USACE CONTRACT NO. DACW33-94-D-0002
TASK ORDER NO. 020
TOTAL ENVIRONMENTAL RESTORATION CONTRACT

ENGINEERING EVALUATION/COST ANALYSIS
FOR THE CAUSEWAY AND DIKE
STRATFORD ARMY ENGINE PLANT
Stratford, Connecticut

Prepared for:

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

Prepared by:

Foster Wheeler Environmental Corporation
Boston, Massachusetts

and

Harding Lawson Associates
Portland, Maine

February 2000

Revision	Date	Prepared By	Approved By	Pages Affected
1	2/2/00	A. Piecuch	N. Walter J Borkland	

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EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) was prepared by Foster Wheeler Environmental Corporation and Harding Lawson Associates under contract to the United States Army Corps of Engineers – New England District for the U.S. Army Tanks-Automotive and Armament Command for a Non-time-Critical Removal Action (NCRA) for the Causeway and Dike area at the Stratford Army Engine Plant (SAEP), located in Stratford, Connecticut. This EE/CA has been prepared for surface and subsurface soil. Groundwater associated with the Causeway and Dike area will be addressed in the Remedial Investigation (RI) Report and Feasibility Study for the SAEP facility. The Draft RI Report is scheduled to be submitted in March 2000.

The purpose of the EE/CA is to identify removal action objectives, evaluate removal action alternatives that will achieve those objectives, and to recommend, based on the evaluation, the alternative that best meets the evaluation criteria. This document was prepared in accordance with the United States Environmental Protection Agency (USEPA) guidance for preparing EE/CAs (USEPA, 1993b) and is intended to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990).

The SAEP property is zoned as light commercial, and the site has been used for development, manufacture, and assembly of aircraft or engines since 1929. In October 1995, SAEP was placed on the Base Closure and Realignment (BRAC) list, known as BRAC 95. Pursuant to the Defense Base Closure and Realignment Act of 1990, the BRAC Environmental Restoration Program mandates that environmental contamination on BRAC properties be investigated and remediated, as necessary, prior to disposal and reuse. In August 1998, SAEP was transitioned from an active production facility to caretaker status.

SAEP consists of approximately 124 acres, of which approximately 76 acres are improved land and 48 acres are riparian rights. The 76 acres of improved land consist of 49 buildings, paved roadway and grounds, and five paved parking lots. Included in the improved land are an estimated 10 acres along the Housatonic River where fill was placed over tidal flats during the development of SAEP. The 48 acres of riparian rights property consist of intertidal flats of the Housatonic River. An estimated two acres of property comprise a causeway constructed in the 1930s to provide access to the river channel.

The Causeway was initially constructed and used as a means of launching seaplanes in the 1930s. Additional materials, of unknown origin, were deposited along the northern edge of the Causeway during the 1950s and 1960s. The Causeway consists of fill material that was originally deposited on the tidal flats of the Housatonic River. The fill material consists of soil (i.e., coarse to fine sand), cobbles, and construction debris (e.g., metal, wood, concrete, brick, asphalt, and rebar).

A severe flood of the Housatonic River occurred in 1948, rendering the Stratford plant's manufacturing space unusable. The Dike was constructed in 1951 to provide flood protection for the SAEP facility. Generally, the Dike fill material consists of sand and gravel with varying amounts of cobbles. Crushed stone and riprap cover the side slopes of the Dike, and an asphalt-paved road traverses a portion of the top of the Dike.

Soil analytical data collected during the 1999 pre-design investigation activities for the Causeway and Dike were compared to the Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulation (RSR) Direct Exposure Criteria (DEC) and Pollutant Mobility Criteria (PMC). The Causeway and Dike area is proposed for future use as a recreational area, and the groundwater associated with the SAEP is classified as a GB area. Therefore, the CTDEP RSR DEC for residential exposure and the GB PMC were used in the data evaluation. Soil analytical data for asbestos were compared to the residential standard established for another project (i.e., Raymark in

Stratford, CT) of 1 percent total asbestos by the polarizing light microscope (PLM) method.

Causeway. The contaminants detected that exceed the CTDEP RSR DEC and PMC include chlorinated and fuel-related volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganics. Asbestos was not detected in 23 of 27 samples analyzed. Four samples had a trace (less than 1 percent) visual (by PLM) estimate of asbestos content, which is less than the residential standard of 1 percent total asbestos.

Low-level radiological contaminated material has been identified at three isolated locations in the Causeway fill material. This low-level radiological contaminated material is scheduled to be removed, containerized, and transported to an appropriate off-site licensed treatment/disposal facility. It is anticipated that these activities will be completed by the spring 2000. Therefore, this radiological-contaminated material is not included in the scope of the removal action alternatives evaluated in this EE/CA.

Dike. The contaminants detected that exceed the CTDEP RSR DEC and PMC include chlorinated and fuel-related VOCs, SVOCs, PCBs, and inorganics. These exceedances were detected in three isolated hand auger explorations located on the south face and edge of the Dike. Exceedances were not detected from samples collected over the remainder of the Dike. Because theses locations are not within the Dike, and the horizontal and vertical extent of contamination at these locations has not been fully defined, these areas will be addressed in the Feasibility Study for the remainder of the SAEP facility. Asbestos was not detected in 21 of the 24 samples analyzed. Three samples had a trace (less than 1 percent) visual (by PLM) estimate of asbestos content, which is less than the residential standard of 1 percent total asbestos. Therefore, the scope of the Causeway and Dike NCRA includes only the Causeway, where surface and subsurface soils exceed the CTDEP RSRs.

The objective of the Causeway and Dike NCRA is to prevent exposure to contaminated soils in accordance with the CTDEP RSR DEC (residential exposure scenario) and PMC (GB area). Due to the heterogeneous nature of the Causeway fill material and the large percentage of construction debris, treatment technologies, either in-situ or ex-situ, are not feasible for addressing the subsurface contamination present in the Causeway. Therefore, the general response actions considered for this NCRA are containment and removal/disposal. The following removal action alternatives are evaluated in the EE/CA:

Alternative 1	Capping with Hydraulic Barrier
Alternative 2	Capping with Composite Cover System
Alternative 3	Excavation and Off-site Disposal

The evaluation of alternatives was conducted using the effectiveness, implementability, and cost criteria set forth in the NCP and USEPA guidance (USEPA, 1993b). Based on this evaluation, Alternative 2 is the proposed removal action alternative.

Alternative 2 includes the following components:

- Demolition of Building 59 and other structures (concrete ramp and pad);
- Installation of a sheet pile seawall;
- Capping the Causeway with a composite cover system;
- Covering the Causeway with a Stone/Riprap Armor; and
- Establishing environmental land use restrictions.

Based on the comparative analysis of the removal action alternatives evaluated in the EE/CA, Alternative 2 has been identified as the recommended removal action alternative. Alternative 2 is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements (ARARs), and is cost-effective. Alternative 2 does not satisfy the statutory preference for remedies that involve treatment that reduces toxicity, mobility, or volume as a principal element. Although

Alternative 2 does not include active treatment technologies as a principal element, the cap and seawall components of the alternative provide a reduction in the mobility of contaminants.

Alternative 2 provides both short- and long-term effectiveness, and is technically and administratively feasible. Additionally, the alternative can be implemented using standard or commonly available construction methods, services, and materials. Alternative 2 is also expected to be consistent with the RI and Feasibility Study, currently being conducted for the overall SAEP facility. Therefore, Alternative 2 is believed to provide the optimum combination of overall protection of human health and the environment and compliance with ARARs, at a reasonable cost.

1.0 INTRODUCTION

Foster Wheeler Environmental Corporation (Foster Wheeler) and Harding Lawson Associates (HLA) have been contracted through the United States Army Corps of Engineers – New England District (USACE) to complete a Non-time-Critical Removal Action (NCRA) for Operable Unit 1, the Causeway and Dike Area, at the Stratford Army Engine Plant (SAEP) under Task Order No. 020 of The New England Total Environmental Restoration Contract (TERC) (Contract No. DACW33-94-D-0002). The objectives of this Task Order are to: (1) complete additional field activities necessary to characterize physical and chemical subsurface conditions on the Causeway and Dike, (2) summarize the results of field activities in a Pre-Design Investigation Report (Foster Wheeler/HLA, 2000), and (3) document the decision process for selection of a removal action for the Causeway and Dike area in an Engineering Evaluation/Cost Analysis (EE/CA) and a Removal Action Memorandum (RAM).

1.1 PURPOSE AND SCOPE OF THE ENGINEERING EVALUATION/COST ANALYSIS

The purpose of the EE/CA is to identify removal action objectives and evaluate removal action alternatives that will achieve these objectives. The evaluation process for removal action alternatives presented in this EE/CA consists of four steps: (1) identification of removal action objectives; (2) identification of removal action alternatives; (3) evaluation of removal action alternatives; and (4) selection of the proposed remedy. The EE/CA serves as the basis for the RAM, the primary decision document substantiating the need for a removal response, and for design and implementation of the removal action.

This EE/CA has been prepared for surface and subsurface soil for the Causeway and Dike area at the SAEP. Groundwater associated with the Causeway and Dike Area is being addressed in the Remedial Investigation (RI) Report and Feasibility Study for the SAEP

facility. This EE/CA was developed primarily from the information presented in the Pre-Design Investigation Report for the Causeway and Dike (Foster Wheeler/HLA, 2000).

This removal action is being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (United States Environmental Protection Agency [USEPA], 1990), and the USEPA "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (USEPA, 1993b). This removal action is also being conducted in accordance with the Base Realignment and Closure (BRAC) Cleanup Plan Guidebook (Department of Defense, 1993), which was prepared for implementing President Clinton's decision to promote early reuse of closing military installations by expediting environmental cleanup.

1.2 Report Organization

Section 1.0 of this document introduces the purpose and scope of the EE/CA. Section 2.0 summarizes the site characteristics, which includes the location and history of the site, existing conditions, geology and hydrogeology, and contamination assessment.

Section 3.0 discusses the scope, goals, and objectives of the removal action. The Applicable or Relevant and Appropriate Requirements (ARARs) that will govern the removal action are also included in Section 3.0.

Section 4.0 describes the removal action alternatives and evaluates the alternatives based on effectiveness, implementability, and cost. Section 5.0 provides a comparison of the alternatives relative to the evaluation criteria, and identifies the advantages and disadvantages relative to one another. Section 6.0 then presents the recommended removal action alternative, based on the evaluation and comparative analysis of the alternatives.

2.0 SITE CHARACTERIZATION

This section provides a summary of the site characteristics, which includes the location and history of the site, existing conditions, geology and hydrogeology, and contamination assessment.

2.1 SITE DESCRIPTION AND BACKGROUND

This subsection includes a description and history of the SAEP site. The USEPA has given the SAEP site the CERCLA Information System Identification Number of CTD 001181502.

2.1.1 Location

SAEP is located in Stratford, Connecticut, on the Stratford Point peninsula in the southeast corner of Fairfield County (Figure 2-1). The site lies on the borderline of the Bridgeport and Milford Quadrangles. Latitudinal and longitudinal coordinates of SAEP are approximately 41° 10' North and 73° 07' West. The site is bounded on the east by the Housatonic River, on the south and north by paved parking and open areas, and on the west by Main Street and the Sikorsky Memorial Airport.

2.1.2 Type of Facility and Operational History

The SAEP property is zoned as light commercial, and the site has been used for development, manufacture, and assembly of aircraft or engines since 1929. The plant history has been categorized into the following periods:

1929 to 1939: Sikorsky Aero Engineering Corporation developed and manufactured sea planes at the Stratford plant.

1939 to 1948: Chance Vought Aircraft located its operations at the Stratford plant in 1939, and the company became known as Vought-Sikorsky Aircraft Division. Sikorsky developed the helicopter and left the plant in 1943 because of overcrowding. Chance Vought developed the 'Corsair' for the U.S. Navy, and mass-produced Corsairs during World War II. Chance Vought vacated the Stratford Plant in 1948.

1948 to 1951: The Stratford plant was idle.

1951 to 1976: The U.S. Air Force procured the Stratford plant in 1951 and named it Air Force Plant No. 43. The Avco Corporation (AVCO) was contracted by the Air Force to operate the plant. AVCO manufactured radial engines for aircraft in the 1950s, and developed and manufactured turbine engines, primarily for aircraft, in the 1960s and 1970s.

1976 to 1995: The plant was transferred from the U.S. Air Force to the U.S. Army in 1976. At that time the plant was renamed the Stratford Army Engine Plant, although it continued under AVCO operations. AVCO was contracted by the Army to develop the AGT-1500 engine to power the Abrams tank and develop and manufacture industrial engines. AVCO merged with Textron in December 1985, and subsequently formed the Textron Lycoming Stratford Division. The contract for operation of SAEP was transferred from Textron Lycoming to AlliedSignal in 1994. AlliedSignal continued to develop, manufacture, and test turbine engines at the SAEP for both military and commercial aircraft and land vehicles until 1997.

1995: Responsibility for the jurisdiction, control, and accountability of SAEP was transferred from the U.S. Army Aviation and Troop command to the U.S. Army Tank-Automotive and Armament Command (TACOM) in September 1995. In October 1995, SAEP was placed on the BRAC list, known as BRAC 95. Pursuant to the Defense Base Closure and Realignment Act of 1990, the BRAC Environmental Restoration Program

mandates that environmental contamination on BRAC properties be investigated and remediated, as necessary, prior to disposal and reuse.

1998: In August 1998, SAEP was transitioned from an active production facility to caretaker status. Since the cessation of AlliedSignal operations, the focus of activities at SAEP has been completion of an environmental assessment and cleanup of the site with the goal of future redevelopment.

2.1.3 Existing Conditions

SAEP facility. SAEP consists of approximately 124 acres, of which approximately 76 acres are improved land and 48 acres are riparian rights. A riparian right is a right of access to, or use of, the shore, bed, or water of land on the bank of a natural watercourse. The 76 acres of improved land consist of 49 buildings, paved roadway and grounds, and five paved parking lots. Included in the improved land are an estimated 10 acres along the Housatonic River where fill was placed over tidal flats during the development of SAEP. The 48 acres of riparian rights property consist of intertidal flats of the Housatonic River. An estimated two acres of property comprise a causeway constructed in the 1930s to provide access to the river channel.

Causeway. The Causeway was initially constructed and used as a means of launching seaplanes in the 1930s. Additional materials, of unknown origin, were deposited along the northern edge of the Causeway during the 1950s and 1960s. Building 59 was constructed to house the nose cones of missiles (without warheads), including the explosive charges used to open the nose cones. The source of the fill used to construct the Causeway is unknown, but the fill contains soil, cobbles, and construction debris (e.g., wood, concrete, brick, asphalt, and rebar). Analyses of ten surface soil samples collected from depths of 0 to 6 inches on non-vegetated areas of the Causeway during the Phase I RI did not indicate the presence of asbestos (ABB Environmental Services, Inc., [ABB-ES] 1996). It was also reported that paint solvents and wastes were burned on the Causeway as part of fire training operations.

Dike. A severe flood of the Housatonic River occurred in 1948, rendering the Stratford plant's manufacturing space unusable. In 1951, the U.S. Air Force purchased the plant and repaired the water-damaged buildings. Additionally, the Dike was constructed along the shoreline to provide flood protection for the facility.

Information regarding the construction of the Dike, including the material used to complete construction is generally unknown; however, aerial photographs indicate riprap material was primarily used during dike construction. Currently, an asphalt-paved road approximately 8 to 10 feet wide is placed on top of the Dike. Riprap covers each of the sloped sides of the Dike.

Future land use. Future land use at the site has been the subject of intensive study by the SAEP Local Redevelopment Authority (LRA). As reported in the "SAEP Redevelopment Plan and Implementation Strategy and Homeless Assistance Submission", the preferred land use plan developed by the LRA includes the development of approximately 800,000 square feet of building space for office, research and development, and "flex space". In addition, approximately 100,000 square feet of museum space and approximately 16 acres of parkland along the Housatonic River waterfront are proposed (RKG Associates, Inc. [RKG], 1997). The approximately 16 acres of proposed parkland (i.e., recreational area) would include a landscaped park with pathways for pedestrians and bicyclists, public water access from a new dock located at the end of the former seaplane boat ramp at the end of the Causeway, and an off-street parking area. The Causeway and Dike, which is within this proposed recreational area, is the focus of this EE/CA.

Topography. SAEP is located in the Western Highlands of Connecticut, part of the New England Physiographic Province. The local area is part of a coastal belt of dissected hilly country that extends along the coast of Connecticut. The coastal belt is characterized by uplands that range from mean sea level (MSL) to 650 feet above MSL, with an irregular, rocky coastline. Within the coastal belt, hilltops slope southward at a rate of about 50 feet per mile. Topographic features in the area mostly trend in the north-south or northeast-southwest direction, reflecting the structural trends of the local bedrock (Flint, 1968).

SAEP is situated on the Stratford Point peninsula that extends into Long Island Sound. The peninsula is relatively flat, with a slight slope toward the sound. Almost all the land at SAEP is less than 10 feet above MSL. The exception to this is a dike that was constructed along the Housatonic River in 1951 for flood protection. SAEP is within the 100-year floodplain.

Surface water. Surface water bodies in the site vicinity include Long Island Sound, the Housatonic River, Frash Pond, and the Marine Basin and drainage channel. Long Island Sound receives all of the region's drainage, in large part via the Housatonic River. Reported average tidal levels for the Housatonic River at Stratford are:

- Low tide level 0.8 feet MSL
- Mean tide level 2.9 feet MSL
- High tide level 5.5 feet MSL

Most of the SAEP surface is paved or covered with buildings; therefore, runoff during storm events is heavy. Most of the precipitation that falls on SAEP is treated and drained to the Housatonic River. Runoff at SAEP is collected by one of a network of six storm drainage systems. Each of the storm drain systems is equipped with a pumping station because of the low elevation of the site and proximity of the Housatonic River and Long Island Sound. Effluent from the storm drainage system is pumped through the Oil Abatement Treatment Plant, except in times of heavy precipitation, when some runoff is pumped directly to the Housatonic through individual outfalls.

2.1.4 Geology and Hydrogeology

This subsection summarizes the geology and hydrogeology at the SAEP, as well as the geologic conditions associated with the Causeway and Dike area.

2.1.4.1 Site Geology and Hydrogeology. The shallow geology at SAEP is characterized by four distinct units: fill material, estuarine silt, peat, and glacial deposits. The following is a summary of the geology and hydrogeology at the SAEP.

Fill. Fill material is found throughout most of the SAEP. Fill was used for road construction, site grading, and as foundation material for buildings. Fill material consists of soil, concrete, brick, asphalt, wood, cinders, copper wire, and rebar. Fill in areas along the shoreline is reported to consist of materials hydraulically dredged from the Housatonic River. The composition of the fill is variable, but most of it is described as a granular material that was placed to promote drainage.

Fill also consists of glacial material deposited on the surface from cut-and-fill operations made during facility development between 1940 and 1960. The glacial fill material generally consists of brown medium to fine sand and gravelly sand.

The thickness of fill is generally about five feet, although it may reach a thickness of up to 19 feet. The fill appears to thin somewhat with distance away from the river. This may be a result of more extensive historical filling operations along the river in order to bring the shoreline up to grade with the rest of the site.

Estuarine silt. A thick silt deposit underlies the fill at the northern edge of the SAEP along the Housatonic River. This deposit consists of black organic silt containing shell and sand layers. This material is estuarine sediment deposited by the Housatonic River

and subsequently topped with fill (both artificial and glacial fill) during enlargement of the SAEP property.

The estuarine silt layer ranges from 2 to 30 feet in thickness and extends inland from the shoreline approximately 150 to 250 feet.

Peat. A deposit of brown and black peat with some organic silt was encountered in the eastern portion of the SAEP in the vicinity of the former lagoons (impoundment area adjacent to the South Parking Lot. The extent of this peat deposit is roughly circular, which indicates that it was probably formed by a marsh or swamp. Older U.S. Geological Survey quadrangle maps show that this area was formerly a tidal marsh that was subsequently filled. The peat in this area forms a continuous concave layer, approximately seven feet thick, which deepens to the west-northwest.

Peat was also encountered near Building B-8 and just south of the Causeway at approximately 2 feet and 5 feet thick, respectively. These two peat deposits are apparently small, isolated pockets and are not a part of the continuous peat deposit in the former lagoon area.

Glacial sediments. A thick deposit of glacial sediments underlies the fill, estuarine silt, and peat deposits at the SAEP, and overlies the bedrock. The glacial sediments range in thickness from approximately 40 feet to 70 feet, and consist of sands, silty sands, and gravelly sands with occasional boulders and varved silt. The glacial deposits can be generally grouped into three layers: (1) a layer of gray to brown, medium to coarse sand with varying amounts of gravel, underlain by (2) light to medium brown, medium to fine sand and silty sand with occasional clay stringers, followed by (3) another layer of brown to gray sand and gravel immediately above the bedrock.

Bedrock. The bedrock geology underlying the SAEP is reported to be a competent amphibole-mica schist, ranging in elevation from approximately –50 to –170 feet MSL.

Hydrogeology. Based on data from monitoring wells installed at SAEP, groundwater flow direction is easterly towards the Housatonic River, northwesterly towards Frash Pond, and toward the drainage channel in the southern portion of SAEP. There may be a groundwater divide and buried tidal inlets on SAEP, and other buried outlets from Frash Pond may pass under SAEP. These types of features appear to be a factor controlling groundwater movement patterns and fate of potential contaminants. Very little flow reversal, as related to tidal influences, have been measured.

Groundwater flow at the SAEP is influenced by three surface water features. The primary influence is that of the intertidal flats. Groundwater flow in the northern half of SAEP is in the direction of the intertidal flats at low tide.

A second surface water body influencing the groundwater flow at SAEP is Frash Pond, located approximately 300 feet from the northwest corner of SAEP. Frash Pond appears to be located downgradient of the northwest portion of SAEP. The airport, as well as other off-site properties, are also located upgradient of Frash Pond. Water elevations measured in monitoring wells suggest that groundwater from off-site locations south and west of the SAEP are flowing toward SAEP.

The third surface water body influencing groundwater flow at SAEP is the drainage channel located in the southern portion of SAEP. The presence of groundwater mounds in the shallow portion of the aquifer in this area of SAEP is due to the existence of a peat layer that causes a perched water condition above the peat. The area of SAEP influenced by groundwater flow to the drainage channel is limited to the former lagoon area in the vicinity of the drainage channel.

2.1.4.2 Causeway and Dike Geology. Based on the 1999 pre-design investigation activities, the shallow geology in the vicinity of the Causeway and Dike consists primarily of fill material. Figure 2-2 shows the Causeway and Dike exploration

locations. Interpretive geologic profile cross-sections A-A' and B-B' are shown on Figures 2-3 and 2-4, respectively.

Causeway geology. The Causeway consists of fill material that was originally deposited on the tidal flats of the Housatonic River during construction of the Causeway in the 1930s. The fill material consists of soil (i.e., coarse to fine sand), cobbles, and construction debris (e.g., metal, wood, rebar, asphalt, brick, and concrete). The depth of fill is approximately 10 to 12 feet throughout the Causeway, with lesser amounts in the low area just north of Building B-59. The thickness of the fill is greatest in the central portion of the Causeway, which coincides with the area of highest topographic relief. Below the Causeway fill material is very fine sand and silt overlying coarser sands. In general, the bedrock elevation in the vicinity of the Causeway is estimated to be approximately –95 to –120 feet MSL.

Dike geology. The Dike was constructed in 1951 to provide flood protection for the SAEP facility. Crushed stone and riprap cover the side slopes of the Dike, and an asphalt-paved road traverses the top of the Dike. Generally, the fill material consists of sand and gravel with varying amounts of cobbles.

2.1.5 Surrounding Land Use, Populations, and Sensitive Ecosystems

SAEP is bounded by a paved parking lot and wetlands to the north; the Housatonic River to the east; an open field, a drainage channel, and small commercial businesses to the south; and hangar buildings, the Sikorsky Memorial Airport, several small businesses, and Frash Pond to the west.

Land Use. Historically, land in the SAEP vicinity has been used for agricultural and residential purposes. At present, local land-based agricultural activities are practically nonexistent. The primary agricultural (aquaculture) activity in the area involves growing oysters. Oysters are seeded in areas of the Housatonic River in the spring, collected in the fall, and placed in Long Island Sound to mature. The seed oyster beds are carefully managed by the State of Connecticut Department of Agriculture because of concerns regarding bioaccumulation of contaminants from the Housatonic River.

The SAEP property is zoned light industrial, and land in the vicinity of SAEP is zoned light industrial, business, commercial, or residential. Recreational facilities in the area include Short Beach Park, and nearby public wildlife areas include Nells Island and the Great Meadow Salt Marsh.

Population. The Greater Bridgeport Regional Planning Agency's population census of Stratford was 49,389 people in 1990. Slow population growth has been a trend in Stratford for nearly two decades, and the Connecticut Office of Policy and Management anticipates a continued slow or declining growth rate for Stratford through the end of the century, with a population projection of 48,650 for the year 2000, and 45,800 for the year 2010 (Woodward-Clyde Consultants [W-C], 1991).

SAEP is located about 3/4-mile southeast of Johnson Junior High School and Birdseye School. SAEP is located about 1/2-mile northwest of Short Beach Park, which had over 80,000 users reported for the year 1991. There are several businesses located west of Main Street, across from SAEP, including a small strip mall, several gas stations, and a restaurant.

Access into the plant is restricted, with a perimeter fence and security guards. Boaters, fishermen, and shell fishers could potentially access unrestricted intertidal flats within SAEP property.

Drinking water sources. The Bridgeport Hydraulic Company supplies the cites of Bridgeport and Stratford with potable water from the Trap Falls Reservoir in Shelton, Connecticut, approximately 6.5 miles north-northwest (upgradient) of SAEP. In 1989, the Trap Falls Reservoir supplied drinking water to 99.9 percent of the population of Bridgeport and Stratford, including residents in the immediate area of SAEP. There are no water supply wells within a 0.5-mile radius of SAEP according to a well survey conducted by the Connecticut Department of Environmental Protection (CTDEP) and the Stratford Health Department.

Historic preservation. Two prehistoric archeological sites are reportedly located on SAEP property, as well as an Indian burial site (W-C, 1991). However, these sites are not located within the Causeway and Dike area.

Sensitive ecosystems. Freshwater wetlands, intertidal flats, and tidal marshes occur both in the vicinity of SAEP and on site. Freshwater wetlands in the vicinity are associated with Frash Pond, Salby Pond, and a small acreage of land abutting the SAEP property to the north. Intertidal flats in the vicinity are located in a band along the shoreline of the Housatonic River and Long Island Sound. SAEP's riparian rights encompass an estimated 51 acres of intertidal flats. Large tidal marshes occur in the vicinity of SAEP, including the Great Meadow Salt Marsh, areas along the Housatonic River, Nells Island, and land around Sikorsky Airport.

No federally-listed threatened or endangered mammalian, amphibian, invertebrate, aquatic, or plant species have been reported to occur in the vicinity of SAEP. Two federally-listed (the piping plover and roseate tern) and 11 state-listed threatened, endangered, or special concern birds have the potential to occur in the vicinity of SAEP. The intertidal flats area of SAEP may be feeding areas for the plover and tern.

2.1.6 Meteorology

The climate of the SAEP area is strongly influenced by a land-sea breeze, which is most pronounced from spring to early autumn. The sea breeze promotes air mixing, which results in slightly higher amounts of precipitation and slightly cooler temperatures at SAEP than inland.

The prevailing wind is from the southwest at an average speed of about 11 miles per hour. Precipitation averages about 44 inches per year, with about 16 inches per year of snowfall. Average monthly temperatures range from a low of about 28° Fahrenheit (F) in January, to a high of about 73°F in July.

SAEP is located in an area that is subjected to hurricanes, and has an intermediate tornado frequency. On average, SAEP is subject to hail approximately twice each year.

2.2 Previous Removal Actions

No previous CERCLA removal actions have been conducted at SAEP. Closure activities at SAEP have been conducted in accordance with the Resource Conservation and Recovery Act (RCRA). These activities include closure of three former storage lagoons, an equalization basin, and drum storage area. However, these former RCRA units were not located within the Causeway and Dike area.

2.3 Source, Nature, and Extent of Contamination

Soil samples collected during the 1999 pre-design investigation activities for the Causeway and Dike were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), Target Analyte List (TAL) inorganics, and asbestos. Soil samples collected above the water table were also analyzed for inorganics by the Synthetic Precipitate Leaching Procedure (SPLP).

Additionally, soil samples were collected on the Causeway by the CTDEP and AlliedSignal for radionuclide analysis.

The soil analytical data collected during the 1999 pre-design investigation activities for the Causeway and Dike were compared to the CTDEP Remediation Standard Regulation (RSR) Direct Exposure Criteria (DEC) and Pollutant Mobility Criteria (PMC). The Causeway and Dike area is proposed for future use as a recreational area, and the groundwater associated with the SAEP is classified as a GB area. Therefore, the CTDEP RSR DEC for residential exposure and the GB PMC were used in the data evaluation. Soil analytical data for asbestos were compared to the residential standard established for another TERC project (i.e., Raymark in Stratford, CT) of 1 percent total asbestos by the polarizing light microscope (PLM) method. The following subsections summarize the contamination assessment for the Causeway and Dike.

2.3.1 Causeway

A summary of the soil analytical data with concentrations exceeding the CTDEP RSR residential DEC and GB PMC is presented in Tables 2-1 and 2-2, respectively. A summary of the soil analytical data with concentrations exceeding the CTDEP RSR residential DEC and GB PMC is also shown on Figures 2-5 and 2-6, respectively. A detailed discussion of the analytical data is presented in Subsection 6.1.3 of the Pre-Design Investigation Report for the Causeway and Dike (Foster Wheeler/HLA, 2000).

The greatest extent of soil with contaminant concentrations exceeding the CTDEP RSR DEC and PMC is largely confined to the northern one-third and southern one-third of the Causeway. The soil in the central one-third of the Causeway also has contaminant concentrations exceeding the CTDEP RSR DEC and PMC; however, the contamination is somewhat more limited.

The Causeway is approximately 2.2 acres in size, with an average depth of approximately 10 to 12 feet. Based on these dimensions, the total volume of Causeway fill material is approximately 43,000 cubic yards (cy).

Chemical. The contaminants detected that exceed the CTDEP RSR DEC and PMC include chlorinated and fuel-related VOCs, SVOCs, PCBs, and inorganics. The concentrations of the contaminants detected and the CTDEP RSR DEC and PMC are presented in Tables 2-1 and 2-2.

Asbestos. Results of the samples analyzed for asbestos content by the PLM method indicated that asbestos was not detected in 23 of the 27 samples collected. Four samples have a trace (less than 1 percent) (by PLM) visual estimate of asbestos content, which is less than the residential standard of 1 percent total asbestos discussed previously in Section 2.3 of this EE/CA.

Radiological. Prior to the 1999 pre-design investigation activities, the CTDEP identified four areas of particular concern (TP-DEP-11, TP-DEP-12, TP-DEP-15, and TP-DEP-17) due to locally elevated radiological readings. According to the CTDEP, these areas showed elevated readings along linear trends; in plan view these trends are much longer in one direction relative to the other. Visually, the four test pits all contained a thin layer of grayish-white "clay-like" material. These layers are at relatively shallow depths (generally 12-inches or less) within each test pit, and appear to be the source of the elevated radiological readings.

The CTDEP and AlliedSignal collected representative samples of the whitish "clay-like" material from selected locations for radionuclide analysis. The results of these samples indicate the presence of thorium-234, thorium-228, and radium-226. The data collected by the CTDEP and AlliedSignal are summarized in Tables 2-3 and 2-4, respectively.

In January 2000, a radiological survey was conducted on the Causeway to further delineate the extent of radiological contaminated material. The survey identified three areas with elevated radiological readings. These areas are in the vicinity of: (1) TP-DEP-11, TP-DEP-12, and TP-99-26; (2) TP-DEP-15; and (3) TP-DEP-17 (see Figure 2-2).

The low-level radiological-contaminated material present in the Causeway fill material is scheduled to be removed, containerized, and transported to an appropriate off-site licensed treatment/disposal facility. It is anticipated that these activities will be completed by the spring 2000. Therefore, this radiological-contaminated material will not be included in the scope of the removal action alternatives evaluated in this EE/CA.

2.3.2 Dike

A summary of the soil analytical data with concentrations exceeding the CTDEP RSR residential DEC and GB PMC is presented in Tables 2-5 and 2-6, respectively. A summary of the soil analytical data with concentrations exceeding the CTDEP RSR residential DEC and GB PMC is also shown on Figures 2-5 and 2-6, respectively. A detailed discussion of the analytical data is presented in Subsection 6.2.3 of the Pre-Design Investigation Report for the Causeway and Dike (Foster Wheeler/HLA, 2000).

Chemical. The contaminants detected that exceed the CTDEP RSR DEC and PMC include chlorinated and fuel-related VOCs, SVOCs, and inorganics. These exceedances were detected in hand auger explorations HA-99-03, HA-99-07, and HA-99-08, which are located south of the Dike (see Figures 2-5 and 2-6). Additionally, the PCB Aroclor 1260 was detected at a concentration exceeding the CTDEP RSR DEC at one boring location (DB-99-08) on the Dike, located near the entrance to the Causeway (see Figure 2-2).

Asbestos. Results of the samples analyzed for asbestos content by the PLM method indicated that asbestos was not detected in 21 of the 24 samples collected. Three samples have a trace (less than 1 percent) visual (by PLM) estimate of asbestos content, which is

less than the residential standard of 1 percent total asbestos discussed previously in Section 2.3 of this EE/CA.

2.4 PRELIMINARY RISK EVALUATION

A risk evaluation is being conducted for surface and subsurface soils in the Causeway and Dike area as part of the RI for the SAEP facility, but will not be published until the spring of 2000. Therefore, the CTDEP RSR criteria will be used in the selection and implementation of removal actions at SAEP. The CTDEP has established RSR criteria for various media, including target concentrations for indoor air and criteria for soil, groundwater, and surface water. Soil analytical data for asbestos will be compared to the residential standard established for another TERC project (i.e., Raymark in Stratford, CT) of 1 percent total asbestos by the PLM method. Detected contaminant concentrations will be compared to the RSR criteria and the residential standard of 1 percent total asbestos, and the Causeway and Dike NCRA will address areas where contaminant concentrations in surface and subsurface soils exceed these criteria.

3.0 IDENTIFICATION OF REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES

The NCP states that an appropriate removal action may be conducted at a site when a threat to human health or welfare or the environment is determined. The removal action is undertaken to abate, minimize, stabilize, mitigate, or eliminate the release or the threat of release at a site. Section 300.415 of the NCP outlines factors to be considered when determining the appropriateness of a removal action, such as high concentrations of hazardous substances, pollutants, or contaminants in soil, largely at or near the surface, that may migrate.

Once it is decided that a removal action is appropriate, a determination is made whether the removal is an "emergency", "time-critical", or "non-time-critical" removal. "Emergencies" are those removals in which response actions must begin within hours or days after completion of the site evaluation. "Time-critical" removals are those for which, based on a site evaluation, it is determined there are less than six months available before on-site response activities must begin. "Non-time-critical" removals are those for which it is determined there are more than six months available before removal actions must begin. The removal action for the Causeway and Dike area is considered a "non-time-critical removal action" (i.e., NCRA).

The following subsections present the scope, goals, and objectives of the removal action, including the ARARs that will govern the removal action.

3.1 STATUTORY LIMITS OF REMOVAL ACTION

CERCLA Section 104(c)(1) has established statutory limits for Superfund-financed removal actions, which require that removal actions be terminated after $2 million has been allocated for the removal or 12 months have elapsed since the removal was initiated. Funding for removal activities at SAEP will be provided through the Department of

Defense's Defense Environmental Restoration Account, rather than Superfund. Therefore, the CERCLA duration and cost limitations are used only as guidance for this EE/CA.

3.2 DETERMINATION OF REMOVAL ACTION SCOPE

To determine the scope of the Causeway and Dike NCRA, the data collected during pre-design field investigations (Foster Wheeler/HLA) were compared to the CTDEP RSRs. Based on the contamination assessment presented in Section 2.3, there are exceedances of the CTDEP RSRs throughout the Causeway fill material. As discussed in Section 2.3, asbestos-containing material has not been identified that exceeds the residential standard of 1 percent total asbestos. Additionally, the radiological-contaminated material identified during previous site investigations will be addressed outside the scope of this Causeway and Dike NCRA.

There are also exceedances of CTDEP RSRs at three hand auger locations south of the Dike (i.e., HA-99-03, HA-99-07, and HA-99-08) (see Figures 2-5 and 2-6). Because theses locations are not within the Dike, and the horizontal and vertical extent of contamination at these locations has not been fully defined, these areas will be addressed in the Feasibility Study for the remainder of the SAEP facility. Therefore, the scope of the Causeway and Dike NCRA includes only the Causeway, where surface and subsurface soils exceed the CTDEP RSRs.

3.3 DETERMINATION OF REMOVAL ACTION SCHEDULE

Because the removal action is not financed by Superfund, it is exempt from the 12-month statutory limit. Implementation of the Causeway and Dike NCRA is anticipated to begin in the summer of 2000.

3.4 REMOVAL ACTION OBJECTIVES

The objective of the Causeway and Dike NCRA is to prevent exposure to contaminated soils in accordance with the CTDEP RSR DEC (residential exposure scenario) and PMC (GB area).

The Causeway and Dike area is proposed for use as a recreational area, which would include a landscaped park with pathways for pedestrians and bicyclists, public water access from a new dock located at the end of the former seaplane boat ramp at the end of the Causeway, and an off-street parking area. Therefore, for shallow soil, the CTDEP RSR residential DEC will be used for the Causeway and Dike NCRA. The groundwater associated with the SAEP is classified as a GB area. Therefore, for subsurface soil, the CTDEP RSR GB PMC will be used for the Causeway and Dike NCRA.

3.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The NCP requires that removal actions pursuant to CERCLA Section 106 attain ARARs under federal or state environmental laws or facility citing laws to the extent practicable considering the urgency of the situation and the scope of the removal action.

ARARs are federal and state human health and environmental requirements and guidelines used to (1) evaluate the appropriate extent of site cleanup; (2) define and formulate removal action alternatives; and (3) govern implementation and operation of the selected action. Only those promulgated state requirements identified by the state in a timely manner that are more stringent than federal requirements may be ARARs.

Under CERCLA Section 121(e), permits are not required for response actions conducted entirely on site. This permit exemption applies to administrative permit requirements (e.g., documentation, recordkeeping, and enforcement). However, compliance with the substantive requirements of applicable regulations must be achieved.

The NCP defines three categories of potential requirements in the remedial response process: (1) applicable requirements, (2) relevant and appropriate requirements, and (3) information to be considered. These definitions are discussed in the following paragraphs.

- **Applicable requirements** are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. An example of an applicable requirement is the use of Maximum Contaminant Level (MCL) drinking water standards for a site where groundwater contamination has affected a public water supply.

- **Relevant and appropriate requirements** are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. There is discretion in this determination in that it is possible for only part of a requirement to be considered relevant and appropriate, the rest being dismissed if judged not to be relevant and appropriate in a given case. For example, MCLs for drinking water would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential, rather than actual, drinking water source.

- **Information to be considered** is nonpromulgated advisories or guidance issued by the federal or state government that are not legally binding, and do not have the status of potential ARARs. However, if there are no specific ARARs for a chemical or site condition, or if existing ARARs are not deemed sufficiently

protective, then guidance or advisory criteria should be identified and used to confirm protection of human health and the environment.

Development of a comprehensive inventory of ARARs involves a two-tiered analysis: establishing the applicability of an environmental regulation, and evaluating relevancy and appropriateness if the regulation is not applicable. A requirement may be "applicable" or "relevant and appropriate", but not both.

Because of their site-specific nature, identification of ARARs requires evaluation of federal, state, and local environmental and health regulations regarding chemicals of concern, site characteristics, and proposed remedial alternatives. Requirements that pertain to the remedial response at a CERCLA site can be categorized in three distinct areas:

- **Chemical-specific ARARs** are typically health- or risk-based numerical values or methodologies that establish site-specific acceptable chemical concentrations or amounts. These values are used to develop action levels or clean-up concentrations.

- **Location-specific ARARs** involve restrictions established for specific substances or activities based on their location.

- **Action-specific ARARs** involve performance, design, or other action-specific requirements and are generally technology- or activity-based.

A discussion of chemical- and location-specific ARARs, and potential action-specific ARARs is presented in the following subsections.

3.5.1 Chemical-specific ARARs

Chemical-specific ARARs are numerical values or procedures that, when applied to a specific site, establish numerical limits for individual chemicals or groups of chemicals.

These ARARs will govern the extent of site remediation by providing either actual cleanup levels or the basis for calculating such levels.

There are no promulgated federal standards for soil. However, the CTDEP RSR includes standards for soil remediation. Therefore, as stated previously in Subsection 3.4 of this EE/CA, the appropriate DEC and PMC, in accordance with the CTDEP RSR, will govern the cleanup for the Causeway and Dike NCRA. The chemical-specific ARARs are presented in Table 3-1.

3.5.2 Location-specific ARARs

Location-specific ARARs set restrictions on the concentrations of hazardous substances or the performance of activities solely because they are in special locations. These ARARs set restrictions relative to special locations such as wetlands, floodplains, sensitive ecosystems, and historical or archeological sites, and provide a basis for assessing existing site conditions. The location-specific ARARs are presented in Table 3-2.

3.5.3 Action-specific ARARs

Action-specific ARARs, unlike chemical- or location-specific ARARs, are usually technology- or activity-based limitations that direct how removal actions are conducted. The applicability of this set of requirements is directly related to the particular activities selected for the site. Evaluation of action-specific ARARs is one criterion for assessing the feasibility and effectiveness of proposed removal alternatives. The potential action-specific ARARs that may apply to the proposed removal alternatives identified in this EE/CA are presented in Table 3-3. The action-specific ARARs for the selected removal action alternative will be presented in the Causeway and Dike RAM.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Section 300.415 of the NCP provides examples of removal actions appropriate for a range of situations. These examples include:

- Fences, warning signs, or other security or site control;
- Stabilization of berms, dikes, or impoundments;
- Using chemicals and other materials to retard the spread of the release or to mitigate its effects;
- Excavation, consolidation, or removal of highly contaminated soils; and
- Containment, treatment, disposal, or incineration of hazardous materials.

Although the NCP provides examples of removal actions, it sets forth no specific requirements for identifying and evaluating removal alternatives. USEPA guidance on preparing EE/CAs suggests identifying and assessing a limited number of alternatives appropriate for addressing the removal action objectives, while considering the CERCLA preference for treatment. The guidance also suggests the use of presumptive remedy guidance to provide an immediate focus to the discussion and selection of alternatives, and limit the universe of alternatives for NCRAs (USEPA, 1993b).

Following development of a limited number of removal action alternatives, the alternatives are evaluated using the effectiveness, implementability, and cost criteria set forth in the NCP and USEPA guidance on preparing EE/CAs.

The effectiveness of each alternative is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment

- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Implementability addresses the technical and administrative feasibility of implementing the alternative, and is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

State and community acceptance will be addressed following regulatory agency and public review of this EE/CA.

A cost estimate was prepared for each alternative to help in selection of a removal action. Each estimate contains the capital cost (including direct and indirect costs) and operation and maintenance (O&M) costs.

As discussed in Section 2.0 of this EE/CA, the Causeway is constructed of fill material consisting largely of construction debris (concrete, brick, asphalt, wood, and rebar), with lesser amounts of glacial material (medium to fine sand and gravelly sand).

Due to the heterogeneous nature of the fill and the large percentage of construction debris, treatment technologies, either in-situ or ex-situ, are not feasible for addressing the subsurface contamination present in the Causeway. Therefore, the general response actions considered for this NCRA are containment and removal/disposal.

The following subsections provide a detailed description of the alternatives, and evaluate the alternatives using the effectiveness, implementability, and cost criteria. The removal action alternatives evaluated in the following subsections are:

Alternative 1 Capping with Hydraulic Barrier
Alternative 2 Capping with Composite Cover System
Alternative 3 Excavation and Off-site Disposal

4.1 ALTERNATIVE 1 – CAPPING WITH HYDRAULIC BARRIER

The scope of Alternative 1 includes the following components:

- Demolition of Building 59 and other structures (concrete ramp and pad);
- Capping the Causeway with a hydraulic barrier cover system;
- Covering the Causeway with a Stone/Riprap Armor; and
- Establishing environmental land use restrictions.

4.1.1 Description of the Alternative

The removal action provided under Alternative 1 consists primarily of containment of the contaminated fill material within the Causeway by constructing a low permeability (hydraulic barrier) cover system. The low-level radiological-contaminated material identified during previous site investigations is scheduled to be removed, containerized, and transported to an appropriate off-site licensed treatment/disposal facility by the spring of 2000. Therefore, this radiological-contaminated material is not included in the scope of this alternative.

For this alternative, it is assumed the existing Causeway toe of slope location would be maintained. In order to maintain the location of the toe and construct the cap, the existing toe and side slope materials would be excavated and re-consolidated on top of the Causeway. It was also assumed the Causeway would be initially re-graded by cutting

and filling existing material to establish base grades. In addition, Building 59 and the concrete ramp and pad would be demolished prior to cap construction.

On top of the Causeway, the cover system (from bottom to top) would consist of:

- 12-inch sand bedding/gas venting layer;
- flexible membrane liner (FML);
- 18-inch sand protection layer; and
- 36-inch thick riprap/stone armor.

The riprap armor over the entire Causeway has been provided to ensure protection of the cover from storm surge or wave action. It has been assumed that the average stone size required for the armor protection would be approximately 600 pounds. The sand layers above and below the FML are provided to protect the liner. The sand layer below the FML would also include perforated piping connected to vertical vents to allow this layer to serve as a passive gas venting layer. If necessary, this passive system could later be converted to an active gas treatment system. The FML (the hydraulic barrier) would consist of a 60-mil geomembrane material, either high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), or polyvinyl chloride (PVC). A detail of the cover system for Alternative 1 is provided on Figure 4-1.

In accordance with the CTDEP RSR, an environmental land use restriction would be required for the Causeway. The environmental land use restriction would establish restrictions on the future use of the Causeway to (1) prevent exposure to the contaminated Causeway fill material, and (2) maintain the integrity of the cover system that would be installed as part of this removal action alternative.

4.1.2 Effectiveness

The effectiveness of Alternative 1 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. The CTDEP RSR allows use of an engineered control (e.g., cover or containment system) to isolate contaminated soil. Alternative 1 provides protection of human health and the environment primarily through engineering controls (i.e., cover system) to eliminate receptor exposure to the contaminated Causeway fill material, and institutional controls (i.e., environmental land use restrictions in accordance with CTDRP RSR) to establish restrictions on the future use of the Causeway and maintain the integrity of the cover system.

Compliance with ARARs. Alternative 1 would be designed and implemented to attain the identified federal and state ARARs.

Long-term effectiveness. Alternative 1 would provide long-term effectiveness by capping the Causeway, which will prevent exposure to the contaminated fill material and minimize the leaching of contaminants due to precipitation infiltrating through the contaminated fill material. The riprap armor over the Causeway would provide protection of the cover from storm surge or wave action. To ensure the long-term integrity of the cap, periodic inspection and maintenance would be required.

Alternative 1 may not prevent water from the tidal action of the Housatonic River in contacting some of the contaminated material and potentially transporting soluble

contaminants out of the limits of the cap. Potential groundwater contamination associated with the Causeway will be addressed in the Feasibility Study for the SAEP facility.

Reduction of toxicity, mobility, or volume through treatment. Alternative 1 does not include active treatment and therefore, does not satisfy the CERCLA statutory preference for treatment. Alternative 1 does not provide a reduction in the toxicity of contaminants; however, capping the contaminated Causeway fill material would minimize the leaching of contaminants due to precipitation infiltrating through the contaminated fill material.

Short-term effectiveness. The short-term effectiveness criterion addresses the effects of the alternative during implementation, including the protection of the community and site workers, environmental impacts, and the time until the response objectives are achieved.

Access to the SAEP facility is restricted. The activities associated with Alternative 1 would be conducted in areas where access is limited to trained workers. Therefore, potential risks to the community would be minimized. Alternative 1 has potential short-term risks to site workers; however, these risks would be minimized by effectively implementing an approved site-specific health and safety plan.

Alternative 1 has the potential for short-term adverse effects on ecological receptors resulting from excavation of contaminated material and installation of the cap. To prevent the migration of contaminated material out of the work area and to minimize environmental impacts, erosion and sediment control measures would be implemented. In addition, a portable dam would be installed around the Causeway to facilitate construction and to prevent adverse effects on the adjacent tidal flats.

It is anticipated that implementation of Alternative 1 could be completed in approximately ten months, at which time the response objectives would be achieved.

4.1.3 Implementability

The implementability of Alternative 1 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative 1 is considered technically feasible for the Causeway. Capping of contaminated material that has been land disposed is a commonly used and reliable remediation technology. During implementation of the alternative, construction practices and schedules would need to consider the tidal/wave actions of the Housatonic River.

Technical feasibility issues associated with construction of a cover system in a tidal river environment would be addressed during design of the cover system. The Causeway is underlain by loose river sediments, which are potentially highly organic and approximately 60 feet thick. It is not anticipated that construction of the cover system would result in significant differential settlement, and therefore, the alternative does not currently include pre-loading of the Causeway prior to construction of the cover system. However, design issues include settlement, slope and global stability, and erosion of the cover system due to tidal and storm surges. Pre-design activities would include geotechnical investigation and evaluation of settlement and stability. Additionally, further evaluation of the effects of the tidal river environment on the Causeway cover system would be conducted (e.g., size and thickness of the stone/rock armor layer of the cover system to minimize potential future erosion).

Administrative feasibility. Alternative 1 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements would be met. Additionally, an environmental land use restriction would be implemented for the Causeway in accordance with the CTDEP RSR.

Availability of services and materials. Alternative 1 can be implemented using standard or commonly available construction methods, services, and materials. Alternative 1 includes demolition (e.g., Building 59), earthwork activities, and installation of an FML. Experienced contractors and materials necessary for construction are readily available. Off-site licensed treatment, storage, and disposal facilities (TSDFs) for demolition debris (e.g., Building 59) are also available.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

4.1.4 Cost

The 30-year net worth of this alternative is estimated to be $5,301,861 for capital and O&M costs. O&M costs include monitoring and maintenance of the cover system and five-year site reviews. Groundwater monitoring will be included in the Feasibility Study for the remainder of the SAEP facility.

Consistent with USEPA guidance, a discount rate of seven percent before taxes and after inflation was used to prepare the cost estimate (USEPA, 1993a). The cost evaluation for this alternative is provided in Table 4-1.

The following assumptions were used in preparing the cost estimate for Alternative 1:

- The low-level radiological-contaminated material would be removed, containerized, and transported to an off-site TSDF prior to implementation of this alternative.
- The existing Causeway toe of slope location would be maintained, requiring existing toe and slope material to be excavated and re-consolidated on top of the Causeway.
- A portable dam would be used around the Causeway to facilitate construction and to prevent adverse effects on the adjacent tidal flats.
- HDPE was used for the FML.
- An average stone size of 600 pounds in a 3-foot thick layer was used for the riprap/stone armor. Placement of the rock would be by heavy equipment with positioning assisted by laborers to provide a relatively flat finished surface.
- A passive gas venting layer would be included below the FML.
- Pre-design activities include geotechnical investigation and evaluation for settlement, slope and global stability.
- Engineering activities include evaluation and design of the riprap/stone armor to withstand storm surges.
- The alternative could be implemented in approximately ten months.
- Unit costs are based on vendor-supplied information, recently completed projects with similar tasks and materials, and unit costs from 1999 R.S. Means Site Work Cost Data.

4.2 ALTERNATIVE 2 - CAPPING WITH COMPOSITE COVER SYSTEM

The scope of Alternative 2 includes the following components:

- Demolition of Building 59 and other structures (concrete ramp and pad);
- Installation of a sheet pile seawall;
- Capping the Causeway with a composite cover system;

- Covering the Causeway with a Stone/Riprap Armor; and
- Establishing environmental land use restrictions.

4.2.1 Description of the Alternative

The removal action for Alternative 2 would be similar to Alternative 1, in that containment of the contaminated fill material within the Causeway is provided by constructing a low permeability (hydraulic barrier) cover system. However, the cover system for Alternative 2 is more rigorous than that provided in Alternative 1 and would satisfy the cover requirements for a RCRA hazardous waste landfill. The low-level radiological-contaminated material identified during previous site investigations is scheduled to be removed, containerized, and transported to an appropriate off-site licensed treatment/disposal facility by the spring of 2000. Therefore, this radiological-contaminated material is not included in the scope of this alternative.

Like Alternative 1, it is assumed that the existing location of the Causeway toe of slope would be maintained. A sheet pile seawall would be installed at the existing toe location. It has been assumed that some of the existing fill material near the toe of slope would require excavation in order to install the sheet pile seawall. The excavated toe material would be re-consolidated on top of the Causeway. The sheet pile seawall would provide protection from tidal and wave action, serve as the limit of the cover system, and act as a hydraulic barrier. A UV-stabilized vinyl (i.e., PVC) sheet pile material was selected for this alternative because it provides excellent weatherability properties and is not degraded by marine organisms, rust, rot, or corrosion, thus providing superior service life. For added wall stability, the sheet pile wall would be tied-back into the Causeway above and below the cover system with a geogrid attached to wales. During design of the alternative, further evaluation of the PVC sheet pile seawall would be conducted. An alternate material that might be considered for the seawall is steel. However, a steel sheet pile seawall would likely need to be installed to greater depths, at significantly greater cost. Following seawall installation, the Causeway would be re-graded by cutting and

filling existing material to establish base grades. In addition, Building 59 and the concrete ramp and pad would be demolished prior to cap construction.

The cover system for Alternative 2 (from bottom to top) would consist of:

- 12-inch sand bedding/gas venting layer;
- geocomposite clay liner (GCL);
- flexible membrane liner (FML);
- geocomposite drainage layer (GDL);
- 18-inch filter/sand protection layer;
- 36-inch thick riprap/stone armor.

In addition to the seawall, a riprap armor over the entire Causeway has been provided to ensure protection of the cover from storm surge or wave action. It has been assumed that the average stone size required for the armor protection would be approximately 600 pounds. The hydraulic barrier layer for Alternative 2 would consist of two components, a GCL and a FML. The GCL is a hydraulic barrier made of clay (natural sodium bentonite) encapsulated between two or more layers of geotextile. GCLs are used as substitutes for compacted clay liners, which allows for a thinner cover cross-section and provides advantages in cost, ease of installation and performance. The FML would consist of a 60-mil geomembrane material, either HDPE, LLDPE, or PVC. The sand-bedding layer is provided to protect the GCL and the FML from punctures due to the nature of the existing fill material. This sand layer would also include perforated piping connected to vertical vents to allow this layer to serve as a passive gas venting layer. If necessary, this passive system could later be converted to an active gas treatment system. A GDL would be placed above the FML to facilitate drainage of the cover system and lower the hydraulic head behind the sheet pile wall. The GDL consists of a geonet sandwiched between two layers of geotextile. The GDL provides the advantage of a thinner cover cross-section and ease of construction over conventional graded aggregate

and/or perforated-pipe subsurface drainage systems. A detail of the cover system for Alternative 2 is provided on Figure 4-2.

In accordance with the CTDEP RSR, an environmental land use restriction would be required for the Causeway. The environmental land use restriction would establish restrictions on the future use of the Causeway to (1) prevent exposure to the contaminated Causeway fill material and (2) maintain the integrity of the cover system that would be installed as part of this removal action alternative.

4.2.2 Effectiveness

The effectiveness of Alternative 2 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. The CTDEP RSR allows use of an engineered control (e.g., cover or containment system) to isolate contaminated soil. Alternative 2 provides protection of human health and the environment primarily through engineering controls (i.e., cover system) to eliminate receptor exposure to the contaminated Causeway fill material, and institutional controls (i.e., environmental land use restrictions) to establish restrictions on the future use of the Causeway and maintain the integrity of the cover system.

Compliance with ARARs. Alternative 2 would be designed and implemented to attain the identified federal and state ARARs.

Long-term effectiveness. Alternative 2 would provide long-term effectiveness by capping the Causeway, which will prevent exposure to the contaminated fill material and minimize the leaching of contaminants due to precipitation infiltrating through the contaminated fill material. The riprap armor over the Causeway would provide protection of the cover from storm surge or wave action. To ensure the long-term integrity of the cap, periodic inspection and maintenance would be required.

Alternative 2 would not prevent water from the tidal action of the Housatonic River in contacting some of the contaminated material. However, the sheet pile seawall does have the ability to provide some measure of protection as a hydraulic barrier. The composite cover system (i.e., FML and GCL barrier layer) in conjunction with the sheet pile seawall would minimize the transport of contaminants, especially from areas of the Causeway with elevated contaminant concentrations, outside the limits of the cover system. Potential groundwater contamination associated with the Causeway will be addressed in the Feasibility Study for the SAEP facility.

Reduction of toxicity, mobility, or volume through treatment. Alternative 2 does not include active treatment and therefore, does not satisfy the CERCLA statutory preference for treatment. Alternative 2 does not provide a reduction in the toxicity of contaminants. The cap and seawall components of Alternative 2 provide a reduction in the mobility of contaminants. Capping the contaminated Causeway fill material would minimize the leaching of contaminants due to precipitation infiltrating through the contaminated fill material. The sheet pile seawall provides additional protection as a barrier to minimize the potential of transporting soluble contaminants outside the limits of the cap.

Short-term effectiveness. The short-term effectiveness criterion addresses the effects of the alternative during implementation, including the protection of the community and site workers, environmental impacts, and the time until the response objectives are achieved.

Access to the SAEP facility is restricted. The activities associated with Alternative 2 would be conducted in areas where access is limited to trained workers. Therefore,

potential risks to the community would be minimized. Alternative 2 has potential short-term risks to site workers; however, these risks would be minimized by effectively implementing an approved site-specific health and safety plan.

Alternative 2 has the potential for short-term adverse effects on ecological receptors resulting from excavation of contaminated material and installation of the cap. To prevent the migration of contaminated material out of the work area and to minimize environmental impacts, erosion and sediment control measures would be implemented. In addition, a portable dam would be installed around the Causeway to facilitate construction and to prevent adverse effects on the adjacent tidal flats. The sheet pile seawall would also provide an effective means to prevent the spread of contaminated material.

It is anticipated that implementation of Alternative 2 could be completed in approximately ten months, at which time the response objectives would be achieved.

4.2.3 Implementability

The implementability of Alternative 2 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative 2 is considered technically feasible for the Causeway. Capping of contaminated material that has been land disposed is a commonly used and reliable remediation technology. Installation of a sheet pile seawall is also a commonly

used construction technique. During implementation of the alternative, construction practices and schedules would need to consider the tidal/wave actions of the Housatonic River.

Technical feasibility issues associated with construction of a cover system in a tidal river environment would be addressed during design of the cover system. The Causeway is underlain by loose river sediments, which are potentially highly organic and approximately 60 feet thick. It is not anticipated that construction of the cover system would result in significant differential settlement, and therefore, the alternative does not currently include pre-loading of the Causeway prior to construction of the cover system. However, design issues include settlement, slope and global stability, sheet pile serviceability and structural stability, and erosion of the cover system due to tidal and storm surges. Pre-design activities would include geotechnical investigation and evaluation of settlement, structural stability, and sheet pile serviceability and stability (e.g., driveability, weather resistance, tide fluctuations, and seam leakage). Additionally, further evaluation of the effects of the tidal river environment on the Causeway cover system would be conducted (e.g., size and thickness of the stone/rock armor layer of the cover system to minimize potential future erosion).

Administrative feasibility. Alternative 2 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements would be met. Additionally, an environmental land use restriction would be implemented for the Causeway in accordance with the CTDEP RSR.

Availability of services and materials. Alternative 2 can be implemented using standard or commonly available construction methods, services, and materials. Alternative 2 includes demolition (e.g., Building 59), sheet pile seawall construction, earthwork activities, and installation of a soil and geosynthetic composite cover system. Experienced contractors and materials necessary for construction are readily available. Off-site licensed TSDFs for demolition debris (e.g., Building 59) are also available.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

4.2.4 Cost

The 30-year net worth of this alternative is estimated to be $6,682,843 for capital and O&M costs. O&M costs include monitoring and maintenance of the cover system and five-year site reviews. Groundwater monitoring will be included in the Feasibility Study for the remainder of the SAEP facility.

Consistent with USEPA guidance, a discount rate of seven percent before taxes and after inflation was used to prepare the cost estimate (USEPA, 1993a). The cost evaluation for this alternative is provided in Table 4-2.

The following assumptions were used in preparing the cost estimate for Alternative 2:

- The low-level radiological-contaminated material would be removed, containerized, and transported to an off-site TSDF prior to implementation of this alternative.
- The existing Causeway toe of slope location would be maintained, requiring existing toe and slope material to be excavated and re-consolidated on top of the Causeway.
- The sheet pile seawall consists of 24-fot lengths of vinyl sheet pile with two geogrid tie-back locations and pressure-treated timber wales and cap.
- A portable dam would be used around the Causeway to facilitate construction and to prevent adverse effects on the adjacent tidal flats.
- HDPE was used for the FML.

- An average stone size of 600 pounds in a 3-foot thick layer was used for the riprap/stone armor. Placement of the rock would be by heavy equipment with positioning assisted by laborers to provide a relatively flat finished surface.
- A passive gas venting layer would be included below the FML.
- Pre-design activities include geotechnical investigation and evaluation for settlement, slope and global stability, and sheet pile serviceability and stability.
- Engineering activities include evaluation and design of the riprap/stone armor to withstand storm surges.
- The alternative could be implemented in approximately ten months.
- Unit costs are based on vendor-supplied information, recently completed projects with similar tasks and materials, and unit costs from 1999 R.S. Means Site Work Cost Data.

4.3 ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL

The scope of Alternative 3 includes the following components:

- Demolition of Building 59 and other structures (concrete ramp and pad);
- Excavation of the Causeway fill material; and
- Off-site disposal of the excavated Causeway material.

4.3.1 Description of the Alternative

The removal action provided under Alternative 3 consists of excavation and proper off-site disposal of the contaminated fill material within the Causeway. Reconstruction of the Causeway was not considered under this alternative.

The low-level radiological-contaminated material identified during previous site investigations is scheduled to be removed, containerized, and transported to an

appropriate off-site licensed treatment/disposal facility by the spring of 2000. Therefore, this radiological-contaminated material is not included in the scope of this alternative.

Initial activities would include demolition of Building 59 and the concrete ramp and pad. The demolition debris would be transported and disposed of at an appropriate off-site licensed TSDF.

The excavation of the fill material would begin at the end of the Causeway and progress toward the main shore. Based on available data, it appears the fill thickness is approximately 10 to 14 feet over an area of approximately 2.2 acres. The total estimated volume of fill material that would require excavation is 43,000 cy. Pre-excavation sampling and analysis for waste characterization would eliminate the need to provide for temporary stockpiling of excavated material on-site prior to transportation and disposal. Reconstruction of the Causeway with clean fill was not included under this alternative. A new section of riprap dike would be constructed at the location where the Causeway once joined the main shore.

4.3.2 Effectiveness

The effectiveness of Alternative 3 is evaluated in accordance with the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness

Overall protection of human health and the environment. Alternative 3 provides protection of human health and the environment by physically removing the

contaminated Causeway fill material from the SAEP site with treatment and/or disposal of the contaminated material at appropriate licensed off-site TSDFs.

Compliance with ARARs. Alternative 3 would be designed and implemented to attain the identified federal and state ARARs.

Long-term effectiveness. Alternative 3 would provide long-term effectiveness by physically removing the contaminated Causeway fill material from the SAEP site.

Reduction of toxicity, mobility, or volume through treatment. Alternative 3 provides a reduction in mobility of contaminants by removing the contaminated fill material from the site and transporting the material to an appropriate licensed off-site TSDF. Excavation of the contaminated Causeway fill material reduces the toxicity and volume of contaminants at the site; however, the contaminated material is simply transferred to another facility (i.e., off-site TSDF).

Short-term effectiveness. The short-term effectiveness criterion addresses the effects of the alternative during implementation, including the protection of the community and site workers, environmental impacts, and the time until the response objectives are achieved.

Access to the SAEP facility is restricted. With the exception of transportation of demolition debris (e.g., Building 59) and excavated contaminated fill material, the activities associated with Alternative 3 would be conducted in areas where access is limited to trained workers. Therefore, potential risks to the community would be minimized. Alternative 3 has potential short-term risks to site workers; however, these risks would be minimized by effectively implementing an approved site-specific health and safety plan.

Alternative 3 has the potential for short-term adverse effects on ecological receptors resulting from excavation of contaminated material. To prevent the migration of contaminated material out of the work area and to minimize environmental impacts,

erosion and sediment control measures would be implemented. In addition, a portable dam would be installed around the Causeway to facilitate excavation and to prevent adverse effects on the adjacent tidal flats.

It is anticipated that implementation of Alternative 3 could be completed in approximately five months, at which time the response objectives would be achieved.

4.3.3 Implementability

The implementability of Alternative 3 is evaluated in accordance with the following criteria:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials
- State acceptance
- Community acceptance

Technical feasibility. Alternative 3 is considered technically feasible for the Causeway. Excavation and off-site disposal of contaminated material is a commonly used and reliable remediation technology. During implementation of the alternative, construction practices and schedules would need to consider the tidal/wave actions of the Housatonic River.

Administrative feasibility. Alternative 3 is considered feasible from an administrative aspect. Although permits are not required for on-site CERCLA actions, the substantive requirements will be met.

Availability of services and materials. Alternative 3 can be implemented using standard or commonly available construction methods, services, and materials.

Alternative 3 includes demolition (e.g., Building 59), earthwork activities, and transportation/treatment/disposal of contaminated material. Experienced contractors and materials necessary for construction are readily available. Off-site licensed TSDFs are also available for the contaminated Causeway fill material.

State and community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. Comments and concerns raised by the state regulatory agencies and the community will be considered in the final selection of the removal action alternative in the RAM.

4.3.4 Cost

The total capital cost for this alternative is estimated to be $18,349,359. No O&M costs are included as part of this alternative. The cost for this alternative is highly dependent on the percentages of excavated material that are characterized for disposal as non-hazardous versus hazardous. For this cost analysis, it was assumed 50 percent of the excavated material would be non-hazardous and 50 percent would be hazardous. The cost evaluation for this alternative is provided in Table 4-3.

The following assumptions were used in preparing the cost estimate for Alternative 3:

- The low-level radiological-contaminated material would be removed, containerized, and transported to an off-site TSDF prior to implementation of this alternative.
- The volume of Causeway material to be excavated is approximately 43,000 cubic yards (12 feet deep over approximately 2.2 acres).
- Reconstruction of the Causeway is not included as a component of the alternative.
- The Causeway material to be excavated consists of 50 percent non-hazardous material and 50 percent hazardous material.

- Characterization sampling for disposal of the Causeway material would be required at a rate of approximately one sample per 200 cy and analyzed for full-suite TCLP and TCL PCBs.
- Following excavation of the Causeway fill material, confirmation sampling would be conducted at a rate of approximately one sample per 500 square feet and analyzed for full-suite VOCs, SVOCs, PCBs, inorganics, and TCLP.
- Dewatering fluids encountered during excavation activities would be routed through the on-site Oil Abatement Ttreatment Plant prior to discharge to surface water.
- A portable dam would be used around the Causeway to facilitate excavation and to prevent adverse effects on the adjacent tidal flats.
- The alternative could be implemented in approximately five months.
- Unit costs are based on vendor-supplied information, recently completed projects with similar tasks and materials, and unit costs from 1999 R.S. Means Site Work Cost Data.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section presents a comparative analysis of the removal action alternatives described in Section 4.0 of this EE/CA. The comparative analysis is a comparison of the alternatives relative to the evaluation criteria. The purpose of the comparative analysis is to identify the advantages and disadvantages of the alternatives relative to one another, and to aid in the eventual selection of a removal alternative.

5.1 APPROACH TO THE COMPARATIVE ANALYSIS

Specific CERCLA requirements are considered when comparing alternatives for selection of a preferred site remedy. The NCP outlines the approach for performing the comparative analysis of alternatives. The recommended alternative must reflect the scope and purpose of the actions being undertaken and indicate how these actions relate to other removal and remedial actions, and the long-term response at the site. Identification of the preferred alternative and final remedy selection are based on an evaluation of the major tradeoffs among the alternatives in terms of the CERCLA evaluation criteria. The USEPA categorizes these evaluation criteria into three groups: threshold, balancing, and modifying. Each of these groups is discussed in the following subsections.

5.1.1 Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP.

- **Overall protection of human health and the environment** addresses whether or not the remedy provides adequate protection to human health and the environment and describes how risks posed through each pathway are

eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- **Compliance with ARARs** addresses whether or not the remedy will meet all of the ARARs of federal and more stringent state environmental laws and/or provide grounds for invoking a waiver.

5.1.2 Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria.

- **Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.
- **Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.
- **Short-term effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.
- **Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.
- **Cost** includes estimated capital costs (indirect and direct) and O&M costs.

5.1.3 Modifying Criteria

The modifying criteria are used on the final evaluation of alternatives, generally after the public comment period on the EE/CA.

- **State acceptance** addresses the state's position and key concerns related to the preferred alternative and other alternatives, and the state's comments on ARARs and to be considered information or the proposed use of waivers.
- **Community acceptance** addresses the public's general response to the alternatives described in the EE/CA.

5.2 COMPARATIVE ANALYSIS

The following removal action alternatives were evaluated in detail in Section 4.0 and will undergo comparative analysis in this section:

Alternative 1 Capping with Hydraulic Barrier
Alternative 2 Capping with Composite Cover System
Alternative 3 Excavation and Off-site Disposal

5.2.1 Comparison of Threshold Criteria

Overall protection of human health and the environment. Alternatives 1, 2, and 3 are protective of human health and the environment by eliminating, reducing, or controlling risks posed by the site. Alternatives 1 and 2 provide overall protection to human health and the environment by using an engineered control (e.g., capping system) to eliminate receptor exposure to the contaminated Causeway fill material, and an environmental land use restriction for the Causeway to ensure that the integrity of the capping system is maintained. Alternative 2 provides additional protection to human health and the environment over Alternative 1 because (1) the cover system includes a composite barrier (i.e., FML and GCL), rather than an FML alone; and (2) the sheet pile seawall provides

additional protection as a barrier to minimize the potential of transporting soluble contaminants outside the limits of the cap. Alternative 3 also provides overall protection of human health and the environment by physically removing the contaminated Causeway fill material from the SAEP site with treatment and/or disposal of the contaminated material at appropriate licensed off-site TSDFs.

Compliance with ARARs. Alternatives 1, 2 and 3 would be designed and implemented to attain their respective federal and state ARARs.

5.2.2 Comparison of Primary Balancing Criteria

Long-term effectiveness and permanence. Alternatives 1, 2, and 3 all provide long-term effectiveness and permanence. Alternatives 1 and 2 provide long-term effectiveness by capping the Causeway, which will prevent exposure to the contaminated fill material and minimize the leaching of contaminants due to precipitation infiltrating through the contaminated fill material. Additionally, the riprap armor over the Causeway would provide protection of the cover from storm surge or wave action. An appropriate O&M program must be implemented as part of Alternatives 1 and 2 to ensure that the capping systems remain effective in the long term. Alternative 2 provides a greater level of long-term effectiveness than Alternative 1 because (1) the cover system includes a composite barrier (i.e., FML and GCL), rather than an FML alone; and (2) the sheet pile seawall provides additional protection as a barrier to minimize the potential of transporting soluble contaminants outside the limits of the cap. Alternative 3 provides a long-term effectiveness and permanence by removing the contaminated Causeway fill material from the site and transporting the material to an appropriate licensed off-site TSDF.

Reduction of toxicity, mobility, or volume through treatment. Alternatives 1 and 2 provide a reduction in the mobility of contaminants by capping the contaminated Causeway fill material, which would minimize the leaching of contaminants due to precipitation infiltrating through the contaminated fill material. The sheet pile seawall provides additional protection as a barrier to minimize the potential of transporting soluble

contaminants outside the limits of the cap, thereby providing additional reduction in the mobility of contaminants. Alternatives 1 and 2 do not provide a reduction in the toxicity or volume of contaminants. Alternative 3 provides a reduction in mobility of contaminants by removing the contaminated fill material from the site and transporting the material to an appropriate licensed off-site TSDF. Excavation of the contaminated Causeway fill material (Alternative 3) reduces the volume of contaminants at the site; however, the contaminated material is simply transferred to another facility (i.e., TSDF).

Short-term effectiveness. Alternatives 1, 2, and 3 provide short-term effectiveness. All three alternatives are anticipated to be completed in one construction season; Alternatives 1 and 2 in approximately ten months and Alternative 3 in approximately five months. Alternatives 1, 2, and 3 all have potential short-term risks to site workers; however, these risks can be minimized by effectively implementing an approved site-specific health and safety plan. Alternatives 1, 2, and 3 are also anticipated to have some short-term adverse effects on ecological receptors resulting from excavation of contaminated material. Designing and implementing appropriate erosion and sediment control measures, and the use of a portable dam around the Causeway construction area would minimize any adverse effects on the environment.

Implementability. All of the alternatives are easily implemented. All equipment, materials, and services that are required for implementation of the alternatives are readily available. The CTDEP RSR allows the use of an engineered control (e.g., capping or containment system) to isolate contaminated soil. Capping (Alternatives 1 and 2) is a reliable and proven remediation technology for contaminated material that is left in place. Installation of a sheet pile seawall (Alternative 2) is also a commonly used construction technique. Alternatives 1 and 2 include an environmental land use restriction to (1) prevent exposure to the contaminated Causeway fill material and (2) maintain the integrity of the cover system. The environmental land use restriction for the Causeway would be implemented in accordance with the CTDEP RSR. Excavation and off-site disposal (Alternative 3) requires only standard excavation equipment, and off-site TSDFs

have available capacity for the treatment and/or disposal of the contaminated Causeway fill material.

The proposed future land use may include public water access from a new dock located at the end of the former seaplane boat ramp at the Causeway. Alternative 3 does not include reconstruction of the Causeway. Therefore, Alternative 3 may not be completely compatible with the future development of the site.

Cost. Based on the cost estimates presented in Section 4.0 of this EE/CA, the estimated present worth costs for the removal action alternatives are as follows:

Alternative 1	Capping with Hydraulic Barrier	$ 5,301,861
Alternative 2	Capping with Composite Cover System	$ 6,682,843
Alternative 3	Excavation and Off-site Disposal	$18,349,359

5.2.3 Comparison of Modifying Criteria

State acceptance and Community acceptance. Evaluation of state and community acceptance will be completed after receipt of comments provided during both the development of the EE/CA and following the 30-day public comment period for the EE/CA. A Responsiveness Summary will be prepared that provides responses to comments received during the public comment period. The Responsiveness Summary will be included in the RAM, which is a decision document that presents the selected removal action alternative, explains the rationale for the selection, and provides responses to public comments and concerns raised during the public comment period for the EE/CA.

6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Alternative 2, Capping with Composite Cover System, is the recommended alternative for the Causeway. Alternative 2 is recommended primarily because this alternative provides a high degree of overall protection to human health and the environment, as well as long-term effectiveness and permanence, by using a composite cover system (i.e., FML and GCL barrier layer) in conjunction with a sheet pile seawall to minimize the potential transport of contaminants outside the limits of the cover system. The riprap armor installed over the Causeway provides additional long-term effectiveness and permanence by protecting the cover system from erosion due to storm surge and wave action. At the same time, Alternative 2 allows the Causeway to be available for the proposed future use, which may include public water access at the end of the Causeway. The final elevation of the riprap armor will be approximately the same elevation as the Dike, which is also beneficial to the proposed future use of the Causeway (i.e., public water access).

Alternative 2 will be designed and implemented to attain federal and state ARARs. The CTDEP RSR allows the use of an engineered control (e.g., cover or containment system) to isolate contaminated soil. Alternative 2 also includes an environmental land use restriction for the Causeway, which would be implemented in accordance with the CTDEP RSR.

Alternative 2 will be designed and implemented using appropriate erosion and sediment control measures, a portable dam will be used around the Causeway construction area, and the limits of the cover system and sheet pile seawall will be consistent with the existing Causeway toe of slope, thereby minimizing any adverse effects on the environment.

All equipment, materials, and services required for implementation of Alternative 2 are readily available, and it is anticipated that the alternative can be completed in approximately ten months. The estimated cost of Alternative 2 is approximately $6.7

million, which is approximately 26 percent higher than the cost of Alternative 1, but significantly less than the cost of Alternative 3. Alternative 2 is also expected to be consistent with the RI and Feasibility study, currently being conducted for the overall SAEP facility. Therefore, Alternative 2 is believed to provide the optimum combination of overall protection of human health and the environment and compliance with ARARs, at a reasonable cost.

ABB-ES	ABB Environmental Services, Inc.
ARAR	Applicable or Relevant and Appropriate Requirement
AVCO	Avco Corporation
BRAC	Base Closure and Realignment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CTDEP	Connecticut Department of Environmental Protection
cy	cubic yard
DEC	Direct Exposure Criteria
EE/CA	Engineering Evaluation/Cost Analysis
F	Fahrenheit
FML	flexible membrane liner
Foster Wheeler	Foster Wheeler Environmental Corporation
GCL	geocomposite clay liner
GDL	geocomposite drainage layer
HDPE	high-density polyethylene
HLA	Harding Lawson Associates
LLDPE	linear low-density polyethylene
LRA	Local Redevelopment Authority
MCL	Maximum Contaminant Level
MSL	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCRA	Non-time-Critical Removal Action
O&M	operation and maintenance
OU	Operable Unit
PCB	polychlorinated biphenyl
PLM	polarizing light microscope
PMC	Pollutant Mobility Criteria
PVC	polyvinyl chloride
RAM	Removal Action Memorandum
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation

RKG	RKG Associates, Inc.
RSR	Remediation Standard Regulation
SAEP	Stratford Army Engine Plant
SPLP	Synthetic Precipitate Leaching Procedure
SVOC	semivolatile organic compound
TACOM	United States Tank-Automotive and Armament Command
TAL	Target Analyte List
TERC	Total Environmental Restoration Contract
TSDF	treatment, storage, and disposal facility
USACE	United States Army Corps of Engineers – New England District
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
W-C	Woodward-Clyde Consultants

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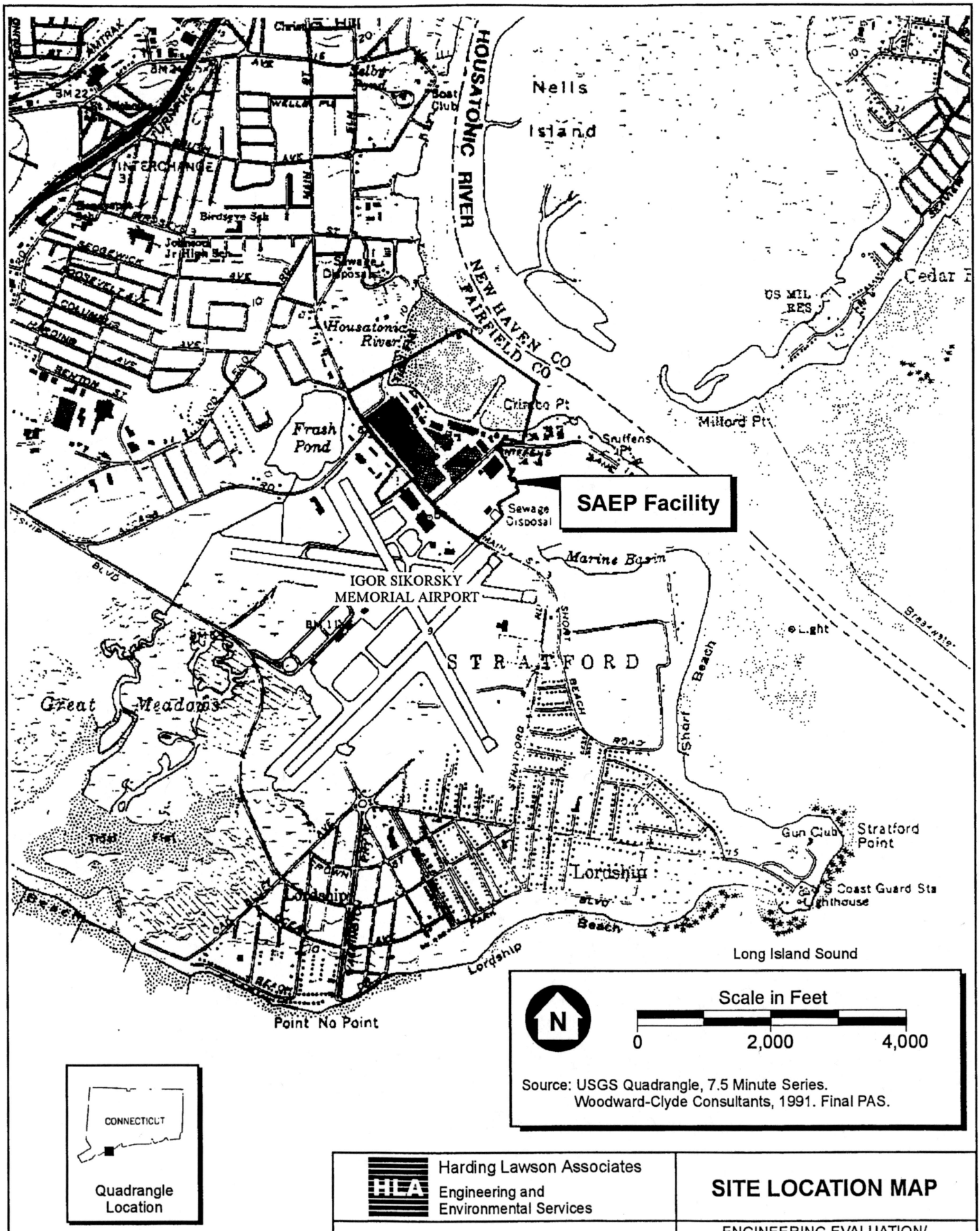


Harding Lawson Associates
Engineering and Environmental Services

SITE LOCATION MAP

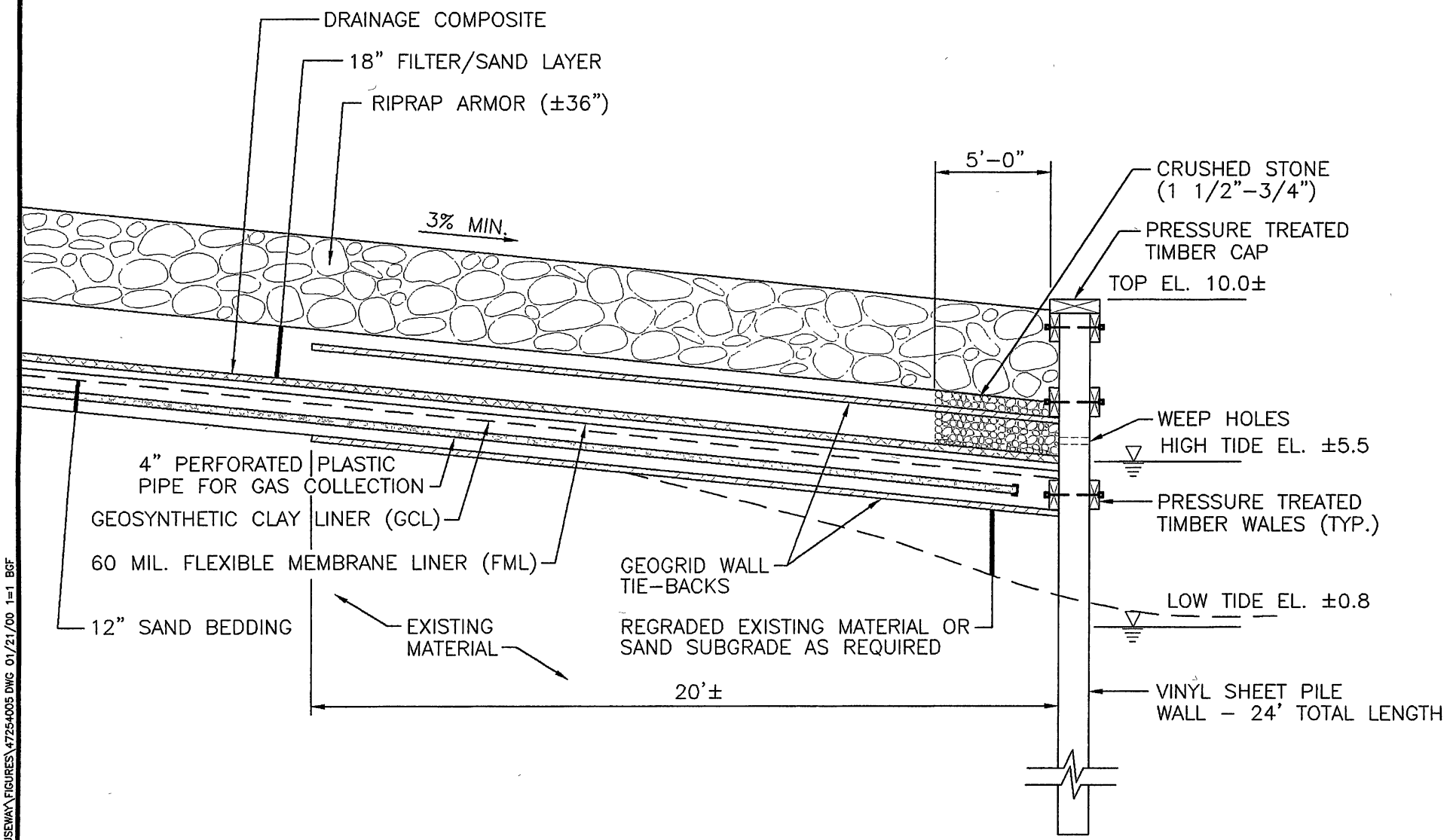
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

ENGINEERING EVALUATION/
COST ANALYSIS

47254

FIGURE 2-1

W9909003(a)



ALTERNATIVE 2 – CAP WITH COMPOSITE COVER SYSTEM

N.T.S.

FIGURE 4-2
ALTERNATIVE 2
EE/CA FOR THE CAUSEWAY
NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
Harding Lawson Associates

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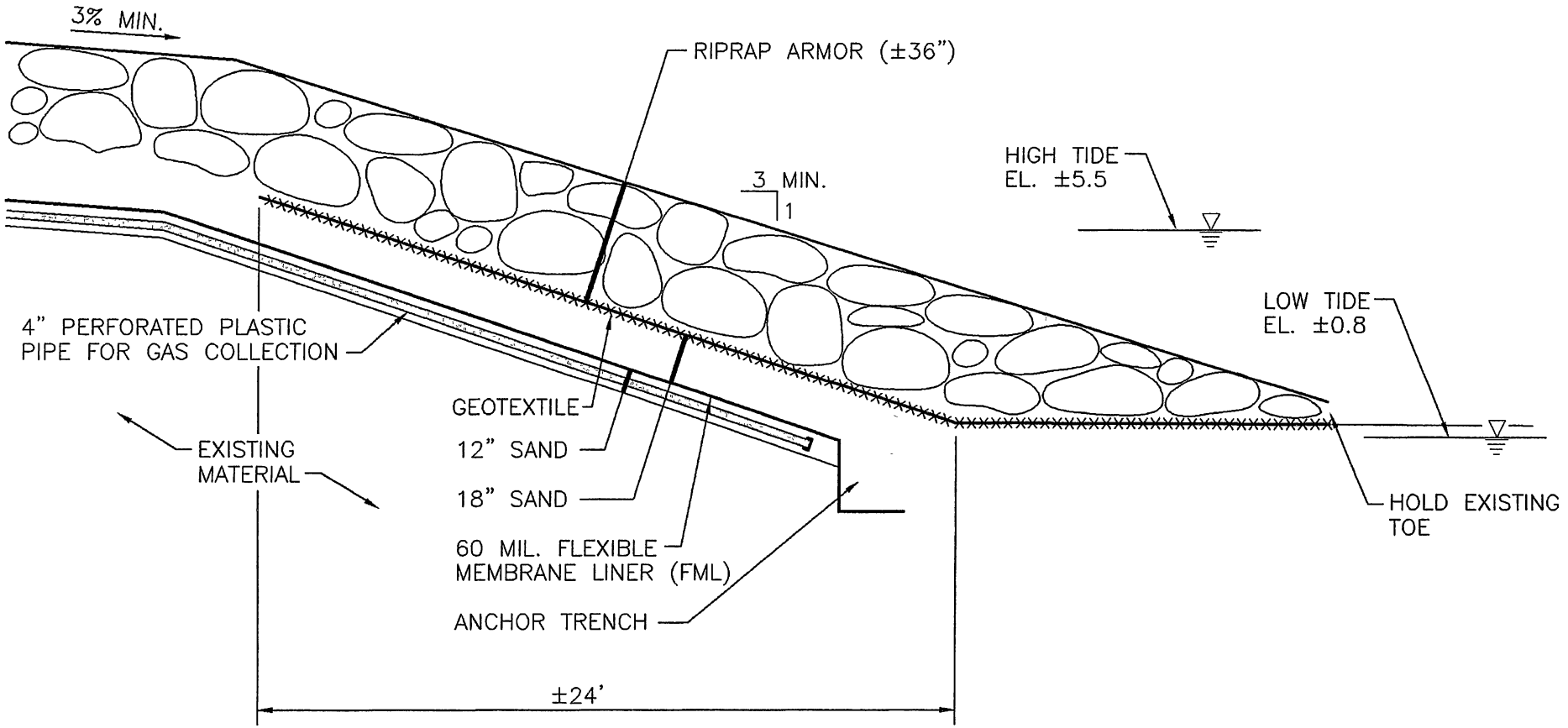

NOTE:

EXCAVATE EXISTING MATERIAL SO THAT EXISTING TOE CAN BE MAINTAINED.

ALTERNATIVE 1 – CAP WITH HYDRAULIC BARRIER

N.T.S.

FIGURE 4-1
ALTERNATIVE 1
EE/CA FOR THE CAUSEWAY
NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
Harding Lawson Associates

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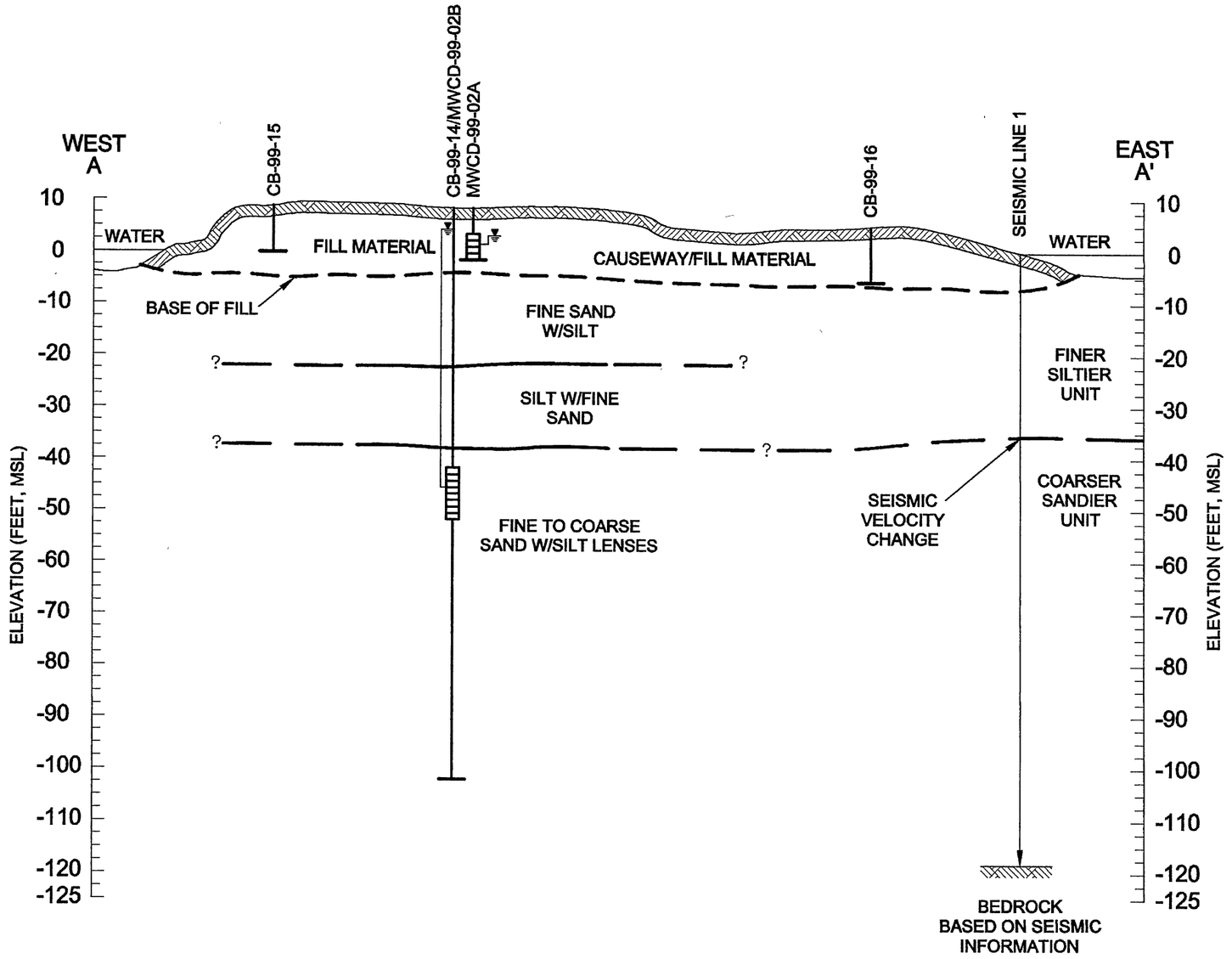
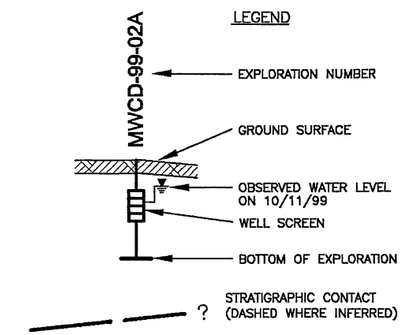
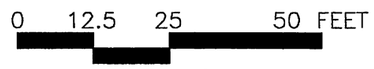




WATER ELEVATIONS ON 10/11/99

LOCATION	WATER DEPTH BELOW RISER	RISER ELEVATION	WATER ELEVATION
MWCD-99-02A	6.92'	10.47'	3.55'
MWCD-99-02B	5.00'	10.33'	5.33'



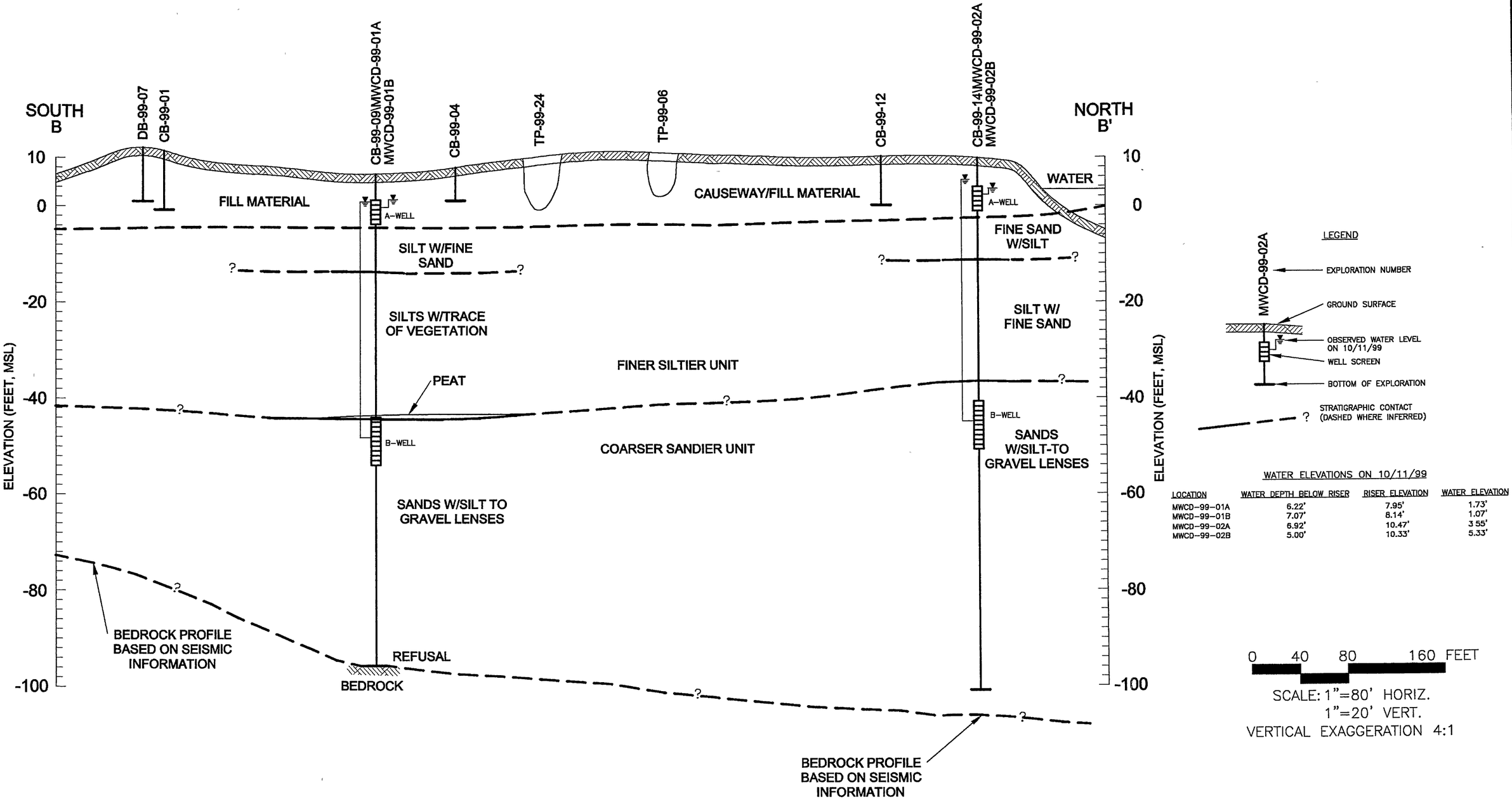
SCALE: 1"=25' HORIZ.
1"=25' VERT.
VERTICAL EXAGGERATION 1:1

CROSS-SECTION A-A'

SEE FIGURE 2-2 FOR LOCATION OF PROFILE

FIGURE 2-3
INTERPRETIVE GEOLOGIC PROFILE
CROSS-SECTION A-A'
ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT
Harding Lawson Associates

G:\PROJECTS\TERCS\PROJECTS\0020\CAUSEWAY\FIGURES\472540S23.DWG 2-02-2000 DEL



WATER ELEVATIONS ON 10/11/99

LOCATION	WATER DEPTH BELOW RISER	RISER ELEVATION	WATER ELEVATION
MWCD-99-01A	6.22'	7.95'	1.73'
MWCD-99-01B	7.07'	8.14'	1.07'
MWCD-99-02A	6.92'	10.47'	3.55'
MWCD-99-02B	5.00'	10.33'	5.33'

SCALE: 1"=80' HORIZ.
1"=20' VERT.
VERTICAL EXAGGERATION 4:1

CROSS-SECTION B-B'

SEE FIGURE 2-2 FOR LOCATION OF PROFILE

FIGURE 2-4
INTERPRETIVE GEOLOGIC PROFILE
CROSS-SECTION B-B'
ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT
Harding Lawson Associates

G:\PROJECTS\TERCS\PROJECTS\0020\OU2\CAUSEWAY\FIGURES\47254CS24.DWG 2-02-2000 DEL

N/F ALLIEDSIGNAL

DIKE RIPRAP

TIDAL FLATS

BLACKTOP PATHWAY

DB-99-16 DB-99-15 DB-99-17 DB-99-18 DB-99-14 DB-99-13 DB-99-12 DB-99-11 DB-99-10 DB-99-09 DB-99-08 DB-99-07 DB-99-06 DB-99-05 DB-99-04 DB-99-03 DB-99-02 DB-99-01

HA-99-08 HA-99-07 HA-99-06 HA-99-05 HA-99-04 HA-99-03 HA-99-02 HA-99-01

HA-99-08	0′-1′
Arsenic	10 15.7

HA-99-07		0′-1′
1,1-Dichloroethene	1	12J
Tetrachloroethene	12	1200
Trichloroethene	56	560
Vinyl Chloride	0.32	36J
bis2-Ethylhexyl Phthal	44	96
cis-1,2-Dichloroethene	500	3300

CB-99-14		1′-3′/1′-3′ DUP
Benzo(a)Anthracene	1	1.5/2.2
Benzo(a)Pyrene	1	2.3/3.3
Benzo(b)Fluoranthene	1	2.4/3.2
Indeno(1,2,3-CD)Pyrene	1	2.2/2.6

CB-99-15		1′-3′
Benzo(a)Anthracene	1	50
Benzo(a)Pyrene	1	43
Benzo(b)Fluoranthene	1	35
Benzo(k)Fluoranthene	8.4	32J
Indeno(1,2,3-CD)Pyrene	1	30

CB-99-16		1′-3′
Arsenic	10	15.7
Lead	500	721J

TP-99-10		3′-5′
Aroclor-1260	1	1.8
Arsenic	10	10.7
Benzo(a)Anthracene	1	9.4
Benzo(a)Pyrene	1	8
Benzo(b)Fluoranthene	1	7.2
Indeno(1,2,3-CD)Pyrene	1	4.8

TP-DEP-11		0-1′
Aroclor-1260	1	1.6
Arsenic	10	11.7
Beryllium	2	13.1
Cadmium	34	94.7
Hexachlorobenzene	1	1.4
Lead	500	1510J
Thallium	5.4	6.6
Vanadium	470	2640

CB-99-11		0′-2′
Beryllium	2	2.6

TP-DEP-12		1′-3′
Beryllium	2	3.9
Vanadium	470	970
Vinyl Chloride	0.32	1.9J

CB-99-02		0′-2′
Aroclor-1260	1	2.1

CB-99-07		0′-2′/0′-2′ DUP
Arsenic	10	10.7/10.9

CB-99-08		1′-3′/1′-3′ DUP	3′-5′
Arsenic	10	34.5/19.8	--
Beryllium	2	2.3/2.3	2.1
Cadmium	34	43.9/--	--
Lead	500	1380J/1250	--
Thallium	5.4	8.3/5.4	5.4

TP-99-23		1′-3′
Aroclor-1260	1	2.2

CB-99-05		0′-2′
Beryllium	2	3.2

DB-99-08		2′-4′
Aroclor 1260	1	3.7

TP-99-22		1′-3′
Aroclor-1016	1	1.7J
Aroclor-1260	1	1.2J

HA-99-03		0′-1′
Benzo(a)Anthracene	1	13
Benzo(a)Pyrene	1	13
Benzo(b)Fluoranthene	1	9.9
Benzo(k)Fluoranthene	8.4	12
Indeno(1,2,3-CD)Pyrene	1	9

CAUSEWAY

FILL AREA

FENCE

CONCRETE RAMP (BADLY DETERIORATED)

CONCRETE PAD & CHAIN LINK FENCE

SIGN

MWCD-99-02A MWCD-99-02B MWCD-99-01A MWCD-99-01B

SF-1 SF-2 SF-3 SF-4 SF-5 SF-6 SF-7 SF-8 SF-9 SF-10

TP-DEP-10 TP-DEP-11 TP-DEP-12 TP-99-10 TP-99-22 TP-99-23 TP-99-24 TP-99-25

CB-99-01 CB-99-02 CB-99-03 CB-99-04 CB-99-05 CB-99-06 CB-99-07 CB-99-08 CB-99-09 CB-99-10 CB-99-11 CB-99-12 CB-99-13 CB-99-14 CB-99-15 CB-99-16 CB-99-17

END OF DIKE RIPRAP

END OF DIKE RIPRAP

BLACKTOP PATHWAY

DIKE RIPRAP

BLACKTOP PATHWAY

A A′ B B′

N

B-36 B-73 B-58 B-80 B-65 B-74 B-15 B-52 B-37 B-38 B-68 B-81 B-64-2 B-64-1 B-13 B-44 B-48 B-42 B-16 B-40 B-12 B-8 B-7 B-7A B-9 B-10 B-63 B-70 B-67 B-3 B-3A B-4 B-69 B-34 B-33 B-19 B-59

LEGEND

SF-1	EXISTING WOODWARD-CLYDE ASBESTOS SURFACE SOIL SAMPLING LOCATION (APPROXIMATE)
MWCD-99-01A	EXISTING HLA CAUSEWAY/DIKE MONITORING WELLS
TP-99-22	EXISTING HLA TEST PIT LOCATIONS
CB-99-01	EXISTING HLA CAUSEWAY BORING
DB-99-01	EXISTING HLA DIKE BORING
HA-99-01	EXISTING HAND AUGERS
B-53	BUILDING DESIGNATIONS
	CHAINLINK FENCE
	SAEP PROPERTY BOUNDARY
	LIMITS OF PRE-DESIGN INVESTIGATION
A A′	GEOLOGIC PROFILE LOCATION

DUP	DUPLICATE SAMPLE
--	LESS THAN REPORTING EXCEEDANCES
J	VALUE IS ESTIMATED
BGS	BELOW GROUND SURFACE

LOCATION IDENTIFIER → CB-99-07 | 0′-2′/0′-2′ DUP ← SAMPLING INTERVAL (BGS)

COMPOUND → Arsenic | 10 | 10.7/10.9 ← CONCENTRATION (mg/kg)

REMEDIATION STANDARD REGULATION (RSR) CRITERION

ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

NOTES:
1. MAP IS IN CONNECTICUT STATE PLANE COORDINATES.
2. BASE MAP SOURCE: ALLIEDSIGNAL, INC.
3. ALL ELEVATION CONTOURS ARE INTERPRETIVE AND APPROXIMATE. CONTOUR INTERVAL IS 1 FOOT.

0 40 80 160 FEET

SCALE: 1"=80'

G:\PROJECTS\TERCS\PROJECTS\Do20\CAUSEWAY\FIGURES\47254010.DWG 2-02-2000 DEL

FIGURE 2-5
EXCEEDANCES OF DIRECT EXPOSURE CRITERIA FOR SOIL
ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Harding Lawson Associates

N/F ALLIEDSIGNAL

DIKE RIPRAP

BLACKTOP PATHWAY

TIDAL FLATS

TIDAL FLATS

DIKE RIPRAP

BLACKTOP PATHWAY

DIKE RIPRAP

BLACKTOP PATHWAY

END OF DIKE RIPRAP

END OF DIKE RIPRAP

CAUSEWAY

FILL AREA

CONCRETE RAMP (BADLY DETERIORATED)

CONCRETE PAD & CHAIN LINK FENCE

FENCE

SIGN

MWCD-99-02B

MWCD-99-02A

A

A'

B'

N

DB-99-18 DB-99-17 DB-99-16 DB-99-15 DB-99-14 DB-99-13 DB-99-12 DB-99-11 DB-99-10 DB-99-09 DB-99-08 DB-99-07 DB-99-06 DB-99-05 DB-99-04 DB-99-03 DB-99-02 DB-99-01

HA-99-08 HA-99-07 HA-99-03 HA-99-02 HA-99-01

CB-99-17 CB-99-16 CB-99-15 CB-99-14 CB-99-13 CB-99-12 CB-99-11 CB-99-10 CB-99-09 CB-99-08 CB-99-07 CB-99-06 CB-99-05 CB-99-04 CB-99-03 CB-99-02 CB-99-01

TP-DEP-12 TP-DEP-11 TP-DEP-10 TP-99-22 TP-99-23 TP-99-24 TP-99-25

SF-1 SF-2 SF-3 SF-4 SF-5 SF-6 SF-7 SF-8 SF-9 SF-10

MWCD-99-01A MWCD-99-01B

B-36 B-73 B-80 B-58 B-65 B-74 B-15 B-52 B-37 B-38 B-68 B-81 B-64-2 B-64-1 B-13 B-44 B-48 B-42 B-16 B-40 B-12 B-8 B-7 B-7A B-9 B-10 B-63 B-67 B-70 B-3 B-3A B-4 B-69 B-19 B-34 B-33 B-59

HA-99-07		0′ -1′
1, 1, 1-Trichloroethane	40	340
1, 1-Dichloroethane	14	120J
1, 1-Dichloroethene	1. 4	12J
2-Methylnapthalene	9. 8	25
Benzene	0. 2	3. 8J
Tetrachloroethene	1	1200
Toluene	67	180J
Trichloroethene	1	560
Vinyl Chloride	0. 4	36J
Xylene (total)	19. 5	26J
bis(2-Ethylhexyl)Phthalate	11	9. 6
cis-1, 2-Dichloroethene	14	3300

CB-99-15		1′ -3′	7′ -9′
Acenapthene	84	--	190
Anthracene	400	--	520J
Benzo(a)Anthracene	1	50	1200J
Benzo(a)Pyrene	1	43	880J
Benzo(b)Fluoranthene	1	35	940J
Benzo(k)Fluoranthene	1	32J	880J
Carbazole	1	6. 9	310
Chrysene	1	46	1, 200
Dibenzofuran	5. 6	6. 9	130
Fluoranthene	56	120	2700
Fluorene	56	--	250J
Indeno(1, 2, 3-CD)Pyrene	1	30	350
Naphthalene	56	--	97J
Phenanthrene	40	100	2400
Pyrene	40	93	1800J

CB-99-14		1′ -3′/1′ -3′ DUP
Benzo(a)Anthracene	1	1. 5/2. 2
Benzo(a)Pyrene	1	2. 3/3. 3
Benzo(b)Fluoranthene	1	2. 4/3. 2
Benzo(k)Fluoranthene	1	1. 4/2. 9
Chrysene	1	1. 6/2. 4
Indeno(1, 2, 3-CD)Pyrene	1	2. 2/2. 6

CB-99-13		7′ -9′ /7′ -9′ DUP
Tetrachloroethene	1	37/28

TP-99-10		3′ -5′
Benzo(a)Anthracene	1	9. 4
Benzo(a)Pyrene	1	8
Benzo(b)Fluoranthene	1	7. 2
Benzo(k)Fluoranthene	1	7. 2
Carbazole	1	1. 6
Chrysene	1	9. 2
Indeno(1, 2, 3-CD)Pyrene	1	4. 8
Tetrachloroethene	1	2. 1J
Trichloroethene	1	2. 3J

TP-99-06		6′ -8′
Trichloroethene	1	1. 2J

CB-99-11		0′ -2′
Benzo(k)Fluoranthene	1	1. 1J
Trichloroethene	1	2J

CB-99-04		0′ -2′	5′ -7′
Tetrachloroethene	1	--	2. 7J
Trichloroethene	1	3. 4J	1. 2J
Vinyl Chloride	0. 4	--	24
cis-1, 2-Dichloroethene	14	--	120

CB-99-12		8′ -10′
Benzo(a)Anthracene	1	22J
Benzo(a)Pyrene	1	19J
Benzo(b)Fluoranthene	1	17J
Benzo(k)Fluoranthene	1	18J
Chrysene	1	20
Dibenz(a, b)Anthracene	1	8. 1
Fluoranthene	56	58
Phenanthrene	40	60
Pyrene	40	46

TP-DEP-12		1′ -3′
Trichloroethene	1	4J
Vanadium	0. 5	1. 07
Vinyl Chloride	0. 4	1. 9J

CB-99-03		2′ -4′ /2′ -4′ DUP	4′ -6′
2-Methylnapthalene	9. 8	--	45
Methylene Chloride	1	1J/3. 3J	--
Vanadium	0. 5	--	5. 92

CB-99-02		5′ -7′	5′ -7′
Methylene Chloride	1	2. 6J	--
Tetrachloroethene	1	26	81
Trichloroethene	1	2. 4J	4. 3J
cis-1, 2-Dichloroethene	14	--	100

TP-DEP-11		0′ -1′
Hexachlorobenzene	1	1. 4
Tetrachloroethene	1	2. 9
Trichloroethene	1	8. 8
Vanadium	0. 5	0. 807

CB-99-08		1′ -3′ /1′ -3′ DUP
Trichloroethene	1	--/8. 4J

CB-99-09		10′ -12′
Benzo(a)Anthracene	1	1. 2J
Benzo(a)Pyrene	1	1J
Benzo(b)Fluoranthene	1	1J
Crysene	1	1. 3

CB-99-01		0′ -2′	9′ -11′
Methylene Chloride	1	1. 4	1. 9
Trichloroethene	1	--	3J

HA-99-03		0′ -1′
Benzo(a)Anthracene	1	13
Benzo(a)Pyrene	1	13
Benzo(b)Fluoranthene	1	9. 9
Benzo(k)Fluoranthene	1	12
Carbazole	1	4. 2
Chrysene	1	14
Indeno(1, 2, 3-CD)Pyrene	1	9

LEGEND

SF-1	EXISTING WOODWARD-CLYDE ASBESTOS SURFACE SOIL SAMPLING LOCATION (APPROXIMATE)
MWCD-99-01A	EXISTING HLA CAUSEWAY/DIKE MONITORING WELLS
TP-99-22	EXISTING HLA TEST PIT LOCATIONS
CB-99-01	EXISTING HLA CAUSEWAY BORING
DB-99-01	EXISTING HLA DIKE BORING
HA-99-01	EXISTING HAND AUGERS
B-53	BUILDING DESIGNATIONS
	CHAINLINK FENCE
	SAEP PROPERTY BOUNDARY
	LIMITS OF PRE-DESIGN INVESTIGATION
A A'	GEOLOGIC PROFILE LOCATION

DUP	DUPLICATE SAMPLE
--	LESS THAN REPORTING EXCEEDANCES
J	VALUE IS ESTIMATED
BGS	BELOW GROUND SURFACE

LOCATION IDENTIFIER → CB-99-07 | 0′ -2′ /0′ -2′ DUP ← SAMPLING INTERVAL (BGS)

COMPOUND → Arsenic | 10 | 10. 7/10. 9 ← CONCENTRATION (mg/kg)

REMEDIATION STANDARD REGULATION (RSR) CRITERION

ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg) EXCEPT FOR VANADIUM WHICH IS REPORTED IN MILLIGRAMS PER LITER (mg/L)

NOTES:
1. MAP IS IN CONNECTICUT STATE PLANE COORDINATES.
2. BASE MAP SOURCE: ALLIEDSIGNAL, INC.
3. ALL ELEVATION CONTOURS ARE INTERPRETIVE AND APPROXIMATE. CONTOUR INTERVAL IS 1 FOOT.

0 40 80 160 FEET

SCALE: 1"=80'

G:\PROJECTS\TERC'S\PROJECTS\Do20\CAUSEWAY\FIGURES\47254011.DWG 2-02-2000 DEL

FIGURE 2-6
EXCEEDANCES OF GB POLLUTANT MOBILITY CRITERIA
ENGINEERING EVALUATION/COST ANALYSIS
STRATFORD ARMY ENGINE PLANT

Harding Lawson Associates

T/ 2-1

SUMMARY OF DIRECT EXPOSURE CRITERIA EXCEEDANCES - CAUSEWAY

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

	SAMPLE DEPTH (bgs) SAMPLE COLLECTION		CB-99-02 0-2 09/20/1999		CB-99-05 0-2 09/21/1999		CB-99-07DUP 0-2 09/21/1999		CB-99-07 0-2 09/21/1999		CB-99-08 1-3 09/21/1999		CB-99-08DUP 1-3 09/21/1999	
Analyte	**RSR Value**	**Units**												
VOCs														
1,1-Dichloroethene	1	mg/kg												
Vinyl Chloride	0.32	mg/kg												
SVOCs														
Benzo(a)Anthracene	1	mg/kg												
Benzo(a)Pyrene	1	mg/kg												
Benzo(b)Fluoranthene	1	mg/kg												
Benzo(k)Fluoranthene	8.4	mg/kg												
Hexachlorobenzene	1	mg/kg												
Indeno(1,2,3-CD)Pyrene	1	mg/kg												
PCBs														
Aroclor-1016	1	mg/kg												
Aroclor-1260	1	mg/kg	2.1											
Inorganics														
Arsenic	10	mg/kg					10.9		10.7		19.8		34.5	
Beryllium	2	mg/kg			3.2						2.3		2.3	
Cadmium	34	mg/kg											43.9	
Lead	500	mg/kg									1,250	J	1,380	J
Thallium	5.4	mg/kg									5.4		8.3	
Vanadium	470	mg/kg												

Notes:

RSR = Remediation Standard Regulation

mg/kg = milligram per kilogram

J = estimated values

VOCs = volatile organic compounds

bgs = below ground surface

DUP = duplicate sample

PCBs = polychlorinated biphenyls

SVOCs = semivolatile organic compounds

T/ 2-1

SUMMARY OF DIRECT EXPOSURE CRITERIA EXCEEDANCES - CAUSEWAY

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

			CB-99-08		CB-99-11		CB-99-14		CB-99-14DUP		CB-99-15		CB-99-16	
	SAMPLE DEPTH (bgs)		3-5		0-2		1-3		1-3		1-3		1-3	
	SAMPLE COLLECTION		9/21/1999-5		09/21/1999		09/22/1999		09/22/1999		09/21/1999		09/21/1999	
Analyte	**RSR Value**	**Units**												
VOCs														
1,1-Dichloroethene	1	mg/kg												
Vinyl Chloride	0.32	mg/kg												
SVOCs														
Benzo(a)Anthracene	1	mg/kg					1.5		2.2		50			
Benzo(a)Pyrene	1	mg/kg					2.3		3.3		43			
Benzo(b)Fluoranthene	1	mg/kg					2.4		3.2		35			
Benzo(k)Fluoranthene	8.4	mg/kg									32	J		
Hexachlorobenzene	1	mg/kg												
Indeno(1,2,3-CD)Pyrene	1	mg/kg					2.2		2.6		30			
PCBs														
Aroclor-1016	1	mg/kg												
Aroclor-1260	1	mg/kg												
Inorganics														
Arsenic	10	mg/kg											15.7	
Beryllium	2	mg/kg	2.1		2.6									
Cadmium	34	mg/kg												
Lead	500	mg/kg											721	J
Thallium	5.4	mg/kg	5.4											
Vanadium	470	mg/kg												

Notes:

RSR = Remediation Standard Regulation

mg/kg = milligram per kilogram

J = estimated values

VOCs = volatile organic compounds

bgs = below ground surface

DUP = duplicate sample

PCBs = polychlorinated biphenyls

SVOCs = semivolatile organic compounds

TA 2-1

SUMMARY OF DIRECT EXPOSURE CRITERIA EXCEEDANCES - CAUSEWAY

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

			TP-99-10		TP-99-22		TP-99-23		TP-DEP-11		TP-DEP-12	
	SAMPLE DEPTH (bgs)		3-5		1-3		1-3		0-1		1-3	
	SAMPLE COLLECTION		09/21/1999		09/22/1999		09/22/1999		09/21/1999		09/21/1999	
Analyte	**RSR Value**	**Units**										
VOCs												
1,1-Dichloroethene	1	mg/kg										
Vinyl Chloride	0.32	mg/kg									1.9	J
SVOCs												
Benzo(a)Anthracene	1	mg/kg	9.4									
Benzo(a)Pyrene	1	mg/kg	8									
Benzo(b)Fluoranthene	1	mg/kg	7.2									
Benzo(k)Fluoranthene	8.4	mg/kg										
Hexachlorobenzene	1	mg/kg							1.4			
Indeno(1,2,3-CD)Pyrene	1	mg/kg	4.8									
PCBs												
Aroclor-1016	1	mg/kg			1.2	J						
Aroclor-1260	1	mg/kg	1.8		1.7	J	2.2		1.6			
Inorganics												
Arsenic	10	mg/kg	10.7						11.7			
Beryllium	2	mg/kg							13.1		3.9	
Cadmium	34	mg/kg							94.7			
Lead	500	mg/kg							1,510	J		
Thallium	5.4	mg/kg							6.6			
Vanadium	470	mg/kg							2,640		970	

Notes:

RSR = Remediation Standard Regulation

mg/kg = milligram per kilogram

J = estimated values

VOCs = volatile organic compounds

bgs = below ground surface

DUP = duplicate sample

PCBs = polychlorinated biphenyls

SVOCs = semivolatile organic compounds

T[illegible]2-2
SUMMARY OF GB POLLUTANT MOBI[illegible]RITERIA EXCEEDANCES - CAUSEWAY

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

	SAMPLE DEPTH (bgs)		CB-99-01		CB-99-01		CB-99-02		CB-99-03DUP		CB-99-03		CB-99-03		CB-99-04		CB-99-04	
	SAMPLE COLLECTION		0-2		9-11		5-7		2-4		2-4		4-6		0-2		5-7	
			09/20/1999		09/20/1999		10/12/1999		09/20/1999		09/20/1999		09/20/1999		09/20/1999		09/20/1999	
Analyte	RSR Values	Units																
VOCs																		
1,1,2,2-Tetrachloroethane	0.1	mg/kg																
1,1,2-Trichloroethane	1	mg/kg																
1,1-Dichloroethene	1.4	mg/kg																
1,2-Dichloroethane	0.2	mg/kg																
1,2-Dichloropropane	1	mg/kg																
Benzene	0.2	mg/kg																
Bromoform	0.8	mg/kg																
Carbon Tetrachloride	1	mg/kg																
Chloroform	1.2	mg/kg																
cis-1,2-Dichloroethene	14	mg/kg					100										120	
cis-1,3-Dichloropropene	0.1	mg/kg																
Dibromochloromethane	0.1	mg/kg																
Methylene Chloride	1	mg/kg	1.4		1.9				3.3	J	1	J						
Tetrachloroethene	1	mg/kg					81										2.7	J
trans-1,3-Dichloropropene	0.1	mg/kg																
Trichloroethene	1	mg/kg			3	J	4.3	J							3.4	J	1.2	J
Vinyl Chloride	0.4	mg/kg															24	
SVOCs																		
2-Methylnaphthalene	9.8	mg/kg											45					
Acenaphthene	84	mg/kg																
Anthracene	400	mg/kg																
Benzo(a)Anthracene	1	mg/kg																
Benzo(a)Pyrene	1	mg/kg																
Benzo(b)Fluoranthene	1	mg/kg																
Benzo(k)Fluoranthene	1	mg/kg																
Carbazole	1	mg/kg																
Chrysene	1	mg/kg																
Dibenz(a,h)Anthracene	1	mg/kg																
Dibenzofuran	5.6	mg/kg																
Fluoranthene	56	mg/kg																
Fluorene	56	mg/kg																
Hexachlorobenzene	1	mg/kg																
Indeno(1,2,3-CD)Pyrene	1	mg/kg																
Naphthalene	56	mg/kg																
Phenanthrene	40	mg/kg																
Pyrene	40	mg/kg																
SPLP Metals																		
Vanadium	0.5	mg/L											5.92					

Notes:
DUP = duplicate sample
J = estimated values
mg/kg = milligram per kilogram
mg/L = milligram per liter
RSR = Remediation Standard Regulation
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

T. 2-2

SUMMARY OF GB POLLUTANT MOBI[illegible] 'RITERIA EXCEEDANCES - CAUSEWAY

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

			CB-99-08DUP	CB-99-08	CB-99-09	CB-99-11	CB-99-12	CB-99-13DUP	CB-99-13	CB-99-14DUP
	SAMPLE DEPTH (bgs)		1-3	3-5	10-12	0-2	8-10	7-9	7-9	1-3
	SAMPLE COLLECTION		09/21/1999	09/21/1999	09/23/1999	09/21/1999	09/21/1999	10/12/1999	10/12/1999	09/22/1999
Analyte	RSR Values	Units								
VOCs										
1,1,2,2-Tetrachloroethane	0.1	mg/kg								
1,1,2-Trichloroethane	1	mg/kg								
1,1-Dichloroethene	1.4	mg/kg								
1,2-Dichloroethane	0.2	mg/kg								
1,2-Dichloropropane	1	mg/kg								
Benzene	0.2	mg/kg								
Bromoform	0.8	mg/kg								
Carbon Tetrachloride	1	mg/kg								
Chloroform	1.2	mg/kg								
cis-1,2-Dichloroethene	14	mg/kg								
cis-1,3-Dichloropropene	0.1	mg/kg								
Dibromochloromethane	0.1	mg/kg								
Methylene Chloride	1	mg/kg								
Tetrachloroethene	1	mg/kg						28	37	
trans-1,3-Dichloropropene	0.1	mg/kg								
Trichloroethene	1	mg/kg	8.4 J			2 J				
Vinyl Chloride	0.4	mg/kg								
SVOCs										
2-Methylnaphthalene	9.8	mg/kg								
Acenaphthene	84	mg/kg								
Anthracene	400	mg/kg								
Benzo(a)Anthracene	1	mg/kg			1.2 J		22 J			2.2
Benzo(a)Pyrene	1	mg/kg			1 J		19 J			3.3
Benzo(b)Fluoranthene	1	mg/kg			1 J		17 J			3.2
Benzo(k)Fluoranthene	1	mg/kg				1.1 J	18 J			2.9
Carbazole	1	mg/kg								
Chrysene	1	mg/kg			1.3		20			2.4
Dibenz(a,h)Anthracene	1	mg/kg					8.1			
Dibenzofuran	5.6	mg/kg								
Fluoranthene	56	mg/kg					58			
Fluorene	56	mg/kg								
Hexachlorobenzene	1	mg/kg								
Indeno(1,2,3-CD)Pyrene	1	mg/kg								2.6
Naphthalene	56	mg/kg								
Phenanthrene	40	mg/kg					60			
Pyrene	40	mg/kg					46			
SPLP Metals										
Vanadium	0.5	mg/L								

Notes:
DUP = duplicate sample
J = estimated values
mg/kg = milligram per kilogram
mg/L = milligram per liter
RSR = Remediation Standard Regulation
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

TABLE 2-2
SUMMARY OF GB POLLUTANT MOBILITY CRITERIA EXCEEDANCES - CAUSEWAY

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

			CB-99-14	CB-99-15	CB-99-15	TP-99-06	TP-99-10	TP-DEP-11	TP-DEP-12
	SAMPLE DEPTH (bgs)		1-3	1-3	7-9	6-8	3-5	0-1	1-3
	SAMPLE COLLECTION		09/22/1999	09/21/1999	09/21/1999	09/21/1999	09/21/1999	09/21/1999	09/21/1999
Analyte	**RSR Values**	**Units**							
VOCs									
1,1,2,2-Tetrachloroethane	0.1	mg/kg							
1,1,2-Trichloroethane	1	mg/kg							
1,1-Dichloroethene	1.4	mg/kg							
1,2-Dichloroethane	0.2	mg/kg							
1,2-Dichloropropane	1	mg/kg							
Benzene	0.2	mg/kg							
Bromoform	0.8	mg/kg							
Carbon Tetrachloride	1	mg/kg							
Chloroform	1.2	mg/kg							
cis-1,2-Dichloroethene	14	mg/kg							
cis-1,3-Dichloropropene	0.1	mg/kg							
Dibromochloromethane	0.1	mg/kg							
Methylene Chloride	1	mg/kg							
Tetrachloroethene	1	mg/kg					2.1 J	2.9	
trans-1,3-Dichloropropene	0.1	mg/kg							
Trichloroethene	1	mg/kg				1.2 J	2.3 J	8.8	4 J
Vinyl Chloride	0.4	mg/kg							1.9 J
SVOCs									
2-Methylnaphthalene	9.8	mg/kg							
Acenaphthene	84	mg/kg			190				
Anthracene	400	mg/kg			520 J				
Benzo(a)Anthracene	1	mg/kg	1.5	50	1,200 J		9.4		
Benzo(a)Pyrene	1	mg/kg	2.3	43	880 J		8		
Benzo(b)Fluoranthene	1	mg/kg	2.4	35	940 J		7.2		
Benzo(k)Fluoranthene	1	mg/kg	1.4	32 J	880 J		7.2		
Carbazole	1	mg/kg		6.9	310		1.6		
Chrysene	1	mg/kg	1.6	46	1200		9.2		
Dibenz(a,h)Anthracene	1	mg/kg							
Dibenzofuran	5.6	mg/kg		6.9	130				
Fluoranthene	56	mg/kg		120	2,700				
Fluorene	56	mg/kg			250 J				
Hexachlorobenzene	1	mg/kg						1.4	
Indeno(1,2,3-CD)Pyrene	1	mg/kg	2.2	30	350		9.2		
Naphthalene	56	mg/kg			97 J				
Phenanthrene	40	mg/kg		100	2,400				
Pyrene	40	mg/kg		93	1,800 J				
SPLP Metals									
Vanadium	0.5	mg/L						0.807	1.07

Notes:
DUP = duplicate sample
J = estimated values
mg/kg = milligram per kilogram
mg/L = milligram per liter
RSR = Remediation Standard Regulation
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

TABLE 2-3
SUMMARY OF CTDEP RADIOLOGICAL TESTING

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

CTDEP SAMPLE NUMBER	LABORATORY NUMBER	APPROXIMATE CORRESPONDING EXPLORATION LOCATION	NUCLIDE AND ACTIVITY IN pCi/g	
			TH-234	RA-226
SAEP-A1	19223	CB-99-05	1.3	1.47
SAEP-A1	19224	CB-99-05	0.65	0.65
SAEP-A2	19225	CB-99-12	0.689	1.05
SAEP-A3	19226	CB-99-02	1.88	5.17
SAEP-A4	19227	TP-99-10	3.02	10.8
SAEP-A5	19228	CB-99-11	0.8	0.91
SAEP-A6	19229	TP-DEP-11/12	28.3	80.7
SAEP-A7	19230	TP-DEP-15	11.2	68.5

Notes:

CTDEP = Connecticut Department of Environmental Protection
pCi/g = picocurie per gram
See Appendix I of the Pre-Design Investigation Report for the Causeway and Dike for full results
See Figure 2-2 for exploration locations

TABLE 2-4
SUMMARY OF ALLIED SIGNAL RADIOLOGICAL TESTING

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

ALLIED SIGNAL SAMPLE NUMBER	APPROXIMATE CORRESPONDING EXPLORATION LOCATION	NUCLIDE AND ACTIVITY IN pCi/g		
		TH-234	TH-228	RA-226
AS-97	CB-99-14	17.53	30.49	53.18
AS-109	TP-DEP-11/12	23.97	55.83	108.2
AS-114	TP-DEP-15	15.30	34.92	43.24
AS-121-4	CB-99-09	NI	68.05	14.56

Notes:

NI = not identified
pCi/g = picocurie per gram
See Appendix I of the Pre-Design Investigation Report for the Causeway and Dike for full results
See Figure 2-2 for exploration locations.

TABLE 2-5

SUMMARY OF DIRECT EXPOSURE CRITERIA EXCEEDANCES - DIKE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

			DB-99-08		HA-99-03		HA-99-07		HA-99-08	
	SAMPLE DEPTH (bgs)		2-4		0-1		0-1		0-1	
	SAMPLE COLLECTION		09/14/1999		09/23/1999		09/23/1999		09/23/1999	
Analyte	**RSR Value**	**Units**								
VOCs										
1,1-Dichloroethene	1	mg/kg					12	J		
cis-1,2-Dichloroethene	500	mg/kg					3,300			
Tetrachloroethene	12	mg/kg					1,200			
Trichloroethene	56	mg/kg					560			
Vinyl Chloride	0.32	mg/kg					36	J		
SVOCs										
Benzo(a)Anthracene	1	mg/kg			13					
Benzo(a)Pyrene	1	mg/kg			13					
Benzo(b)Fluoranthene	1	mg/kg			9.9					
Benzo(k)Fluoranthene	8.4	mg/kg			12					
bis(2-Ethylhexyl)Phthalate	44	mg/kg					96			
Indeno(1,2,3-CD)Pyrene	1	mg/kg			9					
PCBs										
Aroclor 1260	1	mg/kg	3.7							
Arsenic	10	mg/kg							15.7	

Notes:

DUP = duplicate sample

J = estimated values

mg/kg = milligram per kilogram

RSR = Remediation Standard Regulation

PCBs = polychlorinated biphenyls

SVOCs = semivolatile organic compounds

VOCs = volatile organic compounds

TA 2-6

SUMMARY OF GB POLLUTANT MOBILITY CRITERIA EXCEEDANCES - DIKE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

			HA-99-03		HA-99-07	
		SAMPLE DEPTH (bgs)	HA9903001XX		HA9907001XX	
		SAMPLE COLLECTION	0-1		0-1	
			09/23/1999		09/23/1999	
Analyte	**RSR Value**	**Units**				
VOCs						
1,1,1-Trichloroethane	40	mg/kg			340	
1,1-Dichloroethane	14	mg/kg			120	J
1,1-Dichloroethene	1.4	mg/kg			12	J
Benzene	0.2	mg/kg			3.8	J
cis-1,2-Dichloroethene	14	mg/kg			3,300	
Tetrachloroethene	1	mg/kg			1,200	
Toluene	67	mg/kg			180	J
Trichloroethene	1	mg/kg			560	
Vinyl Chloride	0.4	mg/kg			36	J
Xylene (total)	19.5	mg/kg			26	J
SVOCs						
Benzo(a)Anthracene	1	mg/kg	13			
Benzo(a)Pyrene	1	mg/kg	13			
Benzo(b)Fluoranthene	1	mg/kg	9.9			
Benzo(k)Fluoranthene	1	mg/kg	12			
bis(2-Ethylhexyl)Phthalate	11	mg/kg			96	
Carbazole	1	mg/kg	4.2			
Chrysene	1	mg/kg	14			
Indeno(1,2,3-CD)Pyrene	1	mg/kg	9			
2-Methylnaphthalene	9.8	mg/kg			25	

Notes:

DUP = duplicate sample

J = estimated values

mg/kg = microgram per kilogram

RSR = Remediation Standard Regulation

PCBs = polychlorinated biphenyls

SVOCs = semivolatile organic compounds

VOCs = volatile organic compounds

TABLE 3-1
CHEMICAL-SPECIFIC ARARS CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
SOIL/SEDIMENT				
State	Connecticut Department of Environmental Protection (CTDEP) Remediation Standard (Title 22a Parts 133k and 133q)	Applicable	Remediation standards have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in soil and groundwater (Section 22a-133k-2, and Appendices A and B).	Contaminated soil will be remediated in accordance with the standards for soil remediation as specified in this regulation.
			Section 22a-133k-2(f)(2) allows the use of an engineered control to isolate contaminated soil. This section includes specific requirements for the engineered control, including but not limited to, permeability, monitoring, and maintenance. In conjunction with the engineered control, an environmental land use restriction must be implemented in accordance with Section 22a-133q-1.	An engineered control and environmental land use restriction will be implemented in accordance with these requirements.
			Sections 133k and 133q also provide requirements for public involvement and approval by the Commissioner of Environmental Protection prior to implementation of any engineered control or environmental land use restriction.	

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement
CTDEP = Connecticut Department of Environmental Protection

TABLE 3-2
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
WETLAND/FLOODPLAINS				
Federal	Protection of Wetlands - Executive Order 11990 (40 CFR 6, Appendix A)	Applicable	Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands and preserve and enhance natural and beneficial values of wetlands.	These requirements will be met during the development of alternatives. If no practicable alternative exists, potential harm will be minimized and action taken to restore the natural and beneficial values of the wetland. In addition, remedial activities will be designed to minimize impacts to the wetlands.
	Flood Plains Management – Executive Order 11988 (40 CFR 6, Appendix A)	Applicable	Under this order, federal agencies are required to avoid long-term and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid support of floodplain development wherever there is a practicable alternative.	These requirements will be met during the development of alternatives. If no practicable alternative exists, potential adverse impacts will be minimized and action taken to restore the floodplain. In addition, remedial activities will be designed to minimize adverse impacts on the floodplains.
	Clean Water Act (CWA) Section 404(b)(i) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230; 33 CFR Parts 320-330)	Applicable	Section 404 of the CWA regulates the discharge of dredged or fill material into U.S. waters, including wetlands. The purpose of Section 404 is to ensure that proposed discharges are evaluated with respect to impact on the aquatic ecosystem.	Remedial activities that involve dredged or fill material discharge to a wetland will comply with these requirements.
	Rivers and Harbors Act of 1899 (33 USC 403)	Applicable	Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Secretary of the Army, acting through the U.S. Army Corps of Engineers (USACE), for the construction of any structure in or over any "navigable water of the U.S.", the excavation from or deposition of material in such waters, or any obstruction or alteration in such waters.	Permits are not required for on-site actions conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). However, the action taken will comply with the substantive requirements of this act.
	Coastal Zone Management Act (16 USC 1451)	Applicable	The Coastal Zone Management Act requires activities affecting the coastal zone, including lands therein and thereunder and adjacent shorelands, be conducted in accordance with approved state management programs.	Remedial activities affecting the coastal zone of the site will be conducted in accordance with these requirements.

TABLE 3-2
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
State	Inland Wetlands and Watercourses Act (Title 22a Chapter 440)	Applicable	This act requires that actions be taken to protect, preserve, and maintain inland wetlands and watercourses, including protecting the quality of the wetlands and watercourses for their conservation, economic, aesthetic, recreational, and other public and private uses and values.	Remedial activities will be conducted to minimize disturbance of wetlands and watercourses, prevent loss of beneficial aquatic organisms, wildlife, and vegetation, and prevent destruction of natural habitats.
	Coastal Management Act (Title 22a Chapter 444)	Applicable	This act requires that actions be taken to insure that the development, preservation, or use of land and water resources of the coastal area is conducted without significantly disrupting either the natural environment or sound economic growth.	Remedial activities will be conducted to minimize adverse impacts on natural coastal resources, including the potential impact of coastal flooding and erosion and damage to and destruction of life and property.
OTHER NATURAL RESOURCES				
Federal	Endangered Species Act (16 USC 1531)	Applicable	This act requires that actions be taken to conserve endangered or threatened species, including consultation with the Department of Interior.	Remedial activities will not impact any endangered or threatened species.
	Fish and Wildlife Coordination Act (16 USC 661)	Relevant and Appropriate	This act requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and other related state agencies.	Notification is not required for on-site actions conducted under CERCLA. However, actions will be taken to minimize impacts to wetlands.
	National Historic Preservation Act (16 USC 470)	Applicable	This act requires that actions be taken to preserve historic properties, recover and preserve artifacts, and minimize harm to National Historic Landmarks.	Remedial activities will comply with these requirements.
State	Connecticut Endangered Species Law	Applicable	This act requires that actions be taken to conserve endangered or threatened species.	Remedial activities will not impact any endangered or threatened species.

Notes: ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CWA = Clean Water Act
USACE = United States Army Corps of Engineers
USC = United States Code

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
AIR				
Federal	Clean Air Act (CAA) National Ambient Air Quality Standards (40 CFR Part 50)	Applicable	This requirement provides standards for specific pollutants (i.e., "criteria pollutants"), including particulate matter (40 CFR 50.6). This requirement specifies maximum annual arithmetic mean and maximum 24-hour concentrations for particulate matter equal to or less than 10 microns particle size (PM_{10}).	PM_{10} emissions at the property boundary will be maintained below the 24-hour maximum of 150 $\mu g/m^3$ and the annual arithmetic mean of 50 $\mu g/m^3$ by dust suppression.
	CAA National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61, Subpart M)	To be considered	This requirement provides emission standards for specific pollutants for which no ambient air quality standard exists. NESHAPs have been promulgated for specific source types emitting certain pollutants, including asbestos. Subpart M establishes standards for inactive waste disposal sites and disposal of asbestos-containing material from demolition and renovation operations.	Although these standards do not directly apply to the asbestos-containing material in subsurface soil on the Causeway, these standards will be considered during design and implementation of remedial activities.
State	Connecticut Department of Environmental Protection (CTDEP) Abatement of Air Pollution (Title 22a Part 174-24)	Applicable	This requirement specifies maximum annual arithmetic mean and maximum 24-hour concentrations for particulate matter equal to or less than 10 microns particle size (PM_{10}).	PM_{10} emissions at the property boundary will be maintained below the 24-hour maximum of 150 $\mu g/m^3$ and the annual arithmetic mean of 50 $\mu g/m^3$ by dust suppression.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
SURFACE WATER				
Federal	Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) (40 CFR Part 122)	Applicable	This rule requires permits for the discharge of pollutants from any point source into U.S. waters.	Excavation dewatering fluids will be routed through the on-site Oil Abatement Treatment Plant (OATP) prior to discharge to surface water. Effluent will meet the OATP discharge limitations, monitoring requirements, and best management practices.
State	Water Pollution Control Act (Title 22a Chapter 446k)	Relevant and Appropriate	This act requires permits for any discharge of water, substance, or material into the waters of the state.	Excavation dewatering fluids will be routed through the on-site OATP prior to discharge to surface water. This activity will be conducted in accordance with the requirements of this act (e.g., permit application/modification, monitoring requirements, and discharge limitations).
SOIL/WASTE MATERIAL				
Federal	RCRA Identification and Listing of Hazardous Waste; Toxicity Characteristic (40 CFR 261.24)	Applicable	This requirement defines those wastes that are subject to regulation as hazardous waste under 40 CFR Parts 124 and 264.	Analytical results will be evaluated against the criteria and definitions of hazardous waste. The criteria and definition of hazardous waste will be referred to and utilized in development of alternatives and during remedial actions.
	RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262)	Applicable	These standards govern storage, labeling, accumulation times, and disposal of hazardous waste.	Any hazardous waste generated during remedial activities will be managed in accordance with these standards.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
	RCRA Container Storage Requirements (40 CFR Part 264, Subpart I)	Applicable	These requirements apply to owners and operators of facilities that use container storage to store hazardous waste.	If containers are used to store materials that are hazardous wastes, the containers will be managed according to these rules.
	RCRA Subtitle C Requirements (40 CFR Part 264)	Relevant and Appropriate	These requirements outline specifications and standards for design, operation, closure, and monitoring of performance for hazardous waste treatment, storage, and disposal facilities (TSDFs).	Substantive RCRA requirements will be met and adhered to for on-site remedial activities.
	RCRA Subtitle C, Subpart B – General Facility Standards (40 CFR 264.10 – 264.19)	Relevant and Appropriate	These standards provide general requirements regarding waste analysis, security, training, inspections, and location applicable to a facility that stores, treats, or disposes of hazardous waste (i.e., a TSDF).	This regulation may be applicable to remedial actions that address a waste that is a listed or characteristic waste under RCRA and constitute current treatment, storage, or disposal as defined by RCRA.
	RCRA Subtitle C, Subpart C – Preparedness and Prevention (40 CFR 264.30 – 264.37)	Relevant and Appropriate	These requirements are applicable to the design and operation, equipment, and communications associated with a TSDF, and to arrangements with local response departments.	This regulation may be applicable to remedial actions that address a waste that is a listed or characteristic waste under RCRA and constitute current treatment, storage, or disposal as defined by RCRA.
	RCRA Subtitle C, Subpart D – Contingency Plan and Emergency Procedures (40 CFR 264.50 – 264.56)	Relevant and Appropriate	These requirements include planning procedures applicable to a TSDF.	This regulation may be applicable to remedial actions that address a waste that is a listed or characteristic waste under RCRA and constitute current treatment, storage, or disposal as defined by RCRA.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
	RCRA Subtitle C, Subpart F – Releases from Subtitle C Solid Waste Management Units (40 CFR 264.90 – 264.101)	Relevant and Appropriate	This regulation details groundwater monitoring requirements for hazardous waste treatment facilities. The regulation outlines general groundwater monitoring standards, as well as standards for detection monitoring, compliance monitoring, and corrective action monitoring.	Long-term groundwater monitoring for the site will be included as a component of remedial alternatives in a separate operable unit. Because this removal action is an interim action for the site, groundwater monitoring requirements will not be complied with for this interim action. However, at the conclusion of remedial actions for the entire site, the action will comply with these requirements.
	RCRA Subtitle C, Subpart G – Closure and Post-Closure (40 CFR 264.110 – 264.120)	Relevant and Appropriate	This regulation details general requirements for closure and post-closure of hazardous waste facilities, including installation of a groundwater monitoring program.	Remedial activities associated with design, monitoring, and maintenance will meet these requirements.
State	Connecticut Department of Environmental Protection (CTDEP) Solid Waste Management (Title 22a Part 209)	Relevant and Appropriate	This regulation specifies requirements for the design, operation, and closure of solid waste disposal facilities.	The design of a cover system will meet the minimum standards of this regulation.
	CTDEP Hazardous Waste Management (Title 22a Part 449(c)	Relevant and Appropriate	This regulation specifies requirements for the design, operation, and closure of hazardous waste disposal facilities. This regulation incorporates by reference the RCRA requirements for hazardous waste facilities.	The design of a cover system will meet the minimum standards of this regulation.

TABLE 3-3
POTENTIAL ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME-CRITICAL REMOVAL ACTION

STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR

Notes:

ARAR	=	Applicable or Relevant and Appropriate Requirement
CAA	=	Clean Air Act
CFR	=	Code of Federal Regulations
CTDEP	=	Connecticut Department of Environmental Protection
CWA	=	Clean Water Act
NESHAP	=	National Emission Standards for Hazardous Air Pollutants
NPDES	=	National Pollutant Discharge Elimination System
OATP	=	Oil Abatement Treatment Plant
PM_{10}	=	particulate matter equal to or less than 10 microns particle size
RCRA	=	Resource Conservation and Recovery Act
TSDF	=	treatment, storage, and disposal facility
$\mu g/m^3$	=	micrograms per cubic meter

TABLE 4-1
ALTERNATIVE 1 - CAPPING WITH HYDRAULIC BARRIER
CONCEPTUAL COST ESTIMATE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

Key Components:

Construct Cover System
Construct RipRap Armor
Land Use Restrictions

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
Preparation				
Pre-Design Geotech. Investigation/Evaluation	1	Lump Sum	$ 83,000 00	$ 83,000
Design and Planning	1	Lump Sum	$ 135,000.00	$ 135,000
Preparation of Plans (Work, H&S, E&S, QA/QC)	1	Lump Sum	$ 23,000 00	$ 23,000
Mobilization and Demobilization	1	Lump Sum	$ 38,418.00	$ 38,418
Portable Dam (install & remove)	1	Lump Sum	$ 583,540.00	$ 583,540
Demolition - Bldg 59, ramp, concrete	1	Lump Sum	$ 37,097 00	$ 37,097
Soil/Waste Excavation and Site Grading				
Excavate & Consolidate Toe Material in Causeway	5200	Cubic Yard	$ 12 44	$ 64,696
Initial Grading Top of Causeway	1815	Cubic Yard	$ 15.14	$ 27,478
Capping System Construction				
12-inch Sand Bedding Layer	3600	Cubic Yard	$ 31 24	$ 112,478
Gas Collection Piping	4000	Linear Feet	$ 5 86	$ 23,445
FML Installation w/ anchor trench & QC testing	2 5	Acre	$ 77,690 80	$ 194,227
18-Sand Protection Layer w/ Geotextile	5400	Cubic Yard	$ 30 27	$ 163,468
RipRap Armor (Ave = 600 lbs)	10,000	Cubic Yard	$ 125 00	$ 1,250,000
QA Soil Testing	1	Lump Sum	$ 40,000 00	$ 40,000
Sampling and Analysis	1	Lump Sum	$ 45,000 00	$ 45,000
PPC/PPE	1	Lump Sum	$ 70,000.00	$ 70,000
Office and Field Engineering/Administrative	1	Lump Sum	$ 1,205,800.00	$ 1,205,800
Land Use Restrictions	1	Lump Sum	$ 5,000 00	$ 5,000
Final Remediation Report	1	Lump Sum	$ 8,000 00	$ 8,000
TOTAL CAPITAL COSTS				$ 4,109,647

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Cap Inspection & Maintenance	30	$ 2,500.00	$ 31,023
Five Year Site Reviews	6	$ 10,600.00	$ 50,525
O&M COSTS			$ 81,548
Subtotal			$ 4,191,195
Contingency	15%		$ 628,679
Subtotal			$ 4,819,874
Fee	10%		$ 481,987
TOTAL FOR ALTERNATIVE 1			**$ 5,301,861**
Annualized cost			$427,258

Notes:
1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ
2. Present worth assumes 7% annual discount rate.
3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 4-2
ALTERNATIVE 2 - CAPPING WITH COMPOSITE COVER SYSTEM
CONCEPTUAL COST ESTIMATE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

Key Components:

Construct Cover System
Construct RipRap Armor
Construct Sheetpile Seawall
Land Use Restrictions

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Worth
Preparation				
Pre-Design Geotech. Investigation/Evaluation	1	Lump Sum	$ 95,000 00	$ 95,000
Design and Planning	1	Lump Sum	$ 189,000.00	$ 189,000
Preparation of Plans (Work, H&S, E&S, QA/QC)	1	Lump Sum	$ 23,000 00	$ 23,000
Mobilization and Demobilization	1	Lump Sum	$ 63,418 00	$ 63,418
Portable Dam (install & remove)	1	Lump Sum	$ 583,540 00	$ 583,540
Demolition - Bldg 59, ramp, concrete	1	Lump Sum	$ 37,097.00	$ 37,097
Soil/Waste Excavation and Site Grading				
Excavate & Consolidate Toe Material in Causeway	2400	Cubic Yard	$ 15 04	$ 36,098
Initial Grading Top of Causeway	1815	Cubic Yard	$ 15 14	$ 27,478
Capping System Construction				
12-inch Sand Bedding Layer	3600	Cubic Yard	$ 31.24	$ 112,478
Gas Collection Piping	4000	Linear Feet	$ 5 86	$ 23,445
GCL/FML Installation w/ anchor trench & QC testing	2 5	Acre	$ 107,418.00	$ 268,545
Drainage Composite Installation	2 3	Acre	$ 45,991 30	$ 105,780
18-inch Filter Layer	5400	Cubic Yard	$ 29 16	$ 157,478
RipRap Armor (Ave = 600 lbs)	10,000	Cubic Yard	$ 125 00	$ 1,250,000
QA Soil Testing	1	Lump Sum	$ 40,000 00	$ 40,000
Sheetpile Seawall w/Geogrid Tiebacks	1,665	Linear Feet	$ 513 62	$ 855,175
Sampling and Analysis	1	Lump Sum	$ 45,000 00	$ 45,000
PPC/PPE	1	Lump Sum	$ 70,000 00	$ 70,000
Office and Field Engineering/Administration	1	Lump Sum	$ 1,205,800 00	$ 1,205,800
Land Use Restrictions	1	Lump Sum	$ 5,000 00	$ 5,000
Final Remediation Report	1	Lump Sum	$ 8,000 00	$ 8,000
TOTAL CAPITAL COSTS				$ 5,201,332

O&M COSTS

Item Description	Years	Unit Cost	Present Worth
Cap Inspection & Maintenance	30	$ 2,500 00	$ 31,023
Five Year Site Reviews	6	$ 10,600 00	$ 50,525
O&M COSTS			$ 81,548

Subtotal			$ 5,282,880
Contingency	15%		$ 792,432
Subtotal			$ 6,075,312
Fee	10%		$ 607,531
TOTAL FOR ALTERNATIVE 2			**$ 6,682,843**
Annualized cost			$538,546

Notes: 1. This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.
2 Present worth assumes 7% annual discount rate
3. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.

TABLE 4-3
ALTERNATIVE 3 - EXCAVATION AND OFFSITE DISPOSAL
CONCEPTUAL COST ESTIMATE

ENGINEERING EVALUATION/COST ANALYSIS
CAUSEWAY AND DIKE NON-TIME CRITICAL REMOVAL ACTION
STRATFORD ARMY ENGINE PLANT
STRATFORD, CONNECTICUT

Key Components: Soil/Waste Excavation and Off-Site Disposal
No Causeway Restoration

CAPITAL AND FIXED COSTS

Item Description	Quantity	Units	Unit Cost	Present Work
Preparation				
Design and Planning	1	Lump Sum	$ 81,000.00	$ 81,000
Preparation of Plans (Work, H&S, E&S, QA/QC)	1	Lump Sum	$ 23,000.00	$ 23,000
Mobilization and Demobilization	1	Lump Sum	$ 35,818 00	$ 35,818
Portable Dam (install & remove)	1	Lump Sum	$ 393,540.00	$ 393,540
Demolition - Bldg 59, ramp, concrete	1	Lump Sum	$ 37,097 00	$ 37,097
Soil/Waste Excavation				
Excavate Soil/Waste or Debris	43000	Cubic Yard	$ 10.12	$ 435,268
Disposal of Excavated Soil and Waste				
Sampling for Waste Characterization	1	Lump Sum	$ 468,500 00	$ 468,500
Confirmation Sampling	1	Lump Sum	$ 400,000 00	$ 400,000
Transport and Disposal of Haz Soil/Waste or Debris	32250	Ton	$ 280 00	$ 9,030,000
Transport and Disposal of Non-Haz. Soil/Waste	32250	Ton	$ 90 00	$ 2,902,500
Restoration				
Stone Dike Construction	200	Linear Feet	$ 84 00	$ 16,800
Final Remediation Report	1	Lump Sum	$ 10,000.00	$ 10,000
PPC/PPE	1	Lump Sum	$ 49,000 00	$ 49,000
Office and Field Engineering/Administration	1	Lump Sum	$ 622,900 00	$ 622,900
TOTAL CAPITAL COSTS				$ 14,505,423
Contingency	15%			$ 2,175,813
Subtotal				$ 16,681,236
Fee	10%			$ 1,668,124
TOTAL FOR ALTERNATIVE 3				**$ 18,349,359**

Notes: 1 This cost estimate was prepared using costs considered appropriate for typical operations associated with a TERC remedial construction project. It is intended for use in comparing the relative cost of remedial alternatives. Actual costs may differ.
2. The contingency costs and fee are standard assumptions by FW/HLA for conceptual designs.