Feasibility Study Report
Cumberland Bay Sludge Bed - Wilcox Dock
Operable Unit No. 1

Work Assignment No. D002520-32

Prepared for:

SUPERFUND STANDBY PROGRAM
New York State
Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233

Prepared by:

Rust Environment & Infrastructure
12 Metro Park Road
Albany, New York 12205

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New York State
Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233-7010

Submitted By:

Rust Environment & Infrastructure
12 Metro Park Road
Albany, New York 12205

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1.0 INTRODUCTION

This Remedial Alternatives Evaluation is being performed under Work Assignment D002520-32 of the State Superfund Contract between the New York State Department of Environmental Conservation (NYSDEC) and Rust Environment & Infrastructure (Rust) and it's subconsultant, TAMS Consultants, Inc. (TAMS). It represents Tasks 3 and 4 of a series of five tasks[1] associated with the implementation of a Feasibility Study (FS) for the Cumberland Bay Sludge Bed Project.

1.1 Purpose and Organization of Report

The purpose of the document is to identify and analyze remedial alternatives that: are protective of human health and the environment; attain, to the maximum extent practicable, federal and State standards, criteria and guidelines (SCGs); and are cost effective. Accordingly, the Cumberland Bay Sludge Bed Feasibility Study is based on the objectives, methodologies, and evaluation criteria as generally set forth in the following federal and State regulations and guidelines:

- the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and the Superfund Reauthorization Act of 1986 (SARA);
- the National Oil and Hazardous Substances Contingency Plan (NCP);
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, October 1988);
- New York Rules for Inactive Hazardous Waste Disposal Site Remedial Program; 6 NYCRR Part 375 (May 1992);
- CERCLA Compliance with Other Laws Manual, 1988, OSWER Directive No. 9234.1-01 and -02;
- NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #HWR-89-4025 "Guidelines for RI/FS's";
- NYSDEC TAGM #HWR-90-4030 "Selection of Remedial Actions at Inactive Hazardous Waste Sites"; and
- NYSDEC TAGM #HWR-89-4022 "Records of Decision for Remediation of Class 2 Inactive Hazardous Waste Disposal Sites".

[1]Task 1 of the Work Assignment is preparation of a Work Plan, a site-specific Health and Safety Plan (HASP), and a Sampling and Analysis Plan (SAP). Task 2 is the performance of a Site Characterization to determine the extent of the sludge bed and the nature and extent of any contaminants within the bed. Tasks 3 and 4 are the development, screening and evaluation of remedial alternatives for the remediation of the sludge bed. The preparation of detailed design documents for the sludge bed remedy is Task 5.

The remainder of Section 1.0 contains background information about the Site and surrounding area, and a brief summary of the scope of the Site Characterization (SC) and pertinent SC findings including the physical systems and nature and extent of contamination. Section 1.0 also includes a brief summary of the Treatability Studies performed in conjunction with the SC and the Baseline Health Risk Assessment and Environmental Risk Assessment performed for the Cumberland Bay Sludge Bed Site. Section 2.0 identifies the remedial action objectives, general response actions and remedial technologies, and presents the screening of the remedial technologies on the basis of effectiveness, technical implementability, and cost. In Section 3.0, the technologies are grouped into remedial alternatives, which are then screened to eliminate those that are not suitable. In Section 4.0, a detailed analysis of the alternatives retained is presented, and the recommended remedial alternative is identified and described. Section 5.0 provides a brief description of the conceptual design for the recommended remedial alternative.

1.2 Background Information

1.2.1 Description of the Cumberland Bay Site

The Cumberland Bay Sludge Bed - Wilcox Dock Site (Cumberland Bay Site or Site) is located in the northwest corner of Cumberland Bay in Lake Champlain, east of the City of Plattsburgh, Clinton County, New York. The Site is bordered to the south by Wilcox Dock (also referred to as the New York State Department of Transportation Barge Terminal) and to the west by the shoreline. (Cumberland Bay and Wilcox Dock are described in more detail in Section 1.2.2.) The Site extends to the north to the approximate location of the Chamber of Commerce building and to the east approximately 750 feet offshore. The present Site definition includes all underwater areas within and along the northwestern portion of Cumberland Bay in Lake Champlain that contain accumulations of contaminated sludge (see Figure 1.1).

The sludge bed is composed of wood pulp, woodchip debris, fine organic matter, and other processing wastes that were discharged from local wood product industries (sawmills, woodchip producing industries, and paper manufacturing and processing industries). Records show that for several decades, wastes were discharged to local streams that discharge into Cumberland Bay or were directly discharged into the Bay. Sawmills on the Saranac River discharged wastes into Cumberland Bay, where prevailing winds and currents in the summer lodged the solids against the beach areas at the north end of the Bay. Also, pulp and paper mills on the shore of the Bay near Dead Creek disposed of solids and organic materials (Frederic R. Harris, Inc. 1979). Untreated waste disposal ended in the early 1970's when the Plattsburgh sewage treatment plant began treating wastes from the local industries.

Over the years, wave action and water currents eroded the sludge bed and transported woodchips and organic debris along the shorelines and beaches to the north as well as to other areas within Cumberland Bay. For several years, the Site was considered nothing more than a public nuisance, emitting unpleasant odors and hampering boating and swimming activities in the area. However, environmental sampling from 1992 through 1994 confirmed the presence of polychlorinated biphenyls (PCBs), and to a lesser extent polychlorinated dibenzodioxins (dioxins) and dibenzofurans (furans), and other contamination in the sludge. The high levels of PCBs in the sludge, pulp, and fine wood debris is the major concern at the site. Previous sampling within the sludge bed indicates that total PCB concentrations are as high as 1,850 parts per million (ppm). New York State Department of Health (NYSDOH) sampling in 1994 detected PCB concentrations in the woodchip debris washing up on shore and nearby bathing beaches as high as 210 ppm.

At the time of this report, there is a health advisory in effect for several species of fish within Lake Champlain and Cumberland Bay due to elevated PCB levels in the fish. The health advisory for women of child bearing years and children under the age of 15 is to eat no fish from these sources. For others, the advisory is to eat no more than one meal of fish per month. In addition, the commercial sale of yellow perch from Cumberland Bay is prohibited due to PCB concentrations in the fish, which exceed the US Food and Drug Administration (FDA) marketplace standard of 2 ppm.

1.2.2 Description of Cumberland Bay and Wilcox Dock

Cumberland Bay is a small, somewhat rectangular part of the west side of Lake Champlain. Depths in the Bay can exceed 50 feet but water depths in the vicinity of the Site do not exceed 17 feet and are generally under 10 feet. The City of Plattsburgh is located on the west side of the Bay, where the Saranac River and Dead Creek flow into the Bay. The north shoreline of Cumberland Bay is occupied by the Plattsburgh Municipal Beach, a NYS Office of Parks and Recreation campground, and numerous motels and restaurants. On the east side, Cumberland Head, a large peninsula, extends into the Bay.

The Wilcox Dock is an engineered structure, 200 feet wide by 400 feet long and is presently controlled by the New York State Canal Corporation under the jurisdiction of the New York State Thruway Authority (NYSTA). Historically, land deeded to Willard G. Wilcox by the State of New York in the late 1800's was reappropriated back to the State of New York Department of Public Works in 1914. Subsequently, a barge canal terminal was envisioned, planned, designed and constructed. In the mid-1960's, as a result of a rehabilitation project conducted to preserve the dock as a Barge Canal Terminal at Plattsburgh, the south and east sides of the dock and a short portion of the north side of the dock were reinforced with sheetpiling. The NYS Canal Corporation currently issues permits for the mooring of small water craft around the dock and limits access to the dock. The Georgia Pacific Corporation also controls access to a second entry to the dock area where it maintains a pump house for plant operations.

1.2.3 Previous Investigations

A number of relevant investigations, including physical and analytical sampling studies, have been conducted at the Site. A brief summary of pertinent investigations is provided below.

- G.E. Myer and K. W. Loach of the State University of New York (SUNY) at Plattsburgh prepared a report entitled *Preliminary Report of the Physical Parameters of the Plattsburgh, New York Sludge Bed*, dated March 1974. This report summarizes preliminary testing of the sludge bed depth, thickness and percent solids. It indicates that the sludge has a high water content, averaging 91.7 percent of the total mass.

- The NYSDEC has performed PCB analysis of the fish in Lake Champlain since 1979 to the present.

- A report entitled, *Final Report Mudflats Removal Feasibility Study, Plattsburgh, New York* was prepared by Frederic R. Harris, Inc. Consulting Engineers in July, 1979 under contract with the Economic Development Administration. The report summarizes "mudflat deposits" or sludge bed properties. Properties include: composition (wet, dry, and percent organic); chemical oxygen demand (COD); fecal coliform; volume estimates; filtration and leaching trials; and decomposition estimates.

- The NYSDEC Division of Water collected 14 sludge, sediment, and wood debris samples from the sludge bed and adjacent locations near Wilcox Dock for PCB analysis in the summer of 1993. In addition, six (6) core samples were collected on March 17, 1994 from the sludge bed and analyzed for PCBs, percent solids, organic content, and percent of volatile solids. Core depths ranged from approximately 20.5 to 45.5 cm below the sludge surface. Concentrations ranged from below laboratory detection limits to 1,850 ppm.

- The NYSDOH collected a total of 29 water, sediment, sludge and wood debris samples from the beach/shore line north of the sludge bed and the bay water during August, November, and December, 1994. Samples were analyzed for PCBs. Lake water samples ranged from below laboratory detection limits to 310 part per trillion (ppt) for PCBs. Sediment and wood chip analytical sample concentrations ranged from below laboratory detection limits to 210 ppm.

- The NYSDEC Division of Hazardous Waste Remediation collected sludge and sediment samples from the sludge bed and bay areas south of Wilcox Dock and east across the bay on Cumberland Head shoreline on August 9 and 10, 1994. Samples were collected for PCB, pesticides, metals and cyanide, dioxin, and furans. Core depths ranged from 14 to 136 cm below the top of the sludge/sediment surface. Concentrations of PCBs ranged from below the laboratory detection limits to 550 ppm. Dioxins ranged from below the laboratory detection limit to 330 ppt of octachlorodibenzodioxin.

1.3 Summary of Site Characterization

The SC was initiated in June 1995. A draft SC Report was submitted to the NYSDEC in October, 1995. This section briefly describes the scope of the SC and its pertinent findings.

1.3.1 Scope of the Cumberland Bay Site Characterization

The purpose of the SC was to assess the nature and extent of sludge bed contamination, characterize the Site, and gather the data necessary to support the evaluation of remedial alternatives for the Cumberland Bay Sludge Bed FS. The investigation included a review of available technical data generated during previous investigations, preparation of an accurate base map of the site from existing aerial photogrammetry, evaluation of hydraulic and environmental conditions, determination of the extent of the sludge bed, sampling and analysis of sludge and sediment (physical, chemical, and geotechnical), delineation of the contaminated area, and estimation of the volume of the sludge bed. The scope of the investigation is detailed in the SC Report (Rust, October 1995).

1.3.2 SC Findings

The physical setting and nature and extent of contamination are described below. Additional detail is provided in the SC Report (RUST, October 1995).

1.3.2.1 Physical Setting

Site Geology

Unconsolidated deposits of glacial origin generally overlie middle Ordovician limestone and /or shale bedrock throughout the Site and most of the regional study area. In the study area, the glacial deposits reach an observed thickness in excess of 36 feet. Recent deposits such as alluvium and swamp deposits have also been mapped in the surrounding study area.

The sludge bed material covers most of the Site area ranging in thickness from approximately 0.25 to 10 feet. The thickest portions are located in a dredged channel adjacent to Wilcox Dock. The underlying "natural" soils, as observed in five geotechnical borings drilled in the Site area during the SC, vary from grey coarse to fine sand, grey clay and silt, to grey fine sand and silt. These soils are more compact and hard with depth and are probably of alluvial or glacial origin. In four of the borings, a significant increase in blow counts was observed at an interval ranging between 14 and 21 feet below the Bay bottom surface. The soil below this interval is characterized by an increase in density (described by the geologist as very dense) and an increase in percentage of coarse to fine gravel (5 to 30 percent). Sample blow counts above this interval ranged from approximately 1 to 20 blows per 6 inches, and below this interval ranged from approximately 20 to greater than 100 blows.

Site Meteorologic and Hydraulic Conditions

According to a Flood Insurance Study performed for the City of Plattsburgh by the US Department of Housing and Urban Development (October 1977), the mean minimum temperature in the city in January is 9° F and the mean maximum in July is 83° F. On the average there are about 220 days per year when the temperature is 32° F or below. The mean annual precipitation is about 30 inches, about six inches of which is the water content of snowfall in the area; the mean seasonal snowfall is about 60 inches. The prevailing winds as measured at the US Air Force Base, are westerly and southerly.

Also reported in the Flood Insurance Study is information on Cumberland Bay flood potential. High-water levels result from a complex combination of climatic conditions which characterize the winter period including unusually large quantities of precipitation or sudden thaws. Also, resilient ice sheets can be lifted by high waters and strong winds, crushing lake-front structures in their path.

Highest water levels have generally occurred in April or early May. The 100 year flood level is estimated to be Elevation 101.97 and the 500 year flood level (based on the highest recorded water level at the closest Lake Champlain gaging station) is estimated to be Elevation 102.32. The maximum height of waves in the Plattsburgh area was estimated to be 3.85 feet.

Water depths determined during the SC are shown on Figure 1.2. The deepest water locations were between Wilcox Dock and the breakwater located to the south (approximately 10 to 17 feet) resulting from previous dredging activities performed by the NYSTA for the passage of barges. Similar dredging was performed along the north and northeast sides of Wilcox Dock. Water depths within the sludge bed area vary between 0 feet at the shore line and approximately 10 feet.

1.3.2.2 Nature and Extent of Contamination

Nature of the Sludge Bed Material

The general stratigraphy within the sludge bed (based on observations made during the SC) consists of a top layer of dark (brown to black) fibrous pulp with highly organic material such as wood chips, root matter, and saturated sludge exhibiting a chemical-type odor. The thickness of this material ranges from essentially non-existent to a maximum of 17 inches. Directly below this initial sludge layer, a lighter-colored (grey) fibrous pulp layer is typically present. This sludge, where present, ranges in thickness from 6 to 14 inches. Further north from the center of the sludge bed, a sand with silt layer generally overlies a dark (black) organic sludge with wood chips.

Generally beneath both light and dark organic pulp sludge layers, a brown sand with silt layer exists with interlayered wood chips. This layer grades to a grey and/or brown "native" sand containing silt and, in certain areas, a layer of coarse wood chips. Gradation curves for six representative samples of the sand beneath the sludge layer classified the sand as SM (silty sand), SP (poorly graded fine sands with silts less than 5 percent) or SP-SM.

Cores collected at locations in the channel adjacent to Wilcox Dock contained an extensive layer of white paper pulp sludge which appeared to exhibit medium to high plasticity properties and high PCB concentrations. The density of this white pulp is close to that of water, resulting in the occurrence of floating masses.

Extent of the Sludge Bed Material

The vertical and horizontal extent of sludge within the sludge bed was determined during the SC. The lateral and vertical extent of the sludge bed is shown on Figure 1.3. NYSTA maps of the Wilcox Dock illustrate a deep channel which extends from Wilcox Dock south into Cumberland Bay. Apparently, sludge from the Bay has dispersed into these deeper areas adjacent to the dock. Sludge thicknesses within the sludge bed ranges from approximately 0.25 feet to greater than 10 feet (adjacent to Wilcox Dock).

The volume of sludge was estimated based on the lateral and vertical extent of sludge identified through coring and probing during the SC. Approximately 90,000 to 95,000 cubic yards of sludge is contained within the Site boundary.

1.4 Summary of Baseline Health Risk Assessment

1.4.1 Approach

A baseline Health Risk Assessment (HRA) was prepared as part of the SC for the Site, to characterize the potential for human exposure and the possibility of health effects associated with exposure to PCBs at the Site and surrounding area. As discussed previously, the State of New York has instituted fish advisories due to the finding of high PCB levels in Cumberland Bay fish. The HRA was performed to verify the necessity of the fish advisories, to identify other potential human exposure pathways within the area of the sludge bed, and to determine whether the Site may pose a risk to human health based on data collected as part of the SC or previous investigations performed by or on behalf of the State of New York. The HRA was also performed to fulfill the requirements of the Remedial Investigation/Feasibility Study required under the National Oil and Hazardous Substances Contingency Plan (the NCP) (EPA, 1994b).

The HRA is based on a myriad of data used to characterize the exposure routes, the chemical intakes and potential risks associated with the Site conditions. The following items were addressed within the HRA's scope of work:

- evaluation of Site history, chemical, hydrologic, demographic and other information;
- identification and evaluation of potential exposure pathways through a review of data collection activities, analytical protocols, current and surrounding land use, populations-at-risk and other related data;
- characterization of completed exposure pathways by the evaluation of chemical release sources, fate and transport, human exposure (contact) points and chemical intake routes;
- quantification and summarization of estimated potential chemical intakes, chemical-specific risk-based criteria and potential toxic effects; and,
- characterization and discussion of potential chemical-specific carcinogenic and noncarcinogenic risks and their respective uncertainties.

1.4.2 Conclusions

Environmental data collected in the SC, and by the NYSDEC and NYSDOH revealed that the sludge bed, off-shore sediments, surface water, and beach sand and wood chips/debris (from beach areas to the north) contain detectable levels of PCBs. It is expected that the recreational activities directly over the sludge bed would be limited to wading activities because of restricted access to Wilcox Dock and the relatively heavy aquatic vegetation immediately off the shoreline. Therefore, potential limited exposure of nearby residents and area visitors (current and future) to the surface water and sludge bed material during wading activities were evaluated in the HRA. Because the Route 9 and public beach areas to the north are used for recreational purposes, swimming and recreational beach activities (e.g., sun-bathing and playing) were also evaluated. In addition, recreational fishing in Cumberland Bay was also evaluated in the HRA.

The toxicity assessment of PCBs included a review of the most up-to-date regulatory and toxicology computerized databases and information. This information was reviewed and then summarized in a toxicology profile. This information was then used to characterize the toxic hazards and risks.

Exposures to PCBs were quantitated using actual environmental analytical data. These environmental data were validated when possible and then used to estimate potential noncarcinogenic and carcinogenic risks following EPA risk assessment guidelines.

Based on the exposure pathways presented in the baseline HRA, there are two current and potential future exposure scenarios that may pose a potential long-term health concern. These exposure pathways are:

- direct contact with sludge bed and surface water while wading in the sludge bed near Wilcox Dock; and
- recreational ingesting of Cumberland Bay fish.

Each of these exposure pathways may pose a risk of chronic systemic effects and risk of developing cancer due to the presence of PCBs.

1.5 Summary of Fish and Wildlife Analysis

1.5.1 Approach

A Fish and Wildlife Impact Analysis (FWIA) was performed for the Cumberland Bay Sludge Bed Site. The FWIA was performed following the NYSDEC FWIA procedures presented in the NYSDEC, Division of Fish and Wildlife, "Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites" (dated June 18, 1991). The results of the Step I (Site Description) and the Step II (Contaminant-Specific Impact Analysis) sections of the FWIA are presented.

The objective of the Step I, site description, is to identify the fish and wildlife resources, land-use and habitat types that exist in the vicinity of the Site. In addition, fish and wildlife species that may utilize habitats that could potentially be impacted by site-related contaminants are identified. This information is necessary to allow identification of potential pathways of contaminant migration that could impact fish and wildlife resources.

The objective of the Step II, contaminant specific impact, is to determine the impacts, if any, of site-related contaminants on fish and wildlife resources. The pathway analysis evaluates and identifies potential contaminants of concern, sources of contaminants, potential pathways of contaminant migration and potential for fish and wildlife resources to be impacted by site-related contaminants.

The criteria-specific analysis determines if reported chemical concentrations represent a potential threat to aquatic life and wildlife. The toxic effect analysis attempts to determine or predict what effects the chemicals of concern will have on fish and wildlife and on the use of fish and wildlife by humans.

The purpose of the analysis was to determine if the PCBs present in the sludge bed represent a potential threat to fish and wildlife resources. The document did not attempt to determine the exact magnitude of any impact or the what the complete effect any potential impact will have on individual animals, species, populations or ecosystems. A comprehensive evaluation of what potential impact the sludge bed will have on fish and wildlife populations was beyond the scope of the FWIA and could not be completed with the available data. However, sludge bed PCB concentrations are compared to published numerical criteria and an estimate of the effect of PCB concentrations reported in fish collected from Cumberland Bay on a sensitive piscivorous predator was evaluated.

1.5.2 Results

The baseline assessment indicated that the principle aquatic resources within one-half mile of the Site were Cumberland Bay, Scomotion Creek and the Saranac River. The principle palustrine wetland habitat within a one-half mile radius of the site is NYSDEC wetland PB-5 which is located along the Scomotion Creek. Also there is a small deciduous forested wetland and a shallow/deep emergent wetland complex located within the boundaries of the Site. There are no significant terrestrial habitats located within a one-half mile radius of the Site that could be impacted by the PCBs detected in the sludge bed.

Significant wildlife species that may utilize the habitats located within a one-half mile radius of the Site include Atlantic salmon, osprey, great blue herons and mink. Lake Champlain and the Saranac River represent a significant landlocked salmon fishery. Osprey, a threatened species in New York State has been observed nesting in wetland PB-5. Mink, a species highly sensitive to PCBs would be expected to utilize the habitats associated with wetland PB-5. Mink could potentially be exposed to PCBs from the Site via ingestion of fish which contain a PCBs. Great blue herons have been observed feeding in Cumberland Bay.

The pathways exposure analysis indicates that pathways exist via which wildlife could be exposed to PCBs from the Site. Fish samples collected in the vicinity of the Site exhibit PCBs, which documents that there has been a completed exposure pathway. Mink, utilizing the habitats in wetland PB-5 could be exposed to PCBs by consumption of fish containing PCBs.

The criteria specific analysis revealed that surface water in Cumberland Bay in the vicinity of the Site exhibit PCB concentrations that are elevated with respect to the NYSDEC surface water standard for protection of wildlife from bioaccumulation of PCBs. Available data indicate that there is a potential for fish and wildlife to be affected by dissolved PCBs in the Cumberland Bay surface water column.

Sludge samples from the Site exhibit PCB concentrations that are elevated with respect to the NYSDEC sediment quality criteria value for PCBs. The sediment criteria value for PCBs is based on protection of piscivorous wildlife from toxic effects of PCB bioaccumulation. Available data indicate a potential for an impact to piscivorous wildlife from the toxic effects associated with bioaccilmulation of PCBs.

A toxicity analysis on the potential impact on mink reproductive success from consumption of fish flesh containing PCBs was performed. It was assumed that fish containing PCBs could move into Scomotion Creek and the adjacent wetland PB-5 from Cumberland Bay. The analysis indicates that there is a potential for an impact on the reproductive success of mink which utilize the habitats associated with wetland PB-5.

This toxicity analysis was based on a number of assumptions which could impact the analysis and either lower or increase the potential for an effect on mink reproductive success. These assumptions include the following:

- The ratio of congener 77 to total PCBs (0.0404) based on the large-mouth bass/brown bullhead data, is applicable to the Yellow Perch total PCB data.
- The concentration reported for congener 77/congener 110 is completely due to congener 77. If this is not true then the estimated ratio of congener 77 to total PCBs is high and the calculated hazard quotients are potentially high and the potential impact could be over estimated.
- There are no other co-planar PCBs present in the fish tissue samples. The congener analyses performed was not capable of detecting the other potential co-planar congeners. If additional co-planar congeners were present, then the reported hazard quotients are potentially low and the potential risk to the reproductive success of mink could be greater.
- There are no other environmental contaminants, such as dioxin, which would cause an additive effect. If dioxins are present in the fish tissue, then the potential impact on mink reproductive success would potentially be higher than estimated.

1.6 Summary of Treatability Study

A Treatability Study Report was prepared in November 1995 by Kiber Environmental Services, Inc. (Kiber), under contract to Rust, as a presentation of the final results for the treatability study conducted on sludge sampled from the Cumberland Bay Sludge Bed Site. The treatability study was conducted to determine the effectiveness of dewatering and immobilization treatment of the sludge, and water treatment protocols for the process water.

1.6.1 Scope

The objectives of the treatability study were to identify:

- the chemical and physical properties of the untreated sludge,
- the volume and weight reduction achievable through removal of free water from the sludge using dewatering processes,
- water treatment techniques capable of removing biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and PCBs from the filtrate generated by the dewatering process,
- immobilization reagents capable of reducing the leachability of PCBs present in the untreated material, and
- immobilization reagents which improved the physical properties of the sludge.

The treatability study was conducted in four distinct phases including untreated characterization, dewatering evaluations, water treatment evaluations, and immobilization evaluations.

Untreated characterization analyses involved the determination of the physical and chemical properties of sludges sampled from the Site. During the dewatering phase of the treatability study, Kiber evaluated several mechanical and non-mechanical dewatering methods, including filter press, Buchner funnel, and gravity drainage. Biological and chemical precipitation processes were both investigated for treatment of the filtrate generated during dewatering. Kiber performed immobilization treatment using a variety of non-proprietary reagents. The treated materials were evaluated for chemical and physical properties.

1.6.2 Results

The results of the treatability study indicate that both dewatering and immobilization technologies are effective at improving the physical characteristics of the sludge. Dewatering treatment provided volume reduction in the untreated sludge. Immobilization treatment was successful at maintaining low leachable concentrations of PCBs and at improving the physical properties of the untreated sludge. Testing methods, tabulated results, photographs and back-up calculations and data sheets are provided in the November 1995 report from Kiber.

Untreated Characterization

The results of the analysis of untreated sludge are summarized in the following table:

Parameter	Unit	Results(1)		
		A	B	C
I. Chemical Analysis				
Material pH	s.u.	6.1	6.2	6.2
II. Physical Properties				
Moisture Content(2)	%	71	64	71
Bulk Density	lb/ft^3	74	75	74

Parameter	Unit	Results[1]		
		A	B	C
Bulk Specific Gravity	-	1.2	1.2	1.2
Solid Specific Gravity	-	2.3	2.3	2.3
Paint Filter	Pass/Fail	Fail	-	-
Liquid Release	Pass/Fail	Fail	-	-

(1) A, B and C represent multiple aliquots of the untreated sludge
(2) Wet weight basis
- Not analyzed or not applicable

Dewatering Evaluations

The results of the dewatering testing indicate that treatment will reduce the moisture content of the untreated sludge. The moisture content of the sludge was decreased from 69% for the raw sludge to between 54 and 64% for the dewatered filter cakes. Overall, filter press and Buchner funnel treatment provided the best dewatering treatment for the sludge, achieving final sludge moisture contents 54 and 57% respectively. The available data indicates that a belt filter press or a recessed plate filter press would most efficiently reduce the volume of sludge during remediation.

Slight improvement was achieved in the dewatering efficiency through addition of aluminum sulfate or sulfuric acid in conjunction with filter press treatment at a pressure of 100 lbs/in^2. Due to the small decrease in moisture content obtained using the conditioning agents, it may not be cost effective to use conditioners during full-scale sludge dewatering.

Water Treatment Evaluations

Water treatment testing included column settling evaluations, slurry reactor testing and chemical precipitation testing. The analyses were performed using a 5% slurry developed with tap water and the as-received sludge. Analyses performed during the column testing indicate that concentrations of suspended solids generally decreased at each sample depth throughout the testing process. The data indicated that the majority of settling occurred within the first 2 hours of testing.

Results of the slurry reactor testing indicate significant variation in the COD analyses performed over a period of 14 days. Due to the high variability of the data obtained, no conclusions have been drawn on the effectiveness of this technology. Chemical precipitation treatment of the 5% slurry indicates that precipitation treatment can remove the suspended solids and significnantly reduce contaminant concentrations.

Immobilization Evaluations

Immobilization treatment successfully increased the unconfined compressive strength of the sludge and reduced the leachability of PCBs from the sludge. A maximum unconfined compressive strength of 20 lbs/in^2 was achieved using the as-received sludge and 29 lbs/in^2 was acheived using the dewatered sludge.

1.7 New York State Standards, Criteria and Guidelines

Applicable or relevant and appropriate requirements (ARARs) are defined in Section 121(d) of CERCLA (P.L. 96-510), as amended by SARA (P.L. 99-499), as any Federal or State standard, requirement, criteria, or limitation that is legally applicable to the contaminants of concern or which is relevant and appropriate under the circumstances of the contaminant release or threatened release. Section 121(d) of CERCLA, as amended by SARA, establishes standards that govern the degree of cleanup required at a site. The selected remedial measure must attain a level or standard of control that satisfies ARARs except under certain conditions.

New York State, in 6 NYCRR Part 375, has developed rules for selecting and designing remedial programs at inactive hazardous waste sites which are not inconsistent with the CERCLA requirements. A remedial alternative must conform with NYS Standards and Criteria that are generally applicable, consistently applied, and officially promulgated, that are either directly applicable, or that are not directly applicable but are relevant and appropriate. The Site remedial program should also be selected with consideration given to NYS Guidance which is determined to be applicable on a case-specific basis. The Federal equivalent of Guidance is "To Be Considered" guidance and advisories (TBC).

The potential standards, criteria and guidance are identified in the sections below and the associated tables. Standards, Criteria and Guidance may be specific to either the site location, the contaminants present, or the remedial actions planned.

1.7.1 Location-Specific Standards and Criteria

Location-specific Standards and Criteria, which relate to requirements for wetlands protection, floodplain management, fish and wildlife conservation, and historic preservation, apply to remedial alternatives within specific geographical locations. Potential location-specific Standards and Criteria and their applicability to the Site are identified in Table 1-1.

1.7.2 Chemical-Specific Standards and Criteria

Chemical-specific Standards and Criteria are Federal or State standards (promulgated by regulation) or health/risk-based numerical values that are used to establish acceptable amounts or concentrations of constituents allowed in the environment. Sources of promulgated standards and criteria are identified on Table 1-2.

There are no promulgated Federal or State chemical-specific Standards and Criteria for soil or sediments. NYS guidance regarding soil and sediments is identified in Section 1.4.4, Potential Guidance.

1.7.3 Action-Specific Standards and Criteria

Action-specific Standards and Criteria apply to specific treatment and disposal activities, and may set controls or restrictions on the design, performance and implementation of the remedial actions taken at a site. For example, RCRA requirements will be applicable if the remediation constitutes treatment, storage or disposal of a hazardous waste as defined under RCRA. Other examples of action-specific requirements are Clean Water Act standards for discharge of treated groundwater and New York State regulations 6 NYCRR Part 703, which establish surface water and groundwater quality standards and groundwater effluent standards.

Table 1-3 identifies the action-specific Standards and Criteria that are potentially applicable to the Cumberland Bay Site. Since action-specific Standards and Criteria apply to discrete remedial activities, their evaluation is presented with the detailed analysis of alternatives for each retained alternative. In addition, if a technology is used that may result in emissions of compounds into the air, emissions must comply with Federal and State air quality standards.

1.7.4 Potential Guidance

There are instances when Standards and Criteria do not exist for a particular chemical or remedial action. In these instances, other State and Federal criteria, advisories and guidance may be used to aid in the evaluation and selection of a remedial alternative for a site. The guidance or advisories that may be relevant to the Cumberland Bay Site are identified on Table 1-4.

1.8 Focus of the Feasibility Study

This Feasibility Study focuses on the remedial alternatives that can be readily implemented and can achieve the remedial action objectives within a reasonable time frame. As such, technologies that could prove difficult to implement or might not be applicable or feasible based on site-specific conditions, are eliminated from further consideration.

The results of the SC indicate that PCBs are effectively restricted to the sludge bed material. Analysis of sediment cores from the Site area indicate that natural material below the sludge has not been impacted by PCBs. Therefore, the remedial technology screening and remedial alternative development is specifically focused on the remediation of sludge bed material only.

The NYSDEC and NYSDOH have concluded that the concentrations of dioxin and furan detected in the sludge during the SC do not constitute a significant threat to human health or the environment and are not considered a compound of concern for the Cumberland Bay Sludge Bed FS. Therefore, dioxin and furan will not be considered during the remedial alternatives evaluation with regard to cleanup levels, performance monitoring or material handling.

Table 1-1
Location-Specific Standards and Criteria
Cumberland Bay Sludge Bed

Requirement	Synopsis	Application
STATE:		
Use and Protection of Waters (6 NYCRR Part 608; ECL 15-0501 and 15-0505)	Under this regulation, a permit is required to change, modify, or disturb any protected stream, its bed or banks, sand, gravel, or any other material; or to excavate or place fill in any of the navigable waters or in any marsh, estuary or wetland, contiguous to any of the navigable waters of the State.	Applicable. Remedial activities which would disturb the bay must be conducted in accordance with the regulations and typical permit requirements, although a permit from the NYSDEC may not be required. Placement of permanent fill or structures in the bay would not be permitted under Part 608.8 unless no other alternative remedial action could be reasonably implemented.
New York State Ambient Water Quality Standards (6 NYCRR Parts 700-705)	Defines surface water and aquifer classification and lists specific chemical standards.	Applicable. Classifications and standards would be used develop criteria for PCB levels in surface water and process water treatment effluent during implementation of the remedial alternative.
Endangered and Threatened Species of Wildlife (6 NYCRR Part 182)	Site activities must minimize impact on identified endangered or threatened species of fish or wildlife.	Applicable. Habitats of threatened species in NYS have been identified within one half mile of the Site. Access routes exist between the Site and these habitats.
Coastal Zone Management (19 NYCRR Part 600-602)	Site activities must be consistent with the NYS Coastal Zone Management Program which has developed policies to: promote the beneficial use of coastal resources; prevent the impairment of certain coastal resources (i.e., fish and wildlife habitats); and provide for the management of activities which may impact the coastal zone (i.e., dredging or construction of structures).	Applicable, since the Site is within the NYS Coastal Zone. Policies specifically applicable to the Site would be include, but not limited to: Policy 7 related to protection of habitats fundamental to assuring the survival of fish and wildlife; Policy 8 which relates to handling, storage or disposal of hazardous wastes; and Policy 9 which relates to actions that will impede existing or future utilization of State's recreational fish and wildlife resources. All policies would be considered prior to issuance of a permit.
Water Quality Certification	A State Water Quality Certification is required if a federal permit is needed for discharge into navigable waters.	Possibly applicable, since a federal permit may be required.

Table 1-1
Location-Specific Standards and Criteria
Cumberland Bay Sludge Bed

Requirement	Synopsis	Application
STATE (Continued):		
New York State Canal Law (Section 50)	Abandonment of portions of barge canal lands requires approval by the Commissioner of the NYSDOT. Abandonment of a barge canal terminal cannot occur unless it has been, by a special act of legislature, previously determined to have become no longer necessary or useful as a part of the barge canal system.	Applicable for remedial alternatives which require taking of land owned by the NYS Thruway Authority and or would result in significant loss of the use of Wilcox Dock (i.e., in-place capping or construction of a CDF adjacent to the dock).
FEDERAL:		
Clean Water Act, Section 404(b)(1)/U.S. Army Corps of Engineers Nationwide Permit Program 38 (33 CFR 330)	Activities involving dredging or filling, or the construction or alteration of bulkheads, dikes, in navigable waters, including wetlands, are regulated by the Corps of Engineers.	Applicable. Dredging and/or construction in the bay (i.e., installation of sheet piles and/or CDFs) must be demonstrated to be consistent with the provisions of the USACE Nationwide Permit. Nationwide Permit conditions which would relate to the activities include but are not limited to: wetland and riparian restoration and creation activities, temporary construction, access and dewatering, cleanup of hazardous or toxic waste, water quality certification, coastal zone management, and endangered species.
Fish and Wildlife Coordination Act (16 USC 662)	Any action that proposes to modify a body of water or wetland requires consultation with the U.S. Fish and Wildlife Service.	Applicable. Cumberland Bay would be affected by a remedial action at the Site.
Endangered Species Act (50 CFR 200, 402)	Site activities must minimize impacts on identified endangered plant and animal species.	Applicable. Habitats of threatened species in NYS have been identified within one half mile of the Site. Access routes exist between the Site and these habitats.

Table 1-2

Chemical-Specific Standards and Criteria
Cumberland Bay Sludge Bed

Requirement	Synopsis	Application
STATE:		
NYS Surface Water Quality Standards and Discharge Limitations (6 NYCRR Parts 701, 702, and 704)	Establishes standards for surface water quality.	Applicable. Surface waters of New York.
6 NYCRR Part 371	Defines and regulates PCBs in NYS.	Applicable. Environmental media of New York.
FEDERAL:		
Effluent Limitations (40 CFR Part 301 and 302)	Enforceable standards for effluent discharges.	Applicable. Liquid discharges from the Site.
Toxic Substance Control Act (40 CFR 761)	Regulates management and disposal of materials containing PCBs	Applicable. Site soil cleanup levels and landfill construction and operation requirements.

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Note: If RCRA hazardous wastes are identified on site, the appropriate RCRA requirements would be followed.

Table 1-3

Action-Specific Standards and Criteria
Cumberland Bay Sludge Bed

FEDERAL	• Polychlorinated biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions (40 CFR 761); • CWA (Clean Water Act) - NPDES Permitting Requirements for Discharge of Treatment System Effluent (40 CFR 122-125); • CWA Discharge to Publicly-Owned Treatment Works (POTW) (40 CFR 403); and • Occupational Safety and Health Standards for Hazardous Responses and General Construction Activities (29 CFR 1904, 1910, 1926).
STATE	• New York State Pollution Discharge Elimination System (SPDES) Requirements (Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges) (6 NYCRR Parts 750-757); • New York State regulations regarding water quality standards and discharge limitations (6 NYCRR Parts 700-703); • Standards for Hazardous Waste Management (6 NYCRR Parts 370-373); • Standards for Waste Transportation (6 NYCRR Part 364); and • Solid Waste Management Facilities (6 NYCRR Part 360).

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Table 1-4

Potential Guidance
Cumberland Bay Sludge Bed

FEDERAL	• USEPA Office of Water Regulations and Standards, Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Contaminants; May 1988, Updated for specific contaminants (primarily PAHs) in 1993; • USEPA Health Effects Assessment (HEAs); • TSCA Health Data; • Toxicological Profiles, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service; • Policy for the Development of Water-Quality-Based Permit Limitations for Toxic Pollutants (49 Federal Register 9016); • Cancer Assessment Group (National Academy of Science Guidance); • Waste Load Allocation Procedures; • USEPA Soil Screening Guidance (EPA/540/R-94/101); • The USEPA PCB Spill Policy; • Fish and Wildlife Coordination Act Advisories; and. • Executive Order 11990, "Protection of Wetlands".
STATE	• TAGM 4046, Determination of Soil Cleanup Objectives and Cleanup Levels, January 1994; • NYS Division of Fish and Wildlife, Technical Guidance for Screening Contaminated Sediments, November 1993; • New York State Analytical Detectability for Toxic Pollutants; • New York State Toxicity Testing for the SPDES Permit Program (TOGS 1.3.2); • New York State Regional Authorization for Temporary Discharges (TOGS 1.6.1); and • Selection of Remedial Actions at Inactive Hazardous Waste Sites (DHWR TAGM 4030).

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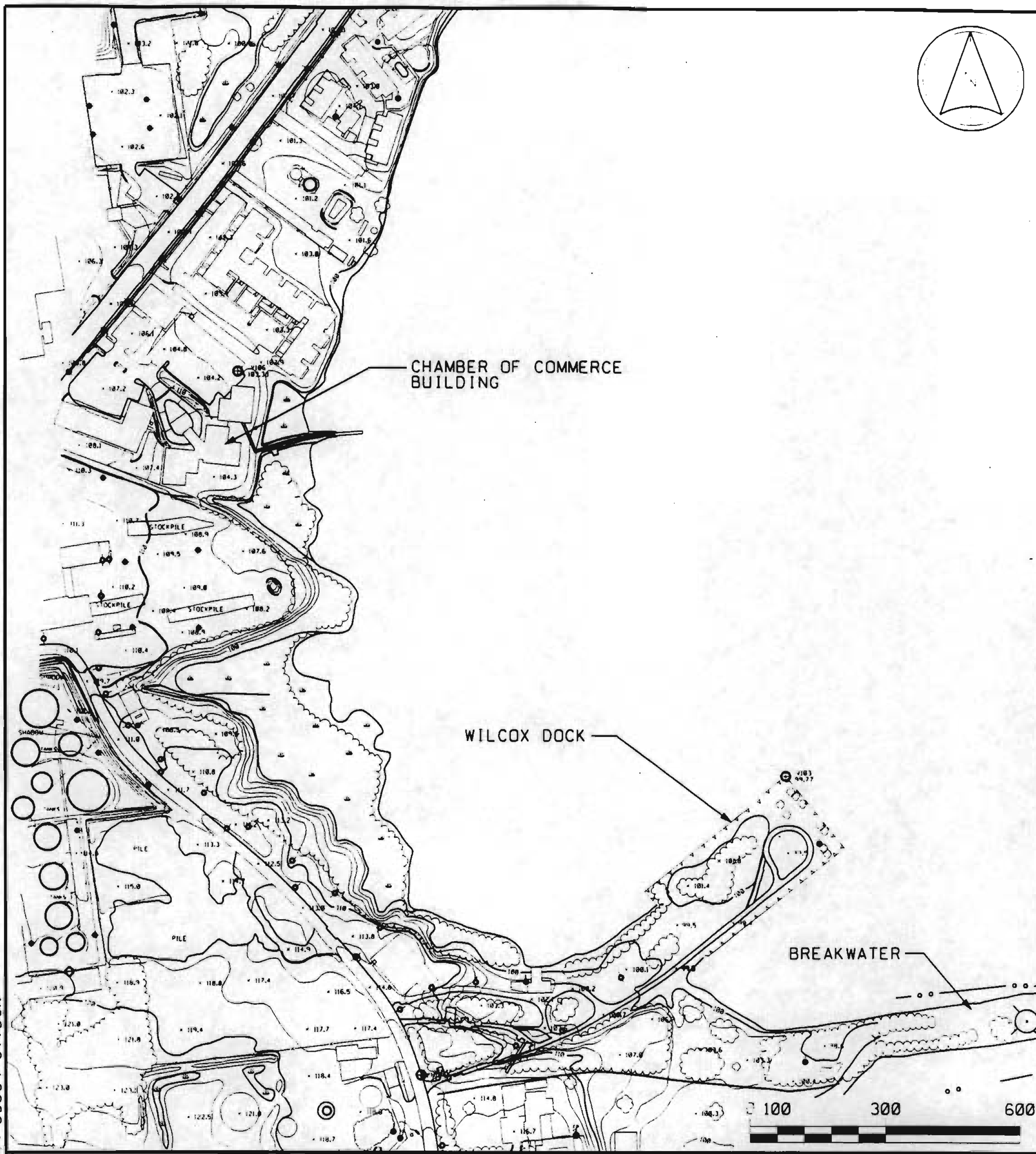


RUST ENVIRONMENT & INFRASTRUCTURE

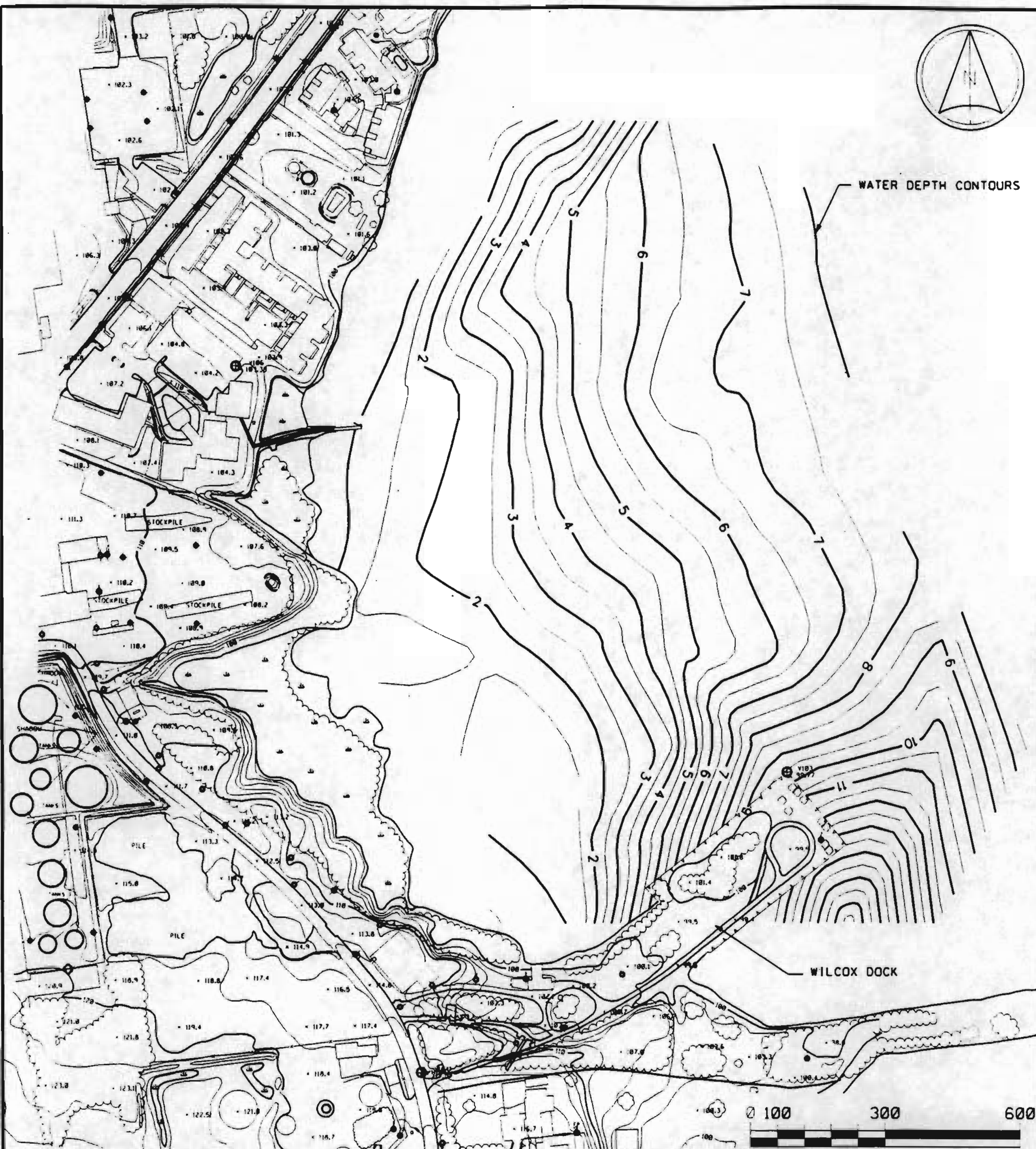
SITE PLAN

SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY | CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-01	SCALE 1"=300'	FIGURE No. 1.1

DRAWING No. 39304-01.DGN



DRAWING No. 39304-05

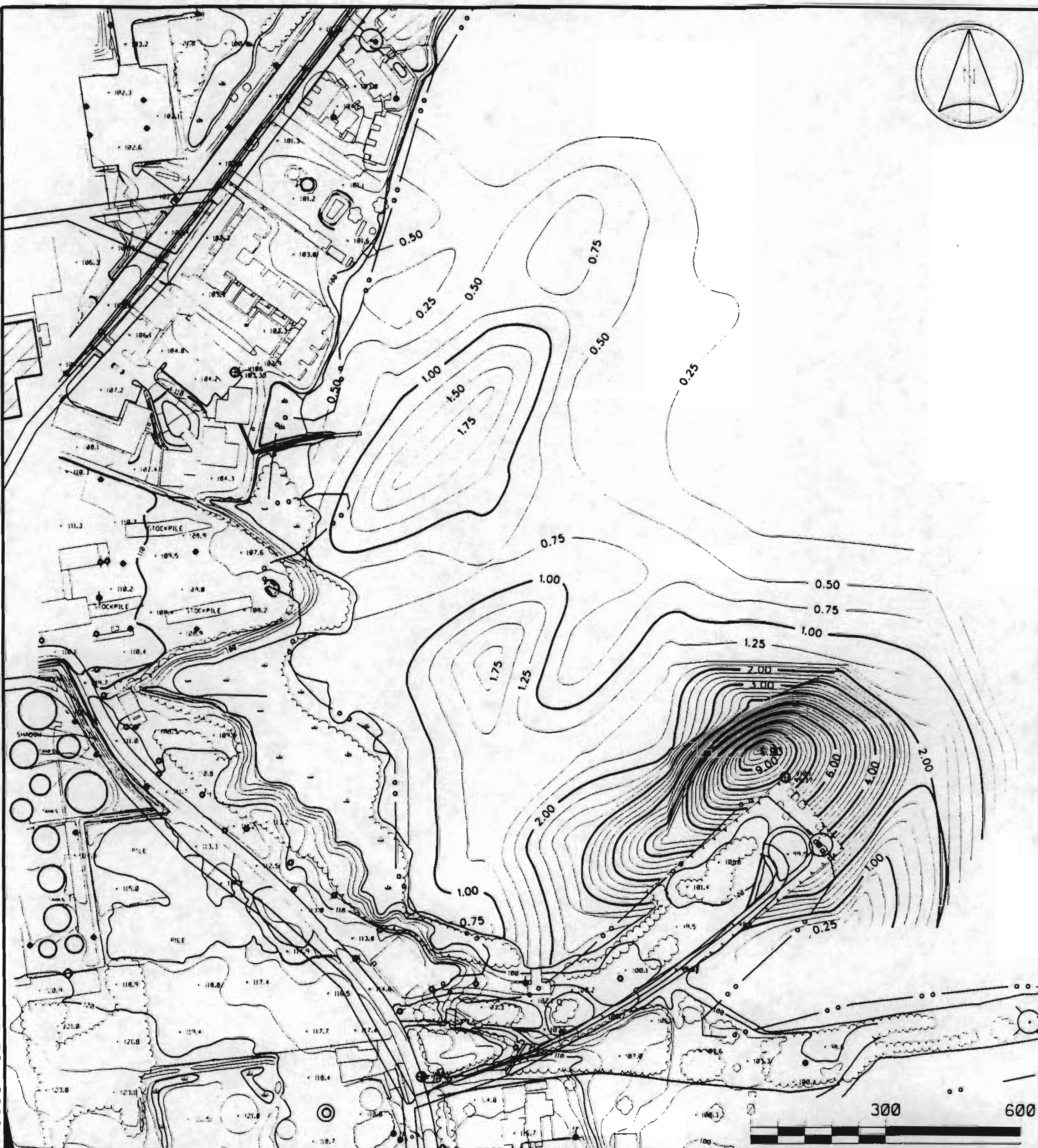
RUST ENVIRONMENT & INFRASTRUCTURE

WATER DEPTH CONTOUR MAP

SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY | CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-05	SCALE 1"= 300'	FIGURE No. 1.2



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RUST ENVIRONMENT & INFRASTRUCTURE

SLUDGE BED THICKNESS CONTOUR MAP

SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY | CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-02	SCALE 1"=300'	FIGURE No. 1.3

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

This section identifies the remedial action objectives, general response actions, and remedial technologies for the Cumberland Bay Site. A wide range of remedial technologies are identified as potentially capable of meeting the remedial action objectives. Each remedial technology is evaluated, and the most appropriate technologies are retained for use in developing remedial action alternatives for the Site.

2.2 Remedial Action Objectives

Remedial action objectives for the Site were defined by the NYSDEC in the scope of Work Assignment #D002520-32. The remedial action objectives provide for protection of human health and the environment. They have been selected to minimize or reduce to target levels, the potential for human exposure to or environmental damage due to the presence or migration of PCB impacted sludge. The site-specific objectives for sludge bed remedy are as follows:

- Mitigate the potential threat to the environment posed by the PCB contaminated sludge bed;
- Rapidly and significantly reduce human health and environmental risks; and
- Prevent further environmental degradation resulting from this known source of PCB contamination.

2.3 General Response Actions

General response actions are actions that will satisfy the remedial action objectives. They may include treatment, containment, excavation, disposal, institutional controls, or monitoring, individually or in combination. The general response actions selected for the sludge bed at the Cumberland Bay Site are identified below:

- no action,
- institutional controls,
- containment,
- removal,
- treatment, and
- disposal.

The area of sludge that may require remediation has been identified and the volumes to which the identified general response actions might be applied have been estimated to the extent possible. The volume of sludge to be addressed in the FS is estimated to be 90,000 to 95,000 cubic yards (cy) based on SC data.

2.4 Identification and Screening of Remedial Technologies

NYSDEC guidance recommends screening alternative remedial technologies using the criteria of effectiveness and implementability. In this section, a broad range of remedial technologies is identified and screened to eliminate from further consideration those technologies and processes that may be of limited effectiveness, or may not be able to be rapidly and practically implemented at the Site. The purpose of this screening is to better focus the FS on those technologies that offer the greatest promise of being effective and that can be implemented at the Site within an reasonable time frame.

Potentially applicable remedial technologies are identified for the Site to satisfy each of the general response actions specified in Section 2.3. The remedial action objectives, general response actions, and remedial technologies are identified on Table 2-1. These remedial technologies are evaluated based on site-specific information and are screened initially for technical applicability. Technologies are considered applicable if, individually or in combination, they would achieve the remedial action objectives. Innovative technologies are not retained for further analysis unless they are proven and are readily available. Table 2-2 provides the results of the initial screening of the remedial technologies, including the technical justification for eliminating technologies from further consideration.

Those technologies retained after the initial screening are further evaluated/screened based on effectiveness and implementability. The anticipated effectiveness of a technology refers to the ability of that technology to contribute to a remedial program that is protective of human health and the environment, and capable of meeting the stated remedial action objectives. In assessing the effectiveness of each technology, the demonstrated successful performance of each technology is considered. Implementability is the feasibility and the ease with which the technology can be applied at the Site. Implementability takes into consideration both technical and adminstrative factors as:

- Are the hazardous substances present at the Site compatible with the technology?
- Is there sufficient room at the Site to install and/or operate the technology?
- Will access difficulties prevent delivery of certain treatment equipment?
- Is the use of the technology compatible with surrounding land uses?
- Will application of the technology unacceptably interfere with other ongoing uses of the Site?
- What permitting and other regulatory requirements apply to use of the technology?
- Does the technology require resources of a type or in a quantity that is not readily available at the Site?
- Are there experienced contractors that can provide, install, and operate the technology?

During this secondary phase of the screening process, the relative costs of the alternative technologies are also considered. Table 2-3 presents the results of the second level of screening.

2.5 Summary of Remedial Technologies

2.5.1 Remedial Technologies Retained for Further Consideration

The remedial technologies retained for further consideration following the secondary phase of the screening process (detailed on Table 2-3) are listed below.

- No action: Consideration of the "No Action Alternative" is required by NYSDEC guidance.

- Institutional Controls (deed restrictions and health advisories): Access limitations and health advisories are effective methods for reducing potential exposure of humans to contaminated material and fish.

- Removal (mechanical/hydraulic dredging; containment walls for dewatering; drawdown and wet/dry excavation; transportation; suspended sediment barriers): A combination of dredging, bay dewatering, conventional excavation, sludge transportation and suspended sediment technologies could be implemented to remove the sludge bed.

- Ex Situ Treatment (dewatering; solidification/stabilization; rotary kiln thermal treatment; supercritical water oxidation): Dewatering and solidification/stabilization of dredged sludge may be necessary prior to treatment or disposal. Rotary kiln thermal treatment would be considered for off-site disposal. Supercritical water oxidation may be a viable on-site treatment option because it destroys organic compounds and is amenable to sludges with high water content and high percentages of organics. This technology has been successfully used for municipal waste sludges, but testing on other forms of sludge is limited.

- On-Site Disposal (confined disposal facility): Sludge containment barriers combined with a cap would constitute a confined disposal facility (CDF) and could be used for sludge dewatering as well as be effective for isolating and preventing exposure to or contact with sludge containing PCBs. Under NYS law it is not permissible to allow filling of a water body when reasonable alternatives to filling are available, this technology will be retained in case no other reasonable alternative can be identified.

- Off-Site Disposal (off-site facility): Off-site disposal of the sludge bed material is a proven and readily implementable method for remediation. Permitted disposal facilities are available to receive sludge containing PCBs. Currently, wastes from the beach cleaning activities are being sent to an off-site facility. The relative costs of constructing a CDF versus transport and disposal at an off-site facility will be evaluated during the detailed analysis of remedial alternatives.

2.5.2 Remedial Technologies Not Retained for Further Consideration

Certain technologies were not retained for further consideration because although they may be applicable to PCBs sludges, they may not be effective over the long term, would likely take longer to implement, may not be amenable to specific Site conditions, and are not likely to be as cost effective as other viable technologies. The remedial technologies not retained for further consideration following the secondary phase of the screening process (detailed on Table 2-3) are:

- Containment (in-place capping); In Situ Treatment (solidification/stabilization); and On-Site Disposal (contained aquatic disposal): In situ technologies other than the CDF have been eliminated since under NYS law filling of water bodies is not permissible when reasonable alternatives to filling are available. The CDF technology will be retained in case no other reasonable alternative can be identified. Additionally, the containment technologies would be difficult to implement due to the nature of the sludge and the shallow conditions in the sludge bed area. The long-term effectiveness would be affected by erosional forces and would be difficult to monitor.

- Ex Situ Treatment (base catalyzed dechlorination): A pilot test would be required to evaluate the potential effectiveness of base catalyzed dechlorination. Pretreatment such as dewatering and stabilization may be required to prepare the waste for transport through the base catalyzed dechlorination system. Treated residuals would require disposal. Selection of a location to perform on-site treatment may pose logistical problems and the relatively large volume of sludge to be treated would likely extend the length of time to complete the remedy.

Table 2-1
Remedial Action Objectives, General Response Actions, and Remedial Technologies
Cumberland Bay Sludge Bed

Remedial Action Objectives	General Response Actions	Remedial (and Associated) Technologies	Process Options
• Mitigate the potential threat to the environment posed by the sludge bed. • Rapidly and significantly reduce human health and environmental risks. • Prevent further environmental degradation from this known source of contamination.	No Action	Non-technology Based	Not Applicable
	Institutional Actions	Access Restrictions	Deed Restrictions/ Health Advisories
	Containment	Cap	In Place Capping
		Vertical Subsurface Hydraulic Barriers	Slurry Wall/Grout Curtain
			Vibrating Beam
		Horizontal Subsurface Hydraulic Barriers	Grout Injection
			Block Displacement
	Removal	Mechanical Dredging	Grab Dredge
			Dipper Dredge
			Bucket Ladder Dredge
		Hydraulic Dredging	Hopper Dredge
			Cutterhead Dredge
			Plain Suction Dredge
			Dustpan Dredge
			Sidecasting Dredge
			Horizontal Auger
		Pneumatic Dredging	Pneuma Pump
			Oozer Dredge
		Drawdown and Wet/Dry Excavation	Backhoe
			Clamshell
			Dragline
			Front End Loader
			Mudcat
			Hand Held Equipment
		Transportation	Pipeline
			Barge
			Railroad
			Truck
		Suspended Sediment Barriers	Sheet Pile
			Silt Curtain
			Boom
	Ex Situ Treatment	Biological Treatment	Landfarming (Treatment Cells)
		Physical Treat.	Dewatering
			Solidification/Stabilization

Table 2-1
Remedial Action Objectives, General Response Actions, and Remedial Technologies
Cumberland Bay Sludge Bed

Remedial Action Objectives	General Response Actions	Remedial (and Associated) Technologies	Process Options
• Mitigate the potential threat to the environment posed by the sludge bed. • Rapidly and significantly reduce human health and environmental risks. • Prevent further environmental degradation from this known source of contamination.	Ex Situ Treatment	Physical Treatment	Soil Washing
		Chemical Treatment	Chemical Extraction
			Base Catalyzed Dechlorination
		Thermal Treatment	Rotary Kiln
			Fluidized Bed
			Infrared Thermal
			Low Temperature Thermal
			Supercritical Water Oxid.
	In Situ Treatment	In Situ Treatment	Bioremediation
			Vitrification
			Solidification/Stabilization
			Soil Vapor Extraction
			Steam Stripping
	Disposal	On site Disposal	Contained Aquatic Disposal
			Confined Disposal Facility
		Off-site Disposal	Off-site Facility

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Table 2-2
Initial Screening of Remedial Technologies
Cumberland Bay Sludge Bed

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments
No Action	Non-technology Based	Not Applicable	No action is taken	Not applicable but required under NCP.
Institutional Actions	Access Restrictions (non-technology based)	Deed Restrictions/ Health Advisories	Restriction to future use of affected areas are specified in the property deed. Advisories and restrictions reduce exposure to contaminated fish.	Potentially Applicable
Containment	Cap	In-place capping	Cover areas of contamination with clean sediment, without consolidating.	Potentially Applicable
	Vertical Subsurface Hydraulic Barriers	Slurry Wall/Grout Curtain	Trench or regular pattern of drilled holes around areas of con-tamination are filled or injected with a soil (or cement) bentonite slurry	Not applicable because PCBs are not traveling through subsurface units
		Vibrating Beam	Force beams into the ground and inject a slurry as beam is withdrawn	Not applicable because PCBs are not traveling through subsurface units
	Horizontal Subsurface Hydraulic Barriers	Grout Injection	Pressure injection of grout at depth through closely spaced drilled holes	Not applicable because PCBs are not traveling through subsurface units
		Block Displacement	In conjunction with vertical barriers, injection of slurry in notched injection holes	Not applicable because PCBs are not traveling through subsurface units
Removal	Mechanical Dredging	Grab Dredge	Grab bucket (ie, clamshell) is operated from a crane mounted on a barge or on shore	Potentially Applicable
		Dipper Dredge	Barge-mounted power shovel	Not applicable because barge requires a minimum of 5-6 feet of draft which is not available in the sludge bed area
		Bucket Ladder Dredge	Continuous chain of buckets supported on an inclinable ladder that moves up and down around two pivots	Not applicable because it is not widely available and generates high levels of turbidity
	Hydraulic Dredging	Hopper Dredge	Self-propelled ship equipped with a draghead, suction pipe, hoppers, and dredge pump.	Not applicable because the hopper dredge would require too much draft and generates high levels of turbidity
		Cutterhead Dredge	A cutterhead, suction pipe and dredging pump	Potentially Applicable
		Plain Suction Dredge	The suction created by a centrifugal pump to dislodge and transport sediment	Potentially Applicable
		Dustpan Dredge	Similar to the plain suction dredge, but with a widely flared dredging head equipped with water jets to dislodge sediments	Potentially Applicable
		Sidecasting Dredge	Similar to the hopper dredge except dredged material is pumped overboard rather than accumulated	Not applicable because open water disposal would not meet remedial objectives
		Horizontal Auger	A small portable suction dredge that uses a horizontal auger to draw sediment into a suction pipe; propelled through the water by winching along cables on shore	Potentially Applicable

Table 2-2
Initial Screening of Remedial Technologies
Cumberland Bay Sludge Bed

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments
Removal	Pneumatic Dredging	Pneuma Pump	Three large cylindrical pressure vessels with an inlet valve on the bottom and an air port and discharge outlet on the top	Not applicable to water depths less than 12 feet because the Pneuma pump operates using hydrostatic pressure
		Oozer Dredge	Similar to the Pneuma pump with a ladder and cutterhead	Not applicable because it is not available in the United States.
	Barrier Wall for Dewatering	Sheetpile Wall Cofferdam	Single or double sheet pile wall embedded into a low permeablity stratigraphic unit.	Potentially applicable.
		Portable Dam	Temporary water retaining wall (structure or inflatable) which is installed at the bottom surface of the Bay without embedment.	Potentially applicable
		Earthen Dam	Earhen wall designed to retain water	Not applicable because dewatering would be a temporary measure which would not warrent such a large and permanent structure.
	Drawdown and Wet/Dry Excavation	Backhoe	Common excavation equipment	Potentially applicable
		Clamshell	Mechanical dredge operated from a crane	Potentially applicable
		Dragline	A dragline bucket is loaded by being pulled by a drag cable through the material being excavated and toward a crane	Potentially applicable
		Front End Loader	Common excavation equipment	Potentially applicable
		Aquatic Weed Harvester	Equipment used to remove aquatic weeds that would obstruct dredging	Potentially applicable
		Hand Held Equipment	Common excavation equipment such as shovels, rakes, etc.	Potentially applicable
	Transportation	Pipeline	Commonly used to transport dredged materials over relatively short distances	Potentially applicable
		Barge	The most widely used method of transporting large quantities of dredged materials over long distances	Potentially applicable
		Railroad	Normally used when distances to disposal facilities exceed 50 miles	Potentially applicable
		Truck	Appropriate when distance to the disposal facility lies between 15 and 50 miles.	Potentially applicable
	Suspended Sediment Barriers	Sheet Pile	Drive interlocking steel sheet piles around areas containing sludge to prevent migration of suspended sediments in water	Potentially applicable
		Silt Curtain	Suspend fabric around areas containing sludge to prevent migration of suspended sediments in water	Potentially applicable
		Boom	Long surface barriers assembled to prevent migration of floating material	Potentially applicable

Table 2-2
Initial Screening of Remedial Technologies
Cumberland Bay Sludge Bed

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments
Ex Situ Treatment	Biological Treatment	Landfarming (Treatment Cells)	Inoculate and spread soil in controlled shallow cells to encourage biodegradation	Not applicable because it is not widely available or a proven technology for PCBs
	Physical Treatment	Sludge Dewatering	Sludge is drained, pressed or a vacuum is applied to reduce the water content	Potentially Applicable
		Solidification/ Stabilization	Introduce specially designed admixtures to excavated soil to improve its physical properties	Potentially Applicable
		Soil Washing	Soil is mechanically screened, washed, and rinsed with water to remove contaminants	Not applicable due to organic and fine-grained nature of the sludge bed material
	Chemical Treatment	Chemical (Solvent) Extraction	Similar to soil washing, except that solvents rather than water are used to extract contaminants	Not applicable due to the organic and fine-grained nature of the sludge bed material
		Base Catalyzed Dechlorination	Catalysts and elevated temperatures are used to break down organic compounds and convert them to lower toxicity water soluble materials	Potentially applicable
	Thermal Treatment	Rotary Kiln	Combustion in a horizontally rotating cylinder designed for uniform heat transfer	Not applicable for on-site treatment because facility would be too large for Site conditions. Potentially applicable for treatment at a TSDF
		Fluidized Bed	Waste injected into hot agitated bed of sand where combustion occurs	Not applicable for on-site treatment because facility would be too large for Site conditions.
		Infrared Thermal	Combustion using thermal radiation (beyond the red end of the visible spectrum) as the material passes on a conveyor belt through a treatment unit	Not applicable for on-site treatment because facility would be too large for Site conditions.
		Low Temperature Thermal	Soil is heated at low (non-combustible) temperatures to cause volatilization of contaminants	Not applicable for PCBs
		Supercritical Water Oxidation	Uses the properties of water in the supercritical state to destroy hazardous aqueous organic wastes. Also effective on sludges.	Potentially Applicable

Table 2-2
Initial Screening of Remedial Technologies
Cumberland Bay Sludge Bed

General Response Actions	Remedial (and Associated) Technologies	Process Options	Description	Screening Comments
In Situ Treatment	In Situ Treatment	Bioremediation	Sediment is treated through microbial decomposition	Not applicable because it is not widely available or a proven technology for PCBs
		Vitrification	Soil is heated to the melting point to destroy, volatilize, or immobilize contaminants in a monolithic mass	Not applicable. Technology not amenable for highly organic wastes or in under water conditions.
		Solidification/ Stabilization	A solidification/stabilization agent and water are added to convert the affected sediment to a hardened mass	Potentially Applicable
		Soil Vapor Extraction	Organic compounds are removed by drawing a vacuum toward vertical or horizontal vapor extraction wells	Not applicable to PCBs; also not applicable due to saturated condition of sediments
		Steam Stripping	Using wells, inject and recover steam to mobilize and remove volatile/semi-volatile compounds	Not applicable to PCBs; also not applicable due to saturated condition of sediments
Disposal	On site Disposal	Contained Aquatic Disposal (CAD)	Excavated material is consolidated in an under water depression and capped	Potentially Applicable
		Confined Disposal Facility (CDF)	Excavated material is placed in a common on-site disposal area	Potentially Applicable
	Off-site Disposal	Off-site Facility	Excavated material is transported to an appropriate off-site facility for final disposition	Potentially Applicable

Table 2-3
Remedial Technology Screening
Cumberland Bay Sludge Bed Site

General Response Action	Remedial (and Associated) Technologies	Description	Screening
No Action	Non-Technology Based	No action is taken to remove or control affected sludge bed sediments.	**Comments:** RETAINED. This technology is retained for comparison to other alternatives.
Institutional Controls	Deed Restrictions/ Health Advisories	Restrictions to future use of selected areas are specified in the property deed. Advisories and restrictions reduce exposure to contaminated fish.	**Effectiveness:** A deed restriction, in itself would not meet the remedial action objectives. Deed restrictions combined with another remedial technology such as a confined disposal facility could be an effective means of controlling access and use of the facility area. Restrictions could include prohibiting construction or future development of the disposal area. Health advisories and restrictions regarding consumption of fish would reduce potential exposure to contaminated fish which will likely be present after completion of remedial construction. **Implementability/Cost:** Deed restrictions or health advisories could be readily implemented at a minimal cost. **Comments:** RETAINED.
Contain-ment	In-place capping	Cover areas of contaminated sludge with clean sediment	**Effectiveness:** Placement of cap material over the sludge bed would reduce the potential for direct contact with or migration of sludge containing PCBs. However, addition of several feet of cover material in the already shallow sludge bed area would impact existing habitats and future recreational uses of this portion of the Bay. Long-term effectiveness of the cap would be difficult to monitor without extensive sampling. The potential for future exposure to or migration of sludge would be present due to natural erosion associated with water currents and plant and animal activity. **Implementability/Cost:** Construction of a cap could be difficult because the wide distribution of sludge, the shallow depth of water and the low bearing capacity of the sludge material. Administrative issues include the following: • This technology would be difficult to implement because under 6 NYCRR 608 and ECL Article 15, filling of a water body in such a manner that natural resources would be lost or impacted would not be permitted if a reasonable alternative is available (i.e., removal of the sludge bed). • Use of this technology in the Site remedy would require approval from an EPA Regional Administrator according to TSCA. TSCA contains minimum requirements for disposal facilities which are designed to ensure protection of human health and the environment. Difficulties with controlling leachate migration and issues with long-term permanence constitute serious obstacles to gaining approval from an EPA Regional Administrator. • Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to natural resource damage. • Since an in-place cap would significantly limit use of Wilcox Dock, according to NYS Canal Law, approval from the Commissioner of the NYSDOT and/or a special act of legislature (required to abandon a barge canal terminal) would be required to gain a permit for placing such a cap. If these implementation problems were overcome, a cap would likely be a less costly alternative compared to removal alternatives because no dredging, dewatering, water treatment or disposal would be necessary. **Comments:** ELIMINATED. According to NYCRR 608 (use and protection of waters) this alternative would not be implementable unless no other reasonable alternative was available. A wet CDF disposal option will be carried through the FS evaluation in case no other reasonable option can be identified. The CDF technology will be carried through rather than in-place capping because it constitutes a similar technology with the added benefit of engineered structures which would increase its long-term reliability.

Table 2-3
Remedial Technology Screening
Cumberland Bay Sludge Bed Site

General Response Action	Remedial (and Associated) Technologies	Description	Screening
Removal	Mechanical Dredging	A grab bucket (e.g., clamshell) is operated from a crane mounted on a barge or on shore	**Effectiveness:** A grab bucket is a highly precise digging tool efficient in close quarters such as dock and pier areas. It can recover all types of material except highly consolidated sediment and can operate at varying depths. Mechanical dredging yields a lower production rate (30 to 700 cy/hr) than hydraulic dredging and produces a greater amount of resuspended sediments. **Implementability/Cost:** A crane could be operated from Wilcox Dock or from a barge. The grab bucket excavates a higher percentage of solids than hydraulic dredging, it can lower the cost of subsequent dewatering. **Comments:** RETAINED. Mechanical dredging may be used in combination with dewatering and wet/dry excavation, particularly in low-lying areas that may be difficult to dewater and contain thicker deposits of sludge (i.e., adjacent to Wilcox Dock).
	Hydraulic Dredging	Hydraulic dredges are usually barge-mounted systems that use centrifugal pumps to remove and transport the sediment/ water mixture. Potentially applicable hydraulic dredging equipment includes the cutterhead, plain suction, dustpan or horizontal auger dredge.	**Effectiveness:** Hydraulic dredges generally exhibit higher production rates (10 to 10,000 cy/hr) and lower resuspension than mechanical dredges. However, they are susceptible to damage by debris and clogging with weeds. Slurries of up to 10 to 20 percent solids by weight are typically achieved particularly if the dredge is equipped with a cutterhead, dustpan or auger attachment. **Implementability/Cost:** A hydraulic dredge can operate at shallow depths and therefore could be used to remove the sludge bed sediments. The typical draft of the barge is 3 to 5 feet. Substantial amounts of water would be added to the sludge which could increase the cost of dewatering. **Comments:** RETAINED.
	Barrier Wall for Dewatering	Sheet pile walls (single or double) or portable dams would be used to temporarily retain surface water outside the sludge bed for dewatering and wet/dry excavation in the sludge bed area.	**Effectiveness:** A sheet pile cofferdam or portable dam could be used to isolate and dewater areas to be wet/dry excavated. The underlying stratigraphic units are amenable to embedding sheet piles (15 to 20 feet of sand over a dense glacial till). Portable dams could be used where depth of water is relatively shallow (less than 10 feet). **Implementability/Cost:** Conventional equipment is available for installing sheet piles or portable dams. A cost benefit analysis could be performed to evaluate the benefits of more effective and expensive barrier walls verses the cost of water pumping and/or treatment. **Comments:** RETAINED.
	Drawdown and Wet/Dry Excavation	Conventional earthmoving equipment is used to remove sediment from dewatered or shallow water areas. Excavation equipment could include backhoes, front-end loaders, clamshells, draglines, aquatic weed harvesters or hand held equipment.	**Effectiveness:** A sheet pile cofferdam or portable dam could be used to isolate the areas to be excavated for the purpose of dewatering. Use of conventional earthmoving equipment is a proven method for removing sediments. **Implementability/Cost:** The sand underlying the sludge bed would likely support excavation equipment although roads and working pads could be constructed if necessary. Conventional excavation may be the only means of removing impacted material along the shoreline in the wooded areas since it is not submerged. The dewatering and wet/dry excavation approach could be limited to just the shoreline or, since the sludge bed occurs in a relatively shallow part of Cumberland Bay, could be expanded to include a portion or all of the sludge bed. **Comments:** RETAINED.

Table 2-3
Remedial Technology Screening
Cumberland Bay Sludge Bed Site

General Response Action	Remedial (and Associated) Technologies	Description	Screening
Removal	Transportation	Pipelines, barges, railroads or trucks can be used to transport dredged or excavated material to on-site or off-site processing or disposal facilities	**Effectiveness:** Pipelines, barges, railroads or trucks would be effective means for transporting dredged or excavated materials. **Implementability/Cost:** Transportation of removed material would be implementable using any of these means. If transport is selected as part of a remedial action alternative, the relative costs would be evaluated during the detailed analysis of alternatives. **Comments:** RETAINED.
	Suspended Sediment Barriers	Installation of a Portadam, sheet pile, silt curtain or boom to control resuspended sediments during dredging activities.	**Effectiveness:** Mechanisms for controlling migration of suspended sediments range from booms to control floating sediments, weighted fabric curtains, to interlocking sheet piles. The effectiveness of these structures depends on the hydraulic and climatic conditions at the site. A strong storm could threaten the integrity of the a fabric curtain. Such structures may not be required if resuspension of sediments during dredging is minimized. **Implementability/Cost:** Installation of silt curtains or booms would be easier and less expensive to implement than installation of a sheet pile. Maintenance of a silt curtain or boom would likely require greater effort than for a sheet pile, especially after storm events. **Comments:** RETAINED.
Ex Situ Treatment	Dredged or Excavated Sludge Dewatering	Sludge is drained, pressed or a vacuum is applied to reduce the water content	**Effectiveness:** Mechanisms for dewatering sludge include gravity drainage, belt filters and filter presses. The results of bench tests indicated that filter pressing is more effective that other dewatering methods although the reduction of water content using the filter press was relatively small. A pilot scale test would be more representative of full scale dewatering and would be more useful for designing a sludge dewatering system. Dewatering is a commonly used, proven technology. Effluent from the dewatering process may require treatment prior to discharge. **Implementability/Cost:** Dewatering could be performed in a CDF, on shore, or on a barge. **Comments:** RETAINED.
	Solidification/ Stabilization	Introduce specially designed admixtures to excavated soil to improve its physical properties	**Effectiveness:** Cement-based and silicate-based solidification techniques have been more successful in treating hazardous wastes than thermoplastic-based or organic polymer-based techniques. The effectiveness of stabilization depends on the selected stabilization agents, other additives, the waste-to-additive ratio, mixing variables, and curing conditions. They all depend on the chemical and physical characteristics of the waste. Bench-scale treatability tests indicated that the leachability and compressive strength of the sludge could be improved using commonly available additives. The effectiveness of stabilization for PCBs is not proven. Solidification should be effective for increasing the bearing capacity of the sludge to provide greater support to a confined disposal facility cap. **Implementability/Cost:** Solidification/stabilization could be performed before, during or after dewatering of the dredged or excavated sludge. **Comments:** RETAINED.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 Development of Alternatives

In this section, the remedial technologies selected for further consideration are assembled into appropriate remedial alternatives that achieve the remedial action objectives. As required by the NCP, the "No Action" remedial alternative is included. The six remedial alternatives for the sludge bed are as follows:

Alternative 1: No Action

Under this alternative, no action would be taken to contain, remove, or treat the sludge bed or to restrict use or access to the these areas.

Alternative 2a: Removal and Wet On-Site Disposal in a CDF

Under this alternative, the sludge bed would be removed using a combination of hydraulic dredging (with measures taken to control resuspended sediments) and/or dewatering/dry excavation. Contaminated sludge along the shoreline would be removed using conventional excavation methods. The sludge would be placed in a CDF located adjacent to Wilcox Dock where the sludge bed material is thickest. The CDF construction would consist of a double-wall sheet pile cofferdam installed to a depth below the highly consolidated till unit underlying the natural bay sediments. The portion of the sludge bed incorporated inside the sheet piling would not require removal, which would significantly reduce the total volume of sludge to be hydraulically dredged and processed. Upon completion of sludge removal, the CDF would be covered with a cap consisting of synthetic membranes and soil. The containment system created by the combination of the cap, sheet pile cofferdam and till confining layer would prevent direct contact with or migration of the sludge containing PCBs. Structural surface features or solidification would be considered for achieving the necessary bearing capacity for future use of the dock. The supernate drained from the CDF would be monitored and treated prior to discharge to the local POTW or the Bay. Long-term monitoring would be performed to ensure isolation of the PCBs.

Alternative 2b: Removal and Dry On-Site Disposal in a CDF

Under this alternative, the sludge bed would be removed using a combination of hydraulic dredging (with measures taken to control resuspended sediments) and/or dewatering/dry excavation. Contaminated sludge along the shoreline would be removed using conventional excavation methods. Sludge would be dewatered on shore using mechanical methods such as filter pressing. The CDF would be located in a shallow area along the shoreline. The CDF would be constructed in accordance with TSCA landfill requirements, including liner and cover systems constructed above the Bay water level and confined by a dike. Removed sludge would be dewatered prior to placement in the CDF. Final use of the CDF area would be as an extended shoreline. The filtrate from dewatering would be monitored and treated prior to discharge to the local POTW or the bay. Long-term monitoring would be performed to ensure isolation of the PCBs.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section describes the evaluation criteria for the detailed analysis of the alternatives retained after the preliminary screening of alternatives. Section 4.1 identifies and describes the evaluation criteria. Sections 4.2 presents the detailed analysis of the remedial alternatives. In these sections, the remedial alternatives are described, and then systematically assessed, on an individual basis, relative to the evaluation criteria. In Section 4.3 the alternatives are compared on the basis of these evaluation criteria.

4.1 Evaluation Criteria

NYSDEC TAGM 4030 on selection of remedial actions (NYSDEC, 1989; revised, 1990) presents seven criteria to be used for evaluating remedial alternatives that have passed the preliminary screening process. These criteria are as follows:

- Compliance with New York State Standards, Criteria and Guidelines (SCGs);
- Overall protection of human health and the environment;
- Short-term effectiveness;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume through treatment;
- Implementability; and
- Costs (capital, annual operation and maintenance, present worth).

There are two tiers to the above seven criteria. The first two are threshold factors and the next five are primary balancing factors. Additionally, community acceptance will be considered as a modifying consideration. These tiers are reflected in the detailed analysis. Descriptions of the seven criteria are provided below.

4.1.1 Compliance with New York State SCGs

This evaluation criterion is used to assess compliance with promulgated chemical-specific, action-specific, and location-specific Standards, Criteria and Guidance (SCGs). SCGs for the Cumberland Bay Sludge Bed Site are discussed in Section 1.4. Proposed remedial alternatives are analyzed to assess whether they achieve SCGs under Federal and State environmental laws, public health laws, and State facility siting laws, or whether they may be subject to one of the six waivers allowed under CERCLA. As a threshold factor, an alternative must be compliant with SCGs (or receive a waiver) to be considered further.

4.1.2 Overall Protection of Human Health and the Environment

This evaluation criterion is designed to determine whether a proposed remedial alternative is adequate with respect to protection of human health and the environment. The evaluation focuses on how each proposed alternative achieves protection over time, how Site risks are eliminated, reduced, or controlled, and whether any unacceptable short-term impacts would result from implementation of the alternative. The overall protection of human health and the environment evaluation draws on the assessments for long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs. As a threshold factor, an alternative must be compliant with overall protection of human health and the environment to be considered further.

4.1.3 Short-Term Effectiveness

This evaluation criterion is used to assess short-term potential impacts associated with the construction and implementation phase of remediation. Alternatives are evaluated with regard to their effects on human health and the environment. These considerations include:

- Protection of the community during implementation of the proposed remedial action (i.e., dust, inhalation of volatile gases);

- Protection of workers during implementation;

- Environmental impacts that may result from the implementation of the remedial alternative and the reliability of mitigative measures to prevent or reduce these impacts; and

- Time until remedial response objectives are met, including the estimated time required to achieve protection.

4.1.4 Long-Term Effectiveness and Permanence

This criterion addresses the long-term effectiveness and permanence of the remedial alternative with respect to the quantity of residual chemicals remaining at the Site after response goals have been met. The principal focus of this analysis is the adequacy and reliability of controls necessary to manage any untreated media and treatment residuals. Characteristics of the residual chemicals such as volume, toxicity, mobility, degree to which they remain hazardous, and tendency to bioaccumulate must also be examined. Specifically, these considerations are:

- Magnitude of residual risk;
- Adequacy of controls; and
- Reliability of controls.

4.1.5 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion assesses the degree to which the remedial alternative utilizes recycling and/or treatment technologies that permanently decrease toxicity, mobility, or volume of the chemicals as their primary element. It also assesses the effectiveness of the treatment in addressing the predominant health and environmental threats presented by the Site. The specific factors considered under this evaluation criterion include:

- Treatment process the remedy would employ and the materials it would treat;

- Amount of contaminants that would be treated or destroyed;
- Degree of expected reduction in toxicity, mobility, or volume (expressed as a percentage of reduction or order of magnitude);
- Degree to which the treatment would be irreversible;
- Type and quantity of treatment residuals that would remain following treatment accounting for persistence, toxicity, mobility and the tendency to bioaccumulate; and
- Whether the alternative would satisfy the statutory preference for treatment as a primary element.

4.1.6 Implementability

This criterion assesses the technical and administrative feasibility of implementing a remedial alternative and the availability of various services and materials that would be required during its implementation. Factors considered include the following.

- Technical feasibility: includes the difficulties and unknowns relating to construction and operation of a technology, the reliability of the technology (including problems resulting in schedule delays), the ease of performing additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- Administrative feasibility: involves coordinating with governmental agencies to obtain necessary permits or approvals.
- Availability of services and materials: includes sufficiency of off-site treatment, storage and disposal capacity; access to necessary equipment, specialists and additional resources; potential for obtaining competitive bids especially for new and innovative technologies; and availability of state-of-the-art technologies.

4.1.7 Costs

This criterion assesses the costs associated with a remedial action. It can be divided into capital costs, annual operation and maintenance (O&M) costs, and net present worth costs. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct capital costs include:

- Construction and equipment costs: materials, labor, equipment required to install/perform a remedial action.
- Land and site-development costs: land purchase and associated expenses, site preparation of existing property.

- Building and service costs: process and non-process buildings, utility connections, and purchased services.

- Disposal costs: transporting and disposing of materials.

Indirect capital costs include:

- Engineering expenses: administration, design, construction, supervision, drafting, and treatability testing.

- Legal fees and license or permit costs: administrative and technical costs expended to obtain licenses and permits for installation and operation.

- Start up costs incurred during initiation of remedial action.

- Contingency allowances: costs resulting from unpredicted circumstances (i.e., encountering unanticipated volumes of sludge, odor control, adverse weather, strikes, etc.).

Annual O&M costs are post-construction costs expended to maintain and ensure the effectiveness of a remedial action. The following are annual O&M costs evaluated:

- Labor costs: wages, salaries, training, overhead, and fringe benefits for operational labor.

- Maintenance materials and maintenance labor costs: labor and parts, etc. necessary for routine maintenance of facilities and equipment.

- Auxiliary materials and utilities: chemicals and electricity needed for treatment plant operations, water and sewer services.

- Disposal of residue: disposal or treatment and disposal of residues such as sludges from treatment processes.

- Purchased services: sampling costs, laboratory fees, and professional fees as necessary.

- Administrative costs: costs associated with the administration of O&M that have not already been accounted for elsewhere.

- Insurance, taxes, and licensing costs: liability and sudden accidental insurance, real estate taxes on purchased land or rights-of-way, licensing fees for certain technologies, permit renewal and reporting costs.

- Replacement costs: maintenance of equipment or structures that wear out over time.

- Cost of periodic Site reviews if a remedial action leaves residual contamination.

Net present worth consists of capital and O&M costs calculated over the lifetime of the remedial action and expressed in present day value. The lifetime of the remedial action is considered to be a maximum of 30 years for costing purposes.

Any remedial action that leaves hazardous waste at a site may affect future land use, resulting in a loss of business activities, residential development, and taxes. This unquantified cost is considered for the alternatives that would leave hazardous wastes on site.

4.1.8 Community Acceptance

Community acceptance is a modifying consideration and can only be evaluated in the FS to a limited extent at this time. Typically, these considerations are not taken into account until the Record of Decision (ROD) is prepared following the public comment period on the proposed plan and RI/FS report. Comments received from the public are assessed to determine aspects of each remedy that are supported or opposed. However, since a public comment period has not yet been held, the evaluation presented in the FS at this time is very general and somewhat speculative. Public comments will be considered prior to completion of the proposed remedial plan.

4.2 Remedial Alternatives Analysis

This detailed analysis evaluates the remedial alternatives that passed the initial alternatives screening in Section 3.0 relative to the seven evaluation criteria and the modifying factor of community acceptance. It focuses upon the relative performance of each alternative. The remedial alternatives that are evaluated in the detailed analysis are as follows:

- Alternative 1: No Action
- Alternative 2a: Removal and Wet On-site Disposal in a CDF
- Alternative 2b: Removal and Dry On-site Disposal in a CDF
- Alternative 3a: Removal and Off-site Disposal at a Solid Waste Landfill
- Alternative 3b: Removal and Off-site Disposal at a Hazardous Waste (TSCA permitted) Landfill
- Alternative 3c: Removal and Off-site Treatment by Incineration at a RCRA Permitted Facility
- Alternative 3d: Removal and Off-site Disposal at Solid and Hazardous Waste Landfills

4.2.1 Alternative 1 - No Action

4.2.1.1 Description

The No Action Alternative (Alternative 1) is at one end of the range of source remediation alternatives for the Cumberland Bay sludge bed. Under this alternative, no action would be taken to contain, remove, or treat the sludge bed or to restrict use or access to the these areas.

4.2.1.2 Assessment

Compliance with SCGs

Under this alternative, sludge containing concentrations of PCBs would remain available for direct contact or migration and would therefore not achieve the site cleanup objectives. Disposal requirements under TSCA, which relate to material containing PCB concentrations greater than 50 ppm, would not apply since no sludge would be actively managed.

Overall Protection of Human Health and the Environment

This alternative provides no means of controlling direct exposure to or migration of PCB laden wood chips or sludge bed materials. Therefore, it would not reduce potential risks to human health or the environment.

Short-Term Effectiveness

Community, worker and environmental protection: Since no action would be taken to disturb the contaminated sludge bed under this alternative, implementation would not pose any short-term risks to workers, the community, or the environment as a result of construction activities.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is not reduced since the potential for migration of PCB laden sludge to the public beaches is not controlled under the No Action Alternative.

Adequacy of controls: Long-term human health or ecological risks due to exposure to affected sludge would not be reduced.

Reliability of controls: No controls would be implemented for this alternative.

Reduction of Toxicity, Mobility, and Volume Through Treatment

The No Action Alternative would not reduce the toxicity, mobility or volume of the PCBs in the sludge. Since treatment is not part of this alternative, irreversibility does not apply.

Implementability

No construction or operation would be required to implement the No Action Alternative. No treatment would be performed, and therefore, no permits or approvals are necessary. The No Action Alternative does not complicate or prevent any future remedial actions from being implemented at the Site.

Cost

Costs relative to continued beach cleaning and affect on tourism have not been calculated but could be sizable.

Community Acceptance

This alternative is unlikely to achieve community acceptance because sludge and wood chips containing PCBs would continue to pose unacceptable potential risks to human health and the environment.

4.2.2 Alternative 2a - Removal and Wet On-Site Disposal in a CDF

4.2.2.1 Description

Removal of the Sludge Bed

Under this alternative, PCBs would be contained on Site through partial dredging and consolidation of the sludge in a CDF located where the sludge bed is the thickest. The location of the CDF is shown on Figure 4.1. Sludge to be consolidated would include subaqueous sludge in the Bay and sludge which has washed up onto the shorelines in the vicinity of the Site.

Methods for sludge removal will vary. Removal methods may include hydraulic dredging or installation of a containment wall and "dry" excavating. In areas with water depths less than 2 feet, hydraulic dredging is not appropriate because typical dredges have minimum draft requirements. Dry excavation could be performed in an areas restricted to the shoreline or as far from the shoreline as is practical to construct a temporary dewatering containment wall. For the purpose of this FS, hydraulic dredging (with dry excavation limited to shoreline and shallow water areas) was assumed for the sludge removal method because the CDF provides a convenient means for dewatering of the dredge slurry. A cost benefit analysis could be performed during design to evaluate the most cost effective and technically appropriate means for sludge removal.

For this alternative, the volume of sludge to be dredged is estimated to be 47,000 cubic yards (cy). This volume excludes approximately 46,000 cy of sludge that would be confined within the walls of the CDF located adjacent to Wilcox Dock. The CDF location was intentionally selected to incorporate the channel adjacent to the dock which contains the thickest portions of the sludge bed. The shoreline excavation area is assumed to include approximately 1,000 feet of heavily vegetated shoreline between Wilcox Dock and the small dock north of the Chamber of Commerce building. The width of the contaminated sludge located along this stretch of shoreline is assumed to range between 100 to 300 feet, with a depth of approximately 1 to 2 feet. The total volume estimated to be removed from this area is 7,900 cy (see Appendix A, Attachment A-1.2). This volume would require mechanical equipment for removal. Actual shoreline dimensions would depend on the bay elevation at the time of remediation.

The sludge bed would be removed by hydraulic dredge unless access is limited by minimum draft requirements. An estimated construction time line, based on estimated durations of activities and estimated construction startup and completion dates provided by the NYSDEC, was developed for this alternative. Based on the conditions at the Site, it is anticipated that sludge could be hydraulically dredged at a rate of 340 cy per day based on a 6 hour day. Assuming operation would occur 30 days per month, it is anticipated that active dredging would be performed for 5 months. For the purpose of this FS it is anticipated that two, 1,000 gpm capacity Mudcat-type dredges, capable of entering shallow areas (approximately 2 foot minimum draft) and equipped with a horizontal auger, cutter head or suction head, would be used for sludge bed removal. Due to time required for construction of the CDF, as shown on the construction timeline, it is anticipated dredging would be performed during two dredging (summer) seasons.

Methods for shoreline sludge removal may include the use of land-based or barge-mounted mechanical excavators or other innovative methods which could limit the disturbance to shoreline habitats. It is anticipated that a separation barrier such as a temporary sheet pile or Portadam™ would be used to dewater the areas near the shoreline for easier access during shoreline excavation activities. Vegetation management may be necessary and may include use of an aquatic weed harvester, NYSDEC-approved herbicides or dyes used to inhibit vegetation growth by eliminating exposure to the sun. Site restoration activities would include restoration of the shoreline wetland habitats after excavation is completed.

Prior to dredging, 2,800 feet of temporary sheet pile would be installed along the perimeter of the dredge area to provide a lower energy hydraulic environment in which to perform dredging. The alignment of the sheet pile wall is shown on Figure 4.1. This would allow the dredge to be more stable in the water enhancing precision dredging techniques. If resuspension results from dredging, the sheet pile wall would also limit transport of suspended sludge material. The design of the dredging program would provide a performance specification to minimize turbidity and suspended solids concentrations in the immediate area of the dredge.

Resuspension data, and other pertinent baseline data required for determining appropriate control methods and monitoring criteria, would be collected during startup activities. These data would be used to select appropriate engineering controls and develop a monitoring program to evaluate surface water quality and rates of resuspension during the dredging program. If significant resuspension occurs, options for controlling the migration of PCBs in the surface water include installation of booms (to control floating material such as wood chips), silt curtains, Portadams™ or temporary sheet piles.

Performance monitoring for dredging and shoreline excavation would include collection of samples from the upper 6 inches of the sediments after completion of sludge bed removal to confirm that the remedial action objectives have been achieved. At locations where residual sludge is identified, a determination will be made if additional dredging or lake bottom restoration (via placement of approximately one foot of sand) is necessary. Samples would be collected at similar locations as used during the SC. Long-term monitoring of fish and other media would be performed to measure the effectiveness of the remedial action on reducing PCB concentrations in fish as well as meeting all of the remedial action objectives for the Site.

The potential for impact to ambient air quality has been demonstrated at PCB contaminated sediment removal sites such as at New Bedford Harbor in Massachusetts. Air would be monitored and controls implemented, as needed, to maintain PCB levels within short-term guideline concentrations (SGCs) and annual guideline concentrations (AGCs) specified in NYSDEC Air Guide 1. Air monitoring locations and frequency would be determined based on data collected prior to and during the initial dredging activities.

Wet Confined Disposal Facility Adjacent to Wilcox Dock

Hydraulically dredged and excavated sludge would be placed in a CDF located adjacent to Wilcox Dock where the sludge bed material is thickest. The configuration of the CDF, as conceptualized for this FS, is shown on Figure 4.1 and 4.2. The CDF would extend 200 feet beyond the northeast and northwest walls of the dock. The CDF would contain four cells for intermittent usage to allow adequate retention time for settling the dredge slurry. The exterior CDF walls would be constructed as a double-wall sheet pile cofferdam approximately 15 feet wide (required to support the weight of the sludge) and would meet the elevation of the existing dock. The interior walls would be constructed as interlocking single wall sheet piles. These CDF dimensions would provide a capacity of approximately 50,000 cy for retaining sludge and water (see Appendix A, Attachment A-2.1). This volume should be adequate to contain the estimated 47,000 cy of sludge to be removed under this alternative.

The sheet piles would extend down to the highly consolidated till unit underlying the natural bay sediments, as shown on Figure 4.3. This till was encountered in geotechnical borings drilled around the existing dock and within the sludge bed area at a depth of 10 to 20 feet below the mudline (top of the sludge bed). A wall of single sheet piles would be placed along the concrete portion of Wilcox Dock to prevent dredged material from migrating into the timber cribbing under the concrete wall.

Upon completion of sludge removal, the CDF would be covered with a cap consisting of geosynthetic membranes and soil components as shown on Figure 4.2. Compression of the loose sludge would cause settling of the cap over time. Therefore, periodic filling and leveling of the cap would be required as part of long-term maintenance. The loading capacity of the CDF cap was evaluated to determine the suitability of the cap for traffic. The strength of the dredged sludge was assumed to be very low. The strength of the geosynthetic, which would bear the majority of the load, was estimated based on manufacturer guidelines. The results indicated that future use of the dock would be suitable for cars or light trucks (18-kip axle load).

The containment system created by the combination of the cap, sheet pile cutoff wall and till confining layer would prevent direct contact with or migration of the sediments containing PCBs. If water levels are lowered within the CDF, a constant inward gradient would be maintained. Sumps would be installed within each of the CDF cells for long-term maintenance of the inward gradient. The rate of water seepage into the CDF through the cap and walls, and under the walls through the till, were estimated based on maintaining a one foot head difference inside the CDF. These calculations are shown in Appendix B. Using conservatively high hydraulic conductivity values for the till and dredged sludge placed in the CDF, the seepage rate was estimated to range between 5 and

10 gpm. A small-scale water treatment system would be constructed for long-term treatment of water pumped from the CDF. The system would be comprised of an aeration tank and granular activated carbon beds housed within a building located on site. Treated water would be discharged to the bay or the local POTW. Long-term operation, maintenance and monitoring of the water recovery and treatment system would be required.

Long-term monitoring of the CDF performance would include installation of wells within the double-walled sheet pile cofferdam and quarterly or annual monitoring for PCBs to evaluate the potential for leaks.

Construction Process Water Treatment System

The hydraulic dredging process would reduce the solids content of the sludge from approximately 30% (based on testing results of untreated sludge) to approximately 5% due to the significant addition of water resulting from slurrying. The dredge slurry would be piped directly to the cells of the CDF where settling would occur at an approximate rate of 2 ft/hr based on column settleability testing. After adequate retention time in the CDF, the water which separates from the sludge (supernate) would be pumped from the CDF into a water treatment system. Laboratory testing of water gravity drained untreated sludge samples indicates that the supernate would require treatment for PCBs and carbon oxygen demand (COD). The treatment system would be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

4.2.2.2 Assessment

Compliance with SCGs

Under 6 NYCRR 608 and ECL Article 15, filling of a water body in such a manner that natural resources would be lost or impacted would not be permissible if a reasonable alternative is available (i.e., removal of the sludge bed). This alternative would only be considered implementable if no other reasonable alternative is identified.

This alternative would be consistent with TSCA (Part 761.60) in that sludge containing PCBs would be disposed using a method that provides adequate protection to human health and the environment. All sludge in the area containing PCBs would be isolated on-site. Approval would be necessary for an EPA Regional Administrator, which may be difficult since long-term effectiveness and permanence may be difficult to demonstrate in a lake environment.

This alternative would take land belonging to the NYS Thruway Authority and change the shape and potentially use of Wilcox Dock. According to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be needed for changing a barge canal terminal.

Overall Protection of Human Health and the Environment

This alternative would effectively isolate contaminated sludge, provide protection against migration of PCBs to surface water through maintenance of an inward gradient, and greatly limit the potential for exposure. Overall protection of human health and the environment is high compared to Alternative 1, however long-term effectiveness and permanence would be difficult to demonstrate in a lake environment.

Short-Term Effectiveness

Community, worker and environmental protection: This alternative would require disturbance of only half of the sludge bed, leaving the thickest and potentially most contaminated material in place. This would significantly reduce the short-term risks compared to alternatives that would require removal of all of the sludge bed. Potential for impact to the community, workers or the environment would be present during sludge removal activities. Supplying workers with proper personal protective equipment, monitoring air and water quality during sludge removal, transport and disposal and water treatment, and employing engineering controls, as necessary, would mitigate exposure risks.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is relatively low. The affected sludge bed materials would be adequately contained and isolated in place within the CDF. Assuming proper functioning of the CDF, the risks to potential future receptors due to migration of or direct contact with contaminated sludge bed materials is mitigated effectively. Migration of PCBs through the CDF would be negligible due to the low permeability of the CDF walls, floor and cap. Maintenance of an inward gradient would mitigate the potential for migration of impacted water. Drainage controls would aid to prevent erosion of the cap.

As the affected sludge bed materials are not treated, a failure or breach of the CDF would result in the reoccurrence of health-based or ecological risks. The considerable thickness of the cap (approximately 5 feet) and the use of appropriate land use restrictions would significantly reduce the potential for a CDF breach.

Adequacy of controls: A CDF should, in all probability, achieve its performance requirement of preventing direct contact to future potential receptors. Implementation of and compliance with land use restrictions and long-term maintenance obligations would aid in preserving CDF integrity (permanence) and limiting exposure. Long-term maintenance activities, including annual visual inspection of the CDF cap, crack and surface repair, as necessary, would ensure CDF integrity.

Reliability of controls: With proper construction and long-term maintenance the CDF would provide a highly reliable isolation barrier to potential future receptors. It is anticipated that with proper maintenance, the CDF should last indefinitely.

Reduction of Toxicity, Mobility, and Volume Through Treatment

A reduction in contaminant mobility (primarily by wind and water erosion) would be achieved by isolating sludge in a CDF. There would be no reduction in the toxicity or volume of the contaminants.

Implementability

Administrative: Under 6 NYCRR 608 and ECL Article 15, filling of a water body in such a manner that natural resources would be lost or impacted would not be permissible if a reasonable alternative is available (i.e., removal of the sludge bed). This alternative would only be considered implementable if no other reasonable alternative is identified. This alternative would require approval by an EPA Regional Administrator that the disposal method meets the requirements of TSCA Part 761.60(a)(5)(iii). Since this alternative would take land belonging to the NYS Thruway Authority and change the shape and potentially use of Wilcox Dock, according to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be required.

Technical: The technologies to be used during this alternative have been implemented at sediment removal sites. The CDF could be constructed using readily available material and equipment. Providing that the CDF is periodically inspected and repaired, it provides a high degree of reliability.

Cost

A summary of the estimated costs for Alternative 2a and a comparison with the costs associated with other alternatives is provided on Table 4-1. The summary of estimated costs is supplemented by Table 4-2, Sludge Removal and Processing Costs; Table 4-3, CDF Construction Costs; and Table 4-4, Water Treatment Costs.

Community Acceptance

This alternative would likely achieve varying degrees of community acceptance. Although it will meet the remedial action objectives, increase the functional use of the bay, and provide a larger dock available for recreational uses, a segment of the community may still object to the intentional disposal of contaminated sludges within the Bay. The shoreline could be restored and the Site would remain relatively unchanged.

4.2.3 Alternative 2b - Removal and Dry On-Site Disposal in CDF

4.2.3.1 Description

Removal of the Sludge Bed

As discussed under Alternative 2a, options are available for sludge removal, including hydraulic dredging or dewatering/dry excavation. For the purposes of comparing sludge removal costs, Alternative 2b is based on the assumption that submerged sludge will be removed by hydraulic dredging (with dry excavation limited to shoreline and shallow water areas). The relative costs between sludge removal through primarily hydraulic dredging were compared to the costs for removal of sludge through primarily dry excavation or a combination of hydraulic dredging and dry excavation. This comparison is described in Appendix A, Attachment A-1.5. Hydraulic dredging (with dry excavation limited to shoreline and shallow water areas) was shown to be the most cost effective although the costs are close enough that dry excavation would be considered during design.

The volume of sludge to be dredged under Alternative 2b is approximately 93,000 cy because the CDF would not incorporate any undisturbed sludge within its design. As discussed in Appendix A, Attachment A-1.1, due to the time required to construct and close the Dry CDF, a conservative dredge rate to complete the project in the most efficient time frame is 500 cy/day which is based on removal of 93,000 cy in 6 months (see Construction Timeline on Figure 4.5). For the purpose of this FS it is anticipated that two, 1,000 gpm capacity Mudcat-type dredges, capable of entering shallow areas (approximately 2 foot minimum draft) and equipped with a horizontal auger, cutter head or suction head, would be used for sludge removal. This estimate would include dredging during two dredging (summer) seasons.

The volume of the shoreline material requiring removal (estimated to be 7,900 cy) and the removal techniques (dewatering using a separation barrier and removal using land-based or barge-mounted mechanical excavators) would be the same as discussed for Alternative 2a. However, for this alternative, a portion of the shoreline in the footprint of the CDF would require removal and temporary storage (within the footprint of the CDF) during the first phase of CDF construction. It is anticipated that a separation barrier such as a temporary sheet pile or Portadam™ would be used to dewater the areas near the shoreline for easier access during shoreline excavation and CDF construction activities. This barrier could be extended to incorporate an area containing sludge, outside of the CDF footprint, that could be used as a temporary holding area for the shoreline materials.

Prior to dredging, 2,800 feet of temporary sheet pile would be installed along the perimeter of the dredge area to provide a lower energy hydraulic environment in which to perform dredging. The alignment of the sheet pile wall is shown on Figure 4.1. This would allow the dredge to be more stable in the water enhancing precision dredging techniques. If resuspension results from dredging, the sheet pile wall would also limit transport of suspended sludge material. The design of the dredging program would provide a performance specification to minimize turbidity and suspended solids concentrations in the immediate area of the dredge.

Resuspension data, and other pertinent baseline data required for determining appropriate control methods and monitoring criteria, would be collected during startup activities. These data would be used to select appropriate engineering controls and develop a monitoring program to evaluate surface water quality and rates of resuspension during the dredging program. If significant resuspension occurs, options for controlling the migration of PCBs in the surface water include installation of booms (to control floating material such as wood chips), silt curtains, Portadams™ or temporary sheet piles.

Performance monitoring for dredging and shoreline excavation would include collection of samples from the upper 6 inches of the sediments after completion of sludge bed removal to confirm that the remedial action objectives have been achieved. At locations where residual sludge is identified, a determination will be made if additional dredging or lake bottom restoration (via placement of approximately one foot of sand) is necessary. Samples would be collected at similar locations as used during the SC. Long-term monitoring of fish and other media would be performed to measure the effectiveness of the remedial action on reducing PCB concentrations in fish as well as meeting all of the remedial action objectives for the Site.

Sludge Dewatering

The hydraulic dredging process would reduce the solids content of the sludge from approximately 30% (based on testing results of untreated sludge) to approximately 5% due to the significant addition of water resulting from slurrying. An evaluation of sludge dewatering methods including gravity drainage and filter pressing was conducted and indicated that gravity drainage would be the most cost effective method for dewatering under Alternative 2b (see Appendix A). Sludge would be dewatered on shore using a series of concrete boxes to drain the dredge slurry. Upon completion of drainage, cement kiln dust or another suitable solidification agent would be applied to the sludge and mixed manually with an excavator. The excavator would then transfer the sludge from the drainage box directly into trucks for transport to the CDF. Laboratory scale testing has indicated that gravity drainage could reduce the moisture content of slurry from 95% to 65% (expressed in weight of water over total weight). This is slightly lower than the 70% moisture content of the sludge bed material in place. Gravity drainage (with a 20% addition of solidification agent) is estimated to reduce the volume of the sludge from 93,000 cy (in place) to 85,500 cy.

Dry Confined Disposal Facility Located on the Shoreline

The objective of constructing a CDF along the shoreline is to provide a containment area that is above the high groundwater/lake water levels, thus providing a dry location for long-term storage of the sludge. The shoreline area would require the least amount of backfilling to achieve necessary elevations. The CDF would occupy approximately 4 to 5 acres along the shoreline (see Figure 4.1 and 4.6) and would be constructed in accordance with TSCA-permitted landfill requirements. The base of the CDF would be raised, as necessary, to bring the liner of the CDF above Elev. 102 feet, the highest recorded bay water level. A cross-section of the CDF is shown on Figure 4.5. The shoreline portion of the CDF would be constructed using a dike protected by rip rap with a peak height of Elev. 120, 18 feet above the highest recorded bay level. The highest portion of the completed CDF is estimated to be Elev. 124 feet which is approximately 14 feet above the nearby plateau which levels off at approximately Elev. 110 to 114 feet. The estimated capacity the dry CDF is 104,000 cy (see Appendix A, Attachment A-2.1). This volume should be adequate to contain the anticipated 85,500 cy of dewatered sludge and 7,900 cy of shoreline sludge, plus provide a 10% excess contingency volume of 11,000 cy. During design, the landfill geometry and associated capacity would be more accurately modeled to represent the most efficient size and use of the area for the anticipated volume of sludge.

The bottom liner of the CDF would consist of structural fill, a geosynthetic clay liner, a geomembrane and a geonet drainage layer (see Figure 4.6). Once all of the dewatered filter cake is placed in the CDF the final cover would be constructed. The final cover would consist of a soil gas vent layer, a geomembrane, barrier protection soil and top soil (see Figure 4.7). Compression of the loose sludge would cause settling of the cap over time. Therefore, periodic filling and leveling of the cap would be required as part of long-term maintenance. Future use of the shoreline created by the CDF berm could include access to a boat launch or floating docks.

Loading on the sludge resulting from the weight of the final cover will cause an initial surge in leachate production that should diminish over time. This leachate would be collected and treated in a small scale water treatment system similar to that discussed for long-term O&M under Alternative 2a. Under Alternative 2b, the small scale treatment system would be considered a capital cost and is anticipated to be operated at its design capacity for one or two years. After compaction of the sludge from the weight of the cap it is anticipated that leachate production will slow to volumes that can be handled by batch processing through the small scale on-site system or periodic pick-up by tanker trucks for off-site disposal. Appendix A provides additional discussion of leachate production estimates.

The containment system created by the CDF would prevent direct contact with or migration of the sludge containing PCBs. Long-term monitoring of the CDF performance would include installation of wells within the dike and quarterly or annual monitoring for PCBs to detect potential leakage.

Water Treatment System

Laboratory testing of water produced through the process of filter pressing the untreated sludge samples indicates that treatment for PCBs and carbon oxygen demand (COD) would be required. The treatment system would be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

4.2.3.2 Assessment

Compliance with SCGs

Under 6 NYCRR 608 and ECL Article 15 filling of a water body (in this case only along the shoreline of Cumberland Bay) in such a manner that natural resources would be lost or impacted would not be permissible if a reasonable alternative to filling is available (i.e., removal of the sludge bed).

Although this alternative complies with the specific disposal requirements of TSCA, approval would still be required from an EPA Regional Administrator.

Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to natural resource damage along the shoreline related to construction of the dry CDF.

Overall Protection of Human Health and the Environment

This alternative would effectively isolate contaminated sludge, provide protection against migration of PCBs to surface water through maintenance of an inward gradient, and greatly limit the potential for exposure. Overall protection of human health and the environment is high compared to Alternative 1. However, under this alternative approximately 4 to 5 acres of shoreline habitat would be destroyed to allow construction of the shoreline CDF. These habitats could not easily restored in this area.

Short-Term Effectiveness

Community, worker and environmental protection: This alternative would require removal and processing of a significantly larger volume of sludge than for Alternative 2a. This would pose an increased potential for short-term risks since the sludge adjacent to Wilcox Dock may contain the highest levels of PCBs in the sludge bed area. Potential for impact to the community, workers or the environment would be present during sludge removal activities. Supplying workers with proper personal protective equipment, monitoring air and water quality during sludge removal, transport and disposal and water treatment, and employing engineering controls, as necessary, would mitigate exposure risks.

Long-Term Effectiveness and Permanence

Residual risk: The long-term risk of exposure for this alternative is relatively low. The affected sludge bed materials would be adequately contained and isolated in place within the CDF. Assuming proper functioning of the CDF, the risks to potential future receptors due to migration of or direct contact with contaminated sludge bed materials is mitigated effectively. Migration of PCBs through the CDF would be negligible due to the low permeability of the CDF walls, floor and cap. Drainage controls would aid to prevent erosion of the cap.

As the affected sludge bed materials are not treated, a failure or breach of the CDF would result in the reoccurrence of health-based or ecological risks. The considerable thickness of the cap (approximately 5 feet) and the use of appropriate land use restrictions would significantly reduce the potential for a CDF breach.

Adequacy of controls: A CDF should, in all probability, achieve its performance requirement of preventing direct contact to future potential receptors. Implementation of and compliance with land use restrictions and long-term maintenance obligations would aid in preserving CDF integrity (permanence) and limiting exposure. Long-term maintenance activities, including annual visual inspection of the CDF cap, crack and surface repair, as necessary, would ensure CDF integrity.

Reliability of controls: With proper construction and long-term maintenance the CDF would provide a highly reliable isolation barrier to potential future receptors. It is anticipated that with proper maintenance, the CDF should last indefinitely.

Reduction of Toxicity, Mobility, and Volume Through Treatment

A reduction in contaminant mobility (primarily by wind and water erosion) would be achieved by isolating the sludge in a CDF. There would be no reduction in the toxicity or volume of the contaminants.

Implementability

Administrative: Implementation may not be possible because under 6 NYCRR 608 and ECL Article 15, filling of a water body (in this case only along the shoreline of Cumberland Bay) in such a manner that natural resources would be lost or impacted would not be permissible if a reasonable alternative to filling is available (i.e., removal of the sludge bed). This alternative would require approval by an EPA Regional Administrator that the disposal facility meets the requirements of TSCA Part 761.60(a)(5)(iii). Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to natural resource damage along the shoreline due to construction of the dry CDF. Gaining access or ownership of shoreline property for construction of the shoreline CDF could present administrative difficulties.

Technical: The technologies to be used during this alternative have been implemented at sediment removal sites. The CDF could be constructed using readily available material and equipment. Providing that the CDF is periodically inspected and repaired, it provides a high degree of reliability.

Cost

A summary of the estimated costs for Alternative 2b and a comparison with the costs associated with other alternatives is provided on Table 4-1. The summary of estimated costs is supplemented by Table 4-2, Sludge Removal and Processing Costs; Table 4-3, CDF Construction Costs; and Table 4-4, Water Treatment Costs.

Community Acceptance

This alternative would likely achieve varying degrees of community acceptance. Although it will meet the remedial action objectives, provide more confidence regarding long-term effectiveness than Alternative 2a, potentially be used for limited recreational purposes (i.e., docks could be constructed along the shoreline berm and the surface of the CDF could used for picnicking or walking), a segment of the community may still object to the intentional destruction of a natural habitat for construction of a landfill adjacent to the Bay. The aesthetically pleasing wetland/shoreline habitat once present in the area occupied by the CDF would be eliminated.

4.2.4 Alternative 3 Series - Removal and Off-Site Disposal

4.2.4.1 Description

This suite of off-site disposal alternatives (Alternatives 3a, 3b, 3c, and 3d) have been grouped and will be described and assessed together since the main difference between them is disposal costs.

Removal of the Sludge Bed

As discussed under Alternative 2a, options are available for sludge removal, including hydraulic dredging or dewatering/dry excavation. Similar to Alternative 2b, for the purposes of comparing sludge removal costs, the Alternative 3 Series is based on the assumption that submerged sludge will be removed by hydraulic dredging (with dry excavation limited to shoreline and shallow water areas). The relative costs between sludge removal through primarily hydraulic dredging were compared to the costs for removal of sludge through primarily dry excavation or a combination of hydraulic dredging and dry excavation. This comparison is described in Appendix A, Attachment A-1.5. Hydraulic dredging (with dry excavation limited to shoreline and shallow water areas) was shown to be the most cost effective although the costs are close enough that dry excavation would be considered during design.

Prior to dredging, 2,800 feet of temporary sheet pile would be installed along the perimeter of the dredge area to provide a lower energy hydraulic environment in which to perform dredging. The alignment of the sheet pile wall is shown on Figure 4.1. This would allow the dredge to be more stable in the water enhancing precision dredging techniques. If resuspension results from dredging, the sheet pile wall would also limit transport of suspended sludge material. The design of the dredging program would provide a performance specification to minimize turbidity and suspended solids concentrations in the immediate area of the dredge.

Resuspension data, and other pertinent baseline data required for determining appropriate control methods and monitoring criteria, would be collected during startup activities. These data would be used to select appropriate engineering controls and develop a monitoring program to evaluate surface water quality and rates of resuspension during the dredging program. If significant resuspension occurs, options for controlling the migration of PCBs in the surface water include installation of booms (to control floating material such as wood chips), silt curtains, Portadams™ or temporary sheet piles.

The volume of sludge to be removed under the Alternative 3 Series is approximately 93,000 cy. The dredge rate of 500 cy/day, proposed under Alternative 2b was used which assumes removal of 93,000 cy in 6 months (see Construction Timeline on Figure 4.8). For the purpose of this FS it is anticipated that two, 1,000 gpm capacity Mudcat-type dredges, capable of entering shallow areas (approximately 2 foot minimum draft) and equipped with a horizontal auger, cutter head or suction head would be used for sludge bed removal. This estimate would include dredging during two dredging (summer) seasons.

The volume of the shoreline materials requiring removal (estimated to be 7,900 cy) and the removal techniques (dewatering using a separation barrier and removal using land-based or barge-mounted mechanical excavators) would be the same as discussed for Alternative 2a.

Performance monitoring for dredging and shoreline excavation would include collection of samples from the upper 6 inches of the sediments after completion of sludge bed removal to confirm that the remedial action objectives have been achieved. At locations where residual sludge is identified, a determination will be made if additional dredging or lake bottom restoration (via placement of approximately one foot of sand) is necessary. Samples would be collected at similar locations as used during the SC. Long-term monitoring of fish and other media would be performed to measure the effectiveness of the remedial action on reducing PCB concentrations in fish as well as meeting all of the remedial action objectives for the Site.

Sludge Dewatering

The hydraulic dredging process would reduce the solids content of the sludge from approximately 30% (based on testing results of untreated sludge) to approximately 5% due to the significant addition of water resulting from slurrying. An evaluation of sludge dewatering methods including gravity drainage and filter pressing was conducted and indicated that due to the relatively high disposal costs, the method that most efficiently dewaters the dredge slurry should be used for the off-site disposal alternatives. Laboratory bench-scale testing indicated that filter pressing would be the most efficient dewatering method, reducing the slurry from 95% to 55% moisture content. This process would include addition of solidification agent on a 5% basis and is estimated to reduce the volume of the dredged sludge from 93,000 cy (in place) to 60,000 cy. Polymers or filter pre-coats may be used to increase the efficiency of the filter pressing process.

Water Treatment System

Laboratory testing of water produced through the process of filter pressing the untreated sludge samples indicates that treatment for PCBs and carbon oxygen demand (COD) would be required. The treatment system would be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

Off-Site Disposal

The volume of sludge to be transported for off-site disposal is estimated to be 60,000 cy (80,000 tons) assuming all of the sludge is dewatered using the filter press. Costs were compared for disposing the material at a variety of facilities.

Alternative 3a assumes that all of the removed sludge would be characterized as non-hazardous waste (i.e., composite samples of filter cake or excavated sludge would contain less than 50 ppm of PCBs). An evaluation of transport options, including truck, rail and barge indicated that trucking would be the most practical and cost effective method. The sludge would be transported by truck to a Part 360 permitted solid waste landfill.

Alternative 3b assumes that all of the sludge would be characterized as a TSCA/RCRA hazardous waste (i.e., testing results over 50 ppm). Consequently, all sludge would be transported to a TSCA/RCRA permitted landfill.

Alternative 3c assumes that all of the sludge would be characterized as a TSCA/RCRA hazardous waste requiring complete destruction at a permitted incinerator. Consequently, all sludge would be transported to an incinerator permitted for destruction of PCB soil.

Alternatives 3a, 3b and 3c represent the extremes in terms of costs relative to how the sludge material is disposed. Alternative 3c (incineration) permanently destroys the contaminants, thereby reducing their toxicity, volume and mobility. However, the high cost of this alternative (>$100 million) is prohibitive. Limited sampling of the sludge during the SC and previous investigations indicates that the majority of the sludge is likely to be characterized as non-hazardous. Alternative 3d assumes that 90 percent of the sludge would be non-hazardous and suitable for disposal at a Part 360 permitted solid waste landfill and 10 percent would require disposal at a TSCA hazardous waste landfill. Alternative 3d is considered a realistic estimate of the remedial costs based on limited sludge bed PCB concentration data. Since solid, commercial and hazardous waste landfills are available that could accept the removed sludge bed materials, Alternative 3d remains as a viable and reasonable remedial alternative.

4.2.4.2 Assessment

Compliance with SCGs

This suite of alternatives would comply with TSCA and RCRA disposal requirements in accordance with the PCB concentrations detected in the removed sludge. All sludge containing PCBs would be removed from the Site.

Construction of temporary containment walls for dewatering would require meeting the provisions in 6 NYCRR 608. Fill associated with wall construction would not have a significant long-term impact on natural habitats located in the vicinity of the Site. Short-term impacts to natural resources related to dewatering of contained areas and dredging or excavation of sludge would be mitigated through restoration methods.

Requirements under the USACE Nationwide Permit and NYS Coastal Management Program would be met. Temporary use of the dock for sludge dewatering and water treatment would require approval from the NYS Thruway Authority.

Overall Protection of Human Health and the Environment

This suite of alternatives would include permanent removal of contaminated sludge from the Site, providing the highest level of overall long-term protection to human health and the environment.

Short-Term Effectiveness

Community, worker and environmental protection: Similar to Alternative 2b, this alternative would require the removal and processing of a significantly larger volume of sludge than for Alternative 2a. This would pose an increased potential for short-term risks since the sludge adjacent to Wilcox Dock may contain the highest levels of PCBs in the sludge bed area. Potential for impact to the community, workers or the environment would be present during sludge removal activities. Supplying workers with proper personal protective equipment, monitoring air and water quality during sludge removal, transport and disposal and water treatment, and employing engineering controls, as necessary, would mitigate exposure risks.

Long-Term Effectiveness and Permanence

Long-term risks due to exposure to sludge or wood chips containing PCBs would be eliminated under this alternative. Disposal of the sludge in a permitted off-site facility effectively removes the PCBs from any potential receptors.

Residual risk: The contaminated sludge would be removed. The risks to potential future receptors would be mitigated effectively by removal of the affected material. Disposal or treatment of affected material at a permitted off-site facility would effectively isolate or destroy the PCBs.

Adequacy of controls: An off-site, industrial, TSCA or RCRA facility should, in all probability, achieve the performance requirement of preventing direct contact to any receptors. There would be no long-term management or land-use restrictions at the Cumberland Bay site in regard to these alternatives, since all impacted material would have been removed.

Reliability of controls: No on-site controls would be required because the contamination would be removed. It is anticipated that the off-site disposal facility could function properly for an indefinite period of time, assuming proper maintenance.

Reduction of Toxicity, Mobility, and Volume Through Treatment

The exact means of off-site disposal or treatment would depend on contaminant concentrations and waste disposal facility requirements. PCBs accepted in a solid waste or hazardous waste landfill are land buried. Volume and toxicity of contaminants would only be reduced through incineration.

Implementability

This alternative would not require acquisition of land for construction of an on-site CDF and would not require EPA approval, which would considerably reduce potential administrative implementability problems. Short-term construction activities including construction of sheet pile walls and treatment systems would require approvals and coordination with NYSDEC, NYSDOH, USACE and the NYS Thruway Authority (in relation to use of Wilcox Dock during construction).

Cost

A summary of the estimated costs for Alternatives 3a, 3b, 3c and 3d, and a comparison with the costs associated with other alternatives is provided on Table 4-1. The summary of estimated costs is supplemented by Table 4-5, Off-Site Disposal Costs.

Community Acceptance

These alternatives would likely achieve community acceptance based on their meeting the remedial action objectives, and since the sludge bed would be removed from the Site, the area would remain relatively unchanged.

4.3 Comparison of Alternatives

This analysis provides a comparative assessment of the remedial alternatives to evaluate the relative performance of each in relation to the specific evaluation criteria. The results of the individual analyses (Section 4.2) are used in this evaluation to determine which alternative best satisfies the evaluation criteria. The purpose is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced can be identified.

The comparative analysis focuses mainly on those aspects of the alternatives that are unique for each. A summary of each of the criteria for each of the soil alternatives carried through the detailed analysis is provided on Table 4-6. This summary can be used to quickly compare the alternatives and facilitate selection of an appropriate remedy for the Cumberland Bay Sludge Bed Site.

4.3.1 Compliance with SCGs

Under 6 NYCRR 608 (use and protection of waters) and ECL Article 15 (water resource) filling of a water body in such a manner that natural resources would be lost or impacted would not be permissible if a reasonable alternative is available (i.e., removal of the sludge bed). Alternatives 2a and 2b would cause a permanent loss of aquatic and shoreline habitats and therefore would only be considered if off-site disposal was deemed unreasonable due to cost or limited availability of off-site disposal facilities. If one of the options under the Alternative 3 Series (removal and off-site disposal) is considered reasonable to implement, it would be favored under 6 NYCRR Part 608 and ECL Article 15.

Alternatives 2a and 2b would be consistent with TSCA (Part 761.60) in that sludge containing PCBs would be disposed using a method that provides adequate protection to human health and the environment. However, approval would be necessary from an EPA Regional Administrator which could be difficult and time consuming. The Alternative 3 Series would also be consistent with TSCA, but would be easier and faster to implement because disposal would be at a facility already permitted under TSCA and RCRA.

Alternative 2a would take land belonging to the NYS Thruway Authority and change the shape and potentially use of Wilcox Dock. According to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be needed for changing a barge canal terminal. Current plans that the NYS Thruway Authority has for developing the use of Wilcox Dock would make obtaining these approvals difficult. Alternatives 2b and the Alternative 3 Series would only temporarily occupy space on Wilcox Dock during the remedial construction period, where the dewatering and water treatment systems would be placed. The NYS Thruway Authority would be more likely to give approval to this temporary use of the dock.

Under Alternatives 2a and 2b, demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to the permanant impact to aquatic and wetland habitats along the shoreline related to construction of the CDFs. The Alternative 3 Series would be consistent with these programs since the programs advocate protection of significant fish and wildlife habitats, promotion of the State's commercial fishing industry, and preservation of coastal historic, scenic and cultural resources.

4.3.2 Overall Protection of Human Health and the Environment

Of the remedial alternatives evaluated, Alternative 1, the No Action Alternative, is the least protective of human health and the environment as it does not prevent exposure or further reduce potential risks to human heath and the environment associated with the sludge bed. With proper design, construction and operation, Alternatives 2a and 2b would effectively isolate contaminated sludge on site and greatly limit the potential for exposure, increasing the overall protection of human health and the environment. Under Alternatives 3a, 3b, 3c, and 3d, potential risks resulting from exposure to PCB-contaminated sludge would be eliminated. The sludge bed materials would be dredged or excavated, transported off-site, and disposed of or treated in an appropriate permitted waste facility. Site-specific cleanup objectives for PCBs would be met in the dredged or excavated areas.

4.3.3 Short-Term Effectiveness

No short-term impacts to human health or the environment would result from Alternative 1 since no construction, treatment, removal or transport of affected sludge would take place. Under Alternatives 2a, 2b, 3a, 3b, 3c, and 3d, potential impacts to the community, workers and the environment related to sludge removal activities would be minimized through proper use of personal protective equipment, monitoring and engineering controls. Under Alternative 2a, the volume of sludge to be removed is significantly reduced due the location of the CDF in an area with the thickest portions of the sludge bed. This area, which is also likely to contain the highest concentrations of PCBs, could be left in place yet would still be contained within the CDF. Alternative 2a would therefore create the lowest short-term risks compared with the other removal alternatives.

4.3.4 Long-Term Effectiveness and Permanence

Alternative 1 is neither effective nor permanent since the residual long-term risks due to exposure to contaminated sludge bed materials would not be reduced. Under Alternatives 2a and 2b long-term risks would be significantly reduced since the contaminated sludge would be isolated. However, because these alternatives rely on isolation rather than removal of contaminated sludge, demarcation and maintenance would be required to ensure the integrity (permanence) of the CDF. Under the Alternative 3 series, long-term residual risks due to exposure to contaminated sludge would be eliminated. Disposal or treatment of the contaminated sludge in a permitted off-site facility effectively and permanently removes the contaminants from potential receptors.

4.3.5 Reduction of Toxicity, Mobility and Volume Through Treatment

Since Alternative 1 does not involve any type of treatment for the sludge bed, this alternative would not reduce the toxicity, mobility or volume of PCB contaminated sludge. Construction of a CDF under Alternatives 2a and 2b involves isolation of the sludge bed materials, reducing contaminant mobility, primarily by wind and water erosion. As the contaminated materials are not treated or removed, there is no reduction in the toxicity or volume of the contamination. The Alternative 3 series would provide the greatest reduction in mobility of Site contaminants by removal of the sludge to a secure landfill or treatment facility. Reduction in mobility of contaminants would be achieved by encapsulation in a secure landfill. Toxicity and volume of PCBs would only be reduced by incineration under Alternative 3c.

4.3.6 Implementability

Alternative 1 is readily implementable technically since no construction or Site activities are part of this alternative, however this alternative could not be implemented administratively since it would not be acceptable to the overseeing regulatory agencies. The remaining alternatives could be implemented using readily available materials, equipment, and construction practices.

As discussed under compliance with SCGs, Under 6 NYCRR 608 (use and protection of waters) and ECL Article 15 (water resource) filling of a water body in such a manner that natural resources would be lost or impacted would not be permissible if a reasonable alternative is available (i.e., removal of the sludge bed). Alternatives 2a and 2b would cause a permanent loss of aquatic and shoreline habitats and therefore would only be considered if off-site disposal was deemed unreasonable due to cost or limited availability of off-site disposal facilities. If one of the options under the Alternative 3 Series (removal and off-site disposal) is considered reasonable to implement, it would be favored under 6 NYCRR Part 608 and ECL Article 15.

Alternatives 2a and 2b would be consistent with TSCA (Part 761.60) in that sludge containing PCBs would be disposed using a method that provides adequate protection to human health and the environment. However, approval would be necessary from an EPA Regional Administrator which could be difficult and time consuming. The Alternative 3 Series would also be consistent with TSCA, but would be easier and faster to implement because disposal would be at a facility already permitted under TSCA and RCRA.

Alternative 2a would take land belonging to the NYS Thruway Authority and change the shape and potentially use of Wilcox Dock. According to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be needed for changing a barge canal terminal. Current plans that the NYS Thruway Authority has for developing the use of Wilcox Dock would make obtaining these approvals difficult. Alternatives 2b and the Alternative 3 Series would only temporarily occupy space on Wilcox Dock during the remedial construction period, where the dewatering and water treatment systems would be placed. The NYS Thruway Authority would be more likely to give approval to this temporary use of the dock.

Under Alternatives 2a and 2b, demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to the permanent impact to aquatic and wetland habitats along the shoreline related to construction of the CDFs. The Alternative 3 Series would be consistent with these programs since the programs advocate protection of significant fish and wildlife habitats, promotion of the State's commercial fishing industry, and preservation of coastal historic, scenic and cultural resources.

4.3.7 Cost

Table 4-1 provides a summary and comparison of the costs for each of the alternatives. Supplemental cost information is provided on Tables 4-2 through 4-5. The present worth cost (based on a 5% discount rate and 30 years of operation and maintenance) of Alternatives 2a and 2b are essentially the same (approximately \$11 to \$13 million). The present worth cost for Alternative 3d, considered the most realistic approximation of conditions for off-site disposal, is approximately $3 to $5 million (20-40%) higher than Alternatives 2a and 2b, but requires no long-term financial commitment to operation and maintenance.

4.3.8 Community Acceptance

Alternative 1, No Action, would not achieve community acceptance because PCB laden wood chips and sludge would continue to wash up on the public beaches presenting unacceptable potential risks to human health and the environment. Alternative 2a would likely achieve community acceptance since it would meet the remedial objectives, increase the functional use of the bay and provide a larger dock for recreational uses. This alternative may raise concerns because the sludge would be contained below the bay water level. Alternative 2b would achieve the remedial objectives and potentially provide greater confidence regarding the long-term security of an on-site CDF, however the CDF itself may not be popular aesthetically, and the public may object to PCB waste disposal within a popular natural resource. The Alternative 3 series would likely be acceptable to the community, since contaminated materials would be removed from the Site and the Site would be restored to its original scenic appearance for use as an open space or for future recreational development.

TABLE 4-1
Summary of Estimated Costs for Remedial Alternatives
Cumberland Bay Sludge Bed

	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3a		Alternative 3b	Alternative 3c	Alternative 3d	
	No Action	Disposal in Wet CDF	Disposal in Dry CDF	Disposal at Solid Waste Landfill Local	Commercial	Disposal at Haz. Waste Landfill	Off-Site Treatment by Incineration	Disposal at Solid (90%) and Haz. Waste (10%) Landfills Local/Haz.	Commerc./Haz.
Hydraulic dredging	-	$564,000	$1,116,000	$1,116,000	$1,116,000	$1,116,000	$1,116,000	$1,116,000	$1,116,000
Shoreline sediment removal	-	$474,000	$474,000	$474,000	$474,000	$474,000	$474,000	$474,000	$474,000
Suspended sediment control	-	$672,000	$672,000	$672,000	$672,000	$672,000	$672,000	$672,000	$672,000
Monitoring	-	$166,000	$222,000	$222,000	$222,000	$222,000	$222,000	$222,000	$222,000
CDF Construction	-	$3,526,000	$2,420,840	-	-	-	-	-	-
Sludge dewatering	-	-	$1,860,000	$3,255,000	$3,255,000	$3,255,000	$3,255,000	$3,255,000	$3,255,000
Water treatment system	-	$1,198,855	$1,198,855	$1,198,855	$1,198,855	$1,198,855	$1,198,855	$1,198,855	$1,198,855
Wetlands restoration	-	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000	$160,000
Off-site disposal	-	-	-	$2,750,000	$5,150,000	$16,350,000	$88,000,000	$4,110,000	$6,270,000
Total Direct Costs:	-	$6,760,855	$8,123,695	$9,847,855	$12,247,855	$23,447,855	$95,097,855	$11,207,855	$13,367,855
Engineering (25%)	-	$1,690,200	$2,030,900	$1,774,500	$1,774,500	$1,774,500	$1,774,500	$1,774,500	$1,774,500
Contingency (20%)	-	$1,352,200	$1,624,700	$1,969,600	$2,449,600	$4,689,600	$19,019,600	$2,241,600	$2,673,600
Bottom restoration (sand)	-	$550,000	$550,000	$550,000	$550,000	$550,000	$550,000	$550,000	$550,000
Total Indirect Costs	-	$3,592,400	$4,205,600	$4,294,100	$4,774,100	$7,014,100	$21,344,100	$4,566,100	$4,998,100
Annual O&M Costs:	-	$62,200	$39,200	$0	$0	$0	$0	$0	$0
Present Worth O&M Costs: (5% discount rate)	-	$956,200	$602,600	$0	$0	$0	$0	$0	$0
Total Present Worth Costs: (direct, indirect & O&M)	-	$11,309,455	$12,931,895	$14,141,955	$17,021,955	$30,461,955	$116,441,955	$15,773,955	$18,365,955

Note:

1. There are no costs directly associated with Alternative 1 (No Action).
2. Present worth costs are calculated based on 30 years of operation and maintenance.
3. Costs associated with any necessary predesign studies are not included.
4. Engineering for off-site disposal options (Alternative 3 Series) is calculated on total capital costs not including disposal costs.
5. A range of costs is provided for disposal at a Part 360 solid waste landfill. If sludge qualifies for use as daily cover then disposal at a local landfill may be appropriate and cost effective. Disposal at a commercial Part 360 permitted landfill may be more practical because administratively, this option is likely more readily implementable.

TABLE 4-2

Alternative 2a

Wet (Dock) CDF - Sludge Removal and Processing Costs

	Item	Quant.	Unit Cost	Unit	Cost
1	Hydraulic Dredging (Wet dock CDF)	47,000	$12	cy	$564,000
2	Shoreline Sludge Removal (incl. Portadam)	7,900	$60	cy	$474,000
3	Suspended Sediment Control (isolate bay)				
	Temporary sheetpile (2800 lf x 20' depth)	56,000	$12	sf	$672,000
	Silt Curtain (2800 lf x 10' high 500# tensile str.)	2,800	$35	lf	$98,000
4	Total monitoring costs				$166,000
	Performance and discharge monitoring	1	$20,000	ls	$20,000
	Environmental monitoring				
	Air monitoring	5	$20,000	mos	$100,000
	Water montoring	5	$6,000	mos	$30,000
	Post sludge removal confirmatory sampling	80	$200	test	$16,000
5	Bottom restoration (1 foot of sand)	27,500	$20	cy	$550,000
6	Wetlands restoration	4	$40,000	acre	$160,000
	Total Direct Costs (Sheetpile)				$2,036,000
	Total Direct Costs (Silt Curtain)				$1,462,000

Alternative 2b

Dry (Shoreline) CDF - Sludge Removal and Processing Costs

	Item	Quant.	Unit Cost	Unit	Cost
1	Hydraulic dredging (dry shoreline CDF)	93,000	$12	cy	$1,116,000
2	Shoreline Sludge Removal (incl. Portadam)	7,900	$60	cy	$474,000
3	Suspended Sediment Control (isolate bay)				
	Temporary sheetpile (2800 lf x 20' depth)	56,000	$12	sf	$672,000
	Silt Curtain (2800 lf x 10' high 500# tensile str.)	2,800	$35	lf	$98,000
4	Total monitoring costs				$222,000
	Performance and discharge monitoring	1	$20,000	ls	$20,000
	Environmental monitoring				
	Air monitoring	7	$20,000	mos	$140,000
	Water montoring	7	$6,000	mos	$42,000
	Post sludge removal confirmatory sampling	100	$200	test	$20,000
5	Sludge Dewatering/Processing (gravity drainage)	93,000	$20	cy	$1,860,000
6	Bottom restoration (1 foot of sand)	27,500	$20	cy	$550,000
7	Wetlands restoration	4	$40,000	acre	$160,000
	Total Direct Costs (Sheetpile)				$4,504,000
	Total Direct Costs (Silt Curtain)				$3,930,000

Alternatives 3a, 3b, 3c and 3d

Off-Site Disposal - Sludge Removal and Processing Costs

	Item	Quant.	Unit Cost	Unit	Cost
1	Hydraulic dredging (off-site disposal)	93,000	$12	cy	$1,116,000
2	Shoreline Sludge Removal (incl. Portadam)	7,900	$60	cy	$474,000
3	Suspended Sediment Control				
	Temporary sheetpile (2800 lf x 20' depth)	56,000	$12	sf	$672,000
	Silt Curtain (2800 lf x 10' high 500# tensile str.)	2,800	$35	lf	$98,000
4	Total monitoring costs				$222,000
	Performance and discharge monitoring	1	$20,000	ls	$20,000
	Environmental monitoring				
	Air monitoring	7	$20,000	mos	$140,000
	Water montoring	7	$6,000	mos	$42,000
	Post sludge removal confirmatory sampling	100	$200	test	$20,000
5	Sludge Dewatering (filter press)	93,000	$35	cy	$3,255,000
6	Bottom restoration (1 foot of sand)	27,500	$20	cy	$550,000
7	Wetlands restoration	4	$40,000	acre	$160,000
	Total Direct Costs (Sheetpile)				$5,899,000
	Total Direct Costs (Silt Curtain)				$5,325,000

See Appendix A for supplemental information regarding cost estimates.

TABLE 4-3
Cost Estimate
CDF Construction, Operation and Maintenance Costs

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
1	Alternative 2a - Wet (Dock) CDF				
	CDF Cofferdam	1	$2,800,000	ls	$2,800,000
	CDF Cap	140,000	$3.70	sf	$518,000
	Water Treatment System (5 to 10 gpm)				
	Recovery Sumps/Pumps	4	$25,000	ea	$100,000
	Piping	800	$10	lf	$8,000
	Building	1	$25,000	ls	$25,000
	Aeration Tank	1	$15,000	ls	$15,000
	2 Granular Activated Carbon Beds	1	$50,000	ls	$50,000
	Misc. Utilities	1	$10,000	ls	$10,000
	Total Direct Costs (Alt. 2a)				**$3,526,000**
2	Alternative 2b - Dry (Shoreline) CDF				
	Grading and Liner	212,000	$3.02	sf	$640,240
	Cover	212,000	$2.15	sf	$455,800
	Shore-side Dike	1,300	$136	lf	$176,800
	Bay-side Dike	900	$1,120	lf	$1,008,000
	Temporary Water Treat. Sys. (5 to 10 gpm)				
	Recovery Pumps	4	$5,000	ea	$20,000
	Piping	200	$10	lf	$2,000
	Building	1	$25,000	ls	$25,000
	Aeration Tank	1	$5,000	ls	$5,000
	2 Granular Activated Carbon Beds	1	$30,000	ls	$30,000
	Misc. Utilities	1	$10,000	ls	$10,000
	Removal/treatment of seepage water/1yr	1	$48,000	ls	$48,000
	Total Direct Costs (Alt. 2b)				**$2,420,840**
	Annual Operation & Maintenance Costs:				
1	Alternatives 2a				
	Pump/treat leachate (5 to 10 gpm)	12	$4,000	mo.	$48,000
	Monitoring (semi-annual)	2	$5,000	events	$10,000
	Well maintenance (6 wells)	6	$700	well	$4,200
	Total O&M Costs (Alternative 2a)				**$62,200**
2	Alternatives 2b				
	Treat leachate (50,000-100,000 gal/year)		$25,000	ls	$25,000
	Monitoring (semi-annual)	2	$5,000	events	$10,000
	Well maintenance (6 wells)	6	$700	well	$4,200
	Total O&M Costs (Alternative 2b)				**$39,200**

See Appendix A for supplemental information regarding cost estimates.

TABLE 4-4
Cost Estimate
Water Treatment System Costs

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
	Pumps and Piping to treatment system:				
1	CDF dewatering pumps (2/cell), 1000 gpm	6	$2,500	each	$15,000
2	Piping to water treatment	2,000	$40	lf	$80,000
	Aerated Surge tank:				
3	Modutank (86,000 gal)	1	$17,890	mo	$17,890
4	Aeration blower & piping	1	$5,000	each	$5,000
	Flocculation/Clarification (250,000 gal):				
5	Coagulant addition (assume alum)	1	$30,000	ls	$30,000
6	Modutank - 250Kgal, baffled, serpentine layout	1	$93,965	ls	$93,965
7	Flocculant mixers	4	$5,000	each	$20,000
8	Pump to filters	2	$3,500	each	$7,000
	Filtration and Adsorption:				
9	Pressure sand filters (8' dia x 6' SWD)	2	$60,000	each	$120,000
10	GAC adsorbers - 10' dia., 2-stage, pre-piped	2	$156,000	each	$312,000
	Outfall:				
11	Piping	200	$100	lf	$20,000
12	Outfall structure	1	$5,000	each	$5,000
	Site Preparation and Installation:				
13	Electrical service	1	$10,000	ls	$10,000
14	Site grading, levelling, stone placement	1	$25,000	ls	$25,000
15	Instrumentation and controls	1	$30,000	ls	$30,000
16	Temporary piping systems	1	$40,000	ls	$40,000
17	Enclosures	1	$20,000	ls	$20,000
18	Drain, prep for winter and re-start in spring	1	$40,000	ls	$40,000
	Plant Operation and Maintenance:				
19	Operator (2-shift)	180	$1,000	days	$180,000
20	Technician (1-shift)	180	$450	days	$81,000
21	Sludge cleaning from clarifier	2	$10,000	each	$20,000
23	Electricity (assume 1 MGD @ 30'TDH)	3.4E+05	$0.08	Kw-hr	$27,000
	TOTAL				$1,198,855

See Appendix A for supplemental information regarding cost estimates.

TABLE 4-5
Cost Estimate
Off-site Disposal Costs

	Item	Quant.	Unit Cost	Unit	Cost
	Direct Capital Costs:				
1	Off-site disposal at RCRA incinerator (Aptus, Utah)	80,000	$800	ton	$64,000,000
	Transportation to incineration facility	80,000	$300	ton	$24,000,000
	TOTAL				**$88,000,000**
2	Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	80,000	$200	ton	$16,000,000
	Disposal acceptance testing	2,500	$140	test	$350,000
	TOTAL				**$16,350,000**
3	Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
	Commercial (Cost from High Acres Landfill, Rochester, NY	80,000	$60	ton	$4,800,000
	Estimated cost for local landfill	80,000	$30	ton	$2,400,000
	Disposal acceptance testing	2,500	$140	test	$350,000
	TOTAL (for transport/disposal at commercial landfill)				**$5,150,000**
	TOTAL (for transport/disposal at local landfill)				**$2,750,000**
4	Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
	Commercial (Cost from High Acres Landfill, Rochester, NY	72,000	$60	ton	$4,320,000
	Estimated cost for local landfill	72,000	$30	ton	$2,160,000
	Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	8,000	$200	ton	$1,600,000
	Disposal acceptance testing	2,500	$140	test	$350,000
	TOTAL (for commercial and hazardous waste landfills)				**$6,270,000**
	TOTAL (for local and hazardous waste landfills)				**$4,110,000**
	Note: 1 cy = 1.3 tons, quantity based on 60,000 cy of dewatered sludge				

See Appendix A for supplemental information regarding cost estimates.

Table 4-6
Comparative Analysis of Remedial Alternatives
Cumberland Bay Sludge Bed Site

	Alternative 1 No Action	Alternative 2a Removal and Wet On-Site Disposal	Alternative 2b Removal, Dewatering and Dry On-Site Disposal	Alternative 3a, 3b, 3c, 3d Removal and Off-Site Disposal (at solid waste/hazardous waste landfill or incinerator)
Compliance with SCGs	Under this alternative, sludge containing PCBs would remain available for direct contact or migration and would therefore not achieve the site cleanup objectives.	• This alternative would be inconsistent with ECL Article 15 and 6 NYCRR Part 608, since filling of a water body is not permissible except when no reasonable alternative is available. • Approval would be required by an EPA Regional Administrator to confirm whether this alternative would be consistent with TSCA (Part 761.60). Potential difficulties with controlling leachate migration and issues with long-term permanence constitute serious obstacles to gaining approval from an EPA Regional Administrator. • According to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be needed for changing a barge canal terminal.	• This alternative would be difficult to implement because under 6 NYCRR 608 and ECL Article 15 filling of a water body (in this case along the shoreline) which would create a permanent impact to aquatic or shoreline habitats is not permissible if a reasonable alternative to filling is available (i.e., removal of the sludge bed). • This alternative complies with the specific disposal requirements of TSCA, although approval would still be required from USEPA. • Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to natural resource damage along the shoreline.	• This alternative would be implementable under 6 NYCRR 608 and ECL Article 15 since filling of a water body in association with sheet pile wall construction would be temporary and would have no long-term impact on natural resources. • This suite of alternatives would comply with TSCA in accordance with the PCB concentrations detected in the removed sludge. • Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program should not be difficult since the site will be restored to conditions which will enhance the natural resources in the Site vicinity.
Overall Protection of Human Health and the Environment	This alternative provides no means of controlling direct exposure to or migration of PCB laden wood chips or sludge. Therefore, it would not reduce potential risks to human health or the environment.	If designed, constructed and maintained properly, this alternative would effectively isolate contaminated sludge and greatly limit the potential for exposure. Construction of the CDF would result in a permanent loss of aquatic habitat. This alternative would require a permanent commitment to maintenance and monitoring of the CDF to ensure its long-term effectiveness.	Same as 2a. Except, under this alternative approximately 4 to 5 acres of contaminated wetland/shoreline habitat would be permanently destroyed to allow construction of the shoreline CDF.	This suite of alternatives would include permanent removal of contaminated sludge from the site, providing the highest level of overall long-term protection to human health and the environment. Aquatic and shoreline habitats would be fully restored.

Table 4-6
Comparative Analysis of Remedial Alternatives
Cumberland Bay Sludge Bed Site

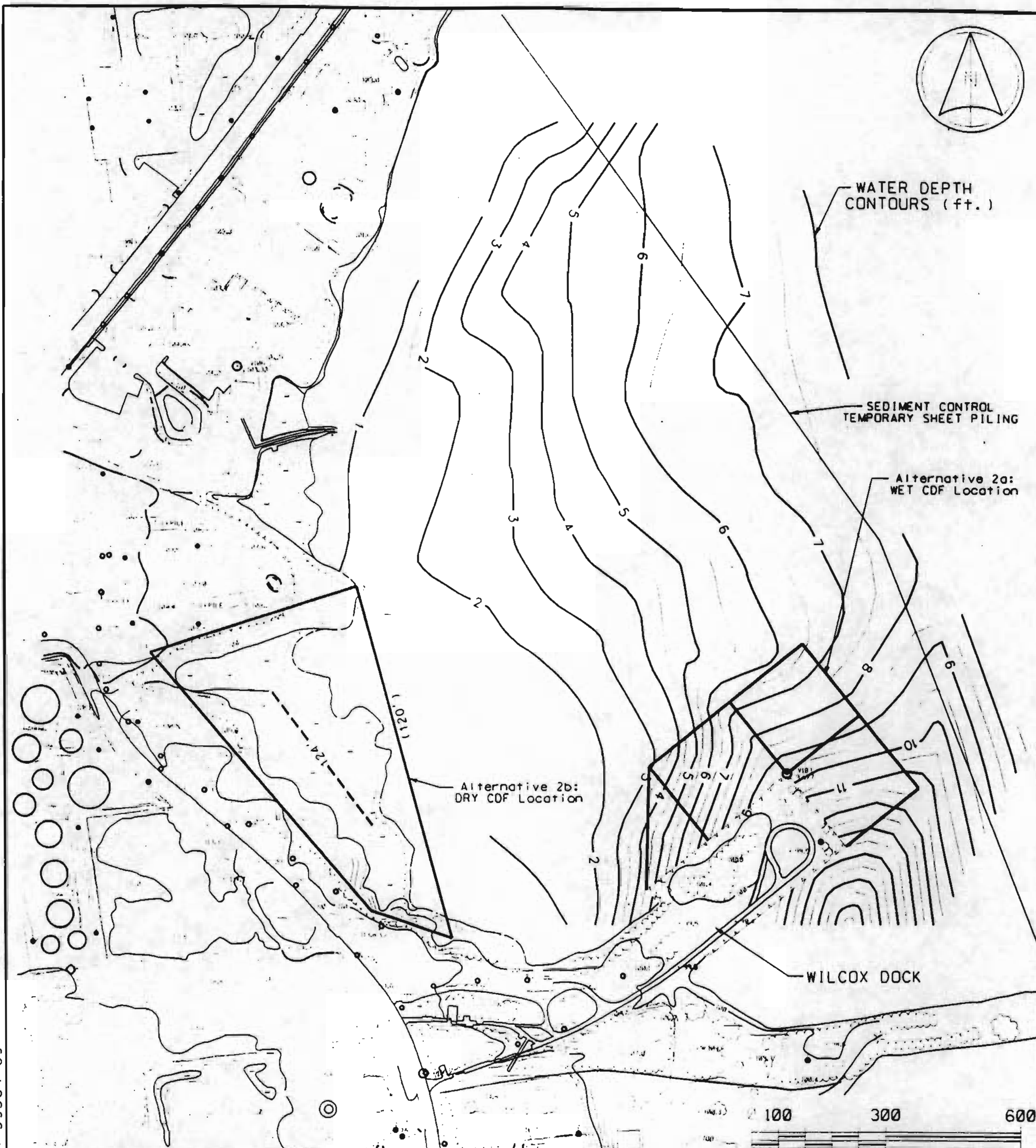
	Alternative 1 No Action	Alternative 2a Removal and Wet On-Site Disposal	Alternative 2b Removal, Dewatering and Dry On-Site Disposal	Alternative 3a, 3b, 3c, 3d Removal and Off-Site Disposal (at solid waste/hazardous waste landfill or incinerator)
Short-term Effectiveness	Since no action would be taken to control or remediate the sludge bed, no short-term impacts to human health and the environment would result. Remedial action objectives would not be achieved.	Potential for impact to the community, workers or the environment would be present during sludge removal activities. Providing workers with the necessary personal protective equipment and monitoring air and water quality during sludge removal, transport and disposal and water treatment would mitigate exposure risks.	Same as 2a except under this alternative a significantly larger volume of sludge would require removal and processing (including on-shore dewatering). The sludge adjacent to Wilcox dock which would be disturbed under this alternative, but not under Alternative 2a, may contain the highest levels of PCBs in the sludge bed area, increasing potential short-term risks.	Same as 2b. Odors may be more prevalent if dry excavation is used as a sludge removal method. Air monitoring and odor suppression methods would be implemented.
Long-term Effectiveness and Permanence	Long-term risks due to exposure to sludge or wood chips containing PCBs would not be reduced.	Because this alternative relies on on-site isolation of sludge rather than off-site disposal, CDF demarcation and maintenance would be required to ensure its integrity, as well as imposing limited future land use restrictions. A permanent commitment to continuous maintenance and monitoring would be required to ensure long-term protectiveness.	Same as 2a. Confidence in the adequacy of monitoring to evaluate CDF performance would be greater with Alternative 2b since monitoring points could be built into the containment system.	Long-term risks due to exposure to sludge or wood chips containing PCBs would be mitigated under this alternative. Disposal of the sludge in a permitted off-site facility effectively removes the PCBs from any potential receptors.
Reduction of Toxicity, Mobility & Volume Through Treatment	This alternative would not reduce the toxicity, mobility or volume of contaminated soils.	A reduction in contaminant mobility (primarily by wind and water erosion) would be achieved by isolating the sludge in a CDF. A breach in the CDF would present the possibility of PCB remobilization. There would be no reduction in the toxicity or volume of the contaminants.	Same as 2a.	The exact means of off-site disposal or treatment would depend on contaminant concentrations and waste disposal facility requirements. PCBs accepted in a solid waste or hazardous waste landfill are land buried. Volume and toxicity of contaminants would only be reduced through incineration.

Table 4-6
Comparative Analysis of Remedial Alternatives
Cumberland Bay Sludge Bed Site

	Alternative 1 No Action	Alternative 2a Removal and Wet On-Site Disposal	Alternative 2b Removal, Dewatering and Dry On-Site Disposal	Alternative 3a, 3b, 3c, 3d Removal and Off-Site Disposal (at solid waste/hazardous waste landfill or incinerator)
Implementability	Since no construction or operation is required, this alternative is readily implementable.	The technologies to be used during this alternative have been implemented at sediment removal sites. This alternative could be constructed using readily available material and equipment. Administratively this alternative would be difficult to implement for the following reason as described under compliance with SCGs: • This alternative would be inconsistent with ECL Article 15 and 6 NYCRR Part 608, since filling of a water body is not permissible except when no reasonable alternative is available. • Approval would be required by an EPA Regional Administrator to confirm whether this alternative would be consistent with TSCA (Part 761.60). Potential difficulties with controlling leachate migration and issues with long-term permanence constitute serious obstacles to gaining approval from an EPA Regional Administrator. • According to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be needed for changing a barge canal terminal.	This alternative would use widely available landfill building technologies and materials. Administratively this alternative would be difficult to implement for the following reason as described under compliance with SCGs: • Under 6 NYCRR 608 and ECL Article 15 filling of a water body (in this case along the shoreline) which would create a permanent impact to aquatic or shoreline habitats is not permissible if a reasonable alternative to filling is available (i.e., removal of the sludge bed). • This alternative complies with the specific disposal requirements of TSCA, although approval would still be required from USEPA. • Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program may be difficult due to issues related to natural resource damage along the shoreline. • Gaining access or ownership of shoreline property for construction of the dry CDF could present administrative difficulties.	This alternative would be readily implementable both technically and administratively. This alternative would use widely available technologies and materials. Administratively this alternative would be implementable as described under compliance with SCGs: • Filling of the bay in association with sheet pile wall construction would be permissible under 6 NYCRR 608 and ECL Article 15 since the features would be temporary and would have no permanent impact on natural resources. • No TSCA approval would be required. • Demonstrating consistence with the USACE Nationwide Permit Program and the NYS Coastal Management Program would not be difficult since the aquatic and shoreline habitats would be fully restored. • Approval from the NYS Thruway Authority for temporary use of Wilcox Dock during remedial construction should be readily obtainable.

Table 4-6
Comparative Analysis of Remedial Alternatives
Cumberland Bay Sludge Bed Site

	Alternative 1 No Action	Alternative 2a Removal and Wet On-Site Disposal	Alternative 2b Removal, Dewatering and Dry On-Site Disposal	Alternative 3a, 3b, 3c, 3d Removal and Off-Site Disposal (at solid waste/hazardous waste landfill or incinerator)
Cost	Costs relative to continued beach cleaning, affect on tourism, and similar sludge bed related impacts have not been calculated but would be sizable.	Capital: $10,400,000 Annual O&M: $62,200 Present Worth: $11,300,000 (based on a 5% discount rate over 30 years)	Capital: $12,300,000 Annual O&M: $39,200 Present Worth: $12,900,000 (based on a 5% discount rate over 30 years)	Off-site disposal of approx. 60,000 cy of dewatered sludge Part 360 Solid waste landfill: Present Worth: $14,100,000 - $17,000,000 TSCA Hazardous waste landfill: Present Worth: $30,500,000 RCRA Incinerator: Present Worth: $116,000,000 90% Solid waste/10% Haz. waste: Present Worth: $15,800,000 - $18,400,000
Community Acceptance	This alternative is unlikely to achieve community acceptance because sludge and wood chips containing PCBs would continue to pose unacceptable potential risks to human health and the environment.	This alternative would likely achieve varying degrees of community acceptance. Although it will meet the remedial action objectives, increase the functional use of the bay, and provide a larger dock available for recreational uses, a segment of the community may still object to the intentional disposal of contaminated sludges within the Bay. The shoreline could be restored and the Site would remain relatively unchanged.	This alternative would likely achieve varying degrees of community acceptance. Although it will meet the remedial action objectives, provide more confidence regarding long-term effectiveness than Alternative 2a, potentially be used for limited recreational purposes, a segment of the community may still object to the intentional destruction of a natural habitat for construction of a landfill adjacent to the Bay. The aesthetically pleasing wetland/shoreline habitat once present in the area occupied by the CDF would be eliminated.	This alternative would likely achieve community acceptance based on it meeting the remedial action objectives, and since the sludge bed would be removed from the Site, the area would remain relatively unchanged.



RUST

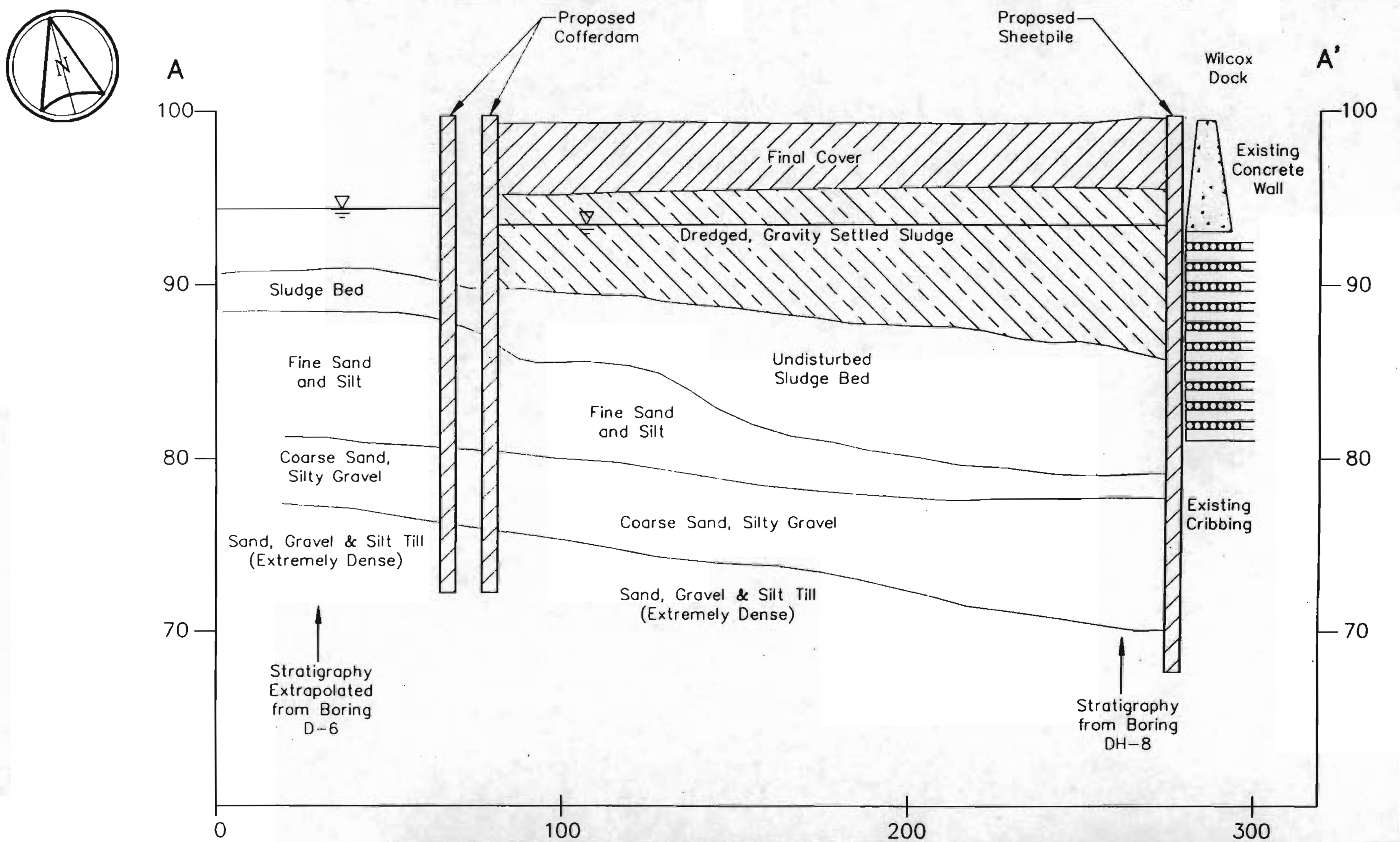
PROPOSED CONFINED DISPOSAL FACILITY (CDF) LOCATIONS

SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY | CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-09	SCALE 1" = 300'	FIGURE No. 4.1

39304-09



RUST ENVIRONMENT & INFRASTRUCTURE

PROFILE A-A'
ALTERNATIVE 2a - WET CDF

SLUDGE BED - WILCOX DOCK
CUMBERLAND SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY — CLINTON COUNTY, NY

PROJECT NO. 39304	DATE 1/12/96	DWG. NO. 39304-11	SCALE AS SHOWN	FIGURE NO. 4.3

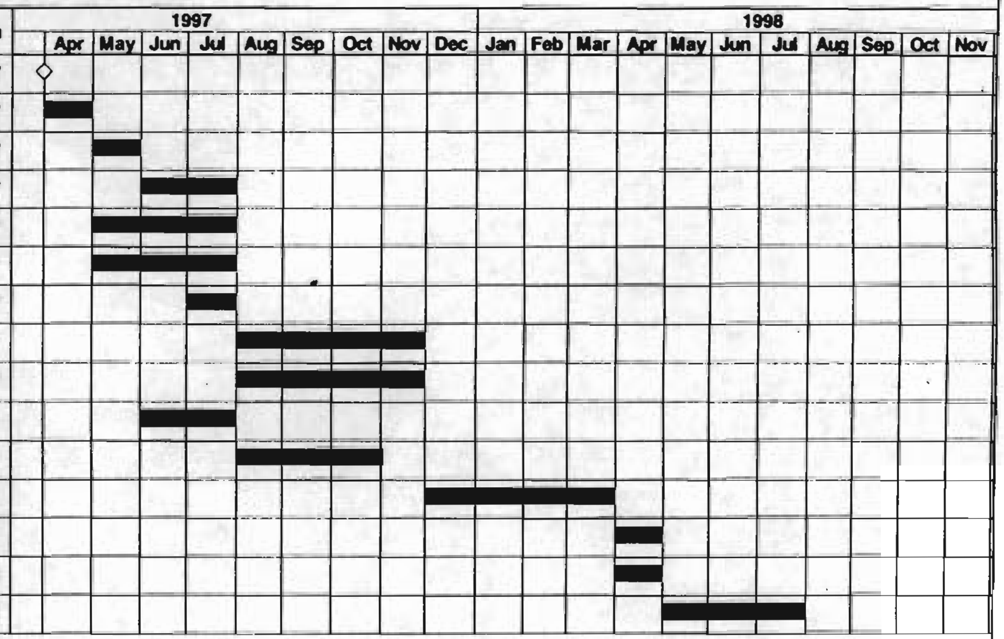
FIGURE 4.4

Cumberland Bay Sludge Bed Feasibility Study

Construction Time Line: Wet CDF

(REVISED 3/1/96)

No.	Task Name	Dura	Sched Start	Sched Fin
1	Obtain Nationwide Permit	0d	04/01/97	04/01/97
2	Contractor Mobilization	1.05M	04/01/97	04/30/97
3	Prepare Site - Clear and Grub	1.05M	05/01/97	05/30/97
4	Construct water treatment facility	2.1M	06/02/97	07/31/97
5	Construct resuspension control sheet piling	3.14M	05/01/97	07/31/97
6	Construct CDF adjacent to dock	3.14M	05/01/97	07/31/97
7	Mobilize and setup 2 Dredges	1.1M	07/01/97	07/31/97
8	First dredge season: Dredge sludge/place in CDF	4.1M	08/01/97	11/28/97
9	First dredge season: Treat CDF supernate	4.1M	08/01/97	11/28/97
10	Install temporary sheet pile around shoreline sediments	8.8w	06/02/97	07/31/97
11	Excavate shoreline sediments/place in CDF	3.19M	08/01/97	11/03/97
12	Dredging off-season	4.14M	12/01/97	03/31/98
13	Second dredge season: Dredge sludge/place in CDF	1.05M	04/01/98	04/30/98
14	Second dredge season: Treat CDF supernate	1.05M	04/01/98	04/30/98
15	Complete final closure of CDF/Demob	3.14M	05/01/98	07/31/98



Note: This schedule was prepared for the purpose of comparing FS alternatives. Completion times for the listed activities are approximated and are subject to change during design or construction.

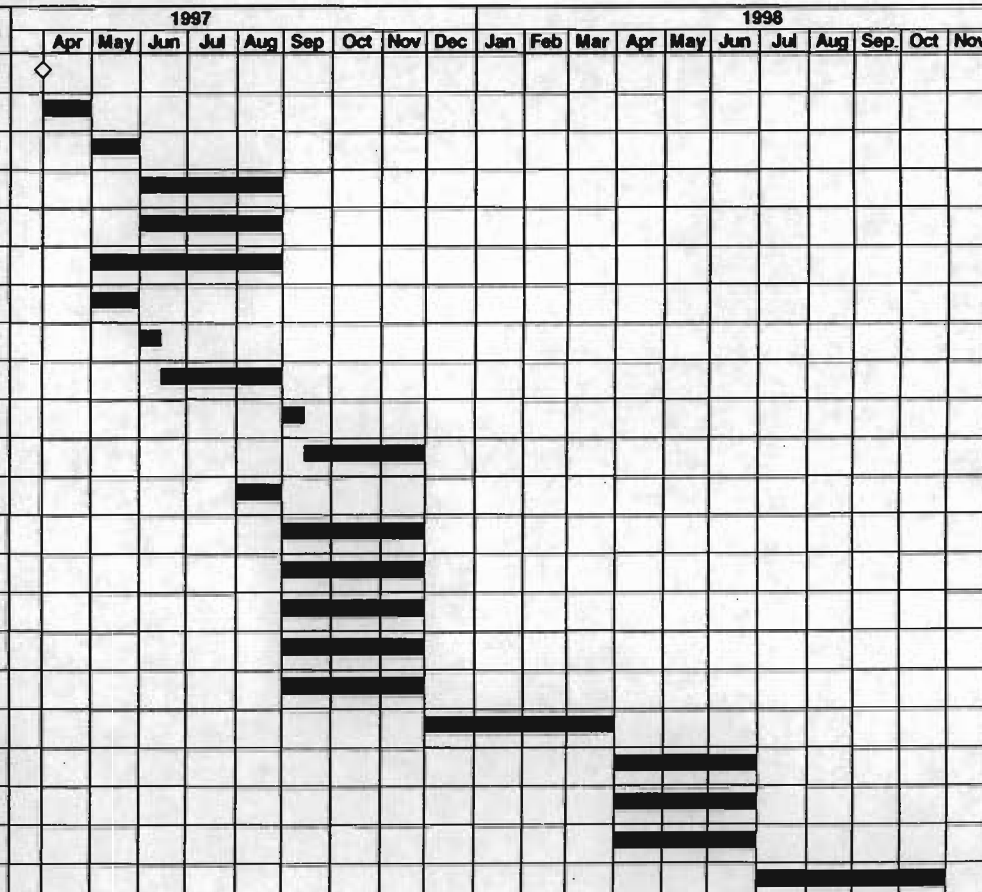
FIGURE 4.5

Cumberland Bay Sludge Bed Feasibility Study

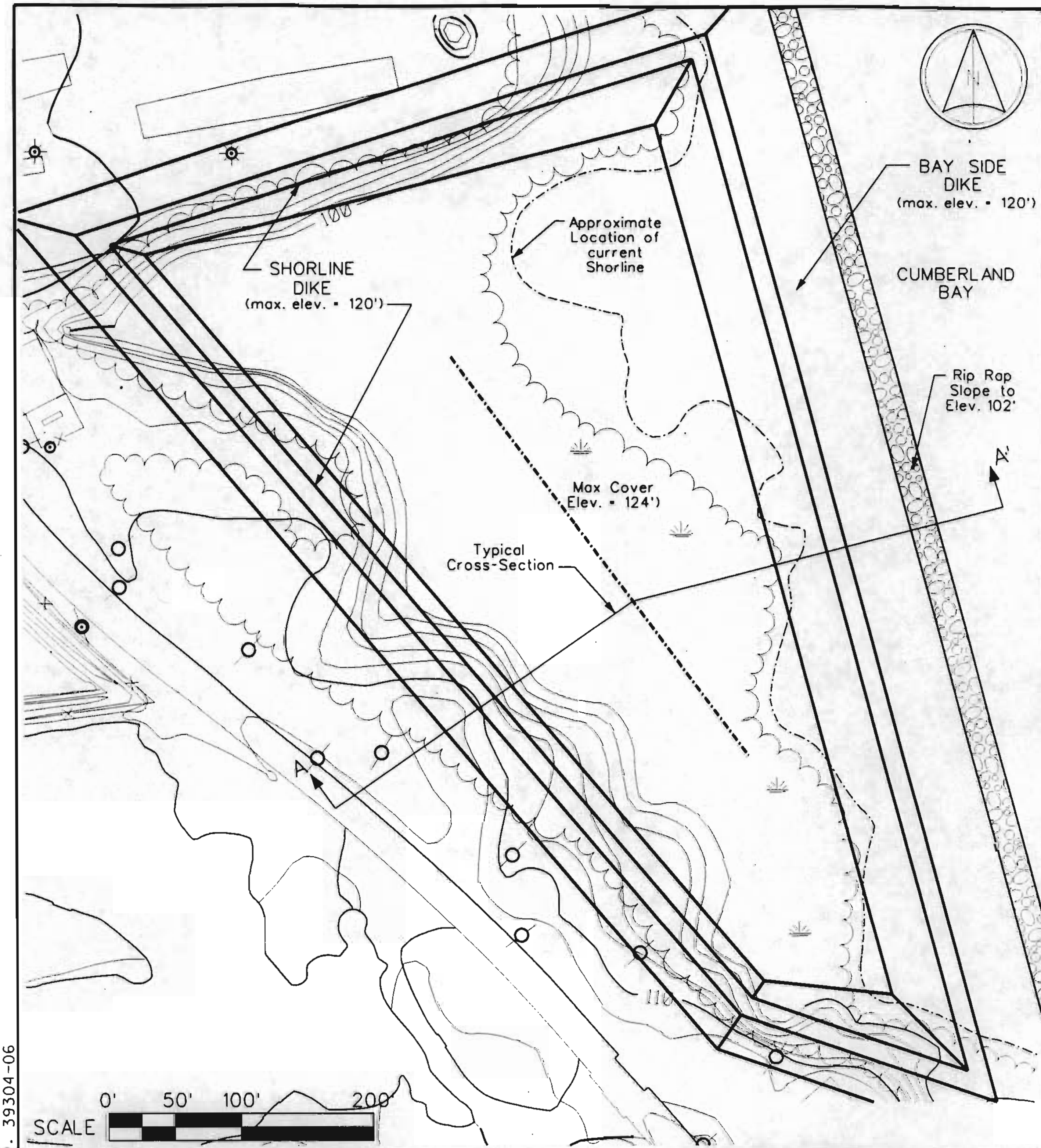
Construction Time Line: Dry CDF

(REVISED 3/1/96)

No.	Task Name	Dura	Sched Start	Sched Fin
1	Obtain Nationwide Permit	0d	04/01/97	04/01/97
2	Contractor Mobilization	1.05M	04/01/97	04/30/97
3	Prepare Site - Clear and Grub	1.05M	05/01/97	05/30/97
4	Construct water treatment facility	3.1M	06/02/97	08/29/97
5	Construct gravity dewatering facility	3.1M	06/02/97	08/29/97
6	Construct resuspension control sheet piling	4.14M	05/01/97	08/29/97
7	Install temporary sheet pile around shoreline sediments	4.4w	05/01/97	05/30/97
8	Move 50% of shoreline sediments to one side of CDF	2w	06/02/97	06/13/97
9	Construct 50% of CDF liner	2.62M	06/16/97	08/29/97
10	Place CDF footprint shoreline sediments in CDF	2w	09/01/97	09/12/97
11	Construct remaining 50% of CDF liner	2.62M	09/15/97	11/28/97
12	Mobilize and setup 2 Dredges	1M	08/01/97	08/29/97
13	First dredge season: Dredge sludge	3.1M	09/01/97	11/28/97
14	First dredge season: Dewater sludge/place in CDF	3.1M	09/01/97	11/28/97
15	First dredge season: Treat process water	3.1M	09/01/97	11/28/97
16	Excavate remaining shoreline sediments	3.1M	09/01/97	11/28/97
17	Process shoreline sediments and place in CDF	3.1M	09/01/97	11/28/97
18	Dredging off-season	4.14M	12/01/97	03/31/98
19	Second dredge season: Dredge sludge	3.1M	04/01/98	06/30/98
20	Second dredge season: Dewater sludge/place in CDF	3.1M	04/01/98	06/30/98
21	Second dredge season: Treat process water	3.1M	04/01/98	06/30/98
22	Complete final closure of CDF/Demob	4.19M	07/01/98	10/30/98



Note: This schedule was prepared for the purpose of comparing FS alternatives. Completion times for the listed activities are approximated and are subject to change during design or construction.



DRAWING No. 39304-06

RUST ENVIRONMENT & INFRASTRUCTURE

ALTERNATIVE 2b
DRY CDF SCHEMATIC

SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY — CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-06	SCALE 1"= 100'	FIGURE No. 4.6

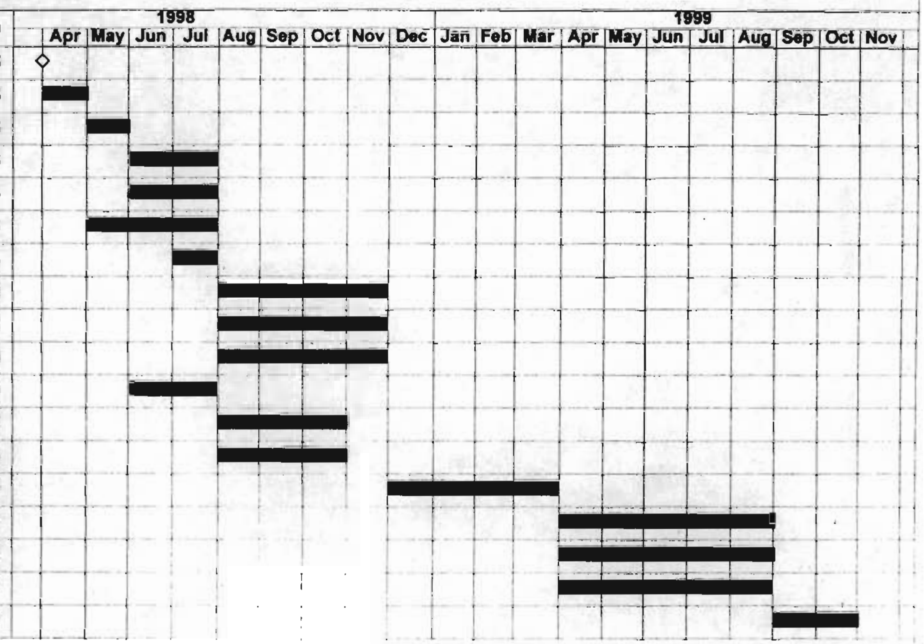
FIGURE 4.8

Cumberland Bay Sludge Bed Feasibility Study

Construction Time Line: Off-site Disposal

(REVISED 4/17/97)

No.	Task Name	Dur	Sched Start	Sched Fin
1	Obtain Nationwide Permit	0d	04/01/98	04/01/98
2	Contractor Mobilization	23d	04/01/98	05/01/98
3	Prepare Site - Clear and Grub	1M	05/04/98	06/01/98
4	Construct filterpress dewatering facility	2.1M	06/02/98	07/31/98
5	Construct water treatment facility	2.1M	06/02/98	07/31/98
6	Construct resuspension control sheet piling	3.1M	05/04/98	07/31/98
7	Mobilize and setup 2 Dredges	1.1M	07/01/98	07/31/98
8	First dredge season: Dredge sludge	4.1M	08/03/98	11/30/98
9	First dredge season: Dewater sludge/test/transport	4.1M	08/03/98	11/30/98
10	First dredge season: Treat process water	4.1M	08/03/98	11/30/98
11	Install temporary sheet pile around shoreline sedime	44d	06/02/98	07/31/98
12	Excavate shoreline sediments	3.14M	08/03/98	11/02/98
13	Process shoreline sediments/test/transport	3.14M	08/03/98	11/02/98
14	Dredging off-season	4.14M	12/01/98	03/31/99
15	Second dredge season: Dredge sludge	5.24M	04/01/99	09/01/99
16	Second dredge season: Dewater sludge/test/transpor	5.24M	04/01/99	09/01/99
17	Second dredge season: Treat process water	5.19M	04/01/99	08/31/99
18	Demob/Initiate Site Restoration	2.1M	09/01/99	11/01/99



Note: This schedule was prepared for the purpose of comparing FS alternatives. Completion times for the listed activities are approximated and are subject to change during design or construction.

5.0 RECOMMENDED ALTERNATIVE

5.1 Alternative Selection

The results of the remedial alternatives evaluation indicate that Alternative 3d, removal and off-site disposal at a combination of permitted solid waste and hazardous waste landfills, is the appropriate remedy for the Cumberland Bay Sludge Bed Site. The following paragraphs summarize the final decision making process used to arrive at the selection of Alternative 3d.

Alternative 1: No Action - In accordance with the requirement of NCP, this alternative was carried through the evaluation process for the purpose of comparison. The deficiencies of this alternative with regard to the evaluation criteria used in the detailed analysis highlight the need to perform a remediation at the Cumberland Bay Site.

Alternative 2a: Removal and Disposal in a Wet CDF - A CDF similar to that proposed for cost estimating purposes, through careful engineering, could be constructed to provide long-term containment of in-place and consolidated sludge. However, the reliability of such a facility would require a permanent commitment to continuous operation and maintenance and a monitoring program which could predict with confidence that the facility is performing to meet the remedial action objectives. Failure of the CDF would jeopardize the protection of human health and the environment. This alternative would take land belonging to the NYS Thruway Authority and change the shape and potentially use of Wilcox Dock. According to NYS Canal Law, approval from the NYS Thruway Authority and/or State legislature would be needed for changing a barge canal terminal. Furthermore, NYS laws and regulations exist (specifically ECL Article 15 and 6 NYCRR Part 608) which are designed to protect water and other resources of the State. As such, these regulations include specific standards which would not permit filling of a water body except when reasonable and necessary. Since the Alternative 3 Series, Removal and Off-site Disposal, provides a reasonable alternative to in-lake disposal, Alternative 2a would be difficult to implement, since it is inconsistent with state laws and regulations.

Alternative 2b: Removal and Disposal in a Dry CDF - As for Alternative 2a, a CDF similar to that proposed for cost estimating purposes, through careful engineering, could be constructed to provide long-term containment of removed sludge. The reliability of a dry CDF would be easier to confirm since monitoring points could be engineered into the disposal system. The facility would require a permanent commitment to continuous maintenance. The large size requirements of the dry CDF and the limited space adjacent to the Site would cause portions of the shoreline habitats to be permanently destroyed. As discussed for Alternative 2a, NYS laws and regulations exist (specifically ECL Article 15 and 6 NYCRR Part 608) which are designed to protect water and other resources of the State. As such, these regulations include specific standards which would not permit filling of a water body except when reasonable and necessary. Since the Alternative 3 Series, Removal and Off-site Disposal, provides a reasonable alternative to in-lake disposal, Alternative 2b would be difficult to implement, since it is inconsistent with state laws and regulations.

Alternative 3 Series: Removal and Off-Site Disposal - Unlike Alternatives 2a and 2b, in-lake structures required for the removal of sludge would be temporary and restoration would be

Sludge Dewatering

Dewatering of removed sludge would be performed if the sludge requires stabilization prior to transport to the landfill or if reduction of the volume significantly reduces the disposal costs. Solidification agents, polymers or filter pre-coats may be used to increase the efficiency of the filter pressing process.

Water Treatment System

Laboratory testing of water produced through the process of filter pressing the untreated sludge samples indicates that treatment for PCBs and carbon oxygen demand (COD) would be required. The treatment system would likely be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

Off-Site Disposal

The volume of sludge to be transported for off-site disposal is estimated to be 60,000 cy (80,000 tons) assuming all of the sludge is dewatered using the filter press. Limited sampling of the sludge during the SC and previous investigations indicates that the majority of the sludge is likely to be characterized as non-hazardous. Alternative 3d assumes that 90 percent of the sludge would be non-hazardous and suitable for disposal at a Part 360 permitted solid waste landfill and 10 percent would require disposal at a TSCA hazardous waste landfill.

5.3 Construction Schedule

Assuming completion of a Record of Decision (ROD) by late summer of 1997 it would be possible to complete permitting, design and contractor acquisition activities such that construction could commence by spring of 1998. Construction is anticipated to take two seasons (spring/summer/fall of 1998 and 1999) with final restoration activities being performed during the summer of 2000.

Appendix A

Supplemental Cost Estimate Information

Appendix A - Supplemental Cost Estimate Information

A-1 Sludge Removal and Processing Costs

1) Hydraulic Dredging:

Volume to be Dredged:

Alternative 2a - Removal of material outside the wet (dock) CDF is estimated to produce approximately 47,000 cy of sludge based on in place density.

Alternatives 2b, 3a, 3b, 3c, 3d - Removal of all underwater material is estimated to produce approximately 93,000 cy of sludge based on in place density (average of 90,000 to 95,000 cy of in place sludge estimated in the SC).

Dredging Rates:

The construction time lines (see Figures 4.4, 4.5 and 4.8) developed for the purpose of the Feasibility Study and based on approximate startup and completion dates provided by the NYSDEC show the estimated durations of active dredging for Alts 2a, 2b and 3. As described in Attachment A-1.1 of this Appendix, removal of 93,000 cy during a 9 month period results in an average dredging rate of 340 cy/day. This rate is considered appropriate for the Wet CDF (Alt 2a) and Off-site Disposal alternatives (Alts 3a-3d) because for Alt 2a, the volume to be dredge is significantly less (47,000 cy) and for Alts 3a-3d the available dredging time would not be shortened by CDF construction and closure. Six months of dredging is considered conservative and reasonable for implementation of the Dry CDF (Alt 2b) to allow time for CDF construction and closure. Removal of 93,000 cy during a 6 month period results in an average dredging rate of 500 cy/day.

Dredging Costs:

Dredging costs are based on use of two, 1,000 gpm dredge units, dredging 6 hours per day, (compensating for down time and inefficiencies), 30 days per month. The unit cost is based on operation for 9-months (see above) and are projected to be similar for shorter durations. The following cost related assumptions are made:

Rental of 2 dredges	$40,000/mo.
Additional supplies (piping, pumps, etc.) and mob/demob	$5,000/mo.
Labor	$2,000/day

The unit dredging cost is estimated as follows:

Dredges operating for approx. 9 months :	$40,000/mo. x 9 mos = $360,000
Additional supplies for approx. 9 months:	$5,000/mo. X 9 mos = $45,000
Labor (dredge operators):	$2,000/day x 270 days = $540,000
Supplemental costs (weed removal, H&S, surveying) - 20%:	= $189,000
	Total = $1,134,000

Total cost per cy: $1,134,000/93,000cy = $12/cy

2) Shoreline Removal:

Volumes to be Excavated:

Assume shoreline removal would be accomplished via mechanical equipment in the dry. Assume Alternatives 2a, 2b, & 3 Series would all require the same volume to be excavated. See Attachment A-1.2 for assumed areas and volumes. A summary of these estimates are as follows:

Area SL-1:	1,650 cy
Area SL-2	5,900 cy
Area SL-3	370 cy

Total Volume = 7,920 cy

Total Area to be excavated = 214,000 sf (5 acres)

Source of Excavation Costs and Specifications:

Means Estimating Guide, 1995 used for per cubic yard cost basis for clearing, excavation and removal by truck to CDF.

Excavation Costs:

Clearing/grubbing:	5 acres x \$5,000/acre = \$25,000
Excavation/transport to CDF/or off-site	7,900cy x \$20/cy = \$158,000
	Sub-Total = \$183,000

Portadam Construction (Based on costs from Portadam Inc. Williamstown, N.J.)

Shipping, installation, removal of 10' high structural frame/liner:

	1,000 lf x \$80/lf = \$80,000
Rental (6 months):	1,000 lf x \$35/mo/lf x 6 mos = \$210,000
	Sub-Total = \$290,000

Total excavation costs = \$473,000

Total unit cost per cy of excavation: \$473,000/7,900cy = \$60/cy

3) Suspended Sediment Control:

Option 1 - Temporary Sheet Pile:

Length of temporary sheet pile to enclose site during dredging is assumed to be 2,800 lf. Source of costs is Means Estimating Guide, 1995

Option 2 - Silt Curtain:

Assume length of curtain to enclose site during dredging is 2,800 lf. Assume 10' tall, middle weight curtain with 500 lb. tensile strength fabric. Total cost assumes 2 day on site instruction, labor, maintanence and two season work schedule. Source of costs and specifications is Containment Systems, Inc.)

4) Performance and Discharge Monitoring:
Performance and discharge monitoring is assumed to be the costs incurred to set dredge height and pump intake during start-up testing for maximum dredge % solids and minimum resuspension. A lump sum of $20,000. is assumed.

5) Environmental Monitoring:
Air Monitoring:
Environmental monitoring of air is assumed to be necessary on a daily basis, approximately 4, 8 or 24 hour samples, to be analyzed for PCB concentrations. Competitive laboratory pricing is $200/sample. Costs were based on $1000/day (approximately $20,000/mos including collection, shipping and analysis).
Water Quality Monitoring:
Water quality monitoring is assumed to incorporate real time measurements of turbidity for calculation of suspended solids to be calibrated to a PCB associated concentration. Coastal Leasing, Inc. 1995 pricing was used to develop costs based upon a minimum of three monitoring points, monitoring units, modems, and software.

6) Post sludge removal confirmatory sampling:
Post sludge removal sampling is assumed to be via collection of shallow sediment cores, and composite PCB analysis of the upper six inches. Competitive lab pricing is approximately $200/sample. Samples are assumed to be collected similarly as was done for the site characterization. Additional numbers of samples were included for the shoreline areas and for contingency purposes if resampling was necessary.

7) Sludge Dewatering
Estimates for dewatering production and costs are developed in the calculation Sheets in Attachment A-1.1 of this Appendix. For the dry (shoreline) CDF, gravity dewatering is assumed and a cost of $20/in-place cy is used; this cost includes $16/cy for dewatering and $4/cy for transport and spreading in the CDF. For off-site disposal options, filter press processing is assumed and a cost of $35/in-place cy is used; costs for trucking are included under the off-site disposal costs.

8) Bottom Restoration:
Costs are based on placement of one foot of sand over areas which have been dredged. Cost includes mobilization and daily rate for placement equipment plus purchase and transport of sand.

9) Wetlands Restoration:
Wetland restoration costs are based upon USEPA cost assessments/data base. On average $25,000 - $50,000/acre is anticipated. For purposes of this cost estimate it is assumed that 4 acres of wetlands would require restoration at $40,000/acre (4 ac. x $40,000 = $160,000).

10) Water Treatment:
Cost detail is shown in Attachment A-1.1 of this Appendix and assumes on-site processing and discharge to the Bay.

A-2 CDF Construction, Operation and Maintenance Costs

1) Wet and Dry CDF Capacity:

The assumptions for estimating the capacity of the wet and dry CDFs are provided in Attachment A-2.1 of this Appendix.

2) CDF Construction:

Cost details and assumptions are shown in Attachment A-2.2

3) Operation and Maintenance:

Wet CDF - Long-term pumping would be required to maintain an inward gradient. Seepage estimates, provided in Appendix B, indicate that 5 to 10 gpm of "leachate" would require treatment. A system capable of treating water pumped at this rate is summarized on Table 4.3 under Direct Capital Costs. Long-term operation and maintenance of this system (including monitoring, labor, and parts replacement) is estimated to cost $4,000 per month. Additional long-term O&M costs include well monitoring and repair/replacement.

Dry CDF - Prior to placement in the Dry CDF, sludge will be gravity dewatered and combined with a solidification agent to reduce moisture content. However, the weight of the final cover system is anticipated to cause compaction of the sludge and additional dewatering will occur. This source of leachate is anticipated to diminish relatively rapidly (within 1 to 2 years) with the long-term source of leachate primarily from infiltration through the cap. To process the short-term production of leachate a water treatment system, similar to that described for the Wet CDF, has been included in the Direct Capital Costs. The costs of the system components are lower because of the shorter-term and/or lower processing rate of the system. Also, one year of operation and maintenance costs (estimated at $4,000 per month) are included in the Direct Capital Costs to handle the short-term production of leachate. Long-term leachate production from the Dry CDF is estimated to be low (primarily for infiltration through the cap). It is anticipated to be low enough to be collected on-site and periodically batch treated through the on-site system or shipped off-site by tanker-truck for final disposition. The estimated annual volume is 50,000 to 100,000 gallons based on 2% infiltration of precipitation through the cap. The estimated cost for processing this volume of leachate is $25,000 per year.

A-3 Off-Site Disposal Costs

1) **Treatment by Incineration:**
Cost estimate provided by Aptus Incinerator, Grantville, Utah. Pricing based on bulk material incineration ($.40/lb = $800/ton). Transport charges assuming use of 20 ton trucks and distance of 2,000 miles traveled from site to the facility is $3.30/mi/truck.

2) **Disposal at a TSCA Permitted Hazardous Waste Landfill:**
Cost estimate provided by Model City Landfill, Model City, New York.

3) **Disposal at a Part 360 Permitted Commercial Solid Waste Landfill:**
Cost estimate provided by High Acres Landfill, Rochester, New York. Material acceptance division pricing is $50/ton ($75/ton maximum) and third party hauler charges of $35/ton (no markup). Competition for material exists and lower per ton disposal costs are anticipated. For purposes of the estimate, $60/ton total is used for transport and disposal.

Disposal at a Part 360 Permitted Local Solid Waste Landfill:
Cost estimate of $30/ton provided by NYSDEC. Acceptance at a local landfill could be inhibited by the following conditions:
1. The presence PCBs (albeit less than 50 ppm) may cause concern for local municipalities relating to leachate treatment.
2. Dewatered sludge may qualify for daily cover material or alternative grading material, but a local landfill may not have the area to store such a large quantity of material delivered in a relatively short time-frame.
3. A local landfill may not want to fill up their landfill space with material other than municipal waste.

4) **Disposal Acceptance Testing:**
Assume testing for PCBs by SW846 Method 8080, with the average cost per analysis at $200. (Based on laboratory quotations)

Appendix A

Attachment A-1.1

Sludge Dewatering, Water Treatment System Cost Details

SEDIMENT WEIGHTS / VOLUMES

Calculations based on Kiber Data (Col. 1, 3 and 4) and on estimated 5% solids (by weight) in dredge slurry

		In-place	Dredge	Gravity Drain	Filter Press
Moisture	(#wtr/#total)	68.7%	95%	63.9%	54%
Water Content	(#wtr/#solids)	219%	1900%	177%	117%
Spec. Grav. of solids		2.27	2.27	2.27	2.27
Density	(#/CF)	75.6	64.2	78.2	84
Solids	(#solids/#total)	31.3%	5%	36.1%	46%

Data and formulas were entered into a working spreadsheet (Sheets A-1.2 and A-1.3)

SCHEDULING and DREDGE RATES

93,000 cy to be removed & managed in 9-mo

1. Gravity Dewater to On-site CDF
   Conservatively deduct 3-mo from dredge schedule to build liner and cover systems

   $$RATE = \frac{93,000 \text{ cy}}{6\text{-mo} \times 30 \text{ d/mo}} = \underline{500 \text{ cy/day}}$$

2. Filter Press to off-site disposal

   $$RATE = \frac{93,000 \text{ cy}}{9\text{-mo} \times 30 \text{ d/mo}} = \underline{340 \text{ cy/day}}$$

3. Wet CDF - use 500 cy/d to do in one season

CUMBERLAND BAY PROCESS VOLUMES - TOTAL PROJECT

Gravity Drainage

	In-Place	Dredge Slurry	*Change From In-Place*	Dewatered	*Change From In-Place*	S/S Agent Addition	*Change From In-Place*
VOLUME (cy)	93000	677931	584931	77109	-15891	85597	-7403
VOLUME (Mgal)	18.7823	136.9149	118.1326	15.5728	-3.2094		-18.7823
WATER CONTENT (%)	223%	1900%	1677%	177%	-46%	114%	-109%
SPECIFIC GRAVITY SOLIDS	**2.27**	**2.27**	-	**2.27**	-	**2.27**	-
UNIT WEIGHT (lb/cf)	75.5	64.2	-11.3	78.2	2.7	84.5	9
TOTAL WEIGHT (tons)	94759	587504	492746	81372	-13387	97646	2887
WATER WEIGHT (tons)	65384	558129	492746	51997	-13387	51997	-13387
WATER VOLUME (Mgal)	15.675	133.808	118.133	12.466	-3.209	12.466	-3.209
SOLIDS WEIGHT (tons)	**29375.22**	**29375.22**	0.00	**29375.22**	0.00	45649.57	16274.36
WEIGHT PERCENT SOLIDS	31.0%	5.0%	***-26.0%***	36.1%	5.1%	46.8%	16%

Add Solids (lb/lb-total) 0.20

FILTER PRESS

	In-Place	Dredge Slurry	*Change From In-Place*	Dewatered	*Change From In-Place*	S/S Agent Addition	*Change From In-Place*
VOLUME (cy)	93000	685882	592882	56980	-36020	58647	-34353
VOLUME (Mgal)	18.7823	138.5207	119.7385	11.5077	-7.2746		-18.7823
WATER CONTENT (%)	219%	1900%	1681%	117%	-102%	106%	-114%
SPECIFIC GRAVITY SOLIDS	**2.27**	**2.27**	-	**2.27**	-	**2.27**	-
UNIT WEIGHT (lb/cf)	75.6	64.2	-11.4	84.0	8.4	85.7	10
TOTAL WEIGHT (tons)	94951	594395	499444	64608	-30343	67839	-27113
WATER WEIGHT (tons)	65232	564675	499444	34888	-30343	34888	-30343
WATER VOLUME (Mgal)	15.639	135.377	119.738	8.364	-7.275	8.364	-7.275
SOLIDS WEIGHT (tons)	**29719.76**	**29719.76**	0.00	**29719.76**	0.00	32950.17	3230.41
WEIGHT PERCENT SOLIDS	31.3%	5.0%	***-26.3%***	46.0%	14.7%	48.6%	17%

Add Solids (lb/lb-total) 0.05

4/4/97

CUMBERLAND BAY PROCESS VOLUMES - DAILY TOTALS

Gravity Drainage

	In-Place	Dredge Slurry	Change From In-Place	Dewatered	Change From In-Place	S/S Agent Addition	Change From In-Place
VOLUME (cy)	500	3645	3145	415	-85	460	-40
VOLUME (Mgal)	0.1010	0.7361	0.6351	0.0837	-0.0173		-0.1010
WATER CONTENT (%)	223%	1900%	1677%	177%	-46%	114%	-109%
SPECIFIC GRAVITY SOLIDS	**2.27**	**2.27**	-	**2.27**	-	**2.27**	-
UNIT WEIGHT (lb/cf)	75.5	64.2	-11.3	78.2	2.7	84.5	9
TOTAL WEIGHT (tons)	509	3159	2649	437	-72	525	16
WATER WEIGHT (tons)	352	3001	2649	280	-72	280	-72
WATER VOLUME (Mgal)	0.084	0.719	0.635	0.067	-0.017	0.067	-0.017
SOLIDS WEIGHT (tons)	**157.93**	**157.93**	0.00	**157.93**	0.00	245.43	87.50
WEIGHT PERCENT SOLIDS	31.0%	5.0%	***-26.0%***	36.1%	5.1%	46.8%	16%

Add Solids (lb/lb-total) 0.20

FILTER PRESS

	In-Place	Dredge Slurry	Change From In-Place	Dewatered	Change From In-Place	S/S Agent Addition	Change From In-Place
VOLUME (cy)	340	2508	2168	208	-132	214	-126
VOLUME (Mgal)	0.0687	0.5064	0.4378	0.0421	-0.0266		-0.0687
WATER CONTENT (%)	219%	1900%	1681%	117%	-102%	106%	-114%
SPECIFIC GRAVITY SOLIDS	**2.27**	**2.27**	-	**2.27**	-	**2.27**	-
UNIT WEIGHT (lb/cf)	75.6	64.2	-11.4	84.0	8.4	85.7	10
TOTAL WEIGHT (tons)	347	2173	1826	236	-111	248	-99
WATER WEIGHT (tons)	238	2064	1826	128	-111	128	-111
WATER VOLUME (Mgal)	0.057	0.495	0.438	0.031	-0.027	0.031	-0.027
SOLIDS WEIGHT (tons)	**108.65**	**108.65**	0.00	**108.65**	0.00	120.46	11.81
WEIGHT PERCENT SOLIDS	31.3%	5.0%	***-26.3%***	46.0%	14.7%	48.6%	17%

Add Solids (lb/lb-total) 0.05

RUST Rust Environment & Infrastructure

PROJECT NO. 39304.000

CLIENT NYSDEC SUBJECT Process Costs Prepared By AWT Date 3/5/96

PROJECT Cumberland Bay Reviewed By ______ Date ______

Approved By ______ Date ______

FILTER PRESS SIZING

Based on origin of sediment and Kiber tests assume:

- belt press used
- conditioner is pH adjustment (H_2SO_4)
- Final cake is blended with 5% CKD to improve handling and neutralize pH

Typical Belt Press Load = 1000 # solids / hour / meter width belt

∴ 2-m press → 2000#-sol / hour

= 1 ton / hour

340 cy - in place yields 107 Tons

Capacity → 10 presses @ 14 hr-d w/ 20% down-time → 112 TON/d

∴ Assume 10-presses run 14-hr/d, 7-d/week

(NOTE: During design or at contractor discretion, could add equalization tank, reduce number of presses, and run 24-hr)

SEE: Process Flow Diagram - page 5
Footprint page 6

Operate: 14-hr/d, 7 days/wk, for 9 months

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. 39304.000

CLIENT NYSDEC

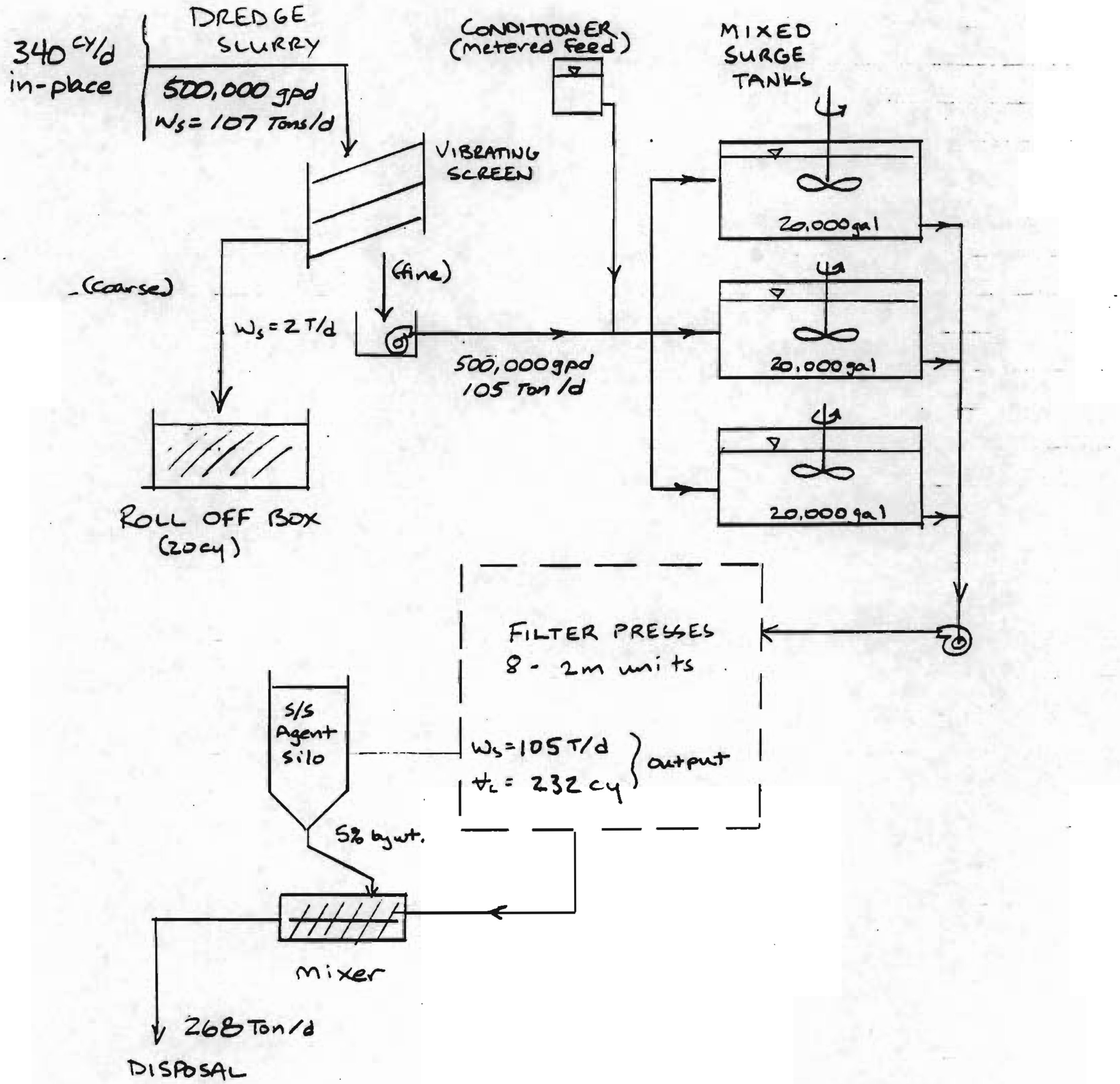
SUBJECT Filter Press Conceptual PFD

PROJECT Cumberland Bay

Prepared By BWT Date 3/5/96

Reviewed By ______ Date ______

Approved By ______ Date ______



Rust Environment & Infrastructure

CALCULATION SHEET

PAGE 6 OF ~~13~~ 14

PROJECT NO. 39304.000

CLIENT NYSDEC

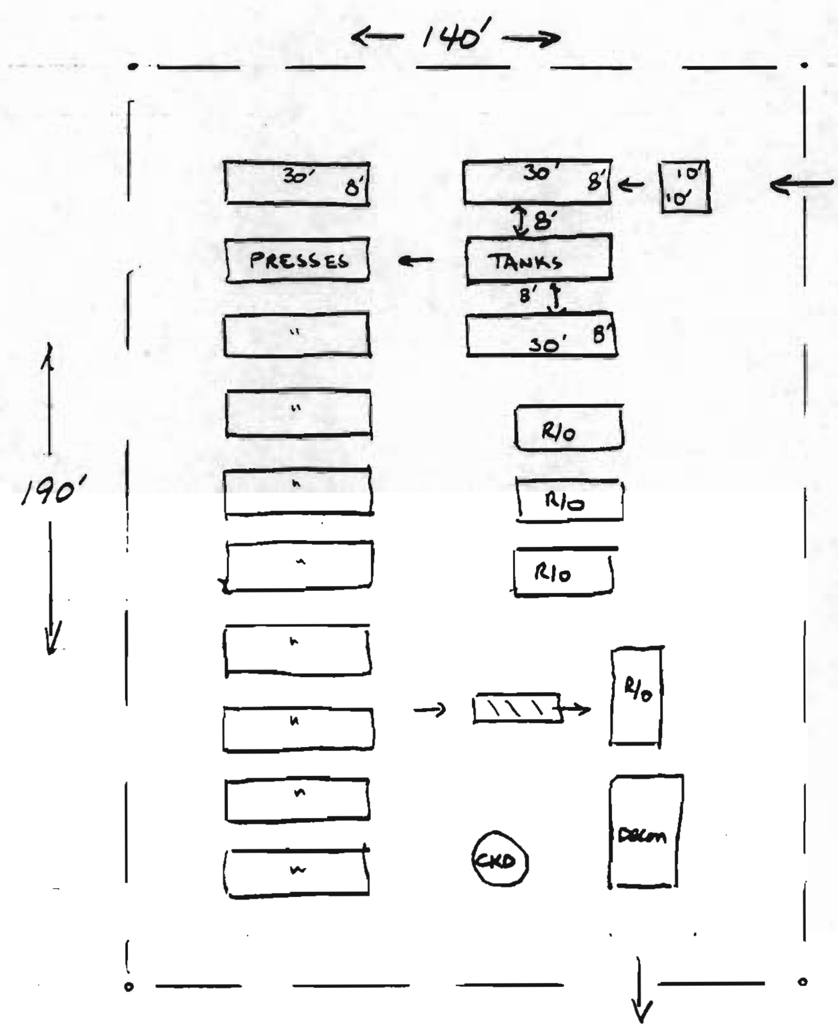
PROJECT Cumberland Bay

SUBJECT FILTER PRESS EQUIPMENT ARRANGEMENT AND FOOTPRINT

Prepared By KWT Date 3/5/96

Reviewed By ______ Date ______

Approved By ______ Date ______



RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO. 39304.000

CLIENT NYSDEC SUBJECT Process Costs Prepared By BNT Date 3/5/96

PROJECT Cumberland Bay Reviewed By ____ Date ____

Approved By ____ Date ____

Gravity Dewatering Conceptual Lay-out and Operation

Design capacity to dewater 500 in place c.y. per 24 hours

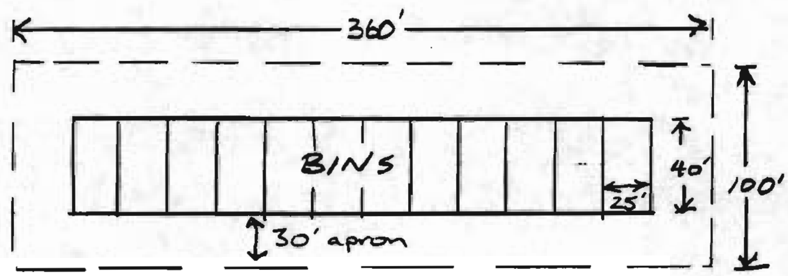
Time = 93,000 cy in-place / 500 cy per day = 186 days

Daily Operation:

1. Fill bins with raw dredge slurry
2. Allow 12-18 hr for water to decant
3. Remove water
4. Manually (with excavator) blend S/S agent
5. Load solids into trucks

Bin sizing: assume 12 @ 8000 cf each

estimate bins @ 8' SWD. x 40' Long x 25' wide



BIN LAY-OUT

For cost estimating purposes, it was assumed that the bins would be constructed of reinforced concrete as would the apron surrounding the bins.

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO. 39304.000

CLIENT NYSDEC | SUBJECT Process Costs | Prepared By ANT Date 3/5/96

PROJECT Cumberland Bay | Reviewed By ______ Date ______

Approved By ______ Date ______

Gravity Dewatering (continued)

Operating Requirements:

- 2 shifts @ 8 hr each
- 7 d/week
- 6 mo duration (180 days)

Excavators		2
Excav. Operators	2x2 =	4
Facility operator	2x1 =	2
Laborers	3x 2 shifts =	6

Processing Capacity / Schedule

6-mo = 180 days

From Spreadsheet:

- 93,000 cy in-place → approx. 500 cy/day
- 678,000 cy dredge slurry @ 5% solids → approx 3600 cy/day

Boxes are: 12 @ 8000 cF (300 cy) each → 3600 cy volume

∴ Cycle time is 24-hr

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO. 39304.000

CLIENT NYSDEC SUBJECT Process Costs Prepared By RWT Date 3/5/96

PROJECT Cumberland Bay Reviewed By ______ Date ______

Approved By ______ Date ______

WATER TREATMENT

1. Gravity Drainage (from page 2 - Process Vol. Spread Sheet)

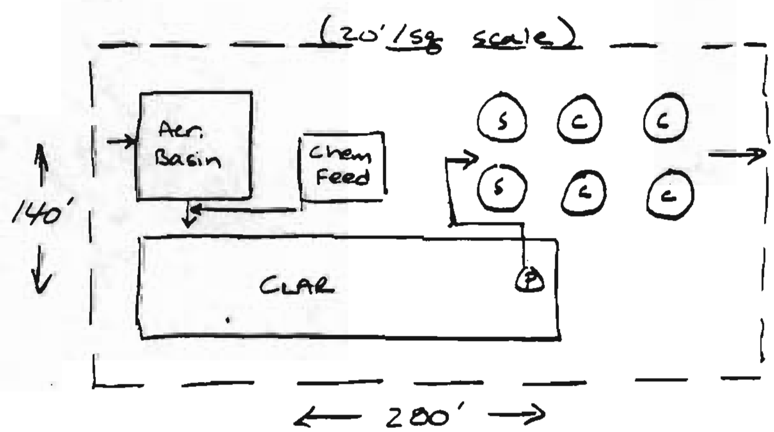
Dredge water - final dewatered = excess water to treat

Dredge Slurry water Vol	730,000 gal
(Deduct) Dewatered " "	− 70,000 gal
	660,000 gal/day

2. Filter Press (page 2 spread sheet)

Dredge water volume	489,000
Deduct final water	− 36,000
Add beltwash	+ 420,000 ← (50gpm/press, 10 presses @ 14 hr/d)
	873,000 gal/day

∴ Conservatively size for 1 Mgd flow



System footprint

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 39304.000

CLIENT NYSDEC

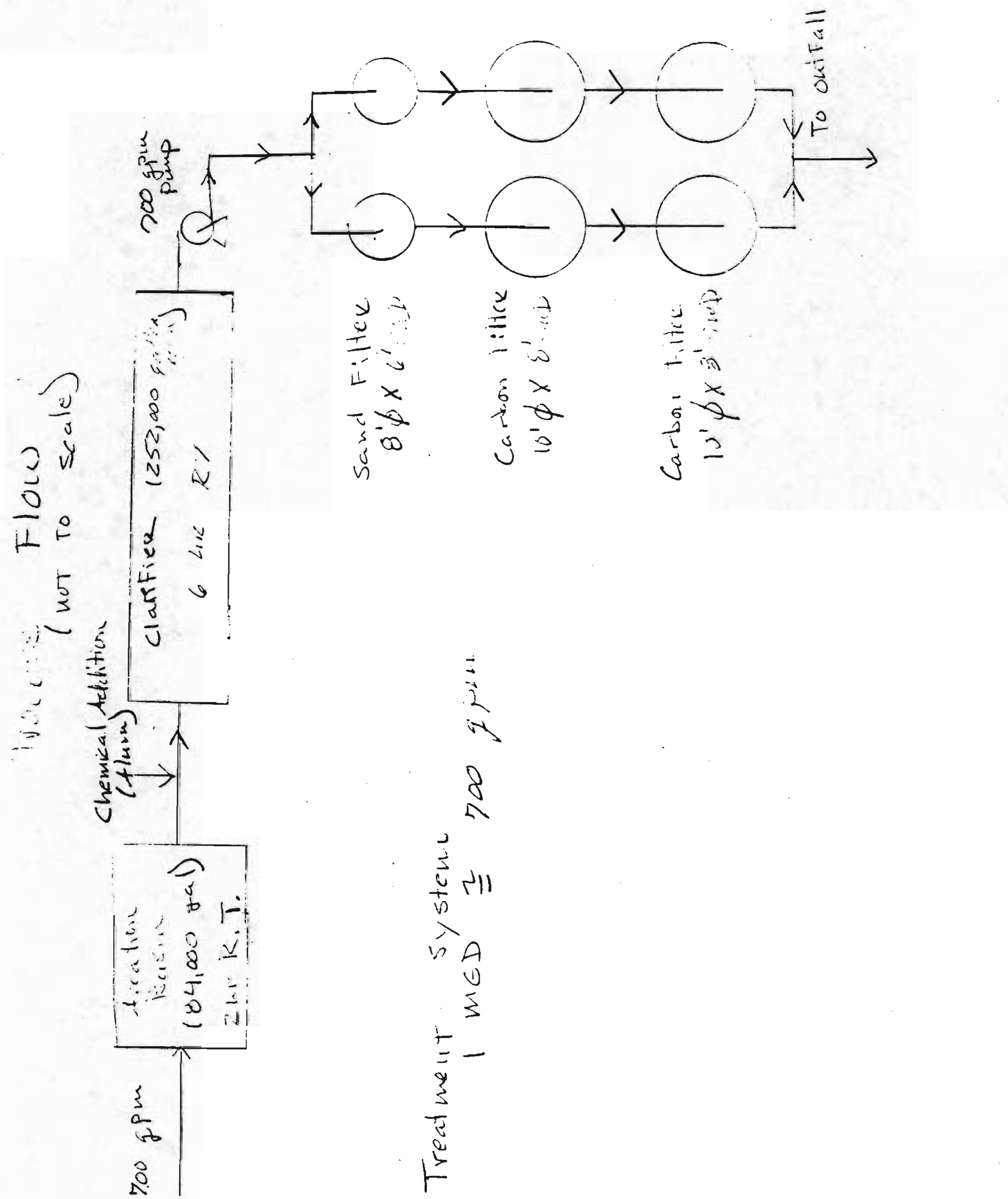
PROJECT Cumberland Bay

SUBJECT Water Treatment · Preliminary PFD

Prepared By AWT Date 3/5/96

Reviewed By ______ Date ______

Approved By ______ Date ______



Analysis of Filter Press vs Gravity Dewatering

Sludge dewatering for disposal off-site or in an on-shore CDF could be accomplished in a number of ways. Two methods considered in preparing this FS and cost analysis are the use of gravity drainage boxes and filter press processing. The gravity drainage boxes are a labor intensive operation, which will result in a higher volume for disposal (due to less efficient dewatering). The filter press processing is an equipment intensive operation, which still requires operating labor. The filter press operation will result in smaller quantities for disposal. A brief description of the two dewatering methods along with sizing and performance projections is provided below.

Gravity Drainage Boxes

A series of concrete boxes would be constructed with a surrounding concrete operations pad. The boxes would each hold 300 cubic yards (cy) of raw slurry. The slurry would be pumped from dredging equipment sequentially to the individual drain boxes through a pipe manifold. The total capacity of the drain boxes would be 3,600 cy. A drain box volume of 3,600 cy would theoretically provide capacity to process all sediments in 180 working days. Dredge slurry would be allowed to gravity settle for 6 to 12 hours, and the supernate pumped out and discharged to the on-site water treatment system. Cement kiln dust or other suitable solidification agent would be applied to the sediment and mixed manually with an excavator. The excavator would then remove the sediment from the drainage box and load it directly into trucks for transportation to the off-site disposal facility or the on-shore CDF. Based on the pilot tests, the gravity settled sludge could be expected to attain a 65% moisture content (expressed as weight of water divided by total weight). It is assumed that solidification agent would be added at a rate of 20 % (of the total settled sludge weight). The above operation is projected to yield 85,500 cy (111,150 tons) of material for disposal from an initial 93,000 cy of sludge. The above dewatering operation is projected to cost $16 plus $4 per in-place cy, and yield an excess of 5,500 cy (10,500 tons) of material over that which would result from filter press operations described below.

Filter Press Dewatering

The filter press operation is anticipated to include the following process components: vibrating screen, rapid mixer surge tanks, acid or polymer application to aid dewatering, filter pressing using recessed chamber or belt presses, and blending with a solidification agent such as cement or CKD in a screw auger (if necessary).

It is projected that 10 presses would be needed to complete dewatering of sediment over 9 months. Based upon the pilot test, the best performance was obtained by depressing the pH, at which time the sediments could be dewatered to 54% moisture content. It is assumed here that the slurry pH will be adjusted and the finished filter cake will be blended with 5% cement of CKD. The above operation is projected to yield 58,600 cy (78,180 tons) of material for disposal from an initial 93,000 cy of sludge. The dewatering operation is projected to cost $34 per in-place cy.

Based upon the above analysis, it appears that gravity dewatering would be appropriate for use under Alternate 2B. For off-site disposal options, filter press processing would be warranted to reduce disposal volumes and costs.

Cost Estimate
Gravity Dewatering of Sludge

Item	Quant.	Unit Cost	Unit	Cost
Processing facility				
Concrete bins 12 x 30 cy each (reinf-concrete cost)	2,200	$60	CY	$132,000
Working pad 10" slab on grade 30' beyond bins	560	$30	CY	$16,800
Subgrade for slab/bins - 3' R.O.C.	4,000	$12	TON	$48,000
Slurry feed manifold	1	$71,000	LS	$71,000
Decant water draw system	1	$46,000	LS	$46,000
Misc Site prep and finishing 20% of above)	1	$62,760	Factored	$62,760
			Facility subtotal	*$376,560*
30% rebuild during job due to wear/damage	1	$112,968	LS	$112,968
Concrete demolition and place in fill	2760	$15	CY	$41,400
			Processing Facility Total	**$489,528**
Operations				
Excavators (3/4 cy - 2 on-site full time)	12	8000	MO	$96,000
Excavator operators (2 operators 2-shifts)	5760	30	HR	$172,800
Operators (1/shift)	2880	35	HR	$100,800
Laborers (3 per shift, 2-shifts)	8640	25	HR	$216,000
Cement kiln dust (delivered)	14,000	$10	TON	$140,000
CKD application equipment	1	40000	LS	$40,000
Contingency @ 30% operations cost	1	229680	Factored	$229,680
			Operations Total	**$995,280**
			Sludge Dewatering Total	**$1,484,808**
			Unit Price for 93,000 cy	**$16**

Cost Estimate
Filter Press Dewatering of Sludge

Item	Quant.	Unit Cost	Unit	Cost
Processing facility				
Vibrascreen 2-deck	1	$80,000	EA	$80,000
Roll-off boxes	4	$3,000	EA	$12,000
Diaphragm pumps	3	$4,000	EA	$12,000
Sealed mix tanks 20,000 gal	3	$10,000	EA	$30,000
Rapid mixers	6	$3,000	EA	$18,000
Diaphragm pumps	3	$4,000	EA	$12,000
Filter presses - 2m skid mount belt press	10	$120,000	EA	$1,200,000
Dedicated cake loader	1	$35,000	EA	$35,000
Cake bin and feed to auger mixer	1	$30,000	LS	$30,000
Screw auger 18"	1	$80,000	EA	$80,000
Cement/CKD silo & feed	1	$50,000	LS	$50,000
Transfer piping systems	400	$100	LF	$40,000
Processing pad (6" reinforced slab, 50% of op's area)	13,300	$5	SF	$66,500
Electrical services	1	$20,000	LS	$20,000
Air supply	1	$10,000	LS	$10,000
Miscellaneous equipment (10% of above)	1	$169,550	Factored	$169,550
Installation	1,800	$40	HR	$72,000
Start-up	360	$40	HR	$14,400
Contractor O&P (10% on materials)	1	$186,505	Factored	$186,505
		Process Facility Construction Total		**$2,137,955**
Processing facility operations				
Operator labor (14hr, 7d, 9mo)	3,780	35	HR	$132,300
Tech's (3) labor (14hr, 7d, 9mo)	11,340	30	HR	$340,200
Mechanic labor (8hr, 7d, 9mo)	2,160	40	HR	$86,400
Equip Operator labor (14hr, 7d, 9mo)	3,780	35	HR	$132,300
Equipment repair (10% of equipment total)	1	$186,505	Factored	$186,505
Consumable supplies	52	$500	week	$26,000
Conditioning agent	20	$3,000	500-gal	$60,000
Cement kiln dust (delivered)	3,500	$10	ton	$35,000
			Operations Total	**$998,705**
			Sludge Dewatering Total	**$3,136,660**
			Unit Price for 93,000 cy	**$34**

Other Shore CDF Costs

Alternative 2b

Trucks (12T - 2 on-site full time)	8	3000	MO	$24,000
Truck drivers (2-drivers, 2-shifts)	5120	30	HR	$153,600
Spreading soils in fill (1-shift)	32	2400	WK	$76,800
Compaction of soils in fill (1-shift)	32	2200	WK	$70,400
			TOTAL	**$324,800**
			Unit Haul Cost	**$4**

Alternative 2b only - assume trucking included in off-site disposal alt's

Appendix A

Attachment A-1.2

Volume of Shoreline Sediments to be Removed

Project: Cumberland Bay FS
Subject: Estimate Volume of Shoreline Sediments requiring Removal

By: HHM
Date: 2/20/96
Ck'd:
Date:

Approximate Shoreline Areas to be Excavated:

The shoreline was divided into three sub-areas (SL-1, SL-2 and SL-3) as shown on Figure A-1a. The estimated areas for each of these sub-areas is as follows:

SL-1 = 44,400 sf

SL-2 = 159,600 sf

SL-3 = 10,000 sf

Approximate Volume of the Areas to be Excavated:

Assume that the depth of sludge in these areas is 1 foot. The estimated volume to be removed from each sub-area is as follows:

SL-1 = 44,400 sf x 1 ft = 44,400 cf x 1 cy / 27 cf = 1,650 cy

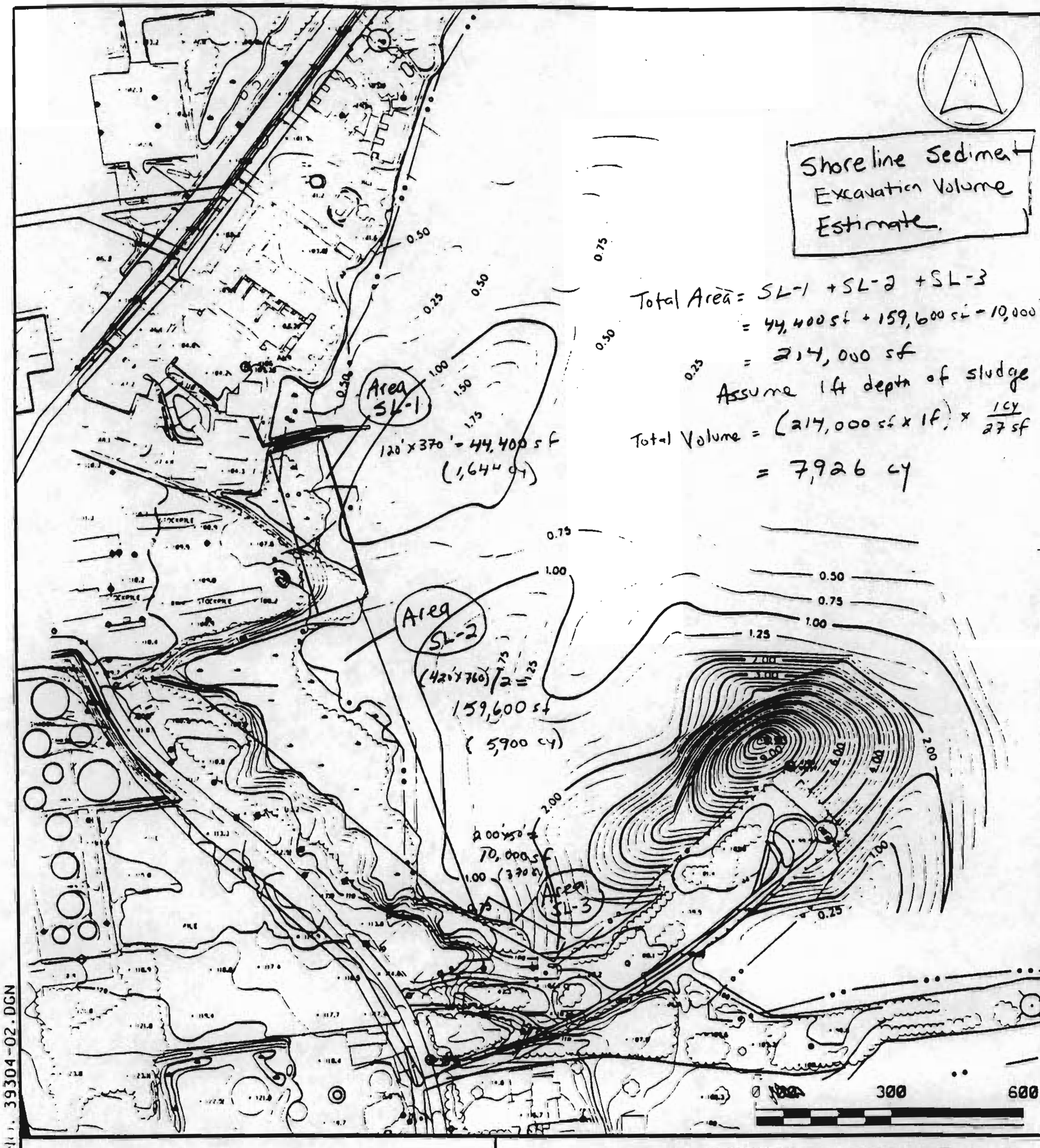
SL-2 = 159,600 sf x 1 ft = 159,600 cf x 1 cy / 27 cf = 5,900 cy

SL-3 = 10,000 sf x 1 ft = 10,000 cf x 1 cy / 27 cf = 370 cy

Total Volume = 1,650 cy + 5,900 cy + 370 cy = 7,920 cy

Volume of Shoreline Sediments to be Removed Prior to Construction of the dry CDF:

The area represented by SL-2 approximates the portion of the dry CDF footprint that contains sludge to be removed. The volume to sludge is estimated to be 5,900 cy.



DRAWING No. 39304-02.DGN

RUST ENVIRONMENT & INFRASTRUCTURE

SLUDGE BED THICKNESS CONTOUR MAP

SLUDGE BED - WILCOX DOCK IRM
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY — CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-02	SCALE 1"=300'	FIGURE No. 1.3

FIGURE A-1a

Appendix A

Attachment A.1.3

Dewatering Containment Wall Cost Estimate (Single/Double Sheet Pile Wall, Portadam)

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO. ______

CLIENT NYSDEC SUBJECT Sheet Piling

Prepared By DJF Date 3/10/97

PROJECT Cumberland Bay

Reviewed By ______ Date ______

Approved By ______ Date ______

Means Sheet Piling Cost estimate:

Estimated steel pile drive depth to be 20 feet (18 feet thick natural sand layer (average) plus 2/3 feet embedment depth)

Materials: \$10.3/sf + labor: \$1.75/sf + Eq't: \$2/sf = \$14.05/sf

\$14/sf from F.S. ok

Add 5.0/sf for difficulty driving through denser sand over water

= \$19/sf

Barge for Piling Installation:

Mobilization \$33/mile (total) x 10 miles = \$330 for tugboat
\$3,000 to dock
\$3330

Marine Barge rental: crew = \$620/day + barge \$700/day = \$1,320/day

\$1,320 day x ≈ 45 days (Installation of piling) ≈ 59,400
3 330
\$62,730

\$62,730 / 181,000 sq = \$0.35/sq ≈ say \$1.50/sf

= \$20.50 sf or \$21/sq ft

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

CLIENT: SSP-DEC	SUBJECT: Dewatering - Piling Costs - 3d	PROJECT NO.	
PROJECT: Cumberland Bay		Prepared By: DDF	Date: 3/11/97
		Reviewed By:	Date:
		Approved By:	Date:

Length of Sheet Piling (double wall encompassing bed)

~~2 690 + 670 + 890 + 590 + 430 + 430 = 3,700 Sq ft~~

Avg Water Depth (ft)	Free Board (ft)	Embedment Depth (ft)	Total (ft)	Length of Pile (ft)	Totals
—	1.5				
9.5	↓	20	31.0	720	22320
7.5	↓	20	29.0	890	25,810
7.0	↓	20	28.5	590	16,815
4.5	↓	20	26.0	430	11,180
1.5	↓	20	23.0	430	9,890

Single Wall - 86,015 sf

required cross-members for 10 ft spacing every 30 feet (1/3 * 86,015)

Total Double Wall = [86,015 * 2) + (1/3 * 86,015)] = 200,702 SF for double wall

RUST **Rust Environment & Infrastructure**

CALCULATION SHEET

PROJECT NO. ______

CLIENT SSP-NYSDEC SUBJECT Sheet Piling Cofferdam Cost Prepared By DDF Date 3/12/97

PROJECT Cumberland Bay Reviewed By ____ Date ____

Approved By ____ Date ____

Total Sq Footage of Sheet pile

= 200,701 sq ft

From Sheet 1 Sheet pile = \$21.00/sq ft (installed only)

∴ 200,701 sq ft * 21.00/sq ft = \$4,214,721 Total for Sheet Pile

Cofferdam Backfill required

Assume 10 foot spacing of double wall sheet pile [See Section lengths and depths from sheet 3] - Note assumed 0.5 ft Settlement

(10 ft * 700 ft) + (8 ft * 890) + (7.5 ft * 540) + (5 ft * 430 ft) + (2 ft * 430 ft)

= 21,755 sq ft * 10 ft (spacing) = 217,500 SF

= 8,057 cy

@ \$30/cy (# from FS and checked by DDF - See attached cost estimate Table 1) Delivered/Installed

8,057 cy * \$30/cy = \$241,710

RUST Rust Environment & Infrastructure

CALLATION SHEET

PROJECT NO. ______

CLIENT SSP-NYSDEC SUBJECT Porta Dam

PROJECT Cumberland Bay Costs/Estimates

Prepared By DDF Date 3/12/97

Reviewed By ______ Date ______

Approved By ______ Date ______

Assume time range for use: June through October ≈ 5 months

Porta Dam Costs:

Rates

1st Month	2nd Month	3rd Month		
125,700	94,275	62,850	x3 =	188,550

125,700
94,275
188,550
$408,525 /5 mo + $112,000

Crew Costs (assume 40 days) for installation/removal

Total = 520,525

Doesn't include: - Sand bags (4,000)
- 2 laborers
- small barge
- back hoe (lifting for installation)

Labor, Rental, other excluded items:

Backhoe @ $75/hr x 10 hrs x 40 days = $30,000

2 laborers (Sand bagging, assistance) x $35/hr x 10 hrs x 40 days = $14,000

2 divers (Maintenance on structure) @ $65/hr x 8 hrs/event x 2 event/mo x 5 mo = $5,200

Small barge mob/demob - $3,000 Lump
- rental $4,700/mo + $1,565/wk (40 days) = $6265
crew $550/day x 40 days = 22,000

Total of "Other Costs" = 80,465

Total Costs: $520,525 + 80,465 = 600,990 x 10% Contingency = $661,089

Rev. 11/94 scale: 4 sq./inch F051/General

S... $50 ... [illegible]

NYSDEC - CUMBERLAND BAY

Alternatives 3d

Comparison of Dewatering Containment Wall Options

	Description	Quant.	Unit Cost	Unit	Cost	Maintenance Dewatering (gpd)	
						Dry Dewatering	Wet Dewater
1	Double Sheet Pile Cofferdam	200,700	$22	sf	$4,457,700	155,500	250,000
2	Single Wall Sheet Pile	86,100	$21	sf	$1,808,100	1,100,000	1,350,000
3	Portadam (shore - 4') & Single Sheet Pile to Breakwater						
	Portadam	3,500	$50	lf/mo	$175,000	2,900,000	---------
	Single Wall Sheet Pile	70,000	$21	sf	$1,470,000	580,000	1,350,000
	Total				$1,645,000		
4	Portadam (shore - 7') & Single Sheet Pile to Breakwater						
	Portadam	7,000	$50	lf/mo	$350,000	5,800,000	---------
	Single Wall Sheet Pile	49,000	$21	sf	$1,029,000	---------	1,350,000
	Total				$1,379,000		
5	Portadam (shore - 7') & Double Sheet Pile to Breakwater						
	Portadam	7,000	$50	lf/mo	$350,000	5,800,000	---------
	Double Wall Sheet Pile	116,364	$22	sf	$2,560,000	---------	250,000
	Total				$2,910,000		

Appendix A

Attachment A.1.4

Alternative 3 Series
Dewatering Seepage Estimates

4/21/97

CUMBERLAND BAY SLUDGE BED IRM REMEDIAL ALTERNATIVES

SUMMARY OF REQUIRED PUMPING RATES FOR VARIOUS DAMS

Flow Scenario	Seepage (gpm) Single Sheet pile	Double Sheet pile	Portadam
Flow through dam	310.0	31.0	1,551
Flow under dam	20.9	15.2	32.4
Groundwater recharge	160.0	160.0	160.0
Precipitation	46.2	46.2	46.2
Total Flow	537.0	252.4	1,789
Factor of Safety = 5	2,685	1,262	8,946
MGD	3.87	1.82	12.88

Assumptions:

ksand = hydr cond of the natural sand underlying the sludge = 1E-4 cm/sec
ktill = hydr cond of the till underlying the sand layer= 1E-5 cm/sec
[hydraulic conductivity values from typical k for sand & silty sand (Das, 1984)]
Natural sand layer thickness = 25 feet (max)
Till layer thickness = 40 feet
Average water height (head) above sludge = 7 feet
Sheet pile embedment depth = 3 feet (into till)
Sheet pile spacing = 5 feet
Length of sheet pile = 3,100 feet
Groundwater collection trench is assummed to also collect 77 gpm (assumed) of stormwater from the City of Plattsburg storm sewer discharge pipes into bay

CUMBERLAND BAY SLUDGE BED IRM REMEDIAL ALTERNATIVES

SUMMARY OF REQUIRED PUMPING RATES FOR VARIOUS DAMS

Flow Type	Method of Calculation	Flow Q (gpm)	Assumptions
Through single sheet pile	Darcy's Equation	310.0	K(sp)=0.11 ft/day, H(sp)=25ft, h=7ft, w(sp)=1ft, L=3100ft
Through double sheet pile	Darcy's Equation	31.0	Same as above, sp spacing=10ft
Under single sheet pile	Harr Method-2 layers	20.9	k1=0.286ft/day, h=7ft, E=0.4, Q/k1h=0.65
Under double sheet pile	Harr Method-2 layers	15.2	k1=0.286ft/day, h=7ft, E=0.4, k1h/Q=2.12
	Harr Method-1 layer	30.5	keq=0.483ft/day, h=7ft, L=3100, H(sp)=s=28ft, T=65ft, sp spacing=10ft
	Flow Net	23.8	kequiv=0.483ft/day, h=7ft, L=3100, H(sp)=28ft, T=65ft, Nf/Nd=0.438
Through portadam	Darcy's Equation	1550.7	K(pd)=27.51 ft/day, H(pd)=25ft, h=7ft, L(pd)=20ft, L=3100ft
Under porta dam	Harr Method-1 layer	133.5	ksand=2.86ft/day, h=7ft, L=20, T=25ft
	Harr Method-2 layers	32.4	k1=2.86ft/day, h=7ft, E=0.1, k1h/Q=1.42
	Flow Net	243.3	kmean=1.57ft/day, h=7ft, L=3100,Nf/Nd=1.375, T=65ft
Groundwater recharge (total)	Darcy's Equation	160.0	ksand=2.86ft/day, 10ft collection trench + flow through sand layer

Notes:
(sp) = sheet pile
(pd) = portadam

2 of 18

Estimate of Seepage Induced by Dewatering

Cumberland Bay Sludge Bed Site Remedial Alternatives Evaluation

Groundwater Recharge and Flow into Sludge Bed Area When Dewateringusing Sheet Piles and Portadams

Parameter	Symbol	Value	Unit	Converted Value	Unit
1a. Flow through single sheet pile	Q(sp)	59675	cfd	310.0	gal/min
1b. Flow through double sheet pile	Q(sp)	5967.5	cfd	31.0	gal/min
2a. Flow under single sheet pile	Q(sp)	3,912	cfd	20.9	gal/min
2b. Flow under double sheet pile	Q(sp)	2,845	cfd	15.2	gal/min
3. Flow through porta dam	Q(pd)	298530.10	cfd	1550.7	gal/min
4. Flow under porta dam	Q(pd)	6,244	cfd	32.4	gal/min
5. Groundwater recharge (total)	Q(gw)	16,017	cfd	83.2	gal/min
6. Precipitation into bed	Q(ppt)	8,886	cfd	46.2	gal/min

Input Parameters:	Area of dewatering	A	1,481,040	sq ft		
	Precipitation		0.006	ft/day	25	in/year
	Head difference	h	7	ft		
	Length of sheet pile/porta dam	L(sp)	3100	ft		
	Height of sheet pile above till	H(sp)	25	ft		
	Double sheet pile spacing	w(sp)	10	ft		
	Hydraulic conduct. (sheet pile)	k(sp)	1.10E-01	ft/day	3.85E-05	cm/sec
	Thickness of till	T2	40	ft		
	Thickness of both layers (till+sand)	Tt	65	ft		
	Embedment depth	s	28	ft		
	Equivalent cond. for both layers	k(equiv.)	4.83E-01	ft/day	1.69E-04	cm/sec
	Hydraulic conduct. (till)	k(till)	0.29	ft/day	1.00E-04	cm/sec
	Hydraul. conduct. (sludge)	k(sldg)	0.10	ft/day	2.40E-05	cm/sec
	Hydraul. conduct. (natural sand)	k(nat sand)	2.86	ft/day	1.00E-03	cm/sec
	Hydraul. conduct. (porta dam)	k(pd)	27.5143	ft/day	9.63E-03	cm/sec
	Width of porta dam	w(pd)	20	ft		
	Height of porta dam	H(pd)	10	ft		
	Embedment depth (porta dam)	s	0	ft		

1a. Flow through single sheet pile - Refer to sheet 1

Q(sp) = [k(sp)*h*H(sp)]/w(sp) * L(sp) = 59675 cfd 309.978 gal/min

1b. Flow through double sheet pile - Refer to sheet 1, where pile spacing w(sp) = 10ft with bank-run between piles

Q(sp) = [k(sp)*h*H(sp)]/w(sp) * L(sp) = 5967.5 cfd 30.998 gal/min

2a. Flow under single sheet pile wall - Harr Method of layered systems (sheet 8)

Q(pd) = k1 * h * Q/k1h where q/k1h = 0.65 for two layers (see calculation and corresponding chart)

Q(pd) = (0.286 ft/day) * (7ft) * (0.65 1.3 ft/day * 3100 ft * 7.48gal/cf / 1440 min/day

Q(pd) = 20.9 gpm

2b. Flow under double sheet pile - Harr Method of two layed systems (figure 9)

Q(pd) = k1 * h/(k1h/Q) where k1h/Q = 2.12 for two layers (see calculation and corresponding chart)

Q(pd) = (0.286 ft/day) * (7ft)/(2.12) 0.944 ft/day * 3100 ft * 7.48gal/cf / 1440 min/day

Q(pd) = 15.2 gpd

2c. Flow under double sheet pile wall - Harr Method using one layer with equivalent k

See Figure 1 Q(usp) =h/[(f1/kequiv)+(f2/ktequiv)] * L(sp)

Q(sp) =		5867	cfd	30.48	gal/min
Segment 1, Segment 2	s/T =	0.43			
(Fragment Type II)	1/(2*f1)	0.56	(see Figure 5-13, Harr, attached)		
	f1, f2 =	0.893			

2d. Flow under double wall sheet pile - Refer to flow net figure Pages 3

q = k*h*Nf/Nd k equivalent of till and sand = 1.69x10-4 cm/sec = 0.48 ft/day
hmax = 7 ft, Nf = # of flow lines = 3.5, Nd = # equipotential drop lines = 8
q = (0.48 ft/day) * 7ft * (3.5/8) = 4.88 ft^2/day * 3100 ft* 7.48 gal/cf * 1/1440 day/min

q = 23.8 gpm

3. Flow through Porta Dam

Q(sp) = [k(pd)*h*H(pd)]/w(pd) * L(pd) = 298530.00 cfd 1550.70 gal/min

4a. Flow under porta dam - Harr Method assuming till layer is impermeable (1 layer) = Refer to sheet 5

Q(usp) =h/[(f1/ksand)+(f2/ksand)+(ksand/f3)] * L(pd)

Q(usp) =		25705	cfd	133.52	gal/min
Segment 1, Segment 3	s/T =	0			
(Fragment Type II)	1/(2*f1)	0.62	(see Figure 5-13, Harr, attached)		
	f1, f2 =	0.81			
Segment 2					
(Fragment Type I)	Lpd/H layer	0.80			

4b. Flow under porta dam - Harr Method of layered systems (see sheet 7)

Q(pd) = k1 * h/phi where phi = 1.42 for two layers (see calculation and corresponding chart)

Q(pd) = (2.86 ft/day) * (7ft)/(1.42) = 32.4 gpm

4c. Flow under porta dam - Refer to flow net sheet 4

Q(pd) = k*h*Nf/Nd k avg of till and sand = 5.5x10-4 cm/sec = 1.57 ft/day
hmax = 7 ft, Nf = # of flow lines = 5.5, Nd = # equipotential drop lines = 4

Q(pd) = (1.57ft/day) * 7ft * (5.5/4) = 15.11 ft^2/day * 3100 ft* 7.48 gal/cf * 1/1440 day/min

Q(pd) = 243.3 gpm

5a. Groundwater recharge into collection trench

Q(gw) = [k(H^2 - h^2)/2L] * x where x = length of collection trench = 1800 ft
k = hydraulic cond. of nat. sand = 2.86 ft/day
L = length of distance from trench to recharge point
h = saturated thickness at trench = 16 ft
H = saturated thickness in sand layer = 30 ft

Q(gw) = [2.86(25^2 - 10^2)/2*200]1800

Q(gw) = 43.1 gpm

Q(gw) = kiA = kha/L

5b. Groundwater recharge through natural sand layer (beneath trench)

Q(gw) = 2.86 * (0.1) * (27000)
k = hydraulic cond. of nat. sand = 2.86 ft/day
L = length of distance from trench to recharge point = 30ft
h = saturated thickness at trench = 3 ft
A = Area of recharge = 1800ft * 15ft

Q(gw) = 7722 cf/day * 7.48 gal/cf

Q(gw) = 57760.6 gal/day /1440 min/day Q(gw) = 40.11 gal/min

Q (for storm drain pipes into bay) = 76.8 gal/min

Total 160.01

RUST ENVIRONMENT & INFRASTRUCTURE

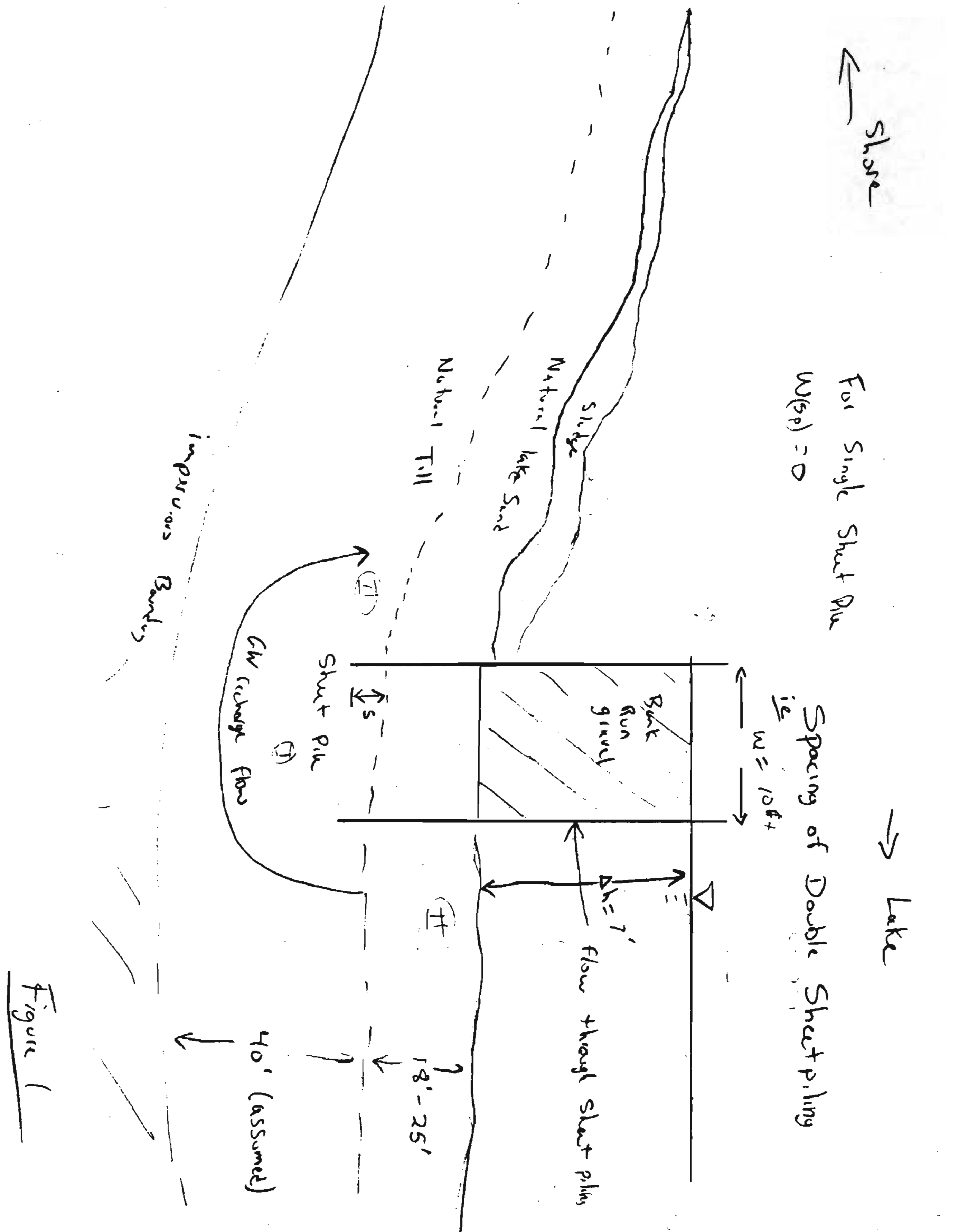
CALCULATION SHEET

PROJECT NO. ______

CLIENT NYSDEC
PROJECT Cumberland Bay

SUBJECT Seepage – GW Recharge Sheet Pile Alternative

Prepared By DDF Date 2-21-97
Reviewed By ______ Date ______
Approved By ______ Date ______



RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ______

CLIENT	NYSDEC	SUBJECT	Flow Net
PROJECT	Cumberland Bay		for Sheet pile - GW recharge
Prepared By	DOF	Date	2-21-97
Reviewed By		Date	
Approved By		Date	

$q = K\, h_{max} \frac{N_f}{N_d}$

$K_{equiv} = 1.97$ ... $= 0.48$ ft/day

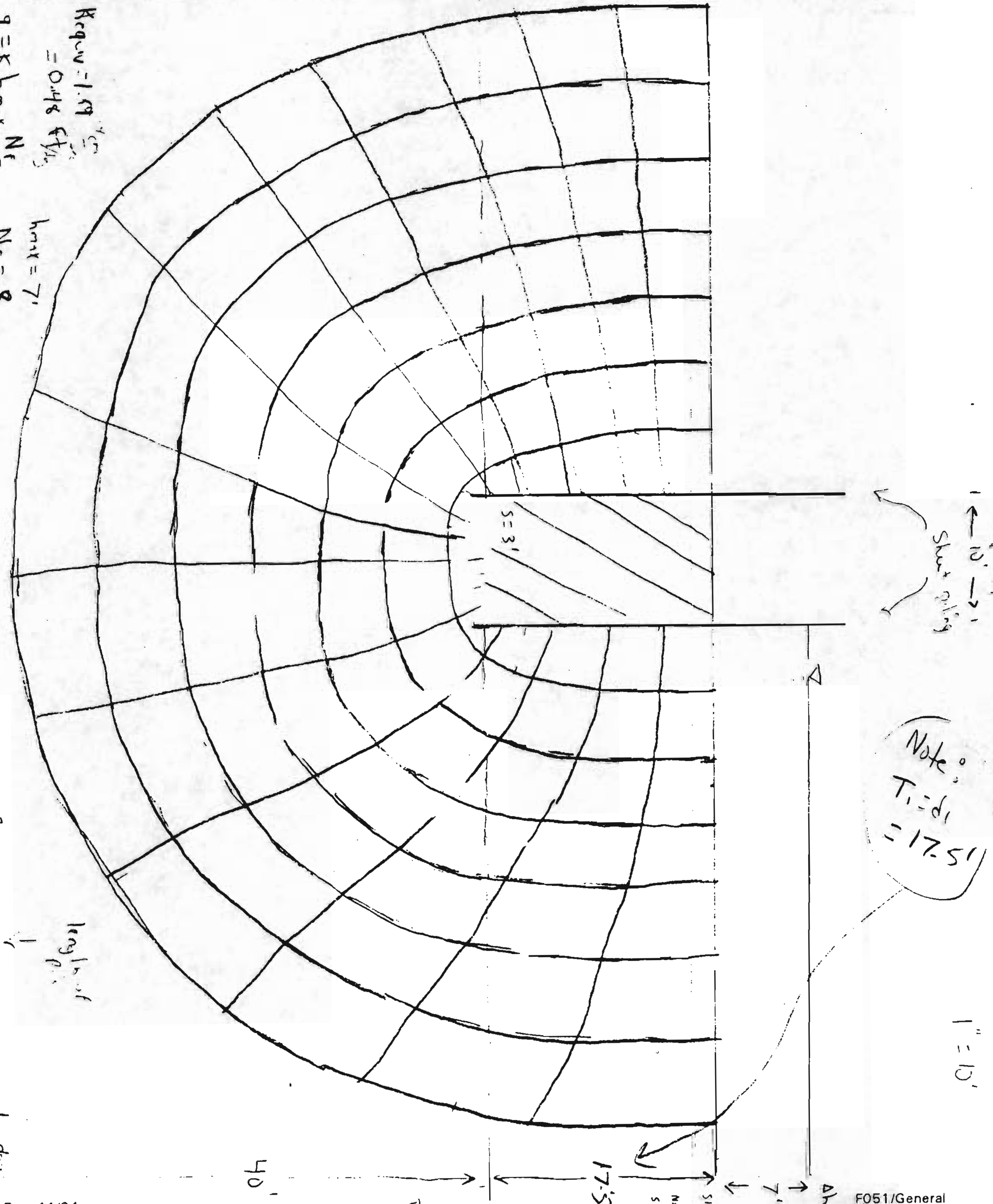
$h_{max} = 7'$

$N_f = 8$

$N_d = 14$

$q = 0.48 \frac{ft}{day} \times 7\,ft \times 8/14 = 1.92\ ft^2/day \times 3100\ ft \times 7.48 \frac{gal}{ft^3} \times \frac{1\ day}{1440\ min}$

length of pi.



RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO.

CLIENT: NYSDEC

PROJECT: Cumberland Bay

SUBJECT: Sheet Pile - Groundwater recharge Flow net

Prepared By: DDF Date: 2-21-97

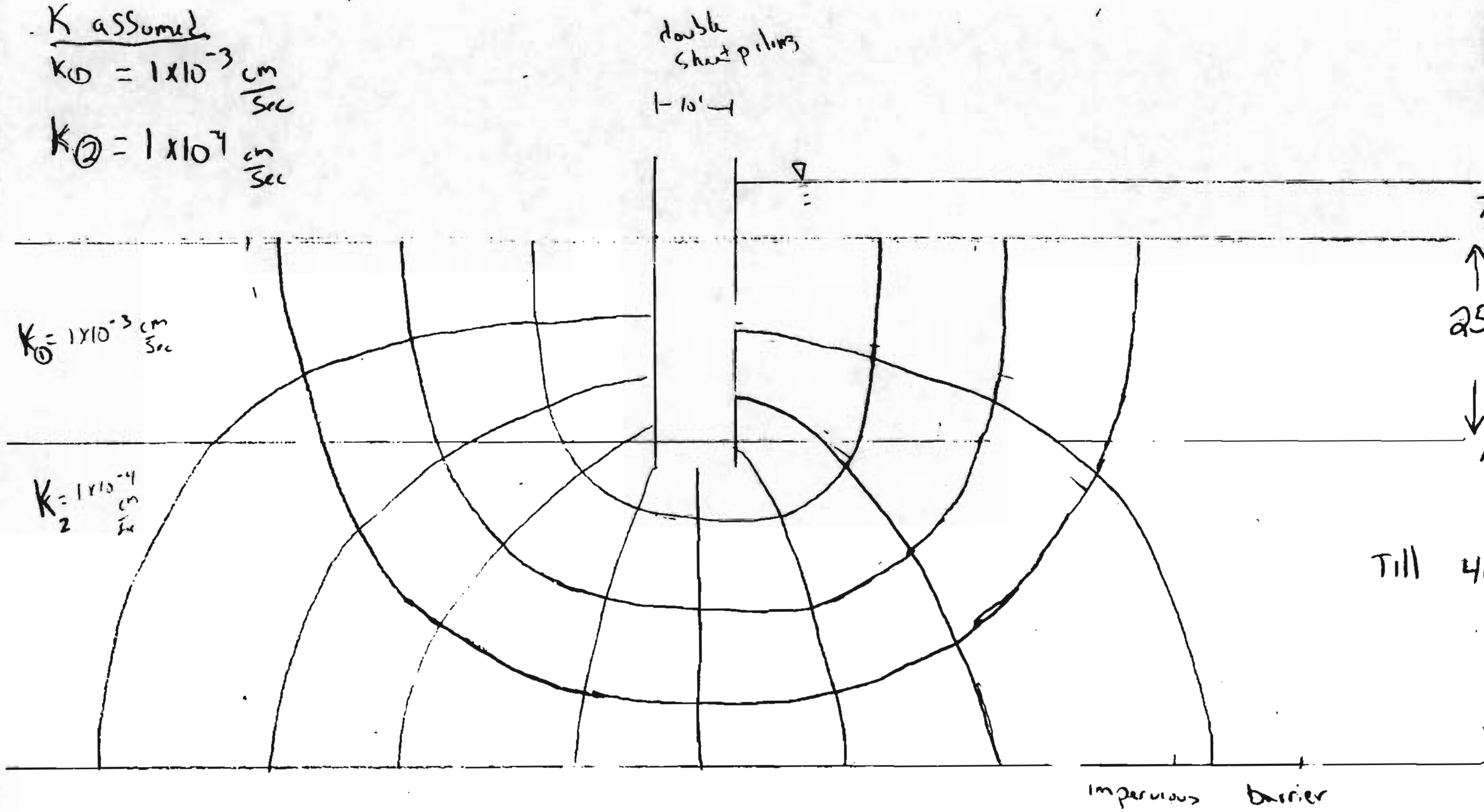
Reviewed By: Date:

Approved By: Date:

K assumed

$K_{①} = 1 \times 10^{-3} \frac{cm}{sec}$

$K_{②} = 1 \times 10^{-4} \frac{cm}{sec}$



$K_{equivalent} = 1.69 \times 10^{-4}$ cm/sec $= 0.48$ ft/day

$\Delta h_{max} = 7$ ft

$N_f = 3.5$

$N_d = 8$

length of pile

$q = K \Delta h \frac{N_f}{N_d} = \left(0.483 \frac{ft}{day}\right)(7\ ft)\frac{3.5}{8} = 1.48 \frac{ft^2}{day} \times 3100\ ft \times 7.48 \frac{gal}{ft^3} \times \frac{1\ day}{1440\ min}$

$q = 23.8$ gpm

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ______

CLIENT: NYSDEC

PROJECT: Cumberland Bay

SUBJECT: Flow Net — GW Recharge under porta dam

Prepared By: DOF Date: 2-21-97

Reviewed By: ______ Date: ______

Approved By: ______ Date: ______

$N_f = 5.5$ $\Delta h = 7$ ft

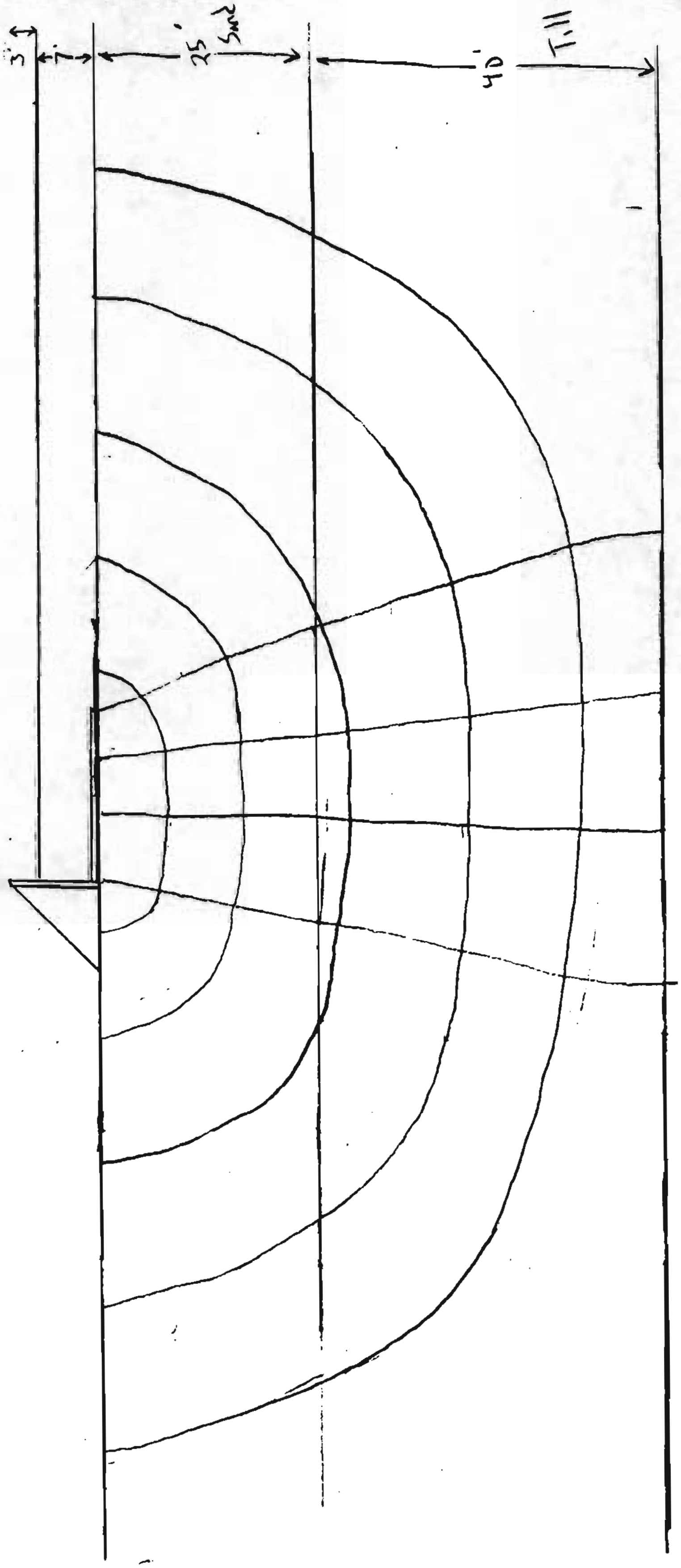
$N_d = 4$

$K_{equivalent} = 5.5 \times 10^{-4} \frac{cm}{sec} = 1.57$ ft/day

$q = K \Delta h \frac{N_f}{N_d} = 1.57 \frac{ft}{day} (7 ft)\, 1.375 = 15.11 \frac{ft^2}{day}$

$= 15.11 \frac{ft^2}{day} * 3100 ft * 7.48 \frac{gal}{ft^3} \cdot \frac{1 day}{1440 min} =$

$= 243.3$ gpm



RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ________

CLIENT: NYSDEC
PROJECT: Cumberland Bay

SUBJECT: Groundwater Seepage under porta dam

Prepared By: DDF Date: 2-24-97
Reviewed By: ______ Date: ______
Approved By: ______ Date: ______

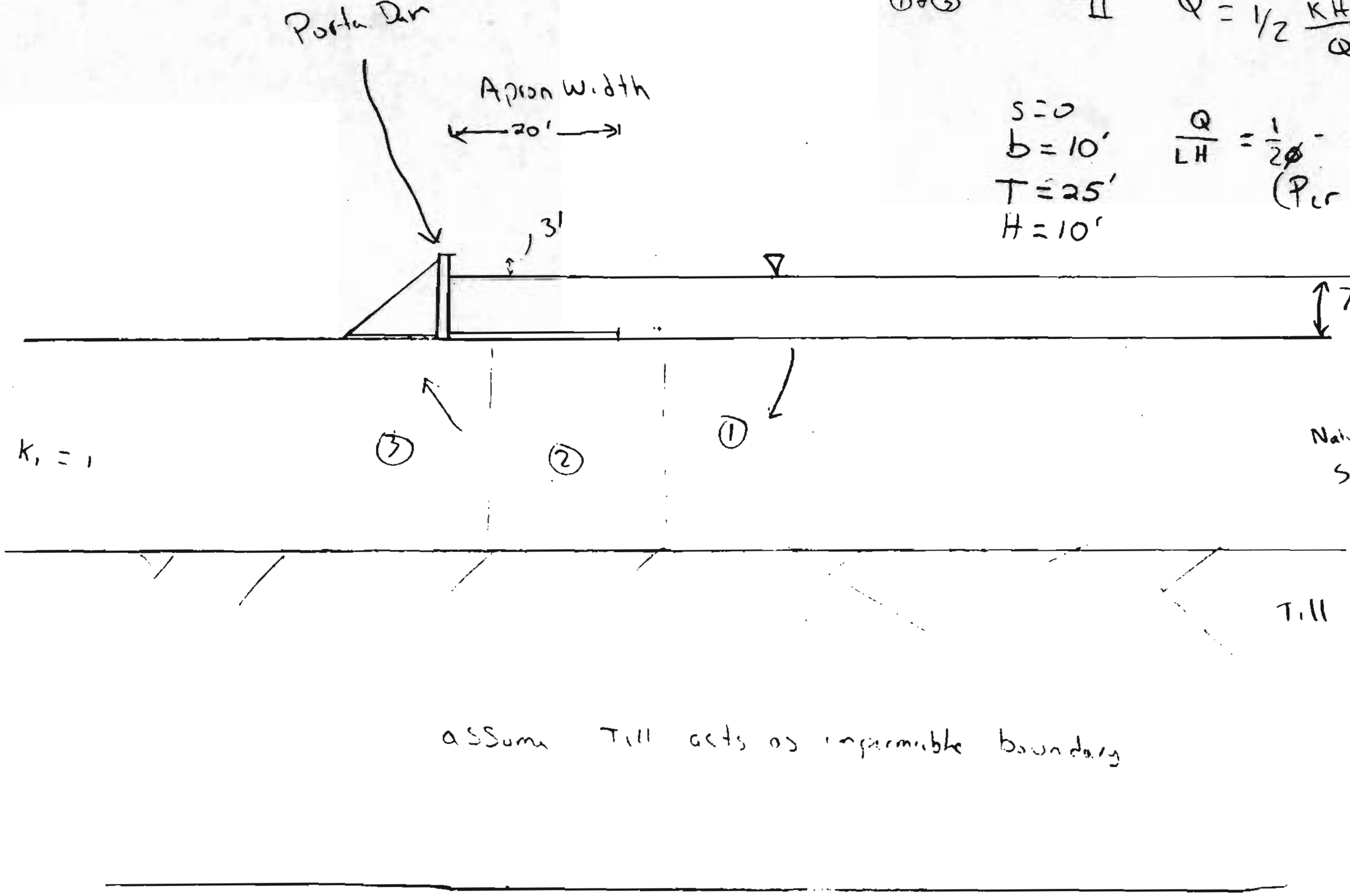
Segment types per HARR Method

② Type I $Q = \frac{L}{A}$

①+③ Type II $Q = \frac{1}{2}\frac{KH}{Q}$

$S = 0$
$b = 10'$
$T = 25'$
$H = 10'$

$\frac{Q}{LH} = \frac{1}{2\phi} = 0.62$ (Per Figure 5-13 HARR)



HARR (Mechanics of Particulate Media, P 171-172)

RUST Rust Environment & Infrastructure

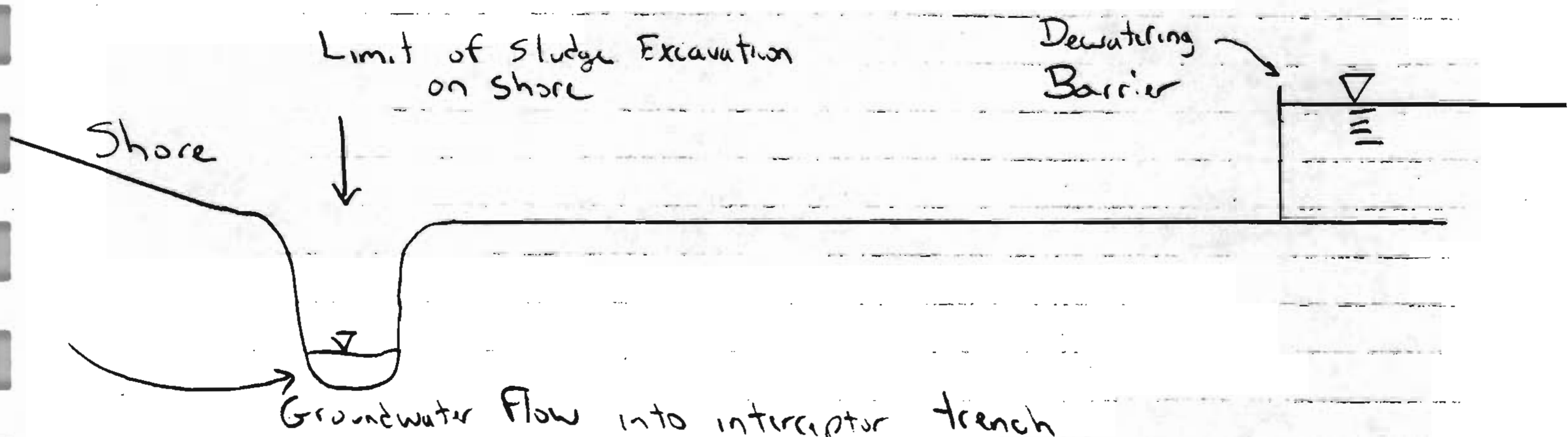
CALCULATION SHEET

PROJECT NO. ______

CLIENT: NYSDEC | SUBJECT: Recharge | Prepared By: DDF | Date: 2-25-97

PROJECT: Cumberland Bay | Reviewed By: ______ | Date: ______

Approved By: ______ | Date: ______



Groundwater Flow from a line source to a drainage Trench:

$$Q = \left[\frac{K(H^2 - h^2)}{2L}\right] X \quad \text{where}$$

X = length of trench = 1800 ft

K = hydraulic conductivity = 2.86 ft/day

L = length / distance from trench to groundwater mound ≅ 200 ft

h = Saturated thickness at trench = 16 ft

H = Saturated thickness in aquifer (Sand layer) = 30 ft

$$Q = \frac{2.86\left((30)^2 - (16)^2\right)}{2(200)}(1800)$$

$$= 8288.3 \frac{ft^3}{day} * 7.48 \frac{gal}{ft^3} \times \frac{1\ day}{1440\ min}$$

$Q = \underline{43.1}$ gpd

Flow through Sand

$Q = KiA = K\frac{h}{L}A$ K = 2.86 ft/day Area = 15' x 1800'

$i = 3/30$ (assumed gradient)

$$Q = (2.86)(0.1)(27000) \times 7.48\ gal/cf * \frac{1\ day}{1440\ min} = 40\ gpm$$

Total Shore Side Seepage = 43 + 40 = **83 gpm**

CLIENT NYSDEC - SSP SUBJECT Porta Dam Prepared By D.F Date 2/25/97

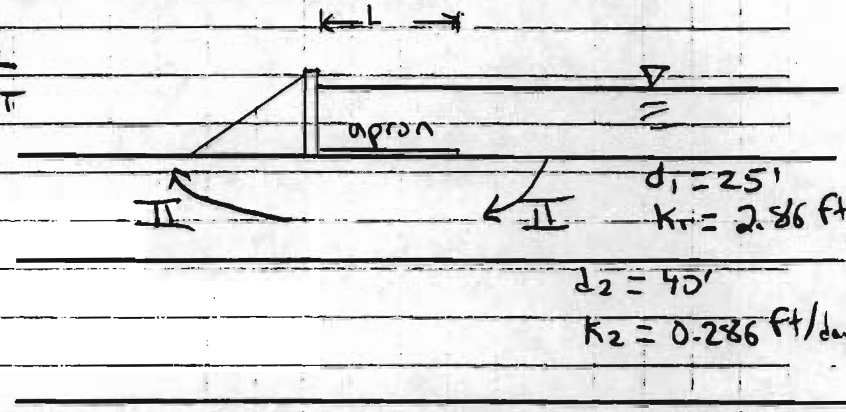
PROJECT Cumberland Dam HARR Method Reviewed By ______ Date ______

Approved By ______ Date ______

Layered Flow Under Porta Dam - HARR Method

Fragment Type I - $\phi = \frac{L}{d_T}$

Type II - $\frac{1}{2}\frac{Kh}{Q}$



$S = 0 \therefore S/T = 0$

$b/T = 10/65$

$T = d_1 + d_2 = 65$

$b = L/2 = 20/2$

Type II

Case ① $\varepsilon = 0$ $K_2 = 0$ $d_1 = T_T = 25'$ $S = 0$

$b/T = 10/25 = 0.4$ $Q/K_1h = 0.6$ $1/0.6 * 0.5$

$= \underline{0.83}$

Case ② $\varepsilon = 0.25$ $K_1 = K_2$ $d_1 + d_2 = 65 = T_T$

$b/T = 10/65 = 0.15$ $S = 0$

$Q/K_1h = 1.1$ $1/1.1 * 0.5 = 0.454$

Case ③ $\varepsilon = 0.5$ $K_2 = \infty$ $\phi \to \underline{\underline{0}}$

$$\varepsilon = \frac{\tan^{-1}\left(\frac{K_2}{K_1}\right)^{1/2}}{\pi} = \frac{\tan^{-1}\left(\frac{0.286}{2.86}\right)^{1/2}}{180} = 0.1$$

over

CALCULATION SHEET

PROJECT NO. ______

CLIENT NYSDEC

SUBJECT Porta Dam Seepage HARR Method

PROJECT Cumberland Bay

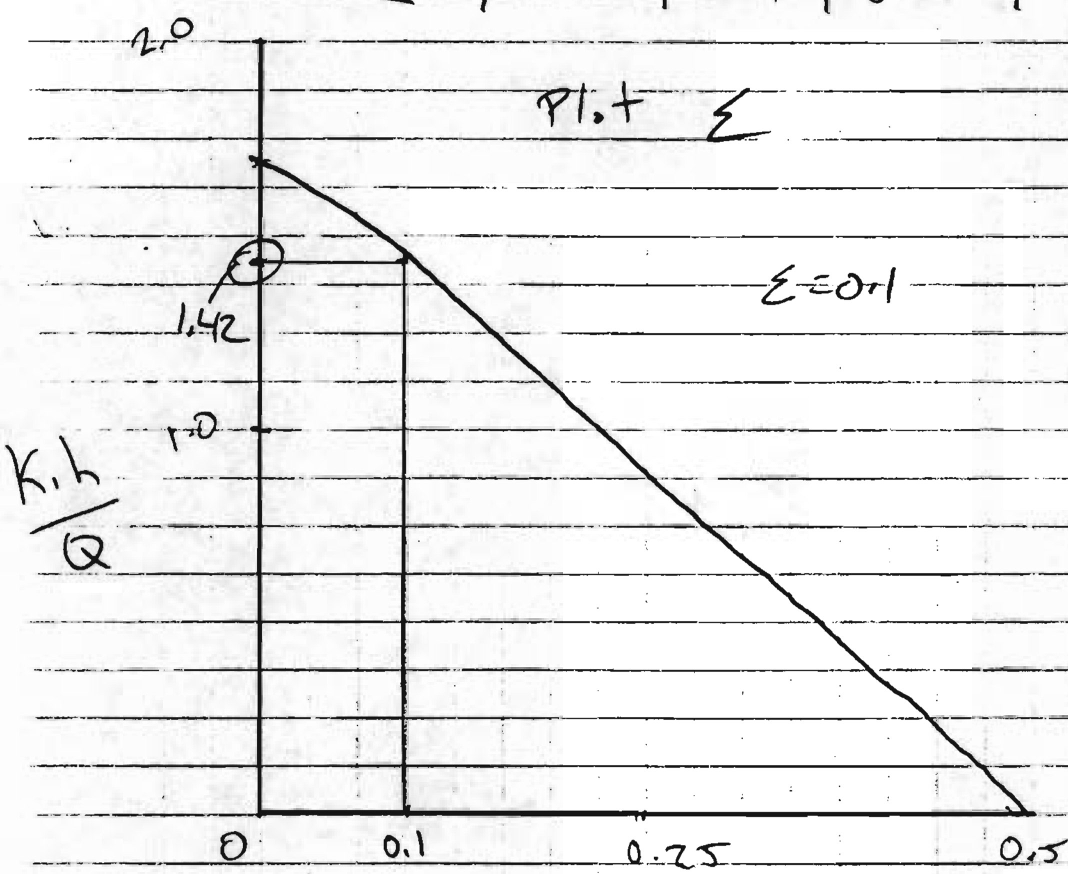
Prepared By DDF Date 2/25/97

Reviewed By ______ Date ______

Approved By ______ Date ______

HARR Method Continued

Area	Type	Σ=0	Σ=0.25	Σ=0.5
①	II	0.83	0.454	0
②	II	0.83	0.454	0
Σ		1.67	0.91	0



$\frac{K \cdot h}{Q} = 1.42$

$\frac{K \cdot h}{1.42} = Q$

$Q = \frac{2.86 \frac{ft}{d} (7ft, ...)}{1.42}$

$Q = 227$ gpd

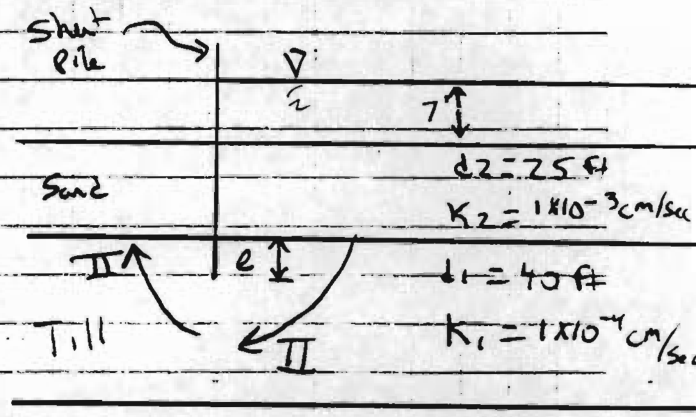
CALCULATION SHEET

CLIENT NYSDEC-SSP	SUBJECT Flow under Single Sheet Pile HARR Method	PROJECT NO.
PROJECT Cumberland Bay		Prepared By DDF Date 2/24/97
		Reviewed By Date
		Approved By Date

Flow in Layered Systems - HARR Method

Case ① $K_2 = 0$ $\varepsilon = 0$

$Q = 0$



Case ② $K_1 = K_2$

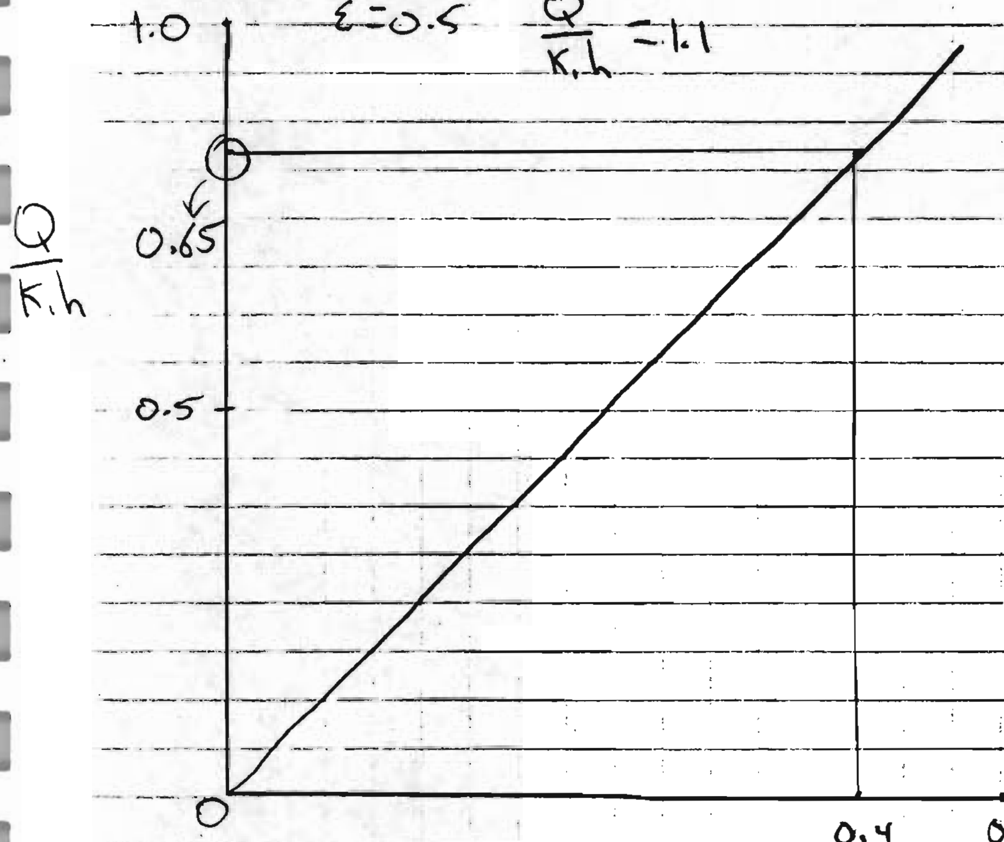
$S = e + d_2 = 28\ ft$

$\varepsilon = 0.25$ $S/T = 0.43$ $T = d_1 + d_2 = 65\ ft$

$Q/K_1 h = 0.5$

Case ③ $K_2 \rightarrow \infty$ $S = e = 3\ ft$ $T = d_1 = 40$ $S/T = 0.08$

$\varepsilon = 0.5$ $\frac{Q}{K_1 h} = 1.1$



$$\varepsilon = \tan^{-1} \left(\frac{1 \times 10^{-3}\ cm/sec}{1 \times 10^{-4}\ cm/sec} \right)^{1/2} \Big/ \pi$$

$= 0.4$

$Q = K_1 h \left(\frac{Q}{K_1 h}\right)$

$= (0.286)(7)(0.65)$

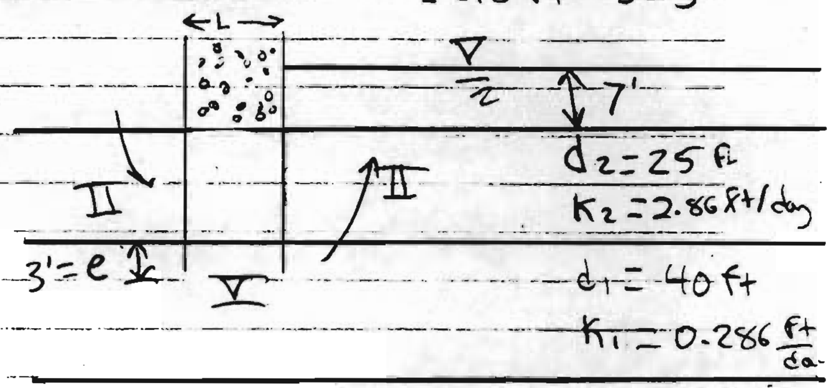
$= 1.3\ ft^2 * 3,100\ ft$

$* 7.48 \times 1440$

$= 20.9\ gpm$

HARR Method for Layered Systems

L = 10 ft b = 5'



Type II

Case ① $\varepsilon = 0$ $K_2 = 0$ $Q = 0$

Case ② $\varepsilon = 0.25$ $K_1 = K_2$

$s = e + d_1 = 28$ $s/T = 0.43$

$T = d_1 + d_2 = 65$ ft $b/T = 5/65 = 0.08$

$Q/k_1h = 0.56$

Case ③ $K_2 \rightarrow \infty$ $s = e = 3$ ft $T = d_1 = 40$

$\varepsilon = 0.5$ $s/T = 0.08$ $b/T = 5/40 = 0.125$

$Q/k_1h = 1.1$

Type V

L = 10 ft $\phi = 2\ln\left(1 + \frac{L}{2a}\right)$

Case ① $\varepsilon = 0$ $K_2 = 0$ $Q = 0$

Case ② $s = e + d_1 = 28$ $a = (d_1 + d_2) - (d_2 + e) = 65 - 28 = 37$

$\phi = 2\ln\left(1 + \frac{10}{2(28)}\right) = 0.254$

Case ③ $k_2 \rightarrow \infty$ $s = e = 3$ $T = d_1 = 40$

$\phi = 2\ln\left(1 + \frac{10}{2(37)}\right) = 0.254$

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO. ______

CLIENT NYSOEC | SUBJECT Flow under Double Sheet Pile (Continued) | Prepared By DDF Date 2-26-97

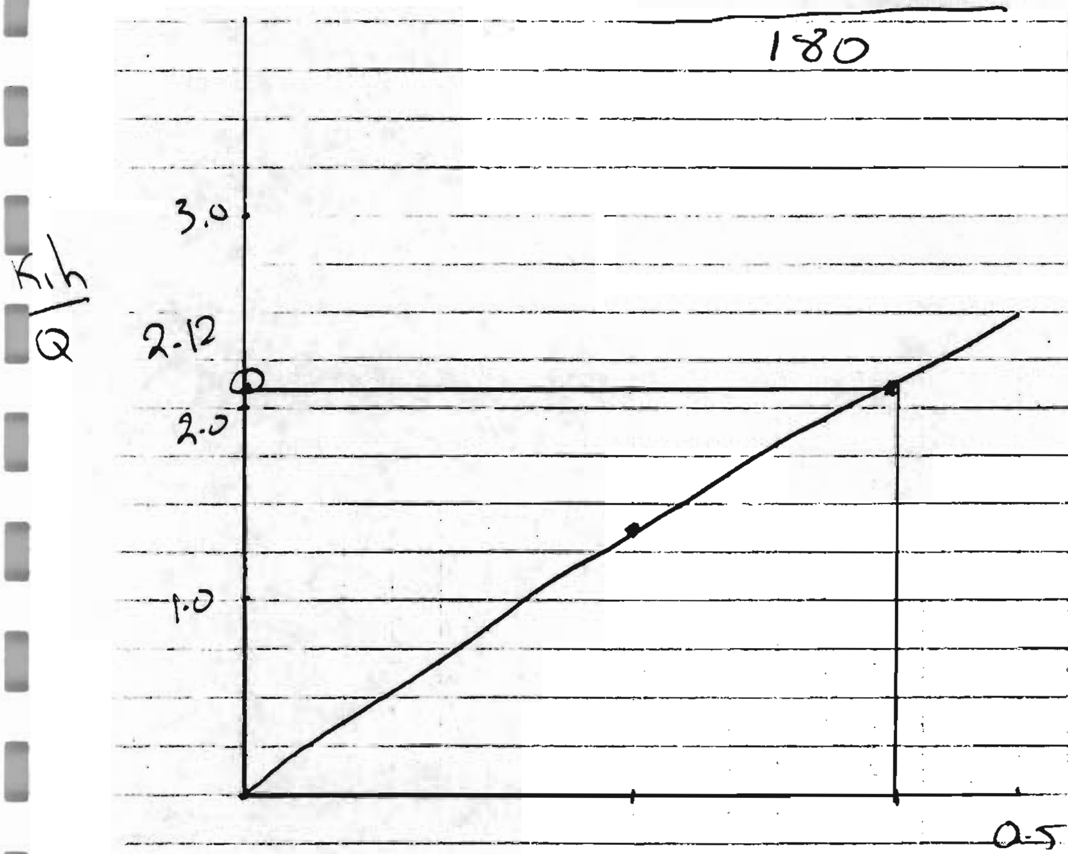
PROJECT Cumberland Bay | Reviewed By ______ Date ______

Approved By ______ Date ______

HARR Method – Double Sheet Pile Continued

Area	Type	ε=0	ε=0.25	ε=0.5
①	II×2	0	1.12	2.2
②	V	0	0.257	0.254
	Σ	0	1.37	2.54

$$\varepsilon = \frac{\tan^{-1}\left(\frac{2.86}{0.286}\right)^{1/2}}{180} = 0.4$$



$$\frac{K_i h}{Q} = 2.12$$

$$\frac{(0.286)(7)}{2.12}$$

$$= \frac{(0.944)(7.48)(310}{1400}$$

$Q = 15.2$ gpm

RUST Rust Environment & Infrastructure

CALCULATION SHEET

PROJECT NO.

CLIENT NYSDEC

SUBJECT Check Double Sheet Pile Calcs

PROJECT Cumberland Bay

Prepared By DDF Date

Reviewed By Date

Approved By Date

Objective: Check Flow Net Seepage Calcs (Sheet 8) vs HARR Method calcs (Sheet 15 + 16) for Double Sheet pile wall cases.

Flow Net

$$\frac{Q}{Kh} = \frac{N_f}{N_d} = 0.483$$

$Q = (0.483)(0.286)(7)$

$* 7.48 \frac{gal}{cf} * 3100 ft$

$* \frac{1 day}{1440 min}$

$Q = 15.6 gpm$

HARR Method - Case 2

$K_1 = K_2$

$$\frac{Q}{K_1 h} = 0.55$$

$Q = (0.55)(7)(0.286)$

$* 7.48 \frac{gal}{cf} * 3100 ft$

$* \frac{1 day}{1440 min}$

$Q = 18.1 gpm$

$15.6 \simeq 18.1$ ✓

Methods compare very well ∴ Flows are OK

Cumberland Bay

Plattsburg Precipitation Totals – 10 yr

Year	Jan	Feb	Mar	April	MAY	June	July	Aug	Sept	Oct	Nov	DEC
1991	1.53	0.85	2.51	3.75	1.64	1.00	2.30	3.58	3.92	2.24	–	2.1[illegible]
1990	2.03	2.67	1.53	3.53	3.57	3.60	3.69	5.55	2.15	4.60	2.13	3.2[illegible]
1989	0.31	0.55	2.24	1.20	3.40	2.89	2.06	3.79	4.88	2.90	2.46	0.7[illegible]
1992	1.67	1.50	1.32	2.57	2.36	1.62	3.80	2.44	2.20	3.54	4.17	0.9[illegible]
1993	2.17	1.86	3.00	3.47	2.65	3.25	4.09	2.25	2.94	3.41	1.75	1.16
1994	1.86	1.16	1.98	2.51	4.03	4.21	2.00	3.97	2.01	0.81	–	1.7[illegible]
1988	0.74	1.75	0.97	3.23	2.39	3.10	2.77	3.50	0.95	1.57	4.13	0.6[illegible]
1987	4.13	0.46	2.82	2.05	1.67	2.65	1.90	3.47	3.68	2.42	2.94	[illegible]
1986	2.89	–	2.54	0.55	2.79	3.28	2.89	4.53	2.91	1.40	2.44	1.40
1984	0.62	–	1.85	3.07	5.94	–	3.91	2.16	–	1.64	2.90	3.2[illegible]
Avg	1.50	1.08	1.73	2.16	2.54	2.33	2.45	2.94	2.33	2.09	2.29	1.35

Total of 12 Month Average Ppt values

$= 24.88 \frac{in}{yr}$ Say 25 in/yr

$= 0.068$ in/day $\simeq 0.07$ inch/day

$= 6.00 \times 10^{-3} \frac{ft}{day} * 34 \text{ Acre} * 43,560 \text{ ft}^2/\text{acre}$

$\simeq 8894 \frac{ft^3}{day} * 7.48 \frac{gal}{cf} * \frac{1 \text{ day}}{1440 \text{ min}}$

≤ 46.2 gpm

APPENDIX A

ATTACHMENT A-1.5

Comparison of Sludge Bed Removal Methods

Comparison of Sludge Bed Removal Methods

Alternative 3 Series - Off-Site Disposal

Conceptual designs were developed for three main sludge removal scenarios for the purposes of comparing costs. The cost comparison was performed to determine if significant cost savings could be gained using a specific technology. The three scenarios evaluated are:

1. Primarily Hydraulic Dredging (Dry excavation restricted to shoreline only)
2. Combination (Approximately half of bed removed through dry excavation and the remaining through dredging).
3. Complete Dry Excavation

The conceptual designs for each Scenario are described in the following pages. A summary of the costs for each scenario are provided on the attached Tables, Comparison of Sludge Bed Removal Methods.

Scenario 1: Primarily Hydraulic Dredging (Dry excavation restricted to shoreline only)

Removal of Sludge Bed and Shoreline Sediments

Prior to dredging, 2,800 feet of temporary sheet pile would be installed along the perimeter of the dredge area to provided a lower energy hydraulic environment in which to perform dredging. The alignment of the sheet pile wall is shown on Figure 4.1 of the text. This would allow the dredge to be more stable in the water enhancing precision dredging techniques. If resuspension results for dredging, the sheet pile wall would also limit transport of suspended sludge material. The design of the dredging program would provide a performance specification to minimize turbidity and suspended solids concentrations in the immediate area of the dredge.

The volume of sludge to be removed is approximately 93,000 cy. A dredge rate of 500 cy/day was used which assumes removal of 93,000 cy in 6 months (see Construction Timeline on Figure 4.8). Under this scenario it is anticipated that two, 1,000 gpm capacity Mudcat-type dredges, capable of entering shallow areas (approximately 2 foot minimum draft) and equipped with a horizontal auger, cutter head or suction head would be used for sludge bed sediment removal. This estimate would include dredging during two dredging (summer) seasons.

The shoreline sediments (estimated to be 7,900 cy) would be removed through dewatering using a separation barrier and removal using land-based or barge-mounted mechanical excavators.

Performance monitoring for dredging and shoreline excavation would include collection of samples from the upper 6 inches of the sediments after completion of sludge bed removal to confirm that the remedial action objectives have been achieved. Samples would be collected at similar locations as used during the SC.

Sludge Dewatering

The hydraulic dredging process would reduce the solids content of the sludge from approximately 30% (based on testing results of untreated sludge) to approximately 5% due to the significant addition of water resulting from slurrying. Laboratory bench-scale testing indicated that filter pressing would be the most efficient dewatering method, reducing the slurry from 95% to 55% moisture content. This process would include addition of solidification agent on a 5% basis and is estimated to reduce the volume of the dredged sludge from 93,000 cy (in place) to 60,000 cy. Polymers or filter pre-coats may be used to increase the efficiency of the filter pressing process.

Water Treatment System

Laboratory testing of water produced through the process of filter pressing the untreated sludge samples indicates that treatment for PCBs and carbon oxygen demand (COD) would be required. The treatment system would be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

Off-Site Disposal

The volume of sludge to be transported for off-site disposal is estimated to be 60,000 cy (80,000 tons) assuming all of the sludge is dewatered using the filter press. This scenario assumes that 90 percent of the sludge would be non-hazardous and suitable for disposal at a Part 360 permitted solid waste landfill and 10 percent would require disposal at a TSCA hazardous waste landfill.

Scenario 2: Combination (Dry Excavate 51,000 cy/Hydraulically Dredge 42,000 cy)

Removal of Sludge Bed and Shoreline Sediments

During the first season of remedial activities the water treatment and sludge filter press dewatering system (described later) would be constructed. Concurrently, the southern portion of a dewatering containment wall would be constructed along the perimeter of the deeper portions of the sludge bed. The alignment of the dewatering containment wall is shown on Figure A-1b. The southern portion of the containment wall will be a single or double sheet pile wall embedded in the dense till underlying the 15 to 20 feet of natural sands and silts. For cost estimating purposes a double sheet pile wall cofferdam is assumed to be necessary although a pre-design study should be performed to evaluate the efficacy and cost effectiveness of a single sheet pile wall. The northern portion of the dewatering containment wall will be constructed of portable dam sections during the second construction season. This dewatering containment wall will cutoff a surface water intake pipe (operated by Georgia Pacific) located at the convergence between Wilcox Dock and the breakwater. This intake would need to be relocated to a point outside the contained area until completion of the remediation project.

The second construction season would begin with installation of the portable dam (Portadams are assumed to be used). Upon completion of the Portadam installation, the contained area would be dewatered approximately 1 foot to allow removal of the shoreline sediments and construction of a groundwater interceptor trench as shown on Figure A-1b. The contained area would be drawn down approximately 1 foot drawdown by high volume pumps (totaling approximately 4,000 gpm) suspended in the water (possibly near Wilcox Dock) so as not to draw up sludge. The water would be discharged directly into the Bay without treatment since no disruption of the sludge bed would have occurred which could potentially impact surface water quality. Attachment A-1.4 of this Appendix details the assumptions used for estimating maintenance dewatering rates. A conservative factor of safety of 5 (i.e., pumping rates are multiplied by 5) has been applied to the seepage components of the maintenance dewatering estimates based on professional experience and an understanding of the uncertainties related to estimating seepage.

The location and design of the groundwater interceptor trench would be selected to intercept groundwater discharging to the Bay and to transport the water to a location outside the contained area. The interceptor trench would be designed to have adequate capacity to handle stormwater runoff from storm drain outlets located along the intercepted portion of the shoreline. It is assumed that treatment of groundwater would not be necessary, although no evaluation of potential upgradient contamination sources has been performed. Sludge identified along the shoreline would be removed prior to installation of the interceptor trench to eliminate potential contact with PCBs. The shoreline sludge (estimated to be 7,900 cy) would be removed using land-based or barge-mounted mechanical excavators, dewatered if necessary via filter pressing, and transported to an off-site landfill. For cost estimating purposes, no dewatering of the shoreline sediments has been assumed. Installation of the interceptor trench would require excavation of an estimated 15,000 cy of sediment. This sediment is assumed to be clean and could be stockpiled for use at the site (i.e., for berm construction or site restoration). Completion of the interceptor trench would end the first season of remedial activities. Installation of the interceptor trench may be postponed until the second construction season if over-wintering of the system would present significant problems with operation.

Upon completion of the interceptor trench, the contained area would be further dewatered to expose the majority of the relatively shallow sludge bed area. For the purpose of this FS it is assumed that water would be drawn down and maintained at an elevation of approximately 88 feet above mean sea level (approximately 7 feet below the average lake elevation of 95 feet amsl). Achieving a 7 foot drawdown in the contained area would initially require removal of approximately 10 million gallons (removed at an estimated rate of 2,000 gpm over a 3 to 4 day period) and maintenance pumping at a rate 6 million gpd (including safety factor of 5 for the seepage component). This water would be drawn from suspended pumps (possibly located near Wilcox dock) and discharged directly into the Bay without treatment since no disruption of the sludge bed would have occurred which would have a potential impact to surface water quality.

Concurrent with dewatering in the contained area, pumping from the groundwater interceptor trench would be initiated. The trench is anticipated to yield 1.1 million gpd (including a factor of safety of 5 for seepage and 75 gpm stormwater inflow) which would be discharged, untreated, to a location outside the contained area.

Once drawdown is stabilized, construction of access roads in the dewatered area would begin and a collection trench would be constructed adjacent to the Portadam. The collection trench would be designed to collect water seeping through or under the Portadam, and to transport it to sumps where it can be pumped directly into the Bay. This water would not need treatment since it would not come in contact with the sludge bed. A berm or other drainage control structure would be constructed to prevent surface runoff from the contained area from draining into the cofferdam collection trench. The collection trench is anticipated to collect an estimated seepage value of 5.8 million gpd. This would reduce maintenance dewatering of the contained area (from the suspended pump) to approximately 250,000 gpd.

It is estimated that 51,000 cy of sludge would be exposed for conventional excavation. It is assumed that 50% of this sludge (25,500 cy) would not require dewatering in a filter press, i.e., the sludge would be dry enough to load for transport to an off-site landfill. The remaining 50% would be excavated and transported to the on-site filter press dewatering system using common excavation equipment and trucks.

Concurrent with dry excavation hydraulic dredging would be initiated in the wet portion of the contained area, which is estimated to contain 42,000 cy of sludge. For the purpose of this FS it is anticipated that two, 1,000 gpm capacity Mudcat-type dredges, capable of entering shallow areas (approximately 2 foot minimum draft) and equipped with a horizontal auger or cutter head, would be used for sludge bed sediment removal. A conservative dredge rate was estimated based on completing the project in the most efficient time frame. This dredge rate is estimated to be 340 cy/day which is based on removal of 42,000 cy in 5 months (see Construction Time Line on Figure 4.5).

Once hydraulic dredging has commenced, water pumped from the wet portion of the contained area would be treated prior to discharge to the Bay. Dredge slurry would be dewatered using the filter press dewatering system. Water from the filter press would be treated and recirculated into the dredge process or discharged to the Bay. Filter cake would be stabilized as necessary, tested and transported to an off-site landfill.

Performance monitoring for dredging and excavation would include collection of samples from the upper 6 inches of the sediments after completion of sludge bed removal to confirm that the remedial action objectives have been achieved. Samples would be collected at similar locations as used during the SC.

Sludge Dewatering

The hydraulic dredging process would reduce the solids content of the sludge from approximately 30% (based on testing results of untreated sludge) to approximately 5% due to the significant addition of water resulting from slurrying. An evaluation of sludge dewatering methods including gravity drainage and filter pressing was conducted and indicated that due to the relatively high disposal costs, the method that most efficiently dewaters the dredge slurry should be used for the off-site disposal alternatives. Laboratory bench-scale testing indicated that filter pressing would be the most efficient dewatering method, reducing the slurry from 95% to 55% moisture content. This process would include addition of solidification agent on a 5% basis and is estimated to reduce the volume of the dredged sludge from 42,000 to approximately 26,500 cy. The filter press could also dewater the anticipated 25,500 cy of dry excavated sludge, reducing the in place moisture content of 70% to the predicted 55%. This would reduce the 25,500 cy to 16,000 cy. Polymers or filter pre-coats may be used to increase the efficiency of the filter pressing process.

Water Treatment System

Laboratory testing of water produced through the process of filter pressing the untreated sludge samples indicates that treatment for PCBs and carbon oxygen demand (COD) would be required. The treatment system would be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

Off-Site Disposal

The volume for off-site disposal would vary based on the amount of sludge that is dewatered using the on-site filter press system. Hydraulically dredged sludge would require dewatering for stabilization purposes prior to off-site disposal. It would be more economical to dispose of the dry excavated material without filter pressing if it is characterized as non-hazardous and if it passes a paint filter test without adding a significant quantity of stabilization agent. Filter pressing of the dry excavated material would only be warranted if it must be disposed as a TSCA hazardous waste or it has a high moisture content.

The volume of sludge to be transported for off-site disposal is estimated to be 68,000 cy (88,000 tons) based on combining the volume of the dewatered hydraulically dredged sludge (26,500 cy), the dewatered dry excavated sludge (16,000 cy) and the non-dewatered dry excavated sludge (25,500 cy). Costs were compared for disposing the material at a variety of facilities. This scenario assumes that 90 percent of the sludge would be non-hazardous and suitable for disposal at a Part 360 permitted solid waste landfill and 10 percent would require disposal at a TSCA hazardous waste landfill.

Scenario 3: Dry Excavation Only

Removal of Sludge Bed and Shoreline Sediments

During the first season of remedial activities the water treatment and sludge filter press dewatering system (described later) would be constructed. Concurrently, the southern portion of a dewatering containment wall would be constructed along the perimeter of the deeper portions of the sludge bed. The alignment of the dewatering containment wall is shown on Figure A-1b. The southern portion of the containment wall will be a single or double sheet pile wall embedded in the dense till underlying the 15 to 20 feet of natural sands and silts. For cost estimating purposes a double sheet pile wall cofferdam is assumed to be necessary although a pre-design study should be performed to evaluate the efficacy and cost effectiveness of a single sheet pile wall. The northern portion of the dewatering containment wall will be constructed of portable dam sections during the second construction season. This dewatering containment wall will cutoff a surface water intake pipe (operated by Georgia Pacific) located at the convergence between Wilcox Dock and the breakwater. This intake would need to be relocated to a point outside the contained area until completion of the remediation project.

The second construction season would begin with installation of the portable dam (Portadams are assumed to be used). Upon completion of the Portadam installation, the contained area would be dewatered approximately 1 foot to allow removal of the shoreline sediments and construction of a groundwater interceptor trench as shown on Figure A-1b (included at the end of this Attachment). The contained area would be drawn down approximately 1 foot by high volume pumps (totaling approximately 4,000 gpm) suspended in the water (possibly near Wilcox Dock) so as not to draw up sludge. The water would be discharged directly into the Bay without treatment since no disruption of the sludge bed would have occurred which could potentially impact surface water quality. Attachment A-1.4 of this Appendix details the assumptions used for estimating maintenance dewatering rates. A conservative factor of safety of 5 (i.e., pumping rates are multiplied by 5) has been applied to the seepage components of the maintenance dewatering estimates based on professional experience and an understanding of the uncertainties related to estimating seepage.

The location and design of the groundwater interceptor trench would be selected to intercept groundwater discharging to the Bay and to transport the water to a location outside the contained area. The interceptor trench would be designed to have adequate capacity to handle stormwater runoff from storm drain outlets located along the intercepted portion of the shoreline. It is assumed that treatment of groundwater would not be necessary, although no evaluation of potential upgradient contamination sources has been performed. Sludge identified along the shoreline would be removed prior to installation of the interceptor trench to eliminate potential contact with PCBs. The shoreline sludge (estimated to be 7,900 cy) would be removed using land-based or barge-mounted mechanical excavators, dewatered if necessary via filter pressing, and transported to an off-site landfill. For cost estimating purposes, no dewatering of the shoreline sediments has been assumed. Installation of the interceptor trench would require excavation of an estimated 15,000 cy of sediment. This sediment is assumed to be clean and could be stockpiled for use at the site (i.e., for berm construction or site restoration). Completion of the interceptor trench would end the first season of remedial activities. Installation of the interceptor trench may be postponed until the second construction season if over-wintering of the system would present significant problems with operation.

Upon completion of the interceptor trench, the contained area would be further dewatered to expose the sludge bed area. For the purpose of this FS it is assumed that water would be drawn down and maintained at an elevation of approximately 88 feet above mean sea level (approximately 7 feet below the average lake elevation of 95 feet amsl). Water would also be pumped out of deeper ponded areas within the contained area (i.e., south side of Wilcox Dock). Maintenance pumping is anticipated to be at a rate 6 million gpd (including safety factor of 5 for the seepage component). Initially water would be drawn from suspended pumps (possibly located near Wilcox dock) and discharged directly into the Bay without treatment since no disruption of the sludge bed would have occurred which would have a potential impact to surface water quality. Once most of the water is pumped from the contained area, maintenance water would be treated until "clean" sumps have been constructed along the perimeter of the containment wall.

Concurrent with dewatering in the contained area, pumping from the groundwater interceptor trench would be initiated. The trench is anticipated to yield 1.1 million gpd (including a factor of safety of 5 for seepage and 75 gpm stormwater inflow) which would be discharged, untreated, to a location outside the contained area.

Once drawdown is stabilized, construction of access roads in the dewatered area would begin and a collection trench would be constructed adjacent to the Portadam and sheet pile cofferdam. The collection trench would be designed to collect water seeping through or under the containment wall, and to transport it to sumps where it can be pumped directly into the Bay. This water would not need treatment since it would not come in contact with the sludge bed. A berm or other drainage control structure would be constructed to prevent surface runoff from the contained area from draining into the cofferdam collection trench. The collection trench is anticipated to collect an estimated seepage value of 6 million gpd. This would reduce maintenance dewatering of the contained area (from the suspended pump) to approximately 250,000 gpd.

It is estimated that 93,000 cy of sludge would be exposed for conventional excavation. It is assumed that 50% of this sludge (46,500 cy) would not require dewatering in a filter press, i.e., the sludge would be dry enough to load for transport to an off-site landfill. The remaining 50% would be excavated and transported to the on-site filter press dewatering system using common excavation equipment and trucks. Water from the filter press would be treated and recirculated into the filter-press process or discharged to the Bay. Filter cake would be stabilized as necessary, tested and transported to an off-site landfill.

Performance monitoring for excavation would include collection of samples from the upper 6 inches of the sediments after completion of sludge bed removal to confirm that the remedial action objectives have been achieved. Samples would be collected at similar locations as used during the SC.

Sludge Dewatering

This process would include addition of solidification agent on a 5% basis and is estimated to reduce the volume of the dredged sludge from 42,000 to approximately 26,500 cy. The filter press would dewater the anticipated 46,500 cy of dry excavated sludge, reducing the in place moisture content of 70% to the predicted 55%. This would reduce the 46,500 cy to 29,000 cy. Polymers or filter pre-coats may be used to increase the efficiency of the filter pressing process.

Water Treatment System

Laboratory testing of water produced through the process of filter pressing the untreated sludge samples indicates that treatment for PCBs and carbon oxygen demand (COD) would be required. The treatment system would be comprised of the following series of components:

- aeration;
- polymer/alum application;
- flocculation and clarification;
- sand filtration; and
- granular activated carbon filtration.

Water would be tested prior to and after treatment to evaluate performance of the system and to ensure that New York SPDES criteria are met. Final discharge of the treated water would be directly to the bay or to the local POTW. If water is discharged to the bay, construction of an outfall structure and placement of the outfall outside the dredge area may be necessary to reduce erosion and potential resuspension of sediment. For purposes of the cost estimate, it is assumed that water will be discharged to the bay.

Off-Site Disposal

The volume of sludge to be transported for off-site disposal is estimated to be 76,000 cy (100,000 tons) based on combining the volume of the dewatered dry excavated sludge (29,000 cy) and the non-dewatered dry excavated sludge (46,500 cy). Costs were compared for disposing the material at a variety of facilities.

This scenario assumes that 90 percent of the sludge would be non-hazardous and suitable for disposal at a Part 360 permitted solid waste landfill and 10 percent would require disposal at a TSCA hazardous waste landfill.

TABLE A-1
Comparison of Sludge Removal Costs for Off-Site Disposal Alternative
Cumberland Bay Sludge Bed Site

	Alternative 3d	Alternative 3d	Alternative 3d
	Removal by Hydraulic Dredging	Removal by Combination of Dry Exc./Hyd. Dredg.	Removal by Dry Excavation
Hydraulic dredging	$1,116,000	$504,000	-
Shoreline sediment removal	$474,000	$181,700	$181,700
Suspended sediment control	$672,000	-	-
Dewatering containment wall	-	$3,189,986	$3,189,986
Maintenance dewatering	-	$262,000	$262,000
Dry sludge excavation	-	$579,000	$873,000
Monitoring	$222,000	$222,000	$222,000
CDF construction	-	-	-
Sludge dewatering	$3,255,000	$2,441,250	$1,627,500
Water treatment system	$1,198,855	$1,198,855	$760,465
Wetlands restoration	$160,000	$160,000	$160,000
Total Direct Costs:	$7,097,855	$8,738,791	$7,276,651
Off-site disposal			
Treatment by Incineration (100%)	$88,000,000	$96,800,000	$110,000,000
Haz. Waste Landfill (100%)	$16,350,000	$17,950,000	$20,350,000
Com. Solid Waste Landfill (100%)	$5,150,000	$5,630,000	$6,350,000
Munic. Solid Waste Landfill (100%)	$2,750,000	$2,990,000	$3,350,000
90% Commercial - 10% Hazardous	**$6,270,000**	**$6,890,000**	**$7,750,000**
90% Municipal - 10% Hazardous	$4,110,000	$4,520,000	$5,050,000
Total Present Worth Costs:			
Includes:			
Engineering (25%)	Based on Total Direct Costs only (Disposal Costs not included)		
Contingency (20%)	Based on combined Total Direct Costs and Disposal Costs		
Bottom Restoration	$550,000	$550,000	$550,000
Off-Site Disposal as specified			
Treatment by Incineration (100%)	$116,441,890	$129,381,247	$143,101,144
Haz. Waste Landfill (100%)	$30,461,890	$34,761,247	$35,521,144
Com. Solid Waste Landfill (100%)	$17,021,890	$19,977,247	$18,721,144
Munic. Solid Waste Landfill (100%)	$14,141,890	$16,809,247	$15,121,144
90% Commercial - 10% Hazardous	**$18,365,890**	**$21,489,247**	**$20,401,144**
90% Municipal - 10% Hazardous	$15,773,890	$18,645,247	$17,161,144

Note:
1. Costs associated with any necessary predesign studies are not included.

TABLE A-2

Sludge Removal and Processing, Site Restoration

Item	Quant.	Unit Cost	Unit	Cost
Sheet Pile Cofferdam (total cost)				$3,189,986
Double sheet piling including x-members and backfill	116,363	$22	sf	$2,559,986
Portadam (installed/demobed two seasons)	7,000	$90	lf/mo	$630,000
Maintenance Dewatering (total cost)				$262,000
2000 gpm pump	1	$10,000	ls	$10,000
1000 gpm pumps (along Portadam containment wall)	4	$5,000	ea	$20,000
200 gpm pumps (in groundwater interceptor trench)	3	$2,000	ea	$6,000
collection sumps (piping and construction)	7	$10,000	ea	$70,000
Dewatering labor (continuious pumping)	90	$1,500	day	$135,000
Piping & appurtenances	3,000	$7	lf	$21,000
Shoreline Sediment Removal (w/o Portadam)	7,900	$23	cy	$181,700
Sediment Excavation - Dry (combined alternative)				$579,000
Access Roads (bank run w/ geotextile)	4,650	$30	cy	$139,500
Excavate Groundwater Interceptor Trench	15,000	$5.5	cy	$82,500
Dry Sludge Removal (eq't & labor to scrape & load)	51,000	$5.5	cy	$280,500
Raking Sediment (for moisture reduction)	25,500	$3	cy	$76,500
Sediment Excavation - Dry (dry excavation only)				$873,000
Access Roads (bank run w/ geotextile)	4,650	$30	cy	$139,500
Excavate Groundwater Interceptor Trench	15,000	$5.5	cy	$82,500
Dry Sludge Removal (eq't & labor to scrape & load)	93,000	$5.5	cy	$511,500
Raking Sediment (for moisture reduction)	46,500	$3	cy	$139,500
Hydraulic dredging (combined alternative)	42,000	$12	cy	$504,000
Total monitoring costs				$222,000
Performance and discharge monitoring	1	$20,000	ls	$20,000
Environmental monitoring				
Air monitoring	7	$20,000	mos	$140,000
Water montoring	7	$6,000	mos	$42,000
Post sludge removal confirmatory sampling	100	$200	test	$20,000
Sludge Dewatering (100%)	93,000	$35	cy	$3,255,000
Sludge Dewatering (75%)	69,750	$35	cy	$2,441,250
Sludge Dewatering (50%)	46,500	$35	cy	$1,627,500
Bottom restoration (1 foot of sand)	60,000	$20	cy	$1,200,000
Wetlands restoration	4	$40,000	acre	$160,000
Total Direct Costs				$8,465,986

TABLE A-3
Cost Estimate
Water Treatment System Costs - Hydraulic Dredging Options (Scenarios 1 & 2)

Item	Quant.	Unit Cost	Unit	Cost
Direct Capital Costs:				
Pumps and Piping to treatment system:				
CDF dewatering pumps (2/cell), 1000 gpm	6	$2,500	each	$15,000
Piping to water treatment	2,000	$40	lf	$80,000
Aerated Surge tank:				
Modutank (86,000 gal)	1	$17,890	mo	$17,890
Aeration blower & piping	1	$5,000	each	$5,000
Flocculation/Clarification (250,000 gal):				
Coagulant addition (assume alum)	1	$30,000	ls	$30,000
Modutank - 250Kgal, baffled, serpentine layout	1	$93,965	ls	$93,965
Flocculant mixers	4	$5,000	each	$20,000
Pump to filters	2	$3,500	each	$7,000
Filtration and Adsorption:				
Pressure sand filters (8' dia x 6' SWD)	2	$60,000	each	$120,000
GAC adsorbers - 10' dia., 2-stage, pre-piped	2	$156,000	each	$312,000
Outfall:				
Piping	200	$100	lf	$20,000
Outfall structure	1	$5,000	each	$5,000
Site Preparation and Installation:				
Electrical service	1	$10,000	ls	$10,000
Site grading, levelling, stone placement	1	$25,000	ls	$25,000
Instrumentation and controls	1	$30,000	ls	$30,000
Temporary piping systems	1	$40,000	ls	$40,000
Enclosures	1	$20,000	ls	$20,000
Drain, prep for winter and re-start in spring	1	$40,000	ls	$40,000
Plant Operation and Maintenance:				
Operator (2-shift)	180	$1,000	days	$180,000
Technician (1-shift)	180	$450	days	$81,000
Sludge cleaning from clarifier	2	$10,000	each	$20,000
Electricity (assume 1 MGD @ 30'TDH)	3.4E+05	$0.08	Kw-hr	$27,000
TOTAL				$1,198,855

See Appendix A for supplemental information regarding cost estimates.

TABLE A-3 (Continued)
Cost Estimate
Water Treatment System Costs - Dry Excavation Only (Scenario 3)

Item	Quant.	Unit Cost	Unit	Cost
Direct Capital Costs:				
Pumps and Piping to treatment system:				
Piping to water treatment	500	$40	lf	$20,000
Aerated Surge tank:				
Modutank (43,000 gal)	1	$9,000	mo	$9,000
Aeration blower & piping	1	$3,000	each	$3,000
Flocculation/Clarification (250,000 gal):				
Coagulant addition (assume alum)	1	$15,000	ls	$15,000
Modutank - 250Kgal, baffled, serpentine layout	1	$93,965	ls	$93,965
Flocculant mixers	1	$5,000	each	$5,000
Pump to filters	1	$3,500	each	$3,500
Filtration and Adsorption:				
Pressure sand filters (8' dia x 6' SWD)	1	$60,000	each	$60,000
GAC adsorbers - 10' dia., 2-stage, pre-piped	1	$156,000	each	$156,000
Outfall:				
Piping	200	$100	lf	$20,000
Outfall structure	1	$5,000	each	$5,000
Site Preparation and Installation:				
Electrical service	1	$10,000	ls	$10,000
Site grading, levelling, stone placement	1	$25,000	ls	$25,000
Instrumentation and controls	1	$30,000	ls	$30,000
Temporary piping systems	1	$40,000	ls	$40,000
Enclosures	1	$20,000	ls	$20,000
Drain, prep for winter and re-start in spring	1	$40,000	ls	$40,000
Plant Operation and Maintenance:				
Operator (1-shift)	90	$1,000	days	$90,000
Technician (1-shift)	180	$450	days	$81,000
Sludge cleaning from clarifier	2	$10,000	each	$20,000
Electricity (assume 0.5 MGD @ 30'TDH)	1.7E+05	$0.08	Kw-hr	$14,000
TOTAL				$760,465

See Appendix A for supplemental information regarding cost estimates.

TABLE A-4
Cost Estimate
Off-site Disposal Costs (Hydraulic Dredging Only)

Item	Quant.	Unit Cost	Unit	Cost
Direct Capital Costs:				
Off-site disposal at RCRA incinerator (Aptus, Utah)	80,000	$800	ton	$64,000,000
Transportation to incineration facility	80,000	$300	ton	$24,000,000
TOTAL				**$88,000,000**
Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	80,000	$200	ton	$16,000,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL				**$16,350,000**
Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
Commercial (Cost from High Acres Landfill, Rochester, NY)	80,000	$60	ton	$4,800,000
Estimated cost for local landfill	80,000	$30	ton	$2,400,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL (for transport/disposal at commercial landfill)				**$5,150,000**
TOTAL (for transport/disposal at local landfill)				**$2,750,000**
90%/10% Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
Commercial (Cost from High Acres Landfill, Rochester, NY)	72,000	$60	ton	$4,320,000
Estimated cost for local landfill	72,000	$30	ton	$2,160,000
Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	8,000	$200	ton	$1,600,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL (for commercial and hazardous waste landfills)				**$6,270,000**
TOTAL (for local and hazardous waste landfills)				**$4,110,000**
Note: 1 cy = 1.3 tons, quantity based on 60,000 cy of dewatered sludge				

TABLE A-4 (Continued)
Cost Estimate
Off-site Disposal Costs (Combined Dry Exc./Hyd. Dredg)

Item	Quant.	Unit Cost	Unit	Cost
Direct Capital Costs:				
Off-site disposal at RCRA incinerator (Aptus, Utah)	88,000	$800	ton	$70,400,000
Transportation to incineration facility	88,000	$300	ton	$26,400,000
TOTAL				**$96,800,000**
Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	88,000	$200	ton	$17,600,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL				**$17,950,000**
Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
Commercial (Cost from High Acres Landfill, Rochester, NY)	88,000	$60	ton	$5,280,000
Estimated cost for local landfill	88,000	$30	ton	$2,640,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL (for transport/disposal at commercial landfill)				**$5,630,000**
TOTAL (for transport/disposal at local landfill)				**$2,990,000**
90%/10% Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
Commercial (Cost from High Acres Landfill, Rochester, NY)	79,000	$60	ton	$4,740,000
Estimated cost for local landfill	79,000	$30	ton	$2,370,000
Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	9,000	$200	ton	$1,800,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL (for commercial and hazardous waste landfills)				**$6,890,000**
TOTAL (for local and hazardous waste landfills)				**$4,520,000**
Note: 1 cy = 1.3 tons, quantity based on 68000 cy 75% of sludge is dewatered				

TABLE A-4 (Continued)
Cost Estimate
Off-site Disposal Costs (Dry Excavation Only)

Item	Quant.	Unit Cost	Unit	Cost
Direct Capital Costs:				
Off-site disposal at RCRA incinerator (Aptus, Utah)	100,000	$800	ton	$80,000,000
Transportation to incineration facility	100,000	$300	ton	$30,000,000
TOTAL				**$110,000,000**
Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	100,000	$200	ton	$20,000,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL				**$20,350,000**
Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
Commercial (Cost from High Acres Landfill, Rochester, NY)	100,000	$60	ton	$6,000,000
Estimated cost for local landfill	100,000	$30	ton	$3,000,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL (for transport/disposal at commercial landfill)				**$6,350,000**
TOTAL (for transport/disposal at local landfill)				**$3,350,000**
90%/10% Off-site transport/disposal to Part 360 solid waste landfill (fully lined with leachate collection system)				
Commercial (Cost from High Acres Landfill, Rochester, NY)	90,000	$60	ton	$5,400,000
Estimated cost for local landfill	90,000	$30	ton	$2,700,000
Off-site transport/disposal to TSCA hazardous waste landfill (cost from Model City Landfill, NY)	10,000	$200	ton	$2,000,000
Disposal acceptance testing	2,500	$140	test	$350,000
TOTAL (for commercial and hazardous waste landfills)				**$7,750,000**
TOTAL (for local and hazardous waste landfills)				**$5,050,000**
Note: 1 cy = 1.3 tons, quantity based on 76,000 cy 50% of sludge is dewatered				

APPENDIX A

ATTACHMENT A-1.6

Bottom Restoration Costs

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE ___ OF ___
PROJECT NO. ______

CLIENT NYSDEC
PROJECT Comb. Bay
SUBJECT ______

Prepared By HHm Date 4/18/97
Reviewed By ______ Date ______
Approved By ______ Date ______

Bottom Restoration Costs (Unit Rate)

1 foot Sand layer

Wet CDF Dredged Area = 1,350,000 sf x 1ft = 50,000 cy

Dry CDF/offsite Disp = 1,485,000 sf x 1ft = 55,000 cy

Estimate unit rate on 27,500 cy (½ of Dredge Area)

Placement Rate: 27,500cy @ 2850 cy/day = 10 days

Equipt: Daily rate for Equip. (see attached sheet) - $7,531
x 10 days
$75,310
+ $3,800 mob/demob
$79,110

Equipt Unit Rate: $3 /cy

Materials: Sand $14 cy
Trucking/Hauling $3 cy

Total Unit Cost $20/cy

27,500 cy x $20/cy = $550,000

Table 1

NEW YORK STATE DEC - SSP
CUMBERLAND BAY SLUDGE BED
WILCOX DOCK SITE
COST ESTIMATE FOR SLUDGE BED SOIL CAP

ITEM	QTY		UNIT	UNIT COST	ITEM TOTAL
Soil					
Sandy or clayey Loam	57,000	*	CY	$14	$798,000
Trucking/Hauling			CY	$3	$171,000
				17	
Equipment					
Marine Barge			Per day	$700	
Navigational Equipment			Per day	$1,000	
Barge Operator Crew			Per day	$620	
Crane			Per day	$1,400	
Clamshell Attachment			Per day	$127	
Crane Operator Crew			Per day	$1,200	
Cap Placement Equipment			Per day	$500	
Cap Placement Labor Crew			Per day	$1,280	
Per Diems			Per day	$704	
Mobilization/Demobilization			Lump	$3,800	$3,800
	Total Daily Rate			$7,531	
TOTAL MATERIAL COST					**$972,800**

Production Rate 57,000 cy @ 2850 cy/day = 20 days

= 20 days x $7,531/day **$150,620** + $17/cy mat'l alone ≈ 30/cy ✓

Material Costs **$972,800**

Total Cost **$1,123,420**

say **$1,200,000**

Notes

* - soil volume calculated as follows:

$$= \frac{35 \text{ acres} \times 43{,}560 \text{ sq ft/acre} \times 1 \text{ ft (thick)}}{27 \text{ cf/cy}}$$

= 56,466.7 cy ~ 57,000 cy

Appendix A

Attachment A-2.1

Wet and Dry CDF Capacity Estimates

Project:	Cumberland Bay FS	**By:**	HHM
Subject:	Wet and Dry CDF Capacities	**Date:**	2/20/96
		Ck'd:	
		Date:	

1) Capacity of Wet CDF:

Area is based on the Wet CDF Schematic and cross-section shown on Figures 4.2 and 4.3. The estimated area of the CDF is 140,000 sf (based on 3½ 200' x 200' square cells) and the estimated depth of the cells is an average of 10 feet. The resulting resulting capacity is 1,400,000 cf or approximately 50,000 cy.

2) Capacity of Dry CDF:

Estimate Area of Dry CDF:

The area is based on the Dry CDF Schematic shown on Figure 4.4. It is assumed that sludge will be contained within the space defined by the inside of the top of the perimeter dikes (berms) as shown in the cross-section on Figure 4.5. The resulting area is estimated to be 212,000 square feet as shown on Figure A-2a.

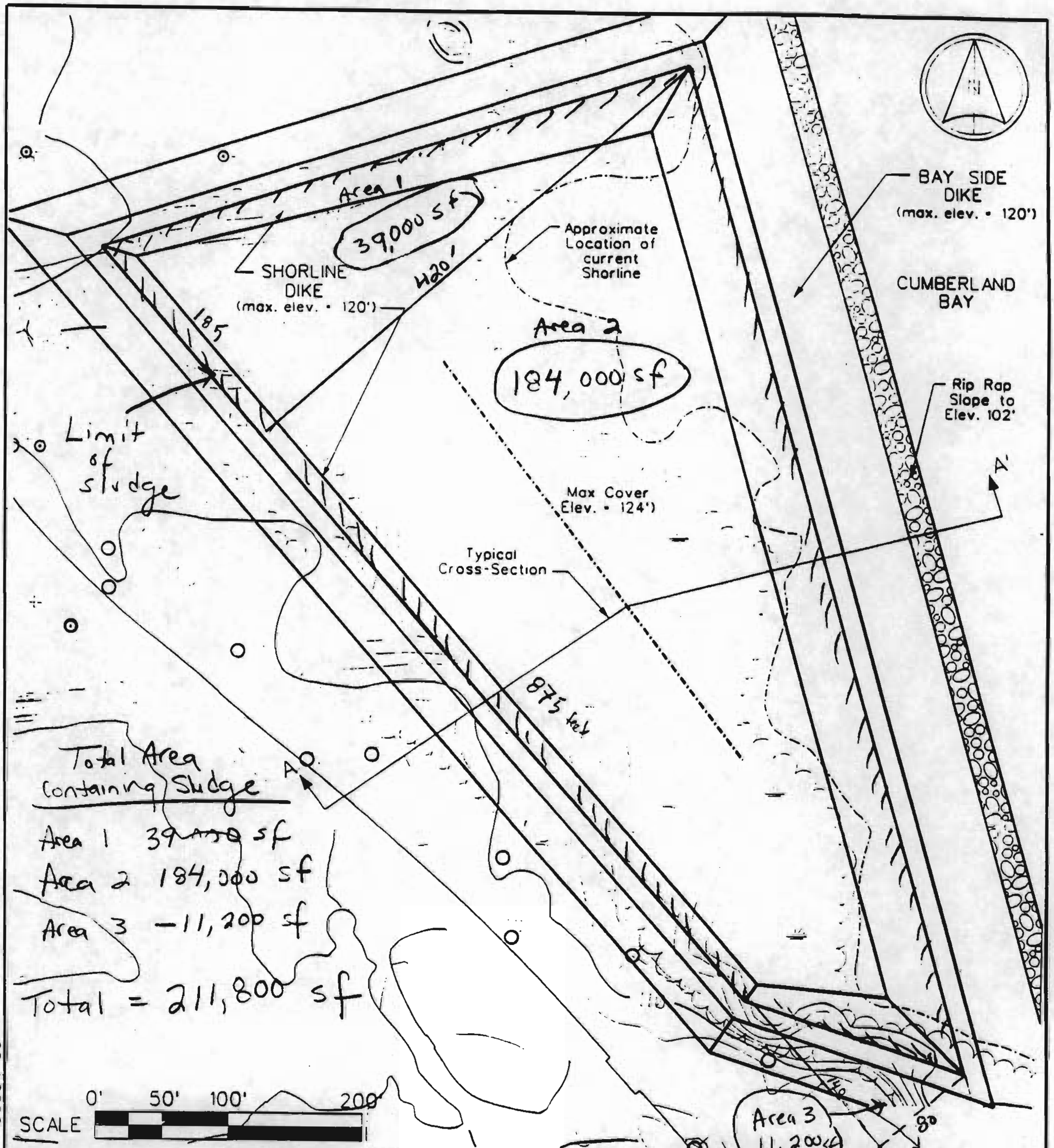
Estimate Average Height of Fill Area:

The average fill height, calculated based on the height measured at 15 evenly spaced points across Dry CDF Cross-Section A-A' shown on Figure 4.5, was used to estimate the average fill height throughout the Dry CDF (see Figure A-2b). The resulting average fill height is estimated to be 13.2 feet.

Estimate Dry CDF Capacity:

The capacity of the Dry CDF is estimated to be:

212,000 sf x 13.2 ft = 2,798,000 cf x 1 cy/27 cf = 104,000 cy



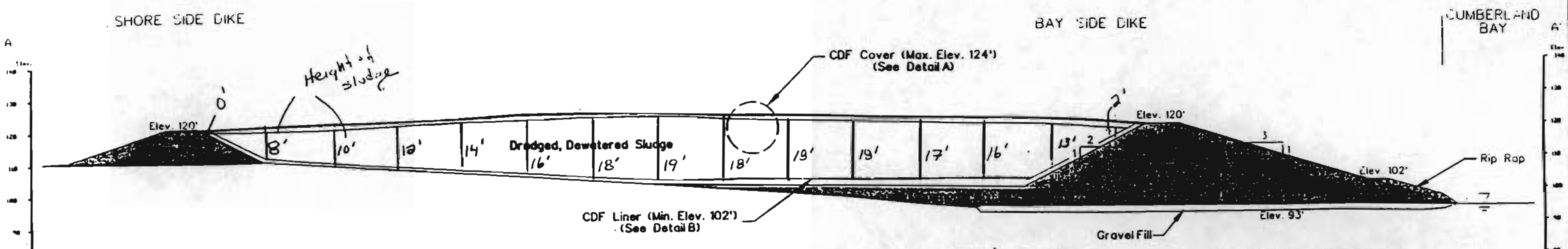
ALTERNATIVE 2b
DRY CDF SCHEMATIC
SLUDGE BED - WILCOX DOCK IRM
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

RUST ENVIRONMENT & INFRASTRUCTURE

CUMBERLAND BAY — CLINTON COUNTY, NY

PROJECT No. 39304	DATE 10/2/95	DWG. No. 39304-06	SCALE 1" = 100'	FIGURE No. 4.4

Figure A-2a

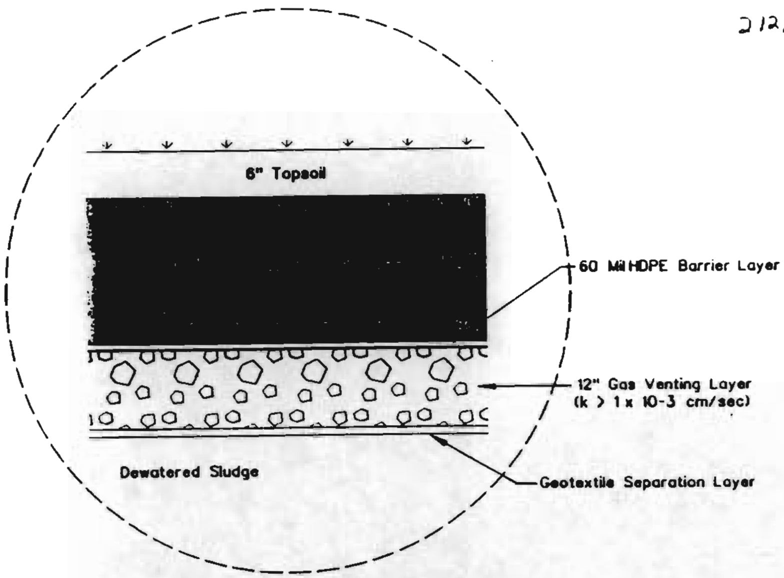


AVERAGE HEIGHT OF SLUDGE (BASED ON 15 PNTS) = 13.2 ft

CAPACITY OF DRY CDF =

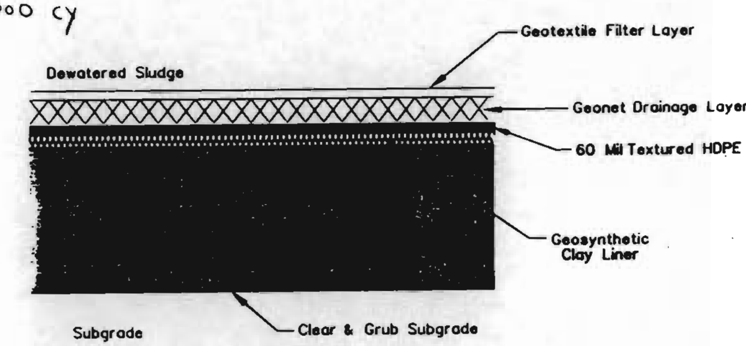
212,000 sf × 13.2 ft = 2,798,400 cf × $\frac{1\ cy}{27\ cf}$

= 104,000 cy



DETAIL A - FINAL COVER SYSTEM

NTS (Synthetic Components are exapperated for clarity)



DETAIL B - LINER SYSTEM

NTS (Synthetic Components are exapperated for clarity)

RUST ENVIRONMENT & INFRASTRUCTURE

ALTERNATIVE 2b
DRY CDF CROSS-SECTION A-A' & DETAILS

SLUDGE BED - WILCOX DOCK IRM
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY — CLINTON COUNTY NY

PROJECT NO 39304	DATE: 11/7/95	DWG. NO. 39304-08	SCALE: AS NOTED	FIGURE NO. 4.5

FIGURE A-2b

Appendix A

Attachment A-2.2

CDF Construction Cost Details

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF 1
PROJECT NO. ______

CLIENT DEC
PROJECT CB

SUBJECT CDF Const. Costs Summary - Alts 2a & 2b

Prepared By JDH Date ~~10/23/95~~ 11/23/95
Reviewed By ______ Date ______
Approved By ______ Date ______

Item	Unit Cost	Units	Quant.	Total
Alt 2b - Shore CDF (dry)				
grading fill + liner	$ ~~2.32~~ 3.02	S.F.	212,000	$ ~~491,840~~ 640,240
final cover	$ 2.15	S.F.	212,000	455,800
shore side dike	$ 136	L.F.	1,300	176,800
bay side dike	$ 1120	L.F.	900	1,008,000
		Alt 2b total		$ ~~2,132,440~~ $2,280,840
Alt 2a - Dock CDF (wet)				
containment cofferdam	$2,200,000	L.S.	1	$2,200,000
final cover	$ 3.70	S.F.	140,000	518,000
		Alt 2a total		$2,718,000

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ______

CLIENT DEC

PROJECT CB

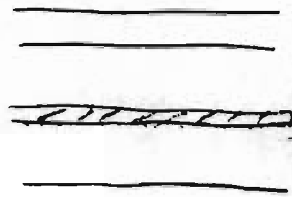
SUBJECT Shore CDF Final Cover Cost Est.

Prepared By JDH Date 10/20/95

Reviewed By ______ Date ______

Approved By ______ Date ______

Final Cover



Est. ~~Per~~ Cost / S.F.

	Item	Unit Cost	Units	Quantity	Cost per S.F. of CDF
1	Top soil	$0.45	S.F.	1	0.45
2	Barrier Protection	$0.75	S.F.	1	0.75
3	Gas venting	$0.45	S.F.	1	0.45
4	60 mil HDPE	$0.50	S.F.	1	0.50
					$2.15/ft^2$

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ______

CLIENT DEC
PROJECT CB
SUBJECT Shore CDF Final Cover
Prepared By JDH Date 10/24/9_
Reviewed By ______ Date ______
Approved By ______ Date ______

① Topsoil – 6" thick + seeding

– use "topsoil/loam" from Means, 1995

022-216-7010 → 7080	topsoil	$17/cy
022-266-450	haul, 3 mi	$4/cy
022-208-3020	spread	$0.72/cy
	in-place cost	$21.72/c.y.
	use	$22/c.y.

calc. vol. per S.F.

$$6'' \times \frac{1\ ft}{12\ in} \times \frac{1\ cy}{27\ ft^3} = 0.0185\ c.y./S.F.$$

calc. cost/S.F. × $22/cy

$0.407/S.F.

022-308-4500 seeding, tractor spread

$$= \$19.05/MSF \times \frac{1\ MSF}{1000\ SF} = \$0.019/S.F.$$

Topsoil + seeding, in-place $0.426/S.F.

use 0.45/S.F.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ______

CLIENT DEC | SUBJECT Shore CDF Final Cover | Prepared By JDH Date 10/20/95

PROJECT CB | Reviewed By ______ Date ______

Approved By ______ Date ______

(2) Barrier Protection layer - 24" thick

- use "common fill" prices from Means

022-216-4020	common fill	\$4.94/c.y.
022-266-450	haul 3 mi.	\$4 /c.y.
022-208-3020	spread	\$0.72 /c.y.
022-226-5100	compact, 12" lifts	\$0.31 /c.y.
	in-place cost	\$9.97 /c.y.
	use	\$10/c.y.

calc. vol. per S.F.

$$24'' \times \frac{1\ ft}{12''} \cdot \frac{1\ cy}{27\ ft^3} = 0.0741\ CY/S.F.$$

cost / S.F. × \$10 /cy

\$0.741 / S.F.

use \$0.75 / S.F.

(3) Gas Venting Layer - 12" thick

- use "select granular fill" prices from Means
- use same haul, spread & compaction \$ from (2)

Gas Vent, cont'd

022-216-5020 select granular fill $6.40/c.y.

↕ from (2)

haul	$4
spread	$0.72
compact	$0.31
in-place cost	$11.43/c.y.

use $11.50/c.y.

calc. vol. per S.F. $12'' \cdot \frac{1\ ft}{12''} \cdot \frac{1\ c.y.}{27\ ft^3} = 0.0371$ c.y./SF

× $11.50 /c.y.

cost/S.F. $0.426/S.F.

use $0.45/S.F.

(4) HDPE geomembrane, 60 mil thick, smooth

- use prices from Rust project files
- adj. upward by 10% for inflation, etc.

mat'l cost	$0.272/S.F.
installation	$0.170/S.F.
	$0.442/S.F.
	× 1.1
	$0.486/S.F.

use $0.50/S.F.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF ~~2~~ 3

PROJECT NO.

CLIENT DEC

PROJECT CB

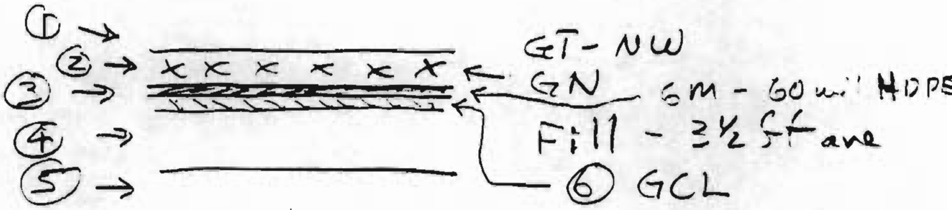
SUBJECT Shore CDF Liner System Cost Est.

Prepared By JDH Date 11/23/95 (~~11/20/95~~)

Reviewed By ______ Date ______

Approved By ______ Date ______

Liner System



	Item	Unit Cost	Units	Quantity	Total
①	Non woven Geotextile	0.16	S.F.	1	
②	Geonet Drainage	0.25	S.F.	1	
③	60 mil HDPE	0.50	S.F	1	
④	3½ ft fill	1.31	S.F.	1	
⑤	clear & grub	0.10	S.F.	1	
⑥	bentonite mat (GCL)	0.70	S.F.	1	
			in-place cost		~~$2.32/S.F.~~
					$3.02/S.F.

Area 212,000 S.F.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO.

CLIENT DEC

PROJECT CB

SUBJECT Shore CDF Liner System

Prepared By JDH Date 10/27/95

Reviewed By ____ Date ____

Approved By ____ Date ____

① Non-woven Geotextile – assume 10 oz/yd²

– cost est. from Rust project files, adj up 10% for inflation *

mat'l	$0.74/sy →	$0.082 /SF
installation – sewn seams		0.065 /SF
		0.147
	adj	× 1.1
	in place cost	0.16 / SF

② Geonet drainage layer

mat'l *		$0.185 /SF
installation		0.045 /SF
		0.23 /SF
	adj	× 1.1
	in place cost	0.25 / SF

③ Geomembrane – 60 mil HDPE, smooth

from Final Cover calc: in place cost $0.50/SF

④ Grading Fill – assume "common fill"; 3½ ft ave.

from Final Cover calc 2ft = 0.75/SF

proportion to thickness $\frac{3\frac{1}{2}\text{ ft}}{2\text{ ft}} \times 0.75/\text{SF} = \$1.31/\text{SF}$

⑤ Clear & Grub w/ dozer, trees to 4"

022-108-0600 $4,325/ac × 1 ac/43560 SF = 0.099/SF

use 0.10/SF

(6) Geosynthetic Clay Liner (GCL) below HDPE
(Bentonite Mat)
- use prices from Rust project files
- adj upward by 10% for inflation, etc.

mat'l cost	$ 0.47 /S.F.
installation	$ 0.16 /S.F.
	$ 0.63 /S.F.
adj	x 1.10
total	0.69 /S.F.
use	0.70 /S.F.

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO.

CLIENT DEC

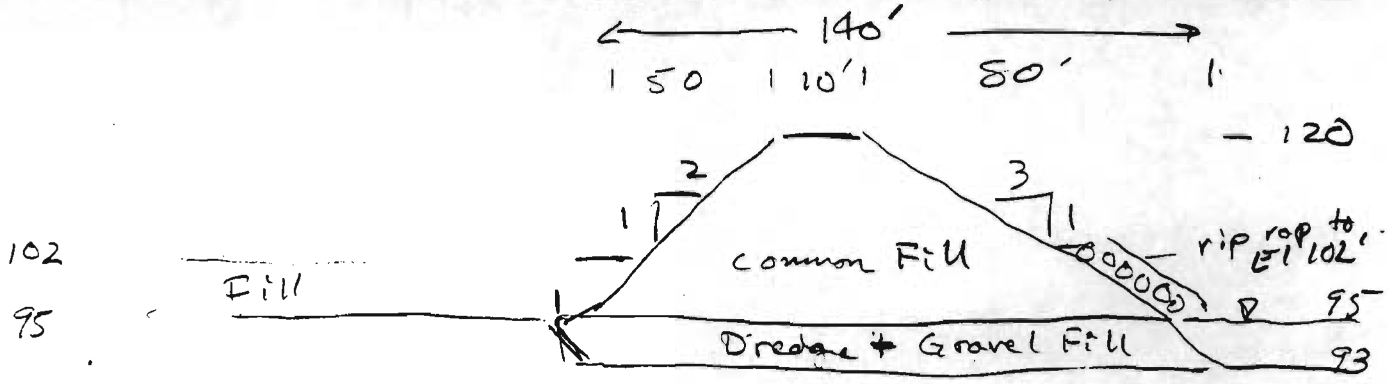
PROJECT CB

SUBJECT Shore CDF Bay Side Dike Cost Est.

Prepared By JDH Date 10/23/95

Reviewed By Date

Approved By Date



Item	Unit Cost	Units	Quantity	Total
① Dredge		—	Done "in Dredging"	
② Gravel	$312	lf		
③ Common Fill	$671	lf		
④ Rip rap	$137	lf		

use $1,120/LF

CLIENT DEC
PROJECT CB
SUBJECT Shore CDF Bay Side Dike
Prepared By JDH Date 10/23/95
Reviewed By Date
Approved By Date

② Gravel

$V = 2\text{ ft h} \times 140\text{ ft w} \times 1\text{ ft} / 27 = 10.4\text{ yd}^3/\text{ft}$

Means 1995 022-308-1523 1½" crushed stone, placed \$32/cy
024-844-6000 crushed stone by clam = \$27.50/cy

say \$30/c.y.

= \$312/ft

③ Dike Fill

$V = ½(135+10) \times 25' / 27\text{ ft}^3/\text{cy} = 67.1\text{ c.y./ft}$

use common fill cost = \$10/c.y
(from Shore CDF final cover)

= \$671./ft

④ Rip rap

022-712-0200 18" rip rap \$59.50/s.y.

slope Elev.
3:1 × (102-95) = 21 ft × 1 ft / 9 ft²/sy = 2.3 sy/ft

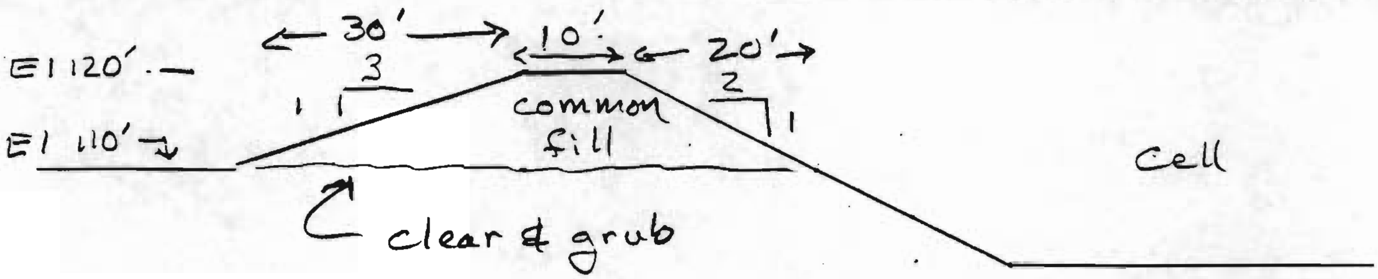
\$59.5/s.y × 2.3 s.y/ft = \$137/ft

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF 1
PROJECT NO.

CLIENT DEC
PROJECT CB
SUBJECT Shore CDF
Shore Side Dike
Prepared By JDH Date 10/23/95
Reviewed By Date
Approved By Date



① Dike fill

— use "common fill", per Final Cover Calc → \$10/CY

calc vol. = ½ (10' + 60') × 10' × 1 CY / 27 ft

= 13 CY/LF

in-place cost \$130/LF

② Clear & Grub

— from Final Cover Calc, use \$0.10/SF

— area per LF = 60' × 1' = 60 SF/LF

= \$6/LF

Total Dike Cost \$136/LF

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. ____

CLIENT DEC

SUBJECT Dock CDF

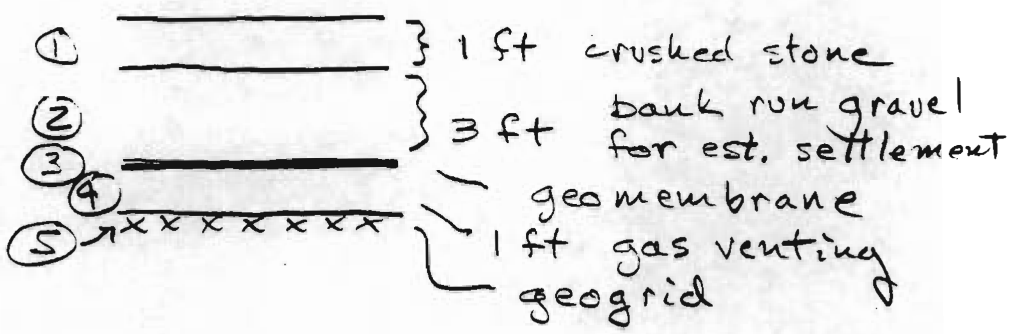
Final Cover

PROJECT CB

Prepared By JDH Date 10/23/95

Reviewed By ____ Date ____

Approved By ____ Date ____



	Item	Unit Cost	Units	Quantity	Total Cost per SF
①	Crushed Stone	$1.10	SF	1	
②	Bank Run Gravel	$1.40	SF	1	
③	60 mil HDPE	$0.50	SF	1	
④	Gas Vent	$0.45	SF	1	
⑤	Geogrid	$0.25	SF	1	

Final Cover In Place $3.70/SF

CLIENT DEC

SUBJECT Dock CDF

Final Cover

PROJECT CB

Prepared By JDH Date 10/23/95

Reviewed By ____ Date ____

Approved By ____ Date ____

① Crushed Stone 1 ft thick

022-308-0300 $9.90/SY in place → $1.10/SF

② Bank Run Gravel 3 ft thick

022-308-1532 $12.60/CY in place

$\times\ 3\,ft^3 \times \frac{1\,CY}{27\,ft^3}$ → $1.40/SF

③ 60 mil HDPE — from Final Cover Calc $0.50/SF

④ Gas Vent — from Shore CDF Final Cover Calc $0.45/SF

⑤ Geogrid assume biaxial

prices from project files, adj 10% for infl.

mat'l $0.134/SF

install $0.07/SF

$0.204/SF × 1.1 = $0.22/SF

use $0.25/SF → 0.25/SF

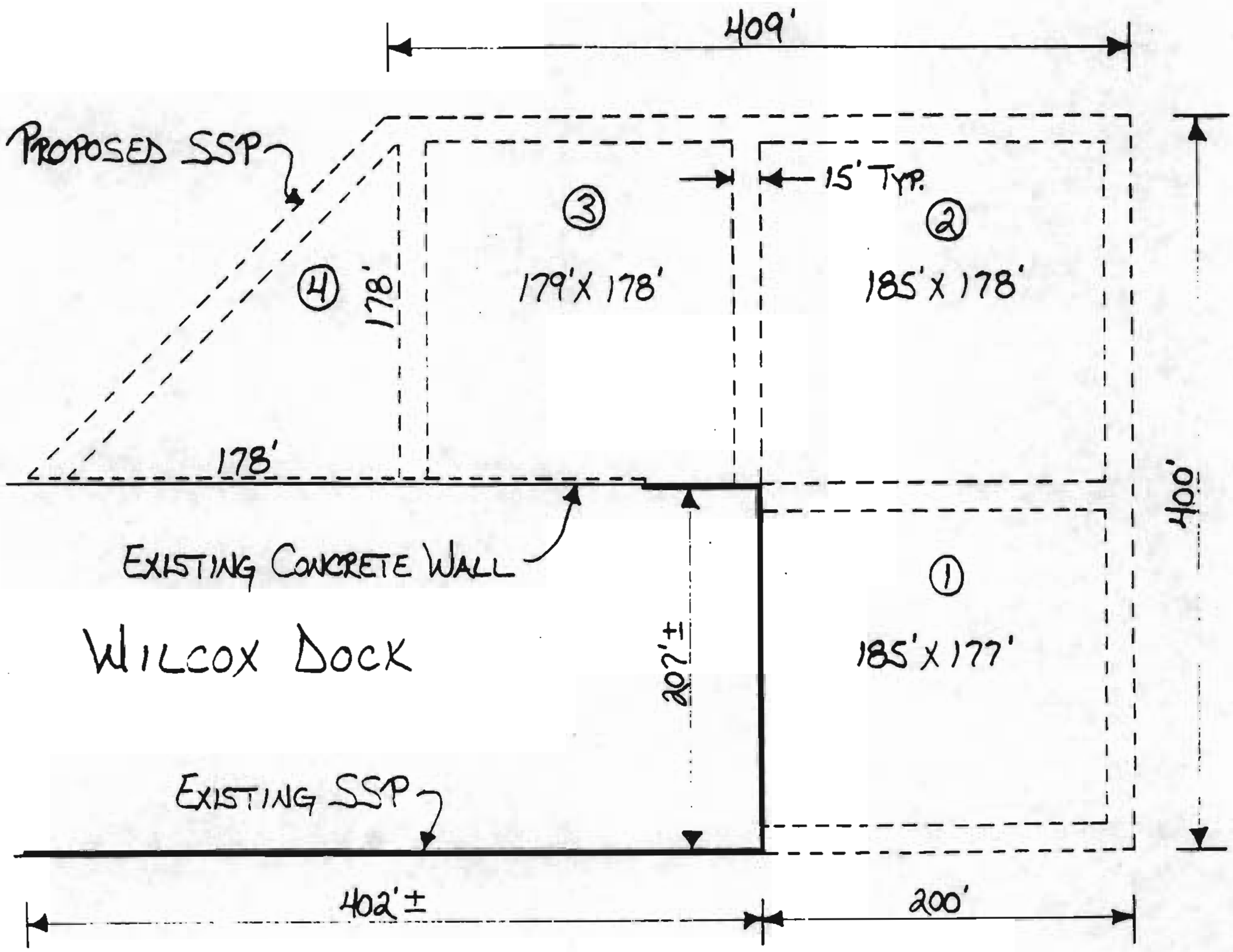
RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PAGE 1 OF ___
PROJECT NO. ___

CLIENT NYSDEC
PROJECT CUMBERLAND BAY
SUBJECT CDF

Prepared By ELH Date 10/18/95
Reviewed By ___ Date ___
Approved By ___ Date ___



LAKE CDF PLAN

CUMBERLAND BAY SLUDGE BED
LAKE CDF
CONCEPTUAL CONSTRUCTION COST ESTIMATE

OCTOBER 19, 1995

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
10 FT LENGTH OF D-WALL:				
PZ 35 (27' long)	SF	540	$20.00	$10,800.00
MC 12x50	LF	40	$34.00	$1,360.00
MC 18x42.7	LF	10	$29.00	$290.00
PL 8"x1 1/2"x10"	LB	34	$1.00	$34.00
1 1/2" Tie Rod (19' long)	LB	115	$3.00	$345.00
7/8" Bolts	EA	4	$7.00	$28.00
1 1/4" Pipe Spacers	LF	1	$9.00	$9.00
Backfill (10'x15'x15')	CY	83.33	$7.00	$583.31
PL 8"x3/4"x14" (splice)	LB	8	$1.00	$8.00
7/8" bolts (splice)	EA	6	$7.00	$42.00
TOTAL/10' LENGTH				$13,499.31
TOTAL/FT (D-WALL)				$1,349.93

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
S-WALL CELL DIVIDER:				
PZ35 (27' long)	SF	27	$20.00	$540.00
TOTAL/FT (S-WALL)				$540.00

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
Double Wall	LF	1260	$1,349.93	$1,700,911.80
Single Wall	LF	875	$540.00	$472,500.00
GRAND TOTAL				$2,173,411.80

Appendix B

Estimate of Seepage into Wet CDF - Alternative 2a

Estimate of Seepage into Wet CDF, Alternative 2a

Project: Cumberland Bay Sludge Bed IRM - Remedial Alternatives Evaluation
Date: 11/28/95
By: Helen H. Mongillo

Problem: Calculate flow into the wet CDF (Alternative 2a) resulting from maintenance of an inward gradient.

	Parameter	Symbol	Value	Unit	Converted Value	Unit
Results:	Total flow into CDF (pumping rate required to maintain inward gradient)	Q(t)	1,531	cfd	8	gal/min
	1. Flow through cap	Q(c)	196	cfd	1.018	gal/min
	2. Flow through cofferdam	Q(cd)	5.14	cfd	0.027	gal/min
	3. Flow through single sheet pile	Q(sp)	34.57	cfd	0.18	gal/min
	4. Flow under cofferdam	Q(ucd)	878	cfd	4.561	gal/min
	5. Flow under single sheet pile	Q(usp)	417	cfd	2.166	gal/min
Input Parameters:	Area of cap	A	140,000	sq ft		
	Precipitation		0.007	ft/day	30	in/year
	Percent Precip. passing cap		0.2			
	Head difference inside CDF	h	1	ft		
	Length of cofferdam	L(cd)	1,200	ft		
	Height of cofferdam above till	H(cd)	15	ft		
	Length of single sheet pile	L(sp)	550	ft		
	Height of sheet pile above till	H(sp)	22	ft		
	Width of cofferdam	w(cd)	15	ft		
	Hydraulic conduct. (cofferdam)	k(cd)	2.86E-04	ft/day	1.00E-07	cm/sec
	Width of single sheet pile	w(sp)	1	ft		
	Hydraulic conduct. (sheet pile)	k(sp)	2.86E-03	ft/day	1.00E-06	cm/sec
	Thickness of till	T	40	ft		
	Embedment depth (cd and sp)	s	4	ft		
	Thickness of sludge inside CDF	t(sludge)	12	ft		
	Hydraulic conduct. (till)	k(till)	8	ft/day	2.80E-03	cm/sec
	Hydraul. conduct. (sludge in CDF)	k(sldg)	0.10	ft/day	2.40E-05	cm/sec
	Half Width of CDF	w	100	ft		

1. Flow through cap

Q(c) = Percent Precip. * Precip. * Area of Cap =	196	cfd	1.018	gal/min

This component of seepage is not critical compared with other components (i.e., flow under cofferdam or sheet pile wall). Therefore, modeling the cap leakage using the HELP model or equivalent was not considered warrented for this evaluation.

2. Flow through cofferdam

See Figure 1 (page 4 of 7)

Q(cd) = [k(cd)*h*H(cd)]/w(sp) * L(cd) =	5.14	cfd	0.027	gal/min

3. Flow through single sheet pile

See Figure 2 (page 4 of 7)

Q(sp) = [k(sp)*h*H(sp)]/w(sp) * L(sp) =	34.57	cfd	0.18	gal/min

4. Flow under cofferdam

See Figure 3 (page 5 of 7) Q(ucd) =h/[(f1/ktill)+(f2/ktill)+(f3/ktill)+(f4/ksldg)] * L(cd)

f = form function (using Method of Fragments from Mechanics of Particulate Media, M. E. Harr)

Q(ucd) =		878	cfd	4.561	gal/min
Segment 1, Segment 3	s/T =	0.1			
(Fragment Type II)	1/(2*f1)	1.06	(see Figure 5-13, Harr, attached)		
	f1, f3 =	0.472			
Segment 2 (Fragment Type V)					
a = T - s					
f2 = 2 ln[1+(s/a)] + [(t(cd)-2s)/T]	f2 =	0.386			
Segment 4 (Fragment Type I)					
f4 = t(sludge)/w	f4 =	0.12			

5. Flow under single sheet pile wall

See Figure 4 (page 7 of 7) Q(usp) =h/[(f1/ktill)+(f2/ktill)+(f3/ksldg)] * L(sp)

Q(usp) =		417	cfd	2.166	gal/min
Segment 1, Segment 2	s/T =	0.1			
(Fragment Type II)	1/(2*f1)	1.06	(see Figure 5-13, Harr, attached)		
	f1, f2 =	0.472			
Segment 3 (Fragment Type I)					
f3 = t(sludge)/w	f3 =	0.12			

RUST ENVIRONMENT & INFRASTRUCTURE

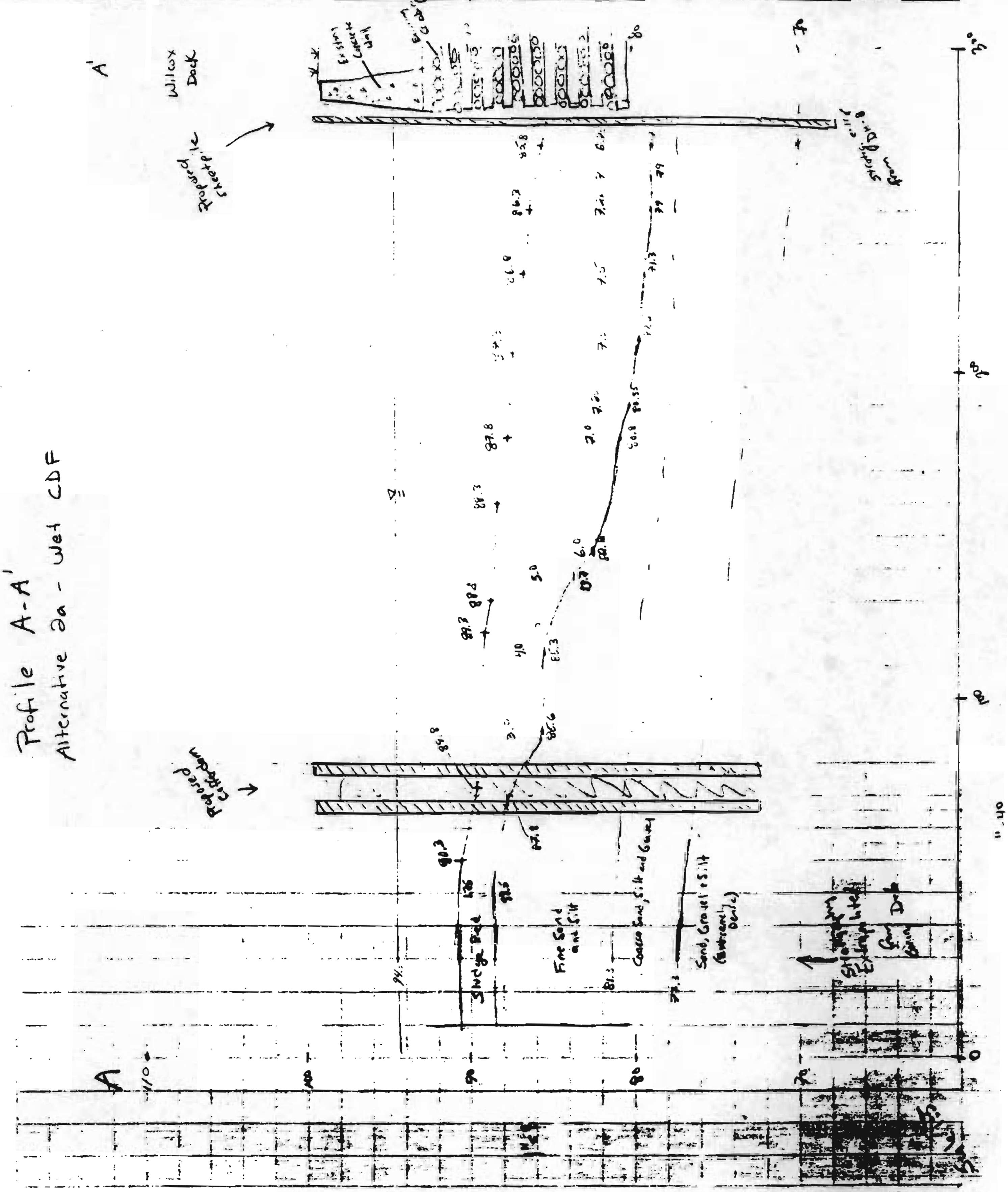
CALCULATION SHEET

PAGE 3 OF 7
PROJECT NO. 39304.004

CLIENT NYSDEC
PROJECT Cumberland Bay

SUBJECT Seepage Est.
Alternative 2a
Wet CDF

Prepared By HHm Date 11/28/95
Reviewed By ______ Date ______
Approved By ______ Date ______



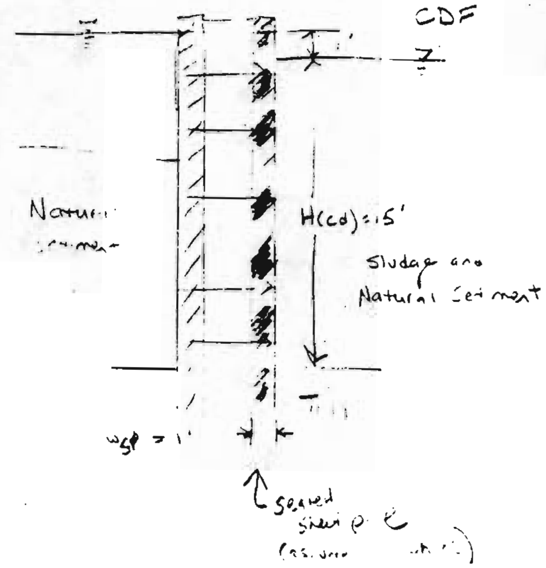
CLIENT NYSDEC
PROJECT Cumberland Bay

SUBJECT Seepage Est.
Alternative 5a
Wet CDF

Prepared By HHM Date 11/28/95
Reviewed By ______ Date ______
Approved By ______ Date ______

2. Flow through double wall sheet pile cofferdam

Figure 1



Assume K of cofferdam = 1×10^{-7} cm/sec

Assume ... unsealed sheet pile and backfill is negligible

$$Q = \frac{K h a}{L} \quad \text{(Harr, Type 1)}$$

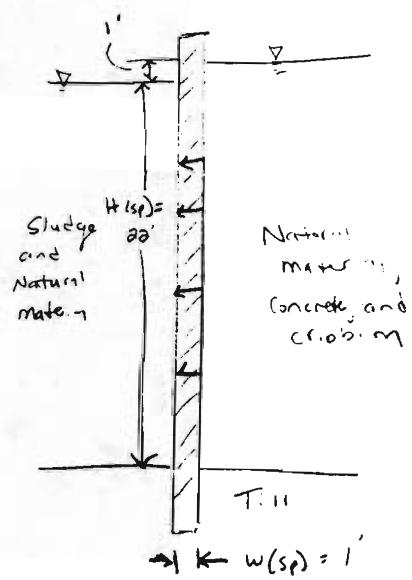
where $a = H(cd) = 15'$

$L = w(sp) = 1'$

L_n = leakance = $\frac{K}{L}$

3. Flow through single wall sheet pile

Figure 2



Assume K of sheet pile = 1×10^{-6} cm/sec

$$Q = \frac{Kha}{L}$$

where $a = H(sp) = 20'$

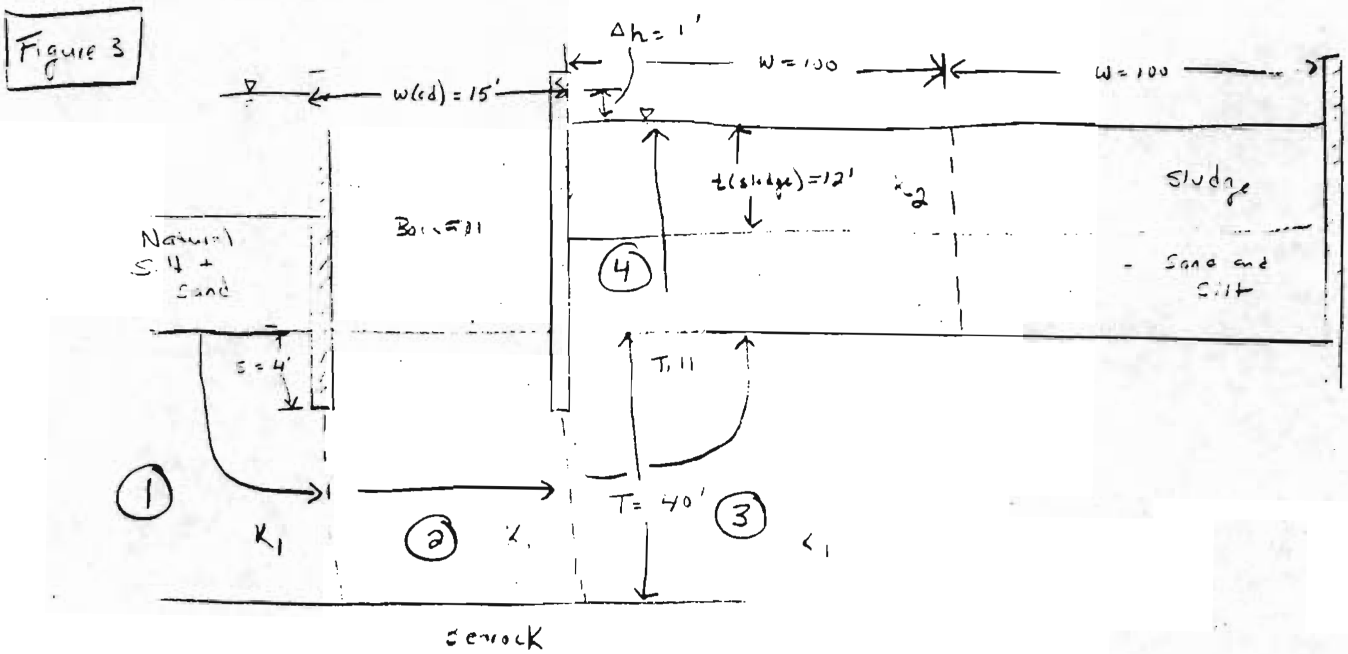
$L = w(sp) = 1'$

CLIENT NYSDEC
PROJECT Cumberland Bay

SUBJECT Seepage Est
Alternative [illegible]
Wet CDF

Prepared By [illegible] Date 1/28/95
Reviewed By ______ Date ______
Approved By ______ Date ______

4. Flow under cofferdam



Assume:

1. Natural sand and [illegible] water (no [illegible]ence)
2. K(till) = 8 ft/day (2.8×10^{-3} cm/sec)
   based on percentage of sand, silt + gravel on boring logs
   (60% sand, 20% silt, 20% gravel)
   Estimate from trilinear diagram, Figure 2 of "The relationship of grain-size distribution and hydraulic conductivity - an alternative approach", Summers and Weber, 1984. (Attached)
3. K(sludge) = 0.1 ft/day (3.5×10^{-5} cm/sec)
   based on estimated percentage of organic material, silt + sand based on on visual observation. (80% org. material + silt, 20% sand)
   (Summers + Weber, 1984)

$$Q(cd) = \frac{K \Sigma h_i}{\Sigma \text{ form factors}_i} = \frac{h}{\Sigma \frac{f_i}{K_i}}$$

where $K_1 \neq K_2$
f_i = form factor

CLIENT NYSDEC
PROJECT Cumberland Bay

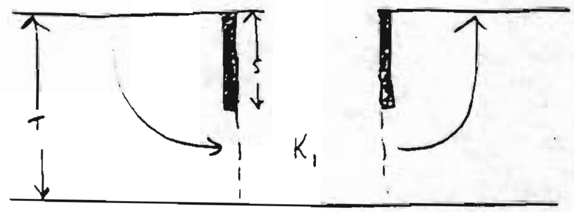
SUBJECT Seepage Est
Alternative 2a
Wet CDF

Prepared By ___ Date 11/29/95
Reviewed By ___ Date ___
Approved By ___ Date ___

(Flow under cofferdam continued)

<u>Segments 1 and 3</u>

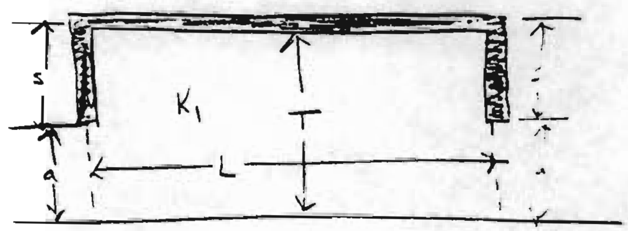
Fragment type II



f1, f3 = [illegible], See Fig 5-3, Harr, Attached (based on s/T)

<u>Segment 2</u>

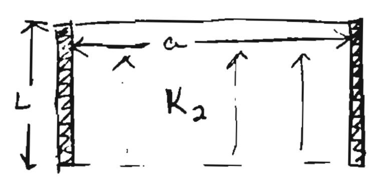
Fragment type V



$L \geq 2s \quad f2 = 2\ln\left(1 + \frac{s}{a}\right) + \frac{L - 2s}{T}$, Harr, Attached

<u>Segment 4</u>

Fragment type I



$f4 = \frac{L}{a}$

note $K_2 \neq K_1$

Harr, Attached

RUST ENVIRONMENT & INFRASTRUCTURE

CALCULATION SHEET

PROJECT NO. 39304.004

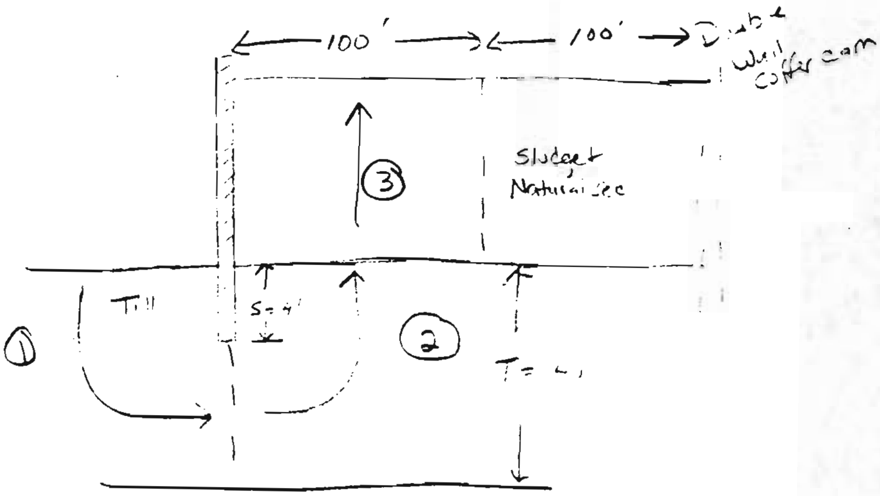
CLIENT NYSDEC
PROJECT Onondaga Bay

SUBJECT Seepage Est
Alternative 2a
Wet CDF

Prepared By ___ Date 1/29/95
Reviewed By ___ Date ___
Approved By ___ Date ___

5. Flow under sheet pile wall

Figure 1



Segment 1 and 2

Fragment type II

$f_1, f_2 = \frac{1}{2}\left(\frac{\Phi}{\Phi}\right)$, See Fig 5-3, Harr, Attached
(based on S/T)

Segment 3

Fragment type I

$f_3 = \frac{L}{a}$ where $L = 12'$ (thickness of sludge)
$a = 100'$ (w)

McGRAW-HILL
INTERNATIONAL
BOOK COMPANY
New York
St. Louis
San Francisco
Auckland
Bogotá
Düsseldorf
Johannesburg
London
Madrid
Mexico
Montreal
New Delhi
Panama
Paris
São Paulo
Singapore
Sydney
Tokyo
Toronto

M. E. HARR
Professor of Civil Engineering
Purdue University
West Lafayette
Indiana, U.S.A.

Mechanics of Particulate Media
A Probabilistic Approach

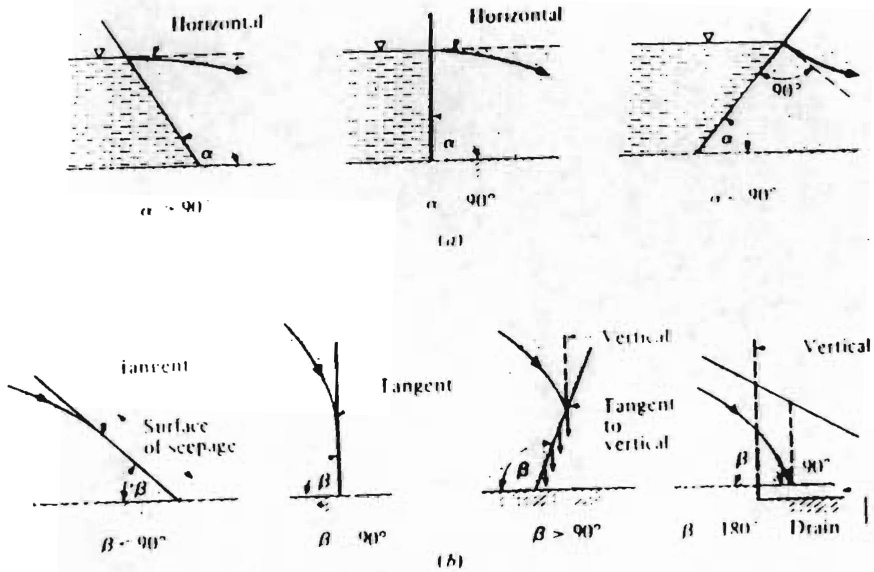


Figure 5-24(a) Entrance and (b) emergence conditions. (After Casagrande, 1940.)

In Fig. 5-25 are presented a summary of fragment types and form factors for easy reference.

To determine the pressure distribution on the base of a structure (such as that along C′CC″ in Fig. 5-26), Pavlovsky assumed that the head loss within the fragment is linearly distributed along the impervious boundary. Thus, in Fig. 5-26, if h_m is the head loss within the fragment, the rate of loss along EC′CC″E′ will be

$$R = \frac{h_m}{L + s' + s''} \tag{5-34}$$

Once the total head is known at any point, the pressure can easily be determined by subtracting the elevation head, relative to the established (tailwater) datum.

Example 5-8 For the section shown in Fig. 5-27*a*, estimate (*a*) the discharge and (*b*) the uplift pressure on the base of the structure.

SOLUTION The division of fragments is shown on the figure. Regions 1 and 3 are both type II fragments, and the middle section is of type V with $L = 2s$. For regions 1 and 3, we have, from Fig. 5-13, with $b/T = 0$, $\Phi_1 = \Phi_3 = 0.78$

Fragment type	Illustration	Form factor, Φ (*h* is head loss through fragment)
I		$\Phi = \frac{L}{a}$
II		$\Phi = \frac{1}{2}\left(\frac{kh}{Q}\right)$, Fig. 5-13
III		$\Phi = \frac{1}{2}\left(\frac{kh}{Q}\right)$, Fig. 5-13
IV		$b \le s$: $\Phi = \ln\left(1 + \frac{b}{a}\right)$ $b \ge s$: $\Phi = \ln\left(1 + \frac{s}{a}\right) + \frac{b - s}{T}$
V		$L \le 2s$: $\Phi = 2\ln\left(1 + \frac{L}{2a}\right)$ $L \ge 2s$: $\Phi = 2\ln\left(1 + \frac{s}{a}\right) + \frac{L - 2s}{T}$
VI		$L \ge s' + s''$: $\Phi = \ln\left[\left(1 + \frac{s'}{a'}\right)\left(1 + \frac{s''}{a''}\right)\right] + \frac{L - (s' + s'')}{T}$ $L \le s' + s''$: $\Phi = \ln\left[\left(1 + \frac{b'}{a'}\right)\left(1 + \frac{b''}{a''}\right)\right]$ where $b' = \frac{L + (s' - s'')}{2}$, $b'' = \frac{L - (s' - s'')}{2}$
VII		$\Phi = \frac{2L}{h_1 + h_2}$ $Q = k\frac{h_1^2 - h_2^2}{2L}$
VIII		$Q = k\frac{h_1 - h}{\cot\alpha}\ln\frac{h_d}{h_d - h}$
IX		$Q = k\frac{a_2}{\cot\beta}\left(1 + \ln\frac{a_2 + h_2}{a_2}\right)$

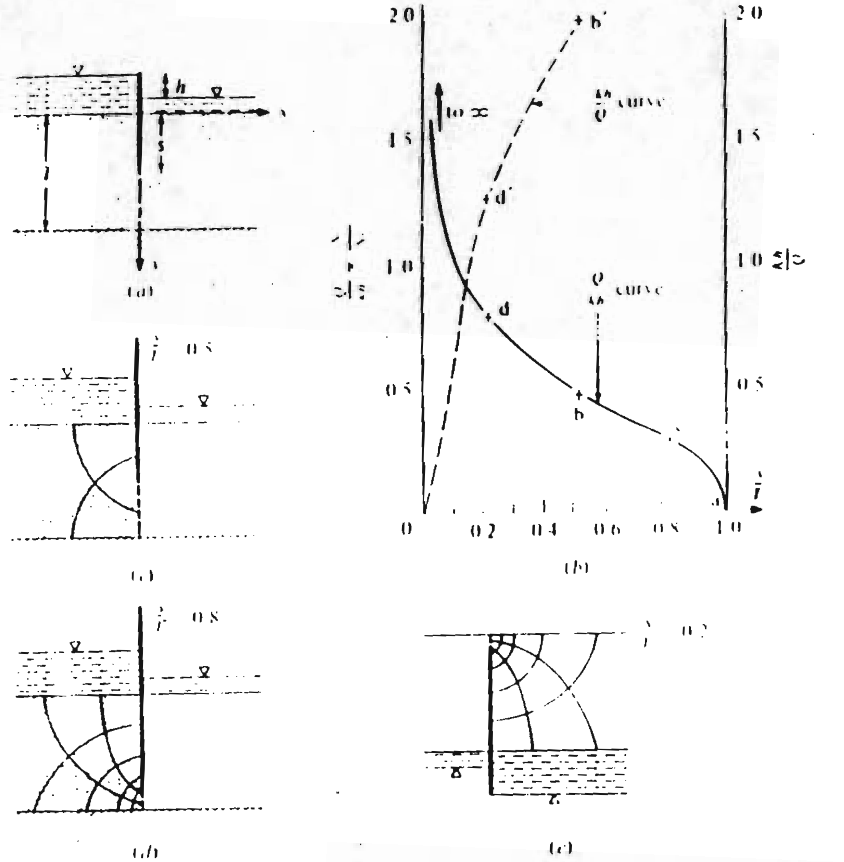
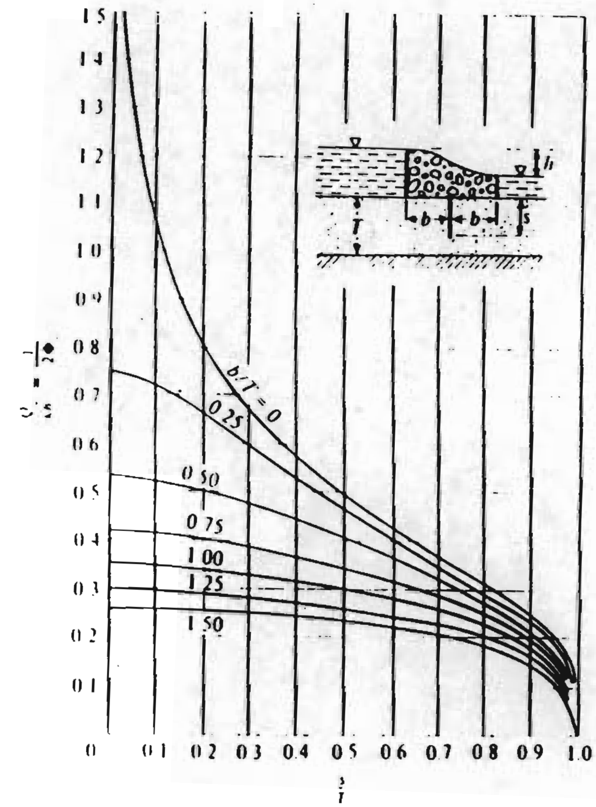


Figure 5-12

limit as s/T approaches zero, Q/kh becomes unbounded (see arrow on Fig. 5-12b). If $s/T = 1/2$ (Fig. 5-12c), each streamline will evidence a corresponding equipotential line in the half-strip; consequently, for the whole flow region, $N_f/N_e = 1/2$ for $s/T = 1/2$ (point b in Fig. 5-12b). Thus, without actually drawing a single flow net, we have learned quite a bit about the functional relationship between Q/kh and s/T. If Q/kh was known for $s/T = 0.8$ we would have another point and could sketch, with some reliability, the portion of the plot in Fig. 5-12b for $s/T \geq 0.5$. In Fig. 5-12d is shown one-half of the flow net for $s/T = 0.8$, which yields the ratio of $N_f/N_e = 0.3$ (point c in Fig. 5-12b). As shown in Fig. 5-12e, the flow net for $s/T = 0.8$ can also serve, geometrically, for the case of $s/T = 0.2$, which yields approximately $N_f/N_e = 0.8$ (plotted as point d in Fig. 5-12b). The portion of the curve for values of s/T close to 0 is still in doubt. Noting that for $s/T = 0$, $kh/Q = 0$, we introduce an ordinate scale of kh/Q to the right of Fig. 5-12b and locate on



*If $m = \cos\frac{\pi s}{2T}\sqrt{\tanh^2\frac{\pi b}{2T} + \tan^2\frac{\pi s}{2T}}$

for $m \leq 0.3$, $\frac{Q}{kh} = \frac{1}{\pi}\ln\frac{4}{m}$

for $m^2 \geq 0.9$, $\frac{Q}{kh} = \frac{\pi}{2\ln\left(\frac{16}{1-m^2}\right)}$

Figure 5-13 Plots of quantity of discharge for symmetrically placed pilings. (After Polubarinova-Kochina, 1952.)

this scale the corresponding values for $s/T = 0$, 0.2, and 0.5 (shown primed). Connecting these points (shown dotted) and obtaining the inverse, Q/kh, at desired points, the required curve can be had.

A plot giving the quantity of discharge (Q/kh) for symmetrically placed pilings as a function of depth of embedment (s/T), as well as for an impervious structure of width ($2b/T$), is shown in Fig. 5-13. This plot was obtained by Polubarinova-Kochina (1952) using a purely mathematical approach. The curve labeled $b/T = 0$ applies for the conditions in Example 5-5. It is interesting to note that this whole family of curves can be obtained, with reasonable accuracy,† by sketching only

† At least commensurate with the determination of the coefficient of permeability, k.

-4

FIELD REPORTS

THE RELATIONSHIP OF GRAIN-SIZE DISTRIBUTION AND HYDRAULIC CONDUCTIVITY—AN ALTERNATE APPROACH

by W. K. Summers[a] and Patricia A. Weber[b]

For unconsolidated clastic sedimentary rocks, we all know that:

1. Sands and gravels have larger hydraulic conductivities than silts and clays.
2. "Clean" sands and gravels have larger hydraulic conductivities than "dirty" sands or gravels.
3. Uncompacted sediments have larger hydraulic conductivities than do compacted sediments or consolidated sedimentary rocks.
4. Cement-free sediments have larger hydraulic conductivities than do compacted sediments of similar size.

Despite these obvious "truths" and extensive efforts by many investigators, we don't have a universally accepted working relation between grain-size frequency distribution and hydraulic conductivity.

This note offers for discussion and debate an approach based on the premise that for a given grain-size frequency distribution (ogive), some unique combination of factors generates a maximum hydraulic conductivity such that *any* change in *any* factor diminishes the hydraulic conductivity. Presumably, if we know the maximum hydraulic conductivity of a rock with a given ogive under ideal conditions, then we can estimate ***by some means*** the hydraulic conductivity of a rock that departs from the ideal.

Four factors get in the way of accurately predicting the field hydraulic conductivity using grain-size frequency distributions alone. These factors are: (1) compaction, (2) grain shape, (3) presence of cement, and (4) fractures.

Except for fractures, changing these factors from some optimum tends to diminish the hydraulic conductivity of a rock with a given ogive.

We argue that for unconsolidated sedimentary rocks, which contain no cement, some optimum combination of grain shape and "looseness" (degree of compaction) exists that produces a maximum hydraulic conductivity. That is, if we were to run repeated tests of any particle suite using a permeameter, we would discover that under "loosest possible packing" conditions, without losing grain-to-grain contact, the hydraulic conductivity would approach some upper limit. We would also discover that changing the packing would only decrease the hydraulic conductivity.

Then, if we were to run successive tests of particle suites with identical ogives but different grain shapes, we would discover that some grain shape or combination of grain shapes would generate the maximum hydraulic conductivity.

Previous efforts to relate grain size to hydraulic conductivity have used the cumulative frequency distribution by picking one or more points from the ogive. Our approach involves plotting points on a trilinear diagram following Folk's (1954) recommendations, which are:

Size (mm):	*Designation:*
less than 0.0625	silt and clay
0.0625 to 2.0	sand
more than 2.0	gravel

Using these criteria, particle-size analyses can be reduced to percent silt and clay, percent sand, and percent gravel—that is, a unique point on a trilinear diagram.

Because any frequency distribution reduces t[o] a point on a trilinear diagram, we hypothesized that the relation of the maximum hydraulic conductivity to grain size could be expressed as contours on a trilinear diagram. To test the hypothesis we made an extensive literature search and found in 35 references more than 500 grain-size frequency distributions of samples for which hydraulic conductivity had also been obtained. W[e]

[a]President and Senior Geologist, W. K. Summers and Associates, Inc., P.O. Box 684, Socorro, New Mexico 87801.

[b]Petroleum Geologist, Southland Royalty Company, Midland, Texas 79705.

Revised March 1984, accepted April 1984.
Discussion open until January 1, 1985.

also obtained unpublished data from other geologists and hydrologists in the United States and Canada. The data include results for slag and mixtures of glass beads, as well as silt and clay, sand, and gravel. Figure 1 shows the distribution of points we accepted as valid and useful. The vast majority of the data falls in the apexes of the diagram. So we have excluded from Figure 1 those points that represent 90 percent or more gravel or 94 percent or more sand. We have also excluded (1) those points for which the values of hydraulic conductivity were much smaller than those of nearby points, and (2) a few points for which the measured hydraulic conductivity was so much larger than nearby values that we think they represent the conductivity of fractures or tubes.

Figure 2 shows the isohydraulic conductivity lines we drew to represent the maximum hydraulic conductivity due to interstitial porosity that an unconsolidated clastic rock with the stated grain-size distribution could possibly have.

To improve the picture we need more data. We especially need data in the area that contains less than 40 percent sand and less than 20 percent gravel (glacial till) to confidently draw isohydraulic conductivity lines in these areas.

We may need to choose other size ranges for definition of the trilinear point. For the rocks made up entirely of clay, silt, sand, or gravel, a trilinear diagram based on fine, medium, and coarse may be better.

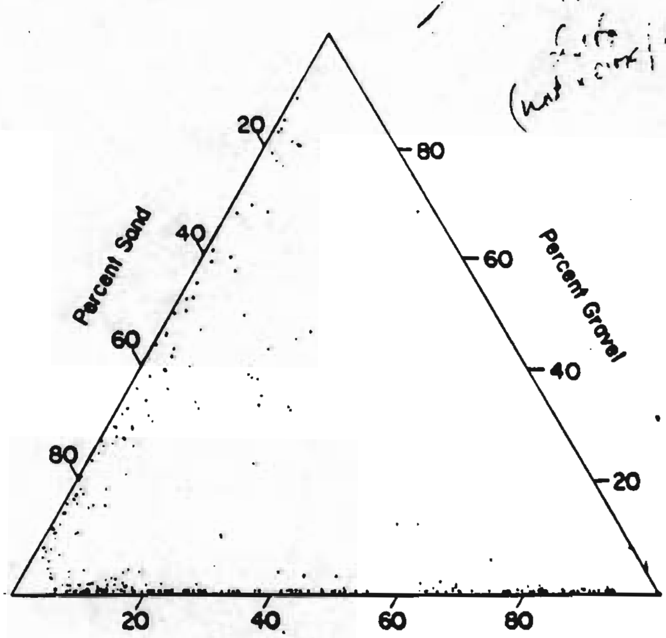


Fig. 1. Trilinear diagram showing the location of data points for which acceptable laboratory measurements of hydraulic

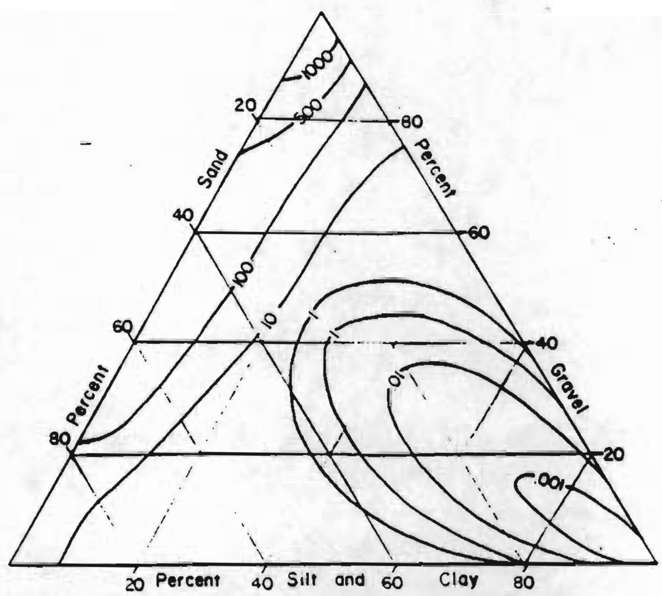


Fig. 2. Trilinear diagram showing isopleths of maximum value of hydraulic conductivity (ft/d) that unconsolidated clastic masses may achieve and still maintain grain-to-grain contact.

1 ft/day = 3.5 x 10^-4 cm/sec

We hope this short note will stimulate a renewed dialog on this perplexing problem. If you have data—especially size analyses with both hydraulic conductivity and porosity measurements—that you would like to share, please send them to the senior author.

Reference Cited

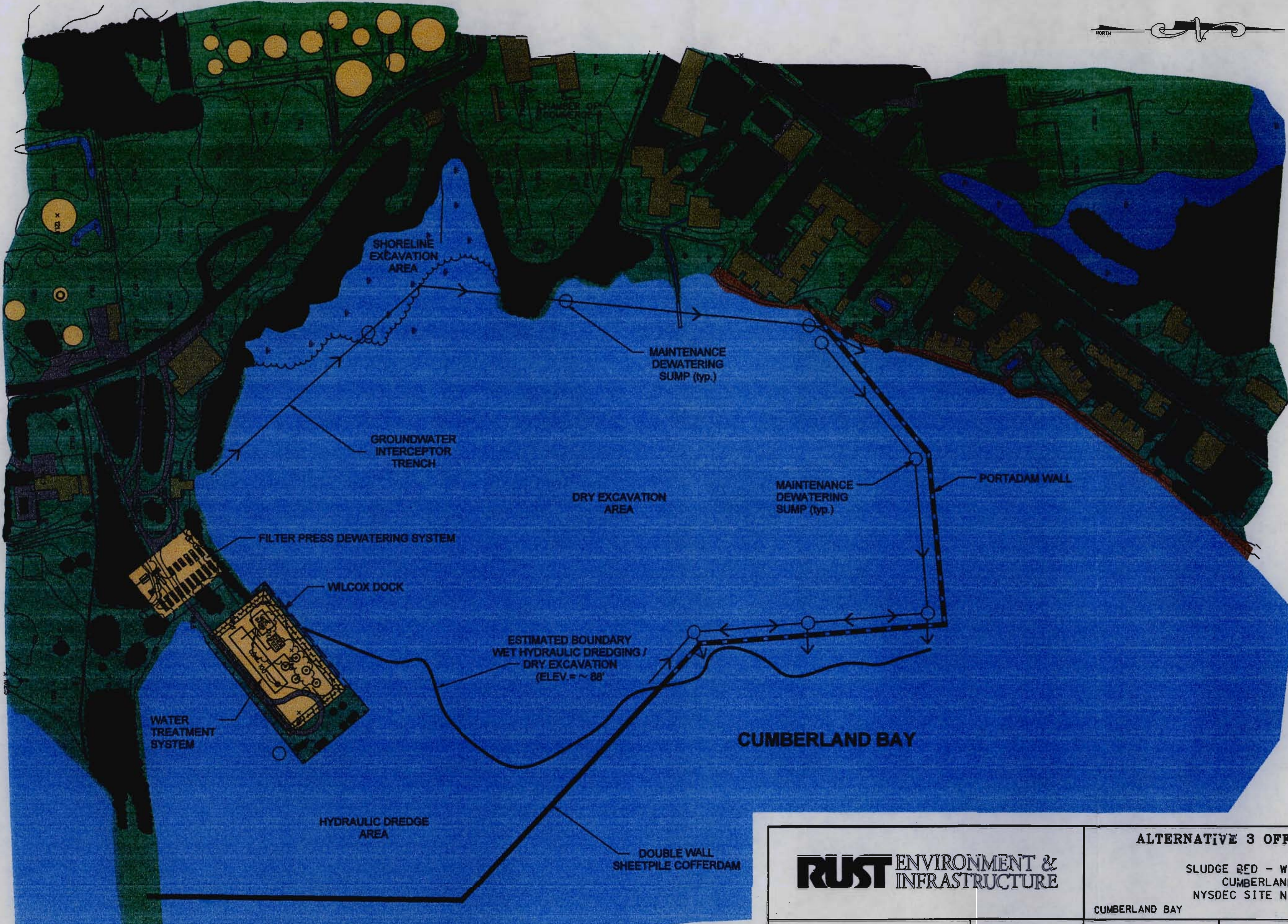
Folk, R. L. 1954. The distinction between grain size and mineral composition in sedimentary-rock nomenclature. Journal of Geology. v. 62, no. 4, pp. 345-351.

[For a list of the 35 references used to obtain data or the summary of the methods that have been proposed to relate grain size to hydraulic conductivity, write W. K. Summers, P.O. Box 684, Socorro, New Mexico 87801.]

• • • • •

William Kelly Summers received his B.S. in Geology from Wayne State University in Detroit, Michigan in 1952 and his M.A. in Geology from Indiana University in 1957. Since 1972, when he left the New Mexico Institute of Mining and Technology where he served as a ground-water geologist, he has been a consultant dealing with water supply, design of wells and well fields, geothermal exploration, and ground-water pollution and the safe storage of toxic wastes.

Patricia A. Weber is a Petroleum Geologist at Southland Royalty Company, Midland, Texas. She received her B.A. in Earth Science/Geology from Western Connecticut State University in 1976. She spent three years from 1976 to 1979 working as a ground-water geologist employed by W. K. Summers and Associates, Socorro, New Mexico. She has been working as a petroleum geologist for the last five years, and most recently has been engaged in



SCALE IN FEET 0 100 200

RUST ENVIRONMENT & INFRASTRUCTURE

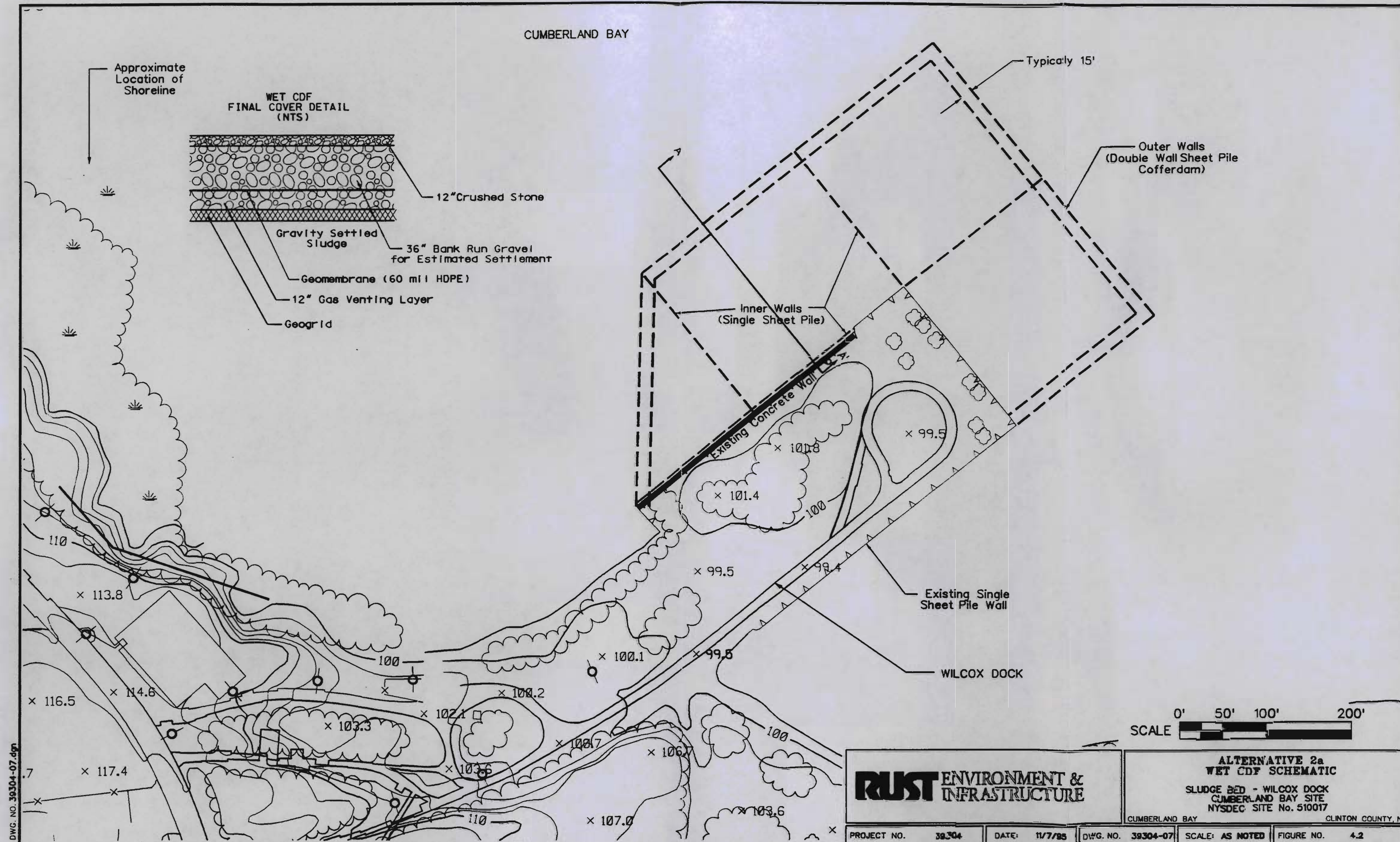
ALTERNATIVE 3 OFF-SITE DISPOSAL

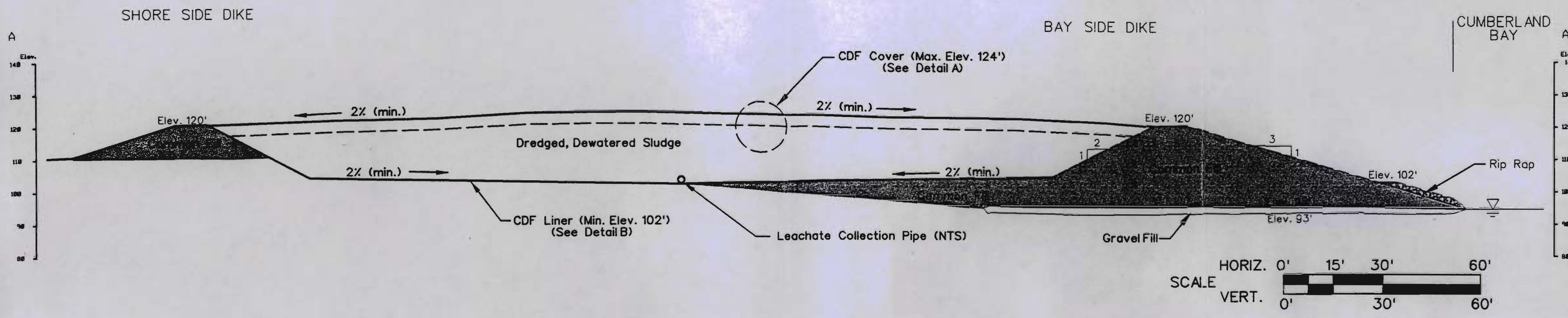
SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY,
NYSDEC SITE No. 510017

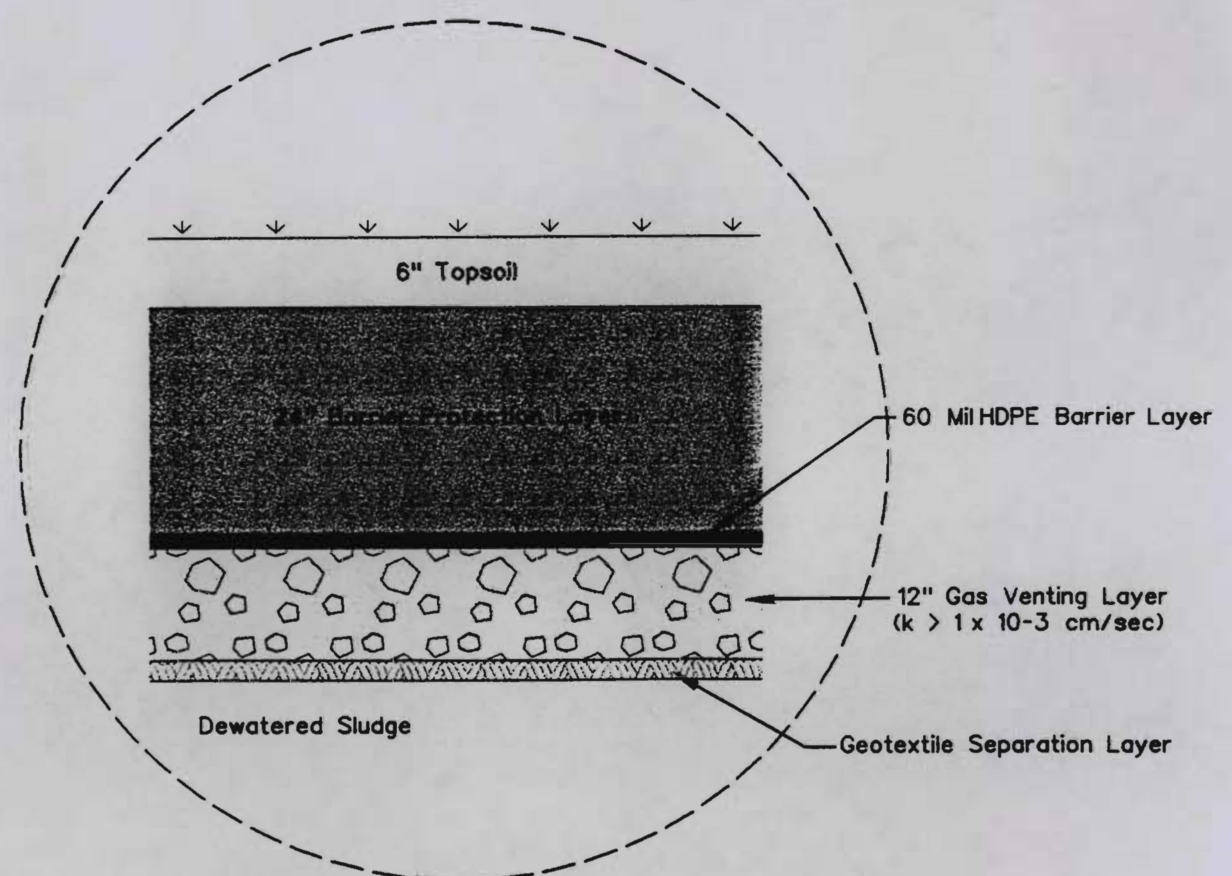
CUMBERLAND BAY — CLINTON COUNTY, NY

PROJECT No.39304	DATE 10/2/95	DWG. No. 39304c14	SCALE AS NOTED	FIGURE No. A-1b

DRAWING No.

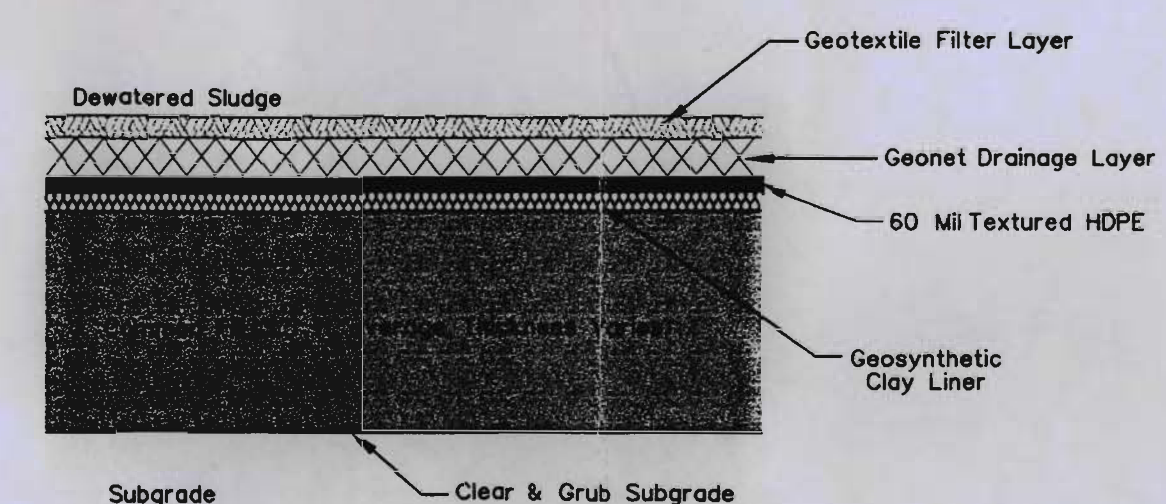

CUMBERLAND BAY
Approximate Location of Shoreline
WET CDF FINAL COVER DETAIL (NTS)
12"Crushed Stone
Gravity Settled Sludge
36" Bank Run Gravel for Estimated Settlement
Geomembrane (60 mil HDPE)
12" Gas Venting Layer
Geogrid
Typically 15'
Outer Walls (Double Wall Sheet Pile Cofferdam)
Inner Walls (Single Sheet Pile)
Existing Concrete Wall
Existing Single Sheet Pile Wall
WILCOX DOCK
110
100
× 113.8
× 116.5
× 114.6
× 117.4
× 103.3
× 102.1
× 100.2
× 100.1
× 99.5
× 99.4
× 101.4
× 101.8
× 103.6
× 100.7
× 106.7
× 107.0
× 103.6
SCALE
0' 50' 100' 200'
RUST ENVIRONMENT & INFRASTRUCTURE
ALTERNATIVE 2a
WET CDF SCHEMATIC
SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017
CUMBERLAND BAY
CLINTON COUNTY, NY
PROJECT NO. 39304
DATE: 11/7/95
DWG. NO. 39304-07
SCALE: AS NOTED
FIGURE NO. 4.2
DWG. NO. 39304-07.dgn





DETAIL A - FINAL COVER SYSTEM

NTS (Synthetic Components are exaggerated for clarity)



DETAIL B - LINER SYSTEM

NTS (Synthetic Components are exaggerated for clarity)

RUST ENVIRONMENT & INFRASTRUCTURE

ALTERNATIVE 2b
DRY CDF CROSS-SECTION A-A' & DETAILS

SLUDGE BED - WILCOX DOCK
CUMBERLAND BAY SITE
NYSDEC SITE No. 510017

CUMBERLAND BAY | CLINTON COUNTY, NY

PROJECT NO.	DATE:	DWG. NO.	SCALE:	FIGURE NO.
39304	11/7/95	39304-08	AS NOTED	4.7