | L.S. | L.S. | 10,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,088,800 |

Ditch and Parking Lot share of
Cost for Constructing Containment Site

$\frac{12,100 \text{ C.Y.}}{46,475 \text{ C.Y. total}}$ = 0.26 x $1,088,800 = $ 283,088

Dredging Share of Cost of
Constructing Containment Site

$\frac{34,375 \text{ C.Y.}}{46,475}$ (includes 3,500 C.Y. for WTP) of total capacity = 0.74 x $1,088,800 = $ 805,712

ALTERNATIVE A-3a-2 COMBINED WITH B-3b

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 5 Ac. | 180.00 | 900 |
| Annual maintenance and repair to cover | L.S. | L.S. | 3,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 14,640 |

ALTERNATIVE A-3a-2 & B-3b

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Containment Site on OMC's Vacant Lot | 125) | 175 |
| 2a. | Construct New Storm Drain thru Parking Lot(Complete) | 86) | |
| 3. | Close Harbor & Reinforce Exist Sheet Pile Wall in Slip 3 | 20 | 29 |
| 4. | Dredge Slip 3 and Harbor | 30 | 42 |
| 5. | Open Harbor | 2) | |
| 6. | Dewater Containment Site | 30) | 42 |
| 6a. | Sheet 1st section of Ditch | 5) | |
| 7. | Excavate & Backfill Ditch | 125) | 190 |
| 7a. | Cover Containment Site | 20) | |
| 8. | Seal Surface of Ditch, Topsoil & Seed | 8 | 10 |
| 9. | Clean-up and Demobilization | 5 | 7 |
| | TOTAL | | 515 |

## ALTERNATIVES A-3a-3 AND B-3c

These Alternatives are also the same as Alternatives A-3a-1 and B-3a except that the volume of material to be removed from the harbor outside of slip 3 is 38,000 C.Y. As a result, a higher cost results for the containment site construction and the shares assigned to each Alternative are different.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3a-3

Remove Selected Highly Contaminated Material from the North Ditch and Parking Lot and Dispose of in Containment Site on OMC's Vacant Lot.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP storm drain | 2,650 L.F. | $ 100.00 | $ 265.000 |
| Manholes 8' dia. precast | 9 EACH | 5,000.00 | 45,000 |
| Dewatering - well point | 2,650 L.F. | 20.00 | 53,000 |
| Rip rap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of contaminated excavation in containment site | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material From Ditch and Parking Lot | | | |
| Relocate utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well point dewatering | L.S. | L.S. | 60,000 |
| Excavation and hauling to containment site | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alternative A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' clay seal, topsoil and seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air monitoring during excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,155,300 |
| Ditch and Parking Lot Share of Cost of Containment Site on OMC's Vacant Lot (see estimate attached) | | | 262,404 |
| TOTAL CONSTRUCTION COST: | | | $1,417,404 |
| Contingencies @ 20% | | | 283,541 |
| Engineering @ 25% | | | 354,426 |
| Legal and Administrative @ 3% | | | 42,531 |
| TOTAL PROJECT COST: | | | $2,098,202 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-3c

DREDGE SLIP 3 AND UPPER HARBOR & DISPOSE OF IN CONTAINMENT SITE ON OMC'S VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 48,900 C.Y. | $ 10.00 | $ 489.000 |
| Temporary Sleet Pile wall for Closing Harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce boisting sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & Labor for Water Treatment | L.S. | L.S. | 20,000 |
| Miscellaneous Water Treatment Equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 30,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 13,900 C.Y. | 6.00 | 83,400 |
| Synthetic liner | 64,000 S.F. | 0.85 | 54,400 |
| Gravel blanket | 2,400 C.Y. | 10.00 | 24,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed, pump, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 50,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $1,048,245 |
| Share of Containment Site Cost for Dredging (See Attached Estimate) | | | 1,049,616 |
| TOTAL CONSTRUCTION COST | | | $2,097,861 |
| Contingencies @ 20% | | | 419,572 |
| Engineering @ 25% | | | 524,465 |
| Legal & Administrative @ 3% | | | 62,936 |
| TOTAL PROJECT COST | | | $3,104,834 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S VACANT LOT
USE WITH ALTERNATIVES B-3c AND A-3a-3
(Construct Containment Site for 73,200 c.y.)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Level and compact site | L.S. | L.S. | $ 45,000 |
| 1' clay blanket | 6,850 C.Y. | $ 10.00 | 68,500 |
| 3' thick clay cut-off walls | 3,822 C.Y. | 10.00 | 38,220 |
| 1' gravel blanket | 6,850 C.Y. | 10.00 | 68,500 |
| 3' clay liner | 21,510 C.Y. | 10.00 | 215,100 |
| 6" dia. PVC leachate collector | 2,000 L.F. | 10.00 | 20,000 |
| 6" dia. PVC dewatering pipe | 2,640 L.F. | 10.00 | 26,400 |
| Manholes - 48" dia. precast | 2 EACH | 1,600.00 | 3,200 |
| Overflow weir piping | L.S. | L.S. | 25,000 |
| Sand berms | 81,000 C.Y. | 6.00 | 486,000 |
| Rip rap slope protection | 140 C.Y. | 40.00 | 5,600 |
| Final Cover Over Site | | | |
| 2' clay cover | 13,700 C.Y. | 10.00 | 137,000 |
| 1' topsoil cover | 9,260 C.Y. | 10.00 | 92,600 |
| Seeding | 6 AC. | 750.00 | 4,500 |
| Monitoring Wells | 4 NESTS | 8,000.00 | 32,000 |
| Air Sampling Unit | L.S. | L.S. | 20,000 |
| Permanent Fence | 2,400 L.F. | 6.00 | 14,400 |
| Electric Power | L.S. | L.S. | 10,000 |
| TOTAL CONSTRUCTION COST: | | | $1,312,020 |

Share of Containment Site Cost for Ditch and Parking Lot Work

$\frac{12,100 \text{ C.Y.}}{61,000 \text{ C.Y. total}}$ = 0.20 x $1,312,020 = $ 262,404

Share of Containment Site Cost for Dredging

$\frac{48,900 \text{ C.Y.}}{61,000 \text{ C.Y. total}}$ = 0.80 x $1,312,020 = $1,049,616

ALTERNATIVE A-3a-3 COMBINED WITH B-3b

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 5 Ac. | 180.00 | 900 |
| Annual maintenance and repair to cover | L.S. | L.S. | 3,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 14,640 |

ALTERNATIVE A-3a-3 & B3c

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Containment Site on OMC's Vacant Lot | 125) | 175 |
| 2a. | Construct New Storm Drain thru Parking Lot(Complete) | 86) | |
| 3. | Close Harbor & Reinforce Exist Sheet Pile Wall in Slip 3 | 20 | 28 |
| 4. | Dredge Slip 3 and Harbor | 50 | 70 |
| 5. | Open Harbor | 2) | 42 |
| 6. | Dewater Containment Site | 30) | |
| 6a. | Sheet 1st section of Ditch | 5) | |
| 7. | Excavate & Backfill Ditch | 125) | 190 |
| 7a. | Cover Containment Site | 20) | |
| 8. | Seal Surface of Ditch, Topsoil & Seed | 8 | 10 |
| 9. | Clean-up and Demobilization | 5 | 7 |
| | TOTAL | | 543 |

## ALTERNATIVES A-3b AND B-2a

Alternative A-3b is similar to Alternative A-3a except that material excavated from the north ditch and parking lot would be placed in a containment site constructed by sealing off slip 3 from the rest of the harbor rather than building a site on OMC's vacant lot.

Under Alternative B-2a, the contaminated material within slip 3 would be sealed off from the upper harbor by the construction of a sheet pile wall and slurry wall across the mouth of the slip. Approximately 21,000 C.Y. of material from the upper harbor would be dredged and pumped into the slip. Additional material would be trucked to the slip from the north ditch and parking lot under Alternative A-3b.

The sheet pile wall and slurry wall across the harbor would be constructed as follows:

- Drive permanent sheet piling at least 10-feet into clay; construct concrete or steel cap.

- Drive a temporary sheet piling wall about 15-feet north of the permanent wall. Backfill the space between the two walls with compacted sand from the dredge spoils piled on OMC's vacant lot.

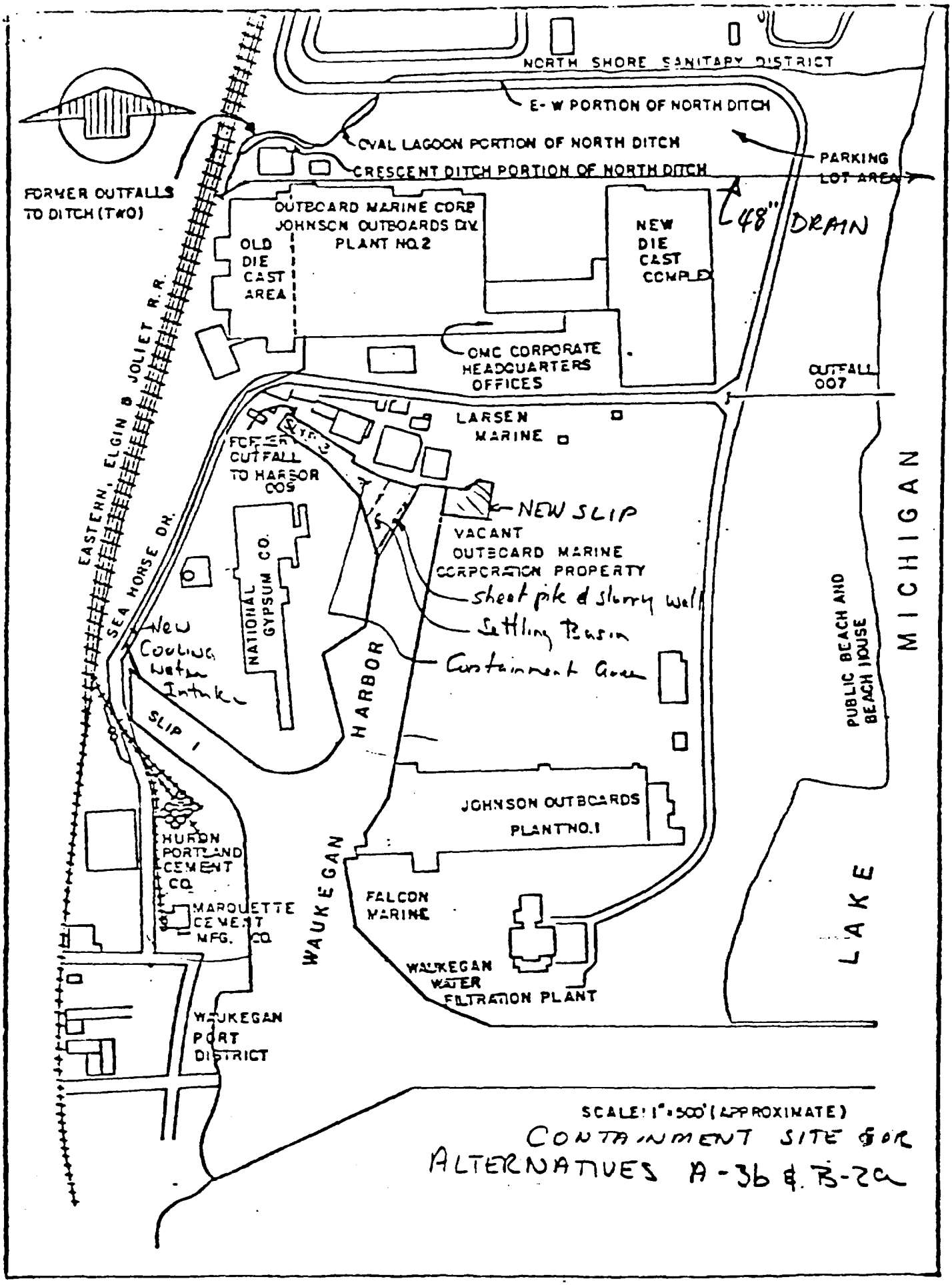
- Construct a 3-foot thick slurry wall extending at least 5-feet into clay in the center of the compacted sand causeway between the two sheet pile walls.

- After filling the containment site, remove the temporary sheet piling wall.

A crude, water treatment facility would be constructed by installing a temporary sheet pile wall within the slip to the west of the permanent wall. Equipment for the additions of polymers would be installed to provide a reasonable degree of settling of the return dredge water, as it passed through this area into the upper harbor. The upper harbor would also be temporarily sealed off during dredging to prevent the loss of PCB's to the lake.

The conversion of slip 3 into a containment site would require the construction of a new slip for Larsen Marine. It is proposed that this slip be constructed at the northeast corner of the upper harbor as shown in the attached sketch. A new cooling water intake for OMC would also be required.

Upon completion of dredging and filling with material from the north ditch and parking lot, the surface of the slip would be sealed with clay, topsoiled and seeded. Because it will not be possible to dewater the slip to any great degree after filling, it should be anticipated that some time will be required for consolidation of the dredged material prior to placing the final cover.


NORTH SHORE SANITARY DISTRICT
E-W PORTION OF NORTH DITCH
OVAL LAGOON PORTION OF NORTH DITCH
CRESCENT DITCH PORTION OF NORTH DITCH
PARKING LOT AREA
48" DRAIN
FORMER OUTFALLS TO DITCH (TWO)
OUTBOARD MARINE CORP JOHNSON OUTBOARDS DIV. PLANT NO. 2
OLD DIE CAST AREA
NEW DIE CAST COMPLEX
OMC CORPORATE HEADQUARTERS OFFICES
OUTFALL 007
EASTERN, ELGIN & JOLIET R.R.
LARSEN MARINE
FORMER OUTFALL TO HARBOR COS
NEW SLIP
VACANT OUTBOARD MARINE CORPORATION PROPERTY
sheet pile & slurry wall
Settling Basin
Containment Area
SEA HORSE DR.
NATIONAL GYPSUM CO.
New Cooling Water Intake
SLIP 1
HARBOR
MICHIGAN
PUBLIC BEACH AND BEACH HOUSE
JOHNSON OUTBOARDS PLANT NO. 1
HURON PORTLAND CEMENT CO.
MARQUETTE CEMENT MFG. CO.
WAUKEGAN
FALCON MARINE
LAKE
WAUKEGAN WATER FILTRATION PLANT
WAUKEGAN PORT DISTRICT
SCALE: 1" = 500' (APPROXIMATE)
CONTAINMENT SITE FOR ALTERNATIVES A-3b & B-2a

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3b

REMOVE CONTAMINATED MATERIAL FROM NORTH DITCH AND PARKING LOT AND DISPOSE OF IN SLIP 3

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP Storm Drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| Manholes - 8 Ft. Dia. Precast | 9 EA. | 5,000.00 | 45,000 |
| Dewatering - Well Point | 2,650 L.F. | 20.00 | 53,000 |
| Rip Rap at Outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of Contaminated Excavation in Slip 3 | 2,000 C.Y. | 5.00 | 10,000 |
| Surface Restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material From Ditch and Parking Lot | | | |
| Relocate Utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary Sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well Point Dewatering | L.S. | L.S. | 60,000 |
| Excavation & Hauling to disposal site (slip 3) | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alt. A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' Clay seal, topsoil & seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air Monitoring during Excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST | | | $1,155,300 |
| Ditch and Parking Lot Share of Cost of Converting Slip 3 to Containment Site | | | |
| 12,100 C.Y. / 38,000 C.Y. Total = 0.32 | X $1,534,722 | = | $ 491,111 |
| TOTAL CONSTRUCTION COST | | | $ 1,646,411 |
| Contingencies @ 20% | | | 329,282 |
| Engineering @ 25% | | | 411,603 |
| Legal & Administrative @ 3% | | | 49,392 |
| TOTAL PROJECT COST | | | $ 2,436,688 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-2a

DREDGE UPPER HARBOR - DISPOSE OF
CONTAMINATED MATERIAL IN SLIP 3

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor | | | |
| Dredging | 21,000 C.Y. | $ 10.00 | $ 210,000 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Pumping treated return water | L.S. | L.S. | 10,000 |
| Chemicals & labor for water treatment | L.S. | L.S. | 15,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 30,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 392,900 |
| Dredging Share of Cost for Converting Slip 3 to Containment Site | | | |
| $\frac{25,900}{38,000}$ = 0.68 X $1,534,722 = | | | $ 1,043,611 |
| Temporary Sheet Pile Wall for Water Treatment area | 6,000 S.F. | 8.10 | 48,600 |
| TOTAL CONSTRUCTION COST | | | $ 1,485,111 |
| Contingencies @ 20% | | | 297,022 |
| Engineering @ 25% | | | 371,278 |
| Legal & Administrative @ 3% | | | 44,553 |
| TOTAL PROJECT COST | | | $ 2,197,964 |

PRELIMINARY COST ESTIMATE

CONVERT SLIP 3 INTO CONTAINMENT SITE
USE WITH ALTERNATIVES B-2a AND A-3b

WITHOUT WATER TREATMENT FACILITIES

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Slip for Larsen Marine | | | |
| Steel sheet pile left in place | 16,000 S.F. | $ 16.55 | $ 264,800 |
| Excavation & disposal | 14,000 C.Y. | 10.00 | 140,000 |
| New Docks, Utilities, etc. | L.S. | L.S. | 350,000 |
| Close Slip 3 | | | |
| Steel sheet piling left in place | 12,000 S.F. | 16.55 | 198,600 |
| Temporary steel sheet piling | 12,000 S.F. | 8.10 | 97,200 |
| Sand Fill | 3,000 C.Y. | 2.50 | 7,500 |
| Slurry Wall | 32,000 C.F. | 8.00 | 256,000 |
| Reroute OMC Cooling Water In-Take | | | |
| 10" dia. D.I.P. | 1,500 L.F. | 45.00 | 67,500 |
| Modify in-take pumps | L.S. | L.S. | 10,000 |
| Utility Relocation at Slip 3 | | | |
| Construct new drains, etc. | L.S. | L.S. | 50,000 |
| Restoration Work | | | |
| 1' of sand cover from new slip | 3,157 C.Y. | 2.50 | 7,892 |
| 1' Clay seal, 1' topsoil & seed. | 9,470 S.Y. | 9.00 | 85,230 |
| TOTAL CONSTRUCTION COST | | | $1,534,722 |

WITH WATER TREATMENT FACILITIES

| | | | |
|---|---|---|---|
| Add temporary sheet pile wall for water treatment area | 6,000 S.F. | 8.10 | 48,600 |
| TOTAL CONSTRUCTION COST | | | $1,583,322 |

ALTERNATIVE A-3b & B-2a

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 12 Samples/yr. | $ 210.00 | 2,520 |
| Water samples & analysis | 2 Samples/yr. | 210.00 | 420 |
| Inspection and annual report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 2 Ac. | 180.00 | 360 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,800 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 11,000 |

ALTERNATIVE B-2a

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilize | 15 | 21 |
| 2. | Construct New slip for Larson | 64) | |
| 2a. | Reroute Cooling Water Intake & Utility reloc. | 15) | 120 |
| 2b. | Construct storm drain in parking lot - complete | 86) | |
| 3. | Close slip 3 & construct WTP area | 75 | 105 |
| 4. | Dredge Harbor | 21) | 29 |
| 4a. | Sheet first section of ditch | 5) | |
| 5a. | Open Harbor | 2) | |
| 5b. | Excavate & backfill ditch | 125) | 190 |
| 5c. | Remove temporary sheeting for WTP area | 2) | |
| 5d. | Close cover | 20) | |
| 6. | Seal surface of Ditch topsoil & seed | 8 | 10 |
| 7. | Clean-up & Demobilization | 5 | 7 |
| | TOTAL | | 482 |

## ALTERNATIVE B-2b

Alternative B-2b is similar to Alternative B-2a except that approximately 38,000 C.Y. of material would be dredged from the upper harbor and placed in a sealed-off slip 3 rather than 21,000 C.Y. It is estimated that this would fill the sealed-off slip to capacity and therefore, no additional material from the north ditch or parking lot could be placed in the slip.

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-2b

Convert Slip 3 into Containment Site, Dredge 50 ppm Contaminated Material from Upper Harbor and Dispose of in Slip 3. Construct new Slip.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Slip for Larsen Marine | | | |
| Steel sheet pile left in place | 16,000 S.F. | $ 16.55 | $ 264,800 |
| Excavation and disposal | 14,000 C.Y. | 10.00 | 140,000 |
| New docks, utilities, etc. | L.S. | L.S. | 350,000 |
| Close Slip 3 | | | |
| Steel sheet piling left in place | 12,000 S.F. | 16.55 | 198,600 |
| Temporary steel sheet pile | 12,000 S.F. | 8.10 | 97,200 |
| Sand fill | 3,000 C.Y. | 2.50 | 7,500 |
| Slurry wall | 32,000 C.F. | 8.00 | 256,000 |
| Temporary sheet pile wall for water treatment area | 6,000 S.F. | 8.10 | 48,600 |
| Reroute OMC Cooling Water In-Take | | | |
| 10" dia. D.I.P. | 1,500 L.F. | 45.00 | 67,500 |
| Modify in-take pumps | L.S. | L.S. | 10,000 |
| Utility Relocation Work At Slip 3 | | | |
| Construct new drains, etc. | L.S. | L.S. | 50,000 |
| Dredge Harbor from Mouth of Slip 3 to Slip 1 | | | |
| Dredging | 38,000 C.Y. | 10.00 | 380,000 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Pumping treated return water | L.S. | L.S. | 15,000 |
| Chemicals and labor for water treatment | L.S. | L.S. | 20,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air and Water Monitoring During Dredging | L.S. | L.S. | 40,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-2b
(Continued)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Restoration Work | | | |
| 1' of sand cover from new slip | 3,157 C.Y. | $ 2.50 | $ 7,892 |
| 1' clay seal, topsoil and seed | 9,470 S.Y. | 9.00 | 85,230 |
| TOTAL CONSTRUCTION COST: | | | $2,166,222 |
| Contingencies @ 20% | | | 433,244 |
| Engineering @ 25% | | | 541,556 |
| Legal & Administrative @ 3% | | | 64,987 |
| TOTAL PROJECT COST: | | | $3,206,009 |

ALTERNATIVE B-2b

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 12 Samples/yr. | $ 210.00 | 2,520 |
| Water samples & analysis | 2 Samples/yr. | 210.00 | 420 |
| Inspection and annual report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 2 Ac. | 180.00 | 360 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,800 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 11,000 |

ALTERNATIVE B-2b

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct New Slip for Larsen | 64) | 90 |
| 2a. | Reroute 10" Dia. cooling water intake, utility relocation | 15) | |
| 3. | Close Harbor & Construct WTP area | 75 | 105 |
| 4. | Dredge Harbor | 38 | 54 |
| 5. | Open Harbor | 2) | 84 |
| 6. | Cover Containment Site | 60) | |
| 7. | Clean-up & Demobilize | 5 | 7 |
| | TOTAL | | 361 |

## ALTERNATIVES A-4 AND B-4

Under Alternative A-4, north ditch and parking lot material contaminated to a level of 50 ppm or greater would be removed and disposed of in a secure containment site constructed in OMC's parking lot.

Under Alternative B-4, contaminated material in slip 3 and the upper harbor would be dredged and placed in the containment site on OMC's parking lot.

The quantities to be disposed of are estimated to be as follows:

| | |
|---|---|
| from harbor and slip 3 | 48,000 C.Y. |
| from crescent ditch and lagoon | 16,800 C.Y. |
| from E-W portion of ditch | 9,000 C.Y. |
| from parking lot | 50,000 C.Y. |
| Total | 123,800 C.Y. |

Three secure containment cells, each with a volume of approximately 50,000 cubic yards, will be constructed on 10 acres in the area currently used as a parking lot north of OMC. A temporary water treatment lagoon, occupying an area of 1.5 acres, with a volume of 3 million gallons, will be constructed in the same area adjacent to the cells for the purpose of treating contaminated water pumped during dewatering operations and during dredging.

Most of the volume of the proposed containment cells will be below the level of the existing parking area. The finished cells will result in raising the parking lot about 7-feet above existing grade.

In order to control ground water during construction, a slurry wall will be installed around the 4,000-foot perimeter of the treatment lagoon and cell areas. Deep wells will be driven within the slurry wall area to pump ground water to levels below the bottom elevation of the containment cells. Ground water will be treated in the lagoon and discharged to a 48-inch storm sewer that will be constructed in a east-west direction, adjacent to the existing railroad siding, from an existing 36-inch culvert, to the lake.

The permanent containment cells will be lined with 5-foot of clay and fitted with an underdrain system for final dewatering purposes.

The sequence of construction is very important. First, all utilities within the proposed cell area will be relocated and a new storm drain constructed to divert water from the north ditch. Contaminated materials excavated during utility work will be stockpiled and covered to prevent volatilization of PCBs. Next, the slurry wall will be built and a water treatment system, consisting of a flocculation basin and settling pond, will be constructed at the east end of the site on top of the parking lot.

When the water treatment plant is ready for use, deep wells or a well point system will be installed inside the slurry wall. Water from the deep wells will be pumped to the treatment system and discharged via the new storm drain.

When the ground water table has been lowered about 12-feet, two containment cells will be built adjacent to the water treatment plant. Sampling data indicates that the soils in this area are relatively free of PCBs.

Once the first two cells have been made ready, the harbor will be sealed and dredged. Dredged material will be pumped to the westerly cell and the slurry water treated in the water treatment system prior to return to the dredging area. After dredging the harbor, this first cell will be dewatered and a temporary clay cover placed over it.

The second cell will be utilized to contain material removed from the crescent ditch, oval lagoon, E-W ditch, and that portion of the parking area between the slurry wall and the ditch. As in Alternatives A-5 and B-5, a mudcat, assisted by a clam shell for deep excavation, will be employed to dredge these areas.

After the ditch is excavated, construction of the third cell will begin. Much of the existing ground in the area to be occupied by the third cell has been contaminated by PCBs. Therefore, materials removed during excavation of the third cell will be stockpiled, temporarily, in the partially filled second cell. Once the third cell is complete, this material will be transferred to it. Finally, the water treatment plant will be removed and placed in the third cell and the entire area covered and restored.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-4

Remove 50 PPM & Greater Contaminated Material from North Ditch, Encapsulate, together with material from Harbor, in a containment site constructed in OMC's Parking Lot.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| New RCP storm sewer | 2,650 L.F. | $ 100.00 | $ 265,000 |
| 8' Dia. Precast MH | 9 EA. | 5,000.00 | 45,000 |
| Well point dewatering | 2,650 L.F. | 20.00 | 53,000 |
| Rip Rap @ Outlet | 50 C.Y. | 50.00 | 2,500 |
| Move & stockpile contaminated excavation | 2,000 C.Y. | 2.50 | 5,000 |
| 10" Dia. DIP sanitary sewer | 1,370 L.F. | 50.00 | 68,500 |
| 48" Dia. MH (precast) | 8 EA. | 1,400.00 | 11,200 |
| Poured-in-place MH | 1 EA. | 10,000.00 | 10,000 |
| Excavate Crescent Ditch & Lagoon | | | |
| Plug culvert between lagoon & ditch | L.S. | L.S. | 500 |
| Steel sheeting around building & tank | 10,250 S.F. | 8.40 | 86,100 |
| Soil stabilization @ water tank | L.S. | L.S. | 20,000 |
| Remove & replace R.R. siding | 300 L.F. | 40.00 | 12,000 |
| Mud cat excavation | 16,800 C.Y. | 10.00 | 168,000 |
| Clamshell excavation | 3,900 C.Y. | 12.00 | 46,800 |
| Return water pumping to WTP | L.S. | L.S. | 1,500 |
| Return water treatment | L.S. | L.S. | 15,000 |
| Return water pumping to lagoon | L.S. | L.S. | 7,500 |
| Backfill Crescent ditch & lagoon | 19,500 C.Y. | 4.00 | 78,000 |
| 1' clay seal, topsoil & seed | 1,800 S.Y. | 9.00 | 16,200 |
| Excavate E-W Ditch | | | |
| Plug end of E-W ditch @ footbridge | 100 C.Y. | 10.00 | 1,000 |
| Mud cat dredge to 5' depth | 9,000 C.Y. | 10.00 | 90,000 |
| Return water pumping to WTP | L.S. | L.S. | 1,500 |
| Return water treatment | L.S. | L.S. | 15,000 |
| Return water pumping to ditch | L.S. | L.S. | 5,000 |

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Backfill ditch | 14,000 C.Y. | $ 4.00 | $ 56,000 |
| 1' clay seal, topsoil & seed ditch | 6,000 S.Y. | 8.00 | 48,000 |
| Place material from Parking Lot in containment cell | 48,000 C.Y. | 2.50 | 120,000 |
| SUBTOTAL: | | | $1,248,300 |
| Share of cost for construction of Water Treatment Plant, Containment Cells & Operating Costs (See Attached Estimate) | | | |
| TOTAL CONSTRUCTION COST: | | | $4,859,348 |
| Contingencies @ 20% | | | 971,870 |
| Engineering @ 25% | | | 1,214,837 |
| Legal & Administrative @ 3% | | | 145,780 |
| TOTAL PROJECT COST: | | | $2,332,487 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-4

DREDGE HARBOR - DISPOSE OF CONTAMINATED MATERIAL
IN CONTAINMENT CELL IN OMC'S PARKING LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Harbor | | | |
| Temporary sheet pile wall across harbor | 9,000 S.F. | $ 8.10 | $ 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Hydraulic dredging | 48,000 C.Y. | 10.00 | 480,000 |
| Return water pumping to WTP | L.S. | L.S. | 2,000 |
| Return water treatment | L.S. | L.S. | 20,000 |
| Return water pumping to Harbor | L.S. | L.S. | 10,000 |
| SUBTOTAL: | | | $ 649,445 |
| Share of cost for Construction of Water Treatment Plant, Containment Cells & Operating Costs (See Attached Estimate) | | | $2,308,702 |
| TOTAL CONSTRUCTION COST: | | | $2,958,147 |
| Contingencies @ 20% | | | 591,629 |
| Engineering @ 25% | | | 739,537 |
| Legal & Administrative @ 3% | | | 88,744 |
| TOTAL PROJECT COST: | | | $4,378,057 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S PARKING LOT

ALTERNATIVES A-4 AND B-4

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| 12" H.P. gas relocation | 2,000 L.F. | $ 50.00 | $ 100,000 |
| Slurry wall 2' wide X 40' deep | 320,000 C.F. | 7.00 | 2,240,000 |
| **Water Treatment Plant** | | | |
| Earthwork | 12,150 C.Y. | 3.00 | 36,450 |
| Bentonite seal on bottom & side | 60,000 S.F. | 1.00 | 60,000 |
| Outlet weir & piping | L.S. | L.S. | 25,000 |
| Under drainage system | 800 L.F. | 10.00 | 8,000 |
| Timber baffle wall | 1,200 S.F. | 1.25 | 1,500 |
| Floating Flocculator | 2 EA. | 35,000.00 | 70,000 |
| Chemical feed pumps, etc. | L.S. | L.S. | 20,000 |
| **Containment Cells** | | | |
| Excavation | 180,000 C.Y. | 2.50 | 450,000 |
| Compacted Sand Berms | 24,240 C.Y. | 2.50 | 60,600 |
| Clay liner (5' thick) | 63,900 C.Y. | 10.00 | 639,000 |
| Underdrain & leachate collection | | | |
| 6" - Perf. pipe | 5,000 L.F. | 15.00 | 75,000 |
| 48" dia. collector MH's | 3 EA. | 1,500.00 | 4,500 |
| Dewatering during excavation | L.S. | L.S. | 400,000 |
| Outlet structures w/pumps | 3 EA. | 25,000.00 | 75,000 |
| **Dewater All Cells** | | | |
| Temporary pumping | L.S. | L.S. | 20,000 |
| Water Treatment | L.S. | L.S. | 40,000 |
| **Close All Cells** | | | |
| 2' Clay cover | 25,500 C.Y. | 10.00 | 255,000 |
| 12" gravel layer | 15,000 C.Y. | 10.00 | 150,000 |
| **Remove WTP & Dispose in Cells** | | | |
| Excavation | 7,800 C.Y. | 4.00 | 31,200 |
| Remove Equipment | L.S. | L.S. | 5,000 |
| Backfill Area | 8,500 C.Y. | 4.00 | 34,000 |
| **Restore Area** | | | |
| Repave Parking area | 55,500 S.Y. | 9.00 | 499,500 |
| Misc. catch basins & other surface drainage | L.S. | L.S. | 75,000 |

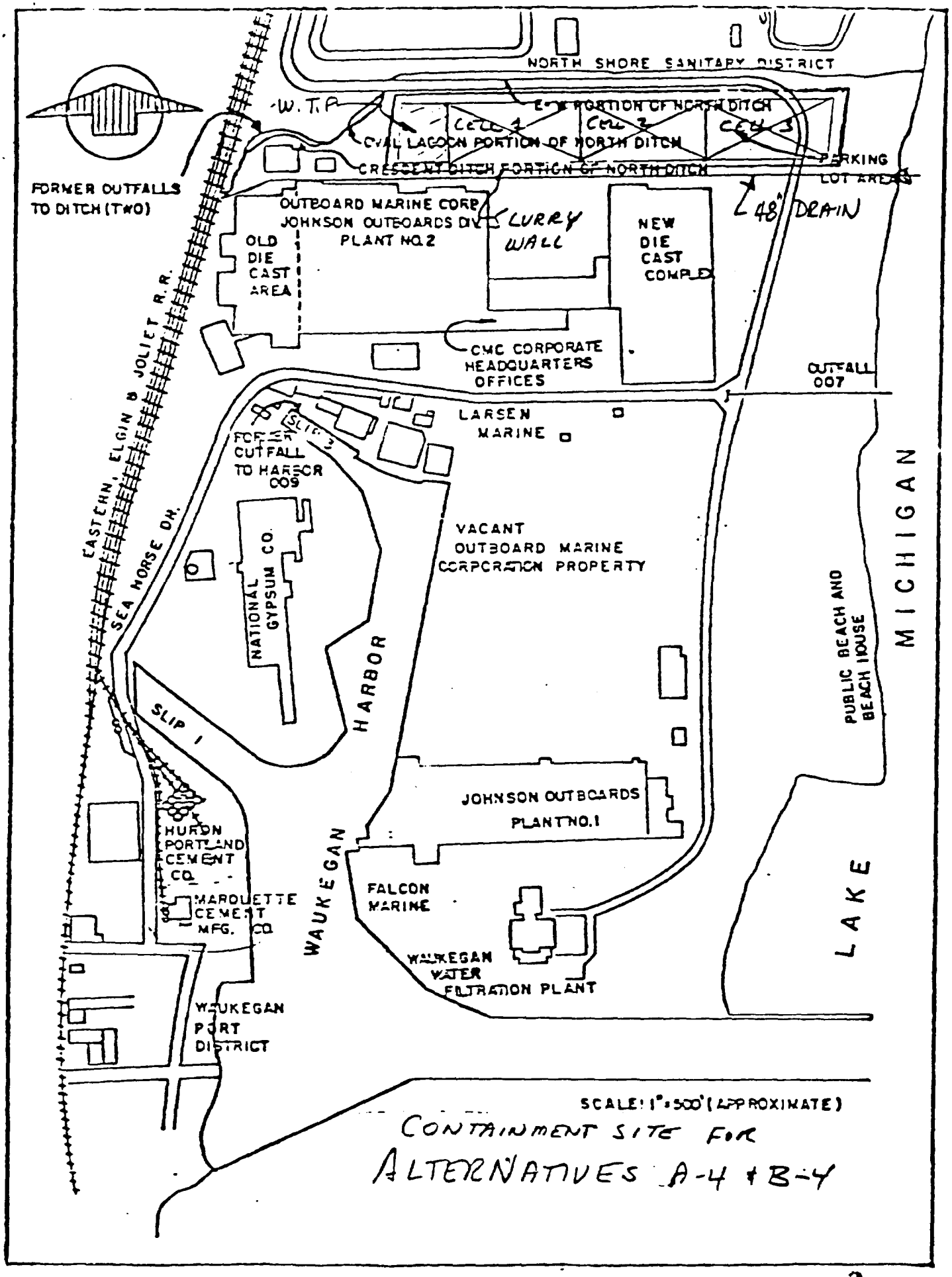
| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dispose of clean excess excavation | 55,000 C.Y. | $ 7.00 | $ 385,000 |
| Other Costs During Construction | | | |
| Monitoring & Sampling air & water | L.S. | L.S. | 100,000 |
| Decontamination of Equipment | L.S. | L.S. | 60,000 |
| SUBTOTAL CONSTRUCTION COSTS | | | $ 5,919,750 |

Share assigned to North Ditch under Alternative A-4:

$$\frac{75{,}800 \text{ C.Y.}}{123{,}800 \text{ C.Y. total}} = .61 \times 5{,}919{,}750 = \$3{,}611{,}048$$

Share assigned to Harbor under Alternative B-4

$$\frac{4{,}800 \text{ C.Y.}}{123{,}800 \text{ C.Y.}} = 0.39 \times 5{,}919{,}750 = \$2{,}308{,}702$$


NORTH SHORE SANITARY DISTRICT
W.T.P.
CELL 1
CELL 2
CELL 3
OVAL LAGOON PORTION OF NORTH DITCH
CRESCENT DITCH PORTION OF NORTH DITCH
PARKING LOT AREAS
48" DRAIN
FORMER OUTFALLS TO DITCH (TWO)
OUTBOARD MARINE CORP. JOHNSON OUTBOARDS DIV. PLANT NO. 2
LURRY WALL
OLD DIE CAST AREA
NEW DIE CAST COMPLEX
CMC CORPORATE HEADQUARTERS OFFICES
OUTFALL 007
LARSEN MARINE
FORMER OUTFALL TO HARBOR
SLIP 2
VACANT OUTBOARD MARINE CORPORATION PROPERTY
NATIONAL GYPSUM CO.
HARBOR
SEA HORSE DR.
EAST CHI., ELGIN & JOLIET R.R.
SLIP 1
PUBLIC BEACH AND BEACH HOUSE
MICHIGAN
JOHNSON OUTBOARDS PLANT NO. 1
HURON PORTLAND CEMENT CO.
MARQUETTE CEMENT MFG. CO.
WAUKEGAN
FALCON MARINE
WAUKEGAN WATER FILTRATION PLANT
LAKE
WAUKEGAN PORT DISTRICT
SCALE: 1" = 500' (APPROXIMATE)
CONTAINMENT SITE FOR
ALTERNATIVES A-4 + B-4

ALTERNATIVES A-4 AND B-4

ESTIMATED ANNUAL O&M COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air Monitoring | 1 Sample/yr. | 400.00 | 400 |
| Yearly site inspection and report | 40 Hours | 60.00 | 2,400 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,000 |
| Leachate collection and treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 12,740 |

ALTERNATIVES A-4 & B-4

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2a. | Relocate utilities in Parking Lot | 30) | 120 |
| 2b. | Construct new storm drain thru Parking Lot | 86) | |
| 3a. | Construct slurry wall around Parking Lot | 100) | 140 |
| 3b. | Construct water treatment | 60) | |
| 4a. | Dewater and construct containment cells | 140) | 196 |
| 4b. | Reinforce existing sheet pile wall in harbor | 10) | |
| 4c. | Close harbor near slip 1 | 20) | |
| 5. | Dredge harbor | 48 | 67 |
| 6. | Open harbor | 3 | 3 |
| 7. | Dredge dtich | 30 | 42 |
| 8a. | Remove water treatment plant & place in cells | 10) | 63 |
| 8b. | Dewater all cells | 45) | |
| 8c. | Backfill ditch, topsoil and seed | 32) | |
| 9. | Place final cover over cells and repave parking lot | 60 | 84 |
| 10. | Clean-up & Demobilize | 5 | 7 |
| | TOTAL | | 743 |

## ALTERNATIVES A-5 AND B-5

Under Alternative A-5, a new storm drain would be constructed through OMC's parking lot and 50 ppm and greater contaminated material from the north ditch and parking lot would be removed and disposed of in a new, off-site landfill.

Under Alternative B-5, 50 ppm and greater contaminated material from slip 3 and the upper harbor would be dredged and disposed of in the off-site landfill.

An estimate of the quantities to be disposed of under these two Alternatives is as follows:

| | |
|---|---|
| from harbor north of slip 1 | 48,000 C.Y. |
| from crescent ditch and lagoon | 16,800 C.Y. |
| from E-W portion of ditch | 9,000 C.Y. |
| from parking lot | 50,000 C.Y. |
| Total | 123,800 C.Y. |

Under these two Alternatives, it is assumed that a 60± acre site with suitable clay soils can be located and purchased within 20± miles of the harbor. A 200,000 C.Y. capacity secure landfill would be built on this site. A temporary, dewatering and containment lagoon would be constructed on OMC's vacant lot. This lagoon would have a capacity of approximately 75,000 C.Y., and would be filled and emptied twice during the dredging process. A settling basin would be constructed as part of the temporary lagoon to treat dredge return water. The materials used to construct the lagoon and settling basin would be disposed in the landfill upon completion of dredging.

The upper harbor and slip 3 would be dredged prior to dredging the north ditch and parking lot. As in other harbor dredging Alternatives, the mouth of the harbor would be sealed-off with a temporary sheet pile wall to prevent loss of PCB's to the lake, and treated, slurry water would be returned to the area of the dredge.

After dredging the harbor, the temporary lagoon would be dewatered through an activated carbon pressure filter and the treated water discharged to the harbor. The material in the lagoon would then be trucked to the secure, off-site landfill.

After the harbor has been dredged, dredging would begin in the north ditch and parking lot.

In order to excavate the oval lagoon and crescent ditch, the culvert at the north (discharge) end of the lagoon would be plugged to contain sufficient water to float a mudcat dredge. This dredge would excavate the oval lagoon to a depth of 9-feet below its present bottom and the easterly end of the crescent ditch to approximately 5-feet. Contaminated material in the westerly end of the crescent ditch, at depths over 15-feet, the maximum working depth for a mudcat, would be excavated by clam shell and placed at a shallower depth for removal by the mudcat. All dredged material would be pumped directly to the temporary dewatering lagoon. Slurry water would be returned to the dredge area via a pipeline and skid mounted pump.

After dredging, the crescent ditch and oval lagoon would be backfilled, sealed, topsoiled and seeded. The temporary lagoon would be dewatered and the material trucked to the landfill; and the temporary lagoon and water treatment plant would be dismantled and hauled to the landfill. The placement of cover material at the off-site landfill would be carried out as material is placed in the site to minimize volatizations of PCBs.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-5

REMOVE CONTAMINATED MATERIAL FROM DITCH AND LAGOON, DISPOSE OF IN NEW, OFF-SITE LANDFILL

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Relocate Utilities in Parking Lot | | | |
| 48" RCP drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| 96" Precast MHs | 9 EA. | 5,000.00 | 45,000 |
| Well point dewatering | 2,650 L.F. | 20.00 | 53,000 |
| Disposal of contaminated Exc. | 2,000 C.Y. | 15.00 | 30,000 |
| 12" H.P. Gas | 1,850 L.F. | 50.00 | 92,500 |
| 10" D.I.P. Sewer | 660 L.F. | 50.00 | 33,000 |
| 48" precast MHs | 3 EA. | 1,400.00 | 4,200 |
| Poured-in-place MH | 1 EA. | 10,000.00 | 10,000 |
| Excavate Crescent Ditch & Lagoon | | | |
| Plug culvert between lagoon & ditch | L.S. | | 500 |
| Steel sheeting around bldg. & tank | 10,250 S.F. | 8.40 | 86,100 |
| Soil stabilization @ water tank | L.S. | | 20,000 |
| Remove & replace railroad siding | 300 L.F. | 40.00 | 12,000 |
| Mud cat excavation | 16,800 C.Y. | 10.00 | 168,000 |
| Clam shell excavation | 3,900 C.Y. | 12.00 | 46,800 |
| Return water pumping from lagoon | L.S. | | 10,000 |
| Backfill Crescent Ditch & Lagoon | | | |
| Sand backfill | 19,500 C.Y. | 6.00 | 117,000 |
| Seal, topsoil & seed | 1,800 S.Y. | 9.00 | 16,200 |
| Excavate E-W Ditch & Parking Lot | | | |
| Plug E-W ditch @ foot bridge | 100 C.Y. | 10.00 | 1,000 |
| Dredge ditch (mud cat) to 5' depth | 9,000 C.Y. | 10.00 | 90,000 |
| Strip parking lot to water table | 18,000 C.Y. | 4.00 | 72,000 |
| Mudcat dredge parking lot | 30,000 C.Y. | 10.00 | 300,000 |
| Return water pumping from lagoon | L.S. | | 70,000 |
| Backfill Ditch & Parking Lot | | | |
| Sand backfill | 48,000 C.Y. | 6.00 | 288,000 |
| Seal, topsoil & seed over ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking area & road | 27,000 S.Y. | 9.00 | 243,000 |

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dewater & Dispose Material in Containment Lagoons | | | |
| Dewater via activated carbon filters | L.S. | $ | $ 50,000 |
| Excavate material from lagoon & truck to secure disposal site | 73,800 C.Y. | 15.00 | 1,107,000 |
| Handle at disposal site | 73,800 C.Y. | 2.00 | 147,600 |
| CONSTRUCTION COST SUBTOTAL | | | $ 3,413,900 |
| Share of Off-Site Secure Landfill | | | $ 1,078,022 |
| Share of Temp. Containment Site, Dewatering lagoon & WTP | | | 899,918 |
| Share of Dismantling Temp. Containment & Dewatering Lagoon | | | 786,900 |
| TOTAL CONSTRUCTION COST | | | $ 6,178,740 |
| Contingencies @ 20% | | | 1,235,748 |
| Engineering @ 25% | | | 1,544,685 |
| Legal & Administrative @ 3% | | | 185,362 |
| TOTAL PROJECT COST | | | $ 9,144,535 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-5

REMOVE CONTAMINATED MATERIAL FROM HARBOR, DISPOSE OF IN NEW, OFF-SITE LANDFILL

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Harbor | | | |
| Dredge between Slip 1 and Slip 3 | 39,000 C.Y. | $ 10.00 | $ 390,000 |
| Sheet pile wall across Slip 1 | 9,000 S.F. | 8.10 | 72,900 |
| Dredge Slip 3 | 9,000 C.Y. | 10.00 | 90,000 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Dewater containment lagoon | L.S. | L.S. | 45,000 |
| Excavate Material from Lagoon and Truck to Secure Disposal Site | 48,000 C.Y. | 15.00 | 720,000 |
| Handle at Disposal Site | 48,000 C.Y. | 2.00 | 96,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,478,445 |
| Share of Off-Site Secure Landfill | | | 689,228 |
| Share of Temporary Containment Site, Dewatering Lagoon and WTP | | | 575,357 |
| Share of Dismantling Temporary Containment and Dewatering Lagoon | | | 503,100 |
| TOTAL CONSTRUCTION COST: | | | $3,246,130 |
| Contingencies @ 20% | | | 649,225 |
| Engineering @ 25% | | | 811,532 |
| Legal & Administrative @ 3% | | | 97,384 |
| TOTAL PROJECT COST: | | | $4,804,271 |

PRELIMINARY COST ESTIMATE

OFF-SITE SECURE LANDFILL, TEMPORARY CONTAINMENT AND DEWATERING LAGOON AND WATER TREATMENT PLANT USE WITH ALTERNATIVES A-5 & B-5

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Off-site Secure Landfill | | | |
| Purchase Land | 60 A.C. | $ 5,000.00 | $ 300,000 |
| Excavate Clay | 76,000 C.Y. | 4.00 | 304,000 |
| Construct Berms (Clay) | 30,000 C.Y. | 3.00 | 90,000 |
| Construct Clay Cover | 35,000 C.Y. | 6.00 | 210,000 |
| Construct Gravel Cover | 18,200 C.Y. | 8.00 | 145,600 |
| Topsoil | 23,700 C.Y. | 10.00 | 237,000 |
| Seed | 15± A.C. | 750.00 | 11,250 |
| Leachate Collection System | 3,600 L.F. | 10.00 | 36,000 |
| Permanent Fencing | 3,500 L.F. | 6.00 | 21,000 |
| Monitoring Wells | 6 NESTS | 8,000.00 | 48,000 |
| Site Drainage | L.S. | L.S. | 100,000 |
| Construct Access Road | 1,000 L.F. | 50.00 | 50,000 |
| Decontamination Station | L.S. | L.S. | 25,000 |
| Electric Power | L.S. | L.S. | 40,000 |
| Misc. (Compaction of bottom, etc.) | L.S. | L.S. | 150,000 |
| CONSTRUCTION COST SUBTOTAL | | | $ 1,767,250 |
| Temporary Containment & Dewatering Lagoon with Treatment Plant on Vacant OMC Land | | | |
| Level Existing dredge spoil piles | 30,000 C.Y. | 1.50 | 45,000 |
| Excavate for lagoon base | 28,000 C.Y. | 1.50 | 42,000 |
| Bentonite Seal | 253,000 S.F. | 1.00 | 253,000 |
| Install leachate drains | 3,000 L.F. | 10.00 | 30,000 |
| 2' Gravel layer | 18,500 C.Y. | 10.00 | 185,000 |
| Construct sand berms | 2,750 C.Y. | 2.50 | 6,875 |
| 2' Clay liners | 22,700 C.Y. | 10.00 | 227,000 |
| Install underdrain system | L.S. | L.S. | 50,000 |
| 2' Gravel layer | 22,700 C.Y. | 10.00 | 227,000 |
| Overflow weir & piping | 1 EA. | 25,000.00 | 25,000 |
| Monitoring wells, air sampling equip., etc. | L.S. | L.S. | 60,000 |
| Roadway & site drainage | L.S. | L.S. | 60,000 |
| Install electric service | L.S. | L.S. | 10,000 |
| Shape & compact basin in sand | L.S. | L.S. | 40,000 |
| Hypalon liner | 6,400 S.F. | 0.85 | 54,400 |

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Overflow weir, piping & pump | L.S. | L.S. | $ 25,000 |
| Static mixer, chem. feed equip., etc. | L.S. | L.S. | 25,000 |
| Pumping from Cell to WTP | | | |
| O&M | L.S. | L.S. | 5,000 |
| Chemicals & staffing O&M | L.S. | L.S. | 60,000 |
| Dismantle & remove | L.S. | L.S. | 45,000 |
| CONSTRUCTION COST SUBTOTAL | | | $1,475,275 |
| Dismantle Containment Lagoon - Dispose at Secure Disposal Site | | | |
| Excavate berms, gravel layer, clay liner & clay liner under-drain material - haul to disposal site. | 70,000 C.Y. | 15.00 | 1,050,000 |
| Handle at disposal site | 70,000 C.Y. | 2.00 | 140,000 |
| Decontamination of Equipment | L.S. | L.S. | 50,000 |
| Monitoring during dredging | L.S. | L.S. | 50,000 |
| CONSTRUCTION COST SUBTOTAL | | | $ 1,290,000 |
| TOTAL CONSTRUCTION COST | | | $ 4,532,525 |

SUMMARY - Harbor Share $= \frac{48,000}{123,800} = .39$ X Cost

Ditch Share $= \frac{75,800}{123,800} = .61$ X Cost

| | | HARBOR SHARE (X .39) | DITCH SHARE (X .61) |
|---|---|---|---|
| Off-site Landfill | $1,767,250 | $689,228 | $1,078,022 |
| Temp. cont. & WTP | $1,475,275 | 575,357 | 899,918 |
| Dismantle | $1,290,000 | 503,100 | 786,900 |

ALTERNATIVES A-5 AND B-5

ESTIMATED ANNUAL O&M COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air monitoring | 1 Sample/yr. | 400.00 | 400 |
| Yearly inspection and report | 40 Hours | 60.00 | 2,400 |
| Annual maintenance and repairs to cover | L.S. | L.S. | 3,800 |
| Mow grass | 15 Ac. | 180.00 | 2,700 |
| Leachate pumping and treatment | L.S. | L.S. | 400 |
| Misc. (fencing, signs and maintenance at access road) | L.S. | L.S. | 600 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 17,840 |

ALTERNATIVES A-5 & B-5

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1a. | Construct off-site landfill | 170 | 240 |
| 1b. | Construct temporary Dewatering lagoon & containment cell on OMC's vacant lot | 110 | |
| 1c. | Construct new storm drain in OMC's parking lot | 86 | |
| 2. | Close harbor & reinforce existing slip wall | 20 | 28 |
| 3. | Dredge slip 3 & harbor | 48 | 68 |
| 4. | Open harbor | 2 | 63 |
| 4a. | Dewater containment cell & water treatment plant | 45 | |
| 5. | Remove dredged material from temporary cell, truck to off-site landfill | 60 | 84 |
| 6a. | Dredge and excavate ditch and parking lot | 80 | 133 |
| 6b. | Dewater containment cell and water treatment plant | 15 | |
| 6c. | Backfill ditch and parking lot | 90 | |
| 7. | Remove dredged material from temporary cell, truck to landfill | 96 | 134 |
| 8. | Remove temporary cell and water treatment plant, truck to landfill | 87 | 121 |
| 9. | Complete final cover at landfill | 10 | 14 |
| 10. | Clean-up & Demobilize | 5 | 7 |
| | TOTAL | | 892 |

## ALTERNATIVE B-6

Under Alternative B-6, slip 3 and approximately 500 C.Y. of contaminated material in the upper harbor near the mouth of the slip which must be removed to prevent loss of use of the harbor by Larsen Marine Co. would be dredged and disposed of in a secure containment site constructed on OMC's vacant lot. This Alternative is the same as Alternative B-3a, except that the containment site would only be used for the material from the slip and upper harbor, and no capacity would be provided for material from the north ditch or parking lot.

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-6

DREDGE HARBOR & SLIP 3; DISPOSE OF IN CONTAINMENT SITE
ON OMC VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Containment site on OMC vacant lot | | | |
| Site Work - level & compact area | L.S. | L.S. | $ 30,000 |
| 1' clay blanket (compacted) | 1,720 C.Y. | $ 10.00 | 17,200 |
| 1' gravel drainage course | 1,720 C.Y. | 10.00 | 17,200 |
| Compacted sand berm | 24,000 C.Y. | 6.00 | 144,000 |
| Clay cut off wall | 1,600 C.Y. | 10.00 | 16,000 |
| 3' clay liner | 4,900 C.Y. | 10.00 | 49,000 |
| 6" leachate collector | 900 L.F. | 10.00 | 9,000 |
| 6" dewatering pipe | 800 L.F. | 10.00 | 8,000 |
| 48" dia. collector MH | 1 EA. | 1,600.00 | 1,600 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Permanent fence | 1,500 L.F. | 6.00 | 9,000 |
| Electric power | L.S. | L.S. | 10,000 |
| Final cover | | | |
| 2' clay cover | 3,450 C.Y. | 10.00 | 34,500 |
| 1' topsoil cover | 1,800 C.Y. | 10.00 | 18,000 |
| Seeding | 2.4 A.C. | 750.00 | 1,800 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 11,000 C.Y. | 6.00 | 66,000 |
| Synthetic liner | 50,000 S.F. | 0.85 | 42,500 |
| Gravel blanket | 2,000 C.Y. | 10.00 | 20,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed pumps, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 30,000 |
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 11,375 C.Y. | 10.00 | 113,750 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & labor for water treatment | L.S. | L.S. | 12,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |

ALTERNATIVE B-6 (continued)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Air & Water Monitoring During Dredging | L.S. | L.S. | $ 25,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 996,995 |
| Contingencies @ 20% | | | 199,399 |
| Engineering @ 25% | | | 249,249 |
| Legal & Administrative @ 3% | | | 29,910 |
| TOTAL PROJECT COST | | | $1,475,553 |

ALTERNATIVE B-6

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 3 Ac. | 180.00 | 540 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 13,280 |

ALTERNATIVE B-6

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilize | 15 | 21 |
| 2. | Construct containment site and water treatment plant on OMC's vacant lot | 125 | 175 |
| 3. | Close harbor and reinforce existing sheet pile wall in slip 1 | 20 | 28 |
| 4. | Dredge slip 3 and harbor | 12 | 16 |
| 5. | Open harbor | 3) | |
| 5a. | Dewater containment site and dismantle WTP | 30) | 45 |
| 6. | Cover containment site | 20 | 28 |
| 7. | Clean-up and Demobilize | 5 | 7 |
| | TOTAL | | 323 |

MALCOLM PIRNIE

# INTER-OFFICE CORRESPONDENCE

To: JOHN C. HENNINGSON

Date: 7/7/82

From: JUDITH A. BEDARD

Subject: ADDITIONAL SUPPORT INFORMATION, WAUKEGAN HARBOR LITIGATION

This memorandum, in response to your request of 7/2/82, presents a brief history of the Upper Hudson River PCB problem and project descriptions, key design criteria and cost/benefit analysis for the following PCB-related projects:

- The Fort Edward Terminal Channel Excavation and Remnant Pool Deposit Mitigation completed by the NYSDEC in 1978.
- The Hudson River PCB Reclamation Project

In addition, dredging production rates are presented for the alternative dredging schemes developed as part of the Hudson River PCB Reclamation Project.

DEPOSITION EXHIBIT
BROWNE 4 - DMC
4-1D 8-10-82

## I. HISTORY OF THE PROBLEM[25]

The Village of Fort Edward is located in Washington County, New York, approximately 45 miles north of Albany (Figure 1). Recent activities in the upper Hudson River at this point began in the spring of 1974 after the removal of a 20-ft high timer crib dam, which was in poor structural condition and presented a hazard to the population living downstream.

After the dam was removed, some 850,000 cu yd of debris and sediment which had accumulated behind the dam for over 100 years was scoured from the deposits above the dam and deposited in the river channel within a distance of about one mile downstream. Various remedial measures, including removal of debris, were undertaken during 1974-75 by the State of New York. All these efforts, however, were carried out with no knowledge of PCB contamination.

In late 1975-76, field investigations were undertaken to determine the extent of PCB contamination in the river system. The presence of this substance had resulted from discharge of PCB-contaminated wastes over many years at two locations in the former pool of Fort Edward dam. Sampling indicated that remnant deposits on the western bank of the river had PCB levels of approximately 10 ug/g, whereas those on the eastern side (where the PCB outfall points were located) has PCB levels on the order of 100 to 5,600 ug/g. High levels of Cd and Pb were also present.

In April 1976 a flood with an approximate recurrence of 100 years occurred. This event caused the scour of an additional 250,000 cu yd from unprotected areas of the former pool. Deposits in the Fort Edward Terminal Channel as a result of the April 1976 flood averaged 20 ug/g PCB, a relatively low level because the material has been scoured primarily from the less contaminated western bank.

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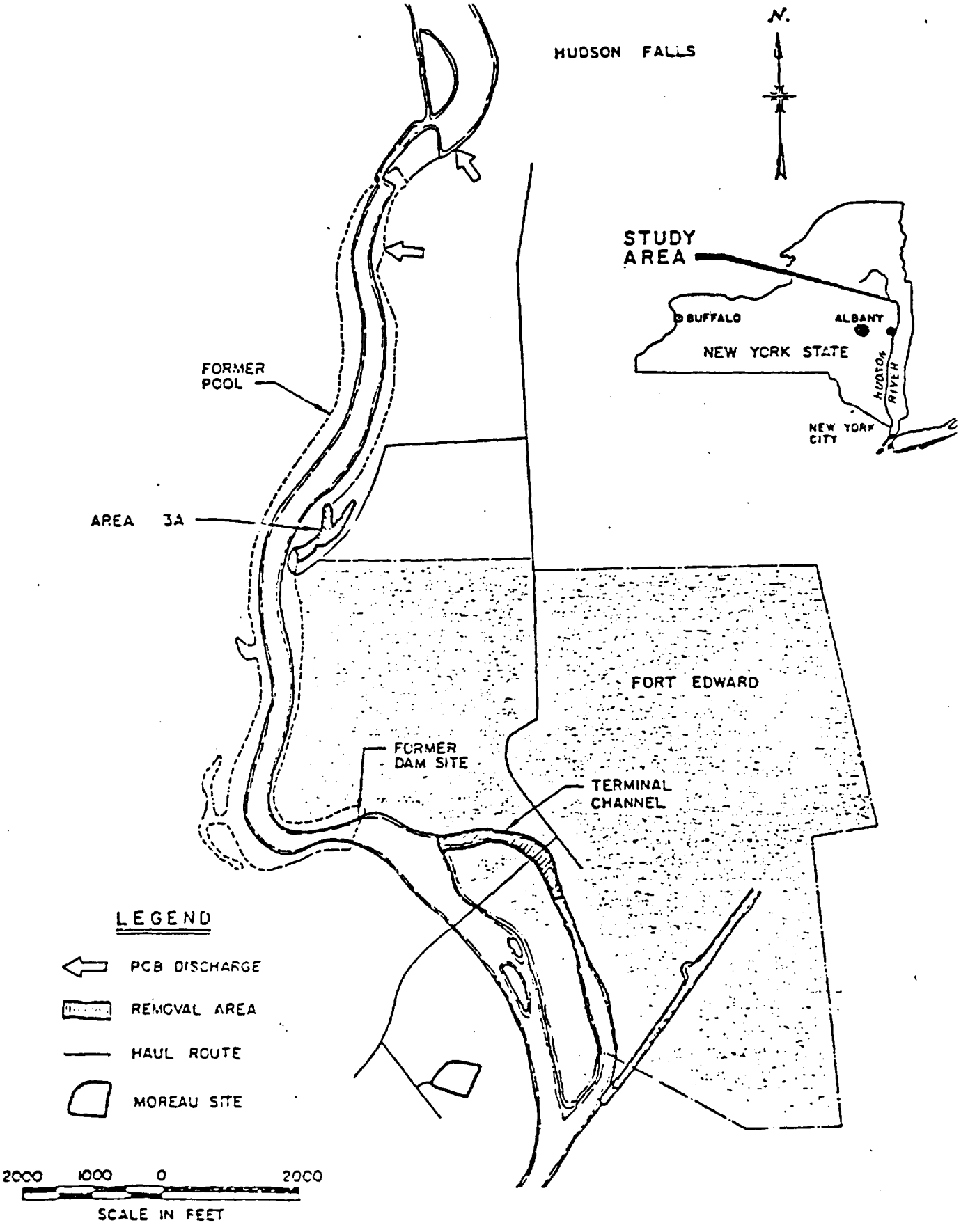



MOREAU
DREDGING AND DISPOSAL AREAS

The need to remove this new material blocking the navigation channel presented an opportunity to demonstrate certain aspects of removal and containment of river debris which, although not classified as hazardous, could be disposed of in a site which essentially met chemical landfill requirements.

The project generated valuable information on several important aspects of contaminated material handling and disposal. These findings are being used in preparing final design and dredging administration procedures for the proposed Hudson River PCB Reclamation Project in the 40-mile river reach between Fort Edward and Albany, where bed and bank sediments are contaminated by some 400,000 lb of PCB. In addition, approximately 700,000 lb of PCB is located in or adjacent to the study area in numerous landfills, dumps, and dredge spoil areas.

## II. THE FORT EDWARD TERMINAL CHANNEL EXCAVATION AND REMNANT DEPOSIT MITIGATION (1978) PROJECT DESCRIPTION

### Moreau PCB Encapsulation Site

The disposal area occupies some ten acres in the Town of Moreau, Saratoga County, New York. The site was owned by the State and was originally an unused hydraulic dredge spoil site.

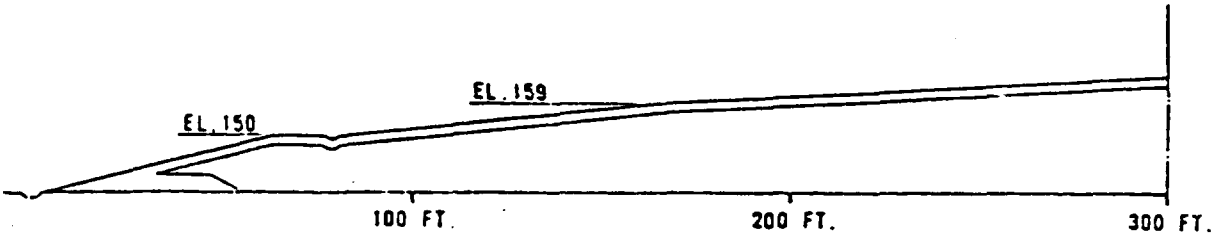
The western one-third of the site is underlain by ten to 40 ft of glacial lake clays, and the remainder by brown silty fine sand. Hydraulic conductivities of the underlying materials are on the order of $10^{-3}$ to $10^{-7}$ cm/sec.

Because of the variety of subsurface deposits, it was determined to cover the entire bottom with an 18-inch thick layer of compacted clay, which has a hydraulic conductivity (k) on the order to $1 \times 10^{-7}$ cm/sec. Before the liner was placed, the site surface was drained of perched water areas, organic material was removed, and a four-ft high interior clay dike was constructed along the southerly and easterly perimeters. The northerly and westerly perimeters of the site were established on existing debris from previous channel dredging programs

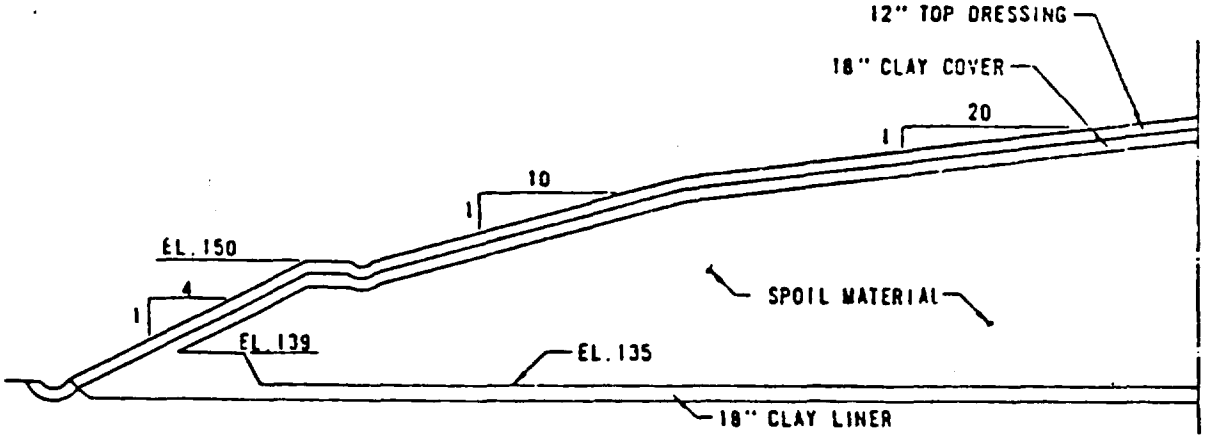
The clay liner was extended up the existing slope to provide a barrier to migration from the existing deposits, and an exterior trench drain of crushed stone and perforated pipe wrapped in filter cloth was installed to intercept groundwater flow. The side slopes of the disposal site had a maximum horizontal:vertical slope of 4:1 (Figure 2). A system of paved surface drains was provided to intercept surface runoff and an 18-inch thick clay cover was placed over the deposited debris. The final slope dressing consisted of 12 inches of material suitable for turf establishment (silty sand), followed by seeding and mulching. The permeability of the compacted clay liner was determined by infiltrometer.

The native clays utilized for the liner and cover were excavated from a borrow pit a few hundred yards from the site.

Figure 3 presents two photographs of the complete Moreau site.



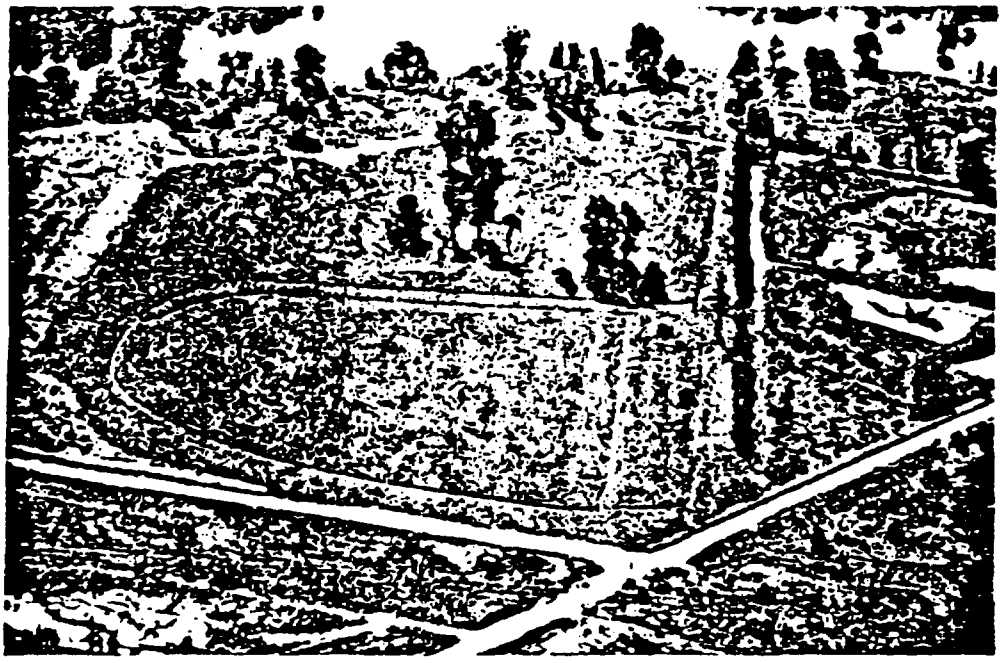

NATURAL SCALE




VERT. SCALE 2 x HORIZ. SCALE

SITE CROSS SECTIONS

PCB encapsulation site, Town of Moreau, New York, July 1979. View looking eastward at completed site eight months after final seeding with mixed grasses and clover. Side slopes of fill are one vertical on four horizontal. Paved drains for surface run off and groundwater are visible (right and foreground). Site is a joint project of DOT and DEC.



PCB encapsulation site, Town of Moreau, New York, June 1980. View looking eastward with completed site in lower half of photograph, Hudson River at top. Paved drains are visible around the perimeter of the site. DOT Moreau spoil site is at left of photograph, previously used borrow area at right. River Road crosses lower right hand corner of photograph.

## Dredging Operations

Approximately 180,000 cu yds of debris and sediment containing 6,400 pounds of PCB were removed from the Fort Edward Terminal Channel during two periods: September-December 1977 and April-June 1978. During October 1978, an additional 14,000 cu yds of material containing approximately 25,000 pounds of PCB were removed from Remnant Deposit Area 3A.

The terminal channel deposits averaged 20 ug/g PCB, whereas deposits from Area 3A had an average PCB concentration of 1,000 ug/g, and thus required a more careful handling operation. The general excavation procedure consisted of removal of material by dragline from the terminal channel and deposit in a windrow to allow for drainage and storage of materials. After a few hours the material became well drained and was easily handled.

During removal of the Fort Edward Terminal Channel material, the agitation of the bed deposits by the dragline excavation generated an oily floating scum which drifted away from the area being excavated. To resolve this problem a conventional oil boom was deployed, trapping the scum, which was removed manually, along with wood debris. PCB levels in the floating scum reached as high as 4,000 ug/g dry weight, which necessitated some care in handling.

The Area 3A deposits, located above normal water level, were removed with conventional power shovels and generally loaded directly into trucks, although some stockpiling was done. Special care was taken to clean loose material from trucks, and loads were covered to prevent contaminated material from being tracked onto highways. At the Moreau site, the dredged material was placed on lifts on the order of one to three ft to a total depth of approximately 15 ft.

## Site Problems

Because of heavy fall rains and the onslaught of an early winter, the site was not covered with clay within the time

frame originally intended. As originally designed, dredging and covering operations were to be completed by December 1977. The material from Area 3A were added to the project because the site was still open thru the summer of 1978.

During the period when the site was exposed (August 1977-November 1978) precipitation in the vicinity was measured at 66.5 inches. This value is about 30 percent greater than average for the same period. Measurements made through the installation of temporary observation wells, as well as several backhoe test pits indicated that some 12 feet of saturated material existed at the site prior to start-up of the dewatering operations.

In May of 1978, wet spots were noticed in two areas of the newly clay covered south and east slopes. A few weeks after the covering of the clay surface with 12 inches of turf establishment material the areas in which the wet spots were noticed experienced tension cracks followed by surface slumping. Slumping along the south slope occurred over an area of about 50 feet, and slumps over an area of about 100 feet long occurred on the east slope.

Dewatering the Site

The site was originally designed under the assumption that material would be spoiled and covered during the same season. An internal clay perimeter dike was constructed three to four feet above the bottom of the liner. In addition, one permanent four-inch monitoring well/drain (DOT) was installed in a low part of the disposal site. It was anticipated that six to seven inches of precipitation might percolate through the clay cover per year. This would have resulted in an accumulation of about $1.9 \times 10^6$ gallons per year, exclusive of leakage through the bottom and drainage out the four-inch monitoring well and drain. The drain was designed to accept a flow of three to five gpm (15 in. of 30 slot screen), or $1.6 \times 10^6$ to $2.6 \times 10^6$

gallons per year. At this rate (and with some bottom leakage) it was expected that water accumulation would be minimal, and that the interior dike would provide storage capacity for at least a few years accumulation. The in-situ hydraulic conductivity of the material was much less than anticipated, with the drain yielding only about 0.5 to 1 gpm.

In July of 1978, various alternatives for dewatering of the site were evaluated for cost and time requirements.

It was determined that a wellpoint dewatering system running parallel to the east and south slopes would be the only timely means of dewatering for slope repairs. It was also decided to install a permanent trench drain system in the vicinity of the two slope slippages. The length of the trench drain would be determined by the ease of installation encountered in the field.

Wellpoint Installation

Nine hundred feet of header and 82 points were installed, during the period September 25-29, 1978.

The operation of the wellpoint system allowed for an almost immediate repair of the failed slope areas, although pumping rates were much less than expected. The repairs consisted of removing the 12 inches of turf establishment material and the 18 inches of clay about and adjacent to the failed areas. All slumping occurred at the clay-dredge spoil interface. Approximately 1,800 square yards of slope were removed and repaired during October of 1978. In addition an interior trench drain 400 ft long by 4.5 wide was installed adjacent to and between the two failure areas.

Analysis of Dewatering Operations

Through December 1978 it is estimated that approximately 1 x $10^6$ gallons were removed from the Moreau site through

wellpoint pumping, siphon operation and gravity drainage (DOT well).

Siphon operations have continued sporatically (no winter operations) to the present time. From December 1978 to March 1980, it is estimated that an additonal 820,000 gallons have been removed. This number is based on a siphon operation for 130 days at 3.5 gpm (655,000 gal) and a gravity drainage of about 0.25 gpm continuous since December 1978 (165,000 gal). The PCB concentration of this water is monitored periodically since it is discharged back into the Hudson River. As of March, 1980 site water levels were on the order of 141.50 ft a drop of 2.7 ft since December 1978. Based on the theoretical porosity area drawdown relationship 785,000 gallons (2.7 x 290,000) would have been removed. This number correlates nicely with the estimated actual withdrawal.

## III. HUDSON RIVER PCB RECLAMATION PROJECT DESCRIPTION

### A. Project Description

The Hudson River PCB Reclamation Project as presented in the Scoping Report (March 1981) includes four components directed toward reducing the impact of PCB on the Hudson River, its biota, and the surrounding Hudson River Valley. These components are:

- Dredging of approximately 27 hot spot[1] areas in the river bed with containment in a secure upland site.
- Design and construction of a secure upland containment site capable of long-term isolation of contaminated material.
- The dressing and fencing of remnant deposit areas 3 and 5, located above the former Fort Edward Dam site.
- Destruction of the recovered PCB at such time as a technically and economically feasible procedure becomes available.

### B. Containment Site

The containment site, referred to as Site 10 in earlier reports, is situated on a 250 acre parcel of land located approximately 2.5 miles south of the Village of Fort Edward, in the Town of Fort Edward, in Washington County, New York. (See Figure 4).

The site's major components include:

- Containment Area
- Roughing and Storage Pond
- Surge Pond
- Water Treatment Plant
- Leachate Collection System
- Storm Water Drainage System
- Chemical Feed System

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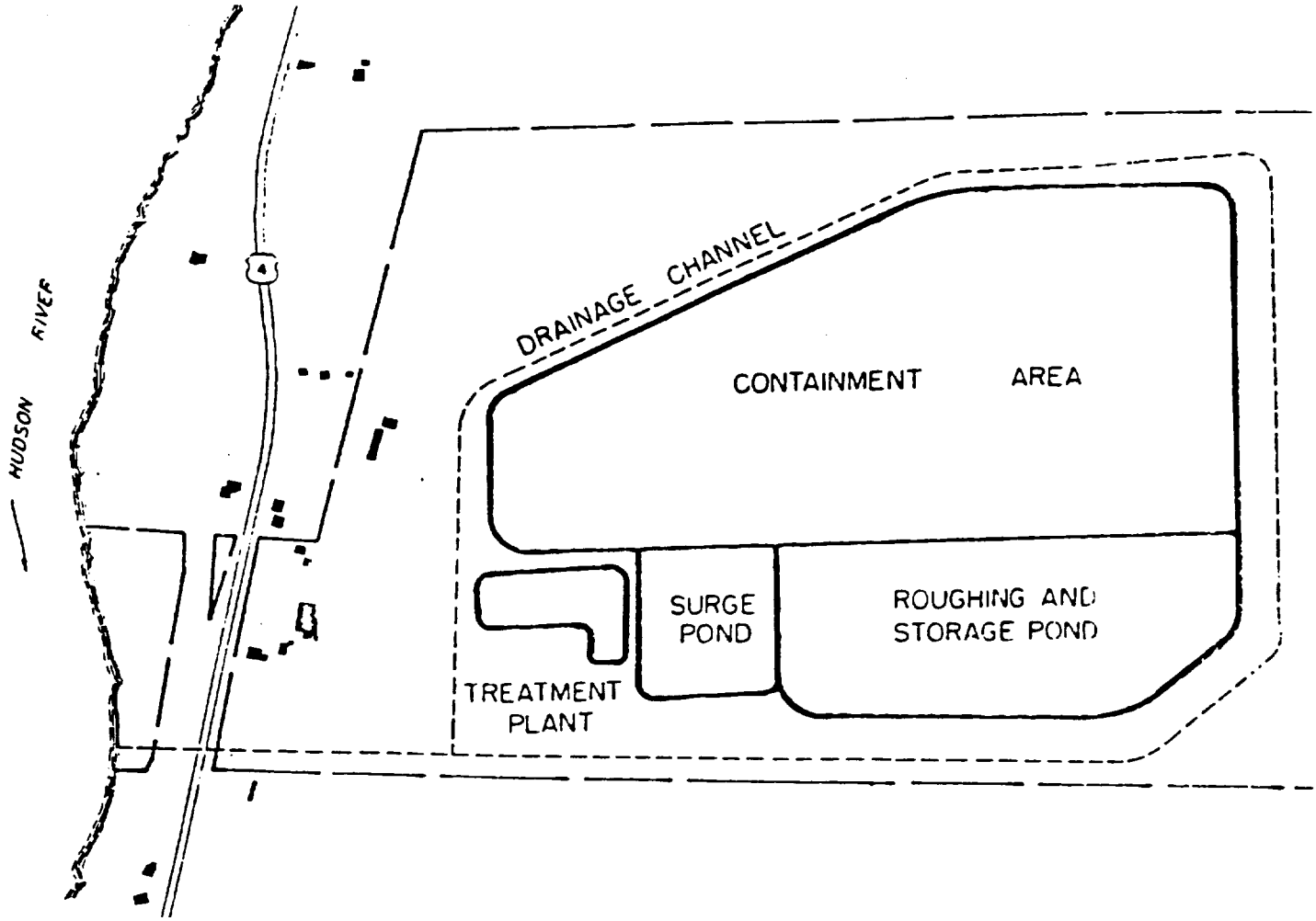
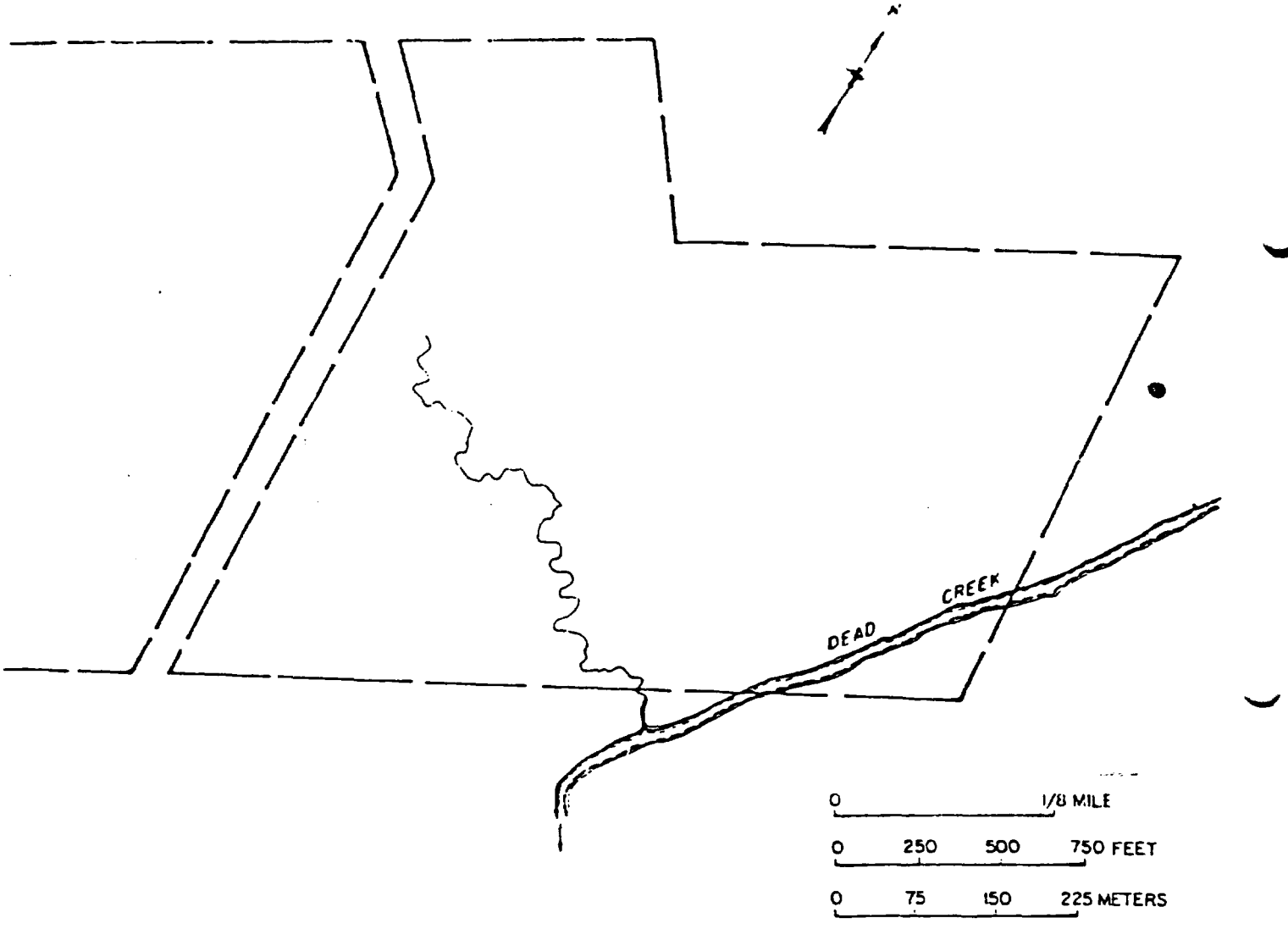
[1] Hot spots have been defined as areas of PCB contamination equal to or greater than 50 μg per g.




RESCOPED

MALCOLM PIRNIE INC

FIGURE 4




NMENT SITE

Containment Area - The containment area is an earthen basin bisected by a cross dike. It occupies approximately 40 acres at its maximum water surface and its total containment volume of approximately 1,100,000 cu yds. This volume is sufficient to hold all of the 27 hot spots.

The containment area is designed for long term encapsulation of PCB-contaminated materials.

Roughing and Storage Pond - The roughing and storage pond (R&SP) is an earthen basin with a maximum water surface area of approximately 12 acres.

After the slurried dredge material is pumped into the containment area, weir overflow is transported via pipeline to the R&SP. The primary purpose of this basin is to ensure efficient sedimentation near the end of each dredging season as the effective overflow rate in the containment area decreases. The R&SP also provides protection for the subsequent treatment units from any upsets in the containment area which might lead to transient escape of dredged material.

A small portable dredge will be operated to recycle settled dredged material back into the containment area.

The R&SP is not a permanent containment unit. At the end of the dredging program, all of the contaminated material in the R&SP will be relocated to the containment area and the pond will be filled in and regraded.

Surge Pond - The surge pond is an earthen basin with a maximum water surface area of 2.4 acres. This pond receives weir overflow from the R&SP. Its purpose is to buffer the treatment plant units from surges in the dredging process and to provide a convenient, sediment-free point for treatment feed and recycle supply pump suctions if a recycle dredging procedure is implemented. A detailed discussion of dredging options is presented in the Containment Site Design Report.

Water Treatment Plant - The water treatment plant consists of two earthen basins, the flocculation basin and the settling basin, with maximum water surface areas of 0.1 and 1.0 acres, respectively. The plant has a capacity of 13 million gallons per day (mgd) and consists of coagulation, flocculation and sedimentation units. The purpose of the water treatment plant is to reduce PCB concentration in the dredge return flow before discharge to the river.

The water treatment plant is expected to achieve effluent suspended solids less than 4 milligrams per liter and turbidity less than 10 NTU with proper chemical doses. The average PCB concentration in the discharge is expected to be in the 10-20 microgram per liter range.

Leachate Collection System - The leachate collection system is a network of perforated drainage piping laid in gravel-filled, filter-cloth-lined collection trenches at the base of the containment area. The bottom of the containment area is sloped to transmit flow towards the trenches.

The leachate collection system will be utilized in two phases: short-term dewatering and long-term percolation.

A piping system connects the drainage system to a leachate storage tank and subsequently to a discharge point at the Hudson River.

In addition valves, collection and sampling wells, and a flow metering and monitoring manhole are provided to determine the quantity and concentration of PCB in the leachate. Discharge to the Hudson River will only be permitted if the observed leachate quantities and concentrations will have no adverse impact on the River. If river discharge proves unacceptable, the leachate will be stored in-place and periodically collected and treated from the leachate storage tank.

Stormwater Drainage System - The stormwater drainage system will intercept and convey stormwater runoff that would have directly affected the containment site. Precipitation

falling on the containment site, and on the watershed north of the containment site, will be transported by the drainage system to the Hudson River.

The components of the drainage system include a combination of swales, open channels, and closed conduits.

Chemical Feed System - Pumps, piping, tanks and dilution water will be provided for two optional treatment processes - polymer only and a alum, caustic and polymer combination. The required equipment will be housed in a chemical feed building.

Other Site Components - Other site components include pump station, access road, electrical services, fencing, seeding, clearing and grubbing and monitoring wells.

C. Hot Spot Dredging

Thompson Island Pool - The Thompson Island Pool is located between the Thompson Island Dam and Rogers Island. The areas to be dredged are the 20 identified hot spots (including four above Lock 7) with a volume of approximately 545,500 cu yds and 105,800 lbs of PCB (see Table 1).

Lower Pools - Based on a range of costs per cubic yard for dredging, transport and treatment, between 160,000 and 265,000 cu yds of material could be dredged in the lower pools within the budget constraints of the rescoped project.

Using the MPI estimates of contaminated volumes and PCB masses listed in Table 1, and applying the criteria described previously in the Rescoping Report, to each of the lower pools, resulted in the following dredging program for the lower pools. Using the lower range value of 160,000 cu yds (high estimate of unit cost), only lower pool hot spots 29-34 in the Lock 5 Pool will be dredged. Using the higher range value of 265,000 cu yds (low estimate of unit cost), both lower pool hot spots 29-34 in the Lock 5 Pool and approximately 80 percent of hot spot 37 in the Lock 3 Pool will be dredged. Table 2 details the hot spots to be dredged under the rescoped program.

Table 1

Hudson River PCB Reclamation Project Areas to be Dredged

Contaminated and Removal Volumes and PCB Quantities[7]

| Hot Spot[1] Area No. | Area (sq ft) | Contaminated[2] Volume (cu yd) | Mean[2,3] PCB Conc. (μg/g) | PCB[2,3,4] Quantity (lbs) | Removal[5] Volume (cu yd) |
|---|---|---|---|---|---|
| 1 | 66,600 | 3,100 | 63 | 340 | 7,400 |
| 2 | 21,200 | 1,000 | 81 | 140 | 2,350 |
| 3 | 38,300 | 1,750 | 46 | 140 | 4,250 |
| 4 | 78,800 | 3,650 | 50[6] | 320 | 8,750 |
| Subtotal | 204,900 | 9,500 | 57 | 900 | 22,750 |
| 5 | 460,400 | 34,100 | 62 | 3,710 | 51,150 |
| 6 | 1,033,700 | 76,550 | 69 | 9,270 | 114,850 |
| 7 | 110,600 | 8,200 | 39 | 560 | 12,300 |
| 8 | 1,462,700 | 108,350 | 99 | 18,830 | 162,500 |
| 9 | 118,500 | 8,800 | 38 | 590 | 13,150 |
| 10 | 191,200 | 14,150 | 78 | 1,940 | 21,250 |
| 11 | 57,100 | 4,250 | 39 | 290 | 6,350 |
| 12 | 45,700 | 3,400 | 71 | 420 | 5,100 |
| 13 | 28,000 | 2,050 | 89 | 320 | 3,100 |
| 14 | 974,200 | 72,150 | 279 | 35,330 | 108,250 |
| 15 | 286,600 | 21,250 | 103 | 3,840 | 31,850 |
| 16 | 446,500 | 33,050 | 380 | 22,060 | 49,600 |
| 17 | 83,200 | 6,150 | 256 | 2,770 | 9,250 |
| 18 | 201,700 | 14,950 | 94 | 2,460 | 22,400 |
| 19 | 42,000 | 3,100 | 83 | 450 | 4,650 |
| 20 | 62,700 | 4,650 | 249 | 2,030 | 6,950 |
| Subtotal | 5,604,800 | 415,150 | 144 | 104,900 | 622,700 |
| 29 | 32,700 | 1,500 | 81 | 220 | 3,650 |
| 30 | 54,400 | 2,500 | 155 | 690 | 6,050 |
| 31 | 194,300 | 9,000 | 516 | 8,150 | 21,600 |
| 32 | 41,200 | 1,900 | 51 | 170 | 4,600 |
| 33 | 119,400 | 5,550 | 98 | 950 | 13,250 |
| 34 | 955,800 | 44,250 | 159 | 12,350 | 106,200 |
| Subtotal | 1,397,800 | 62,700 | 205 | 22,500 | 155,350 |
| Total Using High Estimate of Unit Cost[8] | 7,207,500 | 487,400 | 150 | 128,300 | 800,800 |

Table 2

Rescoped Program

Hot Spot Dredging
High Estimate of Unit Cost

| Pool | Hot Spots | Contaminated Material | |
|---|---|---|---|
| | | vol, cu yd | PCB Mass, lb |
| Thompson Island | 1 thru 20 | 645,500 | 105,800 |
| Lock 5 | 29 thru 34 | 155,350 | 22,530 |
| | | 800,850 | 128,330 |

Hot Spot Dredging
Low Estimate of Unit Cost

| Pool | Hot Spots | Contaminated Material | |
|---|---|---|---|
| | | vol, cu yd | PCB Mass, lb |
| Thompson Island | 1 thru 20 | 645,500 | 105,800 |
| Lock 5 | 29 thru 34 | 155,350 | 22,530 |
| Lock 3 (1) | 37 partial | 109,650 | 9,310 |
| | | 910,500 | 137,640 |

(1) Partial removal will recover approximately 80 percent of in-place PCB in Hot Spot 37.

Note: All values based upon MPI estimates as presented in Draft EIS, N.Y. State Environmental Quality Review, September 1980.

Under the rescoped dredging program between 37 and 40 percent of the 347,200 pounds of PCB in the hot and cold spots in the Upper Hudson river bed will be dredged. The PCB masses used in calculating these percentages are the total masses of PCB associated with the volumes of material expected to be dredged. These percentages therefore do not reflect quantities of PCB missed in the dredging process, lost to the water column or returned to the river in treatment plant effluent. Earlier studies have shown that the losses in these three areas total in the range of 6 to 9 percent.

C. Other Program Elements

Remnant Deposits - The remnant deposits are PCB-contaminated areas adjacent to the Hudson River upstream of the former Fort Edward Dam. These areas are the remains of 150 years of deposition behind the dam, exposed as dry land following dam removal in 1973. Much of the deposited material has washed downstream; those areas which remain have been designated remnant deposits.

Under the rescoped project remnant deposit areas 3 and 5 will be top dressed and perimeter fencing will be installed as required.

Monitoring Program - A brief description of the proposed program for monitoring the effectiveness of the dredging program follows. The program will include two overlapping categories of monitoring, environmental and operations.

Environmental monitoring will involve atmospheric, aquatic and terrestrial sampling before, during and after the completion of dredging activities. Samples will be taken at least daily during dredging and more intensively during early phases of the project to provide supplemental operations control data. Dredged material will be regularly sampled to assure that the dredging operation is recovering contaminated material.

Environmental monitoring after the completion of dredging will record the more immediate effects of the PCB dredging program on PCB levels in the air and water; and, later, any residues on land, foliage and in animal tissues.

The following studies will be included under the environmental monitoring program:

- Sediment Transport Monitoring
- Hudson River Fish Flesh PCB Analysis
- Sediment PCB Desorption Study
- Biological (Macroinvertebrate) PCB Uptake Study
- Foliar Contamination by PCB in Washington County Forage Crops
- Air-Plant PCB Relationships
- Agricultural Inplace Studies.
- Site 10, ground water monitoring.

Operations control includes both monitoring and dredge control. The dredge phase losses, bucket losses, losses to the water column and air, and the loss of PCB in the treatment plant effluent will all be monitored. The purpose of the monitoring is not simply to record the effectiveness of the related processes, but to provide "real time" data that can increase and maintain the best attainable dredging efficiency.

## IV. SUMMARY OF PCB ENCAPSULATION SITE DESIGN CRITERIA

A summary of the design criteria for the Moreau PCB Encapsulation Site and the proposed Site 10 Containment Site is presented in the following Table.

Table 3

Key Design Criteria

| | Moreau Site | Proposed Site 10 |
|---|---|---|
| Capacity (volume) cu yds | 194,000 cu yds<br>180,000 cu yds @ avg. PCB conc. of 20 ppm<br>14,000 cu yds @ avg. PCB conc. of 1000 ppm | 1,100,000 cu yds |
| Fluff Factor | None | 1.1 (Thompson Island Pool and above Lock 7)<br>1.3 (Lower Pools) |
| Liner | 18" of imported clay<br>$k = 1 \times 10^{-6}$ (specified)<br>$k = 1 \times 10^{-7}$ (measured) | in situ clays, depth of 10 feet+<br>$k = 2.6 \times 10^{-7}$ (mean value) |
| Cap | 12" top dressing<br>18" clay cover | 10" top dressing<br>8" gravel<br>18" clay cover |
| Leachate | Wellpoint system and trench drain running parallel to the interior east and south slopes of the containment site. Discharge piping is connected to perimeter asphalt drainage channel. | o Sloped bottom of containment areas.<br>o Network of gravel filled collection trenches wrapped with filter fabric<br>o Perforated drainage piping in collection trench (8" P.E. pipe)<br>o Collection and sampling wells on containment area perimeter, connected to drainage piping.<br>o Piping system connecting drainage system to leachate storage tank<br>o Valved piping system connecting leachate storage tank to discharge point at Hudson River.<br>o Flow metering and monitoring system. |

Table 3
(continued)

Key Design Criteria

| | Moreau Site | Proposed Site 10 |
|---|---|---|
| Leachate Treatment | No leachate treatment required. | If required, leachate will be pumped out of leachate storage tank and treated either off-site, or at a treatment facility on-site. |
| Dredged Slurry Treatment | No slurry, PCB contaminated material trucked to site. | System set up for either polymer or alum, polymer caustic combination. |
| Water Treatment Plant Effluent Discharge Quantities | Not applicable. | Average PCB concentration 10 to 20 µg/l.<br>Maximum PCB concentration 100 µg/l<br>Minimum PCB concentration 4 µg/l<br>Suspended Solids $\leq$4 mg/l<br>Turbidity $\leq$10 NTU |

## V. COST/BENEFIT ANALYSIS

Cost/benefit analyses are presented with respect to two criteria. First the cost per pound of PCB removed was determined, and secondly, the cost per pound of reducing the PCB load over the Federal Dam at Troy and into the Hudson River Estuary was estimated.

### A. Cost Per Pound of PCB Removed

The cost per pound of PCB removal for the Moreau Project was determined by using actual costs, actual yardages removed and measured pounds of PCB contained in the site. These costs are presented as actual costs at the time of performance and again as estimated 1982 costs. The 1982 costs were estimated by using an average annual inflation rate of 8.3 percent over the period 1977 to 1982. This inflation rate was developed from increases in the ENR Indexes for construction costs and material costs over the period.

The cost per pound of PCB removal for the proposed Site 10 project was determined based upon cost estimates presented in the Scoping Report of March 1981. In accordance with the figures developed in this report, a ten percent inflation rate was assumed to adjust 1981 costs up to the 1982 base and 1983 cost down to the 1982 base.

Table 4 presents the results of the cost/benefit analysis based upon cost per pound of PCB removed. Costs have been estimated in three categories - removal and treatment; containment, site work and material handling; and treatment (chemical costs only).

The cost per pound of PCB removed in the Moreau project is $82 per pound. The cost per pound of PCB removed in the Site 10, Hudson River PCB Reclamation Project is $192-206 per pound.

Table 4

Cost/Benefit Analysis
Cost Per Pound of PCB Removed

| | Moreau Site | | | | Proposed Site 10 |
|---|---|---|---|---|---|
| Yardage Removed (cu yds) | Fort Edward Terminal Channel | | 180,000 | | Estimated Range: 800,850 to 910,500 |
| | Remnant Deposit Area 3A | | 14,000 | | |
| | | | 194,000 cu yds | | |
| PCB Removed | Fort Edward Terminal Channel | | 6,400 lbs (measured) | | Estimated Range: 128,300 lbs to 137,640 lbs |
| | | Approximately | 25,000 lbs (estimated) | | |
| | | | 32,000 lbs (estimated) | | |
| Cost of PCB | Fort Edward Terminal Channel | | Remnant Deposit Area 3A | | Estimated 1982 Dollars (6) |
| | (1977 $) | (Est. 1982 $) | (1978 $) | (Est. 1982 $) | |
| Removal and Transport | 605,000 (1) | 901,000 (2) | 403,050 (5) | (2) | 11,150,000 |
| Containment, Site Work, Material Rehandling | 258,000 (1) | 384,000 (2) | 85,400 (5) | (2) | 7,310,000 |
| Treatment (Chemical Costs Only) | - | - | - | - | 740,000 |
| Dewatering Costs (Estimated) | 105,000 (3) | 144,000 (2) | - | - | (monitoring) 1,420,000 |
| Hudson River Probing and Sampling | - | - | - | - | 650,000 |
| Subtotal | 968,000 | 1,429,000 (2) | 488,450 (4) | 672,000 (2) | 21,270,000 |
| Engineering Design, Field Engineering, Construction Administration, and Legal and Administrative Costs | 242,200 (6) | 358,000 | 122,000 (6) | 168,000 | 5,218,000 |
| Total | 1,210,000 | 1,787,000 | 489,000 | 840,000 | 26,488,000 |
| Cost per pound of PCB Removed (1982 Dollars) | Fort Edward Terminal Channel | | $279/lb | | $192-206/lb |
| | Combined Terminal Channel & Site 3A | | $ 82/lb | | |

Table 4
(continued)

Cost/Benefit Analysis
Cost Per Pound of PCB Removed

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(1) Costs from D.A. Collins Construction Co. Inc. Bid Letting, July 14, 1977

(2) Cost escalated at an annual inflation rate of 8.3%.

(3) Costs from August 29, 1978 letter of cost of work to Mr. V. Griffin of NYSDOT from Harold V. Clark of James H. Maloy, Inc.

(4) Cost taken from R.F. Thomas memo to File 266-14-2 dated 7/14/78.

(5) Breakdown of costs was estimated using a ratio of removal and transport cost to total cost as developed in the Engineer's Estimate included in "Removal and Stabilization of Remnant Deposits Fort Edward Flood Control Project Report on Design and Estimate", Malcolm Pirnie, Inc., May 1978.

(6) Cost estimated as 25% of cost for removal, transport, containment, site work, material rehandling, treatment chemical costs and dewatering.

## B. Cost per Pound of PCB Reduction Over the Federal Dam at Troy

The transport of PCB in the Upper Hudson has been modeled by Lawler, Matusky & Skelly Engineers (1978, 1979). Their model is based on a historical flow cycle of the Hudson River of 20 years (1958-1977). The 20 year cycle was selected as a result of a multiple periodic regression analysis of 47 years of flow records at Spier Falls.

The study makes use of the sediment transport model (HEC-6), developed at the Hydrologic Engineering Center of the U.S. Corps of Engineers. Using mean daily flow records, cross sectional geometry, downstream rating curves and grain size distribution of the river bed material, the program computes flow depth, velocity, physical capacity of the river to transport sediments, and the scour or deposition rates of sediments in the river.

A PCB Inventory Model developed by LMS compliments the HEC-6 by accounting for the incoming and outgoing PCB for each reach, and for the PCB exchange between the water column and the river bed based on the computed scour and deposition. The output from this model is a relationship of PCB concentration versus flow for the downstream boundary condition of each modeling reach. The integration of the PCB concentration to flow relationship with the 20 year flow data provides the cumulative mass of PCB transported in each reach over the projected period. The model projections consider the incoming concentrations at Rogers Island as the upstream boundary condition and simulate the movement of PCB to the Federal Dam at Troy in 20 year cycles.

The PCB concentrations monitored at Rogers Island deserve particular attention, for while the PCB transport from Rogers Island to the Troy Dam was simulated, the input load of PCB at Rogers Island is the measured upstream boundary condition of the model. Two conditions are identified and tested by LMS in their model: an upper limit identified as present conditions

(post-1978) which gives an average loading of 2900 pounds of PCB/year, and a lower limit that gives 1300 pounds of PCB/year. The lower limit is an estimate of the reduced loading that would occur if the upstream influent PCB (from Glens Falls to Rogers Island) could be reduced in the future by remedial action, washout or some other method. The report identifies remnant deposits 3 and 5, which have the highest concentration of PCB in the area, as the major contributor of upstream PCB. However, these two areas have been stabilized and are outside the normal scouring path of the Hudson River. Several studies (MPI March 1978, DEC March 1980) consider their contribution of PCB to be negligible.

USGS data collected since the remnant pool mitigating measures of 1978 fall within the limits of 1300 to 2900 pounds per year. Pending additional data collection by USGS, especially at high flow conditions, these figures will be regarded as the upper and lower limits of PCB loadings at Rogers Island.

Based on these conditions, the model estimates the transport of PCB over the Troy Dam and to the estuary. The higher estimate projects 7200 pounds/year of PCB discharge, while the lower estimate predicts 5600 pounds/year. These loadings are averaged over a 20-year period based on historical flow records, and do not reflect the yearly fluctuations of river discharges and variations of the PCB mass transported.

LMS projects average annual transport of 7200 pounds PCB over the dam at Troy for a 66 year period, after which the Upper Hudson source would be exhausted. The transport of PCB is limited by the supply of available PCB. Therefore, if no remedial action is undertaken, the supply of PCB would diminish over time by the quantities transported. The following table adapted from LMS (1979) summarizes this transport.

PCB TRANSPORT, NO-REMEDIAL-ACTION ALTERNATIVE

| Location | PCB Transport pounds/year | Supply of Available PCB pounds | No. of Years to Exhaust Supply |
|---|---|---|---|
| At Lock 7 | 2900 - 1300 | 50,000 | 38 - 19 |
| Lock 7 to Troy | 4300 | 284,000 | 66 |
| Federal Dam at Troy | 7200 | | |

Sources: LMS (1979)
DEC (1980)
Estimates for Draft EIS NYSEQR report, MPI (September 1980)

In addition, LMS (1978, 1979) estimated the average annual PCB load at Troy for the pre-1978 period before either the Remnant Deposit Area 3A Mitigation or the Fort Edward Terminal Channel Excavation occurred. The 1978 LMS study estimates the average annual PCB load (including a low flow correction based on a field data for flows less than 20,000 cfs) assuming no mitigation (pre-1978) as 8,000 pounds per year.

LMS (1979) utilized the same mathematical model developed for the "No Action" alternative to evaluate several "Action" alternatives, Of interest here is the Thompson Island Pool and above Lock 7 dredging scenario. LMS (1979) estimates the reduction in PCB load over the dam at Troy as a result of dredging hot spot areas 1-20 as 500 lbs per year. Dredging the Thompson Island Pool and above Lock 7 would therefore reduce the current PCB load over the dam at Troy from 7,200 pounds per year to 6,700 lbs per year.

Using these three data points - pre-1978 loading of 8,000 lbs/year; post Remnant Deposit Area 3A and Fort Edward Terminal Channel Excavation (post-1978) loading of 7,200 lbs; and, an estimate of the post Thompson Island dredging loading of 6,700 lbs - a cost per pound of PCB reduction over the Federal Dam at Troy was estimated. Table 5 presents the cost/benefit analysis using this data.

Table 5
Reduction of PCB Over the Troy Dam

| | Average Annual PCB Load at Troy (lbs/yr) | Incremental Reduction in PCB Load at Troy (lbs/yr) | % Reduction with with Regard to No Action Alternative | Cost of Removal, Transport & Treatment 1982 (Dollars) | Cost per Pound Reduction at Troy |
|---|---|---|---|---|---|
| "No Action" Alternative | 8,000 | - | - | - | - |
| Moreau Site | | | | | |
| 1976 Remnant Deposits Remedial Actions (Includes East Channel of Rogers Island Dredging) | 7,200 | 800 | 10% | $ 2,100,000 No treatment required | $ 2,600 |
| Proposed Site 10 | | | | | |
| Dredging Lock 7 to Thompson Island Pool | 6,700 | 500 | 16% | $16,000,000 (rough estimate) | $32,000 |

(1) Source: LMS (1979)

## VI. PRODUCTION RATES FOR DREDGING SYSTEMS DEVELOPED UNDER THE HUDSON RIVER PCB RECLAMATION PROJECT

A. Production rates for the following dredging systems are taken from DREDGING REPORT PROGRAM REPORT NO. 2, PCB Hot Spot Dredging Program, Upper Hudson River, September, 1980.

1. Hydraulic Dredging and Transport:

   a) Typical equipment list would include:

      1) One 16-inch hydraulic cutterhead dredge
      2) Two 16-inch booster pump units
      3) One 300 hp tender tug
      4) One 160 hp supply tug
      5) One derrick barge
      6) One fuel barge
      7) Work-deck barge
      8) Pipeline and miscellaneous equipment
      9) Two bulldozers.

   b) The average production rate estimated for one 16-inch hydraulic cutterhead dredge in Hot Spots 1 through 20 (refered to as the Thompson Island pool and areas above Lock 7) is 341 cu yds per hour. Estimated operating time is 17 hours per day or 500 hours per month.

2. Clamshell dredging with mechanical unloading (truck or conveyor transport).

   a) Typical equipment list would include:

      1) Two five-cu yd clamshell dredges
      2) Five 1000 cu yd hopper scows
      3) One work-deck barge
      4) One 800 hp towing tug
      5) Two 200 hp tender tugs
      6) Two six-cu yd clamshell cranes for unloading
      7) Two five-cu yd front-end loaders
      8) Twelve 20-cu yd dump trucks
      9) One work-deck barge

   b) The average production rate estimated for one five-cu yd clamshell dredge is 200 cu yds per hour. Estimated operating time is 600 hrs. per month for a monthly production rate of 120,000 cu yds. (Note: Under this alternative, two five-cu yd dredges will be required to dredge

the Thompson Island Pool and areas above Lock 7 in one dredging season.)

3. Clamshell Dredging and Hydraulic Pumpout Transport with or without Recycling of Water:

   a) Typical equipment list would include:

      1) Two five-cu yd clamshell dredges
      2) Five 1000 cu yd hopper scows
      3) One work-deck barge
      4) One 800 hp towing tug
      5) Two 200 hp tender tugs
      6) One 16-inch pumpout plant
      7) One tie-up barge
      8) Shoreline pipeline and miscellaneous equipment
      9) Two bulldozers

   b) The average production rate estimated for one five-cu yd clamshell dredge is 200 cu yds per hour. Estimated operating time is 600 hrs per month for a monthly production rate of 120,000 cu yds. (Note: Under this alternative, two five-cu yd dredges will be required to dredge the Thompson Island pool and areas above Lock 7 is one dredging season.)

B. Production rates for the Mud Cat dredges are taken from literature received by Mr. Peter Kuniholm, MPI from Mud Cat Division National Car Rental Systems, Inc., and dated 9/80 and 11/80. The cover letter is dated May 29, 1981.

4. Mud Cat dredges

| | Model D-24-1 | Model D-30 |
|---|---|---|
| Main Pump: | Thomas 8-inch intake<br>8-inch discharge<br>24-inch impeller(closed) | Thomas 10-inch intake<br>8-inch discharge<br>30-inch impeller (closed) |
| Operating Depth: | 15 ft (standard) | 25 ft. (standard) |
| Pump Speed: | 900 r.p.m. | 675-700 r.p.m. |
| Detroit Diesel: | 6-71; 203 hp @ 1900 r.p.m. | 8V-71; 225 hp |
| Total Head: | 105 @ 83 p.s.i. @ 14' | 155 @ 75 p.s.i. @ 17'/sec |
| at 1000' | -- | 40' lift |
| Capacity: | 90-140 cu yds/hr. | 110-200 cu yds/hr. |

| | | |
|---|---|---|
| Sand & Gravel: | 100 cu yds/hr. | 140 cu yds/hr. |
| Sand: | 115 cu/yds/hr. | 155 cu yds/hr. |
| Light sand & silt: | 140 cu yds/hr. | 200 cu yds/hr. |
| | 2500 gallons/min. | 2700 gallons/min. |

Other models offer greater operating depths with similar capacities.

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31. Roy F. Weston, "Interim Report, Rogers Island and Moreau Sites", April 6, 1977.

PIRNIE

72 cont'd

INTER-OFFICE CORRESPONDENCE

Date: 7/16/82

To: JOHN C. HENNINGSON

From: JUDITH A. BEDARD

Subject: ADDITIONAL SUPPORT INFORMATION, WAUKEGAN HARBOR LITIGATION

This memorandum, in response to your request of 7/2/82, presents a brief history of the Upper Hudson River PCB problem and project descriptions, key design criteria and cost/benefit analysis for the following PCB-related projects:

- The Fort Edward Terminal Channel Excavation and Remnant Pool Deposit Mitigation completed by the NYSDEC in 1978.
- The Hudson River PCB Reclamation Project

In addition, dredging production rates are presented for the alternative dredging schemes developed as part of the Hudson River PCB Reclamation Project.

DEPOSITION EXHIBIT
Brownell-one
4-A ID 8-31-91

## I. HISTORY OF THE PROBLEM[25]

The Village of Fort Edward is located in Washington County, New York, approximately 45 miles north of Albany (Figure 1). Recent activities in the upper Hudson River at this point began in the spring of 1974 after the removal of a 20-ft high timer crib dam, which was in poor structural condition and presented a hazard to the population living downstream.

After the dam was removed, some 850,000 cu yd of debris and sediment which had accumulated behind the dam for over 100 years was scoured from the deposits above the dam and deposited in the river channel within a distance of about one mile downstream. Various remedial measures, including removal of debris, were undertaken during 1974-75 by the State of New York. All these efforts, however, were carried out with no knowledge of PCB contamination.

In late 1975-76, field investigations were undertaken to determine the extent of PCB contamination in the river system. The presence of this substance had resulted from discharge of PCB-contaminated wastes over many years at two locations in the former pool of Fort Edward dam. Sampling indicated that remnant deposits on the western bank of the river had PCB levels of approximately 10 ug/g, whereas those on the eastern side (where the PCB outfall points were located) has PCB levels on the order of 100 to 5,600 ug/g. High levels of Cd and Pb were also present.

In April 1976 a flood with an approximate recurrence of 100 years occurred. This event caused the scour of an additional 250,000 cu yd from unprotected areas of the former pool. Deposits in the Fort Edward Terminal Channel as a result of the April 1976 flood averaged 20 ug/g PCB, a relatively low level because the material has been scoured primarily from the less contaminated western bank.

The need to remove this new material blocking the navigation channel presented an opportunity to demonstrate certain aspects of removal and containment of river debris which, although not classified as hazardous, could be disposed of in a site which essentially met chemical landfill requirements.

The project generated valuable information on several important aspects of contaminated material handling and disposal. These findings are being used in preparing final design and dredging administration procedures for the proposed Hudson River PCB Reclamation Project in the 40-mile river reach between Fort Edward and Albany, where bed and bank sediments are contaminated by some 400,000 lb of PCB. In addition, approximately 700,000 lb of PCB is located in or adjacent to the study area in numerous landfills, dumps, and dredge spoil areas.

## II. THE FORT EDWARD TERMINAL CHANNEL EXCAVATION AND REMNANT DEPOSIT MITIGATION (1978) PROJECT DESCRIPTION

### Moreau PCB Encapsulation Site

The disposal area occupies some ten acres in the Town of Moreau, Saratoga County, New York. The site was owned by the State and was originally an unused hydraulic dredge spoil site.

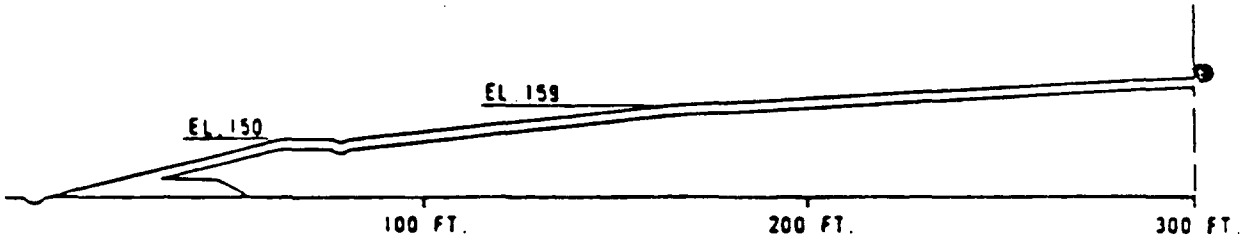
The western one-third of the site is underlain by ten to 40 ft of glacial lake clays, and the remainder by brown silty fine sand. Hydraulic conductivities of the underlying materials are on the order of $10^{-3}$ to $10^{-7}$ cm/sec.

Because of the variety of subsurface deposits, it was determined to cover the entire bottom with an 18-inch thick layer of compacted clay, which has a hydraulic conductivity (k) on the order to $1 \times 10^{-7}$ cm/sec. Before the liner was placed, the site surface was drained of perched water areas, organic material was removed, and a four-ft high interior clay dike was constructed along the southerly and easterly perimeters. The northerly and westerly perimeters of the site were established on existing debris from previous channel dredging programs.

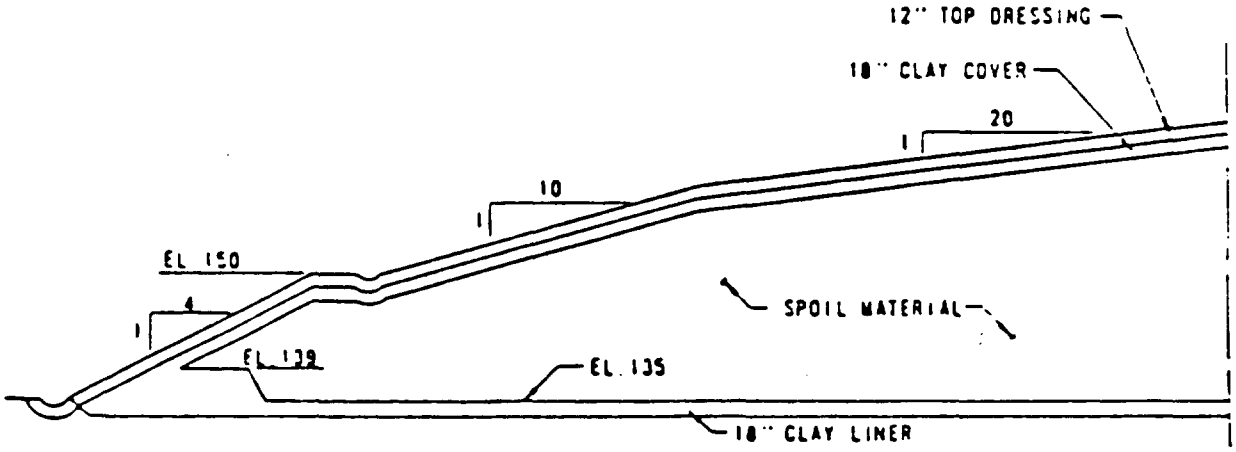
The clay liner was extended up the existing slope to provide a barrier to migration from the existing deposits, and an exterior trench drain of crushed stone and perforated pipe wrapped in filter cloth was installed to intercept groundwater flow. The side slopes of the disposal site had a maximum horizontal:vertical slope of 4:1 (Figure 2). A system of paved surface drains was provided to intercept surface runoff and an 18-inch thick clay cover was placed over the deposited debris. The final slope dressing consisted of 12 inches of material suitable for turf establishment (silty sand), followed by seeding and mulching. The permeability of the compacted clay liner was determined by infiltrometer.

The native clays utilized for the liner and cover were excavated from a borrow pit a few hundred yards from the site.

Figure 3 presents two photographs of the complete Moreau site.

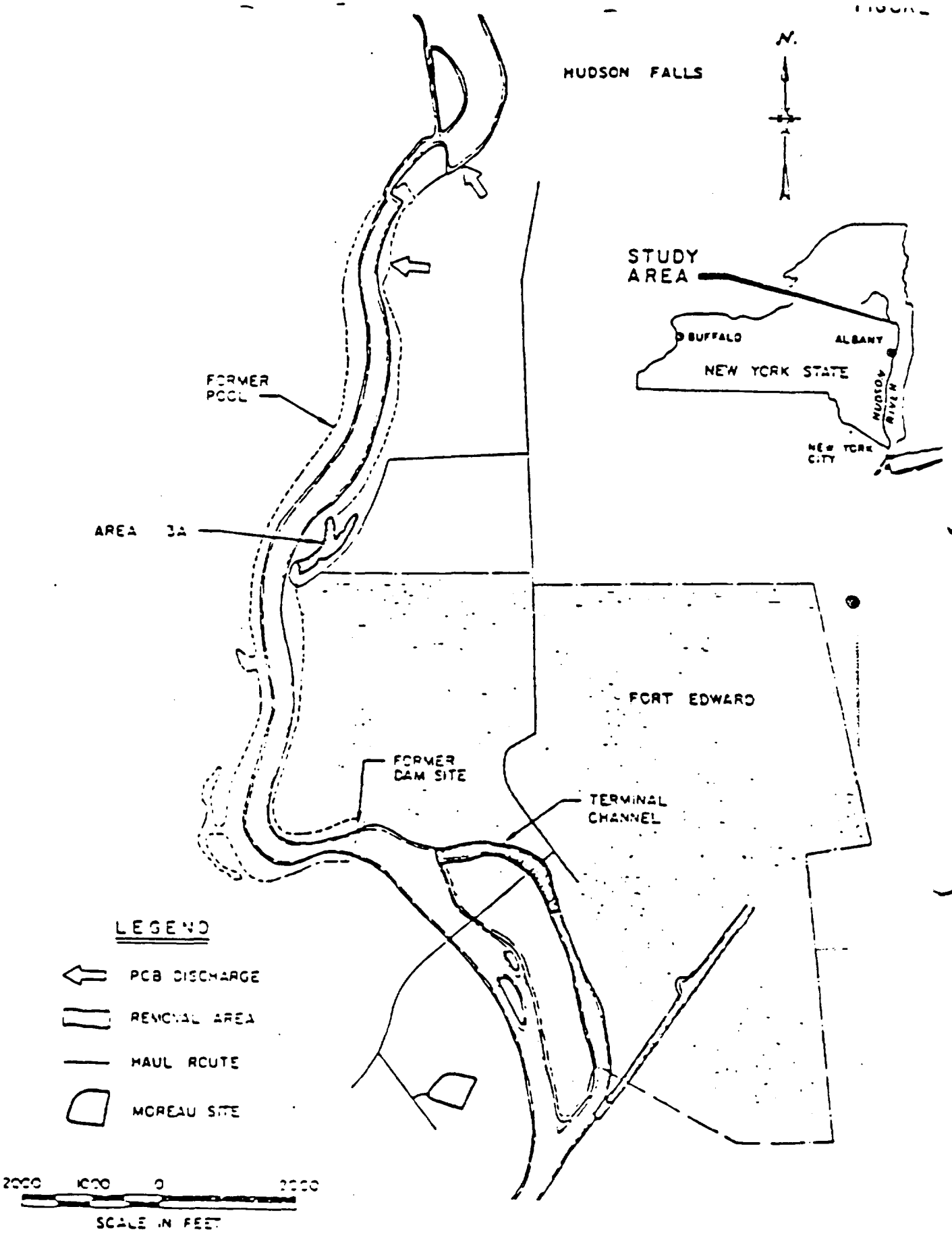



NATURAL SCALE




VERT. SCALE 2 x HORIZ SCALE

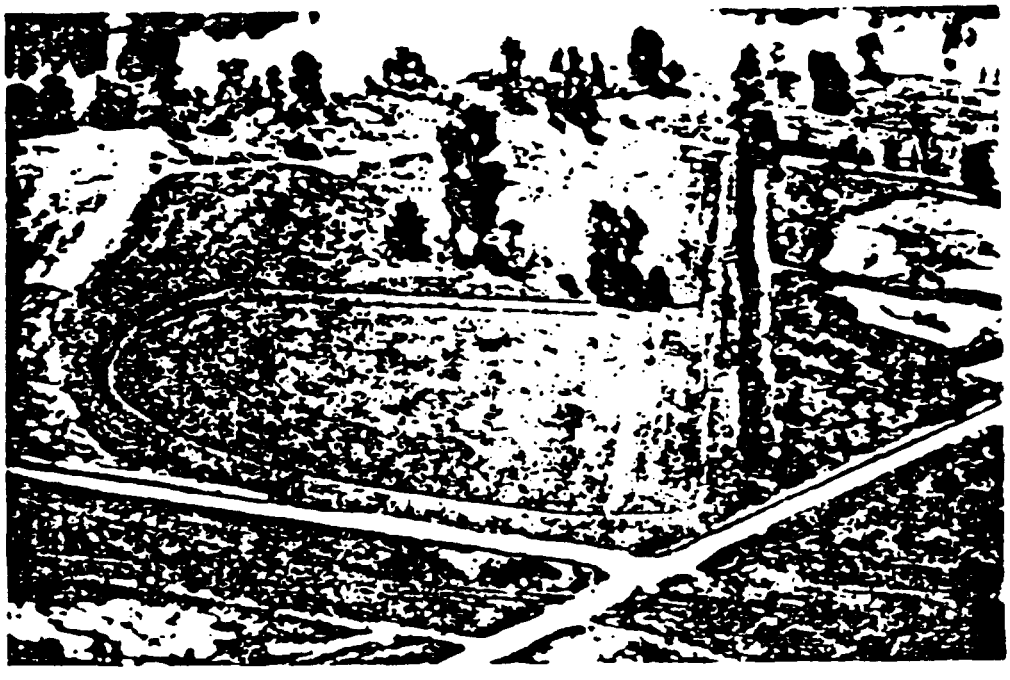
SITE CROSS SECTIONS




MOREAU
DREDGING AND DISPOSAL AREAS

FIGURE 3

PCB encapsulation site, Town of Moreau, New York, July 1979. View looking eastward at completed site eight months after final seeding with mixed grasses and clover. Side slopes of fill are one vertical on four horizontal. Paved drains for surface run off and groundwater are visible (right and foreground). Site is a joint project of DOT and DEC.



PCB encapsulation site, Town of Moreau, New York, June 1980. View looking eastward with completed site in lower half of photograph, Hudson River at top. Paved drains are visible around the perimeter of the site. DOT Moreau spoil site is at left of photograph, previously used borrow area at right. River Road crosses lower right hand corner of photograph.

## Dredging Operations

Approximately 180,000 cu yds of debris and sediment containing 6,400 pounds of PCB were removed from the Fort Edward-Terminal Channel during two periods: September-December 1977 and April-June 1978. During October 1978, an additional 14,000 cu yds of material containing approximately 25,000 pounds of PCB were removed from Remnant Deposit Area 3A.

The terminal channel deposits averaged 20 ug/g PCB, whereas deposits from Area 3A had an average PCB concentration of 1,000 ug/g, and thus required a more careful handling operation. The general excavation procedure consisted of removal of material by dragline from the terminal channel and deposit in a windrow to allow for drainage and storage of materials. After a few hours the material became well drained and was easily handled.

During removal of the Fort Edward Terminal Channel material, the agitation of the bed deposits by the dragline excavation generated an oily floating scum which drifted away from the area being excavated. To resolve this problem a conventional oil boom was deployed, trapping the scum, which was removed manually, along with wood debris. PCB levels in the floating scum reached as high as 4,000 ug/g dry weight, which necessitated some care in handling.

The Area 3A deposits, located above normal water level, were removed with conventional power shovels and generally loaded directly into trucks, although some stockpiling was done. Special care was taken to clean loose material from trucks, and loads were covered to prevent contaminated material from being tracked onto highways. At the Moreau site, the dredged material was placed on lifts on the order of one to three ft to a total depth of approximately 15 ft.

## Site Problems

Because of heavy fall rains and the onslaught of an early winter, the site was not covered with clay within the time

frame originally intended. As originally designed, dredging and covering operations were to be completed by December 1977. The material from Area 3A were added to the project because the site was still open thru the summer of 1978.

During the period when the site was exposed (August 1977-November 1978) precipitation in the vicinity was measured at 66.5 inches. This value is about 30 percent greater than average for the same period. Measurements made through the installation of temporary observation wells, as well as several backhoe test pits indicated that some 12 feet of saturated material existed at the site prior to start-up of the dewatering operations.

In May of 1978, wet spots were noticed in two areas of the newly clay covered south and east slopes. A few weeks after the covering of the clay surface with 12 inches of turf establishment material the areas in which the wet spots were noticed experienced tension cracks followed by surface slumping. Slumping along the south slope occurred over an area of about 50 feet, and slumps over an area of about 100 feet long occurred on the east slope.

Dewatering the Site

The site was originally designed under the assumption that material would be spoiled and covered during the same season. An internal clay perimeter dike was constructed three to four feet above the bottom of the liner. In addition, one permanent four-inch monitoring well/drain (DOT) was installed in a low part of the disposal site. It was anticipated that six to seven inches of precipitation might percolate through the clay cover per year. This would have resulted in an accumulation of about $1.9 \times 10^6$ gallons per year, exclusive of leakage through the bottom and drainage out the four-inch monitoring well and drain. The drain was designed to accept a flow of three to five gpm (15 in. of 30 slot screen), or $1.6 \times 10^6$ to $2.6 \times 10^6$

gallons per year. At this rate (and with some bottom leakage) it was expected that water accumulation would be minimal, and that the interior dike would provide storage capacity for at least a few years accumulation. The in-situ hydraulic conductivity of the material was much less than anticipated, with the drain yielding only about 0.5 to 1 gpm.

In July of 1978, various alternatives for dewatering of the site were evaluated for cost and time requirements.

It was determined that a wellpoint dewatering system running parallel to the east and south slopes would be the only timely means of dewatering for slope repairs. It was also decided to install a permanent trench drain system in the vicinity of the two slope slippages. The length of the trench drain would be determined by the ease of installation encountered in the field.

Wellpoint Installation

Nine hundred feet of header and 82 points were installed, during the period September 25-29, 1978.

The operation of the wellpoint system allowed for an almost immediate repair of the failed slope areas, although pumping rates were much less than expected. The repairs consisted of removing the 12 inches of turf establishment material and the 18 inches of clay about and adjacent to the failed areas. All slumping occurred at the clay-dredge spoil interface. Approximately 1,800 square yards of slope were removed and repaired during October of 1978. In addition an interior trench drain 400 ft long by 4.5 wide was installed adjacent to and between the two failure areas.

Analysis of Dewatering Operations

Through December 1978 it is estimated that approximately 1 x $10^6$ gallons were removed from the Moreau site through

wellpoint pumping, siphon operation and gravity drainage (DOT well).

Siphon operations have continued sporatically (no winter operations) to the present time. From December 1978 to March 1980, it is estimated that an additonal 820,000 gallons have been removed. This number is based on a siphon operation for 130 days at 3.5 gpm (655,000 gal) and a gravity drainage of about 0.25 gpm continuous since December 1978 (165,000 gal). The PCB concentration of this water is monitored periodically since it is discharged back into the Hudson River. As of March, 1980 site water levels were on the order of 141.50 ft a drop of 2.7 ft since December 1978. Based on the theoretical porosity area drawdown relationship 785,000 gallons (2.7 x 290,000) would have been removed. This number correlates nicely with the estimated actual withdrawal.

## III. HUDSON RIVER PCB RECLAMATION PROJECT DESCRIPTION

### A. Project Description

The Hudson River PCB Reclamation Project as presented in the Scoping Report (March 1981) includes four components directed toward reducing the impact of PCB on the Hudson River, its biota, and the surrounding Hudson River Valley. These components are:

- o Dredging of approximately 27 hot spot[1] areas in the river bed with containment in a secure upland site.
- o Design and construction of a secure upland containment site capable of long-term isolation of contaminated material.
- o The dressing and fencing of remnant deposit areas 3 and 5, located above the former Fort Edward Dam site.
- o Destruction of the recovered PCB at such time as a technically and economically feasible procedure becomes available.

### B. Containment Site

The containment site, referred to as Site 10 in earlier reports, is situated on a 250 acre parcel of land located approximately 2.5 miles south of the Village of Fort Edward, in the Town of Fort Edward, in Washington County, New York. (See Figure 4).

The site's major components include:

- o Containment Area
- o Roughing and Storage Pond
- o Surge Pond
- o Water Treatment Plant
- o Leachate Collection System
- o Storm Water Drainage System
- o Chemical Feed System

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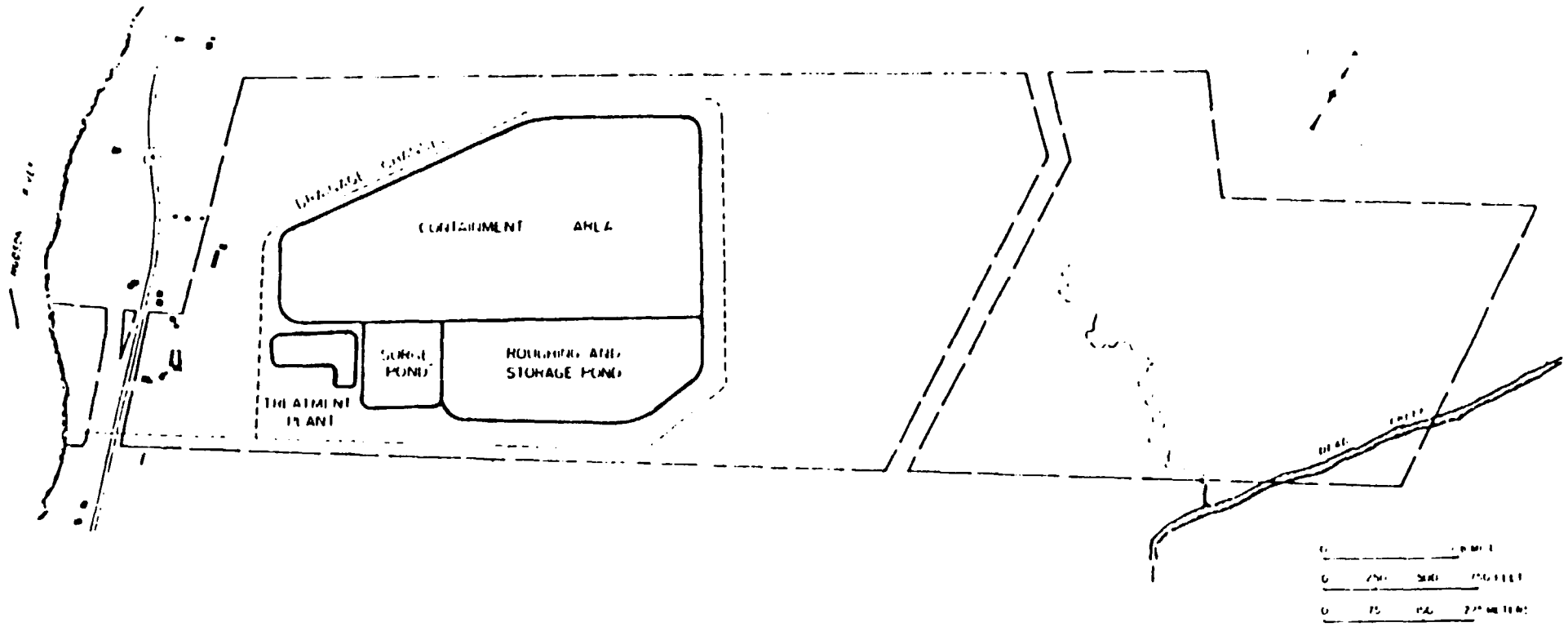
[1] Hot spots have been defined as areas of PCB contamination equal to or greater than 50 μg per g.




RESCOPED CONTAINMENT SITE

MALCOLM PIRNIE, INC

Containment Area - The containment area is an earthen basin bisected by a cross dike. It occupies approximately 40 acres at its maximum water surface and its total containment volume of approximately 1,100,000 cu yds. This volume is sufficient to hold all of the 27 hot spots.

The containment area is designed for long term encapsulation of PCB-contaminated materials.

Roughing and Storage Pond - The roughing and storage pond (R&SP) is an earthen basin with a maximum water surface area of approximately 12 acres.

After the slurried dredge material is pumped into the containment area, weir overflow is transported via pipeline to the R&SP. The primary purpose of this basin is to ensure efficient sedimentation near the end of each dredging season as the effective overflow rate in the containment area decreases. The R&SP also provides protection for the subsequent treatment units from any upsets in the containment area which might lead to transient escape of dredged material.

A small portable dredge will be operated to recycle settled dredged material back into the containment area.

The R&SP is not a permanent containment unit. At the end of the dredging program, all of the contaminated material in the R&SP will be relocated to the containment area and the pond will be filled in and regraded.

Surge Pond - The surge pond is an earthen basin with a maximum water surface area of 2.4 acres. This pond receives weir overflow from the R&SP. Its purpose is to buffer the treatment plant units from surges in the dredging process and to provide a convenient, sediment-free point for treatment feed and recycle supply pump suctions if a recycle dredging procedure is implemented. A detailed discussion of dredging options is presented in the Containment Site Design Report.

Water Treatment Plant - The water treatment plant consists of two earthen basins, the flocculation basin and the settling basin, with maximum water surface areas of 0.1 and 1.0 acres, respectively. The plant has a capacity of 13 million gallons per day (mgd) and consists of coagulation, flocculation and sedimentation units. The purpose of the water treatment plant is to reduce PCB concentration in the dredge return flow before discharge to the river.

The water treatment plant is expected to achieve effluent suspended solids less than 4 milligrams per liter and turbidity less than 10 NTU with proper chemical doses. The average PCB concentration in the discharge is expected to be in the 10-20 microgram per liter range.

Leachate Collection System - The leachate collection system is a network of perforated drainage piping laid in gravel-filled, filter-cloth-lined collection trenches at the base of the containment area. The bottom of the containment area is sloped to transmit flow towards the trenches.

The leachate collection system will be utilized in two phases: short-term dewatering and long-term percolation.

A piping system connects the drainage system to a leachate storage tank and subsequently to a discharge point at the Hudson River.

In addition valves, collection and sampling wells, and a flow metering and monitoring manhole are provided to determine the quantity and concentration of PCB in the leachate. Discharge to the Hudson River will only be permitted if the observed leachate quantities and concentrations will have no adverse impact on the River. If river discharge proves unacceptable, the leachate will be stored in-place and periodically collected and treated from the leachate storage tank.

Stormwater Drainage System - The stormwater drainage system will intercept and convey stormwater runoff that would have directly affected the containment site. Precipitation

falling on the containment site, and on the watershed north of the containment site, will be transported by the drainage system to the Hudson River.

The components of the drainage system include a combination of swales, open channels, and closed conduits.

Chemical Feed System - Pumps, piping, tanks and dilution water will be provided for two optional treatment processes - polymer only and a alum, caustic and polymer combination. The required equipment will be housed in a chemical feed building.

Other Site Components - Other site components include pump station, access road, electrical services, fencing, seeding, clearing and grubbing and monitoring wells.

C. Hot Spot Dredging

Thompson Island Pool - The Thompson Island Pool is located between the Thompson Island Dam and Rogers Island. The areas to be dredged are the 20 identified hot spots (including four above Lock 7) with a volume of approximately 645,500 cu yds and 105,800 lbs of PCB (see Table 1).

Lower Pools - Based on a range of costs per cubic yard for dredging, transport and treatment, between 160,000 and 265,000 cu yds of material could be dredged in the lower pools within the budget constraints of the rescoped project.

Using the MPI estimates of contaminated volumes and PCB masses listed in Table 1, and applying the criteria described previously in the Rescoping Report, to each of the lower pools, resulted in the following dredging program for the lower pools. Using the lower range value of 160,000 cu yds (high estimate of unit cost), only lower pool hot spots 29-34 in the Lock 5 Pool will be dredged. Using the higher range value of 265,000 cu yds (low estimate of unit cost), both lower pool hot spots 29-34 in the Lock 5 Pool and approximately 80 percent of hot spot 37 in the Lock 3 Pool will be dredged. Table 2 details the hot spots to be dredged under the rescoped program.

Table 1

Hudson River PCB Reclamation Project Areas to be Dredged

Contaminated and Removal Volumes and PCB Quantities[7]

| Hot Spot[1] Area No. | Area (sq ft) | Contaminated[2] Volume (cu yd) | Mean[2,3] PCB Conc. (µg/g) | PCB[2,3,4] Quantity (lbs) | Removal[5] Volume (cu yd) |
|---|---|---|---|---|---|
| 1 | 66,600 | 3,100 | 63 | 340 | 7,400 |
| 2 | 21,200 | 1,000 | 81 | 140 | 2,350 |
| 3 | 38,300 | 1,750 | 46 | 140 | 4,250 |
| 4 | 78,800 | 3,650 | 50[6] | 320 | 8,750 |
| Subtotal | 204,900 | 9,500 | 57 | 900 | 22,750 |
| 5 | 460,400 | 34,100 | 62 | 3,710 | 51,150 |
| 6 | 1,033,700 | 76,550 | 69 | 9,270 | 114,850 |
| 7 | 110,600 | 8,200 | 39 | 560 | 12,300 |
| 8 | 1,462,700 | 108,350 | 99 | 18,830 | 162,500 |
| 9 | 116,500 | 8,800 | 38 | 590 | 13,150 |
| 10 | 191,200 | 14,150 | 78 | 1,940 | 21,250 |
| 11 | 57,100 | 4,250 | 39 | 290 | 6,350 |
| 12 | 45,700 | 3,400 | 71 | 420 | 5,100 |
| 13 | 28,000 | 2,050 | 89 | 300 | 3,100 |
| 14 | 974,200 | 72,150 | 279 | 35,330 | 108,250 |
| 15 | 286,600 | 21,250 | 103 | 3,840 | 31,850 |
| 16 | 446,500 | 33,050 | 380 | 22,060 | 49,600 |
| 17 | 83,200 | 6,150 | 256 | 2,770 | 9,250 |
| 18 | 201,700 | 14,950 | 94 | 2,460 | 22,400 |
| 19 | 42,000 | 3,100 | 83 | 450 | 4,650 |
| 20 | 62,700 | 4,650 | 249 | 2,030 | 6,950 |
| Subtotal | 5,604,800 | 415,150 | 144 | 104,900 | 622,700 |
| 29 | 32,700 | 1,500 | 81 | 220 | 3,650 |
| 30 | 54,400 | 2,500 | 155 | 690 | 6,050 |
| 31 | 194,300 | 9,000 | 516 | 8,150 | 21,600 |
| 32 | 41,200 | 1,900 | 51 | 170 | 4,600 |
| 33 | 119,400 | 5,550 | 98 | 950 | 13,250 |
| 34 | 955,800 | 44,250 | 159 | 12,350 | 106,200 |
| Subtotal | 1,397,800 | 62,700 | 205 | 22,500 | 155,350 |
| Total Using High Estimate of Unit Cost[8] | 7,207,500 | 487,400 | 150 | 128,300 | 800,800 |

Table 1
(continued)

Hudson River PCB Reclamation Project Areas to be Dredged

Contaminated and Removal Volumes and PCB Quantities[7]

| Hot Spot[1] Area No. | Area (sq ft) | Contaminated[2] Volume (cu yd) | Mean[2,3] PCB Conc. (ug/g) | PCB[4,5,6] Quantity (lbs) | Removal[5] Volume (cu yd) |
|---|---|---|---|---|---|
| 37 Partial | 986,800 | 45,690 | 116 | 9,300 | 109,650 |
| Subtotal of | 986,800 | 45,690 | 116 | 9,300 | 109,650 |
| Additional Dredging Volumes Possible Because of Low Unit Cost in the Lower Pools | | | | | |
| Total Using Low Estimate of Unit Cost | 8,194,300 | 533,110 | 127 | 137,600 | [illegible] |

[1]Hot Spot Area No. 1-4 Above Lock 7
5-20 Thompson Island Pool
29-34 Lock 5 Pool
37 Lock 3 Pool

[2]Contaminated Volumes based on a contaminated depth of:
15 in. - Above Lock 7
24 in. - Thompson Island Pool
15 in. - Lock 5 Pool
15 in. - Lock 3 Pool

[3]Mean PCB concentration based on average concentration of all surface samples and weighted average concentration of core samples within the hot spot area.

[4]PCB quantity based on a bed material density of 65 lb/cu ft.

[5]Removal volume based on a 36 in. removal depth.

[6]No samples in these areas at this time - mean PCB conc. is assumed to be 50 ug/g.

[7]DEC estimates for these areas varies from quantities shown.

[8]Two estimates were made of the yardage of material that could be dredged the lower pools within budget constraints. The first estimate based on a high unit cost allowed for the removal of 160,000 cu yds (hot spots 29-34). The second estimate based on a low unit cost allowed for 265,000 cu yds to be removed (hots spots 29-34 and partial hot spot 37).

Table 2

Rescoped Program

Hot Spot Dredging
High Estimate of Unit Cost

| Pool | Hot Spots | Contaminated Material | |
|---|---|---|---|
| | | vol, cu yd | PCB Mass, lb |
| Thompson Island | 1 thru 20 | 645,500 | 105,800 |
| Lock 5 | 29 thru 34 | 155,350 | 22,530 |
| | | 800,850 | 128,330 |

Hot Spot Dredging
Low Estimate of Unit Cost

| Pool | Hot Spots | Contaminated Material | |
|---|---|---|---|
| | | vol, cu yd | PCB Mass, lb |
| Thompson Island | 1 thru 20 | 645,500 | 105,800 |
| Lock 5 | 29 thru 34 | 155,350 | 22,530 |
| Lock 3[1] | 37 partial | 109,650 | 9,310 |
| | | 910,500 | 137,640 |

(1) Partial removal will recover approximately 80 percent of in-place PCB in Hot Spot 37.

Note: All values based upon MPI estimates as presented in Draft EIS, N.Y. State Environmental Quality Review, September 1980.

Under the rescoped dredging program between 37 and 40 percent of the 347,200 pounds of PCB in the hot and cold spots in the Upper Hudson river bed will be dredged. The PCB masses used in calculating these percentages are the total masses of PCB associated with the volumes of material expected to be dredged. These percentages therefore do not reflect quantities of PCB missed in the dredging process, lost to the water column or returned to the river in treatment plant effluent. Earlier studies have shown that the losses in these three areas total in the range of 6 to 9 percent.

C. Other Program Elements

Remnant Deposits - The remnant deposits are PCB-contaminated areas adjacent to the Hudson River upstream of the former Fort Edward Dam. These areas are the remains of 150 years of deposition behind the dam, exposed as dry land following dam removal in 1973. Much of the deposited material has washed downstream; those areas which remain have been designated remnant deposits.

Under the rescoped project remnant deposit areas 3 and 5 will be top dressed and perimeter fencing will be installed as required.

Monitoring Program - A brief description of the proposed program for monitoring the effectiveness of the dredging program follows. The program will include two overlapping categories of monitoring, environmental and operations.

Environmental monitoring will involve atmospheric, aquatic and terrestrial sampling before, during and after the completion of dredging activities. Samples will be taken at least daily during dredging and more intensively during early phases of the project to provide supplemental operations control data. Dredged material will be regularly sampled to assure that the dredging operation is recovering contaminated material.

Environmental monitoring after the completion of dredging will record the more immediate effects of the PCB dredging program on PCB levels in the air and water; and, later, any residues on land, foliage and in animal tissues.

The following studies will be included under the environmental monitoring program:

- Sediment Transport Monitoring
- Hudson River Fish Flesh PCB Analysis
- Sediment PCB Desorption Study
- Biological (Macroinvertebrate) PCB Uptake Study
- Foliar Contamination by PCB in Washington County Forage Crops
- Air-Plant PCB Relationships
- Agricultural Inplace Studies.
- Site 10, groundwater monitoring.

Operations control includes both monitoring and dredge control. The dredge phase losses, bucket losses, losses to the water column and air, and the loss of PCB in the treatment plant effluent will all be monitored. The purpose of the monitoring is not simply to record the effectiveness of the related processes, but to provide "real time" data that can increase and maintain the best attainable dredging efficiency.

## IV. SUMMARY OF PCB ENCAPSULATION SITE DESIGN CRITERIA

A summary of the design criteria for the Moreau PCB Encapsulation Site and the proposed Site 10 Containment Site is presented in the following Table.

Table 3

Key Design Criteria

| | Moreau Site | Proposed Site 10 |
|---|---|---|
| Capacity (volume) cu yds | 194,000 cu yds<br>180,000 cu yds @ avg. PCB conc. of 20 ppm<br>14,000 cu yds @ avg. PCB conc. of 1000 ppm | 1,100,000 cu yds |
| Fluff Factor | None | 1.1 (Thompson Island Pool and above Lock 7)<br>1.3 (Lower Pools) |
| Liner | 18" of imported clay<br>$k = 1 \times 10^{-6}$ (specified)<br>$k = 1 \times 10^{-7}$ (measured) | in situ clays, depth of 10 feet+<br>$k = 2.6 \times 10^{-7}$ (mean value) |
| Cap | 12" top dressing<br>15" clay cover | 12" top dressing<br>9" gravel<br>18" clay cover |
| Leachate Collection | Wellpoint system and trench drain running parallel to the interior east and south slopes of the containment site. Discharge piping is connected to perimeter asphalt drainage channel. | o Sloped bottom of containment areas.<br>o Network of gravel filled collection trenches wrapped with filter fabric<br>o Perforated drainage piping in collection trench (8" P.E. pipe)<br>o Collection and sampling wells on containment area perimeter, connected to drainage piping.<br>o Piping system connecting drainage system to leachate storage tank<br>o Valved piping system connecting leachate storage tank to discharge point at Hudson River.<br>o Flow metering and monitoring system. |

Table 3
(continued)

Key Design Criteria

| | Moreau Site | Proposed Site 10 |
|---|---|---|
| Leachate Treatment | No leachate treatment required. | If required, leachate will be pumped out of leachate storage tank and treated either off-site, or at a treatment facility on-site. |
| Dredged Slurry Treatment | No slurry, PCB contaminated material trucked to site. | System set up for either polymer or alum, polymer caustic combination. |
| Water Treatment Plant Effluent Discharge Quantities (1) | Not applicable. | Average PCB concentration 10 to 20 µg/l.<br>Maximum PCB concentration 100 µg/l<br>Minimum PCB concentration 4 µg/l<br>Suspended Solids ≤ [illegible] mg/l<br>Turbidity ≤10 NTU |

(1) The New York State Department of Environmental Conservation State Pollutant Discharge Elimination System (SPDES) Discharge Permit for the Upper Hudson River PCB Encapsulation and Treatment Facility (Site 10) is presented in Appendix A.

## V. COST/BENEFIT ANALYSIS

Cost/benefit analyses are presented with respect to two criteria. First the cost per pound of PCB removed was determined, and secondly, the cost per pound of reducing the PCB load over the Federal Dam at Troy and into the Hudson River Estuary was estimated.

### A. Cost Per Pound of PCB Removed

The cost per pound of PCB removal for the Moreau Project was determined by using actual costs, actual yardages removed and measured pounds of PCB contained in the site. These costs are presented as actual costs at the time of performance and again as estimated 1982 costs. The 1982 costs were estimated by using an average annual inflation rate of 8.3 percent over the period 1977 to 1982. This inflation rate was developed from increases in the ENR Indexes for construction costs and material costs over the period.

The cost per pound of PCB removal for the proposed Site 10 project was determined based upon cost estimates presented in the Scoping Report of March 1981. In accordance with the figures developed in this report, a ten percent inflation rate was assumed to adjust 1981 costs up to the 1982 base and 1983 cost down to the 1982 base.

Table 4 presents the results of the cost/benefit analysis based upon cost per pound of PCB removed. Costs have been estimated in three categories - removal and treatment; containment, site work and material handling; and treatment (chemical costs only).

The cost per pound of PCB removed in the Moreau project is $86 per pound. The cost per pound of PCB removed in the Site 10, Hudson River PCB Reclamation Project is $192-206 per pound.

Table 4

Cost/Benefit Analysis
Cost Per Pound of PCB Removed

| | Moreau Site | | | | Proposed Site 10 |
|---|---|---|---|---|---|
| Yardage Removed (cu yds) | Fort Edward Terminal Channel | 180,000 | | | Estimated Range: 800,850 to 910,500 |
| | Remnant Deposit Area 3A | 14,000 | | | |
| | | 194,000 cu yds | | | |
| PCB Removed | Fort Edward Terminal Channel | 6,400 lbs (measured) | | | Estimated Range: 128,300 lbs to 137,640 lbs |
| | Approximately | 25,000 lbs (estimated) | | | |
| | | 32,000 lbs (estimated) | | | |
| Cost of PCB | Fort Edward Terminal Channel | | Remnant Deposit Area 3A | | Estimated 1982 Dollars (7) |
| | (1977 $) | (Est. 1982 $) | (1978 $) | (Est. 1982 $) | |
| Removal and Transport | 658,000 (2) | 980,000 (3) | 432,000 (5) | 594,000 (3) | 11,150,000 |
| Containment, Site work, Material Remandling | 281,000 (2) | 419,000 (3) | 91,000 (5) | 125,000 (3) | 7,310,000 |
| Treatment (Chemical Costs Only) | - | - | - | - | 740,000 |
| Dewatering Costs (Estimated) | - | - | 104,000 (4) | 143,000 (3) | 1,420,000 (monitoring cost) |
| Hudson River Probing and Sampling | - | - | - | - | 650,000 |
| Subtotal | 939,000 (1) | 1,399,000 (3) | 627,000 (1) | 862,000 (3) | 21,270,000 |
| Engineering Design, Field Engineering, Construction Administration, and Legal and Administrative Costs | 235,200 (6) | 350,000 (6) | 157,000 (6) | 216,000 (6) | 5,218,000 |
| Total | 1,174,000 | 1,689,000 | 784,000 | 1,078,000 | 26,488,000 |
| Cost per pound | Fort Edward Terminal Channel (including dewatering) | | $286/lb | | $192-206/lb |
| | Combined Terminal Channel & Site 3A | | $ 86/lb | | |

Table 4
(continued)

Cost/Benefit Analysis
Cost Per Pound of PCB Removed

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(1) Costs from Victor R. Griffin (NYSDOT) letter to Jeff Schmitt (NYSDEC) dated February 18, 1982.

(2) Breakdown of costs was estimated using a ratio of removal and transport cost to total cost from intemized D.A. Collins Construction Co. Inc. Bid Letting, July 14, 1977.

(3) Cost escalated at an annual inflation rate of 8.3%.

(4) Costs from August 29, 1978 letter of cost of work to Mr. V. Griffin of NYSDOT from Harold W. Clark of James H. Maloy, Inc.

(5) Breakdown of costs was estimated using a ratio of removal and transport cost to total cost as developed in the Engineer's Estimate included in "Removal and Stabilization of Remnant Deposits Fort Edward Flood Control Project Report on Design and Estimate", Malcolm Pirnie, Inc., May 1978.

(6) Cost estimated as 25% of cost for removal, transport, containment, site work, material remanding, treatment chemical costs and dewatering.

(7) Costs from Scoping Report, March 1981.

B. Cost per Pound of PCB Reduction Over the Federal Dam at Troy

The transport of PCB in the Upper Hudson has been modeled by Lawler, Matusky & Skelly Engineers (1978, 1979). Their model is based on a historical flow cycle of the Hudson River of 20 years (1958-1977). The 20 year cycle was selected as a result of a multiple periodic regression analysis of 47 years of flow records at Spier Falls.

The study makes use of the sediment transport model (HEC-6), developed at the Hydrologic Engineering Center of the U.S. Corps of Engineers. Using mean daily flow records, cross sectional geometry, downstream rating curves and grain size distribution of the river bed material, the program computes flow depth, velocity, physical capacity of the river to transport sediments, and the scour or deposition rates of sediments in the river.

A PCB Inventory Model developed by LMS compliments the HEC-6 by accounting for the incoming and outgoing PCB for each reach, and for the PCB exchange between the water column and the river bed based on the computed scour and deposition. The output from this model is a relationship of PCB concentration versus flow for the downstream boundary condition of each modeling reach. The integration of the PCB concentration to flow relationship with the 20 year flow data provides the cumulative mass of PCB transported in each reach over the projected period. The model projections consider the incoming concentrations at Rogers Island as the upstream boundary condition and simulate the movement of PCB to the Federal Dam at Troy in 20 year cycles.

The PCB concentrations monitored at Rogers Island deserve particular attention, for while the PCB transport from Rogers Island to the Troy Dam was simulated, the input load of PCB at Rogers Island is the measured upstream boundary condition of the model. Two conditions are identified and tested by LMS in their model: an upper limit identified as present conditions

(post-1978) which gives an average loading of 2900 pounds of PCB/year, and a lower limit that gives 1300 pounds of PCB/year. The lower limit is an estimate of the reduced loading that would occur if the upstream influent PCB (from Glens Falls to Rogers Island) could be reduced in the future by remedial action, washout or some other method. The report identifies remnant deposits 3 and 5, which have the highest concentration of PCB in the area, as the major contributor of upstream PCB. However, these two areas have been stabilized and are outside the normal scouring path of the Hudson River. Several studies (MPI March 1978, DEC March 1980) consider their contribution of PCB to be negligible.

USGS data collected since the remnant pool mitigating measures of 1978 fall within the limits of 1300 to 2900 pounds per year. Pending additional data collection by USGS, especially at high flow conditions, these figures will be regarded as the upper and lower limits of PCB loadings at Rogers Island.

Based on these conditions, the model estimates the transport of PCB over the Troy Dam and to the estuary. The higher estimate projects 7200 pounds/year of PCB discharge, while the lower estimate predicts 5600 pounds/year. These loadings are averaged over a 20-year period based on historical flow records, and do not reflect the yearly fluctuations of river discharges and variations of the PCB mass transported.

LMS projects average annual transport of 7200 pounds PCB over the dam at Troy for a 66 year period, after which the Upper Hudson source would be exhausted. The transport of PCB is limited by the supply of available PCB. Therefore, if no remedial action is undertaken, the supply of PCB would diminish over time by the quantities transported. The following table adapted from LMS (1979) summarizes this transport.

PCB TRANSPORT, NO-REMEDIAL-ACTION ALTERNATIVE

| Location | PCB Transport pounds/year | Supply of Available PCB pounds | No. of Years to Exhaust Supply |
|---|---|---|---|
| At Lock 7 | 2900 - 1300 | 50,000 | 38 - 19 |
| Lock 7 to Troy | 4300 | 284,000 | 66 |
| Federal Dam at Troy | 7200 | | |

Sources: LMS (1979)
DEC (1980)
Estimates for Draft EIS NYSEQR report, MPI (September 1980)

In addition, LMS (1978, 1979) estimated the average annual PCB load at Troy for the pre-1978 period before either the Remnant Deposit Area 3A Mitigation or the Fort Edward Terminal Channel Excavation occurred. The 1978 LMS study estimates the average annual PCB load (including a low flow correction based on a field data for flows less than 20,000 cfs) assuming no mitigation (pre-1978) as 8,000 pounds per year.

LMS (1979) utilized the same mathematical model developed for the "No Action" alternative to evaluate several "Action" alternatives, Of interest here is the Thompson Island Pool and above Lock 7 dredging scenario. LMS (1979) estimates the reduction in PCB load over the dam at Troy as a result of dredging hot spot areas 1-20 as 500 lbs per year. Dredging the Thompson Island Pool and above Lock 7 would therefore reduce the current PCB load over the dam at Troy from 7,200 pounds per year to 6,700 lbs per year.

Using these three data points - pre-1978 loading of 8,000 lbs/year; post Remnant Deposit Area 3A and Fort Edward Terminal Channel Excavation (post-1978) loading of 7,200 lbs; and, an estimate of the post Thompson Island dredging loading of 6,700 lbs - a cost per pound of PCB reduction over the Federal Dam at Troy was estimated. Table 5 presents the cost/benefit analysis using this data.

Table 5

Reduction of PCB Over the Troy Dam

| | Average Annual PCB Load at Troy (lbs/yr) | Incremental Reduction in PCB Load at Troy (lbs/yr) | % Reduction with with Regard to No Action Alternative | Cost of Removal, Transport & Treatment 1982 (Dollars) | Cost per Pound Reduction at Troy |
|---|---|---|---|---|---|
| "No Action" Alternative | 8,000 | - | - | - | - |
| Moreau Site | | | | | |
| 1978 Remnant Deposits Remedial Actions (includes East Channel of Rogers Island Dredging) | 7,200 | 800 | 10% | $ 2,100,000 No treatment required | $ 2,600 |
| Proposed Site 10 | | | | | |
| Dredging Lock 7 to Thompson Island Pool | 6,700 | 1500 | 16% | $16,000,000 (rough estimate) | $32,000 |

(1) Source: LMS (1979)

## VI. PRODUCTION RATES FOR DREDGING SYSTEMS DEVELOPED UNDER THE HUDSON RIVER PCB RECLAMATION PROJECT

A. Production rates for the following dredging systems are taken from DREDGING REPORT PROGRAM REPORT NO. 2, PCB Hot Spot Dredging Program, Upper Hudson River, September, 1980.

1. Hydraulic Dredging and Transport:

   a) Typical equipment list would include:

      1) One 16-inch hydraulic cutterhead dredge
      2) Two 16-inch booster pump units
      3) One 300 hp tender tug
      4) One 160 hp supply tug
      5) One derrick barge
      6) One fuel barge
      7) Work-deck barge
      8) Pipeline and miscellaneous equipment
      9) Two bulldozers.

   b) The average production rate estimated for one 16-inch hydraulic cutterhead dredge in Hot Spots 1 through 20 (refered to as the Thompson Island pool and areas above Lock 7) is 341 cu yds per hour. Estimated operating time is 17 hours per day or 500 hours per month.

2. Clamshell dredging with mechanical unloading (truck or conveyor transport).

   a) Typical equipment list would include:

      1) Two five-cu yd clamshell dredges
      2) Five 1000 cu yd hopper scows
      3) One work-deck barge
      4) One 800 hp towing tug
      5) Two 200 hp tender tugs
      6) Two six-cu yd clamshell cranes for unloading
      7) Two five-cu yd front-end loaders
      8) Twelve 20-cu yd dump trucks
      9) One work-deck barge

   b) The average production rate estimated for one five-cu yd clamshell dredge is 200 cu yds per hour. Estimated operating time is 600 hrs. per month for a monthly production rate of 120,000 cu yds. (Note: Under this alternative, two five-cu yd dredges will be required to dredge

the Thompson Island Pool and areas above Lock 7 in one dredging season.)

3. Clamshell Dredging and Hydraulic Pumpout Transport with or without Recycling of Water:

   a) Typical equipment list would include:

      1) Two five-cu yd clamshell dredges
      2) Five 1000 cu yd hopper scows
      3) One work-deck barge
      4) One 800 hp towing tug
      5) Two 200 hp tender tugs
      6) One 16-inch pumpout plant
      7) One tie-up barge
      8) Shoreline pipeline and miscellaneous equipment
      9) Two bulldozers

   b) The average production rate estimated for one five-cu yd clamshell dredge is 200 cu yds per hour. Estimated operating time is 600 hrs per month for a monthly production rate of 120,000 cu yds. (Note: Under this alternative, two five-cu yd dredges will be required to dredge the Thompson Island pool and areas above Lock 7 in one dredging season.)

B. Production rates for the Mud Cat dredges are taken from literature received by Mr. Peter Kuniholm, NPI from Mud Cat Division National Car Rental Systems, Inc., and dated 9/80 and 11/80. The cover letter is dated May 29, 1981.

4. Mud Cat dredges

| | Model D-24-1 | Model D-30 |
|---|---|---|
| Main Pump: | Thomas 8-inch intake<br>8-inch discharge<br>24-inch impeller(closed) | Thomas 10-inch intake<br>8-inch discharge<br>30-inch impeller (closed) |
| Operating Depth: | 15 ft (standard) | 25 ft. (standard) |
| Pump Speed: | 900 r.p.m. | 675-700 r.p.m. |
| Detroit Diesel: | 6-71; 203 hp @ 1900 r.p.m. | 8V-71; 225 hp |
| Total Head: | 105 @ 83 p.s.i. @ 14' | 155 @ 75 p.s.i. @ [illegible] |
| at 1000' | -- | 40' lift |
| Capacity: | 90-140 cu yds/hr. | 110-200 cu yds.hr. |

| | | |
|---|---|---|
| Sand & Gravel: | 100 cu yds/hr. | 140 cu yds/hr. |
| Sand: | 115 cu/yds/hr. | 155 cu yds/hr. |
| Light sand & silt: | 140 cu yds/hr. | 200 cu yds/hr. |
| | 2500 gallons/min. | 2700 gallons/min. |

Other models offer greater operating depths with similar capacities.

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1. Hydroscience, Inc., "Analysis of the Fate of PCB's in the Ecosystem of the Hudson Estuary", Prepared for the State of New York Department of Environmental Conservation, October 1979.

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3. Lawler Matusky & Skelly Engineers, "Upper Hudson River Transport Modeling Study, Final Report", December 1979.

4. Malcolm Pirnie, Inc., "Investigation of Conditions Associated with the Removal of Fort Edward Dam," February 1975.

5. Malcolm Pirnie, Inc., "Preliminary Appraisal Sediment Transport Relations Upper Hudson River, " June 1976.

6. Malcolm Pirnie, Inc., "Maintenance Dredging, Champlain Canal, Fort Edward Terminal Channel, Fort Edward, New York," April 1977.

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FILE
FILE
LASKI - BWFD
SWIDYK - BWFD
- EPA, REGION II
- EPA, EDISON, N.Y.

Effective Date (EDP) : EDP (July 1, 19
(July 1, 19
Expiration Date (ExDP) : 5 Years from E.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
STATE POLLUTANT DISCHARGE ELIMINATION SYSTEM (SPDES)
DISCHARGE PERMIT

Special Conditions
(Part I)

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the Clean Water Act, as amended, (33 U.S.C. §1251 et. seq.) (hereinafter referred to as "the Act").

Permittee Name: New York State Department of Environmental Conservation

Permittee Street: 50 Wolf Road

Permittee City: Albany State: NY Zip Code: 12233

is authorized to discharge from the facility described below:

Facility Name: Upper Hudson River PCB Encapsulation and Treatment Facility

Facility Location (C,T,V): Fort Edward (T) County: Washington

Facility Mailing Address (Street): 50 Wolf Road

Facility Mailing Address (City): Albany State: NY Zip Code: 12233

into receiving waters known as: Hudson River

Outfall 001: Latitude; 43° 13 Min. 17 Sec. Longitude; 73° 34 Min. 58 Sec.
Outfall 002: Latitude; 43° 13 Min. 17 Sec. Longitude; 73° 34 Min. 58 Sec.

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or extended pursuant to law. To be authorized to discharge beyond the expiration date, the permittee shall apply for permit renewal as prescribed by Sections 17-0803 and 17-0804 of the Environmental Conservation Law and Parts 621, 752, and 755 of the Departments' rules and regulations.

By Authority of D. A. Corliss, P.E., Regional Engineer
Designated Representative of Commissioner of the
Department of Environmental Conservation

June 14, 1982
Date

D. A. Corliss
Signature

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

ring the period beginning EDP (JULY 1, 1982)
lasting until Five (5) Years from EDP (JULY 1, 1987)
discharges from the permitted facility shall be limited and monitored by the
itted as specified below:

| Outfall Number & Effluent Parameter | Discharge Limitations Daily Avg. | Daily Max. | Units | Monitoring Requir. Measurement Frequency | Sampl Type |
|---|---|---|---|---|---|
| he following discharge limitations shall apply to the effluent from outfalls 001 and 002 during the time period that starts with the commencement of hydraulic dredging and terminates at the commencement of clamshell dredging.(1) | | | | | |
| 01, Arsenic, Total | NA | 0.1 | mg/l | Weekly | 24-hr.Com |
| Cadmium, Total | NA | 0.2 | " | " | " |
| Chromium, Total | NA | 1.0 | " | " | " |
| Copper, Total | NA | 0.8 | " | " | " |
| Lead, Total | NA | 0.2 | " | " | " |
| ercury, Total | NA | 0.02 | " | " | " |
| Nickel, Total | NA | 2.0 | " | " | " |
| Silver, Total | NA | 0.1 | " | " | " |
| Zinc, Total | NA | 1.0 | " | " | " |
| uspended Solids | NA | 25.0 | " | Daily | " |
| PCB's | 2.0 | 10.0 | lbs/day | " | " |
| H shall not be less than 6.0 SU nor greater than 9.0 SU | | | | " | Grab |
| 002 No Discharge | | | | | |

(1) These limitations, with prior Department approval, shall also apply during the period of clamshell dredging if it is found to be infeasible or hazardous to recycle pumpout water.

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning EDP (JULY 1, 1982)
and lasting until Five (5) Years from EDP (JULY 1, 1987)
the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

| Outfall Number & Effluent Parameter | Discharge Limitations Daily Avg. | Daily Max. | Units | Monitoring Requir. Measurement Frequency | Sam Ty |
|---|---|---|---|---|---|
| The following discharge limitations shall apply to the effluents from outfalls 001 and 002 during the time period that starts with the commencement of clamshell dredging and terminates when the last dredge spoil containment site is closed and covered. | | | | | |
| 001, Arsenic, Total | NA | 0.1 | mg/l | Weekly | 24-hr |
| Cadmium, Total | NA | 0.2 | " | " | " |
| Chromium, Total | NA | 1.0 | " | " | " |
| Copper, Total | NA | 0.8 | " | " | " |
| Lead, Total | NA | 0.2 | " | " | " |
| Mercury, Total | NA | 0.02 | " | " | " |
| Nickel, Total | NA | 2.0 | " | " | " |
| Silver, Total | NA | 0.1 | " | " | " |
| Zinc, Total | NA | 1.0 | " | " | " |
| Suspended Solids | NA | 25.0 | " | Daily | " |
| PCB's | 0.26 | 1.3 | lbs/day | " | " |
| pH shall not be less than 6.0 SU nor greater than 9.0 SU | | | | " | Grab |

002 , No Discharge

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS -

During the period beginning EDP (JULY 1, 1982)
and lasting until Five (5) years from EDP (JULY 1, 1987)
the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

| Outfall Number & Effluent Parameter | Discharge Limitations Daily Avg. | Daily Max. | Units | Monitoring Reqmts. Measurement Frequency | Sample Type |
|---|---|---|---|---|---|
| The following discharge limitations shall apply to the effluents from outfalls 001 and 002 when the last dredge spoil containment site is closed and covered and thereafter. | | | | | |
| 001 Discharge of STORMWATER without the admixture of leachate or interstitial water. | | | | | |
| 002 Effluent limited to interstitial water and leachate. | | | | | |
| Arsenic, Total | NA | 0.1 | mg/l | Monthly | 24-hr.Com |
| Cadmium, Total | NA | 0.2 | " | " | " |
| Chromium, Total | NA | 1.0 | " | " | " |
| Copper, Total | NA | 0.8 | " | " | " |
| Lead, Total | NA | 0.2 | " | " | " |
| Mercury, Total | NA | 0.02 | " | " | " |
| Nickel, Total | NA | 2.0 | " | " | " |
| Silver, Total | NA | 0.1 | " | " | " |
| Zinc, Total | NA | 1.0 | " | " | " |
| PCB's | 0.02 | 0.1 | " | Weekly | " |
| Suspended Solids | NA | 45.0 | " | " | " |
| pH shall not be less than 6.0SU nor greater than 9.0 SU | | | | " | Grab |

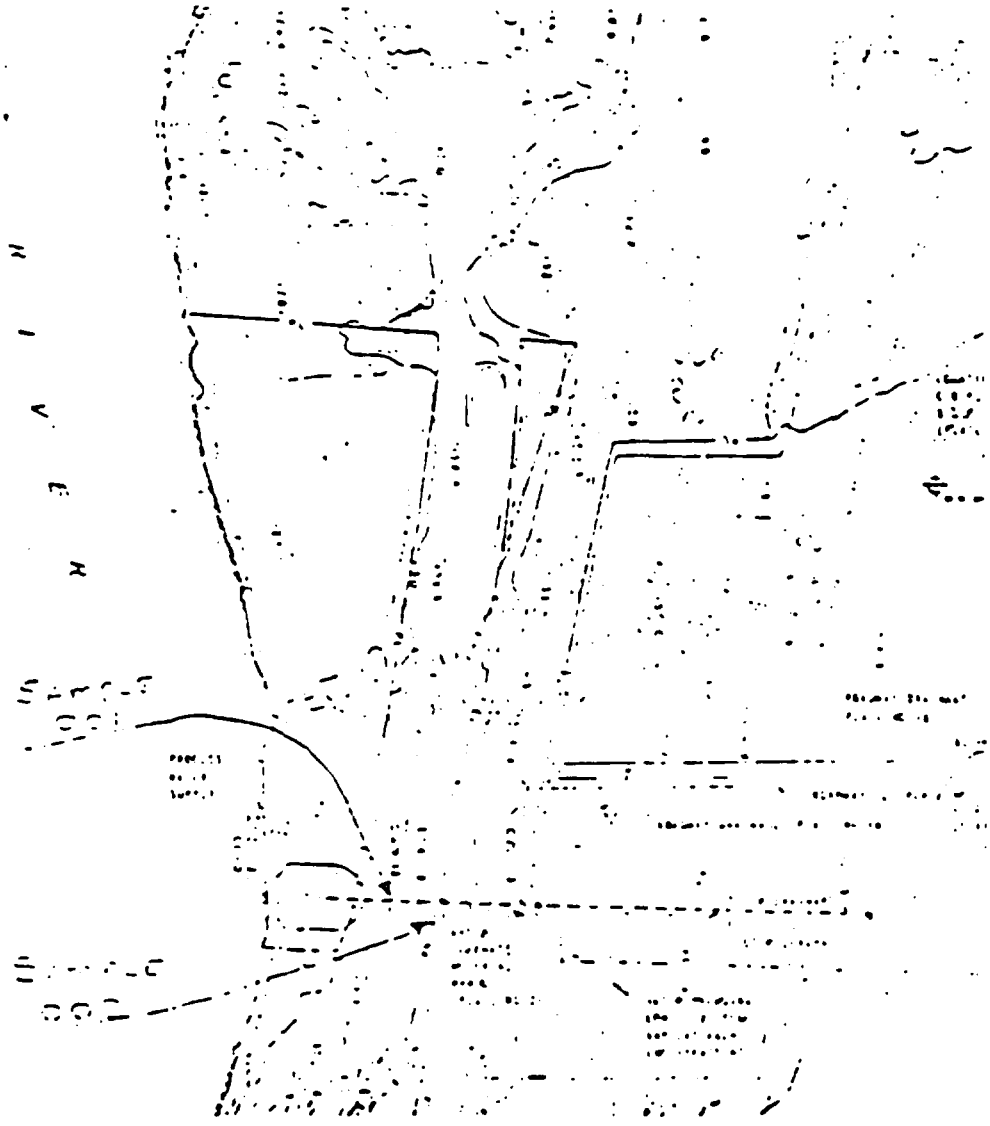
efinition of Daily Average and Daily Maximum

e daily average discharge is the total discharge by weight or in other appropriate ite as specified herein, during a calendar month divided by the number of days in the nth that the production or commercial facility was operating. Where less than daily mpling is required by this permit, the daily average discharge shall be determined by e summation of all the measured daily discharges in appropriate units as specified rein divided by the number of days during the calendar month when the measurements are made.

e daily maximum discharge means the total discharge by weight or in other appropriate its as specified herein, during any calendar day.

onitoring Locations

ittee shall take samples and measurements to meet the monitoring requirements at e location(s) indicated below: (Show locations of outfalls with sketch or flow agram as appropriate).



SCHEDULE OF COMPLIANCE FOR EFFLUENT LIMITATIONS

(a) Permittee shall achieve compliance with the effluent limitations specified in this permit for the permitted discharge(s) in accordance with the following schedule:

| Action Code | Outfall Number(s) | Compliance Action | Due Date |
|---|---|---|---|
| | 001,002 | Contingency Plan for Additional Treatment or Control Measures | |

In order to insure prompt, effective remedial activity in the event that effluent limitations are exceeded, the permittee shall:

1. Submit to the Department an approvable engineering report, describing additional treatment or control measures that will be implemented to bring the discharge into compliance with:

   a. Suspended solids limitations, during the period prior to site closure.
   b. All effluent limitations, after site closure.

2. After approval of the engineering report, submit to the Department approvable final plans and specifications for any additional waste-water treatment facilities, described in the report.

   No discharge shall be permitted from this site until both the engineering report and final plans and specifications have been approved by the Department.

(b) The permittee shall submit to the Department of Environmental Conservation the required document(s) where a specific action is required in (a) above to be taken by a certain date, and a written notice of compliance or noncompliance with each of the above schedule dates, postmarked no later than 14 days following each elapsed date. The notice of noncompliance shall include the following information:

1. A short description of the noncompliance;

2. A description of any actions taken or proposed by the permittee to comply with the elapsed schedule requirement without further delay;

3. A description of any factors which tend to explain or mitigate the noncompliance; and

4. An estimate of the date permittee will comply with the elapsed schedule requirement and an assessment of the probability that permittee will meet the next scheduled requirement on time.

SCHEDULE OF COMPLIANCE FOR EFFLUENT LIMITATIONS
(Continued)

c) The permittee shall submit copies of the written notice of compliance or noncompliance required herein to the following offices:

Chief, Compliance Section
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233

Regional Engineer -
New York State Department of Environmental Conservation
ROUTE 86
RAY BROOK, NEW YORK 12977

DR. RICHARD BAKER, CHIEF
PERMITS ADMINISTRATION BRANCH
PLANNING & MANAGEMENT DIVISION
USEPA REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10278

The permittee shall submit copies of any engineering reports, plans of study, final plans, as-built plans, infiltration-inflow studies, etc. required herein to the New York State Department of Environmental Conservation Regional Office specified above unless otherwise specified in this permit or in writing by the Department or its designated field office.

a) The permittee shall also refer to the General Conditions (Part II) of this permit additional information concerning monitoring and reporting requirements and conditions.

( ) The monitoring information required by this permit shall be summarized and reported using a completed and signed Discharge Monitoring Report form once every 1 months the Department of Environmental Conservation and other appropriate regulatory agencies the offices specified below. The first report will be due no later than AUGUST 28, 1981 reafter, reports shall be submitted no later than the 28th of the following month(s): MONTH.

Water Division
New York State Department of Environmental Conservation
50 Wolf Road - Albany, New York 12233

New York State Department of Environmental Conservation
Regional Engineer -
ROUTE 86 - RAY BROOK, NEW YORK 12977

[ ] (Applicable only if checked):

Dr. Richard Baker, Chief - Permits Administration Branch
Planning & Management Division
USEPA Region II
26 Federal Plaza
New York, New York 10278

c) If so directed by this permit or by previous request, Monthly Wastewater Treatment nt Operator's Reports shall be submitted to the DEC Regional Office and county health tment or county environmental control agency specified above.

) Monitoring must be conducted according to test procedures approved under CFR Part 136, unless other test procedures have been specified in this permit.

e) If the permittee monitors any pollutant more frequently than required by the mit, using test procedures approved under 40 CFR 136 or as specified in the permit, results of this monitoring shall be included in the calculation and reporting of the ta submitted in the Discharge Monitoring Reports.

f) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in the permit.

g) Unless otherwise specified, all information submitted on the Discharge Monitoring rts shall be based upon measurements and sampling carried out during the most recently pleted reporting period.

( ) Blank Discharge Monitoring Report Forms are available at the above addresses.

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
William C. Hennessy, Commissioner

Region 1 Office: 84 Holland Avenue, Albany, New York 12208

February 18, 1982

Department of Environmental Conservation
PCB Project Unit, Room 321
50 Wolf Road
Albany, New York 12233

ATTENTION: Jeff Schmitt

Dear Mr. Schmitt:

As per our telephone conversation, please find attached the information you requested on the Hudson River excavation at Fort Edward.

If any further information is needed, please feel free to call me at 474-0565.

Very truly yours,

Victor R. Griffin
Design
Region #1

VRG:paf
Attachment

# [illegible] EXCAVATION AT FT. EDWARD

| CONTRACTOR | EXCAVATION DATE | | PROJECT DATES | | LOCATION OF EXC. | LOCATION PLACED | AMOUNT C.Y. |
|---|---|---|---|---|---|---|---|
| | START | END | START | END | | | |
| D.A. COLLINS | 7-30-74 | 10-10-74 | 7-19-74 | 5-15-74 | WEST CHANNEL - SO. END OF ROGERS IS. | MOREAU SITE | 69,[illegible] |
| BOHL CONST. (SUBCONTRACTOR) | 7-29-74 | 6-19-75 | | | EAST CHANNEL - NO. END ROGERS IS. TO MOBIL DOCK | MOREAU SITE | 181,[illegible] |
| D.A. COLLINS | 6-9-75 | 10-7-75 | 6-19-75 | 11-21-75 | WEST CHANNEL - NORTH OF ROGERS IS. TO SOUTH END OF ISLAND | MOREAU SITE | 127,657. |
| D.A. COLLINS | 9-[illegible]-77 | 9-7-78 | 8-8-77 | 8-[illegible]-78 | EAST CHANNEL - NORTH OF ROGERS IS. TO MOBIL DOCK | MOREAU - ENCAPSULATED SITE | 181,[illegible] |
| J.H. MALLY | 9-1-78 | 8-10-[illegible] | 8-7-78 | 5-17-79 | AREA 3A | MOREAU - ENCAPSULATED SITE | 14,[illegible] |

CONTRACT COST:

| | |
|---|---|
| M 74-5 | $ 533,450.[illegible] |
| M 75-6 | $ 570,536.[illegible] |
| D 95272 | $ 939,472.[illegible] |
| D 95915 | $ 626,705.[illegible] |

# REMOVAL AND STABILIZATION OF REMNANT DEPOSITS
# FORT EDWARD FLOOD CONTROL PROJECT
## Report on Design and Estimate
## May, 1978

### Project Description

This project consists of the construction of stone fill bank and channel protection along a beach of the Hudson River at Fort Edward, New York, and the excavation, removal and disposal of PCB contaminated soils from portions of the beach area.

### Designer

Malcolm Pirnie, Inc., Consulting Environmental Engineers; 11 Computer Drive West; Albany, New York, under contract to the New York State Department of Environmental Conservation.

### Location of Project

The beach area is located on the easterly shore of the Hudson River near the northerly line of the Village of Fort Edward. The disposal site for contaminated soils is on the westerly side of the Hudson in the Town of Moreau.

### Project Status

This is one portion of a larger project aimed at stabilizing shoreline deposits along the Hudson River to prevent erosion and reduce the amount of sediment reaching the Champlain Canal system. An associated benefit will be a reduction in the amount of PCB contaminated soils entering the Hudson.

### Soils Investigations

Soil borings were taken on the beach area in 1974. Copies of the boring logs are attached.

### Right-of-Way

A right-of-way is required to obtain access to the beach area on the west side of the River. Negotiations are in progress to obtain an access easement. The disposal area is on state-owned lands.

## Utilities

There are no known utilities on the beach area.

## Materials

Stone filling and bedding materials required for the bank and channel protection are available from local quarries.

## Participation

The project will be financed by the New York State Department of Environmental Conservation's Fort Edward Flood Control Fund. Construction administration will be accomplished by the New York State Department of Transportation.

## Proposed Contract Completion Date

| Letting Date | Completion Date |
|---|---|
| July 6 to August 30, 1978 | May 1, 1979 |

Note: Work can be accomplished in 6 months or less. However, disposal area must be seeded at end of job. Spring seeding is indicated from the tentative schedule.

## Estimate of Cost

See Engineer's Estimate of Cost attached. A preliminary estimate received from a contractor to accomplish this work under a change order to an existing contract (Contract D95278) was approximately $600,000.

C 114-2 (10/7
NYSDOT

# ENGINEER'S E MATE – ITEM SHEET

Type of Estimate: COMBINED SHARES | P.I.N. 1940.03(02) | Pg. No. 1 | Tot. Pgs 3

| NO. | ITEM | UNIT | QUANTITY | PRICE | AMOUNT |
|---|---|---|---|---|---|
| | Access Road to River | L.S. | NEC | 50,000.00 | 50,000.0 |
| | Unclassified Excavation and Off-Site Disposal | C.Y. | 14,000. | 7.00 | 98,000.0 |
| | Disposal Area Cover Material | C.Y. | 12,500 | 5.00 | 62,500.0 |
| | Construction of Earth Dam | C.Y. | 560 | 5.00 | 2,800.0 |
| | Selected Material for Turf Establishment | C.Y. | 8,700 | 3.00 | 26,10[illegible] |
| | Unclassified Excavation and On-Site Disposal | C.Y. | 15,000 | 3.00 | 45,000.0 |
| | Preparation of Riverbank for Bank and Channel Protection | C.Y. | 4,000 | 7.00 | 28,000.0 |
| 607.11 | Right-of-Way Fence | L.F. | 1,000 | 6.00 | 6,000.0 |
| | Seeding on Special Areas | Acre | 5.60 | 750 | 4,200.0 |
| 5619.2003 | Maintenance and Protection of Traffic (Non Restricted Highways) | L.S. | NEC | 30,000.00 | 30,000.0 |
| 620.03 | Stone Filling (Light) | C.Y. | 3,600 | 35.00 | 126,000.0 |
| 620.08 | Bedding Material | C.Y. | 2,700 | 35.00 | 94,5[illegible] |
| 1637.0601 | Engineers Office, Type B | MO | 8 | 650.00 | 5,200.0 |
| 699.01 | Mobilization | L.S. | NEC | 17,500.00 | 17,500.0 |
| | TOTAL | | | | 595,800.0 |

C 114-2 (10/70)
NYSDOT

# ENGINEER'S ES..MATE – ITEM SHEET

| Type of Estimate | SHARE 1. WASHINGTON COUNTY | P.I.N. 1940.03(02 | | | Pg. No. 2 | Tot. Pg 3 |
|---|---|---|---|---|---|---|
| NO. | ITEM | UNIT | QUANTITY | PRICE | AMOUNT | |
| | Access Road to River | L.S. | NEC | 50,000.00 | 50,000. | 0 |
| | Unclassified Excavation and Off-Site Disposal | C.Y. | 7,000 | 7.00 | 49,000. | 0 |
| | Construction of Earth Dam | C.Y. | 560 | 5.00 | 2,800. | 0 |
| | Selected Material for Turf Establishment | C.Y. | 450 | 3.00 | 1,350. | 0 |
| | Unclassified Excavation and On-Site Disposal | C.Y. | 15,000 | 3.00 | 45,000. | 0 |
| | Preparation of Riverbank for Bank and Channel Protection | C.Y. | 4,000 | 7.00 | 28,000. | 0 |
| 607.11 | Right-of-Way Fence | L.F. | 1,000 | 6.00 | 6,000. | 0 |
| | Seeding on Special Areas | Acre | 0.50 | 750 | 375. | 0 |
| 15619.2003 | Maintenance and Protection of Traffic (Non-Restricted Highways) | L.S. | NEC | 20,000.00 | 20,000. | |
| 620.03 | Stone Filling (Light) | C.Y. | 3,600 | 35.00 | 126,000. | |
| 620.08 | Bedding Material | C.Y. | 2,700 | 35.00 | 94,500. | |
| 01637.0601 | Engineers Office, Type B | MO. | 4.0 | 650.00 | 2,600. | |
| 699.01 | Mobilization | L.S. | NEC | 12,800.00 | 12,800. | |
| | TOTAL SHARE 1 - WASHINGTON COUNTY | | | | 438,425. | |

C 114-2 (10/70)
NYSDOT

# ENGINEER'S ES ATE – ITEM SH T

| Type of Estimate | SHARE 2. SARATOGA COUNTY | P.I.N. | 1940.03(02) | | Pg. No. 3 | Tot. Pg 3 |
|---|---|---|---|---|---|---|
| NO. | ITEM | UNIT | QUANTITY | PRICE | AMOUNT | |
| | Unclassified Excavation and Off-Site Disposal | C.Y. | 7,000 | 7.00 | 49,000 | |
| | Disposal Area Cover Material | C.Y. | 12,500 | 5.00 | 62,500 | |
| | Selected Material for Turf Establishment | C.Y. | 8,250 | 3.00 | 24,750 | |
| | Seeding on Special Areas | Acres | 5.1 | 750.00 | 3,825 | |
| | Maintenance and Protection of Traffic (Non Restricted Highways) | L.S. | NEC | 10,000.00 | 10,000 | |
| | Engineers Office, Type B | MO. | 4.0 | 650.00 | 2,600 | |
| | Mobilization | L.S. | NEC | 4,700.00 | 4,700 | |
| | TOTAL SHARE 2. SARATOGA COUNTY | | | | 157,375 | |

August 29, 1978

N.Y.S. Dept. of Transportation
84 Holland Avenue
Albany, New York 12232
Att: Mr. V. Griffin
Engineer in Charge

Re: D05918, Fort Edward
Flood Control Project
Saratoga & Washington
Counties

Dear Sir:

Enclosed please find cost analysis of work in the disposal area of the above referred contract, as requested. We must include the following exceptions to your request.

(a) Any damage to wellpoint system while not in use would be an additional charge.

(b) Frost proofing of wellpoint system would be an additional charge.

(c) Holiday pay for operation of wellpoint system would be an additional charge.

(d) Maintenance of wellpoint system would entail an additional cost over and above operator cost.

(e) Fueling of wellpoint point pump when normal contract work is not in operation would entail additional cost.

(f) Daily pumping is based on five day guaranteed 40 hours work week for the operator with no Saturday and Sunday work or overtime.

(g) Cost analysis is based on 1978 labor rates and 29th AED equipment rates. Any work in 1979 would have to be adjusted.

(h) Freight for moving wellpoint equipment to and from the job would be an additional cost.

August 29, 1978

N.Y.S. Dept. of Transportation
Albany, New York
Att: Mr. V. Griffin
Engineer in Charge

Re: D95918, Fort Edward
Flood Control Project
Saratoga & Washington
Counties

Trusting this will meet with your approval, I remain,

Very truly yours,

JAMES H. MALOY, INC.

Harold V. Clark

Harold V. Clark
Vice President

HVC:vs
enclosures

## Install & Remove Wellpoint Header, Pump, Discharge Line and Miscellaneous Fittings

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 24 Hrs | @ | $ 8.54 | = | $204.96 | |
| 2 Laborers | 48 Hrs | @ | 8.14 | = | 390.72 | |
| 2 Wellpoint Installers | 48 Hrs | @ | 9.46 | = | 454.08 | |
| Scoop Operator | 24 Hrs | @ | 10.47 | = | 251.28 | |
| Grove Crane Operator | 8 Hrs | @ | 10.83 | = | 86.64 | |
| Wellpoint Demonstrator | 16 Hrs | @ | 12.775 | = | 204.32 | $1,592.00 |
| **Equipment:** | | | | | | |
| Caterpillar 980 Scoop | 16 Hrs | @ | 222.04 | = | 3555.44 | |
| Grove Crane 14 Ton | 5 Hrs | @ | 20.83 | = | 100.00 | |
| Pick-up Truck | 24 Hrs | @ | 1.80 | = | 43.56 | $ 301.00 |
| **Materials:** | | | | | | |
| Misc. Blocking | | | | | | $ 100.00 |
| **Insurance:** | | | | | | |
| 24% Labor ($1,592.00) | | | | | | $ 382.08 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 72 Hrs | @ | $ 1.87 | = | $134.64 | |
| Operators | 93 Hrs | @ | 2.17 | = | 202.32 | $ 342.00 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor and Materials ($1,592.00) | | | | | | $ 388.40 |
| | | | | Total Cost | | $3,357.04 |

## Install and Remove Wellpoints

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 96 Hrs | @ | $ 8.54 | = | $ 819.84 | |
| 2 Laborers | 192 Hrs | @ | 8.14 | = | 1,562.88 | |
| 2 Wellpoint Installers | 192 Hrs | @ | 9.46 | = | 1,815.32 | |
| Pump Operator | 96 Hrs | @ | 9.46 | = | 908.16 | |
| Crane Operator | 96 Hrs | @ | 10.83 | = | 1,039.68 | |
| Scoop Operator | 60 Hrs | @ | 10.47 | = | 837.60 | |
| Wellpoint Demonstrator | 96 Hrs | @ | 12.775 | = | 1,226.40 | $ 8,210.88 |
| **Equipment:** | | | | | | |
| Caterpillar 330 Scoop | 80 Hrs | 40 @ | $22.84 | = | $ 91.36 | |
| | | 20 @ | 20.30 | = | 405.00 | |
| | | 60 @ | 11.42 | = | 339.52 | |
| Grove Crane | 96 Hrs | 12 @ | 22.86 | = | $ 273.20 | |
| | | 20 @ | 21.20 | = | 424.00 | |
| | | 64 @ | 11.32 | = | 723.52 | |
| Jet Pump & Related Equip.Rental | 2 Weeks | @ | $[illegible] | = | $1,[illegible] | |
| Pickup Truck | 96 Hrs | @ | 1.80 | = | [illegible] | |
| | | | | | | $ 4,[illegible] |
| **Material:** | | | | | | |
| 375 Ton Concrete Sand | | @ | $ 5.00 | = | $1,875.00 | |
| 400 Gal Diesel Fuel | | @ | 0.49 | = | 196.00 | |
| 20 Qts Oil | | @ | 0.75 | = | 15.00 | |
| | | | | | | $2,086.00 |
| **Insurance:** | | | | | | |
| 24% Labor ($8,210.88) | | | | | | $ 1,970.61 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 288 Hrs | @ | $ 1.87 | = | $ 538.56 | |
| Operators | 560 Hrs | @ | 2.17 | = | 1,215.20 | $ 1,753.76 |
| **Travel for Wellpoint Demonstrator:** | | | | | | |
| 500 Miles @ $0.20/mile | | | | | | $ 100.00 |
| **Food & Lodging for Wellpoint Demonstrator:** | | | | | | |
| 12 Days @ $50.00/day | | | | | | $ 600.00 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor & Materials (10,206.36) | | | | | | $ 2,059.33 |
| | | | | | Total Cost | $21,432.67 |

$21,432.67 ÷ 100 = $214.33/Each

## Trench Drain

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 80 Hrs | 2 | $ 8.54 | = | $ 683.20 | |
| Backhoe Crew | 80 Hrs | 2 | 19.39 | = | 1,551.20 | |
| Dozer Operator | 80 Hrs | 2 | 10.47 | = | 837.60 | |
| 1½ C.Y. American Crane Crew | 80 Hrs | 2 | 10.39 | = | 1,551.20 | $ 4,623.20 |
| **Equipment:** | | | | | | |
| Caterpillar 235 Backhoe | 80 Hrs | )20 2 | $73.35 | = | $1,467.00 | |
| | | )20 2 | 65.20 | = | 1,304.00 | |
| | | )40 2 | 33.68 | = | 1,067.20 | |
| D-6 Bulldozer | 80 Hrs | )20 2 | $40.95 | = | $ 819.00 | |
| | | )20 2 | 33.65 | = | 673.00 | |
| | | )40 2 | 20.48 | = | 819.20 | |
| 1½ C.Y. American Crane with Clam Shell | 80 Hrs | )20 2 | $56.23 | = | $1,245.60 | |
| | | )20 2 | 55.85 | = | 1,117.20 | |
| | | )40 2 | 31.24 | = | 1,245.60 | $10,202.00 |
| **Material:** | | | | | | |
| No. 2 Stone | 600 Ton | | $ 4.50 | = | | $ 2,700.00 |
| **Insurance:** | | | | | | |
| 24% Labor ($4,623.20) | | | | | | $ 1,109.57 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 80 Hrs | 2 | $ 1.87 | = | $ 149.60 | |
| Operators | 400 Hrs | 2 | 2.17 | = | 868.00 | $ 1,017.60 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor & Material ($7,323.20) | | | | | | $ 1,464.64 |
| | | | | | Total Cost | $21,117.81 |

$21,117.81 ÷ 355 = $59.49 per Lineal Foot

## Filter Fabric

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| 4 Laborers 10 Days | 320 Hrs | @ | $ 7.94 | = | $2,540.80 | |
| 1 Operator 10 Days | 80 Hrs | @ | 10.33 | = | 826.40 | $3,367.20 |
| **Equipment:** | | | | | | |
| 14 Ton Crane | 80 Hrs | @ | $11.93 | = | $ 954.40 | $ 954.40 |
| **Material:** | | | | | | |
| 2 Rolls Filter Fabric | | @ | $653.57 | = | $1,307.14 | |
| 1000 L.F. 2" X 2" Wood | L.F. | @ | 0.12 | = | 120.00 | |
| Misc. Materials(Nails,Slings,etc.) | | | | = | 250.00 | $1,677.14 |
| **Insurance:** | | | | | | |
| 24% Labor ($3,367.20) | | | | | | $ 817.72 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 320 Hrs | @ | $ 1.97 | = | $ 630.40 | |
| Operators | 80 Hrs | @ | 2.17 | = | 173.60 | $ 772.00 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor and Materials ($8,634.34) | | | | | | $1,613.87 |
| | | | | Total Cost | | $8,345.34 |

$8,345.34 ÷ 7455 S.F. = $1.12/S.F.

## Install 1½" Observation Well - 3 Each

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 16 Hrs | @ | $ 8.54 | = | $136.64 | |
| 4 Laborers | 64 Hrs | @ | 8.14 | = | 520.96 | |
| Crane Crew | 24 Hrs | @ | 10.39 | = | 455.36 | |
| Scoop Operator | 16 Hrs | @ | 10.47 | = | 167.52 | |
| Wellpoint Demonstrator | 16 Hrs | @ | 12.775 | = | 204.40 | |
| Teamster | 8 Hrs | @ | 8.55 | = | 68.40 | $1,563.28 |
| **Equipment:** | | | | | | |
| 45 Ton American Crane | 24 Hrs | @ 20 / @ 4 | $43.28 / 43.80 | = | $865.60 / 175.20 | |
| 930 Scoop | 16 Hrs | @ | 11.42 | = | 182.72 | |
| Pick-up Truck | 16 Hrs | @ | 1.89 | = | 30.24 | |
| Jetting Equipment | 1 Week | @ | 1470.00 | = | 740.00 | $2,113.76 |
| **Material:** | | | | | | |
| 1½" d Pipe & Screening, etc | | | | | $279.00 | |
| Sand | 6 Ton | @ | $ 5.30 | = | 31.80 | |
| Bentonite Pellets | 225 Lbs | @ | 0.85 | = | 191.25 | $ 437.05 |
| **Insurance:** | | | | | | |
| 24% Labor (S1,563.28) | | | | | | $ 375.19 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 80 Hrs | @ | $ 1.87 | = | $149.60 | |
| Operators | 80 Hrs | @ | 2.17 | = | 173.60 | |
| Teamster | 8 Hrs | @ | 2.67 | = | 21.36 | $ 344.56 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor and Material (S2,020.33) | | | | | | $ 404.07 |
| | | | | | Total Cost | $5,257.91 |

$5,257.91 ÷ 3 = $1,752.64/Each

## Install 4" Observation Well

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 8 Hrs | @ | $ 8.54 | = | $ 68.32 | |
| 4 Laborers | 32 Hrs | @ | 8.14 | = | 260.48 | |
| Scoop Operator | 8 Hrs | @ | 10.47 | = | 83.76 | |
| Crane Operator | 8 Hrs | @ | 10.83 | = | 86.64 | |
| Wellpoint Demonstrator | 8 Hrs | @ | 12.775 | = | 102.20 | $ 601.40 |
| **Equipment:** | | | | | | |
| 15 Ton Grove Crane | 8 Hrs | @ | $11.93 | = | $ 95.44 | |
| 930 Scoop | 8 Hrs | @ | 11.42 | = | 91.36 | |
| Pick-up Truck | 8 Hrs | @ | 1.89 | = | 15.12 | |
| Setting Equipment | Min. ½ Week | @ | 1,470.00 | = | 740.00 | $ 941.92 |
| **Material:** | | | | | | |
| Pipe & Fitting | | | L.S. | = | $130.00 | |
| 10 Ton Sand | | @ | $ 6.00 | = | 60.00 | |
| Bentonite Pellets | 750 Lbs | @ | 0.65 | = | 487.50 | $ 677.50 |
| **Insurance:** | | | | | | |
| 24 % Labor ($601.40) | | | | | | $ 144.34 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 40 Hrs | @ | $ 1.87 | = | $ 74.80 | |
| Operators | 24 Hrs | @ | 2.17 | = | 52.08 | $ 126.88 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor and Material ($1,271.00) | | | | | | $ 254.30 |
| | | | Total Cost | | | $2,730.42 |

## Remove Wellpoint Pump, Drain and Secure System

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 8 Hrs | 2 | $ 3.54 | = | $ 60.32 | |
| 2 Laborers | 16 Hrs | 2 | 3.14 | = | 100.24 | |
| Grove Crane | 8 Hrs | 2 | 10.33 | = | 80.64 | |
| Pump Operator | 8 Hrs | 2 | 9.46 | = | 75.68 | |
| Teamster | 8 Hrs | 2 | 8.55 | = | 68.40 | $ 429.23 |
| **Equipment:** | | | | | | |
| 15 Ton Grove | 8 Hrs | 2 | $26.50 | = | $212.00 | |
| Low-Boy Trailer | 8 Hrs | 2 | 11.54 | = | 92.32 | |
| Pick-up Truck | 8 Hrs | 2 | 1.89 | = | 15.12 | $ 319.44 |
| **Insurance:** | | | | | | |
| 24% Labor ($429.23) | | | | | | $ 103.02 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 24 Hrs | 2 | $ 1.87 | = | $ 44.88 | |
| Operators | 16 Hrs | 2 | 2.17 | = | 34.72 | |
| Teamster | 8 Hrs | 2 | 2.64 | = | 21.12 | $ 100.72 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor ($429.23) | | | | | | $ 85.86 |
| | | | | | | $1,038.33 |

## Reinstall Collection Pump and Resume Pumping

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 8 Hrs | [illegible] | $ 3.54 | = | $ 68.32 | |
| 2 Laborers | 16 Hrs | @ | 3.14 | = | 130.24 | |
| Grove Operator | 8 Hrs | @ | 10.03 | = | 83.64 | |
| Pump Operator | 8 Hrs | @ | 9.46 | = | 75.68 | |
| Teamster | 8 Hrs | @ | 3.55 | = | 68.40 | $ 429.28 |
| **Equipment:** | | | | | | |
| 15 Ton Grove | 8 Hrs | @ | $26.50 | = | $212.00 | |
| Low-boy Trailer | 8 Hrs | @ | 11.54 | = | 92.32 | |
| Pick-up Truck | 8 Hrs | @ | 1.39 | = | 10.12 | $ 312.44 |
| **Insurance:** | | | | | | |
| 24% Labor ($429.28) | | | | | | $ 103.03 |
| **Welfare & Pension & Holidays:** | | | | | | |
| Laborers | 24 Hrs | @ | $ 1.87 | = | $ 44.88 | |
| Operators | 16 Hrs | @ | 2.17 | = | 34.72 | |
| Teamster | 8 Hrs | @ | 2.64 | = | 21.12 | $ 100.72 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor & Material ($429.28) | | | | | | $ 85.85 |
| | | | | Total Cost | | $1,033.33 |

## Remove Material From Slope Area

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 40 Hrs | [illegible] | $ 8.54 | = | $341.60 | |
| Crane Crew | 40 Hrs | [illegible] | 19.39 | = | 775.60 | |
| 2 Teamsters | 80 Hrs | [illegible] | 8.55 | = | 684.00 | |
| Dozer Operator | 40 Hrs | [illegible] | 10.47 | = | 413.80 | |
| Laborer | 40 Hrs | [illegible] | 7.94 | = | 317.60 | $2,537.60 |
| **Equipment:** | | | | | | |
| 45 Ton American Crane with Clam Shell | 40 Hrs | 20% / 80% | $54.03 / 48.02 | = | $1080.60 / 960.40 | |
| Caterpillar D-6 Dozer | 40 Hrs | 20% / 80% | $40.96 / 36.40 | = | 819.20 / 728.00 | |
| 10 Wheeler Trucks | 80 Hrs | [illegible] | 11.54 | = | [illegible] | $4,511.20 |
| **Insurance:** | | | | | | |
| 21% Labor ($2,537.60) | | | | | | $ 533.00 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 80 Hrs | [illegible] | $ 1.97 | = | $ 157.60 | |
| Operators | 120 Hrs | [illegible] | 2.17 | = | 260.40 | |
| Teamster | 80 Hrs | [illegible] | 2.67 | = | 213.60 | $ 631.60 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor ($2,537.60) | | | | | | $ 507.52 |
| | | | Total to Remove | | | $8,733.04 |

## Daily Pumping

| | | | |
|---|---|---|---|
| **Labor:** | | | |
| Pump Operator | 8 Hrs @ $9.46 | | $ 75.68 |
| **Material:** | | | |
| Fuel | 25 Gal Diesel @ $0.55/Gal= $13.75 | | |
| " | 2 Qts Oil @ 0.75/Qt = 1.50 | | $ 15.25 |
| **Insurance:** | | | |
| 24% Labor ($75.68) | | | $ 18.16 |
| **Welfare & Pension:** | 8 Hrs @ $2.17 | | $ 17.36 |
| **Overhead & Profit:** | | | |
| 20% Labor & Materials ($200.93) | | | $ 40.18 |
| | | Total Cost | $344.63/8 Hr. Day |

From Substantial Paper "Manual Dewatering, A Case History" April 1980
that uses 100 hours of pumping to dewater. Using this model,
the cost to do the pumping would be $15,863.00.

## Replace Material on Slope Area

| | | | | | | |
|---|---|---|---|---|---|---|
| **Labor:** | | | | | | |
| Foreman | 56 Hrs | @ | $ 8.54 | = | $ 478.24 | |
| Crane Crew | 40 Hrs | @ | 19.39 | = | 775.60 | |
| Laborers | 24 Hrs | @ | 7.94 | = | 190.56 | |
| Seeder & Mulcher Operator | 8 Hrs | @ | 10.47 | = | 83.76 | |
| Dozer Operator | 48 Hrs | @ | 10.47 | = | 502.56 | |
| Teamster | 8 Hrs | @ | 8.55 | = | 68.40 | $ 2,099.12 |
| **Equipment:** | | | | | | |
| 45 Ton American Crane | 40 Hrs | @ | $27.01 | = | $1080.40 | |
| D-6 Dozer | 48 Hrs | @ | 20.43 | = | 983.04 | |
| Seeder & Mulcher | 8 Hrs | @ | 30.00 | = | 240.00 | $ 2,303.44 |
| **Material:** | | | | | | |
| 18" Cover Material Delvd Job Site 900C.Y. | | @ | $ 3.50 | = | $3150.00 | |
| 12" Select MaterialDelvd Job Site 600C.Y. | | @ | 3.50 | = | 2100.00 | |
| 3.4 Acres Seed,Fertilized,Mulch | | | | | [illegible] | $ 5,000.00 |
| **Insurance:** | | | | | | |
| 24% Labor ($2,099.12) | | | | | | $ 503.79 |
| **Welfare & Pension:** | | | | | | |
| Laborers | 80 Hrs | @ | $ 1.87 | = | $ 149.60 | |
| Operators | 136 Hrs | @ | 2.17 | = | 295.12 | |
| Teamster | 8 Hrs | @ | 2.67 | = | 21.33 | $ 466.05 |
| **Overhead & Profit:** | | | | | | |
| 20% Labor and Material ($7,429.12) | | | | | | $ 1,485.82 |
| | | | | | Total Cost | $12,857.25 |

Summation of Total Costs $104,407.24

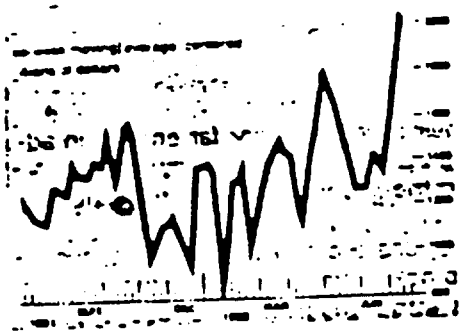
Say $105,000

# ENR Market Trends

## Latest Week

| ENR INDEXES (All 20-cities = 100) | June 24 index value | Change from last month % | Change from last year % |
|---|---|---|---|
| Construction cost | 3 839.51 | +1.3 | +7.8 |
| Building cost | 2 734.25 | +0.7 | +8.1 |
| Common labor (CCI) | 2 589.21 | +1.9 | +10.7 |
| Skilled labor (BCI) | 3 368.66 | +1.6 | +11.2 |
| Materials | 1 541.31 | −0.8 | +0.1 |

CONSTRUCTION BIDDING VOLUME



| 50-state totals ENR-reported | Week of July 1 | Cum. 26 weeks 1982 | Cum. 26 weeks change '81-'82 % |
|---|---|---|---|
| | $ millions | | |
| **BIDDING VOLUME** | | | |
| Total construction* | 3 345.4 | 38 505.9 | − 1 |
| Heavy & highway | 1 176.8 | 12 930.9 | − 2 |
| Nonresidential bldg | 1 972.2 | 19 572.4 | − 2 |
| Housing, multiunit | 196.4 | 5 042.8 | + 3 |
| **NEW PLANS** | | | |
| Total construction* | 2 952.1 | 71 258.4 | − 11 |
| Heavy & highway, total | 1 217.7 | 19 794.1 | − 17 |
| Water use & control | 379.9 | 7 894.2 | − 7 |
| Waterworks | 29.1 | 1 656.6 | − 25 |
| Sewerage | 48.4 | 2 534.3 | − 11 |
| Treatment plants | 13.8 | 1 785.1 | − 16 |
| Earthwork, waterways | 302.5 | 2 603.3 | + 20 |
| Transportation | 137.9 | 5 657.0 | − 24 |
| Highways | 44.7 | 1 984.1 | − 52 |
| Bridges | 14.0 | 564.1 | − 37 |
| Airports | 54.3 | 2 225.1 | + 33 |
| Terminals, hangars | 35.9 | 1 572.9 | + 65 |
| Elec. gas, comm. | 651.3 | 3 922.8 | − 29 |
| Other heavy const. | 47.4 | 1 645.9 | + 14 |
| Nonresidential bldg | 1 258.3 | 37 644.7 | − 10 |
| Manufacturing | 52.9 | 3 988.2 | − 68 |
| Commercial | 448.5 | 18 598.3 | + 15 |
| Offices | 331.9 | 10 666.2 | + 20 |
| Stores, shopping ctrs | 87.3 | 2 997.1 | − 18 |
| Educational | 130.9 | 3 825.1 | + 14 |
| College, university | 41.9 | 1 742.9 | + 48 |
| Medical | 208.0 | 5 442.2 | + 20 |
| Hospital | 171.5 | 4 544.7 | + 30 |
| Other | 418.0 | 7 792.9 | + 1 |
| Housing, multiunit* | 476.3 | 14 419.6 | − 4 |
| Apartments | 392.2 | 8 382.8 | − 12 |

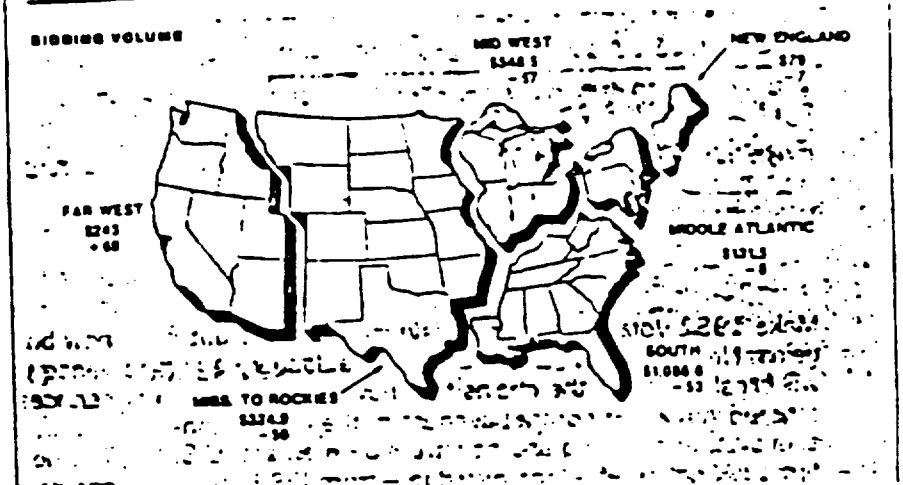
*Includes [illegible] housing units, hotels, dormitories, and nursing homes. New are highway construction $ 30,000 through June 30 [illegible] Jan. 1, 1980.

NEW CONSTRUCTION CAPITAL

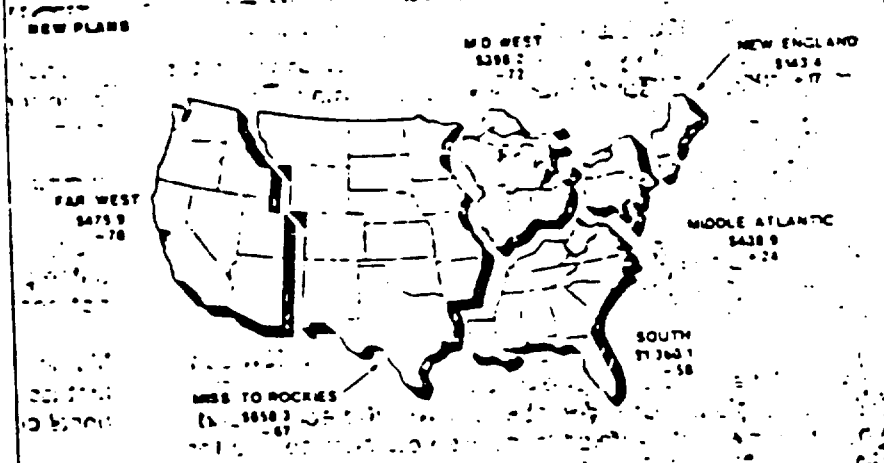
| | Week of June 24 | Cum. 26 weeks 1982 | Cum. 26 weeks change '81-'82 % |
|---|---|---|---|
| | $ millions | | |
| Total new capital | 2 473.1 | 32 635.9 | + 24 |
| Corporate securities | 40.0 | 3 342.5 | + 5 |
| State and municipal | 2 433.1 | 19 264.5 | + 28 |
| Housing | 2 014.0 | 10 283.7 | + 47 |
| Other bldg. and heavy | 419.1 | 8 997.1 | + 12 |

## Latest Month

### ENR regional markets: Manufacturing*




*High interest rates have caused awards to decline in many areas . . .*



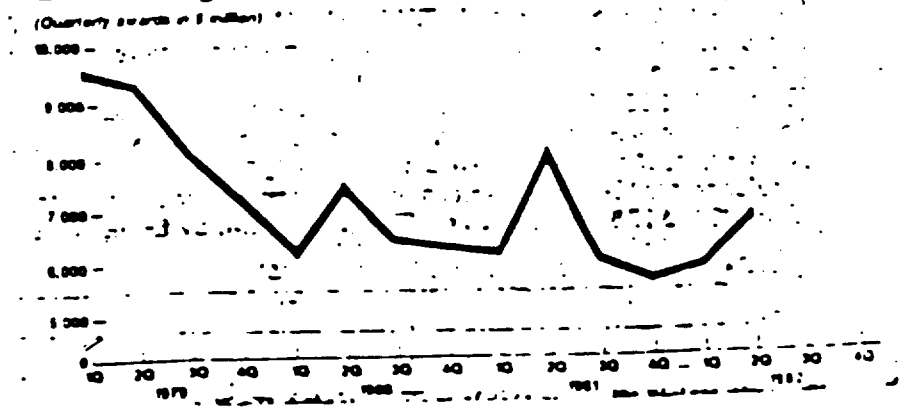

*. . . while low capacity utilization has caused planning to decrease.*

*Source: ENR Construction Economics Dept. $ million. 1982 [illegible] cumulative percent change from same period in 1981.

## Trends to Watch

### ENR bidding volume: heavy construction

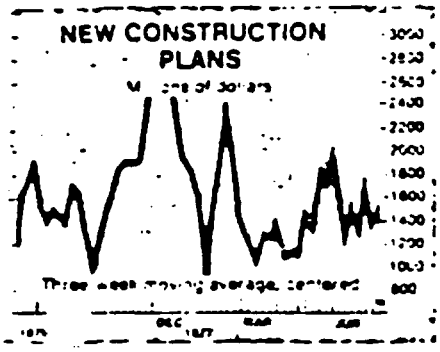
(Quarterly awards in $ million)




Heavy construction awards are running about [illegible]% behind last year's level.

# LATEST WEEK

| INDEXES 20-cities | June 30* Index value | Change from last month % | Change from last year % |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |




| 30-state totals (ENR-reported) | Week of July 7* 1977 | Cum. 27 weeks 1977 | Cum. 27 weeks change 76-77 % |
|---|---|---|---|
| | $ millions | | |
| **BUILDING VOLUME** | | | |
| Total construction* | [illegible] | [illegible] | [illegible] |
| Heavy & highway | [illegible] | [illegible] | [illegible] |
| Nonresidential bldg | [illegible] | [illegible] | [illegible] |
| Housing, multiunit | [illegible] | [illegible] | [illegible] |
| **PLANTS** | | | |
| Construction* | [illegible] | [illegible] | [illegible] |
| Highway total | [illegible] | [illegible] | [illegible] |
| Highways | [illegible] | [illegible] | [illegible] |
| Airports | [illegible] | [illegible] | [illegible] |
| Sewerage | [illegible] | [illegible] | [illegible] |
| Waterworks plants | [illegible] | [illegible] | [illegible] |
| Earthworks materials | [illegible] | [illegible] | [illegible] |
| Amusements | [illegible] | [illegible] | [illegible] |
| Highways | [illegible] | [illegible] | [illegible] |
| Bridges | [illegible] | [illegible] | [illegible] |
| Airports | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| Nonresidential bldg | [illegible] | [illegible] | [illegible] |
| Manufacturing | [illegible] | [illegible] | [illegible] |
| Commercial | [illegible] | [illegible] | [illegible] |
| Offices | [illegible] | [illegible] | [illegible] |
| Stores, shopping ctrs | [illegible] | [illegible] | [illegible] |
| Hospitals | [illegible] | [illegible] | [illegible] |
| College, university | [illegible] | [illegible] | [illegible] |
| Hotels | [illegible] | [illegible] | [illegible] |
| Motels | [illegible] | [illegible] | [illegible] |
| Other | [illegible] | [illegible] | [illegible] |
| Housing, multiunit* | [illegible] | [illegible] | [illegible] |
| Apartments | [illegible] | [illegible] | [illegible] |

[illegible]

**NEW CONSTRUCTION CAPITAL**

| | Week of June 30 | Cum. 28 weeks change 1977 | Cum. 28 weeks change 76-77 |
|---|---|---|---|
| | $ millions | | % |
| Total capital | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| Federal plants, bldgs | [illegible] | [illegible] | [illegible] |
| Private plants | [illegible] | [illegible] | [illegible] |

# LATEST MONTH

**WAGE RATES, 20 cities' average**

| | July 1977 | % change from June 1977 | % change from July 1976 |
|---|---|---|---|
| Common | [illegible] | [illegible] | [illegible] |
| Skilled average 3 trades: | [illegible] | [illegible] | [illegible] |
| Bricklayers | [illegible] | [illegible] | [illegible] |
| Structural ironworkers | [illegible] | [illegible] | [illegible] |
| Carpenters | [illegible] | [illegible] | [illegible] |

**MATERIAL PRICES, 20-cities' averages**

| | | | |
|---|---|---|---|
| Structural steel (average 3 mills) base per cwt | [illegible] | 0 | [illegible] |
| Lumber 2x4 fir per Mbf CL | [illegible] | [illegible] | [illegible] |
| Lumber 2x4 pine per Mbf CL | [illegible] | [illegible] | [illegible] |
| Cement bulk per ton CLT | [illegible] | [illegible] | [illegible] |
| Sand per ton CLT | [illegible] | [illegible] | [illegible] |
| Ready-mix concrete 3,000 psi per cu yd (5 sack) | [illegible] | [illegible] | [illegible] |
| Crushed stone 1½" per ton CLT | [illegible] | [illegible] | [illegible] |
| Concrete blocks sand gravel 8"x8"x16" each CLT | [illegible] | [illegible] | [illegible] |

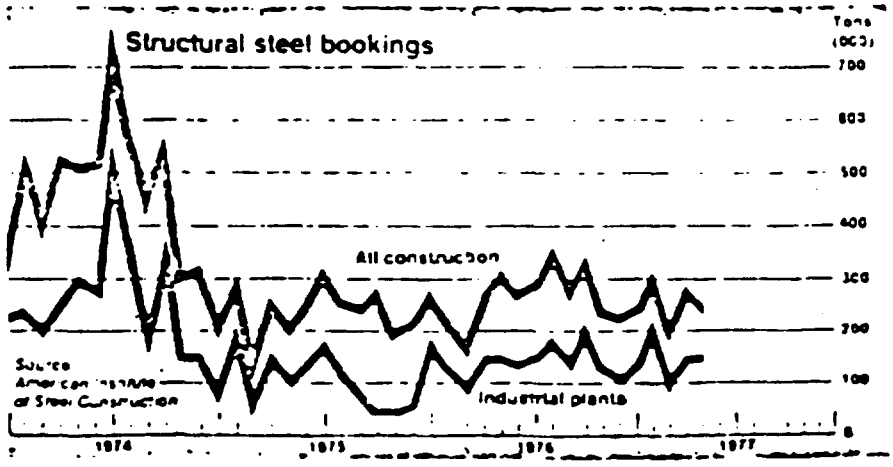
| | June 1977 | May 1977 | June 1976 |
|---|---|---|---|
| Gypsum sheathing [illegible] per Msf CL | [illegible] | [illegible] | [illegible] |
| Plywood [illegible] per Msf CLT | [illegible] | [illegible] | [illegible] |
| Plywood [illegible] per Msf CLT | [illegible] | [illegible] | [illegible] |
| Brick common per M CLT | [illegible] | 0 | [illegible] |
| Reinforcing bars white base per cwt | [illegible] | [illegible] | [illegible] |
| Structural cast iron [illegible] per M [illegible] CLT | [illegible] | 0 | [illegible] |
| Vitrified clay sewer pipe premium per 12" per ft CLT | [illegible] | [illegible] | [illegible] |
| Concrete sewer pipe 12" premium class per ft CLT | [illegible] | [illegible] | [illegible] |

*Delivered [illegible]

**ENR INDEX REVIEW**

| Base year =100 | Construction Cost 1913 | Construction Cost 1967 | Building Cost 1913 | Building Cost 1967 | Wage Rates Skilled 1913 | Wage Rates Skilled 1967 | Wage Rates Common 1913 | Wage Rates Common 1967 |
|---|---|---|---|---|---|---|---|---|
| **1976** | | | | | | | | |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Aug | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Sept | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Oct | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Nov | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Dec | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1976 over | 2399.94 | 223.43 | 1425.07 | 210.94 | 2136 | 214 | 4700 | 232 |
| **1977** | | | | | | | | |
| Jan | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Feb | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Mar | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Apr | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| June | 2540.55 | 236.51 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# TRENDS TO WATCH



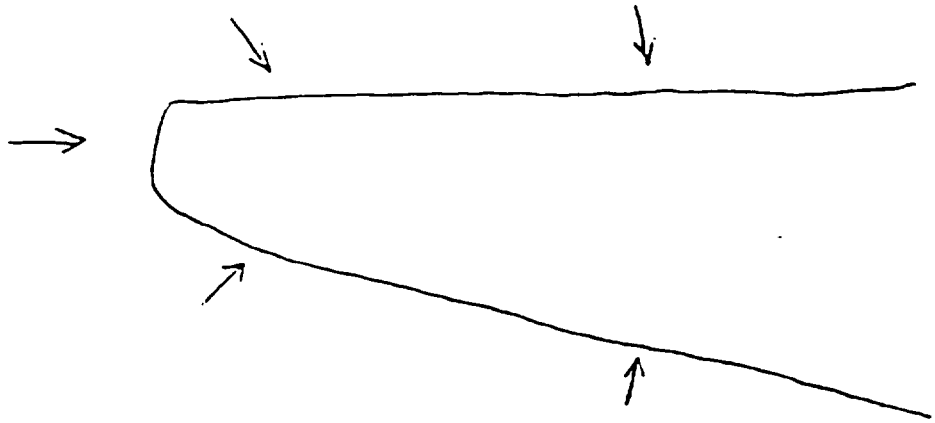

Structural steel bookings for industrial building picked up steam in April

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION
BUREAU OF WATERWAYS

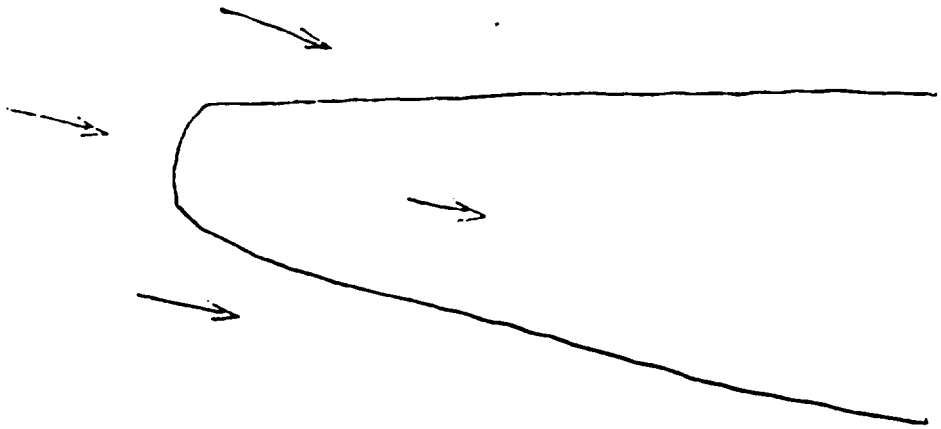
LETTING OF July 14, 1977
CONTRACT NO D 95278
COUNTY SARATOGA & WASHINGTON
HUDSON RIVER CHANNEL Excavation and Disposal

DEPARTMENT ESTIMATE

| NO | ITEM | MEASURE | QUANTITY | ENGINEERS ESTIMATE Cents | ENGINEERS ESTIMATE Dollars | L.A. Collins Const. Co. Inc. Cents | L.A. Collins Const. Co. Inc. Dollars | Aug Bohl Contracting Co Inc. Cents | Aug Bohl Contracting Co Inc. Dollars | James J. Maloy Inc. Cents | James J. Maloy Inc. Dollars |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 201.0601 | Clearing and Grubbing | L.S. | Nec | | 700 | | 5,000 | | 2,000 | | 20,000 |
| [illegible] | River Channel Excavation & Disposal | C.Y. | 200,000 | [illegible] | [illegible] | [illegible] | 34,465 | 2 75 | 550,000 | 3 90 | 780,000 |
| [illegible] | Furnishing Equipment for River Channel Excavation | L.S. | Nec | | 2,000 | | 20,000 | | 15,000 | | 100,000 |
| [illegible] | Drill 300m | L.F. | 500 | 20 | 10,000 | 20 | 10,000 | 30 | 15,000 | [illegible] | 30,000 |
| [illegible] | Dispose of Obstructions | C.Y. | 10,000 | 3 00 | 30,000 | 2 | 20,000 | 1 | 10,000 | 3 | 30,000 |
| [illegible] | Dikes and Cofferdams and Force Material | C.Y. | 21,000 | 6 00 | 126,000 | 5 | 105,000 | [illegible] | [illegible] | 4 | 84,000 |
| [illegible] | Trench and Culvert Excavation | C.Y. | 1,600 | 8 25 | 13,200 | 2 | 3,200 | 4 | 6,400 | 12 | 19,200 |
| [illegible] | Dewatering Cofferdam Material | C.Y. | 410 | | 4,000 | 10 | 4,100 | 15 | 6,150 | 10 | 4,100 |
| [illegible] | Furnish, Install, Pipe Underdrain (1½" Perforated) Complete | L.F. | 1,000 | 2 00 | 2,000 | 4 | 4,000 | 3 32 | 3,320 | 5 | 5,000 |
| [illegible] | Underdrain Filter, Type C | C.Y. | 160 | 18 00 | 3,000 | 30 | 4,800 | 20 | 3,200 | 20 | 3,200 |
| [illegible] | Monitoring Well | L.S. | Nec | | 4,000 | | 3,000 | | 6,000 | | 5,000 |
| [illegible] | [illegible] (Underdrain) | C.Y. | 14,285 | 0 10 | 1,428 | 50 | 7,142 50 | 30 | 4,285 50 | 25 | 3,571 25 |
| [illegible] | Seeding and Special Mixture | Acre | 9.2 | 4 37 | 40 20 | 700 | 6,440 | 1,000 | 9,200 | 700 | 6,440 |
| [illegible] | Selected Material for Embankment | C.Y. | 11,000 | 3 00 | 33,000 | 3 | 33,000 | 3 | 33,000 | 3 | 33,000 |
| [illegible] | Maintenance of Traffic (Non Restricted Areas) | L.S. | Nec | | 1,000 | | 50,000 | | 20,000 | | 20,000 |
| 624.02 | Asphalt Concrete Curbs | Ton | 500 | 35 | 17,500 | 40 | 20,000 | 50 | 25,000 | 40 | 20,000 |
| [illegible] | Engineers Office - Type B | Month | 6 | 500 | 3,000 | 600 | 3,600 | 700 | 4,200 | 1,000 | 6,000 |
| [illegible] | Mobilization | L.S. | Nec | 30,000 | 30,000 | | 32,000 | | 25,000 | | 34,000 |
| | TOTALS | | | | | | 619,000 | | 857,530 | | [illegible] |



1. BEFORE FILL-IN



2. AFTER FILL-IN

EXPLANATION

→ EXPECTED GROUND-WATER FLOW DIRECTION

FIGURE 2

EXPECTED CHANGES IN GROUND-WATER FLOW:

SLIP # 3

1. PCBs are normally tightly bound to soil material with a high organic content.

2. PCBs are "infinitely" soluble in hydrocarbon solvents and in chlorinated solvents. (Monsanto-verbal communication).

3. PCBs desorb completely in the presence of nonpolar solvents, i.e. adsorption = 0.

4. The higher the amount of chlorination of PCBs, the lower the desorption rate.

5. The addition of water affects the behavior of solvents in some way; it probably reduces desorption rates of PCBs, but the rate and amount of desorption is dependent upon the type of solvent and its concentration, the type of soil, the type(s) of PCBs, and other factors. Information on specific desorption rates and amounts is probably only available through actual testing: soil columns, etc. Predictions cannot be made with any degree of certainty.

6. PCBs can move in ground water while adsorbed onto colloidal material (SP Maslansky - verbal communication); this movement can be a significant source of contamination; actual rates and amounts cannot be quantified without testing.

Sources of information not specifically cited are from Bob Griffin, Illinois Geological Survey-verbal communication, and Carter Knowlton and Leon Adams, Southwest Research Institute - verbal communication.

Based on the assumptions and information outlined above, the estimated ground-water discharge and loading rates are:

Ground-Water Discharge (Q)

Scenario #1

| Material | K, cm/sec | I, ft/ft | A, ft | Q, $ft^3$/day |
|---|---|---|---|---|
| Clean sand | $5 \times 10^{-3}$ | 0.001 | 10 x 600 | 43 |
| In-situ sand | $5 \times 10^{-4}$ | 0.001 | 5 x 600 | 2 |
| Muck | $5 \times 10^{-5}$ | 0.001 | 5 x 600 | 0.2 |

Scenario #2

| | | | | |
|---|---|---|---|---|
| Dredged material | $1 \times 10^{-4}$ | 0.001 | 10 x 600 | 1 |
| In-situ sand | $5 \times 10^{-4}$ | 0.001 | 5 x 600 | 2 |
| Muck | $5 \times 10^{-5}$ | 0.001 | 5 x 600 | 0.2 |

## Loading Rates

Each of the scenarios were evaluated in two ways.

1) Loading rates were estimated on the assumption that there are no solvents or colloids in groundwater. This assumes that desorption will occur to the limits of the PCB solubility and then equilibrium will be reached. A PCB solubility value of 200 ug/l, was used for the calculations (based on values given by Bob Griffin). Loading rates were calculated using the discharge rates listed in the previous section times this PCB solubility value.

- Clean sand (PCB source is groundwater) = 0.0005 lbs/day
- In-situ sand (PCB source is groundwater or sediment) = 0.00002 lbs/day
- Muck (PCB source is groundwater or sediment) = 0.000002 lbs/day
- Dredged material (PCB source is groundwater or sediment, PCB concentration in sediment assumed to be 100 ppm) = 0.00001 lbs/day

Scenario #1: Clean sand + sand + muck = 0.0005 lbs/day
Scenario #2: Dredged material + sand + muck = 0.00003 lbs/day
(Figures 3-A and 3-B show the loading rates for each scenario.)
If there are no solvents and/or colloids present, these represent a worst-case condition.

There is a possibility that solvents and/or colloids may be present in the ground water since elevated levels of PCBs were found in monitoring wells at the OMC site. This could cause a higher PCB loading rate in the ground water.

A more reasonable evaluation of a possible range of loading rates could be arrived at after a detailed field/laboratory investigation. The numbers developed above represent, at best, rough estimates of a possible range of loading rates.

## Closing Comments

1. A more definitive assessment of ground-water flow conditions near Slip #3 would require the installation of several nested piezometers in the vicinity of the slip. Information obtained from water-level measurement and permeability tests would be used to define the vertical/horizontal flow components and flow rates.

2. Water samples taken from the nested piezometers could be analyzed for solvent content and presence of colloids.

3. In addition, soil columns or similar tests with site material could be run to determine more clearly the desorption potential of PCBs at this site.

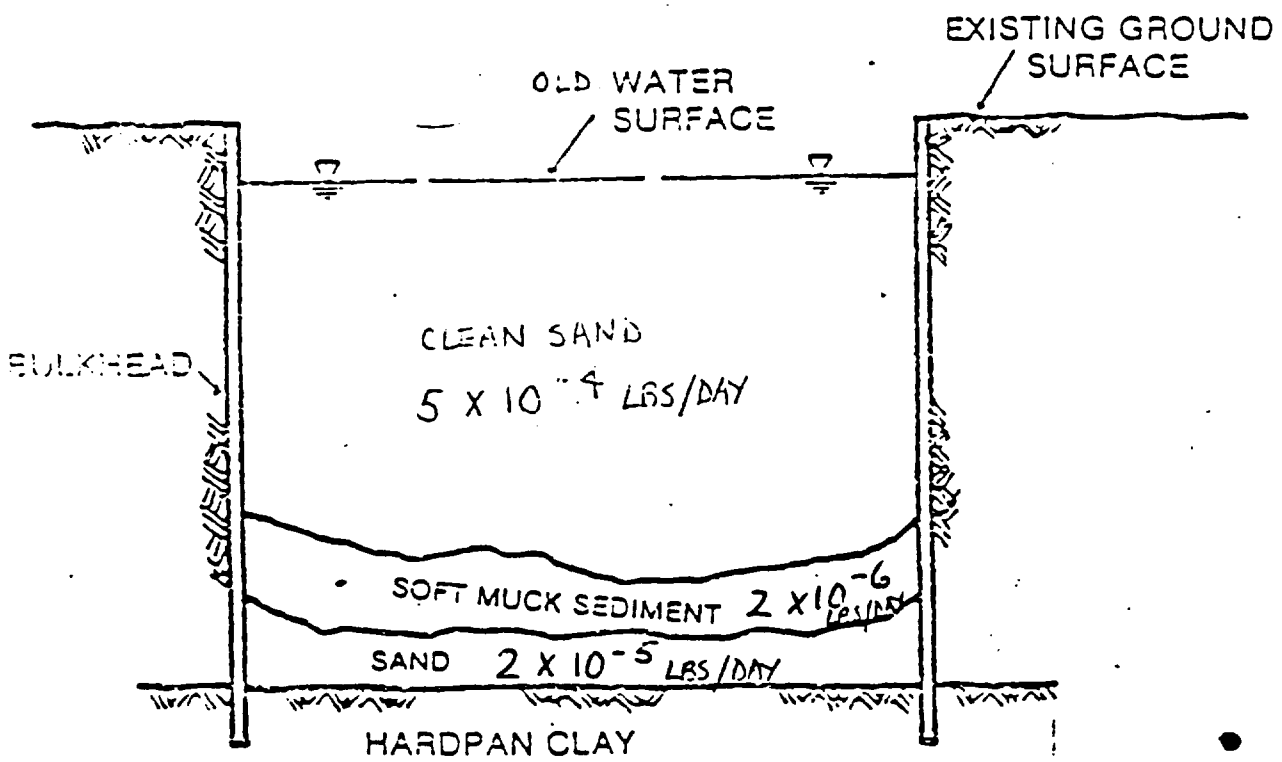



FIGURE 3-A

SCENARIO # 1

PCB LOADING RATES

TOTAL LOADING : $5 \times 10^{-4}$ LBS/DAY

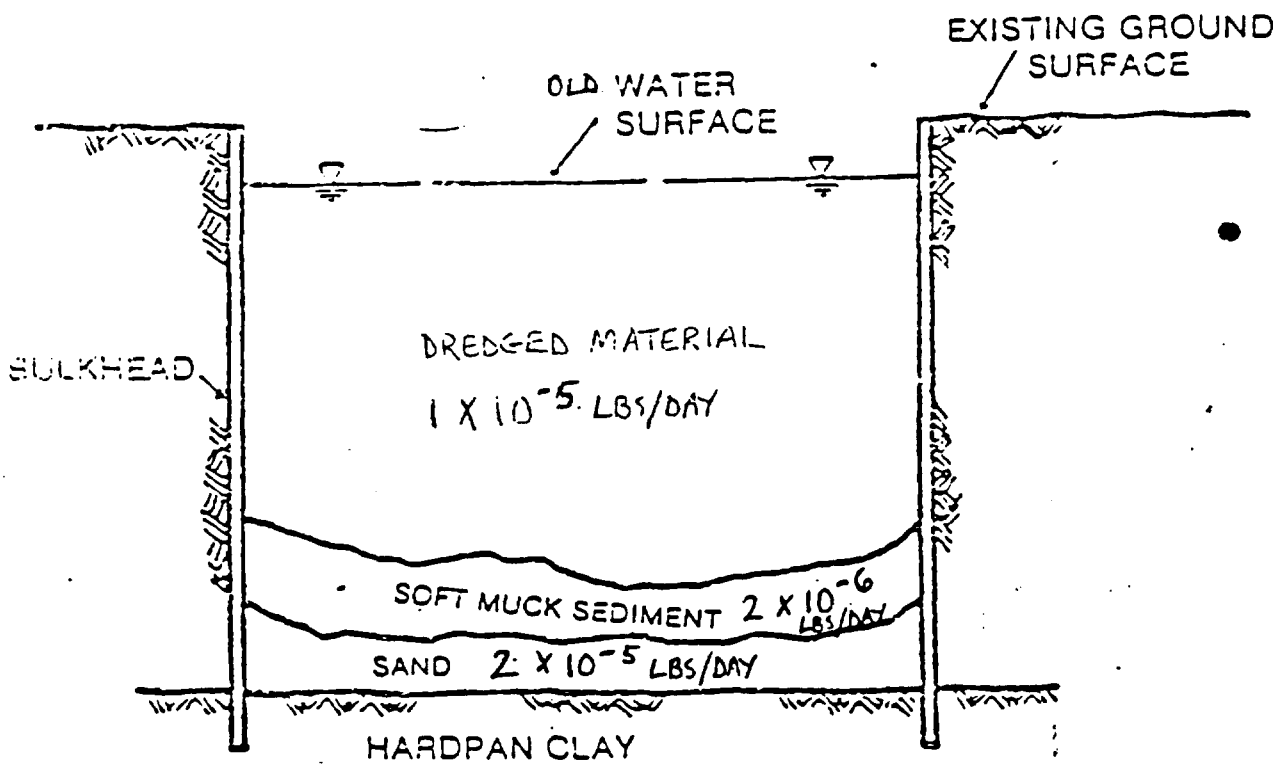



FIGURE 3-B

SCENARIO # 2

PCB LOADING RATES

TOTAL LOADING : $3 \times 10^{-5}$ LBS/DAY

PIRNIE

INTER-OFFICE CORRESPONDENCE

To: JOHN C. HENNINGSON, RICHARD P. BROWNELL

Date: 7/9/82

From: ROSALIND MASON HARRIS RMH

Subject: WAUKEGAN HARBOR PCB FISH LEVELS

This memo summarizes existing data and information on the extent of fish PCB contamination in Waukegan Harbor and Lake Michigan. The results of in-situ live car bioconcentration and depuration studies undertaken in Waukegan Harbor and laboratory studies are also discussed. Finally, estimates of the value of the commerical and recreational fishery in the Waukegan area are discussed in relation to present PCB levels of commercially and recreationally important species.

## Fish PCB Levels

Monitoring of fish PCB levels in Lake Michigan has been done since the early 1970's. In Waukegan Harbor, fish PCB monitoring began in the mid-1970's, with the discovery of high PCB concentrations in harbor sediments. Evaluation of data from these monitoring programs is difficult because of the variability in sampling and analysis procedures. Factors which can influence PCB concentrations include size or age of the fish sample, type of tissue analyzed (whole individual vs. fillet), lipid content, method of analysis (composting whole fish or fillets or averaging individual values), sampling location and various other factors. Year-to-year trends apparent from the data must be interpreted with care due to these factors and the overall variations in the extent and numbers of fish sampled annually.

## Lake Michigan Fish Levels

PCB levels in major Lake Michigan fish species for the period 1971 to 1979 have been summarized in a USEPA status report (Wk IV 99). Information from this report is used in the following discussion and is supplemented with more recent data (1980 and 1981) when it was available.

Lake Michigan fish species are considered in several groups, based on similar habitats and feeding preferences. These groups are:

A) Coho and Chinook Salmon, Brown and Rainbow Trout

B) Whitefish, Bloater and Lake Herring

C) Lake Trout

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Group A, the salmon and trout, have short life spans, are fast growing and migrate considerably. They feed on alewife, smelt and other forage fish, which take them to near shore areas. They migrate to tributaries for spring or fall spawning and are important sport fishery species. Table 1 provides median PCB levels for these species from 1972 to 1981. Values range from less than 2 ppm to approximately 9 ppm, and are variable on a year-to-year basis. No trend is evident from the data. In general, trout and salmon accumulate PCB to a greater degree than other lake species because of their proportionally higher lipid content.

Group B, whitefish, bloater and lake herring, inhabit deep, offshore areas where they feed on plankton. They are important commercial species. Table 1 indicates that median PCB levels for these species appear to be decreasing and for all years are under 5 ppm, the FDA limit. In 1979, only 3 percent of the samples equalled or exceeded 5 ppm.

Group C includes only the lake trout, a major sport and commercial species. The lake trout inhabits deep, cold waters for most of the year and feeds primarily on alewife. Because of its long life span (it reaches maturity in about 7 years) and feeding preference, it can accumulate significant concentrations of PCB, and is considered separately from other trout and salmon species The values in Table 1 indicate a general decrease in median values since the mid-1970's although there have been fluctuations from year-to-year. The 1980 value is based on only 3 values in comparison to 17 to 48 values for preceeding years. Only two values were available for 1981 (1.6 and 7.3 ppm) so no median is shown. Prior to 1978, median values exceeded 5 ppm, but these levels have dropped off to less than 5 ppm since 1978. In 1979, 39 percent of the samples had 5 ppm or more PCB.

Data compiled for the period 1971-1979 by USEPA also provides median PCB levels in these three groups in the northern and southern parts of Lake Michigan. Insufficient data was available to differentiate between northern and southern PCB levels in chinook and coho salmon and brown and rainbow trout. However, the data for the other species (Groups B and C) indicate that median PCB levels are higher in the southern part of the lake, as would be expected. Waukegan Harbor, the Milwaukee River and Harbor and the Sheboygan River are among the PCB "hot spots" identified in the southern part of the lake which may be contributing to these levels.

Table 1

Median PCB Levels
In Lake Michigan Fish
(ppm wet weight)

| Year | Group A | Group B | Group C |
|---|---|---|---|
| 1972 | 4.6 | - | - |
| 1973 | 9.1 | - | - |
| 1974 | 4.85 | - | 10.5 |
| 1975 | 3.7 | - | 5.2 |
| 1976 | 6.4 | 2.5 | 6.0 |
| 1977 | 1.65 | 2.2 | 7.8 |
| 1978 | 5.5 | 2.0 | 3.9 |
| 1979 | 4.3 | 1.7 | 4.1 |
| 1980 | 4.4 | - | 4.9 |
| 1981 | 2.3 | 1.7 | - |

Group A = Coho and Chinook Salmon, Brown and Rainbow Trout
Group B = Whitefish, Bloater and Lake Herring
Group C = Lake Trout

Source: 1972-1979 data from Wk IV 99 - USEPA, A Status Report on the Presence of Polychlorinated Biphenyl Compounds in the Fishes of Lake Michigan 1971 through 1979 with Special Reference to the Waukegan Harbor in Waukegan, Illinois.

1980-1981 data compiled by Malcolm Pirnie, Inc. from available Waukegan references.

Waukegan Harbor Fish Levels

Available data from fish sampling in Waukegan Harbor are summarized in Table 2 for the period 1976-1981. Species have been grouped, based on feeding habits and habitat, as follows:

a) Coho Salmon and Rainbow Trout

b) Largemouth Bass, Yellow Perch, White and Black Crappie, Sunfish and Shiners

c) Alewife

d) White Sucker, Carp, Brown and Black Bullhead

As is obvious from Table 2, there is only scattered sampling data for Waukegan Harbor. Species from Groups B and D have been most heavily sampled.

PCB values for coho salmon and rainbow trout were low and comparable to the lakewide data. These species do not regularly inhabit Waukegan Harbor and would not be expected to reflect typical in-harbor fish PCB levels.

The species from Group B generally inhabit warm, slow-moving water and feed on crustaceans, small fish and insects. They are found most often in sheltered and near-shore environments. Except for 1981 data and one other sample value, the PCB levels in this group were well above 5 ppm. The range of values is 3.5 to 187.4 ppm. The small number of samples taken may in part explain the large difference between 1980 and 1981 data for this group. Apart from 1981 data, it is apparent that this group has been exposed to PCB contamination in some form, whether it be from water column or food sources.

There is insufficient data for alewife to evaluate PCB levels for this species. In general, the species inhabits deep, open lake waters although it may move inshore seasonally. Its primary food is zooplankton. In the harbor, it would be considered only a transitory species.

The last group of species for which data is available are sucker, carp and bullhead. These species are bottom feeders and inhabit sluggish, warm waters. The range of PCB values for these species is 1.41 to 131.0 ppm, comparable to Group B. Median values for these two groups are also comparable, 18.9 and 18.2 ppm. Group D PCB values indicate no apparent downward trend over time for these species common to Waukegan Harbor.

Table 2

PCB Levels
In Fish From Waukegan Harbor
(ppm wet weight)

| | Group | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Year | #/PCB[1] | #/PCB | #/PCB | #/PCB |
| 1976 | - | - | - | 1/ 7.0<br>1/ 8.0 |
| 1977 | - | - | - | - |
| 1978 | - | 1/ 3.5<br>3/ 14.2<br>1/ 17.8<br>9/ 38.8<br>3/ 32.5 | 6/1.8 | 6/ 3.6<br>6/ 28.6<br>3/ 29.0 |
| 1979 | - | 1/ 18.9 | 1/7.0 | 1/ 38.5<br>1/ 18.4<br>2/ 8.2<br>2/ 18.0<br>4/ 8.3<br>1/ 26.8 |
| 1980 | 1/4.2<br>1/2.0 | 5/ 34.0<br>1/ 20.2<br>1/187.4<br>1/162.9 | - | 1/131.0 |
| 1981 | 3/0.5 | 3/ 1.41<br>5/ 0.34<br>1/trace | 10/2.01 | 2/ 1.41<br>3/ 27.9 |
| Median | 2.0 | 18.9 | 2.01 | 18.2 |

[1] #/PCB = Number of fish in sample/PCB value of sample

Group A = Coho Salmon and Rainbow Trout
Group B = Largemouth Bass, Yellow Perch, White and Black Crappie, Sunfish and Shiners
Group C = Alewife
Group D = White Sucker, Carp, Brown and Black Bullhead

Source: Miscellaneous fish PCB data compiled by Malcolm Pirnie, Inc. from available Waukegan references.

The USEPA status report (WK IV 99) compared PCB values for fish species from Waukegan Harbor with similar species in other harbors and estuaries in Lake Michigan (Sheboygan, Lower Green Bay, Milwaukee, Sturgeon Bay) for 1971-1979. There are data gaps for various species in various locations. More comparative information exists for the carp and goldfish group and alewife group than for most other species groups. Median values for Waukegan and other harbors are shown in Table 3. In terms of carp and goldfish, Waukegan Harbor has the second highest value after the Sheboygan River Estuary. It should be noted that there were many more values for Sheboygan than Waukegan, which means that there was a greater chance of high level PCB fish being caught in Sheboygan than in Waukegan. It is expected that comparable values would be found in a larger number of Waukegan samples. Bluegill, crappie, etc. show high median PCB values in Sheboygan and Waukegan, but this is based on limited data. Although data is inadequate to make a definite statement about the degree of contamination in Waukegan in comparison to other harbors, it is apparent from available information that PCB levels in fish sampled in contaminated harbors are generally higher than the same species taken from Lake Michigan.

Bioconcentration and Depuration Studies

Summary results of two live car and one sediment exposure study are provided in Table 4. Data from these studies indicates that fish exposed to Waukegan Harbor water or sediment do tend to bioconcentrate PCB in their flesh over time. After 28 to 30 days in live cars in Slip #3, yellow perch and bluegill composite PCB concentrations increased 100 to 200 times over pre-exposure levels to concentrations of approximately 10 to 30 ppm (Wk III 105 and III 115). Exposure to Waukegan Harbor suspended sediments resulted in an increase in yellow perch concentrations from 0.48 ppm to 2.04 ppm after only seven days (Wk IV 114).

In one live car study (Wk III 115), yellow perch and bluegill exposed to waters in Slip #3 for 30 days were then exposed to Lake Michigan water at the municipal waterworks for 84 days to evaluate depuration rates. As Table 4 shows, after 84 days these fish had not yet returned to pre-exposure levels, although their PCB concentrations had dropped significantly.

In this bioconcentration-depuration study performed by Veith, USEPA, he reports that the bioconcentration of PCB in fish is dependent on 1) size of fish; 2) rate at which water is pumped over gills (species dependent); 3) length of time of exposure to PCB and 4) PCB concentration in water. He also indicates that the elimination of PCB from an organism is often dependent on PCB concentration in the organism. The elimination rate increases as the organism concentration increases. A steady-state is reached when PCB uptake equals the elimination rate. This is the

Table 3

Median PCB Levels
In Fish From Waukegan Harbor
And Other Harbors and Estuaries
1971-1979
(ppm wet weight)

| | Carp and Goldfish Total #/PCB[1] | Bluegill, Crappie, Rockbass, Sunfish Total #/PCB |
|---|---|---|
| Lower Green Bay Estuary | 16/7.6 | 3/0.5 |
| Sturgeon Bay Harbor and Fish Channel | 3/16.3 | - |
| Sheboygan River Estuary | 26/140 | 7/105 |
| Milwaukee Harbor and River Estuary | 7/17 | - |
| Waukegan Harbor | 5/37.3 | 3/14.2 |
| All Lake Michigan (excluding Green Bay) | 19/3.8 | - |

[1] Total #/PCB = Total number of PCB values/median PCB value

Source: Wk IV 99 - USEPA, A Status Report on the Presence of Polychlorinated Biphenyl Compounds in the Fishes of Lake Michigan 1971 through 1979 with Special Reference to the Waukegan Harbor in Waukegan, Illinois.

Table 4

Summary of Bioconcentration and Depuration Studies
Waukegan Harbor

| Summary of Study | Species | Day | Control PCB* | | Test PCB* | | |
|---|---|---|---|---|---|---|---|
| 1. 7-day lab exposure to suspension of Waukegan Harbor sediments (380 mg/l SS, 26.8 ppm dry weight PCB in sediments) May 1979** Wk IV 114 | Yellow Perch | 7 | 0.48 | | 2.04 as 1242 | | |
| | | | | | YP | BC | $H_2O$ Column |
| 2. 28-day live car exposure to Waukegan Harbor water in Slip #3 (Oct-Nov 1978) Wk III 105 | Yellow Perch (YP) | 0 | | | 0.156 | 0.207 | 5 ug/l |
| | Bluegill (BG) | 28 | | | 29.9 | 19.7 | 4.2 ug/l |
| | | | YP | BG | YP | BG | |
| 3. 30-day live car exposure to Waukegan Harbor water in Slip #3 and subsequent 80-day depuration in Lake Michigan water (Jun-Oct 1979) Wk III 115 | Yellow Perch (YP) | 0 | - | - | 0.14 | 0.11 | as 1242:1248 in 1:2 mixture |
| | Bluegill (BG) | 30 | 0.26 | 0.35 | 12.1 | 21.6 | |
| | | 114 | 0.46 | 0.64 | 8.6 | 8.3 | |

* ppm wet weight
** not a live car in-situ study

bioconcentration factor and it may range from 30,000 to 100,000 depending on the PCB mixture and species (i.e., 1 ug/l PCB in water may cause PCB concentration in fish to be 30,000-100,000 ppb or 30-100 ppm). Veith proposed that PCB elimination is a first order process, and implicit in this is that it has a constant half-life in a particular fish. He also proposed that this half-life increases in increasingly large fish. Based on his depuration results and assuming a first-order process, it would take the contaminated yellow perch and bluegill 6 months and 4.5 months, respectively, in Lake Michigan (with a no PCB diet) to drop to levels of 5 ppm after the 30 day bioconcentration period.

In the 28 day bioconcentration study, PCB concentrations in the water column were monitored during the bioconcentration phase (Wk III 105). Over this period, PCB levels remained fairly constant, fluctuating between 2.7 and 5 ug/l, in the water column. PCB water column levels were not reported in the other studies.

Although not summarized in Table 4, laboratory studies (not in-situ) were also undertaken exposing adult fathead minnows and fathead minnow embryo-larvae to various concentrations of North Ditch water (Wk III 105). These studies showed that PCB levels in adult fathead minnows and embryo-larvae stages were greater in test chambers containing higher concentrations of North Ditch water. Lake Michigan water was used for control and dilution water. Concentrations in adult fathead minnows reached 419 ppm PCB after 28 days exposure to 100% North Ditch water containing 10 to 30 ug/l PCB. Control fish reached PCB levels of 1.82 ppm after 28 days exposure to water having less than 0.1 to 0.3 ug/l PCB. Survival of embryo-larvae forms appeared to be affected by exposure to increasing concentrations of North Ditch water. In two control chambers, 71% and 59% of the organisms survived, while in tanks containing 100% North Ditch water, the survival rate was about 45% in both test chambers. PCB water concentrations in control chambers were generally less than 0.1 ug/l and organisms in these chambers had PCB levels of 0.79 ppm in their flesh at the end of the 28 day study. In tanks containing 100% North Ditch water, PCB water levels ranged from 10 to 23 ug/l over the 28 days, and the PCB concentration in organisms on day 28 was about 183 ppm.

HydroQual evaluated the significance of bioconcentration and bioaccumulation for aquatic organisms (Wk IV 108). They assume that aquatic organisms bioconcentrate PCB at levels of $10^5$ times ambient water concentrations (Wk IV 108). They developed equations to relate water PCB levels and food bioaccumulation factors to determine organism PCB levels. As the food chain level gets higher, the bioaccumulation factor becomes greater. They observed water PCB concentrations in Waukegan Harbor to be

in the range of 0.01 to 0.3 ug/l (however, water concentrations up to 5 ug/l were measured in one bioconcentration study mentioned previously, Wk III 105). In order to decrease PCB levels in harbor organisms to 5 to 10 ppm, HydroQual estimated that water concentrations in Waukegan Harbor would have to be decreased to a range of 0.01 to 0.02 ug/l dissolved PCB (Wk IV 108).

Fishery Value

Waukegan Harbor is an important sport fishery area in Lake Michigan. A 1979 creel survey provides information on the extent and value of the Illinois sport fishery in Lake Michigan (Wk IV 112). Information for Waukegan Harbor can be extrapolated from this. General information is summarized in Table 5.

In terms of fishing pressure in angler hours, the Waukegan Harbor area was the most heavily used area for trolling of the 14 locations sampled. It was also the number one location for pier and breakwater fishing, although for shore fishing it ranked second lowest of 22 sites. Coho salmon was the most numerous species caught in the Waukegan area, followed by chinook and yellow perch. Major species taken from the shoreline are rainbow trout and chinook salmon. Total catches for all species in Waukegan Harbor and adjacent areas in the 1979 survey are provided in Table 6.

If 336,852 angler hours (expanded hours for total year) were spent in Waukegan Harbor area and an average fishing trip is 4.8 hours (average hours per trip as per Muench, Wk IV 112), then 70,178 trips were made around Waukegan. Thalhelm (Wk IV 112) estimates an average value of $25 per trip resulting in an annual value of $1,754,000 in purchases generated by the Waukegan sport fishery business. The shore fishery, however, accounts for only 0.6% of the angler hours spent in the Waukegan area.

The extent of the 1980 charter boat catch in Illinois has been summarized (Wk XI 101). Most of the charter boat fishing in the Illinois waters of Lake Michigan is done off of Chicago and Waukegan. Charter boat fishing in 1980 accounted for 68,550 man-hours in the Waukegan area, which includes the western 1/3 to 1/2 of Lake Michigan off of Waukegan, and 58,831 man-hours in the Chicago area. Waukegan area waters accounted for 72% of the total charter boat catch, which is predominately salmonids. Of the 24,227 salmonids taken off Waukegan in 1980, coho salmon comprised 74% of the catch in this area, chinook salmon 11%, lake trout 11%, rainbow trout 3%, and brown trout 1% of the catch. Coho salmon was the species caught in greatest numbers in both the Waukegan and Chicago areas. If the charter boat industry in Illinois accounts for approximately one million dollars annually (Wk IV 112) and Waukegan waters account for 54% of the man-hours spent then Waukegan area charter boat business probably adds another $540,000 annually to the sport fishery business for a total of $2,300,000 ($1,750,000 + $540,000).

Table 5

Results of 1979 Sport Fishing Creel Survey
Summary for Waukegan Harbor Area

| Type of Access | Angler Hours | % of Illinois Total Hours | Fish/Hour* | Total Fish | % of Illinois Total Catch | Major Species |
|---|---|---|---|---|---|---|
| Trolling | 184,554 | 31 | 0.119 (4) | 21,889 | 30 | Coho, Chinook, Yellow Perch |
| Pier/Breakwater | 45,974 | 20 | 0.121 (2) | 5,573 | 4 | Coho, Yellow Perch |
| Shore | 1,179 | 0.4 | 0.122 (3) | 144 | 0.08 | Rainbow Trout, Chinook |
| Creel Survey Total | 231,707 | 21 | | 27,606 | 7 | |
| Expanded Hours and Catch for Total Year | 336,852 | | | 60,195 | | |

* (4) 4th lowest rate out of 14 sites
(3) 3rd lowest rate out of 22 sites
(2) 2nd lowest rate out of 15 sites

Source: Mk IV 112 - Muench, Illinois Department of Conservation, 1979 Sport Fishing Creel Survey on the Illinois Portion of Lake Michigan.

Table 6

Results of 1979 Sport Fishing Creel Survey
Waukegan Harbor Area
Species Data

| Type of Access | Brown Trout | Rainbow Trout | Lake Trout | Coho Salmon | Chinook Salmon | Yellow Perch | Other | Angler Hours |
|---|---|---|---|---|---|---|---|---|
| Trolling | 99 | 1,676 | 986 | 13,705 | 3,155 | 2,169 | 99 | 249,147 |
| Pier/Breakwater | 43 | 578 | 14 | 3,018 | 217 | 1,689 | 14 | 85,512 |
| Shore | - | 48 | - | - | 48 | - | 48 | 2,193 |
| Creel Survey Total | 142 | 2,302 | 1,000 | 16,723 | 3,420 | 3,854 | 161 | - |

Source: Same as Table 5

A report on the 1980-1981 commercial catch in the Illinois waters of Lake Michigan indicates that there are only five licensed commercial fishermen using these waters (Wk XI 102). Bloater chubs and yellow perch account for 75% and 25% of the catch, respectively. Commercial gill nets used for harvesting both species are prohibited in waters less than 30 feet deep.

Bloaters are fished primarily in waters greater than 180 feet deep. The most heavily fished area, accounting for 40% of the catch, is 19 miles east of Lake Forest (and southeast of Waukegan). The area adjacent to Waukegan Harbor accounts for only 2% of the total catch.

Over half of the yellow perch are harvested in waters ranging from 42 to 60 feet deep. About 54% of the catch is taken from waters off of Evanston and Chicago. The area offshore of Waukegan accounts for about 10% of the yellow perch catch.

Bloater chub and yellow perch composite samples collected in Lake Michigan have been analyzed annually since 1975. The bloater samples were collected off of Waukegan. In all years except 1976, PCB values were less than 5 ppm. The composite sample analyzed in 1976 had a PCB concentration of 8.3 ppm. Yellow perch composites collected from the Lake (not specifically off of Waukegan) also had concentrations less than 5 ppm in all years except 1976, when several composites slightly exceeded 5 ppm.

The value of the commercial fishery in the Illinois waters of Lake Michigan in 1980-81 was estimated at $198,700. The immediate Waukegan Harbor area, however, does not appear to be within the prime commercial fishery area.

## References

### Fish PCB Levels

Wk IV 99 - USEPA, A Status Report on the Presence of PCB Compounds in the Fishes of Lake Michigan 1971 through 1979 with Special Reference to the Waukegan Harbor in Waukegan, Illinois.

Various other Waukegan and Lake Michigan fishery references.

### Bioconcentration/Depuration Studies

Wk IV 108 - HydroQual, 1981, Final Contribution to Waukegan EIS.
Wk III 115 - Veith, USEPA, 1980, Uptake and Elimination of PCBs in Fish Contaminated by the Waukegan Harbor.
Wk IV 114 - Great Lakes Fishery Lab, 1980, Memorandum to Region V USEPA on Preliminary Results of an Exposure Study with Waukegan Harbor Sediments.
Wk III 105 - USEPA, 1979, OMC Biological Studies Report.

### Fishery Value

Wk XI 101 - R. Hess, Illinois Department of Conservation, 1980 Charter Boat Catch in the Illinois Waters of Lake Michigan.
Wk IV 112 - B. Muench, Illinois Department of Conservation, 1979 Sport Creel Survey on the Illinois Portion of Lake Michigan.
Wk XI 102 - R. Hess, Illinois Department of Conservation, 1980-81 Commercial Catch from the Illinois Waters of Lake Michigan.

MALCOLM PIRNIE

# INTER-OFFICE CORRESPONDENCE

Date: 8/5/82

To: R.P. Brownell

From: H. L. Shahabian

Subject: Waukegan Harbor Siltation

The review of available reports and data related to sedimentation/siltation of Waukegan Harbor resulted in the following:

1. The main source of siltation and sedimentation of Waukegan Harbor appears to be Lake Michigan. Based on a limited sampling period performed by Argonne National Laboratory, a two-phase flow often exists at the mouth of the Harbor: Water flows out of the harbor at the surface and correspondingly into the Harbor at the bottom of the channel. The bottom current from the Lake carries with it sediments that are deposited in the channel.

2. The channel and a portion of the Harbor located near the mouth have been regularly dredged in the past. The average quantity of dredged material was 20,000 $yd^3$/year.

3. No dredging has taken place since 1977.

4. The upper reach of the Harbor, slip #3, is not affected by sediments originated from Lake Michigan.

5. The probable source of siltation of slip #3 (surface area 70,000 $ft^2$) is the overland flow and storm sewers with outlets into slip #3.

6. Overland flows and storm sewers carry the dust and dirt accumulated in street curbs and parking areas. An estimate was made of the amount of solids that could reach slip #3. The estimate was based on published values[a] for other cities in the U.S. for similar (industrial) land use, and for the City of Milwaukee, located in the same geographical area as Waukegan.

7. These estimates are:

   - Based on the Milwaukee study: 560,000 lbs/year.
   - Based on average values in U.S.: 290,000 lbs/year.

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7-1D 8-10-82

Considering a specific weight of 110 lbs/ft$^3$ these values would correspond to 5,100 ft$^3$/yr. and 2,700 ft$^3$/yr respectively. Moreover, if a uniform distribution of these sediments is assumed into slip #3 and with no movement of these sediments into other parts of the Harbor 0.5 to 0.9 inches of sediments might be expected to accumulate into slip #3.

Correspondingly, 13 to 24 years period would be required to accumulate one foot of sediments.

8. A similar analysis based on the Universal Soil Loss Equation[a] results in similar values 0.05 to 0.1 ft/yr. Or 12 to 24 years to accumulate one foot of sediments.

9. A draft of 6 to 8 ft is required in slip #3 for the free movements of boats. Based on the bathometric contour map in Mason & Hanger report the attached figures were developed. Figure one identifies the areas in slip #3 with draft less than 6 to 8 ft. The draft is based on the low water datum of 576.8 ft.

10. The second figure projects those conditions into the future based on the values estimated above: 12 to 24 years to accumulate one foot of sediments.

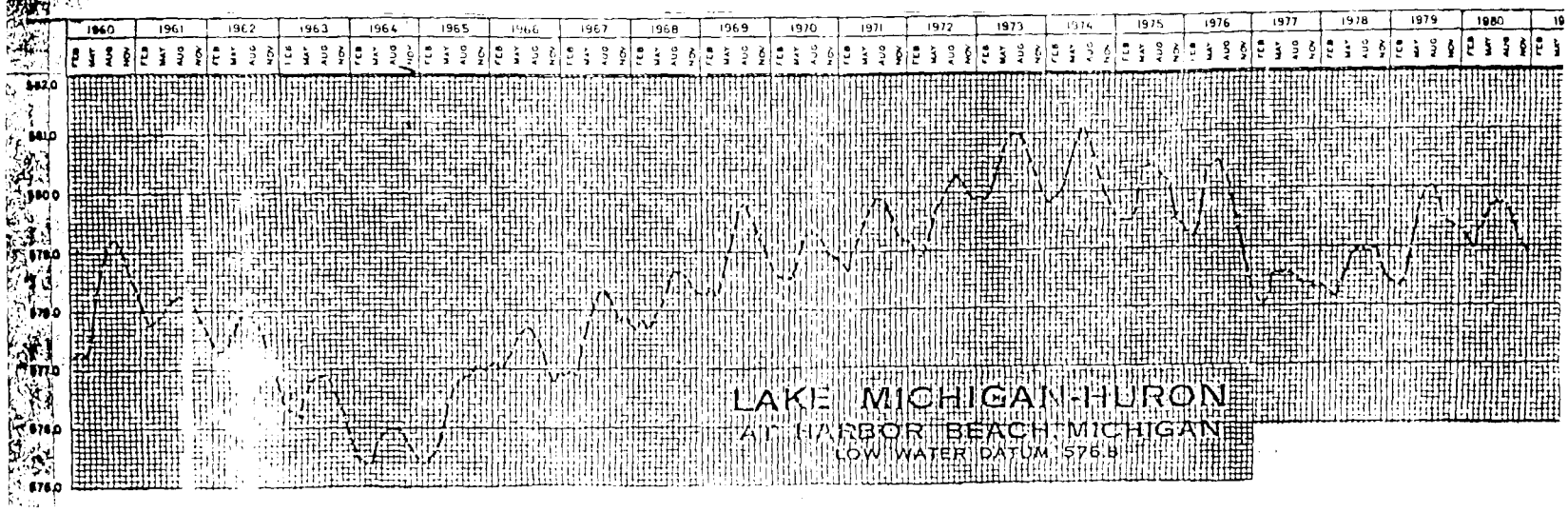
11. Lake fluctuations - The hydrograph of monthly mean levels of Lake Michigan (1960-1980) are shown on Figure 3. The lake levels have a seasonal cyclicity. The annual low levels generally occur during the winter months (Jan. to March) and the high levels in summer (June to August). In addition to the seasonal variations, the annual mean levels appear to have a very low frequency cycle not unlike other hydrologic phenomena. Thus high water level years tend to follow each other and similarly for low water level years. However, it is difficult to predict when the next low water levels will begin.

    An examination of the 1960-1980 hydrograph indicate that the levels were above the Low Water Datum (576.8 feet) since 1967. Record highs (from 1900 to 1980) were registered in 1973-74. However, during the 1963-64 years lake levels were close but generally below the Low Water Datum. The minimum of record was registered in March-April 1964.

UNITED STATES — GREAT LAKES

HYDROGRAPH OF MONTHLY MEAN LEVELS OF THE GREAT LAKES

ELEVATIONS IN FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC, INTERNATIONAL GREAT LAKES DATUM (1955)



WINNIPEG HARBOR SLIP # 3

DEPTH OF WATER ABOVE MUCK LAYER : FUTURE CONDITION:

WATER SURFACE ELEVATION @ HISTORICAL MINIMUM LAKE LEVEL (575.35)

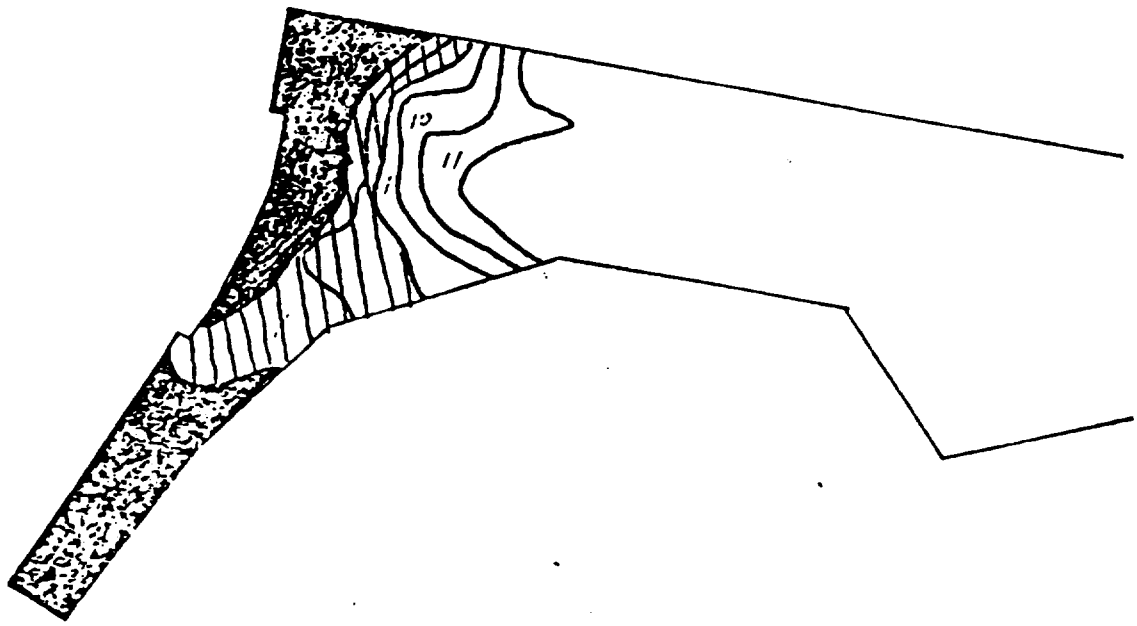



FIG 5

WINNETKA HARBOR SLIP # 3

DEPTH OF WATER ABOVE MUCK LAYER : FUTURE CONDITION:

WATER SURFACE ELEVATION @ HISTORICAL MINIMUM LAKE LEVEL (575.35)

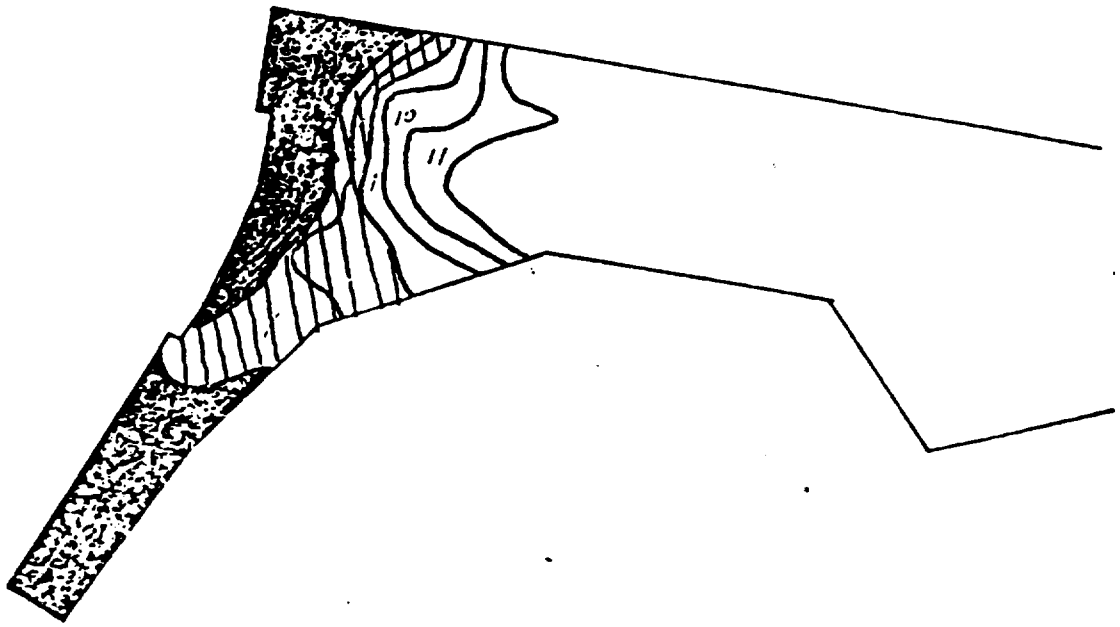



FIG 5

MALCOLM

# INTER-OFFICE CORRESPONDENCE

Date: 7/21/82

To: J.C. Henningson

From: S.A. Roberts SAR

Subject: Waukegan Harbor Slip #3-PCB Loading Rates

The potential PCB loading rates of ground water discharging through Slip #3 have been evaluated using two scenarios:
Scenario #1: The slip filled with clean sand.
Scenario #2: The slip with dredged material from adjoining areas of the harbor.

In order to estimate the ground-water flow and PCB loading rates, the following assumptions were made:

1. The bulkhead is not acting as an effective barrier to ground-water flow; i.e. there is leakage through the bulkhead.

2. Ground water is probably not moving under the bulkhead; since vertical flow components are probably negligible due to the lower permeability clay materials (See Figure 1).

3. Ground water movement is into the slip and there is no movement from the slip into adjoining areas.

4. Filling-in of the slip will create an "artificial aquifer" resulting in ground-water flow in a east-southeast direction. (See Figure 2)

5. A hydraulic gradient (I) of 0.001 ft/ft was assumed for this site; this is a typical value for areas of low relief. At the OMC site, the observed hydraulic gradient is 0.0007 ft/ft.

6. The hydraulic conductivity values (K) of the material are assumed to be:
   - clean sand = $5 \times 10^{-3}$ cm/sec
   - in-situ sand = $5 \times 10^{-4}$ cm/sec
   - muck = $5 \times 10^{-5}$ cm/sec
   - dredged material (mixture of sand and muck = $1 \times 10^{-4}$ cm/sec

   These values are based on the following: 1: expected K values for similar sediments, and 2: values listed in Freeze + Cherry, Groundwater pg. 29.

8. The area at the mouth of the slip = 6,000 $ft^2$. This is based on a 20 ft. depth (PCB report) and a 300 ft. width (Albany Office - verbal communication).

Information gathered on the mobility of PCBs must also be addressed before estimates of PCB loading rates can be made.

DEPOSITION EXHIBIT
BROWNELL-OMC
5-1D 8.10.8

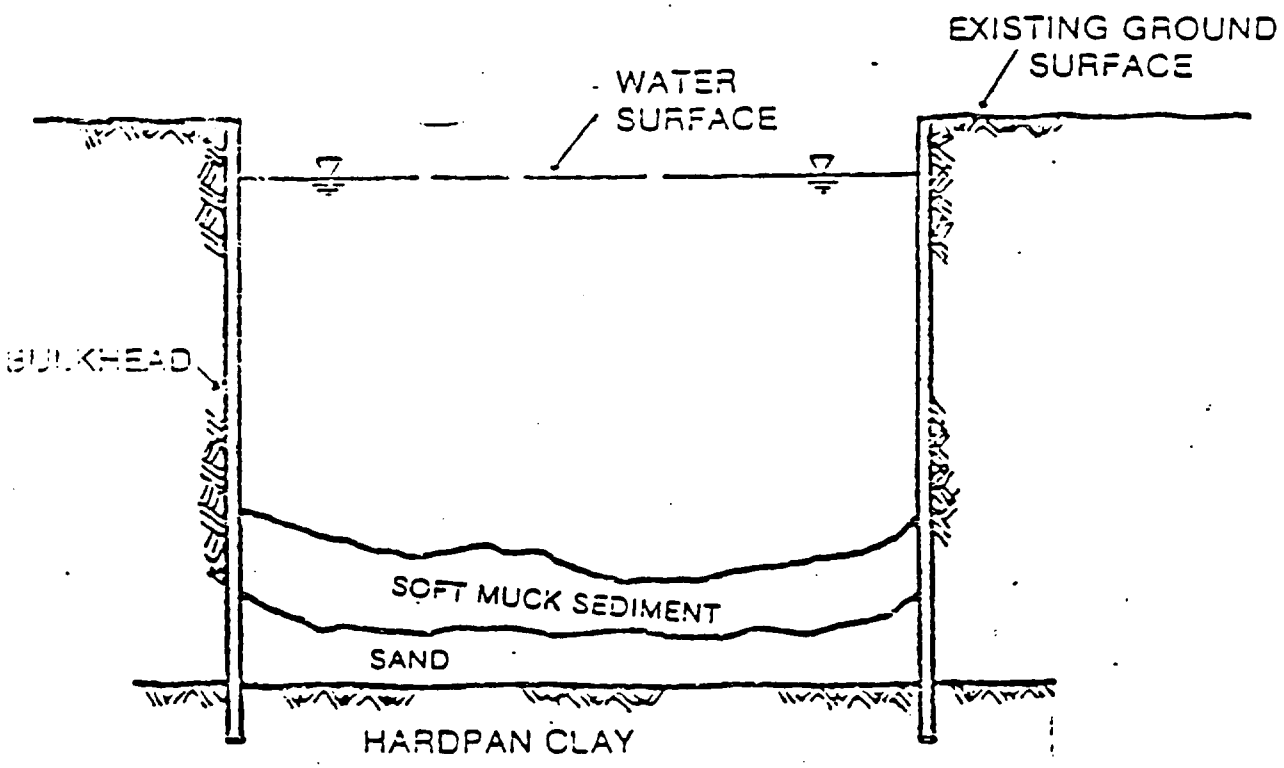



FIGURE 1

CROSS-SECTION OF SLIP #3

PRESENTED AT: Fall Meeting New York Section American Water Works Association September 22-25, 1981, Niagra Falls, NY.

# ACID PRECIPITATION IMPACTS ON DRINKING WATER SUPPLIES

John S. Reed, Malcolm Pirnie, Inc. and
John C. Henningson, Malcolm Pirnie, Inc.

## ABSTRACT

Research on acid precipitation has greatly intensified in the U.S. over the last 10 years. An area of concern which has received attention only very recently is the potential impacts of acid precipitation on drinking water quality. Three areas of concern are evaluated in this paper: 1) increased levels of heavy metals in raw water; 2) biological imbalances; and 3) increased corrosivity. Canadian surveys of heavy metals in representative surface water supplies as well as a group of highly sensitive (poorly buffered) lakes indicate that metals levels are consistently within drinking water standards except for a very small number of lakes where alkalinity approaches zero. Biological imbalances typically include a shift from golden brown algae, green algae, and diatoms to green algae and dinoflagellates. Two-thirds of the U.S. water supplies are corrosive; the extent to which this corrosivity is related to acid precipitation is unknown. In New York State, surface water supplies and deep wells appear relatively less corrosive however shallow wells in the Adirondack mountains directly recharged by rainfall have very high corrosivity. Potential management practices can take place: 1) on a regional basis through reduction in the atmospheric emissions of acid precursors; 2) at the reservoir level through liming; 3) at the treatment plant through pH adjustment and corrosion inhibition; 4) in the distribution system through revisions in plumbing codes; and 5) in the household through increased consumer awareness.

## Introduction

In the Northeast, the region of the U.S. most heavily impacted by acid precipitation, the pH of precipitation is considerably below the national secondary drinking water standard of 6.5 to 8.5. In certain cases, precipitation may also fail to meet primary drinking water standards for heavy metals such as lead and cadmium (Sharpe and Young 1981).

Precipitation which is in equilibrium with atmospheric $CO_2$, but unexposed to airborne pollutants, has a pH of 5.6 to 5.7 as a result of a mildly acidic carbonic acid solution. Combustion of fossil fuels, however, has generated large quantities of atmospheric sulfur and nitrogen oxides which are believed to form strong sulfuric and nitric acids, respectively, when dissolved in airborne water droplets. As a result of these strong acids, rainfall pH in the Northeast typically ranges from 4.0 to 4.5. Certain storms may have pH between 3.0 and 4.0, and values less than 3.0 have been reported (EPA 1981).

Interest in acid precipitation has intensified in the U.S. since the early 1970's, following the lead of European scientists. A series of lectures by the Swedish investigators Ahl and Oden in 1971, followed by a number of publications by American investigators (Likens et al. 1972; Likens 1976, Cogbill and Likens, 1974; Schofield 1976; Galloway and Likens 1976; Shriner 1976; Galloway et al. 1978; Likens et al. 1979) described the distribution of acid precipitation and its impacts, notably injury to vegetation and the elimination of fish populations in certain sensitive (poorly buffered) lakes. Research on acid-precipitation related topics has since proliferated and is likely to further increase in the future. A ten year, multi-agency National Acid Precipitation Assessment Plan was published in draft form January 1981, outlining nine areas of basic research. In the 1982 fiscal year $20 million has been budgeted for acid rain research, an increase from the $12 million budgeted last year.

One research objective identified in the Plan under "Aquatic Impacts" is a relatively new concern which has human health implications: the impacts of acid precipitation on the quality of drinking water supplies. In discussing this topic, two questions will be addressed: 1) to what extent, if any, does a drinking water/acid precipitation problem exist; and 2) if a problem is present, what can be done about it? Three areas of potential concern will first be discussed:

- Increased levels of toxic heavy metals in surface water supplies.
- Biological imbalances caused by acid precipitation, and implications for taste and odor problems.
- Increased corrosivity to transmission lines and plumbing resulting from reduced pH and alkalinities.

In the final section, potential management strategies will be compared and evaluated for practicality.

## Heavy Metal Contamination of Surface Water Supplies

The potential for increased ambient levels of heavy metals - particularly lead, cadmium, copper, and zinc - is of particular concern regarding the effect of acid precipitation on drinking water supplies. These metals may be derived directly from wet or dry deposition, or may be leached from the watershed or lake bottom sediments.

Sharpe and Young (1981) monitored 40 roof catchment cisterns in rural Pennsylvania to evaluate direct input of heavy metals from precipitation. They found that the mean

concentrations of lead (134 ug/l) and cadmium (17 ug/l) in bulk snow in the first year of sampling exceeded the national primary drinking water standards (50 ug/l and 10 ug/l, respectively). Zinc and copper concentrations were within secondary standards. All rain and snow samples failed to meet secondary standards for pH or corrosivity.

When acid precipitation falls upon a watershed it may be neutralized to a limited extent by the forest canopy. Specifically, leaf surfaces may uptake free H+ and release weaker organic acids (Lindberg et al., 1981). Strong acids remaining in solution, however, notably the sulfate ($SO_4^{=}$) ions, subsequently react with the soils and bedrock of the watershed (Likens 1979). Metalic cations are mobilized and transported in runoff. Poorly buffered, shallow soils on granite bedrock are particularly susceptible to this process; in well-buffered soils the strongly acidic, sulfate dominated runoff may be neutralized prior to reaching a lake or reservoir. Trends in the distribution of acid precipitation in the U.S. over the last 25 years are indicated in Figure 1. The relative buffering capacities of various geological formations in New York State are shown in Figure 2. It can be seen that areas of upstate New York have the dubious distinction of combining poorly buffered soils with highly acidic precipitation.

The extent to which acidic runoff raises lake ambient levels of metals is also a function of lake chemistry, morphometry, and hydrology. Poorly buffered lakes with reduced pH

retain metals in the water column; higher metal levels are typically found in lakes with small watersheds, lakes receiving low order streams, and in rapidly flushed lakes (EPA 1980).

Surveys have been conducted in the U.S. and Canada to determine to what extent this heavy metals phenomenon affects the quality of drinking water supplies. The Environmental Health Center, Health and Welfare Canada surveyed 70 municipal water supplies for metals between November 1976 and January 1977 (Meranger, et al. 1979). Levels of 7 metals were compared for raw water, treated water, and distributed water. No attempt was made to correlate metals with pH or alkalinity. With the exception of several values for lead, the concentrations of all metals were well below finished drinking water standards (see Table 1). Although such data do not illustrate long term effects of exposure to acid precipitation, it suggests that most reservoirs in Canada, at least, have not incurred health-threatening levels of heavy metals to date as a result of such exposure.

A more sensitive lake population was examined in northern Ontario by Kelso, et al. of the Great Lakes Biolimnology Laboratory (1981), however the results are similar. Seventy five headwater lakes were sampled, about two thirds of which had conductivities less than 30 μmhos, considered a threshold for acid rain sensitivity (Environment Canada 1979). Copper, nickel, and zinc values were relatively low regardless of pH or alkalinity. Lead and aluminum, however, were found to be

TABLE 1

COMPARISON OF CANADIAN AMBIENT METAL LEVELS
WITH DRINKING WATER STANDARDS (U.S.)

- ALL UNITS μg/l -

| Metal | 70 Canadian Water Supplies (Meranger, et al. 1979) | | 75 Canadian Headwater Lakes (Kelso et al. 1981) | | Maximum Contaminant Level (U.S.) |
|---|---|---|---|---|---|
| | Mean | Range | Mean | Range | |
| Cadmium | ≤0.01 | ≤0.01 - 1.13 | -- | -- | 10 |
| Chromium | 2.0 | ≤2.0 - 7.0 | -- | -- | 50 |
| Copper | ≤5 | ≤5 - 8.0 | 2 | 1 - 8 | 1000(S) |
| Lead | ≤1.0 | ≤1.0 - 235.0* | -- | 2 - 67 | 50 |
| Zinc | ≤5 | ≤5 - 330 | 5 | 1 - 13 | 5000(S) |
| Aluminum | -- | -- -- | 53 | 25 - 240 | -- |
| Nickel | -- | -- -- | 2 | 1 - 5 | -- |

- = No data or standard
S = National Secondary Maximum Contaminant Level. Other standards are National Interim Primary Maximum Contaminant Levels
* = Exceeds standard

highly correlated ($P < .04$) to both pH and alkalinity. At alkalinities approaching zero, several lakes had lead values exceeding EPA's standard of 0.05 mg/l (see Figure 3).

In the U.S., a survey of reservoirs in New York and New England is underway. The project is a joint venture of the USEPA Cincinnati Research Laboratory and the New England Water Works Association, and is a part of the 10 Year National Acid Precipitation Plan (draft 1981). Historical data are being examined and new data collected for pH, alkalinity, metals, and sulfates. At present no interim findings are available; data collection will continue until this winter (Burford, pers. com.). The study is one of four studies envisioned under the Plan pertaining to acid rain and drinking water. These are shown in Table 2.

The New York State Department of Health feels that acid precipitation has not seriously affected surface supplies within the State (Smith, pers. com.). Annual monitoring of all surface water supplies within the State indicate that maximum contaminant levels of heavy metals are rarely exceeded. The most heavily impacted lakes, where fish populations have vanished, are generally remote and not used as water supplies.

The City of Amsterdam, which has retained Malcolm Pirnie, Inc. to review its system, is one example of a relatively acidic public water supply. Water is drawn from three reservoirs in the foothills of the Adirondacks. Raw water alkalinities in these reservoirs frequently range from 2 to 6 mg/l,

TABLE 2

PROPOSED ACID PRECIPITATION - DRINKING WATER RESEARCH
NATIONAL ACID PRECIPITATION ASSESSMENT PLAN
(Draft, January 1981)

| Task | Priority | Duration | Participating Agencies | Contributing Agencies |
|---|---|---|---|---|
| Studying the Acidification of Drinking-Water Sources | 1 | 1980-1984 | EPA, DOI | HHS |
| Monitoring Drinking-Water Systems | 2 | 1983-1986 | DOI, EPA | HHS |
| Studying the Mobilization of Toxic Metals | 2 | 1982-1987 | DOA, DOI,EPA | DOE |
| Examining Methods for Treating Acidified Drinking-Water | 2 | 1983-1986 | EPA | DOI |

and pH from 4.7 to 5.3. Ambient metals levels as measured by the New York State Department of Health, however, are well within state and federal drinking water standards (Kozlowski pers. com.).

In summary, it appears that heavy metals in acidified water supplies at present may exceed standards in a very limited number of lakes and reservoirs, which have alkalinities approaching zero. The preliminary data do not rule out the possibility that changes in a larger number of lakes attributable to acid precipitation are occurring over time, however. A recent report by the National Academy of Sciences (1981) projects that at current levels of sulfur and nitrogen oxide emissions, the number of acidified lakes will more than double by 1990, and will include larger and deeper lakes.

Phytoplankton Effects

Acidified lakes may undergo "oligotrophication", in which both the numbers and the diversity of primary producers decline. Although research has not addressed the implications for drinking water supplies, it is possible that shifts in algal populations may effect taste and odor characteristics as well as treatment strategies.

Non-acidified lakes are typically dominated by Chrysophyceae (golden-brown algae), Chlorophyceae (green algae) and Bacillariophyceae (diatoms) (Conway and Hendrey, 1981). Cyanaphyceae (blue-green algae) may be abundant

particularly in eutrophic, well buffered lakes. With increasing acidity the species composition usually changes and the number of species within each population decreases. Typically the green algae and dinoflagellates become predominant; the dinoflagellate Pernidium inconspicum is often dominant in acidic lakes. There are numerous exceptions to this rule, however, and blue-greens have been found to dominate occasionally (Kwaitkowski and Roff 1976). Changes in algal community are likely caused by one or a combination of the following factors:

- Reduced phosphorus recycling as a result of inhibited microbial degradation, and dense sphagnum mats on the lake bottom.
- Precipitation of phosphorus out of the water column by aluminum, rendering it unavailable.
- Algal intolerance to increases in acidity or heavy metal levels.
- Altered grazing patterns due to changes in fish and invertebrate communities.

While water supply managers should be aware of such algal dynamics, it is unlikely that significant changes in potability or treatability will result. First, water supplies which are sensitive to acid rain are likely to have relativly low primary productivity to begin with and therefore few if any algal problems. Secondly, although species abundance shifts may result in relatively higher numbers of taste or odor-causing algae, the numbers of organisms within all groups tend to

decline with increasing acidity. Therefore any absolute increase within a nuisance species is expected to be rare.

Corrosion

Of the three acid precipitation concerns addressed in this paper, perhaps the most significant with respect to water supplies is an increase in corrosivity or aggressiveness. Corrosivity is a function of pH, alkalinity, dissolved oxygen, total dissolved solids, and hardness. An estimated 16.5 percent of the community water supplies in the U.S. have highly aggressive water (aggressiveness index $\leq 10.0$) while 52 percent are moderately aggressive (aggressiveness index 10.0 to 11.9) (Millette et al. 1980). The extent to which acid precipitation has influenced this corrosivity pattern is unknown (Millette, pers. com.).

Water corrosivity has been given increased attention with the passage of amendments to the Interim Primary Drinking Water Regulations (40 CFR Part 141). This regulation states that as of February 1982, community public water systems must be 1) evaluated for corrosivity to piping and plumbing; and 2) monitored over a period of one year for corrosion-related water quality parameters. Those systems with highly corrosive water must be subjected to additional monitoring, and anti-corrosion measures are expected to be instituted.

The effect of corrosive water on a water distribution system is threefold. Iron leaching from galvanized pipes

will result in "red water," which is unaesthetic and stains fixtures and clothing. Unfortunately, in the absense of such visible corrosion evidence and associated complaints there may be little incentive for a utility to treat for corrosive water. A second effect is the physical deterioration of pipes and plumbing, which results in restricted flows or leaks as well as shortened service life, and costs an estimated $375 million annually in the U.S. (Hudson and Gilcreas 1976). Most importantly, the corroded pipe materials are transported to the tap and represent a potential health hazard to the consumer. Ingestion of lead, copper, cadmium, and zinc has been suggested as a possible cause of cardiovascular disease (EPA, July 1979) and exposure to asbestos has been linked to cancer.

High metals levels are present especially in water which has remained overnight within household fixtures. In Boston, for example, which has widespread lead piping characteristic of older cities, the mean lead tap water levels prior to mid-1977 were consistently above 0.05 mg/l. Since this time pH adjustment with sodium hydroxide has resulted in mean levels below 0.05 mg/l (EPA, July 1979).

The distribution of water supply corrosivity in New York State is of considerable interest to the NYS Department of Health; however, no overall data compilation has yet been undertaken based upon the annual sampling program (Smith pers. com.). Shallow well waters in the Adirondacks are particularly corrosive, (Fuhs pers. com.), perhaps because they are directly

recharged by precipitation with little opportunity for buffering by underlying bedrock. This shallow well corrosivity problem is more serious because many private wells are connected to homes by lead pipes, and no provision is made for anti-corrosion water treatment. In the Oneonta District two children were found to have elevated levels of lead in their blood, resulting in the closing of two home supplies. The N.Y. Environmental Health Center is clearly concerned that continued and potentially increased acidic loadings will aggravate an already serious problem in these sensitive supplies. Deeper wells generally appear less prone to corrosivity, as do surface waters (Fuhs, pers. com.).

## Management Practices

Management strategies for the above concerns can be targeted at 5 general areas as the water progresses toward the tap: in the regional atmosphere, in the surface water supply, at the treatment plant, in the distribution lines, and in the household through consumer awareness.

### Increased Restrictions on Acid Precursor Emissions

The most obvious management strategy to minimize the long-term risks to drinking water supplies is to limit the atmospheric emissions of nitrogen and sulfur oxides. Reductions in acid precipitation, if achievable, would help protect the entire ecosystem of the water supply, including the watershed forest canopy, soils, tributary streams, and reservoir

biology and chemistry. Individual monitoring and management of these various components is virtually impossible. In addition, reductions in acid loadings would protect both large and small water supplies, particularly private supplies where adequate monitoring and treatment cannot be assured.

Atmospheric emissions are regulated at the federal level by the Clean Air Act, which has come up for Congressional reauthorization. The Administration, rather than present specific amendments, recently issued eleven "guiding principles" it seeks to have incorporated into the Act. These include accelerated research on acid precipitation, while at the same time relaxing or revising automobile nitrogen oxide emissions, pollution control standards for coal-fired plants, timetables for achieving primary air quality standards, and the geographical areas covered under the "prevention of significant deterioration" program. The Administration feels that until the relationship between air pollution and acid precipitation is clearly established through an intensified research program, more stringent regulation may be both costly and ineffective. The cost-benefit ratios are indeed unclear at present. The Department of Energy has estimated that reducing sulfur emissions by 5 million to 10 million tons per year would cost $5 to $7 billion (internal DOE study referenced in Ember, 1981). The total damage costs in the eastern U.S., for consistency attributable to acid precipitation have been estimated at $5 billion (National Academy of Sciences 1981); although, this

number is a very rough estimate at best. Only a portion of this damage would likely be reversed by the above emissions reductions.

Under the Administration's approach it may take up to 10 years for the federally sponsored research under the National Acid Precipitation Assessment Plan to be completed before stringent atmospheric emission controls can be implemented. During this same 10-year period, given present nitrogen and sulfur oxide emission rates, the number of acidified lakes is projected to double. As an alternative approach, Senator George Mitchell, (Democrate, Maine) will introduce an amendment to the Clean Air Act requiring an inventory of $SO_2$ emissions in the northeast quadrant of the country, and the achievement of specific reductions in total regional $SO_2$ emissions over a 10-year period.

In-Lake Measures

In certain cases treatment of the whole reservoir may be desirable. Increased fish mortality as a result of acidity could create taste and odor problems or result in reduced recreational use. The inhibition of microbial degradation associated with acidity may result in overly high BOD levels.

The New York State Department of Environmental Conservation (DEC) has treated 50 acidified Adirondack Lakes with lime (Blake 1981). The purpose of this treatment is to restore the fishery rather than to improve drinking water quality. Most lakes were treated with hydrated lime at a rate of 10 to 25

pounds per acre foot, and agricultural limestone has recently also been used at a higher application rate. Although follow-up monitoring has been spotty, measurable improvements in the fishery were noted in 35 lakes. DEC estimates that the period of effectiveness is about 3 years, and may be longer if agricultural lime is used. The cost in 1977-1978 was typically $30 to $50 per acre. Based on experience to date DEC considers liming an economical and effective measure for fishery management.

Corrosion Control at the Treatment Plant

The most effective method of protecting consumers from corrosive water and associated contaminants is through corrosion control at the treatment plant. Nonetheless, to date many water suppliers have not given corrosion control sufficient attention. Although 68 percent of U.S. public water supplies are moderately or highly corrosive, a 1978 EPA inventory indicated that only 500 of 60,000 public water supplies, or about 1 percent, employed corrosion control measures (EPA, July 1979). Corrosion control measures, if instituted across the U.S., would cost an estimated $27 million annually. In contrast, deterioration of piping from corrosion presently costs an estimated $375 million annually (Hudson and Gilcreas 1976).

Corrosion control measures will be only summarized here. They include pH adjustment (i.e., by sodium hydroxide), or the addition of corrosion inhibitors including lime, soda ash, sodium bicarbonate, zinc orthophosphate, and sodium silicate.

The deposition of a protective calcium carbonate film along the interior surfaces of water conveyors is an effective, general corrosion inhibitor (EPA, July 1979).

Corrosion Control in the Distribution System

Aside from measures implemented at the treatment plant, plumbing codes may be revised to limit future installation of corrosion-prone materials. Many widely adopted codes still permit the use of lead pipes, or lead for joining pipes together in water distribution systems. As an anti-corrosion measure, the City of Seattle revised its plumbing code to encourage use of copper rather than galvanized pipe, maximize the use of non-corrosive plastic pipes, limit the lead content of solder, and remove lead and asbestos-cement pipes from the plumbing code (Kirmeyer et al. 1980).

Public Awareness

Public information can also play an important role. For corrosive water supplies, consumers should be advised to let the tap water run for a period of time before use for drinking or cooking, particularly where high levels of lead or other harmful substances may be leached from water standing overnight. In addition, persons should be informed of the availability of corrosion-resistant materials, which should be installed whenever replacing household plumbing.

## Conclusions

1. Surveys of surface water supplies in the Canada and the U.S. indicate that concentrations of heavy metals are below maximum contaminant levels with the exception of lead in a very small number of unbuffered lakes.

2. The data do not permit evaluation of trends in metals levels as a result of continued acid loading.

3. Phytoplankton populations are frequently less diverse in acidified lakes. The dominant groups shift from golden brown algae, green algae, and diatoms to green algae and dinoflagellates. Taste and odor problems as a result of this "oligotrophication" appear unlikely.

4. Corrosive water is a widespread problem in the U.S., affecting tap water aesthetics, pipe and plumbing longevity, and potentially the health and welfare of the consumer.

5. The distribution of corrosive waters in New York State has not been documented. Shallow well water in the Adirondacks is highly corrosive, suggesting the influence of acid precipitation.

6. Strategies to limit acid precursors in the atmosphere are now under intense debate in Congress. The Administration favors a program of accelerated research in combination with a relaxation of certain air quality standards. Others feel emissions must be more stringently regulated at the present time.

7. Liming has been demonstrated as an economical and reasonably effective method (treatment life usually 3 years or more) for restoring fish life in acidified Adirondack lakes.

8. Corrosion control is practiced by a very small percentage of those public systems which have corrosive waters, despite the high cost of corrosion damage and potential health effects on the consumer. Effective corrosion control measures include pH adjustment and the addition of corrosion inhibitors of the treatment plant, revisions of plumbing codes, and increased public awareness.

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DEPOSITION EXHIBIT
Brownell-Oic
14-ID
8-31-82

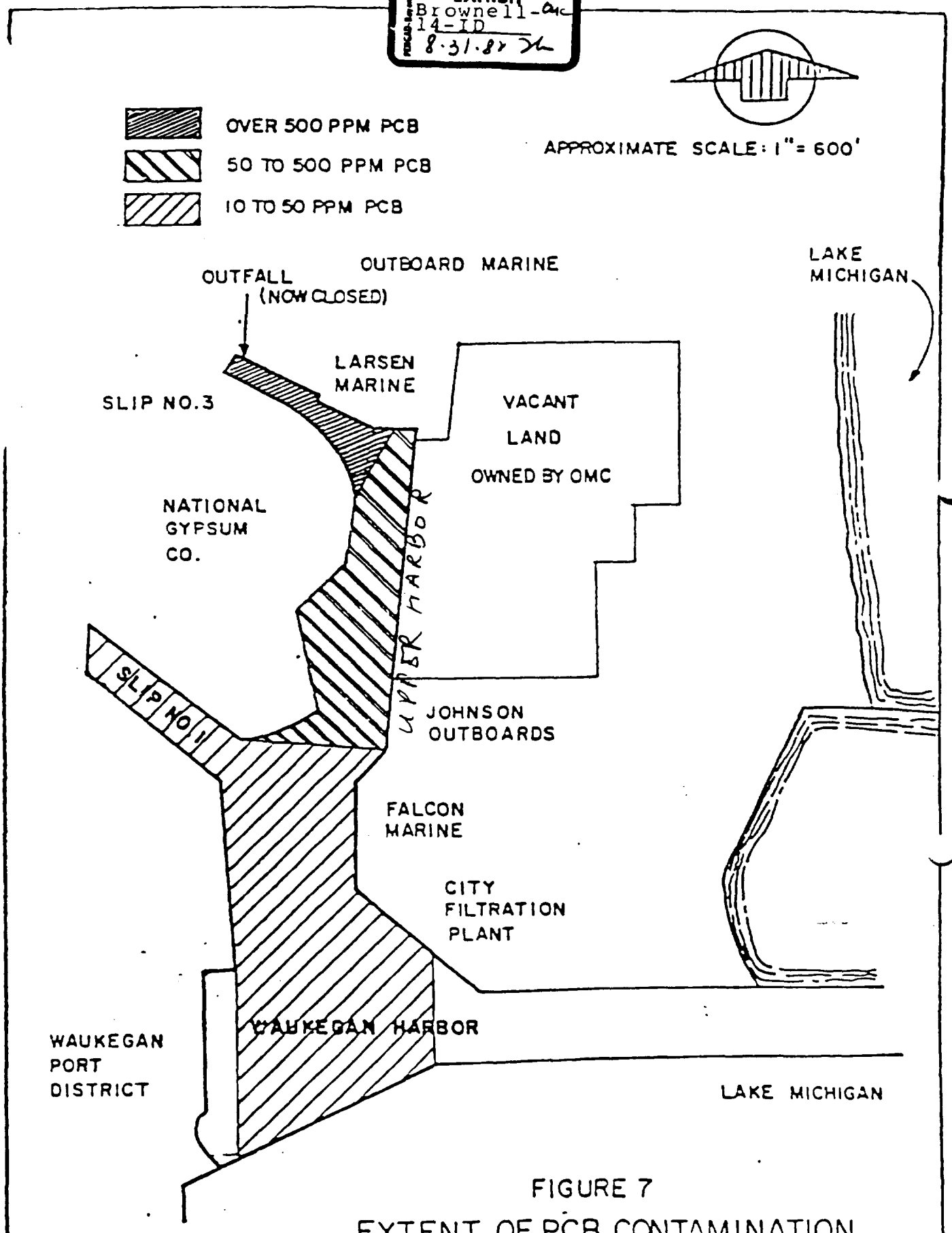


FIGURE 7

EXTENT OF PCB CONTAMINATION IN WAUKEGAN HARBOR BY CONCENTRATION

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CMA HAZARDOUS WASTE SEMINARS
ALTERNATIVE TECHNOLOGY -
LANDFARMING, SUBSURFACE DISPOSAL AND COMPOSTING
(Revised March 1980)

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## INTRODUCTION

Historically, in many areas of waste treatment we have been successful in treating a broad spectrum of individual compounds in a single treatment system. In the chemical industry, biological systems and, to a lesser extent, activated carbon systems have been utilized to remove a wide variety of dilute organic chemical wastes while physical and chemical systems have been used to remove both inorganic and organic compounds. Landfilling has been an expedient disposal method which was economically attractive in the disposal of concentrated organic chemical waste. Recently, however, a better understanding of the nature of the chemicals sent to landfills and the necessary environmental safeguards have reduced the attractiveness of this disposal technique. Incineration systems are developing a reputation for being able to handle a mixture, albeit limited, of wastes and often return a dividend in the form of energy recovered from the heat of combustion liberated by organic wastes. Such a system has recently been placed into operation by the Metropolitan Sewer District of Greater Cincinnati.[1] Such systems have limited application for wastes containing inorganic materials such as heavy metals.

The nature of some wastes generated in chemical manufacturing processes make alternative technologies to biological treatment, activated carbon, physical chemical treatment, landfilling and incineration possible. The alternatives to be reviewed in this paper include composting as well as landfarming and related subsurface disposal.

In general, application of these technologies has been limited to a far less diverse spectrum of compounds which have a reasonably well defined physical and chemical nature.

The hazard and even toxicity of most waste is related directly to its concentration. At low concentrations in the soil and water environment, many materials have a harmless or even beneficial aspect. For example, trace amounts of most heavy metals are essential micronutrients. However, we must be concerned about such issues as: accumulation in soils, crops or compost; or biomagnification as materials are transferred between levels of the food chain, both of which have negative environmental implications. Other concerns include: reactivity and the formation of undesireable and/or unknown compounds; ignitability and associated fire hazards; volatility and associated explosion potential; or secondary water or air pollution.

Little work has been available until recently on the current potential applicability of landfarming/composting technologies for specific types of "hazardous" wastes. Key considerations affecting the applicability of these processes include: existing and proposed regulatory constraints, environmental and siting factors, and screening and testing procedures.

## CURRENT LANDFARMING AND COMPOSTING PRACTICES

A review of current practices assists in an understanding of the future of landfarming. Currently, many domestic and industrial wastes are incorporated with the surface soil and usually undergo several biological and/or chemical treatment processes in situ. Farmers have applied animal manure to cropland for centuries. In many areas sewage sludge and septage has been spread for decades.

With landfarming the waste can be surface applied and mixed with the soil or injected several inches below the surface with a specifically designed tank truck. Injection reduces volatilization of certain substances, but increases the cost of application. Surface application is convenient in that normal farm machinery can be used to disc the waste into the soil; however, undesirable odors and/or volatilization and resultant air pollution may occur if the waste is not incorporated immediately. Fertilizer is usually added to provide nutrients for plant growth or, if no crop is planted, to provide nutrients for the microorganisms which are expected to decompose the organics.

With proper management, supporters claim that land cultivation of hazardous wastes can be considered an ultimate disposal method. The wastes must be decomposed or detoxified, or the surface of the soil could become completely saturated with resultant long-term deterioration of the site.

Among potentially hazardous wastes, oily residues have been most widely disposed of on the land. Several oil refineries have disposed of their wastes in this manner, some for over twenty years. With oily wastes the literature indicates that no crops are grown. The practice is considered a method of disposal only. Types of waste which have been used include slop emulsion bottoms, separator bottoms, and crude tank wastes. Some of these oils have had noticeable amounts of heavy metals which may accumulate in the soil. The success with this method of disposal is due to the efficient microbial decomposition of the oil under aerobic conditions. Generally, the rate of decomposition depends on climate, moisture content of the soil, fertilization, and type of soils. Disposal sites located in dry climates have not achieved as high an oil decomposition rate as those sites where soil moisture content was adequate. An excess of water can also be detrimental to the process if anaerobic conditions result. Optimum microbial activity occurs at soil moistures of 50 to 80 percent of the soil water holding capacity.[2]

The difference in climate and soils between sites makes it necessary to determine optimum loading rate on a case by case basis. In addi-

tion, metals and other nondegradables present in the oil may limit total quantities applied on a given site. Most operations have reported a higher decomposition rate when chemical fertilizer was applied with the oil.

Maintenance of aerobic conditions and soil-waste contact is crucial to the success of oily waste disposal. This is achieved by cultivating the soil regularly, twice per week in some cases. Studies by Cresswell have shown that 8.5 grams of oil per kilogram of soil per year (approx. 5 barrels/acre/month) can be degraded when refinery wastes are fertilized and tilled into the soil.[3] Kincannon reported that the equivalent of 70 barrels of oil/acre/month was decomposed when adequate fertilizer was supplied.[4]

Pharmaceutical wastes also have been successfully cultivated by some companies.[5] Most of these wastes are fermentation by-products such as mycelial residues that are highly organic and contain bio-degradable material. The mycelium supplies several nutrients including organic nitrogen and improves soil water holding capacity and soil aggregation. The success that one company has had with mycelium disposal on land prompted them to start greenhouse screening of organic acids and inorganic residues. After extensive greenhouse screening of the wastes for effects on germination and plant growth, field testing will continue with those wastes which demonstrate the least adverse effects.

Sulfuric acid has potential for improving the productivity of alkaline soils in arid regions.[6] High soil concentrations of exchangable sodium cause poor soil structure (which restricts permeability) and poor germination. Studies in Arizona indicate the possibility of sodic soil reclaimation by land cultivating waste sulfuric acid. Since many heavy metals are more soluble under acidic conditions, the danger of metals leaching from the site may limit loading rates.

Several organic chemical companies dispose of wastewater treatment plant sludges on the land. In one case the pH of the sludge is adjusted to 11-12.2 to control anaerobic odors. The high pH is considered beneficial to the acid, clayey soils in the area. Application rates for wastes from organic chemicals vary but generally have been 5,000 to 25,000 gal/acre/yr.

Other wastes that have been disposed of by land cultivation include paper and pulp residues, food processing by-products and tanning wastes.

Composting is a natural process that has been used to stabilize organic waste for centuries. Until recently, most waste used for composting included animal manures and vegetable matter. The aerobic, and thermophilic decomposition of these materials produces a humus-like material relatively free of odors and pathogens when proper composting procedures are used.

Three methods of composting are recognized: a) windrow, b) static-pile, and c) mechanized or enclosed systems. The basic steps and requirements involved in composting are essentially the same, regardless of the method used. Key factors include maintenance of: aerobic conditions; moisture content; temperature; carbon to nitrogen ratios; and provision of a degradable carbonaceous substrate.

Unfortunately, little research has been conducted on the treatment of hazardous substances by composting, and many questions arise when considering the potential problems associated with the process. Since treatment occurs exclusively by biological mechanisms, two important issues need consideration: 1) the effect of "inhibitory" wastes on microbial activity and 2) the ability of the composting system to reduce the hazardous wastes to an innocuous state. In addressing the first issue, compost systems are generally considered to be extremely resilient ecosystems. The diversity of microbial populations appears to adapt readily to changes in composition and concentrations of waste materials. Obviously, limits exist in their resistance to toxic effects of certain compounds, and these limits have not yet been fully investigated. Concentrations of residual materials and subsequent disposal or use of the compost determine the effectiveness of composting in treating hazardous wastes.

Degradation of two types of organic chemical wastes is currently being studied at Rutgers University.[7] Hydrocarbon mixtures such as crude oil, crankcase oil, synthetic oil, and also mixtures of aroclors of polychlorinated biphenyls (PCB) have been used in small-scale bench composters. Preliminary results have shown that used crankcase oil is resistant to degradation and also inhibits the decomposition of the waste mixture. This resistance may be due to the change in properties resulting from high engine temperatures and other operating factors. PCB's do not appear to be broken down in composting systems. Conversely, unused synthetic oil degrades almost completely and also stimulates the composting process. This is consistent with the degradation of oily refinery sludges in landfarming techniques.

Studies on the degradation of pesticides by the National Canners Association have shown that diazinon and parathion degraded rapidly in thermophilic compost systems.[8] Their work also demonstrated the degradation of organophosphate pesticides by composting. Although dechlorination of organic compounds generally is enhanced by aerobic conditions, DDT was not affected since dechlorination of DDT appears to be greater under anaerobic conditions.

As with landfarming, there are situations where sludges from industrial wastewater treatment plants are conditioned with lime prior to dewatering and composting. The pH's may go above 12 on occassion. Such high pH's may be incompatible with the requirements of the microorganisms necessary for composting.

In Europe composting is used extensively with municipal sludges and solid wastes. However, it is our understanding that the degradation of some solvent type wastes currently is being investigated.

## ENVIRONMENTAL AND REGULATORY CONSTRAINTS

In the past, hazardous wastes have been controlled to varying degrees by nonspecific State and Federal regulations. In many cases the apparent constraints resulting from both implied and explicit requirements have acted as a deterrent towards developing innovative waste disposal methods for wastes which now may be classified as hazardous. In other cases the lack of clear

requirements has not created an incentive for developing methods which are environmentally acceptable. The reliance has been on expedient methods which were economically attractive. As a result, there have been few detailed demonstrations of composting or landfarming of wastes now classified as hazardous.

In recent years we have become increasingly aware of the problems associated with improperly managed disposal of hazardous wastes. We have learned that buried materials may contaminate groundwater or accumulate in soils and crops. Leachate or surface runoff may impair surface water quality. In addition, volatile compounds may escape to the atmosphere causing explosive or locally toxic conditions, odors or contaminate areas a considerable distance from the original source as a result of precipitation or other depositional mechanisms.

The Resource Conservation and Recovery Act of 1976 (RCRA) has provided a comprehensive definition of hazardous wastes. Section 3001(b) of the Act describes a set of characteristics for use in determining whether or not a waste is hazardous. In addition, a list of particularly hazardous wastes is provided. The key characteristics are stated as:

- o Ignitability
- o Corrosivity
- o Reactivity
- o Toxicity
- o Radioactivity
- o Infectiousness
- o Phytotoxicity
- o Teratogenicity and Mutagenicity

The USEPA has proposed regulations, 40 CFR, Part 250, which address the first four of these characteristics. Subsequent revisions may address the others or change the first four. The proposed regulations specifically list several hazardous wastes which shall not be landfarmed. Excluded materials are: ignitable waste; reactive wastes, volatile wastes; and wastes which are incompatible when mixed. Similarily, although not addressed in the proposed rules, it seems logical that the use of composted material on land might also be excluded if the compost retained any of the above characteristics. It is also proposed that hazardous wastes shall not be utilized in the cultivation of food chain crops.

Of concern is the fact that these proposed rules may very likely become the "law of the land", at least for any new sites. At first glance, it appears that the proposed rules exclude almost every chemical landfarmed at some concentration. While there are many exceptions to the exclusions, it is clear that the burden of proof will be on the generator.

The regulations propose specific site constraints, site preparation requirements, waste application and incorporation procedures, and monitoring requirements. In many cases, these proposed constraints may inhibit the economic viability of composting or land application or certain types of hazardous wastes.

Of the first four basic characteristics (ignitability, corrosivity, reactivity and toxicity), corrosive and toxic wastes are generally acceptable to landfarm, if all of the rules are followed. Corrosivity has been related to a pH below 3 or above 12. Unfortunately, a high pH is not an uncommon characteristic of industrial sludges where lime conditioning is involved. Although this characteristic results in a classification as hazardous, the elevated pH may reduce the mobility of certain heavy metals which might otherwise be toxic.

The principal concern regarding toxicity is related to the concentration of specific components and their persistance in the environment. Many materials become toxic at relatively high concentrations while detrimental effects of other wastes are reported at levels in the parts per billion range. In addition, there is a great variability in the rate at which materials degrade naturally. For example, certain chlorinated hydrocarbons, such as PCB are extremely persistant materials. Heavy metals are, of course, not subject to degradation.

Materials specifically excluded from landfarming include volatile wastes, which the proposed regulations define as having a vapor pressure of greater than 78 mm of Hg at 25°C. Such materials may release unacceptable levels of contaminants to the atmosphere. Wastes with greater vapor pressures may be acceptable if they are subsurface injected. Table 1 lists some organic compounds with vapor pressures above and below the 78 mm level. Priority pollutants are found in both sub-lists.

As can be seen, many major organic compounds such as toluene, xylene, phenol, acrylamide and a number of alcohols (but not methanol) are acceptable to landfarm according to the volatility test. If the wastes from organic chemical complexes vary significantly, the overall vapor pressure also may vary. Curiously, skatole, an obnoxious and odoriferous compound present in human wastes is not "volatile" enough. One thing is certain, if any neighbor to a landfarming or outdoor composting facility smells anything, the vapor pressure will become meaningless quickly. Composting in an enclosed system may be more amenable to handling volatile organics. Vapors released during pile turning could be trapped in off gas odor control systems.

Ignitability is another characteristic which also results in specific consideration for landfarming. The inference is that the accident risks of handling such materials is prohibitive.

The reactivity of a number of chemicals is of concern in order to avoid the potential for violent chemical changes which may result in explosions, or generation of toxic gases. Therefore, reactive and incompatible wastes are also excluded from landfarming.

The suitability of landfarming wastes with the remaining four characteristics (radioactivity infectiousness, phytotoxicity and teratogenicity/mutagenicity) have not yet been addressed by the proposed regulations. However, it is reasonable to assume that concern for environmental contamination and the public health risks associated with these characteristics will result in greater control and possible exclusion of some materials unless the attenuation of hazardous characteristics is demonstrated.

SITING AND PROCESS CONSIDERATIONS

The proposed rules and regulations result from the concern that hazardous wastes should be isolated as much as possible from the surrounding environment. Many of the potential environmental impacts of a hazardous waste landfarming operation or the use of compost derived from hazardous wastes may be mitigated by proper consideration of the site to which the material is to be applied.

Soils are the primary concern in the siting of any land cultivation process. Texture may be the most useful general guide for assessing the potential of a soil to adequately treat wastes since it affects several soil properties. Hydraulic conductivity is intimately associated with texture, and the need to maintain aerobic conditions relies upon the soil's ability to conduct water. Clayey soils generally will not have sufficient permeability, so that frequent loading of high moisture wastes could produce an anaerobic surface layer. A very sandy soil, however, may allow wastes to move from the surface without adequate treatment.

The same relationship with texture holds true for water holding capacity, where clayey soils hold more moisture and sandy soils less. A droughty soil may not provide enough moisture for optimum microbial activity.

The cation exchange capacity (CEC) generally indicates the organic matter content and type of clay present in a soil. Organic matter is known to chelate metals, keeping them from leaching to the groundwater. A high CEC is generally believed to be desirable when applying wastes on land; however, for wastes containing certain negatively charged species, a low CEC soil could provide better containment of the waste. Alesii and Fuller reported that cyanide, in the form of KCN and $K_3Fe(CN)_6$, was less mobile in soils with free iron oxide and kaolin.[9] These substances are common in highly weathered, fine textured soils with a low CEC.

The effect of pH on the solubilities of many heavy metal compounds is well documented. There are data which indicate that a pH of above 6.5 will contain many heavy metals in the surface soil. Maintaining a pH near 7.0 will also provide a favorable environment for microbial activity.

Soil depth to groundwater and bedrock influences the degree of waste treatment. It is generally recommended that at least 4 to 5 feet exist to bedrock or a seasonal water table, and at least 15 feet to a permanent groundwater table. Runoff and erosion from a disposal site is affected primarily by slope. To control pollution from these sources, slopes less than 5 percent should be selected whenever possible.

The impact of hazardous waste disposal on soil properties has received little attention from researchers. Wastes with high salt concentrations (potentially corrosive) could destroy soil structure. As a result, poor water infiltration and drainage could occur which would increase runoff and create anaerobic conditions in the soil. The attenuation of waste constitutents in soils involves complexation, ion exchange, adsorption and precipitation. The mechanisms of most of these reactions are dependent upon the types and amount of clay, hydrous oxide and organic matter, as well as several dynamic properties, such as solute composition and concentration, and pH.[10]

Preliminary site selection may be possible using remote sensing techniques, such as NASA's LANDSAT or other digitized aerial photograph interpretations. LANDSAT capabilities include the ability to distinguish agricultural land and some of the crops grown, density of urban land, water and water quality, and type of forest land. Correlating this information with USGS maps (digitized for computer manipulation), potential landfarming sites could be delineated quickly and at a relatively low cost. Data processing of LANDSAT information usually costs about $1.00 to $5.00 per square mile, for screening areas larger than 2,000 square miles. If additional detail is desired, aerial photography could be manually interpreted and incorporated into LANDSAT format but at additional cost. As an example, soil maps for a particular area may be digitized and programmed to coincide with LANDSAT images, providing a relatively accurate picture of the land use and soil properties. In this way, land use status, soil characteristics, type of vegetation, drainage patterns and other useful information could be evaluated by computer analysis.

In addition to the obvious site characteristics which should be evaluated, other considerations may have a bearing on the specific techniques to be employed or the seasonal schedule of activities.

The rate and degree of biodegradation of waste in the soil are controlled by many factors, some of which have been mentioned previously. Ultimately, the concentration and composition of the wastes will determine the effectiveness of treatment by soil processes. Additional factors controlling biodegradation are:[11]

- o concentration of oxygen in the soil
- o degree of soil-waste contact
- o temperature
- o pH
- o availability of water
- o availability of nutrients

In most cases, effective biodegradation will only occur with adequate oxygen in the soil. Aerobic destruction of organic matter is much more complete than anaerobic digestion, and certain compounds, such as saturated hydrocarbons, undergo very little biodegradation in anerobic environments.

The degree of soil-waste contact can be usually controlled by cultivating the soil with normal farming machinery, as shown with oily wastes. For solid or semisolid materials, the waste surface area must be increased by crushing, shredding, or some other mechanical means.

Temperature, although important, is not controlled during landfarming. An increase in surface temperature of oil treated plots has been reported to be as much as 10°C higher than control areas.[12]

The pH of a landfarm can be easily controlled by addition of chemicals. Soil pH has a marked effect on microbial activity and it is generally believed that pH should be maintained near 7.

The importance of available water and nutrients are other key factors. To achieve maximum biodegradation, nitrogen and other nutrients must be supplied to meet the metabolic needs of microorganisms. It has been suggested that for readily biodegradable wastes, such as mycelia, 1 part of nitrogen 25 parts of waste carbon may be necessary to maximize the biodegradation rate.[13] For slowly biodegradable wastes, such as saturated hydrocarbons, nutrient requirements may be significantly less than those needed for easily degradable substances.

Synergistic relationships have been shown to create greater environmental effects than each material separately.[14] The effects of one substance on the degradation of another needs investigation in landfarming systems.

Water quality is a major concern with all land disposal processes. Soluble contaminants will move downward by percolation when wastes are incorporated into the surface soil. Traditionally, metals and nitrates are of greatest concern. Hydraulic conductivity, soil texture and structure, rainfall intensity and duration, and contaminant attenuation compatibility of the soil will affect the degree of movement. Since most soils have a limited anion exchange capacity, many negatively charged constituents will be likely to appear in the groundwater. Surface waters may be affected by land cultivation operations if runoff is not controlled from the site. Runoff caused by intense rainfall or excessive waste applications may transport the pollutants to lakes and streams directly, or by adsorption to sediments carried with the water. Where crops are not grown additional measures need to be taken such as construction of terraces and diversions.

Uptake of heavy metals and other toxic substances by plants have been a major concern at land application sites. Plants vary in their ability to assimilate waste materials, and certain parts of the plant are known to accumulate more toxins than other tissues. For this reason, the Resource Conservation and Recovery Act restricts food chain crops from being grown on land treated with hazardous wastes.

Quantification of air quality is frequently overlooked at current land cultivation sites. Concern has generally been limited to odor generation. When disposing of hazardous wastes, the possibility of toxic dusts and volatilization needs to be considered for safety of personnel at the site, and in the surrounding area. Noxious odors may also be a problem, but injection of the waste or immediate soil incorporation usually resolves the situation.

GROUNDWATER AND SOIL MONITORING

The proposed regulations require a groundwater monitoring and leachate detection system for those hazardous waste facilities which would be classified as a landfill or surface impoundment. For a hazardous waste facility classified as a landfarm a soil monitoring system is required. As a result of our experience with the requirements for land application of municipal sludges we believe that some form of monitoring and/or surface waters will probably be required where the use of local water resources may be of importance.

Facilities landfarming a waste are specifically required to employ a soil monitoring program both prior to and during operation. Background soil conditions are determined by analyzing one soil core per acre of site. Recommended analyses are listed in Table 2. The depth of the core is to be 3 times the depth of waste incorporation or 12 inches, whichever is greater. The initial background analysis is done on the bottom 1/3 of the core prior to waste application. The analysis must be for those constituents in the waste which make it hazardous. During the operation of facility, cores must be taken semiannually and analyzed as indicated above on areas treated.

At those facilities where groundwater monitoring wells are advisable, a minimum of four wells should be employed. One well hydraulically upgradient from the waste emplacement is utilized for operational background water quality. At least three wells should be located down gradient at different depths to insure that a representative sample of the various aquifer portion(s) in which potential contamination might be expected. One of the three wells should be constructed immediately adjacent to the active portion of the facility. The other wells should be located at stategically determined locations. Wells must be cased and grouted. The choice of depth, diameter, material, and emplacement technique is based upon the hydrogeology of the site and the waste(s) to be monitored. The use of shallow nested well points, well clusters or large diameter continuous slotted pipes may also be necessary based on site and waste specific characteristics. Costs for monitoring wells range from a few hundred dollars for a small diameter shallow, driven well to several thousand dollars for a large diameter (>4") deep well. The analysis program should include those chemical parameters that might result in a restriction to the possible use of the local surface or groundwater resources.

The requirements for monitoring the utilization of compost have not been specified by the proposed regulations. Unlike landfarming, composting can only be considered a method of waste treatment and not a method of disposal. Obviously, monitoring requirements need to be defined for the finished compost before it can be safely marketed, and the outlet for compost will generally determine the risk involved.

PRELIMINARY FEASIBILITY EVALUATION

Landfarming and composting both may be attractive for the disposal of modest amounts of organic compounds when capital intensive incineration systems are not feasible for cost, energy or air pollution reasons. Landfarming naturally lends itself to rural "land rich" situations, whereas composting in enclosed systems may be more attractive in "land poor" situations. For both processes, the less the waste character varies, the easier the system will be to manage and the greater its probability of success.

A review of the literature on current practices and the proposed regulations indicate that certain wastes may be more likely candidates than others. The most feasible materials appear to be: organic wastes with heavy metals, readily degradable organic materials, and acidic or alkaline wastes. The limitations on types of material

which can be successfully applied to the land will probably make landfarming and composting less attractive for regional hazardous waste treatment systems than incineration or secure land burial.

For both landfarming and composting, extensive small-scale testing will be necessary to determine the effectiveness of treatment and/or deleterious environmental impacts. Greenhouse pilot tests are generally the most rapid and efficient way of screening wastes for potential landfarming when a cover crop is grown. Several application rates of a number of waste streams can be tested on the crop to be grown with relatively little space required. Germination percentage, growth rate, and uptake of harmful substances can then be determined rather quickly for each waste and application rate.

The wastes that produce the best results should undergo additional greenhouse testing to develop preliminary design parameters. However, greenhouses are an artificial environment and field testing also is necessary to determine the effects of climate on the plant-waste-soil interactions. Since soil-waste contact is crucial to landfarming effectiveness, test results using small plots could significantly differ from full-scale operations. The hand operated rototillers needed to cultivate small plots may not produce the same mixing effect as large tractor drawn plows. Therefore, tests plots should be large enough to allow the same machinery to be used as would be used in full scale operations. When no crop will be grown, pilot testing in the field is probably the only method to assess the effectiveness of land application of hazardous waste.

Bench-scale composters have been frequently used to evaluate the effectiveness of composting waste materials. With such systems it is possible to accurately control the constituents of the raw material and the effectiveness of the composting can be determined.

As part of the feasibility evaluation, cost estimates for alternate processes are necessary. As an example, a typical cost estimate has been prepared for the landfarming of a sludge containing heavy metals and several non-volatile organics including at least one priority pollutant. Costs were generated for application of 10,000 gallons per acre per year on a 100 acre site. It was assumed that only 80 acres were usable. Table 3 indicates two examples of the costs which might be expected. Land and site development costs will, of course, vary significantly depending upon actual location. Monitoring costs are relatively high at $100,000 per year and would represent the major portion of the annual operating cost if the proposed regulations are enacted.

Cost comparisons must then be made with other disposal techniques, such as incineration and/or secure land burial. Each technique will have different factors which affect its suitability. Capital cost, transportation, energy, air quality, residue disposal, labor and equipment will influence incineration systems; while capital cost, transportation, site suitability, monitoring and long-term safeguards will be critical with secure land burial. It will be apparent, however, that monitoring of landfarm operations to assure continued suitability of the program will have a very significant impact on the cost comparisons.

SUMMARY

The feasibility of landfarming or composting hazardous waste is dependent upon the specific characteristics of the waste. Available information demonstrating these alternative techniques is limited. Environmental considerations regarding the disposal of hazardous wastes have received increased attention in recent years. As a result, more stringent Federal regulations have been proposed to control the disposition of hazardous wastes. These regulations specifically exclude certain types of wastes from landfarming. Site limitations, site preparation and monitoring requirements may limit the applicability of these processes for complex or variable waste mixtures. Waste reprocessing, secure land burial and incineration may remain the only viable solution for many hazardous wastes. Regional facilities sponsered by major sewerage authorities is one approach, which is working for some wastes. However, it appears that with proper definition of pertinent problems and careful selection of wastes and sites, landfarming/subsurface disposal and, to a lesser extent, composting systems may be used to dispose of certain specific organic hazardous wastes. In each case screening and pilot testing is essential to determine the feasibility for a specific waste.

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12. Watts, J.R., K.W. McLeod, and J.C. Corey, "Land Application Studies of Industrial Waste Oils and Solvents," Du Pont de Nemours (E.I.) and Co., Aiken, S.C., Savannah River Lab., 1978.

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TABLE 1
VAPOR PRESSURES OF CERTAIN CHEMICALS

Vapor Pressure Less Than 76 mm Hg at 25°C

| | |
|---|---|
| acetic acid | cyclohexanol |
| acrylamide | 1-decanol |
| acrylic acid | diethylene glycol |
| allyl alcohol | ethanol |
| N-Amylamine | ethylene glycol |
| aroclor 1242 | formic acid |
| benzaldehyde | furfural |
| benzylalcohol | glycerol |
| butanol | methylisobutyl ketone |
| butylacetate | nitrobenzene |
| n-butyne acid | phenol |
| chlorobenzene | n-propanol |
| m-chloroaniline | skatole |
| chlorophenol | toluene |
| cresol | xylene |

Vapor Pressures More Than 76 mm Hg at 25°C

| | |
|---|---|
| acetaldehyde | carbon disulfide |
| acetone | chloroform |
| acetonitrile | hexane |
| acrolein | hexene |
| acrylonitrile | methanol |
| allyl chloride | methylethyl ketone |
| benzene | propenoxide |
| n-butylamine | |

TABLE 2
SOIL PARAMETERS TO BE ANALYZED

Before and After Waste Application*

| | |
|---|---|
| pH | $NH_4$-N |
| CEC | Ortho-P |
| Soluble salts (TDS or EC) | Ca, Mg, Na, K |
| Total N | Heavy Metals (Cd, Pb, Zn, Ni, Cu) |
| $NO_3$-N | |

After Application (If Suspected to be Present in Waste)

Organic Compounds Applied
Pesticides
Toxic or Carcinogenic Compounds
Pathogens
B, Se, Mo, Hg, As, Cr

*Recommended by Municipal Environmental Research Laboratory, Cincinnati, OH[10]

TABLE 3
TYPICAL COST ESTIMATE

| | Land Cost at | |
|---|---|---|
| Capital Costs | $2,000/acre | $20,000/acre |
| Land at (100 acres) | $ 200,000 | $ 2,000,000 |
| Impoundments and Other Site Improvements | 500,000 | 500,000 |
| Operating Cost | | |
| Annual Transportation and Sample Collection and Application Costs at $0.08 per gallon | 40,000 | 40,000 |
| Analytical Cost at $500/Sample | 100,000* | 100,000* |
| Review with Regulatory Agencies | 10,000 | 10,000 |
| Total Annual Operating Cost | $ 150,000 | $ 150,000 |
| Total Annual Costs (using Capital Recovery Factor of 0.1) | $ 220,000 | $ 400,000 |

*Including soil, crop and groundwater monitoring programs.

PRESENTED AT: Hazardous Waste Management for the 80's, 1982 Ohio Environmental Engineering Conference, March 29-30, 1982, Columbus, Ohio.

- WK XVI 118 -

# DETERMINATION OF DISPOSAL SITES FOR PCB CONTAMINATED MATERIAL DREDGED FROM THE HUDSON RIVER BED

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## INTRODUCTION

Contaminated sediments may be removed from a river bottom in several situations. Historically, maintenance dredging in navigation channels has been required wherever shoaling occurs, including in contaminated reaches of rivers. More recently, remedial dredging has been proposed in several river systems as a means of removing toxic materials which have accumulated in the river bottom and pose a threat to the aquatic environment.

Both types of dredging serve a useful purpose in our society, but result in the same problem: finding disposal sites for the unwanted, contaminated dredge spoil. Ocean dumping of the spoil is often precluded by high transport costs from inland river dredge sites, as well as the potential harm to the ocean environment. In-river disposal of contaminated materials may reduce transport costs, but incurs similar environmental concerns, especially long-term site stability and the practicality of maintenance and monitoring. State-of-the-art methods appropriate for more concentrated forms of hazardous waste, including microbial decomposition and incineration, have not been demonstrated as practical for dredge spoil.

Upland containment is frequently the preferred alternative, because the material is removed from the aquatic system and placed in a secure containment site. Long-term monitoring and maintenance are facilitated, as is the collec-

tion and treatment of leachate. However, different issues arise. The shoreline areas of contaminated river reaches are likely to be heavily populated, making isolated disposal sites difficult to find. Human health issues arise, including protection of surface and well drinking water supplies, air quality, and local agriculture. Land use problems may be created, including conflicts with existing or intended uses, and possible negative impacts on the local tax base or property values.

SITE SCREENING

Given the myriad of environmental, socioeconomic and political issues associated with upland disposal, it is imperative that any site selection process be scientifically valid, objective and thorough. This paper describes a particular site screening procedure which Malcolm Pirnie successfully applied to two dredging projects in the Hudson River, one a remedial dredging project in the Upper Hudson, the other a maintenance dredging project in the Lower Hudson.

The Hudson River received an estimated 500,000 lbs of polychlorinated biphenyls (PCB) over a 25 year period, from two General Electric capacitor plants located approximately 192 river miles north of New York City [1] In 1974, the New York State Department of Environmental Conservation retained Malcolm Pirnie to devise the optimal strategy for removing the highly contaminated sediments within a 40-mile section of the upper river, north of Albany (see Figure 1). A series of alternatives was examined. It was determined that dredging of the most contaminated sediment "hot spots" in combination with secure upland containment, offered the most feasible opportunity for long-term maintenance and monitoring of the PCB-contaminated spoil. As a second phase of the project, Malcolm Pirnie was to locate a site or sites suitable for such containment.

More recently, the New York District of the Army Corps of Engineers retained Malcolm Pirnie to prepare a 10-year management plan and environmental impact statement for maintenance dredging of the Hudson River federal channel between New York City and Albany. This lower portion of the river has markedly reduced PCB levels in comparison with the upper Hudson. However, as a contingency against encountering sediments contaminated with PCB or other materials such as heavy metals, the Corps requested Pirnie to identify all disposal sites along actively dredged reaches potentially suitable for contaminated or hazardous dredge spoil.

## PHASED APPROACH TO UPLAND SITE IDENTIFICATION

For both studies, a phased approach to site identification was employed. Generalized screening procedures were followed by progressively more rigorous field investigation as potential sites were identified and, in the case of the PCB study, finalized. The approach comprised five steps:

1. Develop screening criteria.
2. Prepare overlays based on the criteria.
3. Delineate specific sites.
4. Conduct preliminary field visits.
5. Conduct detailed field visits.

In addition, public participation played a key role throughout the site identification process. Each of these phases is described in detail below.

### Development of Siting Criteria

The critical first step in the screening process is to develop siting criteria which satisfy regulatory requirements as well as good engineering and scientific judgment. The criteria must then be applied to the entire study area without preconception as to the best site locations. Such objectivity is imperative in anticipation of public opposition to any hazardous waste disposal site, and the inevitable questions "Why here?", "Why not over there?".

Federal and New York State laws pertaining to hazardous waste disposal were researched to determine characteristics which would exclude an area from further consideration. In several cases, as deemed necessary, criteria more stringent than the regulations were developed.

For the remedial dredging project in the Upper Hudson, sediment PCB levels commonly exceed 50 ppm PCB and are therefore classified as a toxic material under 40 CFR Part 761.[2] In the lower river, the majority of the channel sediments are sandy and "clean", with the potential for reuse as fill, road sand, etc. The hazardous sites were delineated as a contingency; sites for clean material and for slightly contaminated material were found as well, but will not be discussed in this paper.

As shown in Table 1, the criteria for maximum hydraulic conductivity is $1 \times 10^{-5}$ cm/sec. Section 360.8 of New York State's "Solid Waste Management Facilites" requires that the soil underlying a hazardous waste site must meet or exceed this standard, and that an impermeable barrier (either

Table 1. Preliminary Site Screening Criteria-
Hazardous Dredged Material

| Parameter | Unacceptable | Reference |
|---|---|---|
| Soil | Permeability greater than $1 \times 10^{-5}$ cm/sec | Part 360 NYCRR[3] |
| | Less than 3 ft thick in situ. | Malcolm Pirnie |
| | Class I or II agricultural soils. | Part 360 NYCRR |
| Slope | Deep gullies, slope over 15%. | Malcolm Pirnie |
| Surface Water | Closer than 300 ft to any pond or lake used for recreational or livestock purposes, or any surface water body officially classified under state law. | Malcolm Pirnie |
| | In 100-year floodplains. | 40 CFR Parts 257[4], 761[2] |
| | In official state-designated wetlands | Malcolm Pirnie |
| Bedrock | Closer than 30 ft to highly fractured rock or carbonates. Closer than 10 ft to all other rock. | Malcolm Pirnie |
| Ground Water | Closer than 10 ft to groundwater table. | Part 360 NYCRR[3] |
| | Closer than 500 ft to any water supply well or recharge area. | 40 CFR Part 250[5] |
| Committed Land | Located in designated agricultural districts or closer than 1000 ft to parks, residential areas, historic sites, reservoirs. | Malcolm Pirnie |
| Biologically Sensitive Areas | Endangered plant or animal habitats, unique or regionally significant habitats. | Malcolm Pirnie |

natural or synthetic), having a hydraulic conductivity of $10^{-7}$ cm/sec or less must exist between the waste and the underlying soil. Because the barrier requirement can be "engineered away" by constructing a liner, $10^{-5}$ cm/sec for the underlying soils was adopted as the criteria.

The minimum depth to ground water is 10 feet, based upon Section 360.8. In addition, the site must be at least 500 feet from a water supply well or recharge area, as specified in 40 CFR Part 250, "State Hazardous Waste Programs, Proposed Guidelines."

The minimum depth to bedrock is 10 feet, as also mandated by Part 360.8. An additional precaution was added: depth to bedrock must be at least 30 feet in highly fractured rock or in carbonate rock, where movement of leachate would be facilitated.

Preparation of Overlays

A series of overlays was prepared on transparent sheets using USGS topographic maps (at a scale of 1:24,000) as a base. This widely used overlay technique was first developed by Ian McHarg at the University of Pennsylvania. Computer data entry and graphics may be substituted for hand drafting; however, unless the data base is to be continually updated and re-used, hand drafting of the overlays may be considerably less costly.

For both studies, the overlays covered a land area 2 miles on either side of the Hudson River. This distance was determined by hydraulic dredge pumping capabilities. Primary references were employed to determine areas of unacceptable conditions on each overlay. These references included:

1. Soils surveys, general soils maps, and preliminary field maps.
2. County ground water bulletins.
3. New York State significant habitat reports.
4. New York State freshwater wetlands maps.
5. Floodplain maps.
6. New York State Land Use and Natural Resources Inventory (LUNR).
7. Aerial photographs.

Because data gaps were encountered with respect to several key criteria, final site determination was deferred until after the detailed field investigation. For example, detailed soils maps were unavailable for portions of the study areas. Judgments based upon general maps were re-

quired, to be confirmed later by borings. Minimum depth to bedrock could be mapped at 5 feet, although the criteria specified 10 feet. Depth to ground water was considered too variable to be mapped at all, based upon scattered well information. In addition, inconsistencies among the various maps required constant checking. A small shift in map scale or alignment could radically alter the acceptability of an area.

Figure 2 illustrates how the individual overlays were utilized. Areas which did not satisfy the criteria were shaded for each overlay. When the overlays were placed together, a composite was formed in which the clear areas or "windows" represented broad areas of environmental suitability. The result of the overlay procedure was a substantially reduced land area in which to concentrate the subsequent site screening procedures, thereby saving labor and expenses. For example, in the Upper Hudson PCB-related study, approximately 3,200 acres consisting of 40 parcels were found to be acceptable, out of approximately 100,000 acres in the original study area.

Delineation of Specific Sites

Specific sites within the environmentally acceptable "windows" were identified by using secondary criteria. The secondary criteria consisted of engineering and economic factors, such as:

1. Adequate size for the projected disposal needs (200 acres for the Upper Hudson PCB study; 20 acres for the Lower Hudson).
2. Proximity to the Hudson River and to the anticipated dredge area.
3. Low elevation and associated transport costs.
4. Site accessibility (presence of nearby roads).
5. Absence of obstacles (utilities, pipelines, and other structures).
6. Sufficient screening from residential areas and other sensitive land uses.
7. Site ownership (one or two owners as opposed to multiple owners).

These criteria were applied to the windows in an iterative manner, with the aid of recent aerial photographs and USGS topographic maps. In the Upper Hudson, where the ultimate objective was to locate a single suitable site of 100 acres or more, the secondary screening process reduced the number of candidate sites to four. In the Lower Hudson, where the objective was to identify all potential sites of 20 acres or more, 133 candidate sites were delineated.

## Preliminary Field Investigation

The objective of the preliminary field investigation was to confirm and refine the in-house screening results and to eliminate obviously unacceptable sites. Two tasks were performed at each site: a preliminary soils investigation, and a site walkover. For the Upper Hudson PCB study, backhoe pits were excavated to a depth of 10 feet and laboratory analyses performed on the soils. For the Lower Hudson maintenance dredging study, hand auger samples to a depth of 4 to 5 feet were collected at a number of locations within each site. The soils were visually examined for clay content. Portions of the sites which did not have a clayey subsoil, or where bedrock was encountered at shallow depth, were eliminated from further consideration.

Based on visual observation, areas exhibiting rock outcrop were eliminated. Aquatic and terrestrial habitats were subjectively evaluated in order to rank otherwise similar sites. Land use was checked, particularly recent changes which did not appear on the maps. Distances to surface waters or nearby wells were determined, and wetland vegetation recorded.

A conflict arose among three criteria: soil permeability, depth to groundwater, and wetland vegetation. In the Northeast, clayey soils with the required permeability (10-5 cm/sec or less) are generally saturated at depths very close to the surface. Depth to ground water is, therefore, considerably less than 10 feet as specified by New York State law. Furthermore, these saturated soils may support wetland vegetation, a second violation of the siting criteria.

In practice, however, water movement in these tight soils is extremely slow to nil. The low yield is not characteristic of a aquifer. Wetland vegetation, if present, would likely be typical of a wet meadow. A priority was therefore assigned to soil permeability.

As a result of the preliminary field visits, three of the four Upper Hudson sites were eliminated from further consideration. The fourth underwent detailed field investigation as described below. In the Lower Hudson study, 62 of the 133 initial sites underwent preliminary field investigation. Thirty one were eliminated, leaving a total of 102 sites. For these sites, a detailed field investigation may be performed in the future when and if: 1) maintenance dredging is required in the vicinity of a given site; and 2) sediment testing indicates that the material to be dredged would be considered hazardous by EPA.

Detailed Field Investigation

The preferred site in the Upper Hudson study area comprises 250 acres of active and abandoned farmland in the Village of Fort Edward, New York. In the winter and spring of 1980, soil borings, a resistivity survey, and test pit investigations were conducted on the site. Twenty borings were initially conducted. Five encountered bedrock at less than 30 feet; the remainder were driven to 30 feet. Six borings were added during the course of the investigation to better verify rock levels. In addition, 10 undisturbed samples were taken and 5 temporary piezometers installed. The borings indicated varved Lake Albany clays at all depths. The varving is in a horizontal plane, and does not affect the vertical permeability of the clays in-situ.

After several days, ground-water levels as measured in the piezometers, were 3 to 4 feet below the surface. An artesian condition was encountered in one of the borings which extended to bedrock. Water was observed flowing slowly out of an auger which had remained in the hole overnight. This artesian condition indicates that groundwater in the bedrock aquifers is under pressure, which should act to limit any movement of leachate from the overlying clays into the bedrock aquifers. If the site leachate collection system should unexpectedly fail, water could accumulate within the site and negate this pressure differential.

Surface resistivity readings were made at a total of 19 stations to provide additional depth to bedrock information. The results indicated that depth to bedrock across the site ranged from near the surface, to 75 feet. The site alignment was shifted slightly to assure that minimum depth to bedrock was 10 feet as required by State regulations.

Eight new test pits were excavated, in addition to those undertaken previously as part of the preliminary field work. The pits were excavated to a depth of 9 to 13 feet, and soil morphological descriptions were provided for all but two of the pits. The predominant soils types were Kingsbury silty clay, Covington silty clay loam, and Vergennes silty clay loam, all poorly drained with seasonally high water tables. The estimated permeability of this association was $2.6 \times 10^{-7}$ cm/sec.

The field investigations showed that with the exception of depth to groundwater as strictly interpreted, the site met or surpassed regulations and/or guidelines established by State and Federal agencies (see Table 2). It was concluded that, with proper design, construction, and maintenance procedures, the site would provide a satisfactory

Table 2. Comparison of Regulatory Requirements

| Factor | 40 CFR 761[2] | 40 CFR 250[5] | 6 NYCRR 360[3] | PCB Feasibility Study-"Ideal"[6] | Actual Site Characteristics |
|---|---|---|---|---|---|
| Permeability | $\leq 1x10^{-7}$ cm/sec | $\leq 1x10^{-7}$ cm/sec | $\leq 1x10^{-7}$ cm/sec | $\leq 1x10^{-7}$ cm/sec | $2.6x10^{-7}$ cm/sec |
| Thickness | in-situ 4 ft | 5 ft | case by case | in-situ > 10 ft | > 30 ft |
| Passing #200 sieve | > 30% | > 30% | - | > 30% | > 90% |
| Plasticity Index | > 15 | > 15 | - | > 15 | 15-37 |
| Liquid Limit | > 30 | > 30 | - | > 30 | 41-85 |
| Depth to Bedrock | - | - | > 10 ft | > 50 ft | > 30 ft |
| Classification | - | CL, CH, SC, OH | - | - | CL, CH, ML |
| pH | - | > 7.0 | - | - | 6.9-8.3 |

containment area for the proposed PCB hot spot dredging program. Hearings were recently completed by the New York State Facilities Sitings Board, to determine whether the site could be approved. If the permit is issued, site preparation is anticipated in 1983 as the first step in the Hudson River PCB reclamation project.

PUBLIC PARTICIPATION AND RESPONSE

In the maintenance dredging study the public was actively involved from beginning to end. Five public meetings were held, to review the screening criteria, evaluate the "window" maps and the potential site maps, and finally to comment on the draft EIS. In addition, a Coordinating Committee was formed comprised of representatives from environmental and business groups and government agencies.

The public participation program improved communications and relations in general between the Corps and the residents along the river. However, fear persisted regarding PCB's and the possible impacts of upland disposal. The principal objections were not technical in nature. They tended to involve subjective judgments related to effects on property values, and on the perception of the community as a desirable location to live or work. Requests were received to delete certain sites. Each of these sites was reexamined with respect to the original criteria. If all criteria were satisfied, the site remained on the maps. Some sites were deleted as a result of this process.

In the Upper Hudson PCB study the public was not involved from the onset. However, a technical advisory committee was set up as a result of the settlement between the New York State Department of Environmental Conservation and General Electric. Public participation was initiated after the site screening had been completed but prior to field investigations. During the meetings and hearings there was considerably more emphasis on technical issues, particularly ground-water and air quality impacts, than observed during the meetings on the Corps of Engineers project. It is difficult to determine whether the emphasis on specific technical issues was a result of the focus on a few specific sites, or a lower degree of confidence in the technical data because the public was not involved in the early stages of the project.

These experiences indicate that the early exposure of the public to the siting process prior to the identification of specific potential disposal sites may be desirable. Such a program may increase the public's understanding of the technical issues. This in turn may simplify the site evalu-

ation process by focusing on the socioeconomic factors which appear to be the most significant public concern.

## CONCLUSION

The need for upland disposal of contaminated dredge spoil will likely continue as a result of both river reclamation efforts and, more commonly, channel maintenance projects. Disposal site location must be determined through a procedure which is both legally and scientifically valid, to assure maximum protection to the environment and to gain public trust. The site screening approach described in this paper has two principal advantages: 1) the overlay technique is objective and applies the criteria equally to all lands; and 2) the phased approach is economical and permits the determination of the level of effort as the study objectives evolve. In the Upper Hudson PCB study, carrying this approach through the detailed field investigation stage resulted in a site which meets or exceeds both State and Federal standards.

## REFERENCES


### Government Publications

1. Tofflemire, T.J., L.J. Hetling, and S.O. Quinn. "PCB in the Upper Hudson River: Sediment Distributions, Water Interactions and Dredging." New York State Department of Environmental Conservation Technical Paper No. 55. January 1979, p.1.

### State and Federal Regulations

2. 40 CFR Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," Subpart E, Annex II, Section 761.41.

3. New York Compilation of Rules and Regulations, Title 6, Chaper 360, "Solid Waste Management Facilites".

4. 40 CFR Part 257, "Criteria for Classifcation of Solid Waste Disposal Facilities and Practices", Section 257.3.

5. 40 CFR Part 750, "State Hazardous Waste Programs, Proposed Guidelines".

## Engineering Reports

6. Malcolm Pirnie, Inc. "PCB Hot Spot Dredging Program Upper Hudson River, Containment Site Investigations Program Report No. 1", for New York State Department of Environmental Conservation, May 1980.

U.S. Department of Justice

*United States Attorney*
*Northern District of Illinois*

*United States Courthouse*
*Chicago, Illinois 60604*

HAND DELIVERY

August 6, 1982

Roseann Oliver
PHELAN, POPE & JOHN, LTD.
180 North Wacker Drive
Chicago, Illinois 60606

Re: United States of America v. Outboard Marine Corporation, et al, No. 78 C 1004 - USDC ND Ill. ED

Dear Roseann:

Enclosed are several worksheets and outlines which the undersigned received today from Malcolm Pirnie. Although these are considered to be work product documents, we are voluntarily providing copies to you since either Mr. Henningsen or Mr. Brownell may need to refer to them during their depositions.

Very truly yours,

DAN K. WEBB
United States Attorney

BY: JAMES T. HYNES
Deputy Chief, Civil Division

cc: James H. Schink, Esquire
KIRKLAND & ELLIS
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Assistant Attorney General
ENVIRONMENTAL CONTROL DIVISION
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Chicago, Illinois 60601

ATTACHMENT B

3/31/82 SHEET NO. 1 OF 3
JOB NO. 607-01-9100
Volatilization

1. Volatilization of PCB's

a Solubility in Water Column (ug/L) based on literature

| Aroclor | Hutzinger, KYK | Verschueren | Summary of Mason & Hanger |
|---|---|---|---|
| 1242 | — | — | 200 to 340, 703 |
| 1248 | 100 | 54 | — |
| 1254 | 40 | 12 | 12 |
| 1260 | 25 | — | — |

b. Reported water column data in Waukegan area; based on Kontaxis 10/21/81

| Location | Total PCB (ug/L) | Dissolved PCB |
|---|---|---|
| Slip #3 | Say 0.8 to 1.0 | ~0.4 |
| Rest of Harbor | 0.1 to 1.0 Say 0.5 | ~0.05 to 0.5 Say 0.25 |
| Outside of Harbor (within 10 km radius) | 0.01 to 0.05 at 1 mile<br>0.005 to 0.1 in open lake<br>Say 0.005 | ? but probably most of total |

DEPOSITION EXHIBIT
BROWNELL - UMC
8-10 8-10-87

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
BY RPB DATE 8/5/82 SHEET NO 2 OF 3
CHKD BY DATE JOB NO 607-01-9100
SUBJECT Volatilization

2. Methods of estimating PCB loss

a) $J = K_L C_d$

$J$ = mass flux, $ug/m^2 day$

$K_L$ = mass transfer coefficient, m/day
0.28 to 0.44

$C_d$ = Dissolved PCB conc. ug/L

Source: PCB Volatilization from Hudson River
D. Toro and O'Connor

b). $Q = (MW)(K_L)(A)(X_i)$

$Q$ = mass flux, lb/hr

$MW$ = molecular wt of PCB

$K_L$ = mass transfer coefficient, $\frac{lb\text{-}mole}{ft^2\text{-}hr}$

$A$ = surface area ($ft^2$)

$X_i$ = mole fraction of PCB in water

Source: Huang - OSEPA Office of Solid Waste
Only has $K_L$ on Aroclor 1254

Use D. Toro and O'Connor

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RPB DATE SHEET NO 3 OF 3

CHKD BY DATE JOB NO

SUBJECT Volatilization

3. PCB losses:

a. Convert J to J* lb/yr by

$$J\,(\mu g/m^2\text{-day}) \times \text{acre} \times 0.0089 \times 365 = J^*$$

b. At 60°F (not really a direct factor in the eqn – use $k_L$ of 0.44) and

1). 37 acres of harbor and values in 1b above

Roughly 14 lb/yr of PCB could be volatilized. Correcting for ice cover indicates about 12 lb/yr of loss.

2). 90 sq mi of near shore waters and 0.005 µg/L.

Roughly 400 lb/yr of PCB might be volatilized.

3). Losses during construction could be calculated similarly. Use 70 µg/L as water column value.

Roughly 63*0.4 lb/day/acre of exposed, agitated, contaminated water area.

MALCOLM PIRNIE

INTER-OFFICE CORRESPONDENCE

To: JOHN C. HENNINGSON, RICHARD P. BROWNELL

Date: 7/9/82

From: ROSALIND MASON HARRIS RMH

Subject: WAUKEGAN HARBOR PCB FISH LEVELS

This memo summarizes existing data and information on the extent of fish PCB contamination in Waukegan Harbor and Lake Michigan. The results of in-situ live car bioconcentration and depuration studies undertaken in Waukegan Harbor and laboratory studies are also discussed. Finally, estimates of the value of the commerical and recreational fishery in the Waukegan area are discussed in relation to present PCB levels of commercially and recreationally important species.

Fish PCB Levels

Monitoring of fish PCB levels in Lake Michigan has been done since the early 1970's. In Waukegan Harbor, fish PCB monitoring began in the mid-1970's, with the discovery of high PCB concentrations in harbor sediments. Evaluation of data from these monitoring programs is difficult because of the variability in sampling and analysis procedures. Factors which can influence PCB concentrations include size or age of the fish sample, typ of tissue analyzed (whole individual vs. fillet), lipid conten method of analysis (composting whole fish or fillets or averag individual values), sampling location and various other factor Year-to-year trends apparent from the data must be interpreted with care due to these factors and the overall variations in t extent and numbers of fish sampled annually.

Lake Michigan Fish Levels

PCB levels in major Lake Michigan fish species for the period 1971 to 1979 have been summarized in a USEPA status report (Wk IV 99). Information from this report is used in the following discussion and is supplemented with more recent data (1980 and 1981) when it was available.

Lake Michigan fish species are considered in several groups, based on similar habitats and feeding preferences. These groups are:

A) Coho and Chinook Salmon, Brown and Rainbow Trout

B) Whitefish, Bloater and Lake Herring

C) Lake Trout

Group A, the salmon and trout, have short life spans, are fast growing and migrate considerably. They feed on alewife, smelt and other forage fish, which take them to near shore areas. They migrate to tributaries for spring or fall spawning and are important sport fishery species. Table 1 provides median PCB levels for these species from 1972 to 1981. Values range from less than 2 ppm to approximately 9 ppm, and are variable on a year-to-year basis. No trend is evident from the data. In general, trout and salmon accumulate PCB to a greater degree than other lake species because of their proportionally higher lipid content.

Group B, whitefish, bloater and lake herring, inhabit deep, offshore areas where they feed on plankton. They are important commercial species. Table 1 indicates that median PCB levels for these species appear to be decreasing and for all years are under 5 ppm, the FDA limit. In 1979, only 3 percent of the samples equalled or exceeded 5 ppm.

Group C includes only the lake trout, a major sport and commercial species. The lake trout inhabits deep, cold waters for most of the year and feeds primarily on alewife. Because of its long life span (it reaches maturity in about 7 years) and feeding preference, it can accumulate significant concentrations of PCB, and is considered separately from other trout and salmon species. The values in Table 1 indicate a general decrease in median values since the mid-1970's although there have been fluctuations from year-to-year. The 1980 value is based on only 3 values in comparison to 17 to 48 values for preceeding years. Only two values were available for 1981 (1.6 and 7.3 ppm) so no median is shown. Prior to 1978, median values exceeded 5 ppm, but these levels have dropped off to less than 5 ppm since 1978. In 1979, 39 percent of the samples had 5 ppm or more PCB.

Data compiled for the period 1971-1979 by USEPA also provides median PCB levels in these three groups in the northern and southern parts of Lake Michigan. Insufficient data was available to differentiate between northern and southern PCB levels in chinook and coho salmon and brown and rainbow trout. However, the data for the other species (Groups B and C) indicate that median PCB levels are higher in the southern part of the lake, as would be expected. Waukegan Harbor, the Milwaukee River and Harbor and the Sheboygan River are among the PCB "hot spots" identified in the southern part of the lake which may be contributing to these levels.

Table 1

Median PCB Levels
In Lake Michigan Fish
(ppm wet weight)

| Year | Group A | Group B | Group C |
|---|---|---|---|
| 1972 | 4.6 | - | - |
| 1973 | 9.1 | - | - |
| 1974 | 4.85 | - | 10.5 |
| 1975 | 3.7 | - | 5.2 |
| 1976 | 6.4 | 2.5 | 6.0 |
| 1977 | 1.65 | 2.2 | 7.8 |
| 1978 | 5.5 | 2.0 | 3.9 |
| 1979 | 4.3 | 1.7 | 4.1 |
| 1980 | 4.4 | - | 4.9 |
| 1981 | 2.3 | 1.7 | - |

Group A = Coho and Chinook Salmon, Brown and Rainbow Trout
Group B = Whitefish, Bloater and Lake Herring
Group C = Lake Trout

Source: 1972-1979 data from Wk IV 99 - USEPA, A Status Report on the Presence of Polychlorinated Biphenyl Compounds in the Fishes of Lake Michigan 1971 through 1979 with Special Reference to the Waukegan Harbor in Waukegan, Illinois.

1980-1981 data compiled by Malcolm Pirnie, Inc. from available Waukegan references.

## Waukegan Harbor Fish Levels

Available data from fish sampling in Waukegan Harbor are summarized in Table 2 for the period 1976-1981. Species have been grouped, based on feeding habits and habitat, as follows:

a) Coho Salmon and Rainbow Trout

b) Largemouth Bass, Yellow Perch, White and Black Crappie, Sunfish and Shiners

c) Alewife

d) White Sucker, Carp, Brown and Black Bullhead

As is obvious from Table 2, there is only scattered sampling data for Waukegan Harbor. Species from Groups B and D have been most heavily sampled.

PCB values for coho salmon and rainbow trout were low and comparable to the lakewide data. These species do not regularly inhabit Waukegan Harbor and would not be expected to reflect typical in-harbor fish PCB levels.

The species from Group B generally inhabit warm, slow-moving water and feed on crustaceans, small fish and insects. They are found most often in sheltered and near-shore environments. Except for 1981 data and one other sample value, the PCB levels in this group were well above 5 ppm. The range of values is 3.5 to 187.4 ppm. The small number of samples taken may in part explain the large difference between 1980 and 1981 data for this group. Apart from 1981 data, it is apparent that this group has been exposed to PCB contamination in some form, whether it be from water column or food sources.

There is insufficient data for alewife to evaluate PCB levels for this species. In general, the species inhabits deep, open lake waters although it may move inshore seasonally. Its primary food is zooplankton. In the harbor, it would be considered only a transitory species.

The last group of species for which data is available are sucker, carp and bullhead. These species are bottom feeders and inhabit sluggish, warm waters. The range of PCB values for these species is 1.41 to 131.0 ppm, comparable to Group B. Median values for these two groups are also comparable, 18.9 and 18.2 ppm. Group D PCB values indicate no apparent downward trend over time for these species common to Waukegan Harbor.

Table 2

PCB Levels
In Fish From Waukegan Harbor
(ppm wet weight)

| Year | Group A #/PCB[1] | Group B #/PCB | Group C #/PCB | Group D #/PCB |
|---|---|---|---|---|
| 1976 | - | - | - | 1/ 7.0<br>1/ 8.0 |
| 1977 | - | - | - | - |
| 1978 | - | 1/ 3.5<br>3/ 14.2<br>1/ 17.8<br>9/ 38.8<br>3/ 32.5 | 6/1.8 | 6/ 3.6<br>6/ 28.6<br>3/ 29.0 |
| 1979 | - | 1/ 18.9 | 1/7.0 | 1/ 38.5<br>1/ 18.4<br>2/ 8.2<br>2/ 18.0<br>4/ 8.3<br>1/ 26.8 |
| 1980 | 1/4.2<br>1/2.0 | 5/ 34.0<br>1/ 20.2<br>1/187.4<br>1/162.9 | - | 1/131.0 |
| 1981 | 3/0.5 | 3/ 1.41<br>5/ 0.34<br>1/trace | 10/2.01 | 2/ 1.41<br>3/ 27.9 |
| Median | 2.0 | 18.9 | 2.01 | 18.2 |

[1] #/PCB = Number of fish in sample/PCB value of sample

Group A = Coho Salmon and Rainbow Trout
Group B = Largemouth Bass, Yellow Perch, White and Black Crappie, Sunfish and Shiners
Group C = Alewife
Group D = White Sucker, Carp, Brown and Black Bullhead

Source: Miscellaneous fish PCB data compiled by Malcolm Pirnie, Inc. from available Waukegan references.

The USEPA status report (WK IV 99) compared PCB values for fish species from Waukegan Harbor with similar species in other harbors and estuaries in Lake Michigan (Sheboygan, Lower Green Bay, Milwaukee, Sturgeon Bay) for 1971-1979. There are data gaps for various species in various locations. More comparative information exists for the carp and goldfish group and alewife group than for most other species groups. Median values for Waukegan and other harbors are shown in Table 3. In terms of carp and goldfish, Waukegan Harbor has the second highest value after the Sheboygan River Estuary. It should be noted that there were many more values for Sheboygan than Waukegan, which means that there was a greater chance of high level PCB fish being caught in Sheboygan than in Waukegan. It is expected that comparable values would be found in a larger number of Waukegan samples. Bluegill, crappie, etc. show high median PCB values in Sheboygan and Waukegan, but this is based on limited data. Although data is inadequate to make a definite statement about the degree of contamination in Waukegan in comparison to other harbors, it is apparent from available information that PCB levels in fish sampled in contaminated harbors are generally higher than the same species taken from Lake Michigan.

Bioconcentration and Depuration Studies

Summary results of two live car and one sediment exposure study are provided in Table 4. Data from these studies indicates that fish exposed to Waukegan Harbor water or sediment do tend to bioconcentrate PCB in their flesh over time. After 28 to 30 days in live cars in Slip #3, yellow perch and bluegill composite PCB concentrations increased 100 to 200 times over pre-exposure levels to concentrations of approximately 10 to 30 ppm (Wk III 105 and III 115). Exposure to Waukegan Harbor suspended sediments resulted in an increase in yellow perch concentrations from 0.48 ppm to 2.04 ppm after only seven days (Wk IV 114).

In one live car study (Wk III 115), yellow perch and bluegill exposed to waters in Slip #3 for 30 days were then exposed to Lake Michigan water at the municipal waterworks for 84 days to evaluate depuration rates. As Table 4 shows, after 84 days these fish had not yet returned to pre-exposure levels, although their PCB concentrations had dropped significantly.

In this bioconcentration-depuration study performed by Veith, USEPA, he reports that the bioconcentration of PCB in fish is dependent on 1) size of fish; 2) rate at which water is pumped over gills (species dependent); 3) length of time of exposure to PCB and 4) PCB concentration in water. He also indicates that the elimination of PCB from an organism is often dependent on PCB concentration in the organism. The elimination rate increases as the organism concentration increases. A steady-state is reached when PCB uptake equals the elimination rate. This is the

Table 3

Median PCB Levels
In Fish From Waukegan Harbor
And Other Harbors and Estuaries
1971-1979
(ppm wet weight)

| | Carp and Goldfish Total #/PCB[1] | Bluegill, Crappie, Rockbass, Sunfish Total #/PCB |
|---|---|---|
| Lower Green Bay Estuary | 16/7.6 | 3/0.5 |
| Sturgeon Bay Harbor and Fish Channel | 3/16.3 | - |
| Sheboygan River Estuary | 26/140 | 7/105 |
| Milwaukee Harbor and River Estuary | 7/17 | - |
| Waukegan Harbor | 5/37.3 | 3/14.2 |
| All Lake Michigan (excluding Green Bay) | 19/3.8 | - |

[1] Total #/PCB = Total number of PCB values/median PCB value

Source: Wk IV 99 - USEPA, A Status Report on the Presence of Polychlorinated Biphenyl Compounds in the Fishes of Lake Michigan 1971 through 1979 with Special Reference to the Waukegan Harbor in Waukegan, Illinois.

Table 4

Summary of Bioconcentration and Depuration Studies
Waukegan Harbor

| Summary of Study | Species | Day | Control PCB* | | Test PCB* | | |
|---|---|---|---|---|---|---|---|
| 1. 7-day lab exposure to suspension of Waukegan Harbor sediments (380 mg/l SS, 26.8 ppm dry weight PCB in sediments) May 1979** Wk IV 114 | Yellow Perch | 7 | 0.48 | | 2.04 as 1242 | | |
| | | | | | YP | BG | $H_2O$ Column |
| 2. 28-day live car exposure to Waukegan Harbor water in Slip #3 (Oct-Nov 1978) Wk III 105 | Yellow Perch (YP) | 0 | | | 0.156 | 0.207 | 5 ug/l |
| | Bluegill (BG) | 28 | | | 29.9 | 19.7 | 4.2 ug/l |
| | | | YP | BG | YP | BG | |
| 3. 30-day live car exposure to Waukegan Harbor water in Slip #3 and subsequent 80-day depuration in Lake Michigan water (Jun-Oct 1979) Wk III 115 | Yellow Perch (YP) | 0 | - | - | 0.14 | 0.11 | as 1242:1248 in 1:2 mixture |
| | Bluegill (BG) | 30 | 0.26 | 0.35 | 12.1 | 21.6 | |
| | | 114 | 0.46 | 0.64 | 8.6 | 8.3 | |

* ppm wet weight
** not a live car in-situ study

bioconcentration factor and it may range from 30,000 to 100,000 depending on the PCB mixture and species (i.e., 1 ug/l PCB in water may cause PCB concentration in fish to be 30,000-100,000 ppb or 30-100 ppm). Veith proposed that PCB elimination is a first order process, and implicit in this is that it has a constant half-life in a particular fish. He also proposed that this half-life increases in increasingly large fish. Based on his depuration results and assuming a first-order process, it would take the contaminated yellow perch and bluegill 6 months and 4.5 months, respectively, in Lake Michigan (with a no PCB diet) to drop to levels of 5 ppm after the 30 day bioconcentration period.

In the 28 day bioconcentration study, PCB concentrations in the water column were monitored during the bioconcentration phase (Wk III 105). Over this period, PCB levels remained fairly constant, fluctuating between 2.7 and 5 ug/l, in the water column. PCB water column levels were not reported in the other studies.

Although not summarized in Table 4, laboratory studies (not in-situ) were also undertaken exposing adult fathead minnows and fathead minnow embryo-larvae to various concentrations of North Ditch water (Wk III 105). These studies showed that PCB levels in adult fathead minnows and embryo-larvae stages were greater in test chambers containing higher concentrations of North Ditch water. Lake Michigan water was used for control and dilution water. Concentrations in adult fathead minnows reached 419 ppm PCB after 28 days exposure to 100% North Ditch water containing 10 to 30 ug/l PCB. Control fish reached PCB levels of 1.82 ppm after 28 days exposure to water having less than 0.1 to 0.3 ug/l PCB. Survival of embryo-larvae forms appeared to be affected by exposure to increasing concentrations of North Ditch water. In two control chambers, 71% and 59% of the organisms survived, while in tanks containing 100% North Ditch water, the survival rate was about 45% in both test chambers. PCB water concentrations in control chambers were generally less than 0.1 ug/l and organisms in these chambers had PCB levels of 0.79 ppm in their flesh at the end of the 28 day study. In tanks containing 100% North Ditch water, PCB water levels ranged from 10 to 23 ug/l over the 28 days, and the PCB concentration in organisms on day 28 was about 183 ppm.

HydroQual evaluated the significance of bioconcentration and bioaccumulation for aquatic organisms (Wk IV 108). They assume that aquatic organisms bioconcentrate PCB at levels of $10^5$ times ambient water concentrations (Wk IV 108). They developed equations to relate water PCB levels and food bioaccumulation factors to determine organism PCB levels. As the food chain level gets higher, the bioaccumulation factor becomes greater. They observed water PCB concentrations in Waukegan Harbor to be

in the range of 0.01 to 0.3 ug/l (however, water concentrations up to 5 ug/l were measured in one bioconcentration study mentioned previously, Wk III 105). In order to decrease PCB levels in harbor organisms to 5 to 10 ppm, HydroQual estimated that water concentrations in Waukegan Harbor would have to be decreased to a range of 0.01 to 0.02 ug/l dissolved PCB (Wk IV 108).

Fishery Value

Waukegan Harbor is an important sport fishery area in Lake Michigan. A 1979 creel survey provides information on the extent and value of the Illinois sport fishery in Lake Michigan (Wk IV 112). Information for Waukegan Harbor can be extrapolated from this. General information is summarized in Table 5.

In terms of fishing pressure in angler hours, the Waukegan Harbor area was the most heavily used area for trolling of the 14 locations sampled. It was also the number one location for pier and breakwater fishing, although for shore fishing it ranked second lowest of 22 sites. Coho salmon was the most numerous species caught in the Waukegan area, followed by chinook and yellow perch. Major species taken from the shoreline are rainbow trout and chinook salmon. Total catches for all species in Waukegan Harbor and adjacent areas in the 1979 survey are provided in Table 6.

If 336,852 angler hours (expanded hours for total year) were spent in Waukegan Harbor area and an average fishing trip is 4.8 hours (average hours per trip as per Muench, Wk IV 112), then 70,178 trips were made around Waukegan. Thalhelm (Wk IV 112) estimates an average value of $25 per trip resulting in an annual value of $1,754,000 in purchases generated by the Waukegan sport fishery business. The shore fishery, however, accounts for only 0.6% of the angler hours spent in the Waukegan area.

The extent of the 1980 charter boat catch in Illinois has been summarized (Wk XI 101). Most of the charter boat fishing in the Illinois waters of Lake Michigan is done off of Chicago and Waukegan. Charter boat fishing in 1980 accounted for 68,550 man-hours in the Waukegan area, which includes the western 1/3 to 1/2 of Lake Michigan off of Waukegan, and 58,831 man-hours in the Chicago area. Waukegan area waters accounted for 72% of the total charter boat catch, which is predominately salmonids. Of the 24,227 salmonids taken off Waukegan in 1980, coho salmon comprised 74% of the catch in this area, chinook salmon 11%, lake trout 11%, rainbow trout 3%, and brown trout 1% of the catch. Coho salmon was the species caught in greatest numbers in both the Waukegan and Chicago areas. If the charter boat industry in Illinois accounts for approximately one million dollars annually (Wk IV 112) and Waukegan waters account for 54% of the man-hours spent then Waukegan area charter boat business probably adds another $540,000 annually to the sport fishery business for a total of $2,300,000 ($1,750,000 + $540,000).

Table 5

Results of 1979 Sport Fishing Creel Survey
Summary for Waukegan Harbor Area

| Type of Access | Angler Hours | % of Illinois Total Hours | Fish/Hour* | Total Fish | % of Illinois Total Catch | Major Species |
|---|---|---|---|---|---|---|
| Trolling | 184,554 | 31 | 0.119 (4) | 21,889 | 30 | Coho, Chinook, Yellow Perch |
| Pier/Breakwater | 45,974 | 20 | 0.121 (2) | 5,573 | 4 | Coho, Yellow Perch |
| Shore | 1,179 | 0.4 | 0.122 (3) | 144 | 0.08 | Rainbow Trout, Chinook |
| Creel Survey Total | 231,707 | 21 | | 27,606 | 7 | |
| Expanded Hours and Catch for Total Year | 336,852 | | | 60,195 | | |

* (4) 4th lowest rate out of 14 sites
(3) 3rd lowest rate out of 22 sites
(2) 2nd lowest rate out of 15 sites

Source: Wk IV 112 - Muench, Illinois Department of Conservation, 1979 Sport Fishing Creel Survey on the Illinois Portion of Lake Michigan.

Table 6

Results of 1979 Sport Fishing Creel Survey
Waukegan Harbor Area
Species Data

| Type of Access | Brown Trout | Rainbow Trout | Lake Trout | Coho Salmon | Chinook Salmon | Yellow Perch | Other | Angler Hours |
|---|---|---|---|---|---|---|---|---|
| Trolling | 99 | 1,676 | 986 | 13,705 | 3,155 | 2,169 | 99 | 249,147 |
| Pier/Breakwater | 43 | 578 | 14 | 3,018 | 217 | 1,689 | 14 | 85,512 |
| Shore | - | 48 | - | - | 48 | - | 48 | 2,193 |
| Creel Survey Total | 142 | 2,302 | 1,000 | 16,723 | 3,420 | 3,854 | 161 | - |

Source: Same as Table 5

A report on the 1980-1981 commercial catch in the Illinois waters of Lake Michigan indicates that there are only five licensed commercial fishermen using these waters (Wk XI 102). Bloater chubs and yellow perch account for 75% and 25% of the catch, respectively. Commercial gill nets used for harvesting both species are prohibited in waters less than 30 feet deep.

Bloaters are fished primarily in waters greater than 180 feet deep. The most heavily fished area, accounting for 40% of the catch, is 19 miles east of Lake Forest (and southeast of Waukegan). The area adjacent to Waukegan Harbor accounts for only 2% of the total catch.

Over half of the yellow perch are harvested in waters ranging from 42 to 60 feet deep. About 54% of the catch is taken from waters off of Evanston and Chicago. The area offshore of Waukegan accounts for about 10% of the yellow perch catch.

Bloater chub and yellow perch composite samples collected in Lake Michigan have been analyzed annually since 1975. The bloater samples were collected off of Waukegan. In all years except 1976, PCB values were less than 5 ppm. The composite sample analyzed in 1976 had a PCB concentration of 8.3 ppm. Yellow perch composites collected from the Lake (not specifically off of Waukegan) also had concentrations less than 5 ppm in all years except 1976, when several composites slightly exceeded 5 ppm.

The value of the commercial fishery in the Illinois waters of Lake Michigan in 1980-81 was estimated at $198,700. The immediate Waukegan Harbor area, however, does not appear to be within the prime commercial fishery area.

## References

### Fish PCB Levels

Wk IV 99 - USEPA, A Status Report on the Presence of PCB Compounds in the Fishes of Lake Michigan 1971 through 1979 with Special Reference to the Waukegan Harbor in Waukegan, Illinois.

Various other Waukegan and Lake Michigan fishery references.

### Bioconcentration/Depuration Studies

Wk IV 108 - HydroQual, 1981, Final Contribution to Waukegan EIS.
Wk III 115 - Veith, USEPA, 1980, Uptake and Elimination of PCBs in Fish Contaminated by the Waukegan Harbor.
Wk IV 114 - Great Lakes Fishery Lab, 1980, Memorandum to Region V USEPA on Preliminary Results of an Exposure Study with Waukegan Harbor Sediments.
Wk III 105 - USEPA, 1979, OMC Biological Studies Report.

### Fishery Value

Wk XI 101 - R. Hess, Illinois Department of Conservation, 1980 Charter Boat Catch in the Illinois Waters of Lake Michigan.
Wk IV 112 - B. Muench, Illinois Department of Conservation, 1979 Sport Creel Survey on the Illinois Portion of Lake Michigan.
Wk XI 102 - R. Hess, Illinois Department of Conservation, 1980-81 Commercial Catch from the Illinois Waters of Lake Michigan.

ATTACHMENT C

(074)

(078)

**U.S. Department of Justice**

*United States Attorney*
*Northern District of Illinois*

*United States Courthouse*
*Chicago, Illinois 60604*

HAND DELIVERY

August 9, 1982

Ms. Roseann Oliver, Esquire
PHELAN, POPE & JOHN, LTD.
180 North Wacker Drive
Chicago, Illinois 60606

Re: United States of America v. Outboard
Marine Corporation, et al,
78 C 1004 - USDC ND Ill. ED

Dear Roseann:

Attached is a copy of cost estimates which Mr. Brownell furnished to the undersigned today. While these are work product documents, we are providing them to you since Mr. Brownell may refer to them in his deposition.

See you at 10:00 a.m., in my office.

Very truly yours,

DAN K. WEBB
United States Attorney

BY: JAMES T. HYNES
Deputy Chief, Civil Division

cc: James Schink, Esquire
KIRKLAND & ELLIS
200 East Randolph Drive
Chicago, Illinois 60601

John Van Vranken, Esquire
Assistant Attorney General
ENVIRONMENTAL CONTROL DIVISION
188 West Randolph, Suite 2315
Chicago, Illinois 60601

ALTERNATIVE B-6

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilize | 15 | 21 |
| 2. | Construct containment site and water treatment plant on OMC's vacant lot | 125 | 175 |
| 3. | Close harbor and reinforce existing sheet pile wall in slip 1 | 20 | 28 |
| 4. | Dredge slip 3 and harbor | 12 | 16 |
| 5. | Open harbor | 3) | |
| 5a. | Dewater containment site and dismantle WTP | 30) | 45 |
| 6. | Cover containment site | 20 | 28 |
| 7. | Clean-up and Demobilize | 5 | 7 |
| | TOTAL | | 323 |

MALCOLM PIRNIE

# INTER-OFFICE CORRESPONDENCE

Date: 7/7/82

To: JOHN C. HENNINGSON

From: JUDITH A. BEDARD

Subject: ADDITIONAL SUPPORT INFORMATION, WAUKEGAN HARBOR LITIGATION

This memorandum, in response to your request of 7/2/82, presents a brief history of the Upper Hudson River PCB problem and project descriptions, key design criteria and cost/benefit analysis for the following PCB-related projects:

- The Fort Edward Terminal Channel Excavation and Remnant Pool Deposit Mitigation completed by the NYSDEC in 1978.
- The Hudson River PCB Reclamation Project

In addition, dredging production rates are presented for the alternative dredging schemes developed as part of the Hudson River PCB Reclamation Project.

## I. HISTORY OF THE PROBLEM[25]

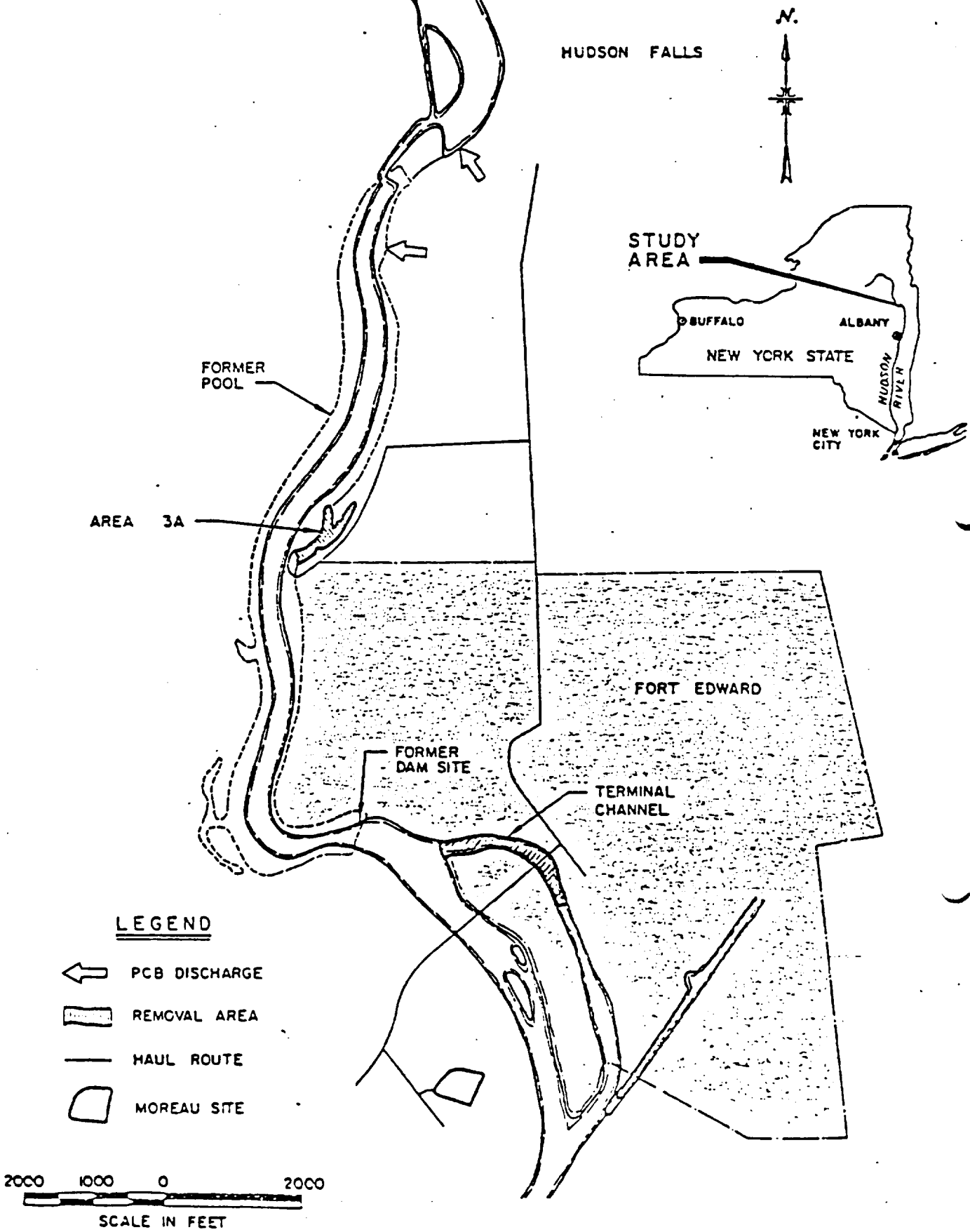
The Village of Fort Edward is located in Washington County, New York, approximately 45 miles north of Albany (Figure 1). Recent activities in the upper Hudson River at this point began in the spring of 1974 after the removal of a 20-ft high timer crib dam, which was in poor structural condition and presented a hazard to the population living downstream.

After the dam was removed, some 850,000 cu yd of debris and sediment which had accumulated behind the dam for over 100 years was scoured from the deposits above the dam and deposited in the river channel within a distance of about one mile downstream. Various remedial measures, including removal of debris, were undertaken during 1974-75 by the State of New York. All these efforts, however, were carried out with no knowledge of PCB contamination.

In late 1975-76, field investigations were undertaken to determine the extent of PCB contamination in the river system. The presence of this substance had resulted from discharge of PCB-contaminated wastes over many years at two locations in the former pool of Fort Edward dam. Sampling indicated that remnant deposits on the western bank of the river had PCB levels of approximately 10 ug/g, whereas those on the eastern side (where the PCB outfall points were located) has PCB levels on the order of 100 to 5,600 ug/g. High levels of Cd and Pb were also present.

In April 1976 a flood with an approximate recurrence of 100 years occurred. This event caused the scour of an additional 250,000 cu yd from unprotected areas of the former pool. Deposits in the Fort Edward Terminal Channel as a result of the April 1976 flood averaged 20 ug/g PCB, a relatively low level because the material has been scoured primarily from the less contaminated western bank.

FIGURE 1




MOREAU
DREDGING AND DISPOSAL AREAS

The need to remove this new material blocking the navigation channel presented an opportunity to demonstrate certain aspects of removal and containment of river debris which, although not classified as hazardous, could be disposed of in a site which essentially met chemical landfill requirements.

The project generated valuable information on several important aspects of contaminated material handling and disposal. These findings are being used in preparing final design and dredging administration procedures for the proposed Hudson River PCB Reclamation Project in the 40-mile river reach between Fort Edward and Albany, where bed and bank sediments are contaminated by some 400,000 lb of PCB. In addition, approximately 700,000 lb of PCB is located in or adjacent to the study area in numerous landfills, dumps, and dredge spoil areas.

## II. THE FORT EDWARD TERMINAL CHANNEL EXCAVATION AND REMNANT DEPOSIT MITIGATION (1978) PROJECT DESCRIPTION

### Moreau PCB Encapsulation Site

The disposal area occupies some ten acres in the Town of Moreau, Saratoga County, New York. The site was owned by the State and was originally an unused hydraulic dredge spoil site.

The western one-third of the site is underlain by ten to 40 ft of glacial lake clays, and the remainder by brown silty fine sand. Hydraulic conductivities of the underlying materials are on the order of $10^{-3}$ to $10^{-7}$ cm/sec.

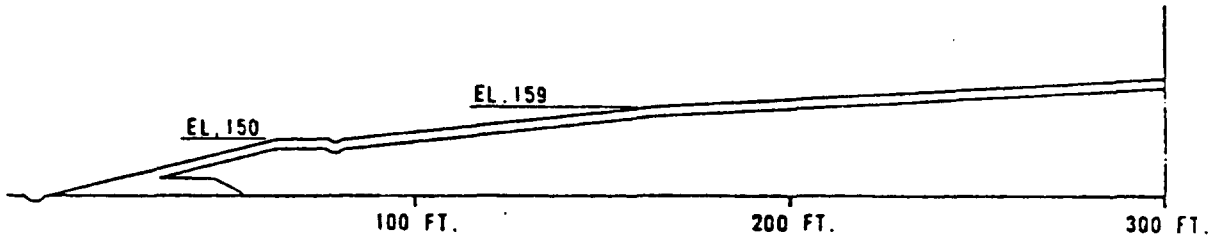
Because of the variety of subsurface deposits, it was determined to cover the entire bottom with an 18-inch thick layer of compacted clay, which has a hydraulic conductivity (k) on the order to $1 \times 10^{-7}$ cm/sec. Before the liner was placed, the site surface was drained of perched water areas, organic material was removed, and a four-ft high interior clay dike was constructed along the southerly and easterly perimeters. The northerly and westerly perimeters of the site were established on existing debris from previous channel dredging programs.

The clay liner was extended up the existing slope to provide a barrier to migration from the existing deposits, an exterior trench drain of crushed stone and perforated pi wrapped in filter cloth was installed to intercept groundwa flow. The side slopes of the disposal site had a maximum horizontal:vertical slope of 4:1 (Figure 2). A system of p surface drains was provided to intercept surface runoff and 18-inch thick clay cover was placed over the deposited debr The final slope dressing consisted of 12 inches of material suitable for turf establishment (silty sand), followed by seeding and mulching. The permeability of the compacted clay liner was determined by infiltrometer.

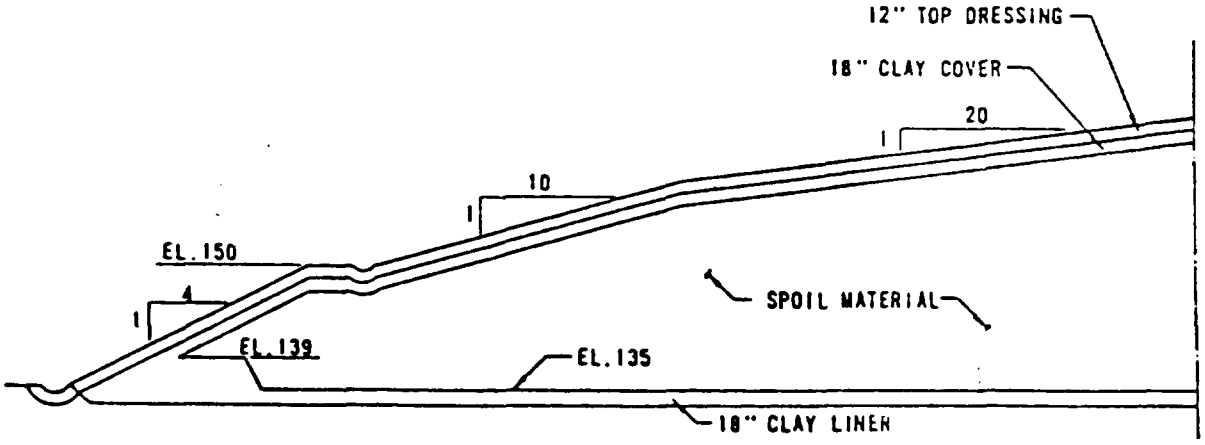
The native clays utilized for the liner and cover were excavated from a borrow pit a few hundred yards from the site.

Figure 3 presents two photographs of the complete Moreau site.

Hudson River, Encapsulation Sites



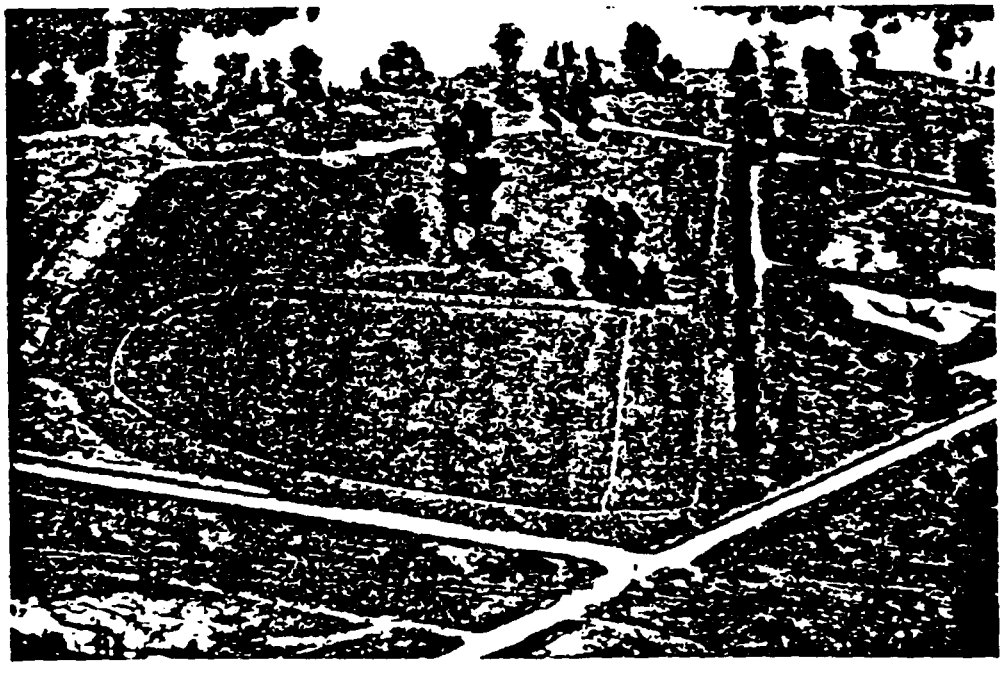

NATURAL SCALE




VERT. SCALE 2 x HORIZ. SCALE

SITE CROSS SECTIONS

PCB encapsulation site, Town of Moreau, New York, July 1979. View looking eastward at completed site eight months after final seeding with mixed grasses and clover. Side slopes of fill are one vertical on four horizontal. Paved drains for surface run off and groundwater are visible (right and foreground). Site is a joint project of DOT and DEC.



PCB encapsulation site, Town of Moreau, New York, June 1980. View looking eastward with completed site in lower half of photograph, Hudson River at top. Paved drains are visible around the perimeter of the site. DOT Moreau spoil site is at left of photograph, previously used borrow area at right. River Road crosses lower right hand corner of photograph.

## Dredging Operations

Approximately 180,000 cu yds of debris and sediment containing 6,400 pounds of PCB were removed from the Fort Edward Terminal Channel during two periods: September-December 1977 and April-June 1978. During October 1978, an additional 14,000 cu yds of material containing approximately 25,000 pounds of PCB were removed from Remnant Deposit Area 3A.

The terminal channel deposits averaged 20 ug/g PCB, whereas deposits from Area 3A had an average PCB concentration of 1,000 ug/g, and thus required a more careful handling operation. The general excavation procedure consisted of removal of material by dragline from the terminal channel and deposit in a windrow to allow for drainage and storage of materials. After a few hours the material became well drained and was easily handled.

During removal of the Fort Edward Terminal Channel material, the agitation of the bed deposits by the dragline excavation generated an oily floating scum which drifted away from the area being excavated. To resolve this problem a conventional oil boom was deployed, trapping the scum, which was removed manually, along with wood debris. PCB levels in the floating scum reached as high as 4,000 ug/g dry weight, which necessitated some care in handling.

The Area 3A deposits, located above normal water level, were removed with conventional power shovels and generally loaded directly into trucks, although some stockpiling was done. Special care was taken to clean loose material from trucks, and loads were covered to prevent contaminated material from being tracked onto highways. At the Moreau site, the dredged material was placed on lifts on the order of one to three ft to a total depth of approximately 15 ft.

## Site Problems

Because of heavy fall rains and the onslaught of an early winter, the site was not covered with clay within the time

frame originally intended. As originally designed, dredging and covering operations were to be completed by December 1977. The material from Area 3A were added to the project because the site was still open thru the summer of 1978.

During the period when the site was exposed (August 1977-November 1978) precipitation in the vicinity was measured at 66.5 inches. This value is about 30 percent greater than average for the same period. Measurements made through the installation of temporary observation wells, as well as several backhoe test pits indicated that some 12 feet of saturated material existed at the site prior to start-up of the dewatering operations.

In May of 1978, wet spots were noticed in two areas of the newly clay covered south and east slopes. A few weeks after the covering of the clay surface with 12 inches of turf establishment material the areas in which the wet spots were noticed experienced tension cracks followed by surface slumping. Slumping along the south slope occurred over an area of about 50 feet, and slumps over an area of about 100 feet long occurred on the east slope.

## Dewatering the Site

The site was originally designed under the assumption that material would be spoiled and covered during the same season. An internal clay perimeter dike was constructed three to four feet above the bottom of the liner. In addition, one permanent four-inch monitoring well/drain (DOT) was installed in a low part of the disposal site. It was anticipated that six to seven inches of precipitation might percolate through the clay cover per year. This would have resulted in an accumulation of about $1.9 \times 10^6$ gallons per year, exclusive of leakage through the bottom and drainage out the four-inch monitoring well and drain. The drain was designed to accept a flow of three to five gpm (15 in. of 30 slot screen), or $1.6 \times 10^6$ to $2.6 \times 10^6$

gallons per year. At this rate (and with some bottom leakage) it was expected that water accumulation would be minimal, and that the interior dike would provide storage capacity for at least a few years accumulation. The in-situ hydraulic conductivity of the material was much less than anticipated, with the drain yielding only about 0.5 to 1 gpm.

In July of 1978, various alternatives for dewatering of the site were evaluated for cost and time requirements.

It was determined that a wellpoint dewatering system running parallel to the east and south slopes would be the only timely means of dewatering for slope repairs. It was also decided to install a permanent trench drain system in the vicinity of the two slope slippages. The length of the trench drain would be determined by the ease of installation encountered in the field.

Wellpoint Installation

Nine hundred feet of header and 82 points were installed, during the period September 25-29, 1978.

The operation of the wellpoint system allowed for an almost immediate repair of the failed slope areas, although pumping rates were much less than expected. The repairs consisted of removing the 12 inches of turf establishment material and the 18 inches of clay about and adjacent to the failed areas. All slumping occurred at the clay-dredge spoil interface. Approximately 1,800 square yards of slope were removed and repaired during October of 1978. In addition an interior trench drain 400 ft long by 4.5 wide was installed adjacent to and between the two failure areas.

Analysis of Dewatering Operations

Through December 1978 it is estimated that approximately 1 x $10^6$ gallons were removed from the Moreau site through

wellpoint pumping, siphon operation and gravity drainage (DOT well).

Siphon operations have continued sporatically (no winter operations) to the present time. From December 1978 to March 1980, it is estimated that an additonal 820,000 gallons have been removed. This number is based on a siphon operation for 130 days at 3.5 gpm (655,000 gal) and a gravity drainage of about 0.25 gpm continuous since December 1978 (165,000 gal). The PCB concentration of this water is monitored periodically since it is discharged back into the Hudson River. As of March, 1980 site water levels were on the order of 141.50 ft a drop of 2.7 ft since December 1978. Based on the theoretical porosity area drawdown relationship 785,000 gallons (2.7 x 290,000) would have been removed. This number correlates nicely with the estimated actual withdrawal.

## III. HUDSON RIVER PCB RECLAMATION PROJECT DESCRIPTION

### A. Project Description

The Hudson River PCB Reclamation Project as presented in the Scoping Report (March 1981) includes four components directed toward reducing the impact of PCB on the Hudson River, its biota, and the surrounding Hudson River Valley. These components are:

- o Dredging of approximately 27 hot spot[1] areas in the river bed with containment in a secure upland site.
- o Design and construction of a secure upland containment site capable of long-term isolation of contaminated material.
- o The dressing and fencing of remnant deposit areas 3 and 5, located above the former Fort Edward Dam site.
- o Destruction of the recovered PCB at such time as a technically and economically feasible procedure becomes available.

### B. Containment Site

The containment site, referred to as Site 10 in earlier reports, is situated on a 250 acre parcel of land located approximately 2.5 miles south of the Village of Fort Edward, in the Town of Fort Edward, in Washington County, New York. (See Figure 4).

The site's major components include:

- o Containment Area
- o Roughing and Storage Pond
- o Surge Pond
- o Water Treatment Plant
- o Leachate Collection System
- o Storm Water Drainage System
- o Chemical Feed System

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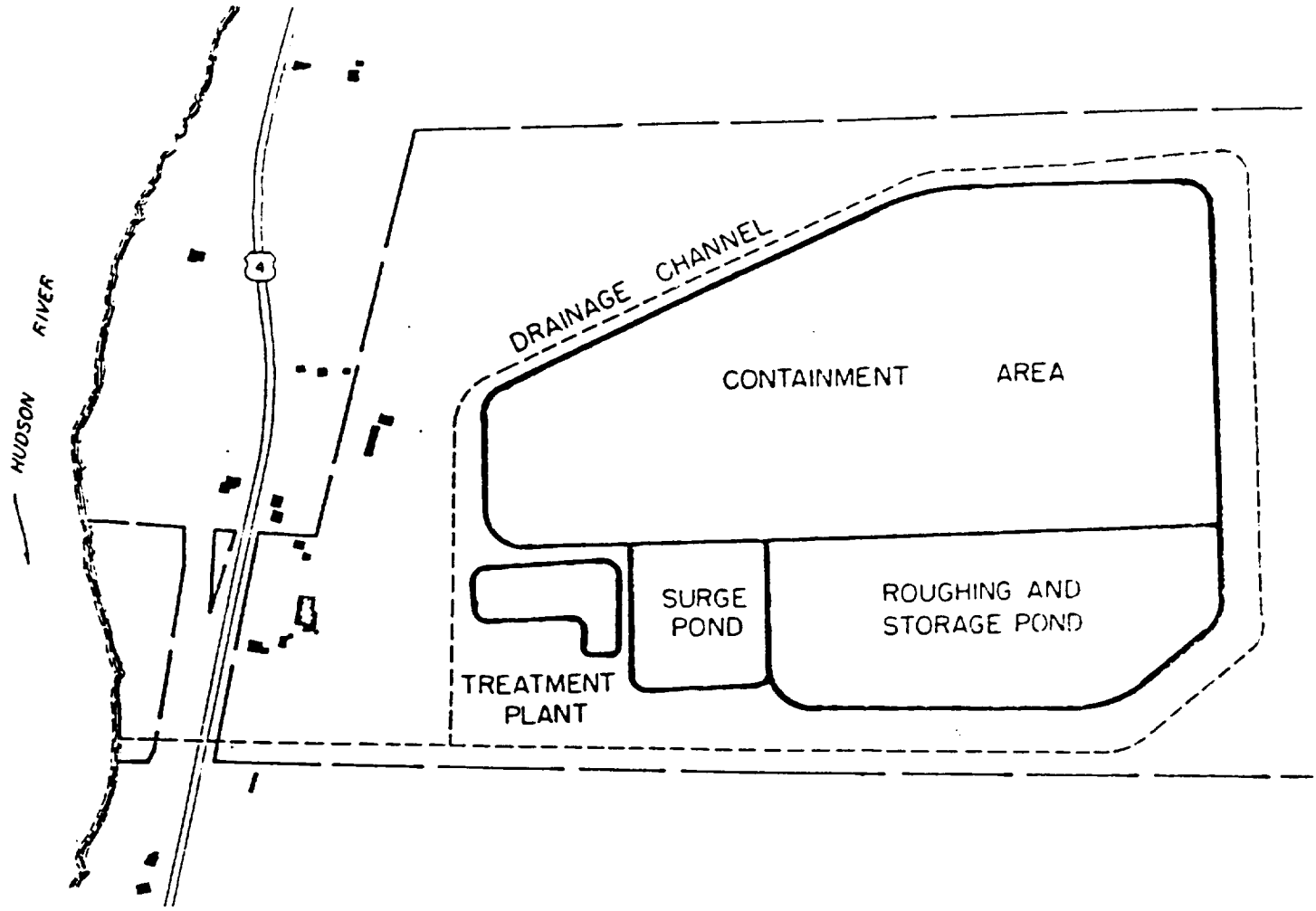
[1] Hot spots have been defined as areas of PCB contamination equal to or greater than 50 μg per g.




RESCOPED C

MALCOLM PIRNIE INC.

FIGURE 4

AINMENT SITE

Containment Area - The containment area is an earthen basin bisected by a cross dike. It occupies approximately 40 acres at its maximum water surface and its total containment volume of approximately 1,100,000 cu yds. This volume is sufficient to hold all of the 27 hot spots.

The containment area is designed for long term encapsulation of PCB-contaminated materials.

Roughing and Storage Pond - The roughing and storage pond (R&SP) is an earthen basin with a maximum water surface area of approximately 12 acres.

After the slurried dredge material is pumped into the containment area, weir overflow is transported via pipeline to the R&SP. The primary purpose of this basin is to ensure efficient sedimentation near the end of each dredging season as the effective overflow rate in the containment area decreases. The R&SP also provides protection for the subsequent treatment units from any upsets in the containment area which might lead to transient escape of dredged material.

A small portable dredge will be operated to recycle settled dredged material back into the containment area.

The R&SP is not a permanent containment unit. At the end of the dredging program, all of the contaminated material in the R&SP will be relocated to the containment area and the pond will be filled in and regraded.

Surge Pond - The surge pond is an earthen basin with a maximum water surface area of 2.4 acres. This pond receives weir overflow from the R&SP. Its purpose is to buffer the treatment plant units from surges in the dredging process and to provide a convenient, sediment-free point for treatment feed and recycle supply pump suctions if a recycle dredging procedure is implemented. A detailed discussion of dredging options is presented in the Containment Site Design Report.

Water Treatment Plant - The water treatment plant consists of two earthen basins, the flocculation basin and the settling basin, with maximum water surface areas of 0.1 and 1.0 acres, respectively. The plant has a capacity of 13 million gallons per day (mgd) and consists of coagulation, flocculation and sedimentation units. The purpose of the water treatment plant is to reduce PCB concentration in the dredge return flow before discharge to the river.

The water treatment plant is expected to achieve effluent suspended solids less than 4 milligrams per liter and turbidity less than 10 NTU with proper chemical doses. The average PCB concentration in the discharge is expected to be in the 10-20 microgram per liter range.

Leachate Collection System - The leachate collection system is a network of perforated drainage piping laid in gravel-filled, filter-cloth-lined collection trenches at the base of the containment area. The bottom of the containment area is sloped to transmit flow towards the trenches.

The leachate collection system will be utilized in two phases: short-term dewatering and long-term percolation.

A piping system connects the drainage system to a leachate storage tank and subsequently to a discharge point at the Hudson River.

In addition valves, collection and sampling wells, and a flow metering and monitoring manhole are provided to determine the quantity and concentration of PCB in the leachate. Discharge to the Hudson River will only be permitted if the observed leachate quantities and concentrations will have no adverse impact on the River. If river discharge proves unacceptable, the leachate will be stored in-place and periodically collected and treated from the leachate storage tank.

Stormwater Drainage System - The stormwater drainage system will intercept and convey stormwater runoff that would have directly affected the containment site. Precipitation

falling on the containment site, and on the watershed north of the containment site, will be transported by the drainage system to the Hudson River.

The components of the drainage system include a combination of swales, open channels, and closed conduits.

Chemical Feed System - Pumps, piping, tanks and dilution water will be provided for two optional treatment processes - polymer only and a alum, caustic and polymer combination. The required equipment will be housed in a chemical feed building.

Other Site Components - Other site components include pump station, access road, electrical services, fencing, seeding, clearing and grubbing and monitoring wells.

C. Hot Spot Dredging

Thompson Island Pool - The Thompson Island Pool is located between the Thompson Island Dam and Rogers Island. The areas to be dredged are the 20 identified hot spots (including four above Lock 7) with a volume of approximately 645,500 cu yds and 105,800 lbs of PCB (see Table 1).

Lower Pools - Based on a range of costs per cubic yard for dredging, transport and treatment, between 160,000 and 265,000 cu yds of material could be dredged in the lower pools within the budget constraints of the rescoped project.

Using the MPI estimates of contaminated volumes and PCB masses listed in Table 1, and applying the criteria described previously in the Rescoping Report, to each of the lower pools, resulted in the following dredging program for the lower pools. Using the lower range value of 160,000 cu yds (high estimate of unit cost), only lower pool hot spots 29-34 in the Lock 5 Pool will be dredged. Using the higher range value of 265,000 cu yds (low estimate of unit cost), both lower pool hot spots 29-34 in the Lock 5 Pool and approximately 80 percent of hot spot 37 in the Lock 3 Pool will be dredged. Table 2 details the hot spots to be dredged under the rescoped program.

Table 1

Hudson River PCB Reclamation Project Areas to be Dredged

Contaminated and Removal Volumes and PCB Quantities[7]

| Hot Spot[1] Area No. | Area (sq ft) | Contaminated[2] Volume (cu yd) | Mean[2,3] PCB Conc. (μg/g) | PCB[2,3,4] Quantity (lbs) | Removal[5] Volume (cu yd) |
|---|---|---|---|---|---|
| 1 | 66,600 | 3,100 | 63 | 340 | 7,400 |
| 2 | 21,200 | 1,000 | 81 | 140 | 2,350 |
| 3 | 38,300 | 1,750 | 46 | 140 | 4,250 |
| 4 | 78,800 | 3,650 | 50[6] | 320 | 8,750 |
| Subtotal | 204,900 | 9,500 | 57 | 900 | 22,750 |
| 5 | 460,400 | 34,100 | 62 | 3,710 | 51,150 |
| 6 | 1,033,700 | 76,550 | 69 | 9,270 | 114,850 |
| 7 | 110,600 | 8,200 | 39 | 560 | 12,300 |
| 8 | 1,462,700 | 108,350 | 99 | 18,830 | 162,500 |
| 9 | 118,500 | 8,800 | 38 | 590 | 13,150 |
| 10 | 191,200 | 14,150 | 78 | 1,940 | 21,250 |
| 11 | 57,100 | 4,250 | 39 | 290 | 6,350 |
| 12 | 45,700 | 3,400 | 71 | 420 | 5,100 |
| 13 | 28,000 | 2,050 | 89 | 320 | 3,100 |
| 14 | 974,200 | 72,150 | 279 | 35,330 | 108,250 |
| 15 | 286,600 | 21,250 | 103 | 3,840 | 31,850 |
| 16 | 446,500 | 33,050 | 380 | 22,060 | 49,600 |
| 17 | 83,200 | 6,150 | 256 | 2,770 | 9,250 |
| 18 | 201,700 | 14,950 | 94 | 2,460 | 22,400 |
| 19 | 42,000 | 3,100 | 83 | 450 | 4,650 |
| 20 | 62,700 | 4,650 | 249 | 2,030 | 6,950 |
| Subtotal | 5,604,800 | 415,150 | 144 | 104,900 | 622,700 |
| 29 | 32,700 | 1,500 | 81 | 220 | 3,650 |
| 30 | 54,400 | 2,500 | 155 | 690 | 6,050 |
| 31 | 194,300 | 9,000 | 516 | 8,150 | 21,600 |
| 32 | 41,200 | 1,900 | 51 | 170 | 4,600 |
| 33 | 119,400 | 5,550 | 98 | 950 | 13,250 |
| 34 | 955,800 | 44,250 | 159 | 12,350 | 106,200 |
| Subtotal | 1,397,800 | 62,700 | 205 | 22,500 | 155,350 |
| Total Using High Estimate of Unit Cost[8] | 7,207,500 | 487,400 | 150 | 128,300 | 800,800 |

Table 1
(continued)

Hudson River PCB Reclamation Project Areas to be Dredged

Contaminated and Removal Volumes and PCB Quantities[7]

| Hot Spot[1] Area No. | Area (sq ft) | Contaminated[2] Volume (cu yd) | Mean[2,3] PCB Conc. (μg/g) | PCB[2,3,4] Quantity (lbs) | Removal[5] Volume (cu yd) |
|---|---|---|---|---|---|
| 37 Partial | 986,800 | 45,690 | 116 | 9,300 | 109,650 |
| Subtotal of Additional Dredging Volumes Possible Because of Low Unit Cost in the Lower Pools | 986,800 | 45,690 | 116 | 9,300 | 109,650 |
| Total Using Low Estimate of Unit Cost | 8,194,300 | 533,100 | 127 | 137,600 | 910,500 |

[1]Hot Spot Area No. 1-4 Above Lock 7
5-20 Thompson Island Pool
29-34 Lock 5 Pool
37 Lock 3 Pool

[2]Contaminated Volumes based on a contaminated depth of:
15 in. - Above Lock 7
24 in. - Thompson Island Pool
15 in. - Lock 5 Pool
15 in. - Lock 3 Pool

[3]Mean PCB concentration based on average concentration of all surface samples and weighted average concentration of core samples within the hot spot area.

[4]PCB quantity based on a bed material density of 65 lb/cu ft.

[5]Removal volume based on a 36 in. removal depth.

[6]No samples in these areas at this time - mean PCB conc. is assumed to be 50 μg/g.

[7]DEC estimates for these areas varies from quantities shown.

[8]Two estimates were made of the yardage of material that could be dredged the lower pools within budget constraints. The first estimate based on a high unit cost allowed for the removal of 160,000 cu yds (hot spots 29-34). The second estimate based on a low unit cost allowed for 265,000 cu yds to be removed (hots spots 29-34 and partial hot spot 37).

Table 2

Rescoped Program

Hot Spot Dredging
High Estimate of Unit Cost

| Pool | Hot Spots | Contaminated Material | |
|---|---|---|---|
| | | vol, cu yd | PCB Mass, lb |
| Thompson Island | 1 thru 20 | 645,500 | 105,800 |
| Lock 5 | 29 thru 34 | 155,350 | 22,530 |
| | | 800,850 | 128,330 |

Hot Spot Dredging
Low Estimate of Unit Cost

| Pool | Hot Spots | Contaminated Material | |
|---|---|---|---|
| | | vol, cu yd | PCB Mass, lb |
| Thompson Island | 1 thru 20 | 645,500 | 105,800 |
| Lock 5 | 29 thru 34 | 155,350 | 22,530 |
| Lock 3(1) | 37 partial | 109,650 | 9,310 |
| | | 910,500 | 137,640 |

(1) Partial removal will recover approximately 80 percent of in-place PCB in Hot Spot 37.

Note: All values based upon MPI estimates as presented in Draft EIS, N.Y. State Environmental Quality Review, September 1980.

Under the rescoped dredging program between 37 and 40 percent of the 347,200 pounds of PCB in the hot and cold spots in the Upper Hudson river bed will be dredged. The PCB masses used in calculating these percentages are the total masses of PCB associated with the volumes of material expected to be dredged. These percentages therefore do not reflect quantities of PCB missed in the dredging process, lost to the water column or returned to the river in treatment plant effluent. Earlier studies have shown that the losses in these three areas total in the range of 6 to 9 percent.

C. Other Program Elements

Remnant Deposits - The remnant deposits are PCB-contaminated areas adjacent to the Hudson River upstream of the former Fort Edward Dam. These areas are the remains of 150 years of deposition behind the dam, exposed as dry land following dam removal in 1973. Much of the deposited material has washed downstream; those areas which remain have been designated remnant deposits.

Under the rescoped project remnant deposit areas 3 and 5 will be top dressed and perimeter fencing will be installed as required.

Monitoring Program - A brief description of the proposed program for monitoring the effectiveness of the dredging program follows. The program will include two overlapping categories of monitoring, environmental and operations.

Environmental monitoring will involve atmospheric, aquatic and terrestrial sampling before, during and after the completion of dredging activities. Samples will be taken at least daily during dredging and more intensively during early phases of the project to provide supplemental operations control data. Dredged material will be regularly sampled to assure that the dredging operation is recovering contaminated material.

Environmental monitoring after the completion of dredging will record the more immediate effects of the PCB dredging program on PCB levels in the air and water; and, later, any residues on land, foliage and in animal tissues.

The following studies will be included under the environmental monitoring program:

- Sediment Transport Monitoring
- Hudson River Fish Flesh PCB Analysis
- Sediment PCB Desorption Study
- Biological (Macroinvertebrate) PCB Uptake Study
- Foliar Contamination by PCB in Washington County Forage Crops
- Air-Plant PCB Relationships
- Agricultural Inplace Studies.
- Site 10, ground water monitoring.

Operations control includes both monitoring and dredge control. The dredge phase losses, bucket losses, losses to the water column and air, and the loss of PCB in the treatment plant effluent will all be monitored. The purpose of the monitoring is not simply to record the effectiveness of the related processes, but to provide "real time" data that can increase and maintain the best attainable dredging efficiency.

## IV. SUMMARY OF PCB ENCAPSULATION SITE DESIGN CRITERIA

A summary of the design criteria for the Moreau PCB Encapsulation Site and the proposed Site 10 Containment Site is presented in the following Table.

Table 3

Key Design Criteria

| | Moreau Site | Proposed Site 10 |
|---|---|---|
| Capacity (volume) cu yds | 194,000 cu yds<br>180,000 cu yds @ avg. PCB conc. of 20 ppm<br>14,000 cu yds @ avg. PCB conc. of 1000 ppm | 1,100,000 cu yds |
| Fluff Factor | None | 1.1 (Thompson Island Pool and above Lock 7)<br>1.3 (Lower Pools) |
| Liner | 18" of imported clay<br>$k = 1 \times 10^{-6}$ (specified)<br>$k = 1 \times 10^{-7}$ (measured) | in situ clays, depth of 10 feet+<br>$k = 2.6 \times 10^{-7}$ (mean value) |
| Cap | 12" top dressing<br>18" clay cover | 10" top dressing<br>8" gravel<br>18" clay cover |
| Leachate | Wellpoint system and trench drain running parallel to the interior east and south slopes of the containment site. Discharge piping is connected to perimeter asphalt drainage channel. | o Sloped bottom of containment areas.<br>o Network of gravel filled collection trenches wrapped with filter fabric<br>o Perforated drainage piping in collection trench (8" P.E. pipe)<br>o Collection and sampling wells on containment area perimeter, connected to drainage piping.<br>o Piping system connecting drainage system to leachate storage tank<br>o Valved piping system connecting leachate storage tank to discharge point at Hudson River.<br>o Flow metering and monitoring system. |

Table 3
(continued)

Key Design Criteria

| | Moreau Site | Proposed Site 10 |
|---|---|---|
| Leachate Treatment | No leachate treatment required. | If required, leachate will be pumped out of leachate storage tank and treated either off-site, or at a treatment facility on-site. |
| Dredged Slurry Treatment | No slurry, PCB contaminated material trucked to site. | System set up for either polymer or alum, polymer caustic combination. |
| Water Treatment Plant Effluent Discharge Quantities | Not applicable. | Average PCB concentration 10 to 20 µg/l.<br>Maximum PCB concentration 100 µg/l<br>Minimum PCB concentration 4 µg/l<br>Suspended Solids $\leq$4 mg/l<br>Turbidity $\leq$10 NTU |

## V. COST/BENEFIT ANALYSIS

Cost/benefit analyses are presented with respect to two criteria. First the cost per pound of PCB removed was determined, and secondly, the cost per pound of reducing the PCB load over the Federal Dam at Troy and into the Hudson River Estuary was estimated.

### A. Cost Per Pound of PCB Removed

The cost per pound of PCB removal for the Moreau Project was determined by using actual costs, actual yardages removed and measured pounds of PCB contained in the site. These costs are presented as actual costs at the time of performance and again as estimated 1982 costs. The 1982 costs were estimated by using an average annual inflation rate of 8.3 percent over the period 1977 to 1982. This inflation rate was developed from increases in the ENR Indexes for construction costs and material costs over the period.

The cost per pound of PCB removal for the proposed Site 10 project was determined based upon cost estimates presented in the Scoping Report of March 1981. In accordance with the figures developed in this report, a ten percent inflation rate was assumed to adjust 1981 costs up to the 1982 base and 1983 cost down to the 1982 base.

Table 4 presents the results of the cost/benefit analysis based upon cost per pound of PCB removed. Costs have been estimated in three categories - removal and treatment; containment, site work and material handling; and treatment (chemical costs only).

The cost per pound of PCB removed in the Moreau project is $82 per pound. The cost per pound of PCB removed in the Site 10, Hudson River PCB Reclamation Project is $192-206 per pound.

Table 4

Cost/Benefit Analysis
Cost Per Pound of PCB Removed

| | Moreau Site | | | | Proposed Site 10 |
|---|---|---|---|---|---|
| Yardage Removed (cu yds) | Fort Edward Terminal Channel | | 180,000 | | Estimated Range: 800,850 to 910,500 |
| | Remnant Deposit Area 3A | | 14,000 | | |
| | | | 194,000 cu yds | | |
| PCB Removed | Fort Edward Terminal Channel | | 6,400 lbs (measured) | | Estimated Range: 128,300 lbs to 137,640 lbs |
| | Approximately | | 25,000 lbs (estimated) | | |
| | | | 32,000 lbs (estimated) | | |
| Cost of PCB | Fort Edward Terminal Channel | | Remnant Deposit Area 3A | | Estimated 1982 Dollars (6) |
| | (1977 $) | (Est. 1982 $) | (1978 $) | (Est. 1982 $) | |
| Removal and Transport | 605,000 (1) | 901,000 (2) | 403,050 (5) | (2) | 11,150,000 |
| Containment, Site Work, Material Rehandling | 258,000 (1) | 384,000 (2) | 85,400 (5) | (2) | 7,310,000 |
| Treatment (Chemical Costs Only) | - | - | - | - | 740,000 |
| Dewatering Costs (Estimated) | 105,000 (3) | 144,000 (2) | - | - | (monitoring) 1,420,000 |
| Hudson River Probing and Sampling | - | - | - | - | 650,000 |
| Subtotal | 968,000 | 1,429,000 (2) | 488,450 (4) | 672,000 (2) | 21,270,000 |
| Engineering Design, Field Engineering, Construction Administration, and Legal and Administrative Costs | 242,200 (6) | 358,000 | 122,000 (6) | 168,000 | 5,218,000 |
| Total | 1,210,000 | 1,787,000 | 489,000 | 840,000 | 26,488,000 |
| Cost per pound of PCB Removed (1982 Dollars) | Fort Edward Terminal Channel | | $279/lb | | $192-206/lb |
| | Combined Terminal Channel & Site 3A | | $ 82/lb | | |

Table 4
(continued)

**Cost/Benefit Analysis**
Cost Per Pound of PCB Removed

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(1) Costs from D.A. Collins Construction Co. Inc. Bid Letting, July 14, 1977

(2) Cost escalated at an annual inflation rate of 8.3%.

(3) Costs from August 29, 1978 letter of cost of work to Mr. V. Griffin of NYSDOT from Harold V. Clark of James H. Maloy, Inc.

(4) Cost taken from R.F. Thomas memo to File 266-14-2 dated 7/14/78.

(5) Breakdown of costs was estimated using a ratio of removal and transport cost to total cost as developed in the Engineer's Estimate included in "Removal and Stabilization of Remnant Deposits Fort Edward Flood Control Project Report on Design and Estimate", Malcolm Pirnie, Inc., May 1978.

(6) Cost estimated as 25% of cost for removal, transport, containment, site work, material rehandling, treatment chemical costs and dewatering.

B. Cost per Pound of PCB Reduction Over the Federal Dam at Troy

The transport of PCB in the Upper Hudson has been modeled by Lawler, Matusky & Skelly Engineers (1978, 1979). Their model is based on a historical flow cycle of the Hudson River of 20 years (1958-1977). The 20 year cycle was selected as a result of a multiple periodic regression analysis of 47 years of flow records at Spier Falls.

The study makes use of the sediment transport model (HEC-6), developed at the Hydrologic Engineering Center of the U.S. Corps of Engineers. Using mean daily flow records, cross sectional geometry, downstream rating curves and grain size distribution of the river bed material, the program computes flow depth, velocity, physical capacity of the river to transport sediments, and the scour or deposition rates of sediments in the river.

A PCB Inventory Model developed by LMS compliments the HEC-6 by accounting for the incoming and outgoing PCB for each reach, and for the PCB exchange between the water column and the river bed based on the computed scour and deposition. The output from this model is a relationship of PCB concentration versus flow for the downstream boundary condition of each modeling reach. The integration of the PCB concentration to flow relationship with the 20 year flow data provides the cumulative mass of PCB transported in each reach over the projected period. The model projections consider the incoming concentrations at Rogers Island as the upstream boundary condition and simulate the movement of PCB to the Federal Dam at Troy in 20 year cycles.

The PCB concentrations monitored at Rogers Island deserve particular attention, for while the PCB transport from Rogers Island to the Troy Dam was simulated, the input load of PCB at Rogers Island is the measured upstream boundary condition of the model. Two conditions are identified and tested by LMS in their model: an upper limit identified as present conditions

(post-1978) which gives an average loading of 2900 pounds of PCB/year, and a lower limit that gives 1300 pounds of PCB/year. The lower limit is an estimate of the reduced loading that would occur if the upstream influent PCB (from Glens Falls to Rogers Island) could be reduced in the future by remedial action, washout or some other method. The report identifies remnant deposits 3 and 5, which have the highest concentration of PCB in the area, as the major contributor of upstream PCB. However, these two areas have been stabilized and are outside the normal scouring path of the Hudson River. Several studies (MPI March 1978, DEC March 1980) consider their contribution of PCB to be negligible.

USGS data collected since the remnant pool mitigating measures of 1978 fall within the limits of 1300 to 2900 pounds per year. Pending additional data collection by USGS, especially at high flow conditions, these figures will be regarded as the upper and lower limits of PCB loadings at Rogers Island.

Based on these conditions, the model estimates the transport of PCB over the Troy Dam and to the estuary. The higher estimate projects 7200 pounds/year of PCB discharge, while the lower estimate predicts 5600 pounds/year. These loadings are averaged over a 20-year period based on historical flow records, and do not reflect the yearly fluctuations of river discharges and variations of the PCB mass transported.

LMS projects average annual transport of 7200 pounds PCB over the dam at Troy for a 66 year period, after which the Upper Hudson source would be exhausted. The transport of PCB is limited by the supply of available PCB. Therefore, if no remedial action is undertaken, the supply of PCB would diminish over time by the quantities transported. The following table adapted from LMS (1979) summarizes this transport.

PCB TRANSPORT, NO-REMEDIAL-ACTION ALTERNATIVE

| Location | PCB Transport pounds/year | Supply of Available PCB pounds | No. of Years to Exhaust Supply |
|---|---|---|---|
| At Lock 7 | 2900 - 1300 | 50,000 | 38 - 19 |
| Lock 7 to Troy | 4300 | 284,000 | 66 |
| Federal Dam at Troy | 7200 | | |

Sources: LMS (1979)
DEC (1980)
Estimates for Draft EIS NYSEQR report, MPI (September 1980)

In addition, LMS (1978, 1979) estimated the average annual PCB load at Troy for the pre-1978 period before either the Remnant Deposit Area 3A Mitigation or the Fort Edward Terminal Channel Excavation occurred. The 1978 LMS study estimates the average annual PCB load (including a low flow correction based on a field data for flows less than 20,000 cfs) assuming no mitigation (pre-1978) as 8,000 pounds per year.

LMS (1979) utilized the same mathematical model developed for the "No Action" alternative to evaluate several "Action" alternatives, Of interest here is the Thompson Island Pool and above Lock 7 dredging scenario. LMS (1979) estimates the reduction in PCB load over the dam at Troy as a result of dredging hot spot areas 1-20 as 500 lbs per year. Dredging the Thompson Island Pool and above Lock 7 would therefore reduce the current PCB load over the dam at Troy from 7,200 pounds per year to 6,700 lbs per year.

Using these three data points - pre-1978 loading of 8,000 lbs/year; post Remnant Deposit Area 3A and Fort Edward Terminal Channel Excavation (post-1978) loading of 7,200 lbs; and, an estimate of the post Thompson Island dredging loading of 6,700 lbs - a cost per pound of PCB reduction over the Federal Dam at Troy was estimated. Table 5 presents the cost/benefit analysis using this data.

Table 5
Reduction of PCB Over the Troy Dam

| | Average Annual PCB Load at Troy (lbs/yr) | Incremental Reduction in PCB Load at Troy (lbs/yr) | % Reduction with with Regard to No Action Alternative | Cost of Removal, Transport & Treatment 1982 (Dollars) | Cost per Pound Reduction at Troy |
|---|---|---|---|---|---|
| "No Action" Alternative | 8,000 | - | - | - | - |
| Moreau Site | | | | | |
| 1978 Remnant Deposits Remedial Actions (Includes East Channel of Rogers Island Dredging) | 7,200 | 800 | 10% | $ 2,100,000 No treatment required | $ 2,600 |
| Proposed Site 10 | | | | | |
| Dredging Lock 7 to Thompson Island Pool | 6,700 | 500 | 16% | $16,000,000 (rough estimate) | $32,000 |

(1) Source: LMS (1979)

the Thompson Island Pool and areas above Lock 7 in one dredging season.)

3. Clamshell Dredging and Hydraulic Pumpout Transport with or without Recycling of Water:

   a) Typical equipment list would include:

      1) Two five-cu yd clamshell dredges
      2) Five 1000 cu yd hopper scows
      3) One work-deck barge
      4) One 800 hp towing tug
      5) Two 200 hp tender tugs
      6) One 16-inch pumpout plant
      7) One tie-up barge
      8) Shoreline pipeline and miscellaneous equipment
      9) Two bulldozers

   b) The average production rate estimated for one five-cu yd clamshell dredge is 200 cu yds per hour. Estimated operating time is 600 hrs per month for a monthly production rate of 120,000 cu yds. (Note: Under this alternative, two five-cu yd dredges will be required to dredge the Thompson Island pool and areas above Lock 7 is one dredging season.)

B. Production rates for the Mud Cat dredges are taken from literature received by Mr. Peter Kuniholm, MPI from Mud Cat Division National Car Rental Systems, Inc., and dated 9/80 and 11/80. The cover letter is dated May 29, 1981.

4. Mud Cat dredges

| | Model D-24-1 | Model D-30 |
|---|---|---|
| Main Pump: | Thomas 8-inch intake<br>8-inch discharge<br>24-inch impeller(closed) | Thomas 10-inch intake<br>8-inch discharge<br>30-inch impeller (closed) |
| Operating Depth: | 15 ft (standard) | 25 ft. (standard) |
| Pump Speed: | 900 r.p.m. | 675-700 r.p.m. |
| Detroit Diesel: | 6-71; 203 hp @ 1900 r.p.m. | 8V-71; 225 hp |
| Total Head: | 105 @ 83 p.s.i. @ 14' | 155 @ 75 p.s.i. @ 17'/sec |
| at 1000' | -- | 40' lift |
| Capacity: | 90-140 cu yds/hr. | 110-200 cu yds/hr. |

| | | |
|---|---|---|
| Sand & Gravel: | 100 cu yds/hr. | 140 cu yds/hr. |
| Sand: | 115 cu/yds/hr. | 155 cu yds/hr. |
| Light sand & silt: | 140 cu yds/hr. | 200 cu yds/hr. |
| | 2500 gallons/min. | 2700 gallons/min. |

Other models offer greater operating depths with similar capacities.

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MALCOLM PIRNIE

# INTER-OFFICE CORRESPONDENCE

To: J.C. Henningson

Date: 8/5/82

From: R. P. Brownell

Subject: Waukegan Harbor

1. The following alternatives have been evaluated:

   a. North Ditch/Upland
      1. No action
      2. Stabilization
      3A. Stabilize + Limited removal of hot material (say 13,500 cy); dispose in b.2a. or b.6 below.
      3B. Stabilize + Limited removal to b3 below.
      4. On site encapsulation to 50 ppm. (See B4)
      5. Off site encapsulation to 50 ppm.(See B5)

   b. Harbor

      1. No action
      2A. Fill slip 3 with hot sand from a 3 above + dredge silted area from upper B-1 + dredge about 20,000 cy from Upper Harbor
      2B. Fill slip 3 with upper B-1 + rest of Upper Harbor
      3A. Dredge slip 3 + Upper B-1 and place hot sand (See a3 above) from No. ditch and encapsulate in vacant lot.
      3B. 3A + 20,000 cy more from Upper Harbor
      3C. Dredge slip 3 + Upper Harbor + hot sand
      3D. Dredge slip 3 + upper B-1 and encapsulate in vacant lot.
      4. Dredge slip 3 and Upper Harbor and encapsulate in parking lot (See A4)
      5. Off site encapsulation to 50 ppm (See A5)
      6. Remove any dewatered material from a.3A and 3D and incinerate. Dispose of ash offsite.

2. Considering the economic impacts which lack of dredging in the slip 3 and Upper Harbor area could have on Larsen Marine, the costly requirements associated with the disposal of material containing PCB's, the possibility of hydraulic or other natural events moving PCB laden materials in an unsecured fashion into the environment, the possibility of man made events moving PCB laden materials in an unsecured fashion into the environment, I feel that the no action options have virtually no merit and will be considered no further.

Also removing highly contaminated material from slip 3 and the North Ditch/Upland area and incinerating the material has serious problems (e.g., double and tripple handling, lengthy operation period, potential loss of PCB during extensive handling, storage and burning, use of 50 to 60 gallons of fuel oil per cubic yard of material burned) which limits its feasibility. Hence it too will be considered no further.

RPB:vm

MALCOLM PIRNIE

**INTER-OFFICE CORRESPONDENCE**

Date: 8/5/82

To: R.P. Brownell

From: H. L. Shahabian

Subject: Waukegan Harbor Siltation

The review of available reports and data related to sedimentation/siltation of Waukegan Harbor resulted in the following:

1. The main source of siltation and sedimentation of Waukegan Harbor appears to be Lake Michigan. Based on a limited sampling period performed by Argonne National Laboratory, a two-phase flow often exists at the mouth of the Harbor: Water flows out of the harbor at the surface and correspondingly into the Harbor at the bottom of the channel. The bottom current from the Lake carries with it sediments that are deposited in the channel.

2. The channel and a portion of the Harbor located near the mouth have been regularly dredged in the past. The average quantity of dredged material was 20,000 $yd^3$/year.

3. No dredging has taken place since 1977.

4. The upper reach of the Harbor, slip #3, is not affected by sediments originated from Lake Michigan.

5. The probable source of siltation of slip #3 (surface area 70,000 $ft^2$) is the overland flow and storm sewers with outlets into slip #3.

6. Overland flows and storm sewers carry the dust and dirt accumulated in street curbs and parking areas. An estimate was made of the amount of solids that could reach slip #3. The estimate was based on published values[a] for other cities in the U.S. for similar (industrial) land use, and for the City of Milwaukee, located in the same geographical area as Waukegan.

7. These estimates are:

   - Based on the Milwaukee study: 560,000 lbs/year.
   - Based on average values in U.S.: 290,000 lbs/year.

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Considering a specific weight of 110 lbs/ft$^3$ these values would correspond to 5,100 ft$^3$/yr. and 2,700 ft$^3$/yr respectively. Moreover, if a uniform distribution of these sediments is assumed into slip #3 and with no movement of these sediments into other parts of the Harbor 0.5 to 0.9 inches of sediments might be expected to accumulate into slip #3.

Correspondingly, 13 to 24 years period would be required to accumulate one foot of sediments.

8. A similar analysis based on the Universal Soil Loss Equation[a] results in similar values 0.05 to 0.1 ft/yr. Or 12 to 24 years to accumulate one foot of sediments.

9. A draft of 6 to 8 ft is required in slip #3 for the free movements of boats. Based on the bathometric contour map in Mason & Hanger report the attached figures were developed. Figure one identifies the areas in slip #3 with draft less than 6 to 8 ft. The draft is based on the low water datum of 576.8 ft.

10. The second figure projects those conditions into the future based on the values estimated above: 12 to 24 years to accumulate one foot of sediments.

11. Lake fluctuations - The hydrograph of monthly mean levels of Lake Michigan (1960-1980) are shown on Figure 3. The lake levels have a seasonal cyclicity. The annual low levels generally occur during the winter months (Jan. to March) and the high levels in summer (June to August). In addition to the seasonal variations, the annual mean levels appear to have a very low frequency cycle not unlike other hydrologic phenomena. Thus high water level years tend to follow each other and similarly for low water level years. However, it is difficult to predict when the next low water levels will begin.

    An examination of the 1960-1980 hydrograph indicate that the levels were above the Low Water Datum (576.8 feet) since 1967. Record highs (from 1900 to 1980) were registered in 1973-74. However, during the 1963-64 years lake levels were close but generally below the Low Water Datum. The minimum of record was registered in March-April 1964.

12. Since the lake level fluctuates, the historical minimum lake level (575.4) is used in Figure 4 together with the present sediment conditions.

13. The historical minimum lake level (575.4 ft) is used in Figure 5 together with projected sediment levels of 12-14/yr. Figure 3 shows that the totality of slip #3 will have a draft of less than 8 feet, with all of the mooring areas with drafts less than 6 feet.

[a] Overton, D.E., M.E. Meadows, "Stormwater Modeling" Academic Press, 1976

HLS:vm
cc: J. C. Henningson

WAUKEGAN HARBOR SLIP # 3

DEPTH OF WATER ABOVE MUCK LAYER : PRESENT CONDITIONS

WATER SURFACE ELEVATION @ LOW WATER DATUM : EL 576.8

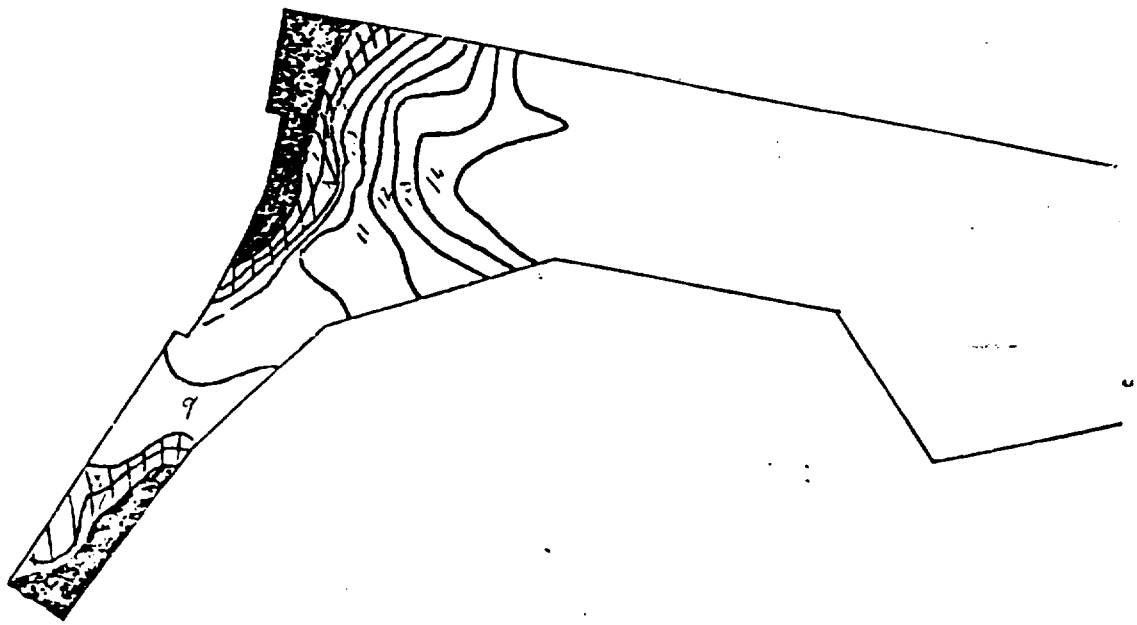


FIG. 1

WAUKEGAN HARBOR SLIP # 3

DEPTH OF WATER ABOVE MUCK LAYER : FUTURE CONDITION 12-26 FEET HIGH

WATER SURFACE ELEVATION @ LOW WATER DATUM. EL 576.8

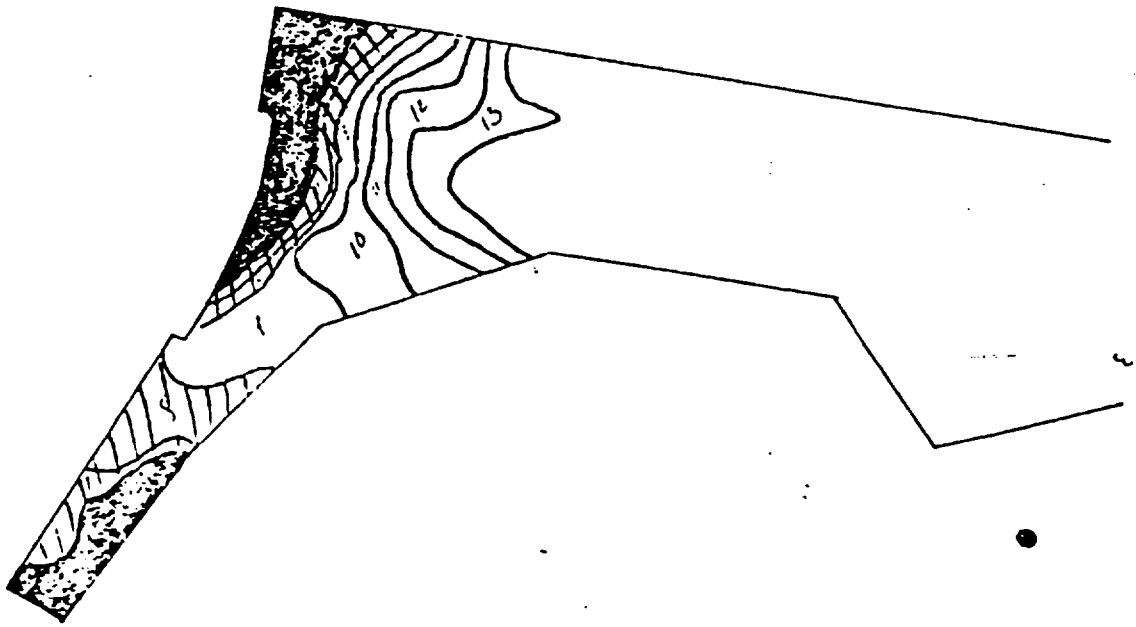


FIG. 2

WAUKEGAN HARBOR SLIP # 3

DEPTH OF WATER ABOVE ROCK LAYER : PRESENT CONDITION

WATER SURFACE ELEVATION @ HISTORICAL MINIMUM LAKE LEVELS (575.35)

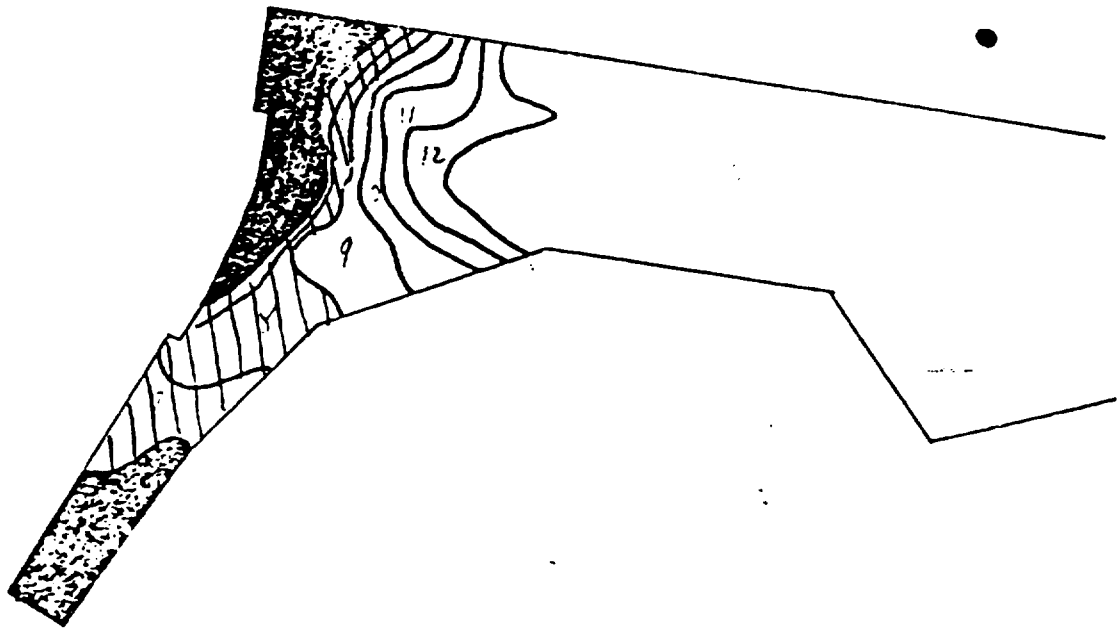


FIG 4

WHITEHALL HARBOR SLIP # 3

DEPTH OF WATER ABOVE MUCK LAYER : FUTURE CONDITION:

WATER SURFACE ELEVATION @ HISTORICAL MINIMUM LAKE LEVEL (575.35)

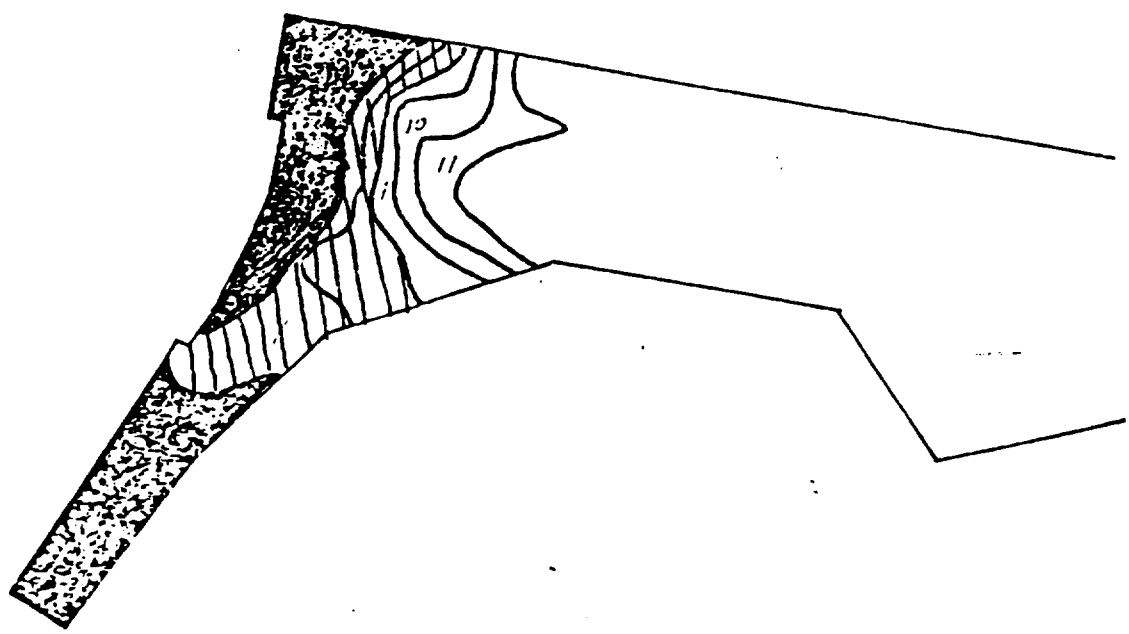


FIG 5

UNITED STATES — GREAT LAKES

HYDROGRAPH OF MONTHLY MEAN LEVELS OF THE GREAT LAKES

ELEVATIONS IN FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC, INTERNATIONAL GREAT LAKES DATUM (1955)

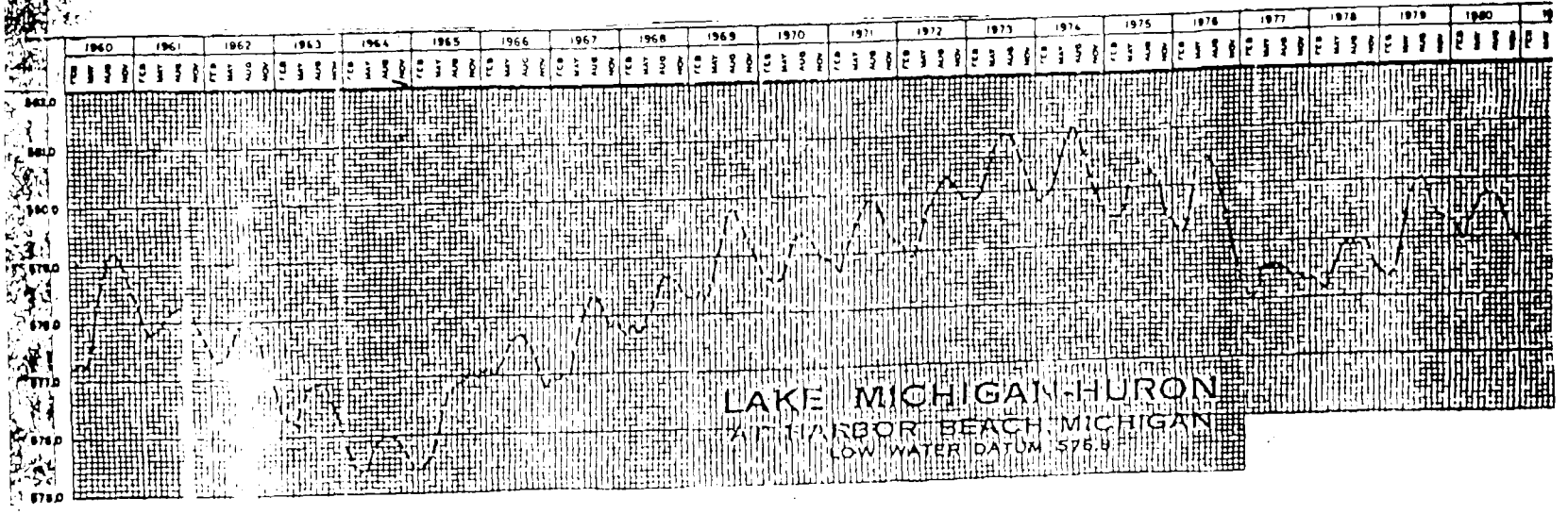


FIG. 3

MALCOLM PIRNIE, INC

Inter-Office Correspondence

To: R.P. Brownell

Date: 8/4/82

From: J.B. Mulligan

Subject: Waukegan Harbor PCB Problem

As requested, we have prepared preliminary cost estimates for a number of alternative methods of reducing the potential for environmental danger from PCB contamination in the Waukegan Harbor area. The alternatives considered are subdivided into two groups: those affecting the north ditch and parking lot and those affecting the harbor. In some instances, however, combined north ditch - harbor solutions have been considered. In these instances, a share of the costs of facilities which would be used jointly has been assigned to both the north ditch and harbor projects in accordance with the ratios of the volumes of contaminated materials removed from each location.

The various alternatives considered are as follows:

North Ditch and Parking Lot Alternatives

A-1 No action - monitor long term losses of PCB's to environment only.

A-2 Construct a new storm drain to divert water from the north ditch; fill in ditch with clean material obtained from off-site sources to prevent PCB losses through erosion of ditch sediments and volatilization.

A-3a-1
A-3a-2
A-3a-3 Remove selected, highly contaminated material from the north ditch and parking lot and dispose of in containment site to be constructed on OMC's vacant lot; fill in remainder of ditch and excavated areas with clean material. The containment site would also be used for disposal of material dredged from Slip 3 and the upper harbor under Alternatives B-3a, B-3b and B-3c.

A-3b Remove selected, highly contaminated material from the north ditch and parking lot and dispose of in a containment site constructed by sealing off Slip 3. Fill in remainder of ditch and excavated areas with clean material. Contaminated material in the upper harbor outside of Slip 3 would be dredged and placed in the containment site under Alternative B-2a.

A-4 Remove 50 ppm and greater contaminated material from the north ditch and parking lot and dispose of in a secure containment site constructed in the parking lot. The containment site would also be used for disposal of material dredged from the harbor under Alternative B-4.

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A-5 Remove 50 ppm and greater contaminated material from the north ditch and parking lot and dispose of in secure containment site to be constructed at a site to be selected with 20+ miles of Waukegan Harbor. This containment site would also be used for disposal of dredged material from the harbor under Alternative B-5.

Harbor Alternatives

B-1 No action - monitor long term losses of PCB's to environment only.

B-2a Convert Slip 3 into a containment site; fill with material dredged from upper harbor outside of Slip 3. This containment site would also be used for disposal of material removed from the ditch and parking lot under Alternative A-3b.

B-2b Convert Slip 3 into a containment site, dredge 50 ppm contaminated material from upper harbor and dispose of in slip.

B-3a Dredge Slip 3 and approximately 500 c.y. of selected, highly contaminated material near mouth of Slip 3 and dispose of in secure containment site constructed on OMC's vacant lot. Selected, highly contaminated material from the north ditch and parking lot would also be placed in this containment site under Alternative A-3a.

B-3b Same as Alternative B-3c but remove 20,000 c.y. from upper harbor outside of Slip 3. Material from the north ditch and parking lot would also be placed in this containment site under Alternative A-3a-2.

B-3c Dredge Slip 3 and upper harbor and dispose in containment site on OMC's vacant lot. This containment site would also be used to dispose of selected, highly contaminated material removed from the north ditch and parking lot under Alternative A-3a-3.

B-4 Dredge Slip 3 and upper harbor and dispose of in containment site on OMC's parking lot. The containment site would also be used for disposal of material removed from the north ditch and parking lot under Alternative A-4.

B-5 Dredge Slip 3 and upper harbor and dispose in a secure containment site to be constructed within 20+ miles of Waukegan Harbor. This containment site would also be used for the disposal of material removed from the north ditch and parking lot under Alternative A-5.

B-6 Dredge Slip 3 and approximately 500 C.Y. of selected, highly contaminated material near the mouth of the slip and dispose of in a secure containment site on OMC's vacant lot.

JBM:mhn:mrw

## ALTERNATIVE A-1

### NORTH DITCH AND PARKING LOT AREA - NO ACTION

Under Alternative A-1, the only action which would be taken would consist of the installation of ground water monitoring wells, a permanent gaging and sampling station on the North Ditch, and an air monitoring station. The six existing monitoring wells would be sampled periodically, if still available, and two new nested well systems consisting of three wells each would be constructed near the easterly end of the ditch.

Estimates of capital costs and annual sampling and maintenance costs are presented below.

### ESTIMATED CAPITAL COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Monitoring wells | 2 Nests of 3 EA. | $ 8,000.00 | $ 16,000 |
| Purchase Flow meter and remote chart recorder | 1 EA. | 2,500.00 | 2,500 |
| Purchase automatic water sampler | 1 EA. | 4,000.00 | 4,000 |
| Purchase automatic air sampler | 1 EA. | 8,000.00 | 8,000 |
| Construct small building | 100 S.F. | 30.00 | 3,000 |
| Install Electrical Power | L.S. | L.S. | 3,000 |
| Construct concrete weir | L.S. | L.S. | 4,000 |
| Install equipment in building | L.S. | L.S. | 3,000 |
| TOTAL ESTIMATED CONSTRUCTION COST | | | $ 43,500 |
| Contingencies @ 20% | | | 8,700 |
| Engineering, Legal & Administrative @ 28% | | | 12,180 |
| TOTAL CAPITAL COST | | | $ 64,380 |

### ESTIMATED ANNUAL O&M COSTS

| | | | |
|---|---|---|---|
| Equipment maintenance and Electric Power Charges | L.S. | L.S. | 2,500 |
| Ground Water Sampling and analysis | 24 Samples | 210.00 | 5,040 |
| Air sampling and analysis | 4 Samples/Yr. | 400.00 | 1,600 |
| Surface water sampling and analysis | 6 Samples/Yr. | 220.00 | 1,320 |
| Annual reports & misc. paper work | L.S. | L.S. | 5,000 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 15,460 |

## ALTERNATIVE B-1

## HARBOR AREA - NO ACTION

Under Alternative B-1, the only action which would be taken would consist of the installation of ground water monitoring wells around the harbor, flow recording and sampling equipment in the harbor entrance and a permanent air monitoring station.

The ground water monitoring wells would consist of four nests of two wells each. Each well would be sampled four (4) times per year.

The flow recording and sampling station in the harbor entrance would be run continuously for the first year to develop background data. Thereafter, sampling and flow measurements would be done on a quarterly basis.

Estimates of capital costs and annual operation and maintenance costs are presented below.

### ESTIMATED CAPITAL COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Monitoring wells | 4 nests of 2 EA. | $ 5,500.00 | $ 22,000 |
| Purchase & Install Automatic Air Sampler | 1 EA. | 8,000.00 | 8,000 |
| Install electric power to automatic equipment | L.S. | L.S. | 3,000 |
| TOTAL ESTIMATED CONSTRUCTION COST | | | $ 33,000 |
| Contingencies @ 20% | | | 6,600 |
| Engineering, Legal & Administrative @ 28% | | | 9,200 |
| TOTAL ESTIMATED CAPITAL COST | | | $ 48,800 |

### ESTIMATED ANNUAL O&M COSTS

| FIRST YEAR COSTS | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,000 |
| Ground water sampling and analysis | 16 Samples | $ 210.00 | 3,360 |
| Air Sampling and Analysis | 4 Samples | 400.00 | 1,600 |
| Continuous flow monitoring and sampling in harbor | L.S. | L.S. | 125,000 |
| Annual reports & Misc. paper work | L.S. | L.S. | 5,000 |
| TOTAL ESTIMATED FIRST YEAR COST | | | $ 136,960 |

ALTERNATIVE B-1 (continued)

| SUBSEQUENT YEARS COSTS | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,000 |
| Ground Water Sampling and analysis | 16 Samples/yr. | $ 210.00 | 3,360 |
| Air Sampling and Analysis | 4 Samples/yr. | 400.00 | 1,600 |
| Water samples from harbor | 24 Samples/yr. | 220.00 | 5,280 |
| Annual report and misc. paper work | L.S. | L.S. | 5,000 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 17,240 |

## ALTERNATIVE A-2

Under Alternative A-2, a new storm drain would be constructed from the existing 36-inch diameter drain near the railroad to the lake to divert surface runoff and cooling water from the north ditch. The ditch would then be filled in and covered with a clay cap, topsoil and vegetative cover to prevent a catastrophic loss of PCB laden sediments to the lake. Monitoring wells would be constructed near the ditch on the easterly end of the parking lot and ground water monitoring would be carried out to determine the long term losses of PCBs via that route.

No action would be taken with respect to PCBs under the surface of the parking lot. However, contaminated material excavated during the construction of the new storm drain through the parking lot would be used to fill a portion of the crescent ditch.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-2

STABILIZE NORTH DITCH

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL COST |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP Storm Drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| Manholes 8-FT. dia. precast | 9 ea. | 5,000.00 | 45,000 |
| Dewatering-well point | 2,650 L.F. | 20.00 | 53,000 |
| Riprap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of Contaminated Exc. (in ditch) | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Fill in Ditch, Crescent Ditch & Lagoon | | | |
| Backfill E-W portion of ditch | 4,730 C.Y. | 10.00 | 47,300 |
| Backfill lagoon | 1,060 C.Y. | 10.00 | 10,600 |
| Backfill Crescent ditch | 1,400 C.Y. | 10.00 | 14,000 |
| 1-FT. Clay Seal, topsoil & seed | 6,000 S.Y. | 6.00 | 36,000 |
| Monitoring Wells | L.S. | | 10,000 |
| TOTAL ESTIMATED CONSTRUCTION COST | | | $ 565,400 |
| Contingencies @ 20% | | | 113,080 |
| Engineering @ 25% | | | 141,350 |
| Legal and Administrative @ 3% | | | 16,962 |
| TOTAL PROJECT COST | | | $ 836,792 |

ALTERNATIVE A-2

ESTIMATED ANNUAL O&M COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 6 Samples | $ 210.00 | 1,260 |
| Air sampling and analysis | 1 Sample | 400.00 | 400 |
| Annual inspection & Report | 40 Hours | 60.00 | 2,400 |
| TOTAL ESTIMATED ANNUAL COSTS | | | $ 6,560 |

ALTERNATIVE A-2

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Storm Drain | 75 | 107 |
| 3. | Restore Parking Lot over Drain | 10) | 16 |
| 3a. | Backfill Ditch | 12) | |
| 4. | Seal Surface of Ditch, Topsoil & Seed | 8) | 10 |
| 4a. | Install Monitoring Wells | 3) | |
| 5. | Demobilization | 2 | 2 |
| | TOTAL | | 156 |

## ALTERNATIVES A-3a-1 AND B-3a

Under Alternative A-3a-1, a new drain would be constructed across the parking lot to divert water away from the north ditch, as in Alternative A-2, and approximately 10,100 C.Y. of the most highly contaminated material in the crescent ditch, oval lagoon and parking lot would be excavated and disposed of in a secure containment site constructed on OMC's vacant lot. Excavation would be accomplished by driving interlocked steel sheeting around small areas to be excavated, dewatering within the sheeted areas, and trucking the excavated material to the containment cell in a relatively dry state.

Under Alternative B-3a, approximately 10,875 C.Y. of material would be dredged from slip 3, together with an additional 500 C.Y. of sediment in the upper harbor near the mouth of slip 3 which will have to be removed to prevent loss of use of the harbor by Larsen Marine Co. This material would be pumped, as a slurry, to the containment site on OMC's vacant lot. The slurry water would be passed through a settling basin and returned to the area of the dredge. To insure that losses of PCB's to the lake were minimized during dredging, the area to be dredged would be sealed off through the installation of a temporary sheet pile wall. The water treatment plant would be dismantled and placed inside the containment cell upon completion of the dredging, and the cell dewatered thru a carbon filter to remove high levels of PCBs.

The capacity of the containment cell was determined as follows:

| | |
|---|---|
| Material to be dredged from Harbor | 11,375 C.Y. |
| Allowance for Water Treatment Plant disposal | 5,500 C.Y. |
| Material to be excavated from north ditch | 10,100 C.Y. |
| Contaminated material from storm drain construction | 2,000 C.Y. |
| SUBTOTAL | 28,975 C.Y. |
| Allowance for expansion of material 20% | 5,800 C.Y. |
| TOTAL | 34,775 C.Y. |
| SAY | 35,000 C.Y. |

An additional two (2) feet of freeboard was allowed in determining the height of the berms surrounding the cell. The area would be filled with the remainder of the material used for the construction of the water treatment plant.

ALTERNATIVES A-3a-1 AND B-3a (continued)

Cost estimates for Alternatives A-3a-1 and B-3a are presented in the attached tables. In preparing these estimates, each Alternative was assigned a share of the "common" cost of the disposal site. It should be noted, however, that if only one of the Alternatives were to be built, the disposal site costs would be entirely different from those shown.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3a-1

Remove Selected Highly Contaminated Material from the North Ditch and Parking Lot and Dispose of in Containment Site on OMC's Vacant Lot.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP storm drain | 2,650 L.F. | $ 100.00 | $ 265.000 |
| Manholes 8' dia. precast | 9 EACH | 5,000.00 | 45,000 |
| Dewatering - well point | 2,650 L.F. | 20.00 | 53,000 |
| Rip rap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of contaminated excavation in containment site | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material From Ditch and Parking Lot | | | |
| Relocate utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well point dewatering | L.S. | L.S. | 60,000 |
| Excavation and hauling to containment site | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alternative A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' clay seal, topsoil and seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air monitoring during excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,155,000 |
| Ditch and Parking Lot Share of Cost of Containment Site on OMC's Vacant Lot (see estimate attached) | | | 369,482 |
| TOTAL CONSTRUCTION COST: | | | $1,524,482 |
| Contingencies @ 20% | | | 304,896 |
| Engineering @ 25% | | | 381,120 |
| Legal and Administrative @ 3% | | | 45,734 |
| TOTAL PROJECT COST: | | | $2,256,232 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-3a

DREDGE SLIP 3 AND UPPER HARBOR AND DISPOSE OF IN CONTAINMENT SITE ON OMC'S VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 11,375 C.Y. | $ 10.00 | $ 113,750 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & labor for water treatment | L.S. | L.S. | 12,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 25,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 11,000 C.Y. | 6.00 | 66,000 |
| Synthetic liner | 50,000 S.F. | 0.85 | 42,500 |
| Gravel blanket | 2,000 C.Y. | 10.00 | 20,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed pumps, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 30,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 606,695 |
| Share of Containment Site Cost for Dredging (See Attached Estimate) | L.S. | L.S. | 531,693 |
| TOTAL CONSTRUCTION COST | | | $1,138,388 |
| Contingencies @ 20% | | | 227,678 |
| Engineering @ 25% | | | 284,597 |
| Legal & Administrative @ 3% | | | 34,152 |
| TOTAL CONSTRUCTION COST | | | $1,684,815 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S VACANT LOT
USE WITH ALTERNATIVES B-3a AND A-3a-1
(Construct Containment Site for 35,000 c.y.)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Level and compact site | L.S. | L.S. | $ 35,000 |
| 1' clay blanket | 4,000 C.Y. | $ 10.00 | 40,000 |
| 3' thick clay cut-off walls | 2,625 C.Y. | 10.00 | 26,250 |
| 1' gravel blanket | 4,000 C.Y. | 10.00 | 40,000 |
| 3' clay liner | 12,500 C.Y. | 10.00 | 125,000 |
| 6" dia. PVC leachate collector | 1,200 L.F. | 10.00 | 12,000 |
| 6" dia. PVC dewatering pipe | 1,250 L.F. | 10.00 | 12,500 |
| Manholes - 48" dia. precast | 2 EACH | 1,600.00 | 3,200 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Sand berms | 60,400 C.Y. | 6.00 | 362,400 |
| Rip rap slope protection | 110 C.Y. | 40.00 | 4,400 |
| Final Cover Over Site | | | |
| 2' clay cover | 8,000 C.Y. | 10.00 | 80,000 |
| 1' topsoil and cover | 5,925 C.Y. | 10.00 | 59,250 |
| Seeding | 4.5 AC. | 750.00 | 3,375 |
| Monitoring Wells | 4 NESTS | 8,000.00 | 32,000 |
| Air Sampling Unit | L.S. | L.S. | 20,000 |
| Permanent Fence | 1,800 L.F. | 6.00 | 10,800 |
| Electric Power | L.S. | L.S. | 10,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $ 901,175 |

Ditch and Parking Lot share of
Cost for Constructing Containment Site

$\frac{12,100 \text{ C.Y.}}{29,475 \text{ C.Y. total}}$ = 0.41 x $901.175 = $ 369,482

Dredging Share of Cost of
Constructing Containment Site

$\frac{17,375 \text{ C.Y.}}{29,475 \text{ C.Y. total}}$ = 0.59 x $901,175 = $ 531,693

ALTERNATIVE A-3a-1 COMBINED WITH B-3a

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 5 Ac. | 180.00 | 900 |
| Annual maintenance and repair to cover | L.S. | L.S. | 3,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 14,640 |

ALTERNATIVE A-3a-1 & B-3a

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Containment Site on OMC's Vacant Lot | 125) | 175 |
| 2a. | Construct New Storm Drain thru Parking Lot(Complete) | 86) | |
| 3. | Close Harbor & Reinforce Exist Sheet Pile Wall in Slip 3 | 20 | 28 |
| 4. | Dredge Slip 3 and Harbor | 12 | 16 |
| 5. | Open Harbor | 2) | 42 |
| 6. | Dewater Containment Site | 30) | |
| 6a. | Sheet 1st section of Ditch | 5) | |
| 7. | Excavate & Backfill Ditch | 125) | 190 |
| 7a. | Cover Containment Site | 20) | |
| 8. | Seal Surface of Ditch, Topsoil & Seed | 8 | 10 |
| 9. | Clean-up and Demobilization | 5 | 7 |
| | TOTAL | | 489 |

## ALTERNATIVES A-3a-2 AND B-3b

These Alternatives are the same as A-3a-1 and B-3a except that the volume of material to be dredged from the harbor outside of slip 3 is 20,000 C.Y. rather than 500 C.Y. As a result, the cost of the containment site is greater and the shares of the site costs assigned to the two Alternatives are different.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3a-2

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP storm drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| Manholes - 8' dia. precast | 9 EACH | 5,000.00 | 45,000 |
| Dewatering - well point | 2,650 L.F. | 20.00 | 53,000 |
| Rip rap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of contaminated excavation in containment site | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material from Parking Lot | | | |
| Relocate utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well point dewatering | L.S. | L.S. | 60,000 |
| Excavation and hauling to containment site | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alternative A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' clay seal, topsoil and seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air monitoring during excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,155,300 |
| Ditch and Parking Lot Share of Containment Site Cost on OMC's Vacant Lot (see estimate attached) | | | 283,088 |
| TOTAL CONSTRUCTION COST: | | | $1,438,388 |
| Contingencies @ 20% | | | 287,678 |
| Engineering @ 25% | | | 359,597 |
| Legal and Administrative @ 3% | | | 43,152 |
| TOTAL PROJECT COST: | | | $2,128,815 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-3b

DREDGE SLIP 3 AND UPPER HARBOR AND DISPOSE OF
IN CONTAINMENT SITE ON OMC'S VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 30,875 C.Y. | $ 10.00 | $ 308,750 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & labor for water treatment | L.S. | L.S. | 15,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 25,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 13,900 C.Y. | 6.00 | 83,400 |
| Synthetic liner | 64,000 S.F. | 0.85 | 54,400 |
| Gravel blanket | 2,400 C.Y. | 10.00 | 24,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed pumps, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 50,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 857,995 |
| Share of Containment Site Cost for Dredging (See Attached Estimate) | L.S. | L.S. | 805,712 |
| TOTAL CONSTRUCTION COST | | | $1,663,707 |
| Contingencies @ 20% | | | 332,741 |
| Engineering @ 25% | | | 415,927 |
| Legal & Administrative @ 3% | | | 49,911 |
| TOTAL CONSTRUCTION COST | | | $2,462,286 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S VACANT LOT
USE WITH ALTERNATIVES B-3b AND A-3a-2
(Construct Containment Site for 54,000 c.y.)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Level and compact site | L.S. | L.S. | $ 40,000 |
| 1' clay blanket | 5,520 C.Y. | $ 10.00 | 55,200 |
| 3' thick clay cut-off walls | 3,260 C.Y. | 10.00 | 32,600 |
| 1' gravel blanket | 5,520 C.Y. | 10.00 | 55,200 |
| 3' clay liner | 16,600 C.Y. | 10.00 | 166,000 |
| 6" dia. PVC leachate collector | 1,600 L.F. | 10.00 | 16,000 |
| 6" dia. PVC dewatering pipe | 2,000 L.F. | 10.00 | 20,000 |
| Manholes - 48" dia. precast | 2 EACH | 1,600.00 | 3,200 |
| Overflow weir piping | L.S. | L.S. | 25,000 |
| Sand berms | 67,400 C.Y. | 6.00 | 404,400 |
| Rip rap slope protection | 120 C.Y. | 40.00 | 4,800 |
| Final Cover Over Site | | | |
| 2' clay cover | 11,050 C.Y. | 10.00 | 110,500 |
| 1' topsoil and cover | 7,500 C.Y. | 10.00 | 75,000 |
| Seeding | 6 AC. | 750.00 | 4,500 |
| Monitoring Wells | 4 NESTS | 8,000.00 | 32,000 |
| Air Sampling Unit | L.S. | L.S. | 20,000 |
| Permanent Fence | 2,400 L.F. | 6.00 | 14,400 |
| Electric Power | L.S. | L.S. | 10,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,088,800 |

Ditch and Parking Lot share of
Cost for Constructing Containment Site

$\frac{12,100 \text{ C.Y.}}{46,475 \text{ C.Y. total}}$ = 0.26 x $1,088,800 = $ 283,088

Dredging Share of Cost of
Constructing Containment Site

$\frac{34,375 \text{ C.Y.}}{46,475 \text{ of total capacity}}$ (includes 3,500 C.Y. for WTP) = 0.74 x $1,088,800 = $ 805,712

ALTERNATIVE A-3a-2 COMBINED WITH B-3b

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 5 Ac. | 180.00 | 900 |
| Annual maintenance and repair to cover | L.S. | L.S. | 3,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 14,640 |

ALTERNATIVE A-3a-2 & B-3b

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Containment Site on OMC's Vacant Lot | 125) | 175 |
| 2a. | Construct New Storm Drain thru Parking Lot(Complete) | 86) | |
| 3. | Close Harbor & Reinforce Exist Sheet Pile Wall in Slip 3 | 20 | 28 |
| 4. | Dredge Slip 3 and Harbor | 30 | 42 |
| 5. | Open Harbor | 2) | 42 |
| 6. | Dewater Containment Site | 30) | |
| 6a. | Sheet 1st section of Ditch | 5) | |
| 7. | Excavate & Backfill Ditch | 125) | 190 |
| 7a. | Cover Containment Site | 20) | |
| 8. | Seal Surface of Ditch, Topsoil & Seed | 8 | 10 |
| 9. | Clean-up and Demobilization | 5 | 7 |
| | TOTAL | | 515 |

## ALTERNATIVES A-3a-3 AND B-3c

These Alternatives are also the same as Alternatives A-3a-1 and B-3a except that the volume of material to be removed from the harbor outside of slip 3 is 38,000 C.Y. As a result, a higher cost results for the containment site construction and the shares assigned to each Alternative are different.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3a-3

Remove Selected Highly Contaminated Material from the North Ditch and Parking Lot and Dispose of in Containment Site on OMC's Vacant Lot.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP storm drain | 2,650 L.F. | $ 100.00 | $ 265.000 |
| Manholes 8' dia. precast | 9 EACH | 5,000.00 | 45,000 |
| Dewatering - well point | 2,650 L.F. | 20.00 | 53,000 |
| Rip rap at outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of contaminated excavation in containment site | 2,000 C.Y. | 5.00 | 10,000 |
| Surface restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material From Ditch and Parking Lot | | | |
| Relocate utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well point dewatering | L.S. | L.S. | 60,000 |
| Excavation and hauling to containment site | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alternative A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' clay seal, topsoil and seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air monitoring during excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,155,300 |
| Ditch and Parking Lot Share of Cost of Containment Site on OMC's Vacant Lot (see estimate attached) | | | 262,404 |
| TOTAL CONSTRUCTION COST: | | | $1,417,404 |
| Contingencies @ 20% | | | 283,541 |
| Engineering @ 25% | | | 354,426 |
| Legal and Administrative @ 3% | | | 42,531 |
| TOTAL PROJECT COST: | | | $2,098,202 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-3c

DREDGE SLIP 3 AND UPPER HARBOR & DISPOSE OF IN CONTAINMENT SITE ON OMC'S VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 48,900 C.Y. | $ 10.00 | $ 489,000 |
| Temporary Sleet Pile wall for Closing Harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce boisting sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & Labor for Water Treatment | L.S. | L.S. | 20,000 |
| Miscellaneous Water Treatment Equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 30,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 13,900 C.Y. | 6.00 | 83,400 |
| Synthetic liner | 64,000 S.F. | 0.85 | 54,400 |
| Gravel blanket | 2,400 C.Y. | 10.00 | 24,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed, pump, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 50,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $1,048,245 |
| Share of Containment Site Cost for Dredging (See Attached Estimate) | | | 1,049,616 |
| TOTAL CONSTRUCTION COST | | | $2,097,861 |
| Contingencies @ 20% | | | 419,572 |
| Engineering @ 25% | | | 524,465 |
| Legal & Administrative @ 3% | | | 62,936 |
| TOTAL PROJECT COST | | | $3,104,834 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S VACANT LOT
USE WITH ALTERNATIVES B-3c AND A-3a-3
(Construct Containment Site for 73,200 c.y.)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Level and compact site | L.S. | L.S. | $ 45,000 |
| 1' clay blanket | 6,850 C.Y. | $ 10.00 | 68,500 |
| 3' thick clay cut-off walls | 3,822 C.Y. | 10.00 | 38,220 |
| 1' gravel blanket | 6,850 C.Y. | 10.00 | 68,500 |
| 3' clay liner | 21,510 C.Y. | 10.00 | 215,100 |
| 6" dia. PVC leachate collector | 2,000 L.F. | 10.00 | 20,000 |
| 6" dia. PVC dewatering pipe | 2,640 L.F. | 10.00 | 26,400 |
| Manholes - 48" dia. precast | 2 EACH | 1,600.00 | 3,200 |
| Overflow weir piping | L.S. | L.S. | 25,000 |
| Sand berms | 81,000 C.Y. | 6.00 | 486,000 |
| Rip rap slope protection | 140 C.Y. | 40.00 | 5,600 |
| Final Cover Over Site | | | |
| 2' clay cover | 13,700 C.Y. | 10.00 | 137,000 |
| 1' topsoil cover | 9,260 C.Y. | 10.00 | 92,600 |
| Seeding | 6 AC. | 750.00 | 4,500 |
| Monitoring Wells | 4 NESTS | 8,000.00 | 32,000 |
| Air Sampling Unit | L.S. | L.S. | 20,000 |
| Permanent Fence | 2,400 L.F. | 6.00 | 14,400 |
| Electric Power | L.S. | L.S. | 10,000 |
| TOTAL CONSTRUCTION COST: | | | $1,312,020 |

Share of Containment Site Cost for Ditch and Parking Lot Work

$\frac{12,100 \text{ C.Y.}}{61,000 \text{ C.Y. total}}$ = 0.20 x $1,312,020 = $ 262,404

Share of Containment Site Cost for Dredging

$\frac{48,900 \text{ C.Y.}}{61,000 \text{ C.Y. total}}$ = 0.80 x $1,312,020 = $1,049,616

ALTERNATIVE A-3a-3 COMBINED WITH B-3b

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 5 Ac. | 180.00 | 900 |
| Annual maintenance and repair to cover | L.S. | L.S. | 3,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 14,640 |

ALTERNATIVE A-3a-3 & B3c

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct Containment Site on OMC's Vacant Lot | 125) | 175 |
| 2a. | Construct New Storm Drain thru Parking Lot(Complete) | 86) | |
| 3. | Close Harbor & Reinforce Exist Sheet Pile Wall in Slip 3 | 20 | 28 |
| 4. | Dredge Slip 3 and Harbor | 50 | 70 |
| 5. | Open Harbor | 2) | |
| 6. | Dewater Containment Site | 30) | 42 |
| 6a. | Sheet 1st section of Ditch | 5) | |
| 7. | Excavate & Backfill Ditch | 125) | 190 |
| 7a. | Cover Containment Site | 20) | |
| 8. | Seal Surface of Ditch, Topsoil & Seed | 8 | 10 |
| 9. | Clean-up and Demobilization | 5 | 7 |
| | TOTAL | | 543 |

## ALTERNATIVES A-3b AND B-2a

Alternative A-3b is similar to Alternative A-3a except that material excavated from the north ditch and parking lot would be placed in a containment site constructed by sealing off slip 3 from the rest of the harbor rather than building a site on OMC's vacant lot.

Under Alternative B-2a, the contaminated material within slip 3 would be sealed off from the upper harbor by the construction of a sheet pile wall and slurry wall across the mouth of the slip. Approximately 21,000 C.Y. of material from the upper harbor would be dredged and pumped into the slip. Additional material would be trucked to the slip from the north ditch and parking lot under Alternative A-3b.

The sheet pile wall and slurry wall across the harbor would be constructed as follows:

- Drive permanent sheet piling at least 10-feet into clay; construct concrete or steel cap.

- Drive a temporary sheet piling wall about 15-feet north of the permanent wall. Backfill the space between the two walls with compacted sand from the dredge spoils piled on OMC's vacant lot.

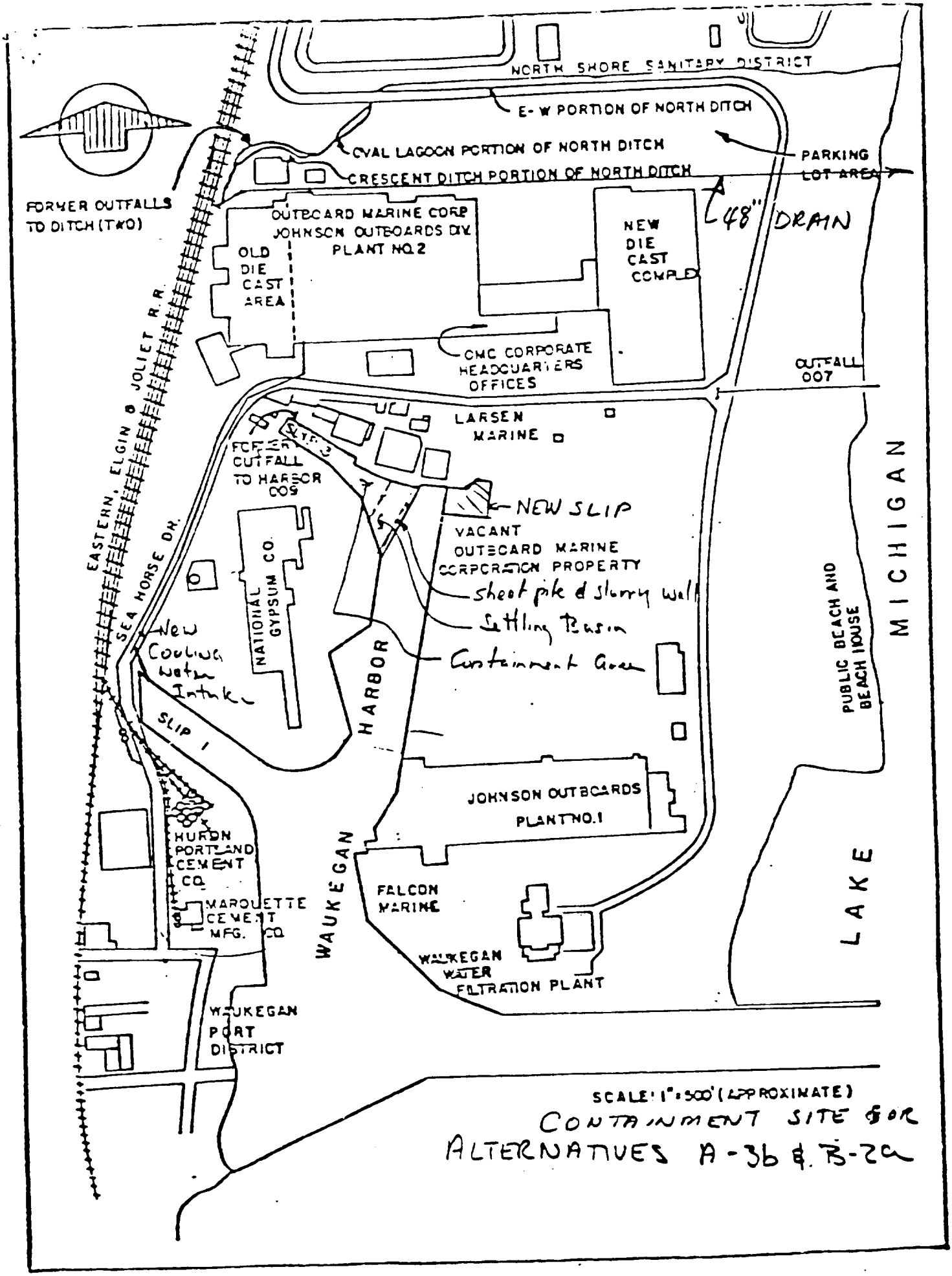
- Construct a 3-foot thick slurry wall extending at least 5-feet into clay in the center of the compacted sand causeway between the two sheet pile walls.

- After filling the containment site, remove the temporary sheet piling wall.

A crude, water treatment facility would be constructed by installing a temporary sheet pile wall within the slip to the west of the permanent wall. Equipment for the additions of polymers would be installed to provide a reasonable degree of settling of the return dredge water, as it passed through this area into the upper harbor. The upper harbor would also be temporarily sealed off during dredging to prevent the loss of PCB's to the lake.

The conversion of slip 3 into a containment site would require the construction of a new slip for Larsen Marine. It is proposed that this slip be constructed at the northeast corner of the upper harbor as shown in the attached sketch. A new cooling water intake for OMC would also be required.

Upon completion of dredging and filling with material from the north ditch and parking lot, the surface of the slip would be sealed with clay, topsoiled and seeded. Because it will not be possible to dewater the slip to any great degree after filling, it should be anticipated that some time will be required for consolidation of the dredged material prior to placing the final cover.


NORTH SHORE SANITARY DISTRICT
E-W PORTION OF NORTH DITCH
OVAL LAGOON PORTION OF NORTH DITCH
CRESCENT DITCH PORTION OF NORTH DITCH
PARKING LOT AREA
48" DRAIN
FORMER OUTFALLS TO DITCH (TWO)
OUTBOARD MARINE CORP JOHNSON OUTBOARDS DIV. PLANT NO. 2
OLD DIE CAST AREA
NEW DIE CAST COMPLD
OMC CORPORATE HEADQUARTERS OFFICES
OUTFALL 007
EASTERN, ELGIN & JOLIET R.R.
LARSEN MARINE
FORMER OUTFALL TO HARBOR COS
NEW SLIP
VACANT OUTBOARD MARINE CORPORATION PROPERTY
sheet pile & slurry wall
Settling Basin
Containment Area
NATIONAL GYPSUM CO.
SEA HORSE DR.
New Cooling Water Intake
SLIP 1
HARBOR
WAUKEGAN
MICHIGAN
PUBLIC BEACH AND BEACH HOUSE
JOHNSON OUTBOARDS PLANT NO. 1
HURON PORTLAND CEMENT CO.
MARQUETTE CEMENT MFG. CO.
FALCON MARINE
WAUKEGAN WATER FILTRATION PLANT
LAKE
WAUKEGAN PORT DISTRICT
SCALE: 1" = 500' (APPROXIMATE)
CONTAINMENT SITE FOR ALTERNATIVES A-3b & B-2a

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-3b

REMOVE CONTAMINATED MATERIAL FROM NORTH DITCH
AND PARKING LOT AND DISPOSE OF IN SLIP 3

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Storm Drain | | | |
| New RCP Storm Drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| Manholes - 8 Ft. Dia. Precast | 9 EA. | 5,000.00 | 45,000 |
| Dewatering - Well Point | 2,650 L.F. | 20.00 | 53,000 |
| Rip Rap at Outlet | 50 C.Y. | 50.00 | 2,500 |
| Disposal of Contaminated Excavation in Slip 3 | 2,000 C.Y. | 5.00 | 10,000 |
| Surface Restoration over drain | 8,000 S.Y. | 9.00 | 72,000 |
| Excavate Contaminated Material From Ditch and Parking Lot | | | |
| Relocate Utilities - sewers, etc. | L.S. | L.S. | 20,000 |
| Temporary Sheeting | 36,000 S.F. | 8.00 | 288,000 |
| Well Point Dewatering | L.S. | L.S. | 60,000 |
| Excavation & Hauling to disposal site (slip 3) | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill excavated areas | 10,100 C.Y. | 10.00 | 101,000 |
| Backfill original ditch (see Alt. A-2) | 7,190 C.Y. | 10.00 | 71,900 |
| 1' Clay seal, topsoil & seed ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking lot excavations | 700 S.Y. | 7.00 | 4,900 |
| Decontaminate equipment | L.S. | L.S. | 20,000 |
| Air Monitoring during Excavation | L.S. | L.S. | 5,000 |
| SUBTOTAL CONSTRUCTION COST | | | $1,155,300 |

Ditch and Parking Lot Share of Cost of Converting Slip 3 to Containment Site

$\frac{12,100 \text{ C.Y.}}{38,000 \text{ C.Y. Total}}$ = 0.32 X $1,534,722 = $ 491,111

| | |
|---|---|
| TOTAL CONSTRUCTION COST | $ 1,646,411 |
| Contingencies @ 20% | 329,282 |
| Engineering @ 25% | 411,603 |
| Legal & Administrative @ 3% | 49,392 |
| TOTAL PROJECT COST | $ 2,436,688 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-2a

DREDGE UPPER HARBOR - DISPOSE OF
CONTAMINATED MATERIAL IN SLIP 3

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Upper Harbor | | | |
| Dredging | 21,000 C.Y. | $ 10.00 | $ 210,000 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Pumping treated return water | L.S. | L.S. | 10,000 |
| Chemicals & labor for water treatment | L.S. | L.S. | 15,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air & Water Monitoring During Dredging | L.S. | L.S. | 30,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 392,900 |
| Dredging Share of Cost for Converting Slip 3 to Containment Site | | | |
| $\frac{25,900}{38,000}$ = 0.68 X $1,534,722 = | | | $ 1,043,611 |
| Temporary Sheet Pile Wall for Water Treatment area | 6,000 S.F. | 8.10 | 48,600 |
| TOTAL CONSTRUCTION COST | | | $ 1,485,111 |
| Contingencies @ 20% | | | 297,022 |
| Engineering @ 25% | | | 371,278 |
| Legal & Administrative @ 3% | | | 44,553 |
| TOTAL PROJECT COST | | | $ 2,197,964 |

PRELIMINARY COST ESTIMATE

CONVERT SLIP 3 INTO CONTAINMENT SITE
USE WITH ALTERNATIVES B-2a AND A-3b

WITHOUT WATER TREATMENT FACILITIES

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Slip for Larsen Marine | | | |
| Steel sheet pile left in place | 16,000 S.F. | $ 16.55 | $ 264,800 |
| Excavation & disposal | 14,000 C.Y. | 10.00 | 140,000 |
| New Docks, Utilities, etc. | L.S. | L.S. | 350,000 |
| Close Slip 3 | | | |
| Steel sheet piling left in place | 12,000 S.F. | 16.55 | 198,600 |
| Temporary steel sheet piling | 12,000 S.F. | 8.10 | 97,200 |
| Sand Fill | 3,000 C.Y. | 2.50 | 7,500 |
| Slurry Wall | 32,000 C.F. | 8.00 | 256,000 |
| Reroute OMC Cooling Water In-Take | | | |
| 10" dia. D.I.P. | 1,500 L.F. | 45.00 | 67,500 |
| Modify in-take pumps | L.S. | L.S. | 10,000 |
| Utility Relocation at Slip 3 | | | |
| Construct new drains, etc. | L.S. | L.S. | 50,000 |
| Restoration Work | | | |
| 1' of sand cover from new slip | 3,157 C.Y. | 2.50 | 7,892 |
| 1' Clay seal, 1' topsoil & seed | 9,470 S.Y. | 9.00 | 85,230 |
| TOTAL CONSTRUCTION COST | | | $1,534,722 |

WITH WATER TREATMENT FACILITIES

| | | | |
|---|---|---|---|
| Add temporary sheet pile wall for water treatment area | 6,000 S.F. | 8.10 | 48,600 |
| TOTAL CONSTRUCTION COST | | | $1,583,322 |

ALTERNATIVE A-3b & B-2a

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 12 Samples/yr. | $ 210.00 | 2,520 |
| Water samples & analysis | 2 Samples/yr. | 210.00 | 420 |
| Inspection and annual report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 2 Ac. | 180.00 | 360 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,800 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 11,000 |

ALTERNATIVE B-2a

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilize | 15 | 21 |
| 2. | Construct New slip for Larson | 64) | |
| 2a. | Reroute Cooling Water Intake & Utility reloc. | 15) | 120 |
| 2b. | Construct storm drain in parking lot - complete | 86) | |
| 3. | Close slip 3 & construct WTP area | 75 | 105 |
| 4. | Dredge Harbor | 21) | 29 |
| 4a. | Sheet first section of ditch | 5) | |
| 5a. | Open Harbor | 2) | |
| 5b. | Excavate & backfill ditch | 125) | 190 |
| 5c. | Remove temporary sheeting for WTP area | 2) | |
| 5d. | Close cover | 20) | |
| 6. | Seal surface of Ditch topsoil & seed | 8 | 10 |
| 7. | Clean-up & Demobilization | 5 | 7 |
| | TOTAL | | 482 |

## ALTERNATIVE B-2b

Alternative B-2b is similar to Alternative B-2a except that approximately 38,000 C.Y. of material would be dredged from the upper harbor and placed in a sealed-off slip 3 rather than 21,000 C.Y. It is estimated that this would fill the sealed-off slip to capacity and therefore, no additional material from the north ditch or parking lot could be placed in the slip.

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-2b

Convert Slip 3 into Containment Site, Dredge 50 ppm Contaminated Material from Upper Harbor and Dispose of in Slip 3. Construct new Slip.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Construct New Slip for Larsen Marine | | | |
| Steel sheet pile left in place | 16,000 S.F. | $ 16.55 | $ 264,800 |
| Excavation and disposal | 14,000 C.Y. | 10.00 | 140,000 |
| New docks, utilities, etc. | L.S. | L.S. | 350,000 |
| Close Slip 3 | | | |
| Steel sheet piling left in place | 12,000 S.F. | 16.55 | 198,600 |
| Temporary steel sheet pile | 12,000 S.F. | 8.10 | 97,200 |
| Sand fill | 3,000 C.Y. | 2.50 | 7,500 |
| Slurry wall | 32,000 C.F. | 8.00 | 256,000 |
| Temporary sheet pile wall for water treatment area | 6,000 S.F. | 8.10 | 48,600 |
| Reroute OMC Cooling Water In-Take | | | |
| 10" dia. D.I.P. | 1,500 L.F. | 45.00 | 67,500 |
| Modify in-take pumps | L.S. | L.S. | 10,000 |
| Utility Relocation Work At Slip 3 | | | |
| Construct new drains, etc. | L.S. | L.S. | 50,000 |
| Dredge Harbor from Mouth of Slip 3 to Slip 1 | | | |
| Dredging | 38,000 C.Y. | 10.00 | 380,000 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Pumping treated return water | L.S | L.S. | 15,000 |
| Chemicals and labor for water treatment | L.S. | L.S. | 20,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |
| Air and Water Monitoring During Dredging | L.S. | L.S. | 40,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-2b
(Continued)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Restoration Work | | | |
| 1' of sand cover from new slip | 3,157 C.Y. | $ 2.50 | $ 7,892 |
| 1' clay seal, topsoil and seed | 9,470 S.Y. | 9.00 | 85,230 |
| TOTAL CONSTRUCTION COST: | | | $2,166,222 |
| Contingencies @ 20% | | | 433,244 |
| Engineering @ 25% | | | 541,556 |
| Legal & Administrative @ 3% | | | 64,987 |
| TOTAL PROJECT COST: | | | $3,206,009 |

ALTERNATIVE B-2b

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 12 Samples/yr. | $ 210.00 | 2,520 |
| Water samples & analysis | 2 Samples/yr. | 210.00 | 420 |
| Inspection and annual report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 2 Ac. | 180.00 | 360 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,800 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 11,000 |

ALTERNATIVE B-2b

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2. | Construct New Slip for Larsen | 64) | 90 |
| 2a. | Reroute 10" Dia. cooling water intake, utility relocation | 15) | |
| 3. | Close Harbor & Construct WTP area | 75 | 105 |
| 4. | Dredge Harbor | 38 | 54 |
| 5. | Open Harbor | 2) | 84 |
| 6. | Cover Containment Site | 60) | |
| 7. | Clean-up & Demobilize | 5 | 7 |
| | TOTAL | | 361 |

## ALTERNATIVES A-4 AND B-4

Under Alternative A-4, north ditch and parking lot material contaminated to a level of 50 ppm or greater would be removed and disposed of in a secure containment site constructed in OMC's parking lot.

Under Alternative B-4, contaminated material in slip 3 and the upper harbor would be dredged and placed in the containment site on OMC's parking lot.

The quantities to be disposed of are estimated to be as follows:

| | |
|---|---|
| from harbor and slip 3 | 48,000 C.Y. |
| from crescent ditch and lagoon | 16,800 C.Y. |
| from E-W portion of ditch | 9,000 C.Y. |
| from parking lot | 50,000 C.Y. |
| Total | 123,800 C.Y. |

Three secure containment cells, each with a volume of approximately 50,000 cubic yards, will be constructed on 10 acres in the area currently used as a parking lot north of OMC. A temporary water treatment lagoon, occupying an area of 1.5 acres, with a volume of 3 million gallons, will be constructed in the same area adjacent to the cells for the purpose of treating contaminated water pumped during dewatering operations and during dredging.

Most of the volume of the proposed containment cells will be below the level of the existing parking area. The finished cells will result in raising the parking lot about 7-feet above existing grade.

In order to control ground water during construction, a slurry wall will be installed around the 4,000-foot perimeter of the treatment lagoon and cell areas. Deep wells will be driven within the slurry wall area to pump ground water to levels below the bottom elevation of the containment cells. Ground water will be treated in the lagoon and discharged to a 48-inch storm sewer that will be constructed in a east-west direction, adjacent to the existing railroad siding, from an existing 36-inch culvert, to the lake.

The permanent containment cells will be lined with 5-foot of clay and fitted with an underdrain system for final dewatering purposes.

The sequence of construction is very important. First, all utilities within the proposed cell area will be relocated and a new storm drain constructed to divert water from the north ditch. Contaminated materials excavated during utility work will be stockpiled and covered to prevent volatilization of PCBs. Next, the slurry wall will be built and a water treatment system, consisting of a flocculation basin and settling pond, will be constructed at the east end of the site on top of the parking lot.

When the water treatment plant is ready for use, deep wells or a well point system will be installed inside the slurry wall. Water from the deep wells will be pumped to the treatment system and discharged via the new storm drain.

When the ground water table has been lowered about 12-feet, two containment cells will be built adjacent to the water treatment plant. Sampling data indicates that the soils in this area are relatively free of PCBs.

Once the first two cells have been made ready, the harbor will be sealed and dredged. Dredged material will be pumped to the westerly cell and the slurry water treated in the water treatment system prior to return to the dredging area. After dredging the harbor, this first cell will be dewatered and a temporary clay cover placed over it.

The second cell will be utilized to contain material removed from the crescent ditch. oval lagoon, E-W ditch, and that portion of the parking area between the slurry wall and the ditch. As in Alternatives A-5 and B-5, a mudcat, assisted by a clam shell for deep excavation, will be employed to dredge these areas.

After the ditch is excavated, construction of the third cell will begin. Much of the existing ground in the area to be occupied by the third cell has been contaminated by PCBs. Therefore, materials removed during excavation of the third cell will be stockpiled, temporarily, in the partially filled second cell. Once the third cell is complete, this material will be transferred to it. Finally, the water treatment plant will be removed and placed in the third cell and the entire area covered and restored.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-4

Remove 50 PPM & Greater Contaminated Material from North Ditch, Encapsulate, together with material from Harbor, in a containment site constructed in OMC's Parking Lot.

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| New RCP storm sewer | 2,650 L.F. | $ 100.00 | $ 265,000 |
| 8' Dia. Precast MH | 9 EA. | 5,000.00 | 45,000 |
| Well point dewatering | 2,650 L.F. | 20.00 | 53,000 |
| Rip Rap @ Outlet | 50 C.Y. | 50.00 | 2,500 |
| Move & stockpile contaminated excavation | 2,000 C.Y. | 2.50 | 5,000 |
| 10" Dia. DIP sanitary sewer | 1,370 L.F. | 50.00 | 68,500 |
| 48" Dia. MH (precast) | 8 EA. | 1,400.00 | 11,200 |
| Poured-in-place MH | 1 EA. | 10,000.00 | 10,000 |
| Excavate Crescent Ditch & Lagoon | | | |
| Plug culvert between lagoon & ditch | L.S. | L.S. | 500 |
| Steel sheeting around building & tank | 10,250 S.F. | 8.40 | 86,100 |
| Soil stabilization @ water tank | L.S. | L.S. | 20,000 |
| Remove & replace R.R. siding | 300 L.F. | 40.00 | 12,000 |
| Mud cat excavation | 16,800 C.Y. | 10.00 | 168,000 |
| Clamshell excavation | 3,900 C.Y. | 12.00 | 46,800 |
| Return water pumping to WTP | L.S. | L.S. | 1,500 |
| Return water treatment | L.S. | L.S. | 15,000 |
| Return water pumping to lagoon | L.S. | L.S. | 7,500 |
| Backfill Crescent ditch & lagoon | 19,500 C.Y. | 4.00 | 78,000 |
| 1' clay seal, topsoil & seed | 1,800 S.Y. | 9.00 | 16,200 |
| Excavate E-W Ditch | | | |
| Plug end of E-W ditch @ footbridge | 100 C.Y. | 10.00 | 1,000 |
| Mud cat dredge to 5' depth | 9,000 C.Y. | 10.00 | 90,000 |
| Return water pumping to WTP | L.S. | L.S. | 1,500 |
| Return water treatment | L.S. | L.S. | 15,000 |
| Return water pumping to ditch | L.S. | L.S. | 5,000 |

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Backfill ditch | 14,000 C.Y. | $ 4.00 | $ 56,000 |
| 1' clay seal, topsoil & seed ditch | 6,000 S.Y. | 8.00 | 48,000 |
| Place material from Parking Lot in containment cell | 48,000 C.Y. | 2.50 | 120,000 |
| SUBTOTAL: | | | $1,248,300 |
| Share of cost for construction of Water Treatment Plant, Containment Cells & Operating Costs (See Attached Estimate) | | | |
| TOTAL CONSTRUCTION COST: | | | $4,859,348 |
| Contingencies @ 20% | | | 971,870 |
| Engineering @ 25% | | | 1,214,837 |
| Legal & Administrative @ 3% | | | 145,780 |
| TOTAL PROJECT COST: | | | $2,332,487 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-4

DREDGE HARBOR - DISPOSE OF CONTAMINATED MATERIAL
IN CONTAINMENT CELL IN OMC'S PARKING LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Harbor | | | |
| Temporary sheet pile wall across harbor | 9,000 S.F. | $ 8.10 | $ 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Hydraulic dredging | 48,000 C.Y. | 10.00 | 480,000 |
| Return water pumping to WTP | L.S. | L.S. | 2,000 |
| Return water treatment | L.S. | L.S. | 20,000 |
| Return water pumping to Harbor | L.S. | L.S. | 10,000 |
| SUBTOTAL: | | | $ 649,445 |
| Share of cost for Construction of Water Treatment Plant, Containment Cells & Operating Costs (See Attached Estimate) | | | $2,308,702 |
| TOTAL CONSTRUCTION COST: | | | $2,958,147 |
| Contingencies @ 20% | | | 591,629 |
| Engineering @ 25% | | | 739,537 |
| Legal & Administrative @ 3% | | | 88,744 |
| TOTAL PROJECT COST: | | | $4,378,057 |

PRELIMINARY COST ESTIMATE

CONTAINMENT SITE ON OMC'S PARKING LOT

ALTERNATIVES A-4 AND B-4

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| 12" H.P. gas relocation | 2,000 L.F. | $ 50.00 | $ 100,000 |
| Slurry wall 2' wide X 40' deep | 320,000 C.F. | 7.00 | 2,240,000 |
| Water Treatment Plant | | | |
| Earthwork | 12,150 C.Y. | 3.00 | 36,450 |
| Bentonite seal on bottom & side | 60,000 S.F. | 1.00 | 60,000 |
| Outlet weir & piping | L.S. | L.S. | 25,000 |
| Under drainage system | 800 L.F. | 10.00 | 8,000 |
| Timber baffle wall | 1,200 S.F. | 1.25 | 1,500 |
| Floating Flocculator | 2 EA. | 35,000.00 | 70,000 |
| Chemical feed pumps, etc. | L.S. | L.S. | 20,000 |
| Containment Cells | | | |
| Excavation | 180,000 C.Y. | 2.50 | 450,000 |
| Compacted Sand Berms | 24,240 C.Y. | 2.50 | 60,600 |
| Clay liner (5' thick) | 63,900 C.Y. | 10.00 | 639,000 |
| Underdrain & leachate collection | | | |
| 6" - Perf. pipe | 5,000 L.F. | 15.00 | 75,000 |
| 48" dia. collector MH's | 3 EA. | 1,500.00 | 4,500 |
| Dewatering during excavation | L.S. | L.S. | 400,000 |
| Outlet structures w/pumps | 3 EA. | 25,000.00 | 75,000 |
| Dewater All Cells | | | |
| Temporary pumping | L.S. | L.S. | 20,000 |
| Water Treatment | L.S. | L.S. | 40,000 |
| Close All Cells | | | |
| 2' Clay cover | 25,500 C.Y. | 10.00 | 255,000 |
| 12" gravel layer | 15,000 C.Y. | 10.00 | 150,000 |
| Remove WTP & Dispose in Cells | | | |
| Excavation | 7,800 C.Y. | 4.00 | 31,200 |
| Remove Equipment | L.S. | L.S. | 5,000 |
| Backfill Area | 8,500 C.Y. | 4.00 | 34,000 |
| Restore Area | | | |
| Repave Parking area | 55,500 S.Y. | 9.00 | 499,500 |
| Misc. catch basins & other surface drainage | L.S. | L.S. | 75,000 |

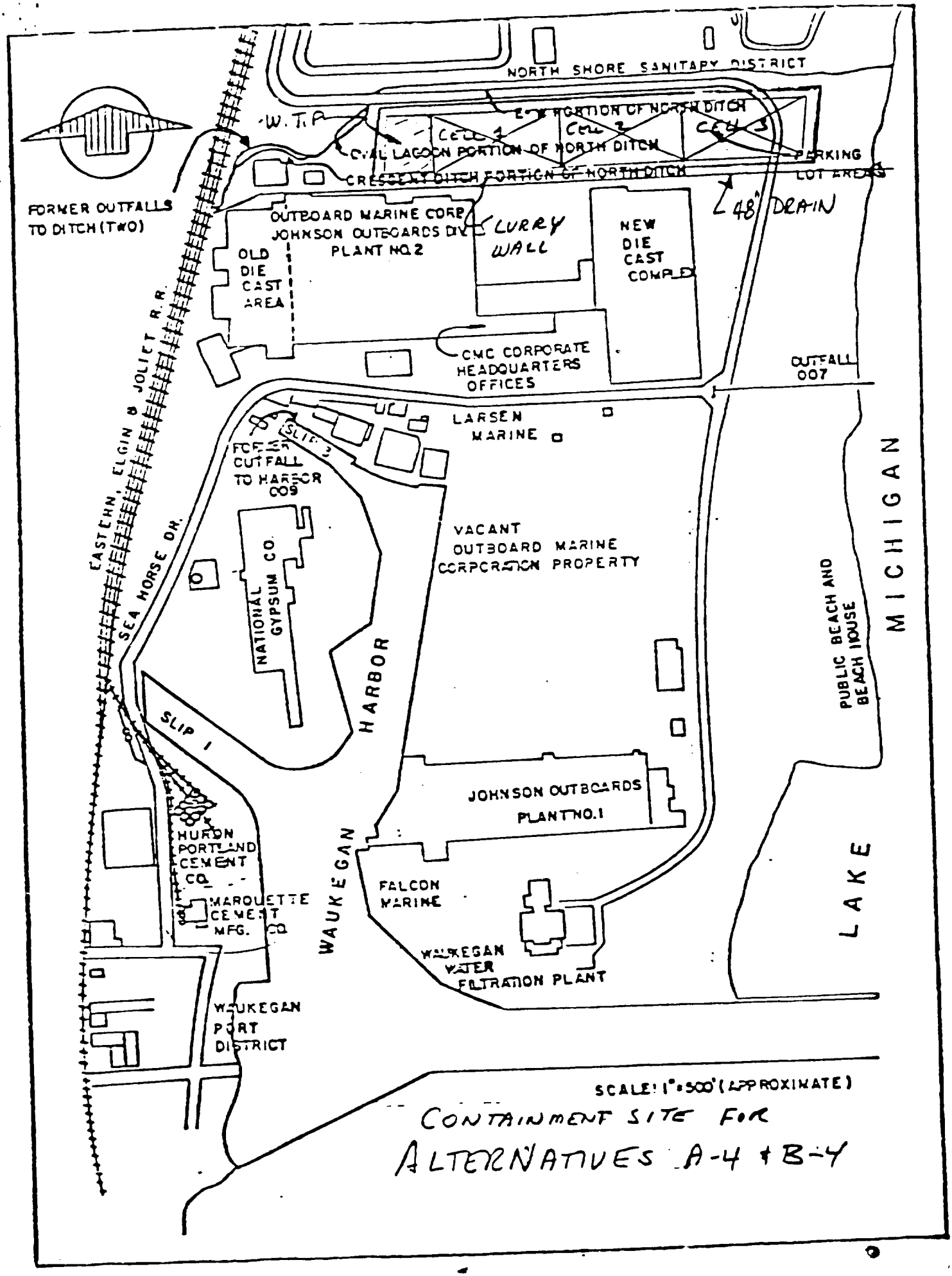
| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dispose of clean excess excavation | 55,000 C.Y. | $ 7.00 | $ 385,000 |
| Other Costs During Construction | | | |
| Monitoring & Sampling air & water | L.S. | L.S. | 100,000 |
| Decontamination of Equipment | L.S. | L.S. | 60,000 |
| SUBTOTAL CONSTRUCTION COSTS | | | $ 5,919,750 |

Share assigned to North Ditch under Alternative A-4:

$$\frac{75{,}800 \text{ C.Y.}}{123{,}800 \text{ C.Y. total}} = .61 \times 5{,}919{,}750 = \$3{,}611{,}048$$

Share assigned to Harbor under Alternative B-4

$$\frac{4{,}800 \text{ C.Y.}}{123{,}800 \text{ C.Y.}} = 0.39 \times 5{,}919{,}750 = \$2{,}308{,}702$$


NORTH SHORE SANITARY DISTRICT
W.T.P.
CELL 1
CELL 2
CELL 3
COAL LAGOON PORTION OF NORTH DITCH
CRESCENT DITCH PORTION OF NORTH DITCH
PARKING LOT AREA
48" DRAIN
FORMER OUTFALLS TO DITCH (TWO)
OUTBOARD MARINE CORP.
JOHNSON OUTBOARDS DIV.
PLANT NO. 2
SLURRY WALL
NEW DIE CAST COMPLEX
OLD DIE CAST AREA
CMC CORPORATE HEADQUARTERS OFFICES
OUTFALL 007
LARSEN MARINE
SLIP 3
FORMER OUTFALL TO HARBOR 009
VACANT OUTBOARD MARINE CORPORATION PROPERTY
NATIONAL GYPSUM CO.
HARBOR
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WAUKEGAN PORT DISTRICT
SCALE: 1" = 500' (APPROXIMATE)
CONTAINMENT SITE FOR
ALTERNATIVES A-4 + B-4

ALTERNATIVES A-4 AND B-4

ESTIMATED ANNUAL O&M COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air Monitoring | 1 Sample/yr. | 400.00 | 400 |
| Yearly site inspection and report | 40 Hours | 60.00 | 2,400 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,000 |
| Leachate collection and treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 12,740 |

ALTERNATIVES A-4 & B-4

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilization | 15 | 21 |
| 2a. | Relocate utilities in Parking Lot | 30) | 120 |
| 2b. | Construct new storm drain thru Parking Lot | 86) | |
| 3a. | Construct slurry wall around Parking Lot | 100) | 140 |
| 3b. | Construct water treatment | 60) | |
| 4a. | Dewater and construct containment cells | 140) | 196 |
| 4b. | Reinforce existing sheet pile wall in harbor | 10) | |
| 4c. | Close harbor near slip 1 | 20) | |
| 5. | Dredge harbor | 48 | 67 |
| 6. | Open harbor | 3 | 3 |
| 7. | Dredge dtich | 30 | 42 |
| 8a. | Remove water treatment plant & place in cells | 10) | 63 |
| 8b. | Dewater all cells | 45) | |
| 8c. | Backfill ditch, topsoil and seed | 32) | |
| 9. | Place final cover over cells and repave parking lot | 60 | 84 |
| 10. | Clean-up & Demobilize | 5 | 7 |
| | TOTAL | | 743 |

## ALTERNATIVES A-5 AND B-5

Under Alternative A-5, a new storm drain would be constructed through OMC's parking lot and 50 ppm and greater contaminated material from the north ditch and parking lot would be removed and disposed of in a new, off-site landfill.

Under Alternative B-5, 50 ppm and greater contaminated material from slip 3 and the upper harbor would be dredged and disposed of in the off-site landfill.

An estimate of the quantities to be disposed of under these two Alternatives is as follows:

| | |
|---|---|
| from harbor north of slip 1 | 48,000 C.Y. |
| from crescent ditch and lagoon | 16,800 C.Y. |
| from E-W portion of ditch | 9,000 C.Y. |
| from parking lot | 50,000 C.Y. |
| Total | 123,800 C.Y. |

Under these two Alternatives, it is assumed that a 60± acre site with suitable clay soils can be located and purchased within 20± miles of the harbor. A 200,000 C.Y. capacity secure landfill would be built on this site. A temporary, dewatering and containment lagoon would be constructed on OMC's vacant lot. This lagoon would have a capacity of approximately 75,000 C.Y., and would be filled and emptied twice during the dredging process. A settling basin would be constructed as part of the temporary lagoon to treat dredge return water. The materials used to construct the lagoon and settling basin would be disposed in the landfill upon completion of dredging.

The upper harbor and slip 3 would be dredged prior to dredging the north ditch and parking lot. As in other harbor dredging Alternatives, the mouth of the harbor would be sealed-off with a temporary sheet pile wall to prevent loss of PCB's to the lake, and treated, slurry water would be returned to the area of the dredge.

After dredging the harbor, the temporary lagoon would be dewatered through an activated carbon pressure filter and the treated water discharged to the harbor. The material in the lagoon would then be trucked to the secure, off-site landfill.

After the harbor has been dredged, dredging would begin in the north ditch and parking lot.

In order to excavate the oval lagoon and crescent ditch, the culvert at the north (discharge) end of the lagoon would be plugged to contain sufficient water to float a mudcat dredge. This dredge would excavate the oval lagoon to a depth of 9-feet below its present bottom and the easterly end of the crescent ditch to approximately 5-feet. Contaminated material in the westerly end of the crescent ditch, at depths over 15-feet, the maximum working depth for a mudcat, would be excavated by clam shell and placed at a shallower depth for removal by the mudcat. All dredged material would be pumped directly to the temporary dewatering lagoon. Slurry water would be returned to the dredge area via a pipeline and skid mounted pump.

After dredging, the crescent ditch and oval lagoon would be backfilled, sealed, topsoiled and seeded. The temporary lagoon would be dewatered and the material trucked to the landfill; and the temporary lagoon and water treatment plant would be dismantled and hauled to the landfill. The placement of cover material at the off-site landfill would be carried out as material is placed in the site to minimize volatizations of PCBs.

PRELIMINARY COST ESTIMATE

ALTERNATIVE A-5

REMOVE CONTAMINATED MATERIAL FROM DITCH AND LAGOON, DISPOSE OF IN NEW, OFF-SITE LANDFILL

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Relocate Utilities in Parking Lot | | | |
| 48" RCP drain | 2,650 L.F. | $ 100.00 | $ 265,000 |
| 96" Precast MHs | 9 EA. | 5,000.00 | 45,000 |
| Well point dewatering | 2,650 L.F. | 20.00 | 53,000 |
| Disposal of contaminated Exc. | 2,000 C.Y. | 15.00 | 30,000 |
| 12" h.P. Gas | 1,850 L.F. | 50.00 | 92,500 |
| 10" D.I.P. Sewer | 660 L.F. | 50.00 | 33,000 |
| 48" precast MHs | 3 EA. | 1,400.00 | 4,200 |
| Poured-in-place MH | 1 EA. | 10,000.00 | 10,000 |
| Excavate Crescent Ditch & Lagoon | | | |
| Plug culvert between lagoon & ditch | L.S. | | 500 |
| Steel sheeting around bldg. & tank | 10,250 S.F. | 8.40 | 86,100 |
| Soil stabilization @ water tank | L.S. | | 20,000 |
| Remove & replace railroad siding | 300 L.F. | 40.00 | 12,000 |
| Mud cat excavation | 16,800 C.Y. | 10.00 | 168,000 |
| Clam shell excavation | 3,900 C.Y. | 12.00 | 46,800 |
| Return water pumping from lagoon | L.S. | | 10,000 |
| Backfill Crescent Ditch & Lagoon | | | |
| Sand backfill | 19,500 C.Y. | 6.00 | 117,000 |
| Seal, topsoil & seed | 1,800 S.Y. | 9.00 | 16,200 |
| Excavate E-W Ditch & Parking Lot | | | |
| Plug E-W ditch @ foot bridge | 100 C.Y. | 10.00 | 1,000 |
| Dredge ditch (mud cat) to 5' depth | 9,000 C.Y. | 10.00 | 90,000 |
| Strip parking lot to water table | 18,000 C.Y. | 4.00 | 72,000 |
| Mudcat dredge parking lot | 30,000 C.Y. | 10.00 | 300,000 |
| Return water pumping from lagoon | L.S. | | 70,000 |
| Backfill Ditch & Parking Lot | | | |
| Sand backfill | 48,000 C.Y. | 6.00 | 288,000 |
| Seal, topsoil & seed over ditch | 6,000 S.Y. | 6.00 | 36,000 |
| Restore parking area & road | 27,000 S.Y. | 9.00 | 243,000 |

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dewater & Dispose Material in Containment Lagoons | | | |
| Dewater via activated carbon filters | L.S. | $ | $ 50,000 |
| Excavate material from lagoon & truck to secure disposal site | 73,800 C.Y. | 15.00 | 1,107,000 |
| Handle at disposal site | 73,800 C.Y. | 2.00 | 147,600 |
| CONSTRUCTION COST SUBTOTAL | | | $ 3,413,900 |
| Share of Off-Site Secure Landfill | | | $ 1,078,022 |
| Share of Temp. Containment Site, Dewatering lagoon & WTP | | | 899,918 |
| Share of Dismantling Temp. Containment & Dewatering Lagoon | | | 786,900 |
| TOTAL CONSTRUCTION COST | | | $ 6,178,740 |
| Contingencies @ 20% | | | 1,235,748 |
| Engineering @ 25% | | | 1,544,685 |
| Legal & Administrative @ 3% | | | 185,362 |
| TOTAL PROJECT COST | | | $ 9,144,535 |

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-5

REMOVE CONTAMINATED MATERIAL FROM HARBOR, DISPOSE OF IN NEW, OFF-SITE LANDFILL

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Dredge Harbor | | | |
| Dredge between Slip 1 and Slip 3 | 39,000 C.Y. | $ 10.00 | $ 390,000 |
| Sheet pile wall across Slip 1 | 9,000 S.F. | 8.10 | 72,900 |
| Dredge Slip 3 | 9,000 C.Y. | 10.00 | 90,000 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Dewater containment lagoon | L.S. | L.S. | 45,000 |
| Excavate Material from Lagoon and Truck to Secure Disposal Site | 48,000 C.Y. | 15.00 | 720,000 |
| Handle at Disposal Site | 48,000 C.Y. | 2.00 | 96,000 |
| SUBTOTAL CONSTRUCTION COST: | | | $1,478,445 |
| Share of Off-Site Secure Landfill | | | 689,228 |
| Share of Temporary Containment Site, Dewatering Lagoon and WTP | | | 575,357 |
| Share of Dismantling Temporary Containment and Dewatering Lagoon | | | 503,100 |
| TOTAL CONSTRUCTION COST: | | | $3,246,130 |
| Contingencies @ 20% | | | 649,225 |
| Engineering @ 25% | | | 811,532 |
| Legal & Administrative @ 3% | | | 97,384 |
| TOTAL PROJECT COST: | | | $4,804,271 |

PRELIMINARY COST ESTIMATE

OFF-SITE SECURE LANDFILL, TEMPORARY CONTAINMENT
AND DEWATERING LAGOON AND WATER TREATMENT PLANT
USE WITH ALTERNATIVES A-5 & B-5

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Off-site Secure Landfill | | | |
| Purchase Land | 60 A.C. | $ 5,000.00 | $ 300,000 |
| Excavate Clay | 76,000 C.Y. | 4.00 | 304,000 |
| Construct Berms (Clay) | 30,000 C.Y. | 3.00 | 90,000 |
| Construct Clay Cover | 35,000 C.Y. | 6.00 | 210,000 |
| Construct Gravel Cover | 18,200 C.Y. | 8.00 | 145,600 |
| Topsoil | 23,700 C.Y. | 10.00 | 237,000 |
| Seed | 15 A.C. | 750.00 | 11,250 |
| Leachate Collection System | 3,600 L.F. | 10.00 | 36,000 |
| Permanent Fencing | 3,500 L.F. | 6.00 | 21,000 |
| Monitoring Wells | 6 NESTS | 8,000.00 | 48,000 |
| Site Drainage | L.S. | L.S. | 100,000 |
| Construct Access Road | 1,000 L.F. | 50.00 | 50,000 |
| Decontamination Station | L.S. | L.S. | 25,000 |
| Electric Power | L.S. | L.S. | 40,000 |
| Misc. (Compaction of bottom, etc.) | L.S. | L.S. | 150,000 |
| CONSTRUCTION COST SUBTOTAL | | | $ 1,767,250 |
| Temporary Containment & Dewatering Lagoon with Treatment Plant on Vacant OMC Land | | | |
| Level Existing dredge spoil piles | 30,000 C.Y. | 1.50 | 45,000 |
| Excavate for lagoon base | 28,000 C.Y. | 1.50 | 42,000 |
| Bentonite Seal | 253,000 S.F. | 1.00 | 253,000 |
| Install leachate drains | 3,000 L.F. | 10.00 | 30,000 |
| 2' Gravel layer | 18,500 C.Y. | 10.00 | 185,000 |
| Construct sand berms | 2,750 C.Y. | 2.50 | 6,875 |
| 2' Clay liners | 22,700 C.Y. | 10.00 | 227,000 |
| Install underdrain system | L.S. | L.S. | 50,000 |
| 2' Gravel layer | 22,700 C.Y. | 10.00 | 227,000 |
| Overflow weir & piping | 1 EA. | 25,000.00 | 25,000 |
| Monitoring wells, air sampling equip., etc. | L.S. | L.S. | 60,000 |
| Roadway & site drainage | L.S. | L.S. | 60,000 |
| Install electric service | L.S. | L.S. | 10,000 |
| Shape & compact basin in sand | L.S. | L.S. | 40,000 |
| Hypalon liner | 6,400 S.F. | 0.85 | 54,400 |

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Overflow weir, piping & pump | L.S. | L.S. | $ 25,000 |
| Static mixer, chem. feed equip., etc. | L.S. | L.S. | 25,000 |
| Pumping from Cell to WTP | | | |
| O&M | L.S. | L.S. | 5,000 |
| Chemicals & staffing O&M | L.S. | L.S. | 60,000 |
| Dismantle & remove | L.S. | L.S. | 45,000 |
| CONSTRUCTION COST SUBTOTAL | | | $1,475,275 |
| Dismantle Containment Lagoon - Dispose at Secure Disposal Site | | | |
| Excavate berms, gravel layer, clay liner & clay liner under-drain material - haul to disposal site. | 70,000 C.Y. | 15.00 | 1,050,000 |
| Handle at disposal site | 70,000 C.Y. | 2.00 | 140,000 |
| Decontamination of Equipment | L.S. | L.S. | 50,000 |
| Monitoring during dredging | L.S. | L.S. | 50,000 |
| CONSTRUCTION COST SUBTOTAL | | | $ 1,290,000 |
| TOTAL CONSTRUCTION COST | | | $ 4,532,525 |

SUMMARY - Harbor Share $= \frac{48,000}{123,800} = .39$ X Cost

Ditch Share $= \frac{75,800}{123,800} = .61$ X Cost

| | | HARBOR SHARE (X .39) | DITCH SHARE (X .61) |
|---|---|---|---|
| Off-site Landfill | $1,767,250 | $689,228 | $1,078,022 |
| Temp. cont. & WTP | $1,475,275 | 575,357 | 899,918 |
| Dismantle | $1,290,000 | 503,100 | 786,900 |

ALTERNATIVES A-5 AND B-5

ESTIMATED ANNUAL O&M COSTS

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air monitoring | 1 Sample/yr. | 400.00 | 400 |
| Yearly inspection and report | 40 Hours | 60.00 | 2,400 |
| Annual maintenance and repairs to cover | L.S. | L.S. | 3,800 |
| Mow grass | 15 Ac. | 180.00 | 2,700 |
| Leachate pumping and treatment | L.S. | L.S. | 400 |
| Misc. (fencing, signs and maintenance at access road) | L.S. | L.S. | 600 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 17,840 |

ALTERNATIVES A-5 & B-5

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1a. | Construct off-site landfill | 170 | |
| 1b. | Construct temporary Dewatering lagoon & containment cell on OMC's vacant lot | 110 | 240 |
| 1c. | Construct new storm drain in OMC's parking lot | 86 | |
| 2. | Close harbor & reinforce existing slip wall | 20 | 28 |
| 3. | Dredge slip 3 & harbor | 48 | 68 |
| 4. | Open harbor | 2 | 63 |
| 4a. | Dewater containment cell & water treatment plant | 45 | |
| 5. | Remove dredged material from temporary cell, truck to off-site landfill | 60 | 84 |
| 6a. | Dredge and excavate ditch and parking lot | 80 | |
| 6b. | Dewater containment cell and water treatment plant | 15 | 133 |
| 6c. | Backfill ditch and parking lot | 90 | |
| 7. | Remove dredged material from temporary cell, truck to landfill | 96 | 134 |
| 8. | Remove temporary cell and water treatment plant, truck to landfill | 87 | 121 |
| 9. | Complete final cover at landfill | 10 | 14 |
| 10. | Clean-up & Demobilize | 5 | 7 |
| | TOTAL | | 892 |

## ALTERNATIVE B-6

Under Alternative B-6, slip 3 and approximately 500 C.Y. of contaminated material in the upper harbor near the mouth of the slip which must be removed to prevent loss of use of the harbor by Larsen Marine Co. would be dredged and disposed of in a secure containment site constructed on OMC's vacant lot. This Alternative is the same as Alternative B-3a, except that the containment site would only be used for the material from the slip and upper harbor, and no capacity would be provided for material from the north ditch or parking lot.

PRELIMINARY COST ESTIMATE

ALTERNATIVE B-6

DREDGE HARBOR & SLIP 3; DISPOSE OF IN CONTAINMENT SITE ON OMC VACANT LOT

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Containment site on OMC vacant lot | | | |
| Site Work - level & compact area | L.S. | L.S. | $ 30,000 |
| 1' clay blanket (compacted) | 1,720 C.Y. | $ 10.00 | 17,200 |
| 1' gravel drainage course | 1,720 C.Y. | 10.00 | 17,200 |
| Compacted sand berm | 24,000 C.Y. | 6.00 | 144,000 |
| Clay cut off wall | 1,600 C.Y. | 10.00 | 16,000 |
| 3' clay liner | 4,900 C.Y. | 10.00 | 49,000 |
| 6" leachate collector | 900 L.F. | 10.00 | 9,000 |
| 6" dewatering pipe | 800 L.F. | 10.00 | 8,000 |
| 48" dia. collector MH | 1 EA. | 1,600.00 | 1,600 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Permanent fence | 1,500 L.F. | 6.00 | 9,000 |
| Electric power | L.S. | L.S. | 10,000 |
| Final cover | | | |
| 2' clay cover | 3,450 C.Y. | 10.00 | 34,500 |
| 1' topsoil cover | 1,800 C.Y. | 10.00 | 18,000 |
| Seeding | 2.4 A.C. | 750.00 | 1,800 |
| Construct Water Treatment Plant | | | |
| Sand Berms | 11,000 C.Y. | 6.00 | 66,000 |
| Synthetic liner | 50,000 S.F. | 0.85 | 42,500 |
| Gravel blanket | 2,000 C.Y. | 10.00 | 20,000 |
| Overflow weir & piping | L.S. | L.S. | 25,000 |
| Static mixer, chemical feed pumps, etc. | L.S. | L.S. | 30,000 |
| Dismantle & place in containment cell @ closure | L.S. | L.S. | 30,000 |
| Dredge Upper Harbor & Slip 3 | | | |
| Dredging | 11,375 C.Y. | 10.00 | 113,750 |
| Temporary sheet pile wall for closing harbor | 9,000 S.F. | 8.10 | 72,900 |
| Reinforce existing sheet pile wall | 3,900 S.F. | 16.55 | 64,545 |
| Chemicals & labor for water treatment | L.S. | L.S. | 12,000 |
| Miscellaneous water treatment equipment | L.S. | L.S. | 30,000 |

ALTERNATIVE B-6 (continued)

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Air & Water Monitoring During Dredging | L.S. | L.S. | $ 25,000 |
| Decontamination of Equipment | L.S. | L.S. | 25,000 |
| Dewatering Containment Cell Prior to Placing Final Cover | L.S. | L.S. | 50,000 |
| SUBTOTAL CONSTRUCTION COST | | | $ 996,995 |
| Contingencies @ 20% | | | 199,399 |
| Engineering @ 25% | | | 249,249 |
| Legal & Administrative @ 3% | | | 29,910 |
| TOTAL PROJECT COST | | | $1,475,553 |

ALTERNATIVE B-6

ESTIMATED ANNUAL O&M COST

| DESCRIPTION | QUANTITY | UNIT COST | TOTAL |
|---|---|---|---|
| Equipment Maintenance and electric power charges | L.S. | L.S. | $ 2,500 |
| Ground water sampling and analysis | 24 Samples/yr. | $ 210.00 | 5,040 |
| Air sampling and analysis | 1 Sample/yr. | 400.00 | 400 |
| Inspection and Annual Report | 40 Hours | 60.00 | 2,400 |
| Mow Grass | 3 Ac. | 180.00 | 540 |
| Annual maintenance and repair to cover | L.S. | L.S. | 2,000 |
| Leachate collection & treatment | L.S. | L.S. | 400 |
| TOTAL ESTIMATED ANNUAL COST | | | $ 13,280 |

ALTERNATIVE B-6

CONSTRUCTION SCHEDULE

| SEQUENCE | DESCRIPTION | DURATION (WORKING DAYS) | DURATION (CALENDER DAYS) |
|---|---|---|---|
| 1. | Mobilize | 15 | 21 |
| 2. | Construct containment site and water treatment plant on OMC's vacant lot | 125 | 175 |
| 3. | Close harbor and reinforce existing sheet pile wall in slip 1 | 20 | 28 |
| 4. | Dredge slip 3 and harbor | 12 | 16 |
| 5. | Open harbor | 3) | |
| 5a. | Dewater containment site and dismantle WTP | 30) | 45 |
| 6. | Cover containment site | 20 | 28 |
| 7. | Clean-up and Demobilize | 5 | 7 |
| | TOTAL | | 323 |

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY RPB DATE SHEET NO 3 OF 3

CHKD BY DATE JOB NO

SUBJECT Volatilization

3. PCB losses:

a. Convert J to J* lb/yr by

$$J\,(\mu g/m^2\text{-day}) \times \text{acre} \times 0.0089 \times 365 = J^*$$

b. At 60°F (not really a direct factor in the eqn – use $k_L$ of 0.44) and

1). 37 acres of harbor and values in 1b above

Roughly 14 lb/yr of PCB could be volatilized. Correcting for ice cover indicates about 12 lb/yr of loss.

2). 90 sq mi of near shore waters and 0.005 µg/L.

Roughly 400 lb/yr of PCB might be volatilized.

3). Losses during construction could be calculated similarly. Use 70 µg/L as water column value.

Roughly 0.3 to 0.4 lb/day/acre. of exposed, agitated, contaminated water area.

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
BY RPB DATE 8/5/82 SHEET NO 2 OF 3
CHKD BY DATE JOB NO 607-01-9100
SUBJECT Volatilization

2. Methods of estimating PCB loss

a) $J = K_L C_d$

$J$ = mass flux, $ug/m^2 day$

$K_L$ = mass transfer coefficient, m/day
0.28 to 0.44

$C_d$ = Dissolved PCB conc. ug/L

Source: PCB Volatilization from Hudson River
D. Toro and O'Connor

b). $Q = (MW)(K_L)(A)(X_i)$

$Q$ = mass flux, lb/hr
$MW$ = molecular wt of PCB

$K_L$ = mass transfer coefficient, $\frac{lb\text{-}mole}{ft^2\text{-}hr}$

$A$ = surface area ($ft^2$)

$X_i$ = mole fraction of PCB in water

Source: Hwang - OSEPA Office of Solid waste
Only has $K_L$ on Aroclor 1254

Use D. Toro and O'Connor

Volatilization

1. Volatilization of PCB's

a Solubility in Water Column (ug/L) based on literature

| Aroclor | Hutzinger, 1974 | Verschueren | Summary of Mason & Hanger |
|---|---|---|---|
| 1242 | — | — | 200 to 340, 703 |
| 1248 | 100 | 54 | — |
| 1254 | 40 | 12 | 12 |
| 1260 | 25 | — | — |

b. Reported water column data in Waukegan area; based on Kontakis 10/21/81

| Location | Total PCB (ug/L) | Dissolved PCB |
|---|---|---|
| Slip #3 | Say 0.8 to 1.0 | ~0.4 |
| Rest of Harbor | 0.1 to 1.0 Say 0.5 | ~0.05 to 0.5 Say 0.25 |
| Outside of Harbor (within 10 km radius) | 0.01 to 0.05 at 1 mile<br>0.005 to 0.1 in open lake<br>Say 0.005 | ? but probably most of total |

DEPOSITION EXHIBIT
BROWNELL-DAK
8-10 8-10-87